

30MS-210

**FOUNDATION
INVESTIGATION
REPORT 3**

CONTRACT NO. 2002- 2002

FOR INFORMATION PURPOSES ONLY

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REPORT ON

**FOUNDATION INVESTIGATION AND DESIGN
EMBANKMENT SECTIONS
NORTH HALF OF QUEEN ELIZABETH WAY
AND GUELPH LINE INTERCHANGE
REGIONAL MUNICIPALITY OF HALTON
GWP: 47-88-00**

Submitted to:

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January 2001

991-1105C

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Record of Borehole Sheets

(Boreholes 5, 7, 9+950NSR, 10+035NSR, 10+100NW, 10+353E-N/S, 10+050WL, 10+025SW)

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PART A

**FOUNDATION INVESTIGATION REPORT
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1.0 INTRODUCTION

Golder Associates Ltd. has been retained by McCormick Rankin Corporation (McCormick Rankin) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation for the north half of the Queen Elizabeth Way (QEW) and Guelph Line interchange at in the Region of Halton, Ontario. The project includes two bridges on Guelph Line as well as associated high embankments and extensions of the Roseland Creek culverts. This report addresses the high embankments for Guelph Line and the associated interchange ramps.

The purpose of the foundation investigation is to determine the subsurface conditions at the site of the proposed embankments by drilling boreholes, and carrying out in-situ tests and laboratory tests on selected samples. The terms of reference for the scope of work are outlined in our Total Project Management proposal P81-1394-1, dated September 1998. The work was carried out in accordance with our Quality Control Plan for Foundation Design Services, Agreement No. 9820-7411-2715, dated January 1999. The digital plan for the Interchange was presented on profiles provided to us by McCormick Rankin on August 31, 2000.

2.0 SITE DESCRIPTION

The site is located at the existing QEW and Guelph Line interchange, and is within the MTO District 4 in the City of Burlington.

The topography of the site area is generally level and gradually slopes downwards towards the south. The existing Guelph Line has been constructed entirely in fill and the existing embankments are up to 10 m in height. The existing ramps and North Service Road are also constructed in fill to meet with Guelph Line. Within the project limits, the vegetation cover generally consists of grass and bushes. Drainage ditches run adjacent to Guelph Line at the toe of the existing embankment on the east and west side, north of the North Service Road.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between July 18 to 24, 2000. At this time eight (8) boreholes were put down at the site. Boreholes 5, 7, 9+950NSR, 10+035NSR, 10+100NW, 10+353E-N/S, 10+050WL, 10+025SW were put down at the toe of the existing Guelph Line embankment within the limits of the proposed embankment for the re-aligned Guelph Line and associated ramps.

The investigation was carried out using a bombardier-mounted CME-55 drill rig supplied and operated by Master Soil Investigations of Toronto, Ontario. In the boreholes, samples of the overburden were obtained at regular intervals of depth using 50 mm outside diameter split-spoon samplers in accordance with the Standard Penetration Test (SPT) procedures. The boreholes were extended to depths between 4.6 m and 12.2 m below the existing ground surface. Groundwater conditions in the open boreholes were observed throughout the drilling operations. Piezometers were installed in two boreholes to permit monitoring of the groundwater levels at the site. The piezometers consist of a 200 mm long slotted tip threaded into 12 mm diameter PVC rigid tubing or a slotted 12 mm diameter tube. The boreholes were backfilled with either bentonite gravel or with a mixture of bentonite gravel and auger cuttings.

The field work was supervised on a full-time basis by a member of our engineering staff who located the boreholes in the field, directed the drilling, sampling and in-situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in labeled containers and transported back to our laboratory in Mississauga for further examination. Index and classification tests were carried out on selected samples. The results of the testing are shown on the attached Record of Borehole sheets and on Figures 1 and 2.

A plan of the proposed Guelph Line Interchange was provided to us in digital format by McCormick Rankin. The borehole locations were surveyed and staked in the field by Bennet Young Limited, professional land surveyors. Based on the information provided, the northing and easting co-ordinates of the borehole locations are given in UTM, and the borehole elevations are referenced to Geodetic Datum. The co-ordinates of the boreholes are indicated on the Record of Borehole sheets and the locations of the boreholes are shown on Drawing 1.

4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY

4.1 Site Geology

The site is located in the physiographic region known as the Iroquois Plain. The Iroquois Plain is generally composed of a shallow cover of sand and till covering portions between Hamilton and Toronto (Chapman and Putnam, "The Physiography of Southern Ontario". 3rd Edition, 1984). The surface topography slopes gradually and fairly uniformly towards Lake Ontario. The native overburden at the site area is a silty clay till which is underlain by bedrock comprised of red shale with limestone interbeds of the Queenston Formation. The depth to bedrock at this site is shallow, varying typically between 2 m to 5 m below original ground surface.

4.2 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Record of Borehole sheets following the text of this report. The stratigraphic boundaries shown on the borehole sheets are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations.

In summary, the surficial subsoils at the site generally consist of a layer of topsoil underlain by silty clay to clayey silt fill material. The boreholes drilled through the existing Guelph Line embankment encountered asphalt and granular road base fill below the roadway surface. The fills are underlain by about 1 m to 3 m of very stiff to hard clayey silt / silty clay or dense to very dense silty sand till which is in turn underlain by shale bedrock of the Queenston Formation.

The location of the borings are shown on the attached Drawing 1. A detailed description of the subsurface conditions encountered in the boreholes for this investigation is provided in the following sections.

4.2.1 Topsoil

A surficial layer of topsoil was encountered in four of the boreholes. The topsoil was measured between about 100 mm and 450 mm in thickness in Boreholes 10+025SW, 10+035NSR, 10+353E-N/S, and 10+050WL.

4.2.2 Road Base Fill

A 0.9 m to 1.0 m thick layer of compact to dense, crushed gravel with sand and gravel fill was encountered beneath the asphalt road surface in Boreholes 5 and 7, which were drilled through the existing Guelph Line embankment.

4.2.3 Clayey Silt to Silty Clay Fill

In general, a 1.4 m to 2.1 m thick layer of silty clay to clayey silt fill exists below the topsoil or road base fill in all boreholes except Borehole 10+050WL. In Boreholes 5 and 7, which were extended through the existing Guelph Line embankment, the fill is between 6.3 m and 7.6 m deep. The clayey silt fill is typically red-brown to brown to grey in colour and contains variable proportions of sand and gravel. The silty clay fill is typically dark brown to red-brown in colour and contains variable proportions of sand, gravel and organics. The measured Standard Penetration (SPT) 'N' values for the clayey silt/silty clay fill were between 8 blows and 54 blows per 0.3 m of penetration indicating a stiff to hard consistency.

Atterberg limits testing carried out on one sample of the clayey silt fill gave a liquid limit of 24.5 percent and a plasticity index of 5.8 percent. This classifies the fill sample as inorganic and of low plasticity. A grain size distribution for this sample is shown in Figure 1 and the result of the Atterberg limits test is shown on Figure 2. The natural water content for selected samples of the clayey silt/silty clay fill ranged from about 9 percent to 20 percent, with an average of about 15 percent.

4.2.4 Sand

In Borehole 10+100NW, a 0.7 m thick layer of moist to wet, red-brown, sand containing some silt was encountered below the fill. The measured SPT 'N' value was 53 blows per 0.3 m of

penetration indicating a very dense state of packing. The measured water content on the one sample obtained was about 13 percent.

In Borehole 10+050WL, a 1.5 m thick layer of red-brown silty sand containing trace clay and gravel and trace shale and limestone fragments was encountered below the topsoil and above the silty clay till. The SPT 'N' values were between 43 blows and greater than 100 blows per 0.3 m of penetration indicating a dense to very dense state of packing.

4.2.5 Clayey Silt / Silty Clay Till

A deposit of red-brown clayey silt to silty clay till was encountered in all boreholes. Some shale and limestone fragments were noted within the till. A grain size distribution curve for a selected sample of the clayey silt till is shown on Figure 3. The SPT 'N' values within the till deposit range from 19 blows to greater than 50 blows per 0.3 m of penetration, indicating a very stiff to hard consistency. In general, the till is hard.

Atterberg limit testing carried out on two selected samples of the clayey silt / silty clay till gave liquid limits of about 18 percent and 23 percent, and a plasticity index of about 4 percent and 8 percent, respectively. This classifies the till as inorganic and of low plasticity. The results of the Atterberg limits testing are shown on Figure 4. The natural water content for selected samples of the till ranged from about 7 percent to 13 percent. The water contents were less than the plastic limit.

4.2.6 Bedrock

Shale bedrock was encountered in all of the boreholes. Hard limestone layers between 25 mm and 150 mm thick were encountered throughout the shale, inferred from augering through the bedrock. Limestone layers up to 200 mm in thickness were encountered throughout the shale in boreholes where bedrock coring was carried out for other aspects of this project. A minimum of 1.4 m of the bedrock was penetrated through augering except in Borehole 9+950NSR where the borehole was extended to the bedrock surface only. The following table summarizes the bedrock surface elevations.

<i>Borehole</i>	<i>Elevation of Surface of Weathered Shale Bedrock (m)</i>
5	103.3
7	106.3
10+025SW	105.2
9+950NSR	104.9
10+035NSR	106.2
10+353E-N/S	106.6
10+100NW	102.5
10+050WL	104.7

4.3 Groundwater Conditions

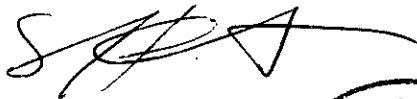
Water levels were noted in the open boreholes during and upon completion of the drilling operation. All boreholes were dry upon completion of drilling except Borehole 10+353NSR which had a water level at Elevation 105.5 m in the open borehole. Piezometers were installed in two boreholes and the water levels are summarized in the table below.

<i>Borehole</i>	<i>Water Levels in Piezometers</i>			
	<i>July 25, 2000</i>		<i>August 16, 2000</i>	
	<i>Depth (m)</i>	<i>Elevation (m)</i>	<i>Depth (m)</i>	<i>Elevation (m)</i>
10+035NSR	2.7	106.4	2.7	106.4
10+353E-N/S	1.1	109.4	0.9	109.6

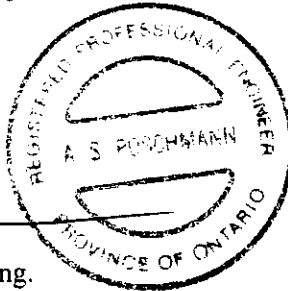
Based on these measurements, and on water level measurements in boreholes for other aspects of this project, the groundwater table slopes downward toward the south and the east. The groundwater table seems to be controlled by the bedrock surface topography and by the water bearing sand deposits which are present sporadically across the site.

It should be noted that groundwater levels are expected to fluctuate seasonally and are expected to be higher during wet periods of the year. It is also expected that water levels could be higher in areas adjacent to the drainage channels on either side of Guelph Line north of the existing North Service Road.

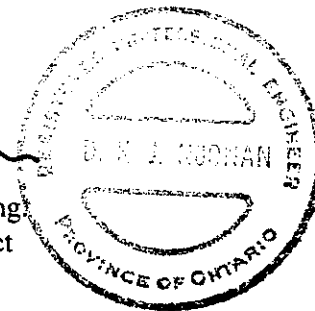
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LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index (Relative Density)	N Blows/300 mm or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

(b) Cohesive Soils

Consistency	kPa	c_u, s_u	psf
Very soft	0 to 12		0 to 250
Soft	12 to 25		250 to 500
Firm	25 to 50		500 to 1,000
Stiff	50 to 100		1,000 to 2,000
Very stiff	100 to 200		2,000 to 4,000
Hard	over 200		over 4,000

Dynamic Cone Penetration Resistance; N_d :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I GENERAL

π	= 3.1416
$\ln x$,	natural logarithm of x
$\log_{10} x$ or $\log x$,	logarithm of x to base 10
g	acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

II STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ϵ	linear strain
ϵ_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stresses (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress = $(\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation
*	Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density \times acceleration due to gravity)

(a) Index Properties (con't.)

w	water content
w_l	liquid limit
w_p	plastic limit
I_p	plasticity Index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(c) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(d) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (overconsolidated range)
C_s	swelling index
C_α	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	Overconsolidation ratio = σ'_p / σ'_{vo}

(e) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3) / 2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3) / 2$
q	$(\sigma_1 - \sigma_3) / 2$ or $(\sigma'_1 - \sigma'_3) / 2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1. $\tau = c' + \sigma' \tan \phi'$

2. Shear strength = (Compressive strength)/2

PROJECT 991-1105 (3000)

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 47-88-00

LOCATION N 4801219.0; E 280105.5

ORIGINATED BY SEP

DIST 4 HWY QEW

BOREHOLE TYPE 114mm SOLID STEM AUGERS

COMPILED BY SEP

DATUM Geodetic

DATE July 19, 2000

CHECKED BY ASP

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					
113.79	GROUND SURFACE																
113.60	Asphalt																
0.20	Crushed Gravel, some sand Light brown Dry (Fill)																
112.79																	
1.00	Clayey Silt with sand, some gravel Firm to hard Red-brown to grey Moist (Fill)		1	SS	40		113										
			2	SS	27		112										
			3	SS	5		111										18 45 28 8
			4	SS	8		110										
							109										
			5	SS	15		108										
			6	SS	8		107										
							106										
			7	SS	33		105										
105.19							104										
8.60	Clayey Silt, some sand, trace gravel, shale and limestone fragments Hard Red-brown Dry (Glacial Till)		8	SS	80/12		103										
103.29							102										
10.50	Red-brown SHALE bedrock (Queenston Formation), with hard limestone layers inferred from auger resistance during drilling from 10.7 m to 12.2 m depth.		9	SS	100/0.1												
101.59																	
12.20	END OF BOREHOLE																
	Note: 1. Open Borehole dry upon completion of drilling.																

ON MOT 991-1105.GPJ ON MOT.GDT 13/12/00

+3, X3 Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 991-1105 (3000)				RECORD OF BOREHOLE No 7				1 OF 1		METRIC				
W.P. 47-88-00				LOCATION N 4801275.0, E 280033.9				ORIGINATED BY SEP						
DIST 4 HWY QEW				BOREHOLE TYPE 114mm SOLID STEM AUGERS				COMPILED BY SEP						
DATUM Geodetic				DATE July 18, 2000				CHECKED BY ASP						
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			20 40 60 80 100	20 40 60 80 100					
115.08	GROUND SURFACE													
8.98 0.10	Asphalt Crushed Gravel, some sand Light Brown Dry (Fill)													
114.18 0.90	Clayey Silt with sand, some gravel Stiff to hard Red-brown to grey Moist (Fill)		1	SS	10									
			2	SS	10									
			3	SS	18									
			4	SS	54/28									
	Asphalt pieces at 4.6 m depth (Elev. 110.48 m)		5	SS	33									
			6	SS	14									
107.88 7.20	Clayey Silt, some sand, trace gravel Very stiff Brown to red-brown Moist (Glacial Till) Cobble inferred from drilling at 7.3 m.		7	SS	19									
106.28 8.80	Red-brown SHALE bedrock (Queenston Formation), with hard limestone layers inferred from auger resistance during drilling.		8	SS	50/05									
104.18 10.90	END OF BOREHOLE Note: 1. Open borehole dry upon completion of drilling.		9	SS	60/07									

ON MOT 991-1105.GPJ ON MOT.GDT 13/12/00

PROJECT 991-1105 (3000)			RECORD OF BOREHOLE No 9+950 (NSR)			1 OF 1			METRIC						
W.P. 47-88-00			LOCATION N 4801304.0; E 279931.1			ORIGINATED BY SEP									
DIST 4 HWY QEW			BOREHOLE TYPE 114mm SOLID STEM AUGERS			COMPILED BY SEP									
DATUM Geodetic			DATE July 19, 2000			CHECKED BY ASP									
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 x REMOULDED							
109.43	GROUND SURFACE														
0.00	Silty Clay, some sand and organics, trace gravel Dark brown Moist (Fill)														
108.53															
0.90	Clayey Silt, trace sand and gravel, trace organics Stiff		1	SS	8										
108.03															
1.40	Brown Moist (Fill)		2	SS	50										
	Clayey Silt with sand, some gravel Hard Red-brown Moist (Glacial Till)														
104.88	Red-brown SHALE bedrock (Queenston Formation). END OF BOREHOLE														
4.60															
	Note: 1. Open Borehole dry upon completion of drilling.														

ON MOT 991-1105.GPJ ON MOT GDT 13/12/00

PROJECT 991-1105 (3000)				RECORD OF BOREHOLE No 10+035 (NSR)				1 OF 1		METRIC		
W.P. 47-88-00				LOCATION N 4801367.0, E 279986.8				ORIGINATED BY SEP				
DIST 4 HWY QEW				BOREHOLE TYPE 114mm SOLID STEM AUGERS				COMPILED BY SEP				
DATUM Geodetic				DATE July 18, 2000				CHECKED BY ASP				
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT		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 20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED		WATER CONTENT (%) w _p w w _L		
110.50	GROUND SURFACE											
0.00	Topsoil											
0.15	Silty Clay, trace sand and gravel, trace organics Stiff Brown Moist (Fill)		1	SS	10							
109.30	Clayey Silt, some sand, trace gravel hard Red-brown Moist (Fill)		2	SS	54							
108.40	Clayey Silt with sand, trace gravel, limestone fragments Hard Red-brown Moist (Glacial Till)		3	SS	73							
2.10			4	SS	99/15							
106.20	Red-brown SHALE bedrock (Queenston Formation), with hard limestone layers inferred from auger resistance during drilling.		5	SS	109/15							
4.30												
104.40	END OF BOREHOLE											
6.10	Note: 1. Open Borehole dry upon completion of drilling. 2. Water level measured in piezometer at 1.15 m depth (Elev. 109.35 m) on July 25, 2000. 3. Water level measured in piezometer at 0.92 m depth (Elev. 109.58 m) on August 16, 2000.											

PROJECT 991-1105 (3000) RECORD OF BOREHOLE No 10+100 (NW) 1 OF 1 METRIC
W.P. 47-88-00 LOCATION N 4801150.0, E 280065.9 ORIGINATED BY SEP
DIST 4 HWY QEW BOREHOLE TYPE 114mm SOLID STEM AUGERS COMPILED BY SEP
DATUM Geodetic DATE July 24, 2000 CHECKED BY ASP

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 REMOULDED						
105.74	GROUND SURFACE							20 40 60 80 100	10 20 30						
0.00	Silty Clay with sand and gravel, with organics														
105.34	Dark brown Moist (Fill)														
0.40	Clayey Silt with sand, trace gravel Stiff Brown Moist (Fill)		1	SS	14		105								
104.34	Sand, some silt Very dense Red-brown Moist to wet		2	SS	53		104								
1.40	Clayey Silt with sand, trace gravel, limestone fragments Hard Red-brown Moist (Glacial Till)														
103.64	Red-brown SHALE bedrock (Queenston Formation), hard limestone layers inferred from auger resistance during drilling from 3.5 m to 4.4 m depth.														
2.10															
102.54															
3.20															
101.14	END OF BOREHOLE														
4.60	Note: 1. Open borehole dry upon completion of drilling.														

+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 991-1105 (3000)		RECORD OF BOREHOLE No 10+353 (E-N/S)		1 OF 1	METRIC
W.P. 47-88-00		LOCATION N 4801309.0; E 280044.7		ORIGINATED BY SEP	
DIST 4 HWY QEW		BOREHOLE TYPE 114mm SOLID STEM AUGERS		COMPILED BY SEP	
DATUM Geodetic		DATE July 18, 2000		CHECKED BY ASP	

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		+ FIELD VANE							● QUICK TRIAXIAL	
109.75	GROUND SURFACE						20	40	60	80	100							
0.00	Topsoil																	
109.29																		
0.46	Clayey Silt with sand, trace gravel Hard Red-brown Moist (Fill)		1	SS	50													
			2	SS	38													
107.65																		
2.10	Clayey Silt with sand, trace gravel Very stiff to hard Red-brown Moist (Glacial Till)		3	SS	25													
			4	SS	50/23													
106.55																		
3.20	Red-brown SHALE bedrock (Queenston Formation), with hard limestone layers inferred from auger resistance during drilling.																	
105.05			5	SS	131/15													
4.70	END OF BOREHOLE Note: 1. Water level measured in open borehole at 4.3 m depth (Elev. 105.45 m).																	

PROJECT 991-1105 (3000)				RECORD OF BOREHOLE No 10+050 (WL)				1 OF 1		METRIC					
W.P. 47-88-00				LOCATION N 4801251.0, E 279992.5				ORIGINATED BY SEP							
DIST 4 HWY QEW				BOREHOLE TYPE 114mm SOLID STEM AUGERS				COMPILED BY SEP							
DATUM Geodetic				DATE July 24, 2000				CHECKED BY ASP							
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					
107.50	GROUND SURFACE														
8.98 0.10	Topsoil														
	Silty Sand, trace clay, trace gravel, trace shale and limestone fragments Dense to very dense Red-brown Dry		1	SS	43										
106.00															
1.50	Silty Clay with sand, trace gravel, trace shale fragments Hard Red-brown Dry (Glacial Till)		2	SS	70/07										
			3	SS	50/07										
104.70															
2.80	Red-brown SHALE bedrock (Queenston Formation), with hard limestone layers inferred from auger resistance during drilling at 3.6 m and 4.0 m depth.		4	SS	100/15										
102.90															
4.60	END OF BOREHOLE														
	Notes: 1. Open borehole dry upon completion of drilling.														

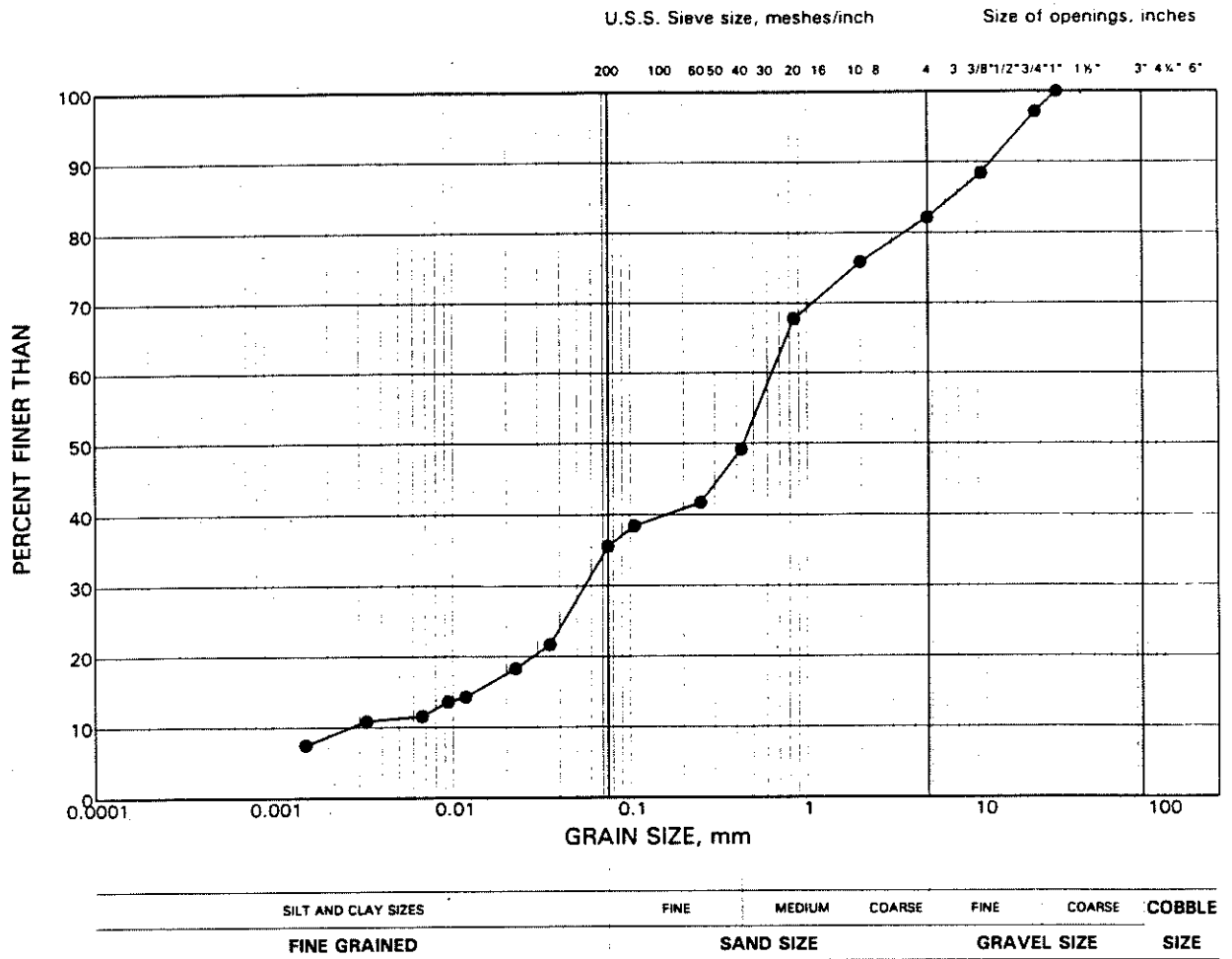
ON MOT 991-1105.GPJ ON MOT.GDT 13/12/00

PROJECT 991-1105 (3000)		RECORD OF BOREHOLE No 10+025 (SW)		1 OF 1		METRIC						
W.P. 47-88-00		LOCATION N 4801283.0, E 280085.9		ORIGINATED BY SEP								
DIST 4 HWY QEW		BOREHOLE TYPE 114mm SOLID STEM AUGERS		COMPILED BY SEP								
DATUM Geodetic		DATE July 21, 2000		CHECKED BY ASP								
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID UNIT WEIGHT REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
109.03	GROUND SURFACE											
8.98 0.10	Topsoil Silty Clay, some to with sand, trace gravel, trace organics Very stiff Red-brown Moist (Fill)		1	SS	21		108					
			2	SS	21		107					
106.93 2.10	Silty Clay, trace to some sand, trace gravel Hard Red-brown Moist (Glacial Till)		3	SS	33		106					
			4	SS	62/15		105					
105.23 3.80	Limestone gravel in tip of spoon at 3.3 m depth. Red-brown SHALE bedrock (Queenston Formation), with 0.03 m to 0.15 m thick hard limestone layers inferred from auger resistance during drilling at 3.9 m, 4.9 m, 5.2 m and 5.8 m depth.						104					
102.93 6.10	END OF BOREHOLE Note: 1. Open Borehole dry upon completion of drilling. 2. Water level measured in piezometer at 2.68 m depth (Elev. 106.35 m) on July 25, 2000 and August 16, 2000.						103					

ON MOT 991-1105.GPJ ON MOT.GDT 13/12/00

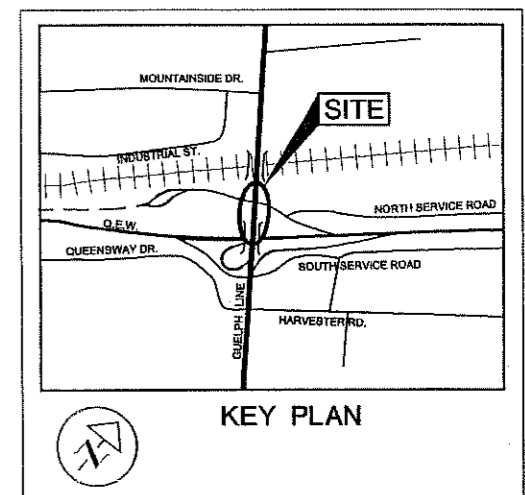
GRAIN SIZE DISTRIBUTION CLAYEY SILT (FILL)

FIGURE 1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
•	5	3	111.1



LEGEND

Borehole

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
5	113.79	4801219	280106
7	115.08	4801275	280034
9+950 NSR	109.43	4801304	279931
10+035 NSR	110.50	4801367	279987
10+353 E-N/S	109.75	4801309	280045
10+050 WL	107.30	4801251	279993
10+100 NW	105.74	4801150	280066
10+025 SW	109.03	4801283	280086

NOTES

The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

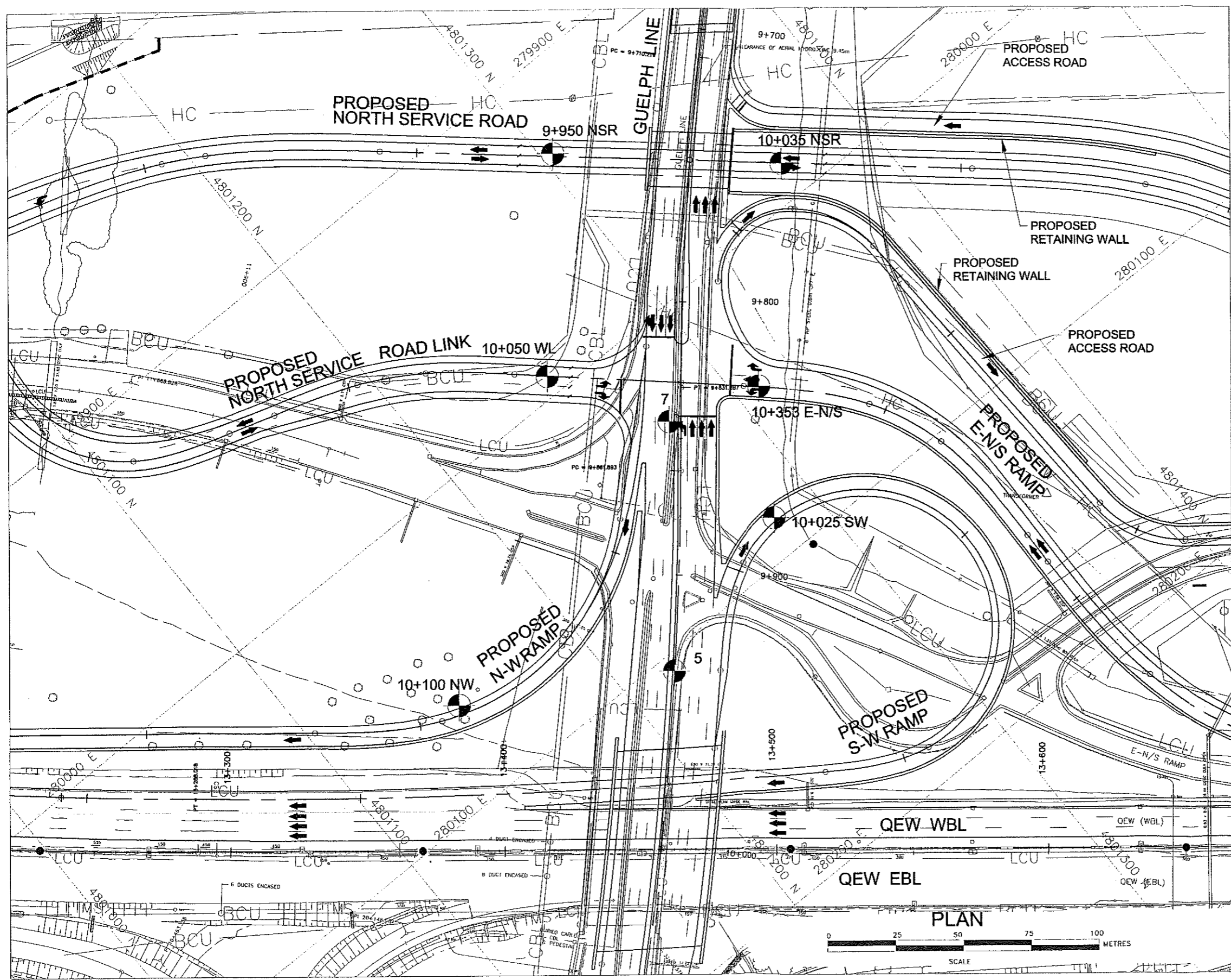
REFERENCE

This drawing was created from digital file "PLAN1117.dwg" titled "QEW/GUELPH LINE NORTH HALF OF INTERCHANGE W.P. 47-88-00" provided by McCormick Rankin Corp. on August 31, 2000

NO.	DATE	BY	REVISION

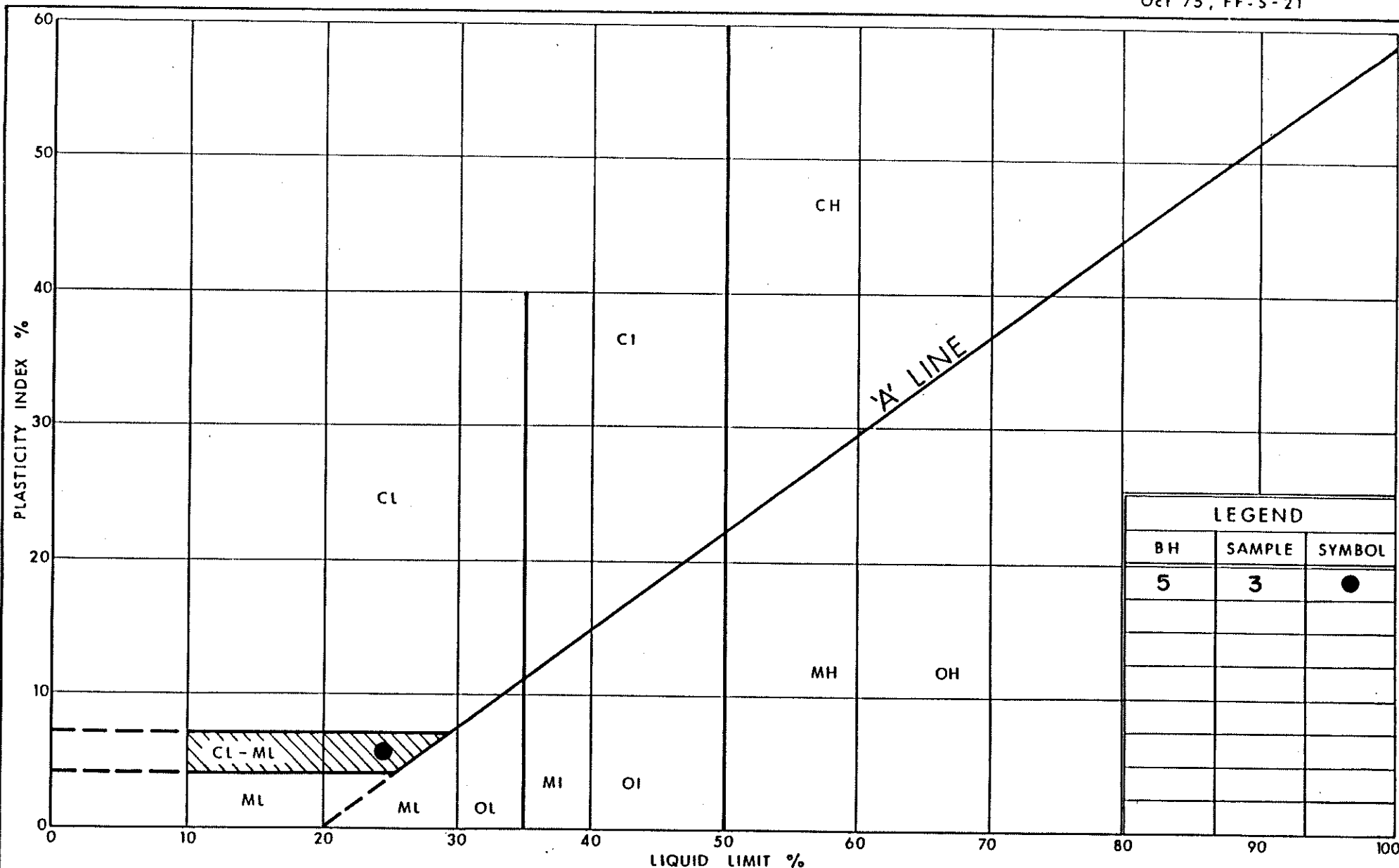
Geocres No.

Q.E.W.	PROJECT NO.: 991-1105	DIST.
SUBM'D. SEP	CHKD: ASP	DATE: 2000 09 26
DRAWN: JFC	CHKD: SEP	APPD.



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Oct 75, FF-5-21



LEGEND		
BH	SAMPLE	SYMBOL
5	3	●



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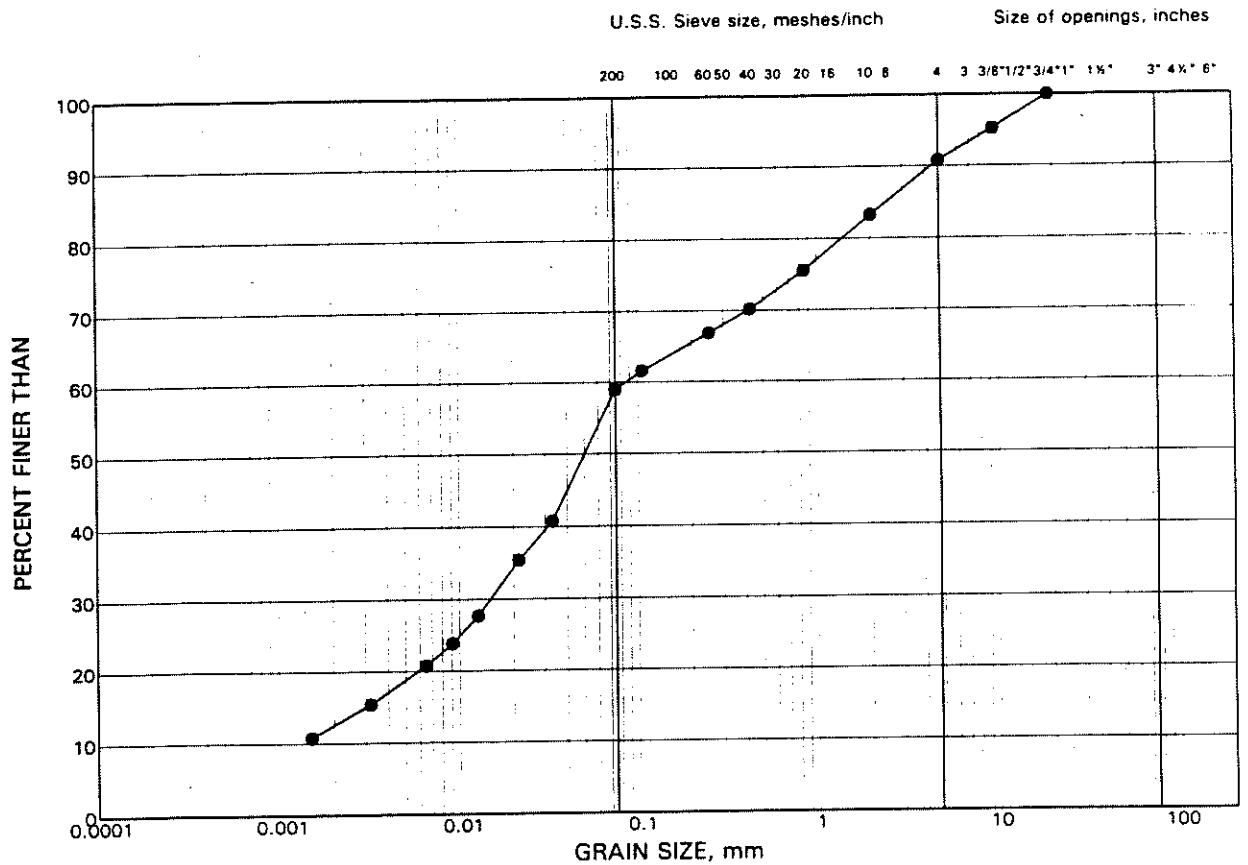
Ontario

PLASTICITY CHART CLAYEY SILT (FILL)

FIG No 2
G W P 47-88-00

GRAIN SIZE DISTRIBUTION CLAYEY SILT (GLACIAL TILL)

FIGURE 3



SILT AND CLAY SIZES			FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED			SAND SIZE			GRAVEL SIZE		
						SIZE		

LEGEND

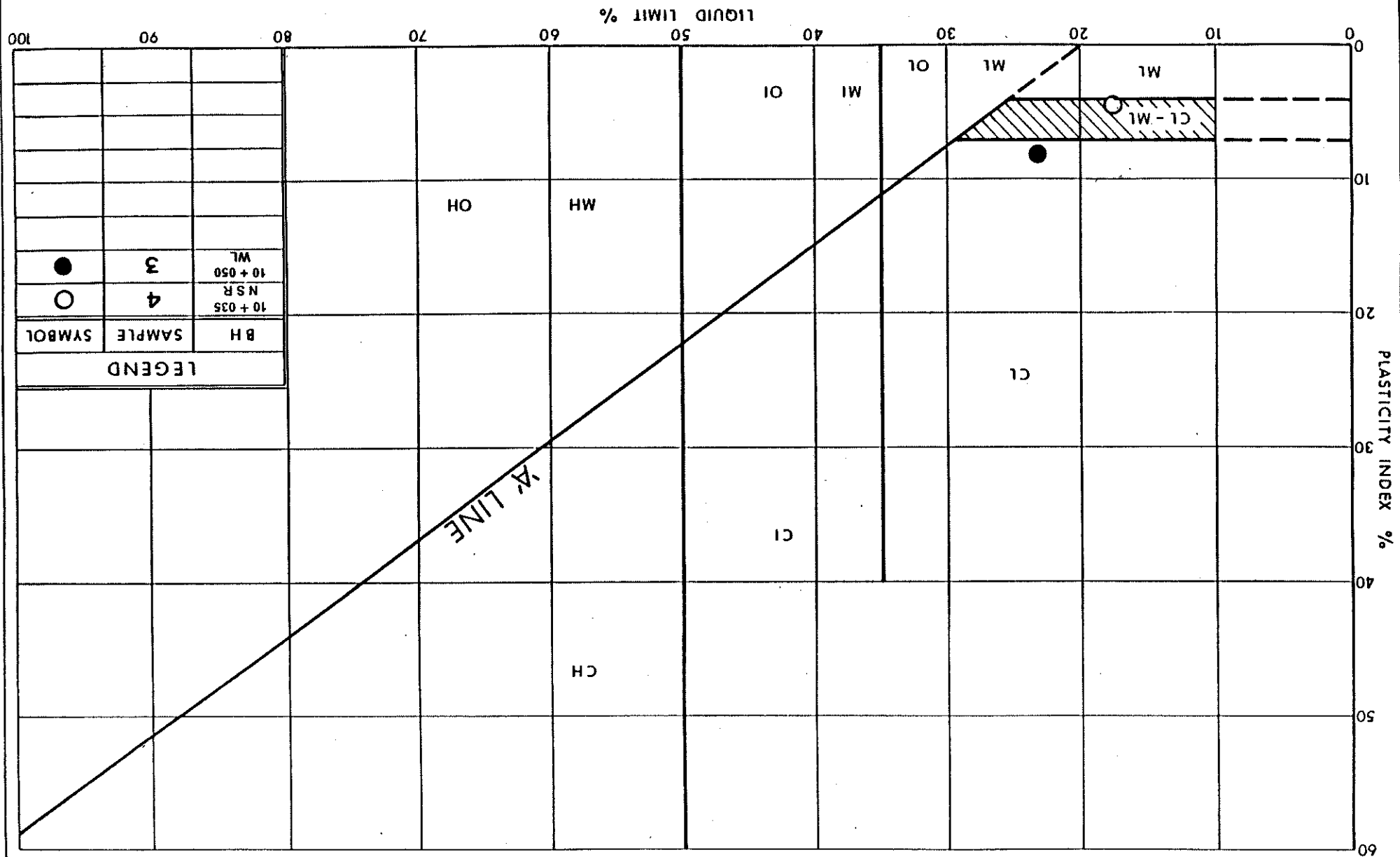
SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
•	10+035 NSR	4	107.5



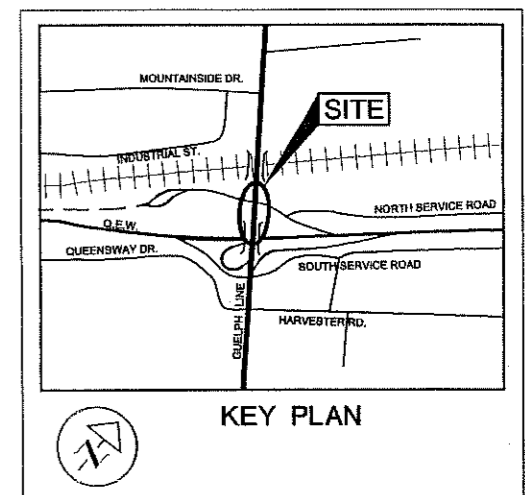
Ontario
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Transportation

PLASTICITY CHART CLAYEY SILT (GLACIAL TILL)

FIG No 4
GWP 47-88-00



LEGEND		
BH	SAMPLE	SYMBOL
10 + 035	4	○
NSR		
10 + 050	3	●
WL		



LEGEND

Borehole

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
5	113.79	4801219	280106
7	115.08	4801275	280034
9+950 NSR	109.43	4801304	279931
10+035 NSR	110.50	4801367	279987
10+353 E-N/S	109.75	4801309	280045
10+050 WL	107.30	4801251	279993
10+100 NW	105.74	4801150	280066
10+025 SW	109.03	4801283	280086

NOTES

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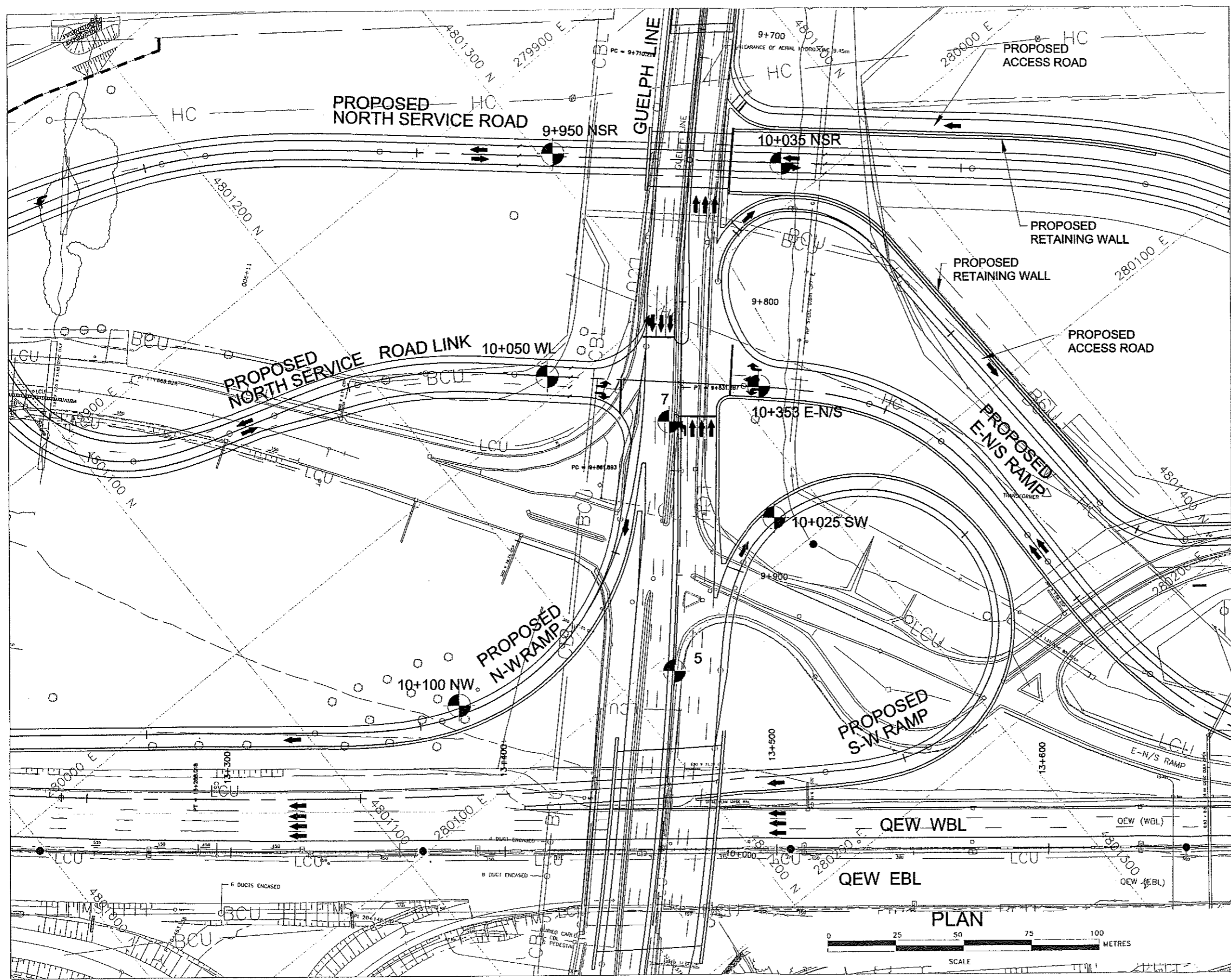
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NO.	DATE	BY	REVISION

Geocres No.

Q.E.W.	PROJECT NO.: 991-1105	DIST.
SUBM'D. SEP	CHKD: ASP	DATE: 2000 09 26
DRAWN: JFC	CHKD: SEP	APPD.



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