

**PRELIMINARY
FOUNDATION INVESTIGATION REPORT
VICTORIA STREET UNDERPASS
HIGHWAY 7-NEW, KITCHENER TO GUELPH
G.W.P. 408-88-00**

Geocres Number: 40P8-202

Report to

**Ministry of Transportation Ontario
West Region**

Thurber Engineering Ltd.
2010 Winston Park Drive, Suite 103
Oakville, Ontario
L6H 5R7
Phone: (905) 829 8666
Fax: (905) 829 1166

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H:\15\64\17 Hwy 7 New\2011 Program\Reports\Bridge
Structure\S-E ramp under Victoria St\Victoria\Victoria St
Underpass - FIR FINAL.doc

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents factual information that may be used in the preliminary design of the foundations of a new structure that will carry Victoria Street over the Kitchener-Waterloo Expressway (KWE) in the Regional Municipality of Waterloo. The new underpass structure will incorporate two new ramps, S-E ramp on the east end of the underpass and E-S ramp and Edna Street connector at the west end of the underpass. The proposed new underpass structure is part of the Highway 7-New project.

It is understood that an alternate design is being considered for this site and consists of extending the existing structure on both sides (west and east) to accommodate the two new ramps: S-E ramp on the east end and E-S ramp/Edna Street connector at the west end.

For preparation of this report, no boreholes were drilled within the footprint of the proposed structure. This report is based on information on subsurface conditions contained in previous foundation reports prepared in 1966 and 2009. The titles of the reports are listed as follows:

- Foundation investigation report for Victoria Street Underpass, Kitchener-Waterloo Expressway, District #4 (Hamilton), W.J. 66-F-36, W.P.635-64, Geocres No. 40P8-44, dated June 17, 1966, prepared by DHO (Department of Highways Ontario, Reference 1).
- Preliminary foundation investigation and design report, E-S ramp and connector street under Victoria Street, Highway 7-New, Kitchener to Guelph, G.W.P. 408-88-00, Geocres No. 40P8-158, prepared by Thurber, dated November 10, 2009. (Reference 2).

Records of boreholes from the previous reports are attached in Appendix A for reference.

A site investigation, field testing and engineering analysis will be required at the detail design stage. The detailed design must be based on site-specific investigation at the foundation elements.

Thurber carried out the investigation for the Ministry of Transportation Ontario, West Region (MTO) under Purchase Order Number 3006-E-0123.

2 SITE DESCRIPTION

The site is located near the eastern limits of the City of Kitchener, approximately 380 m south of the Kitchener-Waterloo Expressway (KWE) and Wellington Street interchange. At this location, an underpass structure carries Victoria Street over the northbound and southbound lanes (NBL and SBL) of the KWE and existing E-S and S-E ramps. The existing underpass at KWE and Victoria Street is a four-span structure supported on two abutments and three piers.

The site lies within an area of industrial and commercial lands and is generally flat.

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within the physiographic region known as the Waterloo Hills, characterized by ridges of sandy till and kames or kame moraines, with outwash sands occupying the intervening hollows.

The following photographs of the site are included in Appendix E and show the general nature of the surrounding lands:

1. An aerial view of Kitchener-Waterloo Expressway and Victoria Street.
2. A view looking at the south side of the existing structure at Kitchener-Waterloo Expressway and Victoria Street underpass.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing at this site was carried out by DHO from April 21 to 29, 1966 (Reference 1) and consisted of drilling and sampling a total of eight boreholes within the underpass area. Eight dynamic cone penetration tests (DCPTs) were conducted adjacent to the boreholes and seven DCPTs were conducted at various locations covering the underpass area. The Boreholes and DCPTs were identified as Boreholes 1 to 15.

Boreholes 1, 4, 5, 8, 9, 12, 13 and 15 were terminated at depths ranging from 11.2 m to 14.2 m (elevations 305.9 to 309.5). DCPTs were terminated upon refusal at 3.0 m to 6.1 m depth (elevations 315.5 to 319.5).

Two boreholes (numbered 08-047 and 08-048) were drilled by Thurber near the proposed west extension of the existing bridge on June 17, 25 and 26, 2008. The depths of Boreholes 08-047 and 08-048 were 18.7 m and 21.6 m (Elevations 305.0 and 301.7), respectively.

The Record of Borehole sheets and DCPTs are included in Appendix A. The approximate locations of the boreholes and DCPTs relative to the Victoria Street Underpass GA are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix F.

4 LABORATORY TESTING

The recovered soil samples were subjected to visual identification and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A. Selected samples were subjected to gradation analysis and Atterberg Limits testing. The results of this testing program are shown on the Record of Borehole sheets in Appendix A. Grain size analysis distribution curves and Atterberg Limits testing results are included in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil stratigraphy along the proposed alignment are presented in this appendix and on the “Borehole Locations and Soil Strata” drawing in Appendix F. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

It should be recognized that since these boreholes were drilled in 1966, it is possible that the current ground surface elevations may differ and the actual subsurface stratigraphy may have been modified by construction of cuts and addition of fills.

In general, at the time of the 1966 investigation, the site was underlain by topsoil overlying native layers of loose to dense sand and sandy silt/silty sand, and very stiff to hard clayey silt/silty clay.

Boreholes 08-47 and 08-48, drilled at the west end of the existing underpass, revealed topsoil or pavement structure and granular fill overlying native loose to dense sand, very stiff to hard silty clay till and silty clay and very dense silt till.

5.1 Topsoil and organics

Topsoil and soft organics were encountered surficially at the following boreholes:

<u>Boreholes</u>	<u>Thickness</u>
1	760 mm (organics)
13 and 15	300 mm
08-48	200 mm

5.2 Pavement structure

Pavement structure consisting of approximately 65 mm of asphalt overlying granular (sand and gravel) fill was encountered in Borehole 08-047 drilled on a residential drive way, in close proximity to the Victoria Street lane.

5.3 Fill

Fill was encountered surficially in Boreholes 4, 5, 8, 9, and 12 and below the pavement structure and topsoil in Boreholes 08-47 and 08-48. The fill consists of silty sand

containing trace gravel to gravelly, trace clay to clayey, occasional organics, some rubbish, layer of asphalt and numerous cobbles

The thickness of the fill varied from 1.7 m to 4.6 m. The base of the fill was encountered between elevations 316.9 and 320.7.

The fill is classified as very loose to very dense based on SPT 'N' values of 3 to 90 blows for 0.3 m of penetration. The 90 blows may represent spoon bouncing on cobbles or rock piece.

The natural moisture content ranged from 5% to 25%.

Grain size distribution curve for a gravelly sand fill sample is presented on the Record of Borehole sheets and on Figure B1 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	44
Sand	42
Silt & Clay	14

5.4 Silty Sand

Native silty sand was encountered below the fill in Boreholes 4, 8, and 12, and below the topsoil in Boreholes 1, 13, and 15. The thickness of the silty sand varied from 0.8 m to 5.6 m.

The depth to the base of the silty sand varied from 3.2 m to 6.4 m (elevations 318.4 and 315.8).

SPT 'N' values recorded in the silty sand ranged from 1 blow for 0.3 m penetration to 70 blows for 0.15 m penetration, indicating a very loose to very dense condition. The natural moisture content ranged from 7% to 25%.

The results of grain size distribution testing of selected samples of the silty sand are presented on the Record of Borehole sheets in Appendix A. The results of these laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	1
Sand	55 to 90
Silt	30 to 42
Clay	1 to 2
Silt & Clay	9

5.5 Sand

Native brown sand containing trace silt and trace gravel was encountered below the fill in Boreholes 08-47 and 08-48. The depths to the base of the native sand were 5.6 m and 8.1 m (Elevations 318.2 and 315.3), in Boreholes 08-047 and 08-048, respectively.

A 300-mm layer of sand was encountered in Borehole 08-048 at 10.7 m depth (Elevation 312.7).

The sand is classified as loose to dense, based on SPT 'N' values of 6 to 37 blows for 0.3 m of penetration. The natural moisture content ranged from 8 to 19%.

Grain size distribution curves for three selected samples of sand are presented on the Record of Borehole sheets and on Figure B2 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 1
Sand	89 to 94
Silt & Clay	6 to 11

5.6 Clayey Silt/Silty Clay and Silty Clay Till

Native brown to grey silty clay/clayey silt and silty clay till containing some sand to sandy, trace gravel and occasional sand seams were contacted below the native sand and silty sand layers. The clayey silt/silty clay and silty clay till were contacted at depths ranging from 3.1 m to 8.1 m (elevations 315.3 to 318.7).

The silty clay and silty clay till extended to 17.8 m and at least 21.6 m (Elevations 306.0 and 301.7) in Boreholes 08-047 and 08-048, respectively.

Boreholes 1, 4, 5, 8, 9, 12, 13 and 15 were terminated within the clayey silt/silty clay at depths ranging from 11.2 m to 14.2 m (elevations 305.9 to 309.5). Borehole 08-048 was terminated within the silty clay till layer at 21.6 m (elevation 301.7).

The cohesive layer is very stiff to hard in consistency, based on SPT 'N' values ranging from 22 blows for 0.3 m penetration to 60 blows for 0.1 m penetration. SPT 'N' values higher than 100 blows per 0.3 m of penetration, indicating a hard consistency, were measured below 15.2 m and 18.3 m depth (Elevations 308.6 and 305.1) in Boreholes 08-047 and 08-048, respectively.

The moisture content varied from 8% to 29%.

Grain size distribution curves for selected samples of silty clay and silty clay till are presented on the Record of Borehole sheets and on Figure B3 of Appendix B. Atterberg

Limits test results are presented on Figure B5 of Appendix B. The results of these laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 15
Sand	0 to 36
Silt	31 to 78
Clay	18 to 63

Liquid Limit	21 to 43
Plastic Limit	12 to 20

The above results show that the silty clay/clayey silt and silty clay till are of low to medium plasticity with group symbols of CL-CI.

Although not encountered in the boreholes, this glacial till layer may contain cobbles and boulders which may account for some high SPT 'N' values.

5.7 Silt Till

Grey silt till was contacted below the silty clay in Borehole 08-047, at 17.8 m (Elevation 306.0). Borehole 08-047 was terminated within the silt till at 18.7 m depth (Elevation 305.0).

SPT 'N' value in this layer was 103 blows per 0.3 m of penetration, indicating a very dense relative density. Moisture content was 18%.

Grain size distribution curve for a silt till sample is presented on the Record of Borehole sheets and on Figure B4 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	5
Silt	89
Clay	6

Although not encountered in the boreholes, this glacial till layer may contain cobbles and boulders which may account for the high SPT 'N' value.

5.8 Groundwater Conditions

In 1966, water levels were observed during drilling at depths ranging from 0.5 m to 1.7 m below ground surface (elevations 319.3 to 321.8). These water levels may have been affected by subsequent construction of the underpass.

Water levels were observed at 16.8 m and 5.5 m depth (Elevations 307.0 and 317.9) in Boreholes 08-047 and 08-048, respectively, during and upon completion of drilling in 2008 (Reference 2).

The water level condition at this site should be confirmed during additional field investigation required for the detailed design.

Seasonal fluctuations of the groundwater level are to be expected, in particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

All-Terrain Drilling of Waterloo, Ontario supplied a truck-mounted CME75 drill rig and conducted the drilling, sampling and in-situ testing operations in 2008.

The coordinates and the ground surface elevations for Boreholes 08-47 and 08-48 were determined by Thurber Engineering Ltd. using GPS equipment.

Interpretation of the 1966 and 2008 borehole data and preparation of the report were carried out by Ms. Lindsey Blaine, E.I.T. and Ms. R. Palomeque Reyna, P.Eng.

Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.

Thurber Engineering Ltd

L. Blaine
Nov. 19/12

Lindsey Blaine, E.I.T.
Project Manager

Rocío Palomeque Reyna, P.Eng.
Geotechnical Engineer

P.K. Chatterji, P.Eng.,
Review Principal, Designated MTO Contact



Appendix A

Record of Borehole Sheets

Previous Investigations:

- Victoria Street Underpass, Kitchener-Waterloo Expressway, District #4 (Hamilton), W.J. 66-F-36, W.P.635-64, Geocres No. 40P8-44, dated June 17, 1966 prepared by DHO
- E-S ramp and connector street under Victoria Street, Highway 7-New, Kitchener to Guelph, G.W.P. 408-88-00, Geocres number 40P8-158, prepared by Thurber, dated November 10, 2009.

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

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

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

TYPE OF SAMPLE

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

SOIL TESTS

Q _u	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Q _{cu}	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q _d	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

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

GENERAL

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

STRESS AND STRAIN

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

EARTH PRESSURE

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

FOUNDATIONS

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

SLOPES

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

MATERIALS & TESTING DIVISION

DATUM 1057.00

BOREHOLE TYPE WashBoring **NX Casing**

FOUNDATION SECTION

CHECKED BY AK

SOIL PROFILE			SAMPLES	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAIT. PLOT			BLOWS / FOOT	TYPE			
1057.0	Ground Level								
1054.5	Soft Org. Muck								Sand 87% Silt 13% W.L. El. 1052.9 Observed in Casing
2.5			1	SS	1.5				
			2	SS	1.				
	Silty Sand Very Loose to Very Dense		3	SS	12				
			4	SS	35				
1036.0			5	SS	22				
21.0									
	Silty Clay		6	SS	24				Sand 4% Silt 46% Clay 50%
			7	SS	47				
	With traces of Sand Very Stiff to Hard								
1015.5			8	SS	70				
41.5	End of Borehole								

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 66-P-36 LOCATION N202.019-244; E210.780.990 ORIGINATED BY W.W.K.
 W.P. 635-64 BORING DATE April 26, 1966 COMPILED BY W.E.
 DATUM 1059.10 BOREHOLE TYPE Penetration Only CHECKED BY AK

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W WP — WL WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE					
1059.10	Ground Level							
0.0								
1048.10	Penetration Only			1050.0				
11.0	End of Penetration			1040.0				

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 66-P-36

LOCATION N20L, 956.644; E210, 820.195

ORIGINATED BY W.W.K.

W.P. 635-64

BORING DATE April 25, 1966

COMPILED BY

DATUM 1059.17

BOREHOLE TYPE Penetration Only

CHECKED BY dk

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE					
1059.17	Ground Level							
0.0	Penetration Only							
1043.17				1050				
16.0	End of Penetration			1040				

DEPARTMENT OF HIGHWAYS - ONTARIO			RECORD OF BOREHOLE NO. 4			FOUNDATION SECTION						
MATERIALS & TESTING DIVISION			LOCATION <u>N202, 035.485; E210, 817.127</u>			ORIGINATED BY <u>W.W.K.</u>						
JOB <u>66-F-36</u>			BORING DATE <u>April 26, 1966</u>			COMPILED BY <u>W.E.</u>						
W.P. <u>635-64</u>			BOREHOLE TYPE <u>Washboring NX Casing</u>			CHECKED BY <u>W.E.</u>						
DATUM <u>1058.14</u>												
SOIL PROFILE		SAMPLES		ELEV. SCALE		DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT		BULK DENSITY		REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT	BLOWS / FOOT	WATER CONTENT %	PLASTIC LIMIT	WATER CONTENT	P.C.F.		
1058.14	Ground Level											
1057.14	Fill-Sand, Gravel Silt some rubbish Compact		1	SS	15							Observed in casing W.L. El. 1055.9 Gravel 1% Sand 68% Silt 30% Clay 1%
7.0	Silty Sand Very Loose to very Dense		2	SS	38							
1039.14			3	SS	70/6"							
19.0	Clayey Silt with traces of Gravel and Sand Hard		4	SS	44							Gravel 15% Sand 31% Silt 36% Clay 18%
			5	SS	50							
			6	SS	97							
46.5	End of Borehole		7	SS	92							

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB - 66-F-36

LOCATION N201, 982-013; E210, 876.200

ORIGINATED BY W.W.K.

BORING DATE April 26, 1966

COMPILED BY W.E.

BOREHOLE TYPE Washboring NX Casing

CHECKED BY *W.E.*

DATUM 1055.83

ELEV. DEPTH	SOIL PROFILE	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
		NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.			
1055.83	Ground Level									
1045.63	Fill - Dirt with Org. matter	1	SS	6	105					
10.2	Loose	2	SS	4						
		3	SS	45						
	Clayey Silt with traces of Sand	4	SS	133	1040					
	Hard	5	SS	64						
		6	SS	71						
1014.3		7	SS	93						
41.5	End of Borehole				1010					

W.L. El. 1050.6
Observed in casing
Gravel 2%
Sand 16%
Silt 55%
Clay 26%

DEPARTMENT OF HIGHWAYS - ONTARIO				RECORD OF BOREHOLE NO. 7				FOUNDATION SECTION					
MATERIALS & TESTING DIVISION				LOCATION <u>N202,008.745 ; E210,928.182</u>				ORIGINATED BY <u>W.W.K.</u>					
JOB <u>66-F-36</u>				BORING DATE <u>April 25, 1966</u>				COMPILED BY <u>W.E</u>					
W.P. <u>635-64</u>				BOREHOLE TYPE <u>Penetration Only</u>				CHECKED BY <u>W.E</u>					
DATUM <u>1055.45</u>													
SOIL PROFILE		SAMPLES		ELEV. SCALE		DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY P.C.F.		REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT	BLOWS / FOOT 20 40 60 80 100		WATER CONTENT % WP W WL					
1055.45 0.0	Ground Level												
Penetration Only													
1035.45 20.0	End of Penetration												

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB _____ 66-5-36

635-64

DATUM 1050-32

RECORD OF BOREHOLE NO. 8

LOCATION N202.097.448 ; E210.924.627

BOILING DATE	APRIL 27, 1966
1	100.0
2	100.0
3	100.0
4	100.0
5	100.0
6	100.0
7	100.0
8	100.0
9	100.0
10	100.0
11	100.0
12	100.0
13	100.0
14	100.0
15	100.0
16	100.0
17	100.0
18	100.0
19	100.0
20	100.0
21	100.0
22	100.0
23	100.0
24	100.0
25	100.0
26	100.0
27	100.0
28	100.0
29	100.0
30	100.0
31	100.0

BOREHOLE TYPE _____ Washboring NX Casing

FOUNDATION SECTION

ORIGINATED BY
W.W.K.

COMPILED BY _____

CHECKED BY JK

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO				RECORD OF BOREHOLE NO. 9				FOUNDATION SECTION			
MATERIALS & TESTING DIVISION				LOCATION N202,027.085 ; E210,978.412				ORIGINATED BY W.W.K.			
JOB 66-F-36				BORING DATE April 22, 1966				COMPILED BY W.T.E.			
W.P. 635-64				BOREHOLE TYPE Washboring NX Casing				CHECKED BY <i>W.T.E.</i>			
DATUM 1054.65											
SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT		BULK DENSITY		REMARKS	
ELEV. / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BLOWS / FOOT	WATER CONTENT %	WATER CONTENT %	WATER CONTENT %	WATER CONTENT %	REMARKS
1054.65	Ground Level										
0.0	Fill - Dirt, Sand Gravel, Silt, Clay and Org. Matter	1	SS	4	1050						
		2	SS	3							
		3	SS	90 Rock							
1039.65		4	SS	25	1040						
15.0	Clayey Silt to Silty Clay	5	SS	15							
	with Traces of Sand	6	SS	16	1030						
	Very Stiff to Hard	7	SS	13							
		8	SS	62	1020						
1008.7		9	SS	75	1010						
146.5	End of Borehole										

W.L. El. 1049.1
Observed in casing
Gravel 14%
Sand 6%
Silt 31%
Clay 59%

Sand 15%
Silt 59%
Clay 26%

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 11

FOUNDATION SECTION

JOB 66-F-36 LOCATION N 202,047.765 : E 211,023.985 ORIGINATED BY W.W.K.
 W.P. 635-64 BORING DATE April 22, 1966 COMPILED BY W.E.
 DATUM 1055.14 BOREHOLE TYPE Penetration Test Only CHECKED BY SK

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE					
1055.14	Ground Level							
0.0	Penetration Only			1050				
1037.14				1040				
18.0	End of Penetration			1030				

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 12

FOUNDATION SECTION

JOB 66-P-36 LOCATION N 202, 137.137 ; E 211, 029.292 ORIGINATED BY W.W.K.
 W.P. 635-64 BORING DATE April 28, 1966 COMPILED BY W.E.
 DATUM 1055.20 BOREHOLE TYPE Washboring NX Casing CHECKED BY AL

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT PLASTIC LIMIT WATER CONTENT		REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLG	NUMBER	TYPE	BLOWS / FOOT	BLOWS / FOOT	W.P.	W.L.	
1055.20 0.0	Ground Level								
1049.7 5.5	Fill - Dirt with Org. matter Loose	F.F.	1	SS	10				
1044.7 10.5	Silty Sand Compact	P.S.	2	SS	11				
	Clayey Silt to Silty Clay With traces of Sand Very Stiff to Hard		3	SS	30				
			4	SS	88				
			5	SS	85				
			6	SS	52				
1013.7 41.5	End of Borehole		7	SS	105				

W.L. El
1050.9
Observed in
Casing
Gravel 3%
Sand 30%
Silt 43%
Clay 24%

BULK
DENSITY
 γ
P.C.F.

WATER CONTENT %
10 20 30

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT
20 40 60 80 100
SHEAR STRENGTH P.S.F.

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 12

FOUNDATION SECTION

JOB 66-F-36 LOCATION N 202, 137.137 ; E 211, 029.292 ORIGINATED BY W.W.K.
 W.P. 635-64 BORING DATE April 28, 1966 COMPILED BY W.E.
 DATUM 1055.20 BOREHOLE TYPE Washboring NX Casing CHECKED BY [Signature]

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	BLOWS / FOOT	20	40	60			80
1055.20	Ground Level										
0.0	Fill - Dirt with Org. matter	1	SS	10							
1049.7	Loose										
5.5	Silty Sand	2	SS	11							
1044.7	Compact										
10.5	Clayey Silt to Silty Clay	3	SS	30							
	With traces of Sand	4	SS	88							
	Very Stiff to Hard	5	SS	85							
		6	SS	52							
1013.7		7	SS	105							
41.5	End of Borehole										

W.L. El
1050.9
Observed in
Casing
Gravel 3%
Sand 30%
Silt 43%
Clay 24%

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 13

FOUNDATION SECTION

JOB 66-F-36 LOCATION N 202, 076.079 : E 211, 099.123
W.P. 635-64 BORING DATE April 21, 1966 ORIGINATED BY W.W.K.
DATUM 1056.18 BOREHOLE TYPE Washboring NX Casing COMPILED BY W.E.
CHECKED BY SK

SOIL PROFILE		SAMPLES		ELEV. 9 SCALE	DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT PLASTIC LIMIT WATER CONTENT	WATER CONTENT %	BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	BLows / FOOT	WL WP	WL WP	P.C.F.	
1056.18	Ground Level								
1056.18	Black Org. Topsoil								
1.0	Silty Sand Loose to Compact	1	SS	8	1050				Observed in Casing W.L. El. = 1051.1
1042.18		2	SS	30					Gravel 1% Sand 90% Silt 9% Clay
14.0	Clay Silt to Silty Clay With Traces of Sand	3	SS	35	1040				
	Hard	4	SS	96					
		5	SS	103	1030				
		6	SS	67					
		7	SS	91	1020				Sand 2% Silt 35% Clay 63%
1014.5		8	SS	89					
41.5	End of Borehole				1010				

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 66-P-36

W.P. 635-64

DATUM 1049.47

RECORD OF BOREHOLE NO. 15

FOUNDATION SECTION

LOCATION N 202, 142.976 ; E 210, 823.216

BORING DATE April 26, 1966

BOREHOLE TYPE Washboring NX Casing

ORIGINATED BY W.W.K.

COMPILED BY W.E.

CHECKED BY *W.E.*

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLWS / FOOT	BLWS / FOOT	20 40 60 80 100	10 20 30	γ	P.C.F.	
1049.47	Ground Level									
1048.47	Black Org. Topsoil									
1.0		1	SS 40							
		2	SS 25							
1036.47	Silty Sand Compact to very Dense	3	SS 80							
13.0		4	SS 80							
	Clayey Silt to Silty Clay with Traces of Sand	5	SS 60/L*							
	Hard	6	SS 100							
1012.8		7	SS 97							
36.6	End of Borehole									

W.L. El. 1047.7
Observed in Casing
Gravel 3%
Sand 36%
Silt 40%
Clay 21%

Appendix B

Laboratory Test Results

Previous Investigations:

- Victoria Street Underpass, Kitchener-Waterloo Expressway, District #4 (Hamilton), W.J. 66-F-36, W.P.635-64, Geocres No. 40P8-44, dated June 17, 1966 prepared by DHO
- E-S ramp and connector street under Victoria Street, Highway 7-New, Kitchener to Guelph, G.W.P. 408-88-00, Geocres number 40P8-158, prepared by Thurber, dated November 10, 2009.

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽¹⁾ 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight		RC Rock Core
			SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$


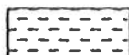



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION		SYMBOLS	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

TERMS	
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

METRIC

ELEV DEPTH	SOIL PROFILE DESCRIPTION	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 (%)	
			NUMBER	TYPE	"n" VALUES			20 40 60 80 100				w _p w w _L
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100				WATER CONTENT (%) 20 40 60
323.8										kN/m ³	GR SA SI C	

[illegible]

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

ONTMT4S 6417R.GPJ 8/27/08

RECORD OF BOREHOLE No 08-047

2 OF 2

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 014.67 E 226 147.74 ORIGINATED BY GA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.06.25 - 2008.06.26 CHECKED BY RPR

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE						
	Continued From Previous Page							20 40 60 80 100	20 40 60						
312.1	Silty CLAY, trace to some sand, trace gravel Very Stiff to Hard Brown (TILL)		10	SS	38		313								
11.7	Silty CLAY, occasional sand Very Stiff Grey		11	SS	22		312								
							311								
			12	SS	27		310								
							309								
	Hard		13	SS	107		308								
	occasional silty sand seams		14	SS	101		307								
306.0															
17.8	SILT, trace sand Very Dense Grey Wet (TILL)		15	SS	103		306								
305.0															
18.7	END OF BOREHOLE AT 18.7m. WATER LEVEL OBSERVED AT 18.8m DURING DRILLING. BOREHOLE BACKFILLED WITH GROUT TO 1.8m, HOLEPLUG TO 1.2m, CONCRETE TO 0.1m THEN ASPHALT PATCH TO SURFACE.														

+³, x³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-048

1 OF 3

METRIC

W.P. 408-88-00 LOCATION N 4 814 022 96 E 226 174.52 ORIGINATED BY SA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.06.17 - 2008.06.17 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
323.4														
0.0	TOPSOIL, occasional roots (200mm)													
0.2	SAND and SILT, some gravel, trace clay Loose to Very Dense Brown to Grey Moist (FILL)		1	SS	20		323							
			2	SS	7									
	Layer of asphalt and gravel: (200mm) Brown to Dark Brown		3	SS	70		322							
			4	SS	24		321							44 42 14 (SI+CL)
	gravelly, numerous cobbles		5	SS	7		320							
	Clayey, occasional black stains, organics													
319.1														
4.3	SAND, trace gravel, trace silt Loose Brown Moist		6	SS	6		319							
							318							
			7	SS	37		317							1 93 6 (SI+CL)
	Dense Wet						316							
315.3			8	SS	25									
8.1	Silty CLAY, some sand to sandy, trace gravel Very Stiff to Hard Grey (TILL)						315							
	occasional silty sand seams		9	SS	31		314							2 20 51 27

Continued Next Page

+ 3, x 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-048

2 OF 3

METRIC

W.P. 408-88-00 LOCATION N 4 814 022 96 E 226 174.52 ORIGINATED BY SA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.06.17 - 2008.06.17 CHECKED BY RPR

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)						
Continued From Previous Page							20 40 60 80 100	20 40 60						
	Silty CLAY , some sand to sandy, trace gravel Hard Grey (TILL) Layer of sand: (300mm)		10	SS	33	313							0 89 11 (SI+CL)	
						312								
			11	SS	30	311								
						310								
			12	SS	48	309							0 3 40 57	
						308								
			13	SS	45	307								
						306								
			14	SS	46	305								
						304								
	Layer of clayey silt		15	SS	103								0 2 78 20	
	occasional cobbles		16	SS	104/									

Continued Next Page

+ 3, × 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

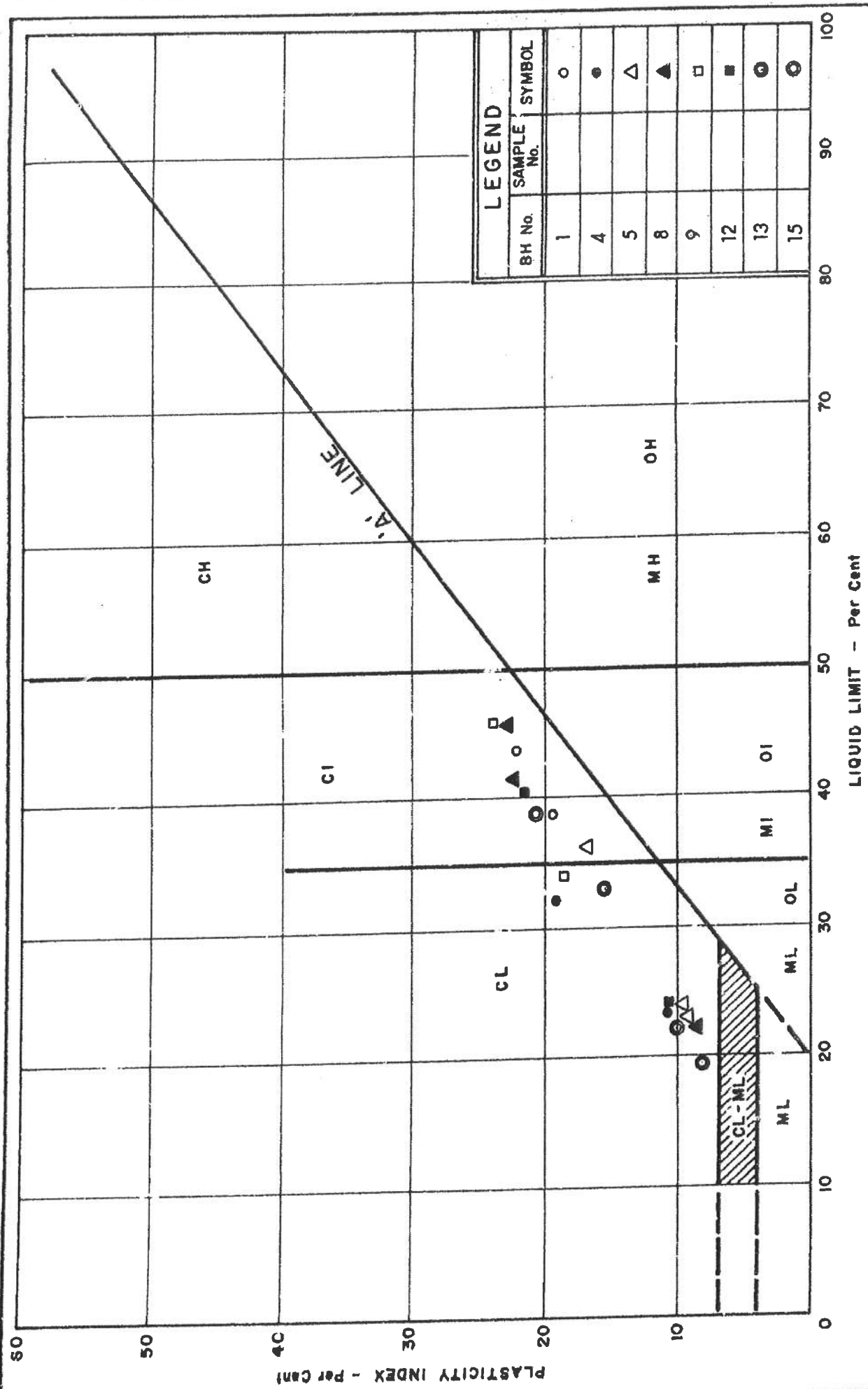
RECORD OF BOREHOLE No 08-048

3 OF 3

METRIC

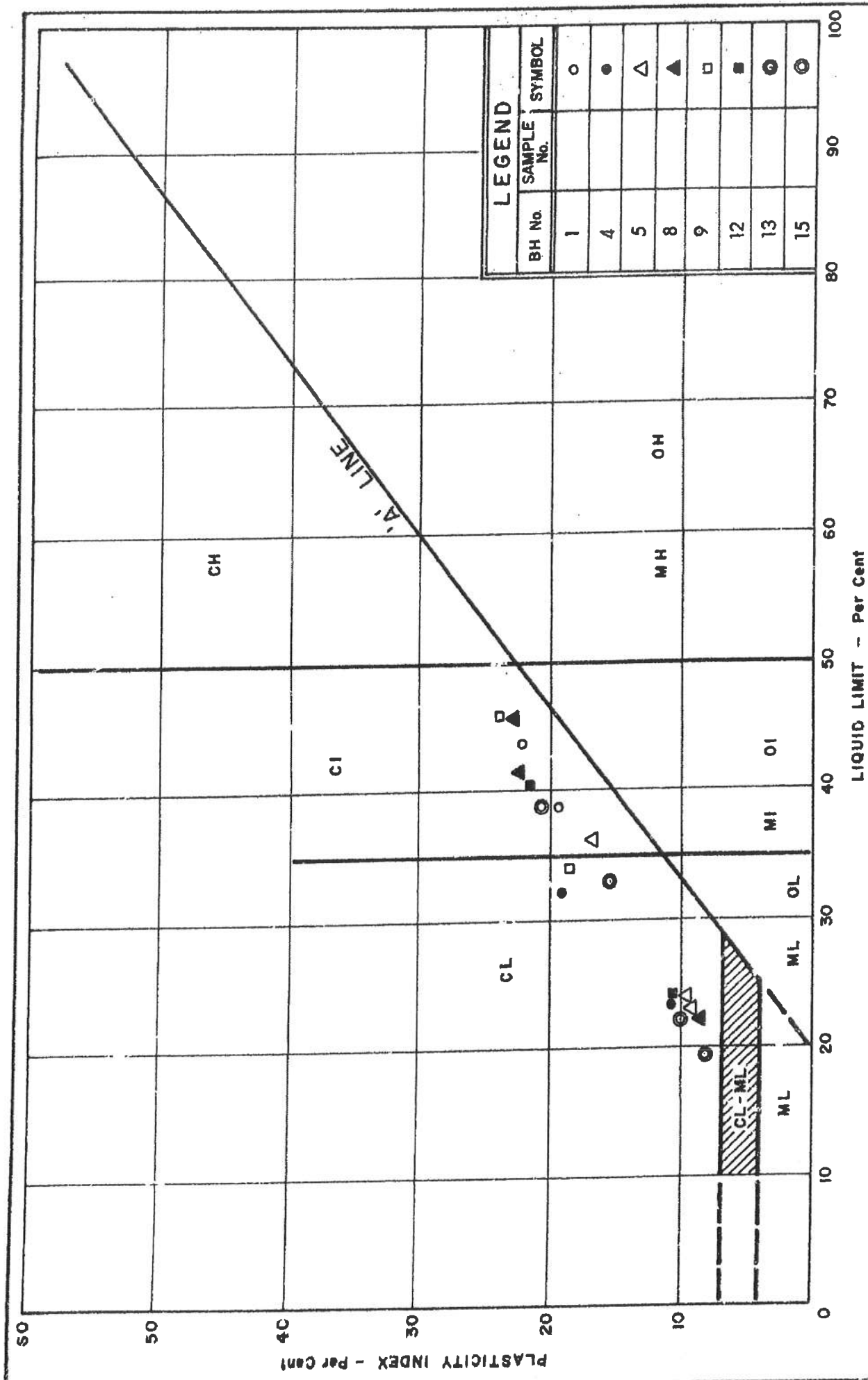
W.P. 408-88-00 LOCATION N 4 814 022.96 E 226 174.52 ORIGINATED BY SA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.06.17 - 2008.06.17 CHECKED BY RPR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa		W _P	W	W _L		
	Continued From Previous Page						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE		WATER CONTENT (%)				
							20 40 60 80 100		20 40 60				
301.7	Silly CLAY, trace sand Hard Grey (TILL)		17	SS	112								
21.6	END OF BOREHOLE AT 21.6m. BOREHOLE OPEN AND DRY TO BOTTOM UPON COMPLETION. WATER LEVEL OBSERVED AT 5.5m DURING DRILLING. BOREHOLE BACKFILLED WITH GROUT TO 0.9m, HOLE PLUG TO 0.05m THEN AUGER CUTTINGS TO SURFACE.												



PLASTICITY CHART

W.P. No. 635-64
 JOB No. 66-F-36



PLASTICITY CHART

DEPARTMENT OF HIGHWAYS
 MATERIALS and
 TESTING
 DIVISION

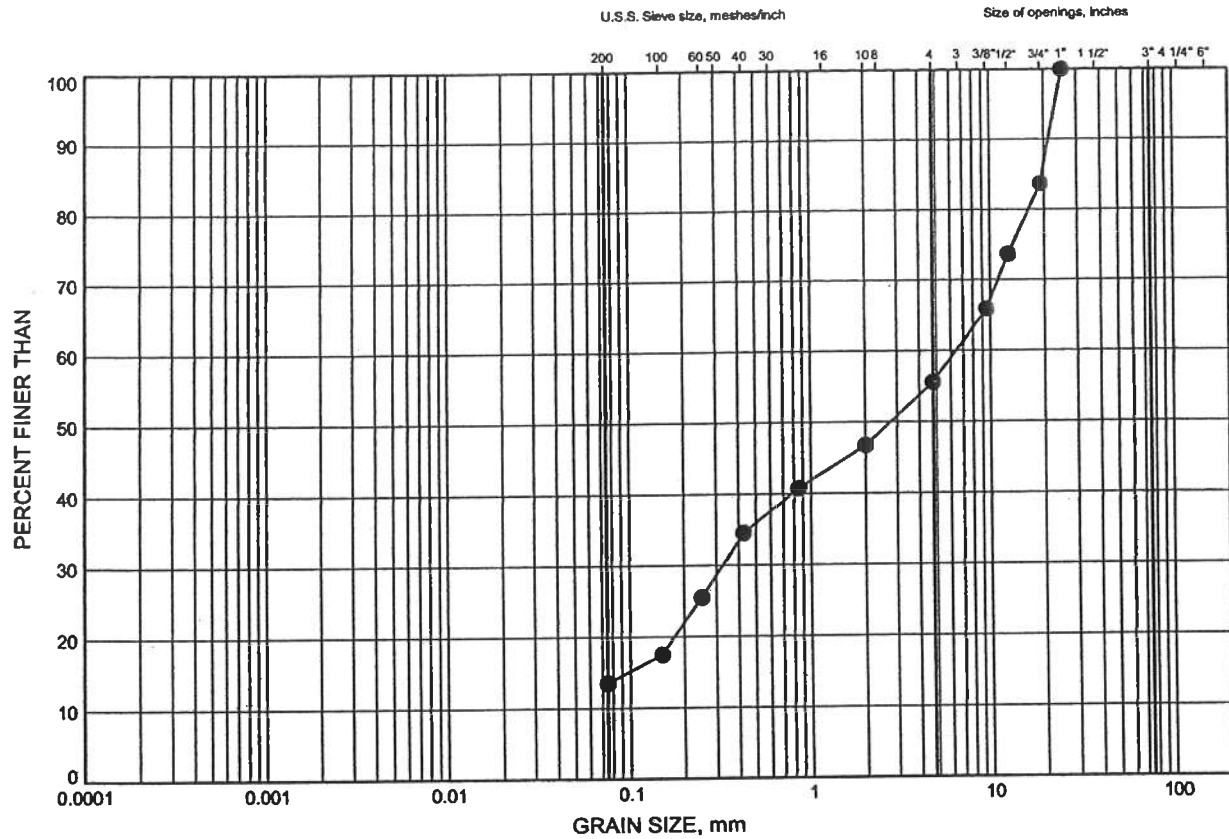


W.P. No. 635-64
 JOB No. 66-F-36

Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B1

Gravelly Sand Fill



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

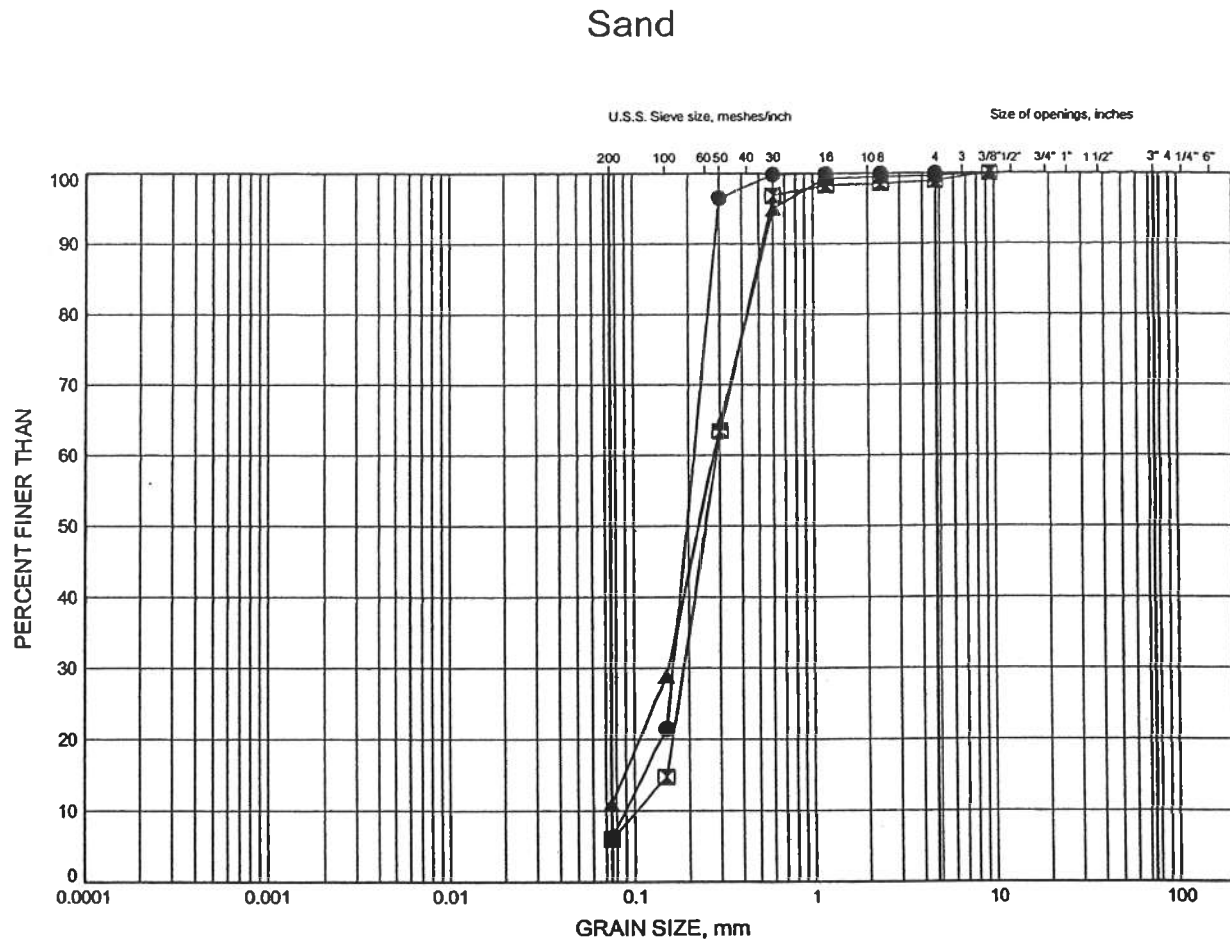
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-048	2.47	320.88



W.P.# 408-88-00
Prepared By AN
Checked By RPR

Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B2



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-047	3.35	320.44
⊠	08-048	6.40	316.95
▲	08-048	10.90	312.46

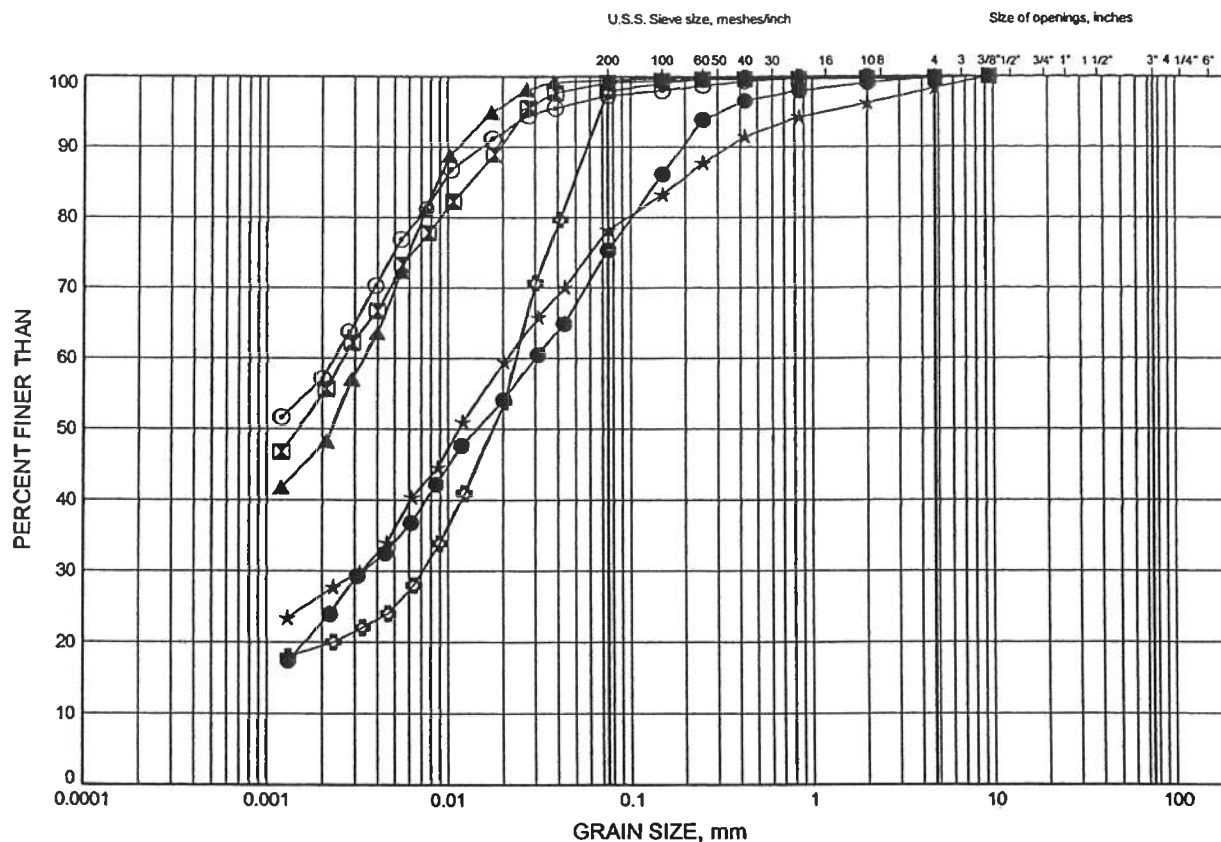


W.P.# 408-88-00
Prepared By SA
Checked By RPR

Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B3

Silty Clay and Silty Clay Till



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-047	7.92	315.86
⊠	08-047	12.50	311.29
▲	08-047	17.07	306.72
★	08-048	9.45	313.90
⊙	08-048	14.02	309.33
⊕	08-048	18.52	304.84

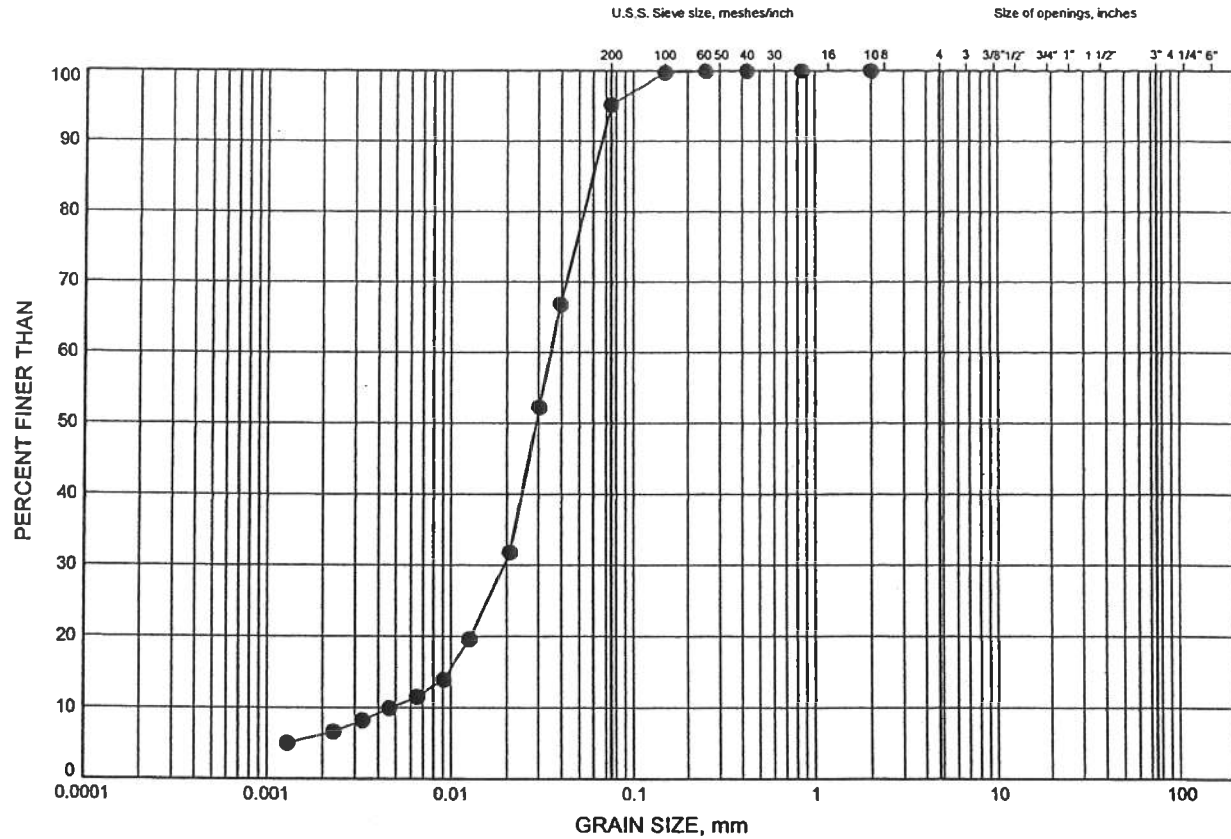


W.P.# 408-88-00
Prepared By SA
Checked By RPR

Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B4

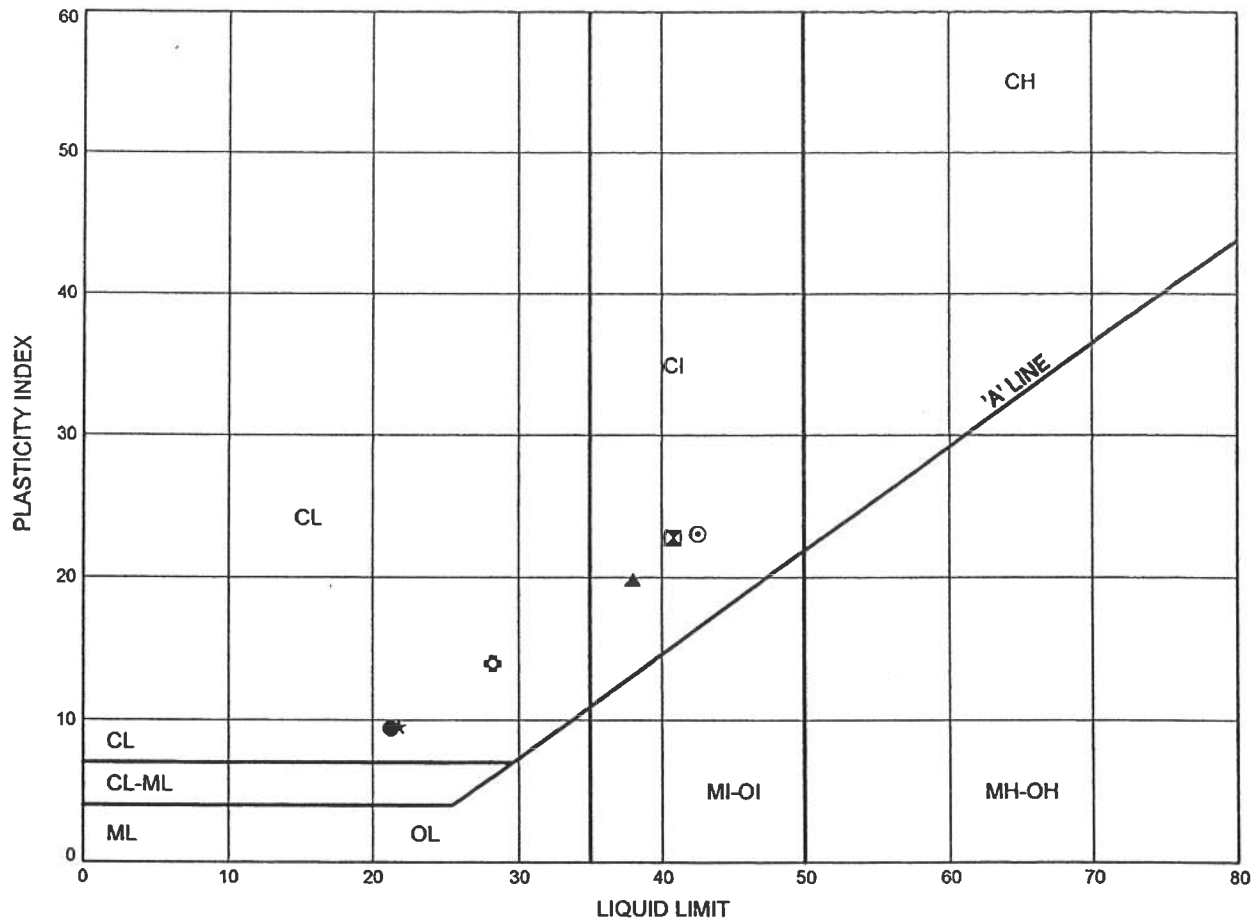
Silt Till



Highway 7 - New ATTERBERG LIMITS TEST RESULTS

FIGURE B5

Silty Clay and Silty Clay Till



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-047	7.92	315.86
⊠	08-047	12.50	311.29
▲	08-047	17.07	306.72
★	08-048	9.45	313.90
⊙	08-048	14.02	309.33
⊕	08-048	18.52	304.84

Date August 2008
 Project 408-88-00



Prep'd MFA
 Chkd. RPR

Appendix C

Site Photographs



Photo 1. Aerial view of KWE and Victoria Street



Photo 2. KWE and Victoria Street (South Side)

Appendix D

Drawings titled “Borehole Locations and Soil Strata”

CONT No
WP No 408-88-00



VICTORIA STREET
UNDERPASS
BOREHOLE LOCATIONS PLAN

SHEET








THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

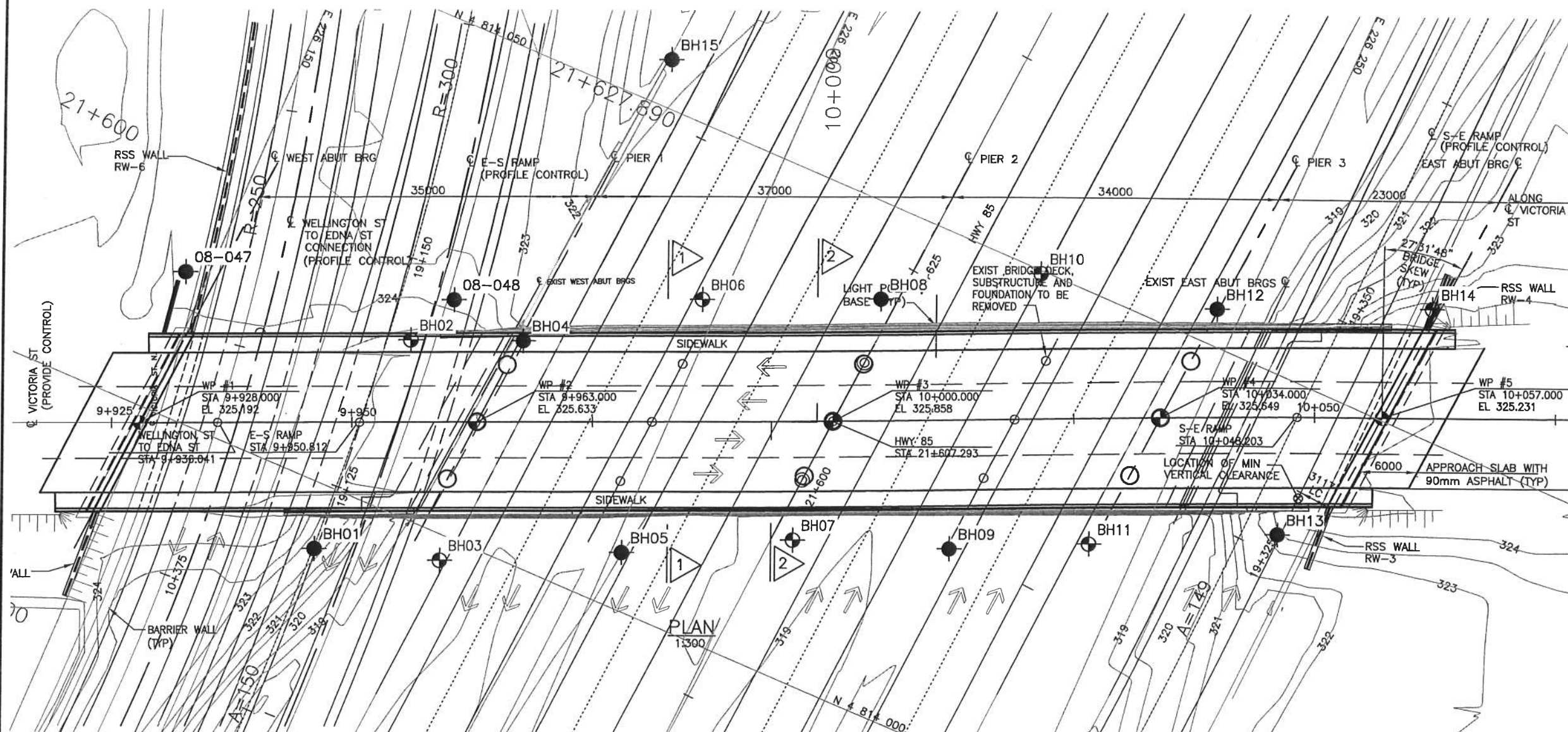
- | | |
|---------------------------------------------------------------------------------------|---------------------------------------------------|
|  | Borehole & Cone (Previous Investigation) |
|  | Cone Penetration Hole
(Previous Investigation) |
| N | Blows /0.3m (Std Pen Test, 475J/blow) |
| PH | Pressure, Hydraulic |
|  | Water Level |
|  | Head Artesian Water |
|  | Piezometer |
| 90% | Rock Quality Designation (RQD) |
| A/R | Auger Refusal |

NO	ELEVATION	NORTHING	EASTING
BH01	322.2		
BH02	322.8		
BH03	322.8		
BH04	322.5		
BH05	321.8		
BH06	320.7		
BH07	321.7		
BH08	320.1		
BH09	321.5		
BH10	319.2		
BH11	321.6		
BH12	321.6		
BH13	321.9		

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 40P8-202

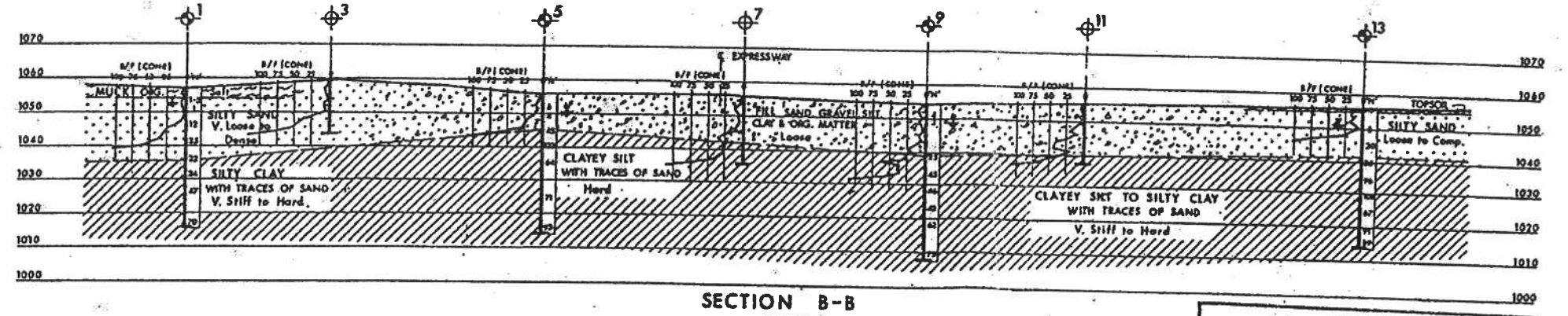
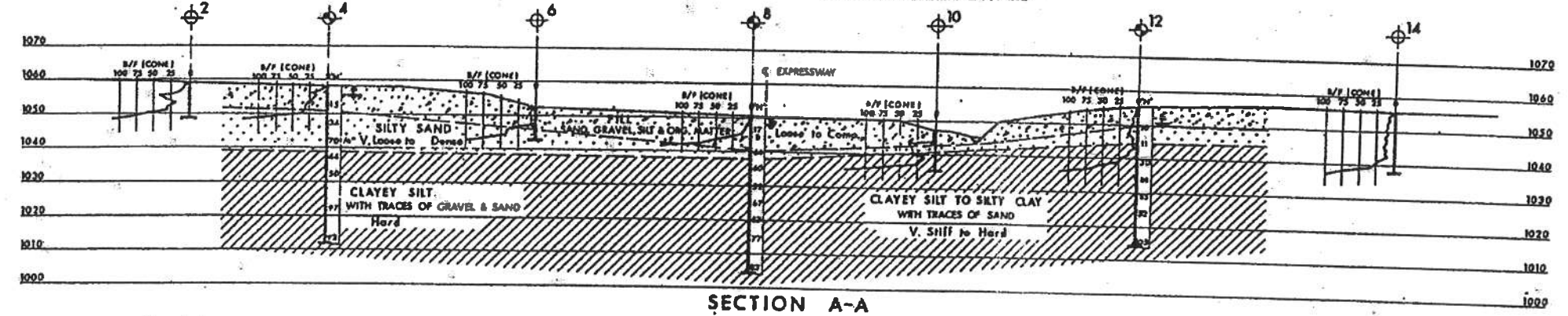
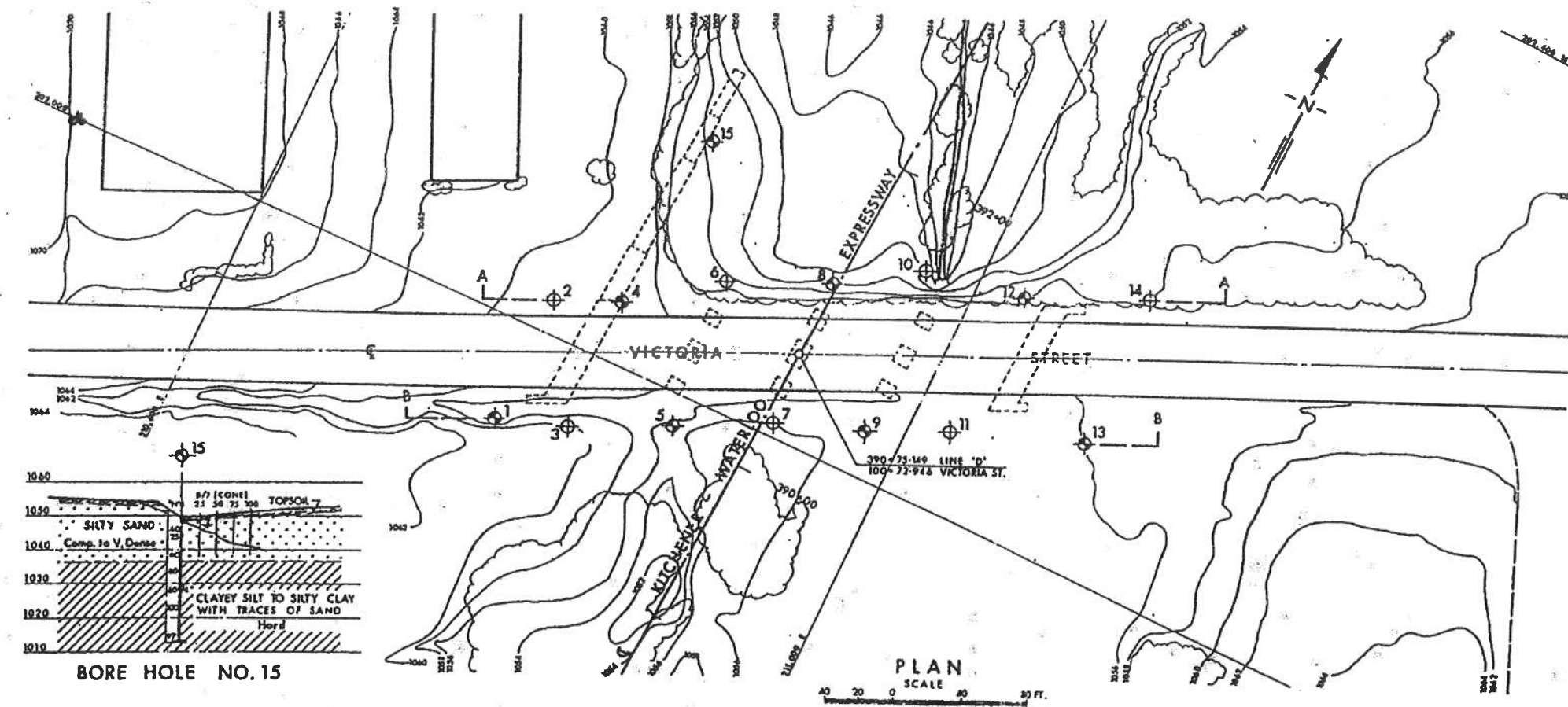
[illegible]

PLAN

SCALE 1:500



BH14	321.8		
BH15	319.9		
08-047	323.8	4 814 014.6	226 147.7
08-048	323.4	4 814 022.9	226 174.5



NOTE
The complete soil investigation report for this structure may be examined at the Bridge Office and Foundation Office, Downsview, and at the Hamilton District Office.



- LEGEND**
- Bore Hole
 - Cone Penetration Hole
 - Bore & Cone Penetration Hole
 - Water Levels established at time of field investigation, APRIL 1964

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	1037.00	201,943	210,780
2	1039.10	202,019	210,780
3	1039.17	201,956	210,820
4	1038.14	202,033	210,817
5	1035.83	201,982	210,874
6	1032.31	202,072	210,867
7	1035.45	202,008	210,928
8	1030.32	202,097	210,924
9	1034.65	202,027	210,978
10	1047.14	202,127	210,968
11	1035.14	202,047	211,023
12	1033.20	202,137	211,029
13	1036.18	202,074	211,099
14	1035.68	202,169	211,097
15	1049.47	202,142	210,822

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISION	DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION - FOUNDATION SECTION

VICTORIA STREET

KING'S HIGHWAY NO. KITCHENER-WATERLOO EXPR. DIST. NO. 4
CO. WATERLOO CITY OF KITCHENER
TWP. LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D. W.K.	CHECKED	REV. NO. 633-64	M.S.T. DRAWING NO.
DRAWN S.O.	CHECKED	JOB NO. 66-F-36	66-F-36A
DATE 17 JUNE 1966	SITE NO. 33-235	BRIDGE DRAWING NO.	
APPROVED	CONT. NO. 68-62	D-8000-2	