

G.I.-30 SEPT. 1976

GEOCRES No. 30M3-211DIST. CR REGION W.P. No. 134-92-00CONT. No. W. O. No. STR. SITE No. 18-161HWY. No. QEWLOCATION GLENDAL AVENUEUNDERPASS - QEW WIDENINGNo of PAGES - =====  
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:



**AGRA** Earth & Environmental  
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**GEOTECHNICAL INVESTIGATION  
HIGH MAST LIGHTING POLES  
WP 134-92-00 QUEEN ELIZABETH WAY/HIGHWAY 405  
DISTRICT 6, CENTRAL REGION**

**Submitted To:**

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**Submitted By:**

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**June 15, 1998  
TG98051**

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## **Part I- Foundation Investigation Report**

### **INTRODUCTION**

A geotechnical investigation was carried out for the installation of High Mast Lighting Poles along the Queen Elizabeth Highway, from Glendale Avenue to the Highway 405/QEW Interchange, in the City of Niagara Falls as indicated on the Key Plan on page A-2.

A total of nine high mast lighting poles will be installed along this section of the QEW. The project was divided into two portions, each portion being carried out by a different consultant. This report deals with the westerly five High Mast Lighting Poles. Reference should be made to AGRA Earth & Environmental Limited Report #TG98050, in which the four easterly high mast lighting poles are dealt with.

For continuity, Part 1 of the report summarizes the factual information obtained from the field work carried out for all of the light poles, on 98 03 25. It consisted of advancing five boreholes to depths of between 9.3 and 9.6 metres, to provide soil parameters for foundation design. Borehole Location Plans are appended as pages A-3 to A-7 inclusive.

Each borehole was accompanied by Standard Penetration Resistance testing and moisture content determinations. In-situ vane testing was carried out in Borehole 2.

### **SITE DESCRIPTION**

The site is located along the centreline of the Queen Elizabeth Way, between Glendale Avenue and the Hwy. 405 Interchange, in the Town of Niagara-On-The-Lake. The topography in the immediate area is generally flat-lying to the north of the QEW. To the south lies the Niagara Escarpment.

Physiographically, the site is located in the region referred to as the Lake Iroquois Clay Plain. North of the escarpment, the indicated soils are stratified clays and silts, deposited by glacial Lake Warren and glacial Lake Iroquois.

Bedrock elevations in the site area vary from 86.6 m near Glendale Avenue to 100.0 m near the Hwy. 405 interchange, based on elevations taken from Bedrock Topography Map P.2400, issued in 1981 by the Ministry of Natural Resources. The bedrock in this area is anticipated to be reddish-brown shale of the Queenston Formation near Glendale Avenue, changing to limestone and dolostone of the Clinton and Cataract Groups towards the Hwy. 405 Interchange.

Maps showing the quaternary geology of the area under investigation indicate Halton Till and Bedrock of the Clinton and Cataract Groups to the south, near the face of the Escarpment. These soil types are confirmed by previous investigations performed in this area.

### **SUBSURFACE CONDITIONS**

The soil on this site generally consists of a clayey silt fill overlying clayey silt/silty clay. For this investigation, boreholes were put down to depths ranging from 9.3 m in Borehole 1, to 9.6 m in each of the other boreholes. The upper brown layer of the clayey silt/silty clay was generally harder near surface due to the effects of weathering and desiccation.

A description of the subsurface soil and groundwater conditions encountered in each of the boreholes, along with the results of Standard Penetration testing are plotted on the Logs of

Boreholes appended as pages A-8 through A-12. A summary of the subsurface conditions encountered is given below.

### Pavement Structure

Boreholes 3 and 5 were put down through the existing partially paved shoulder along the centre median. The pavement structure consisted of 250 mm of asphalt over 100 mm of crushed limestone in Borehole 3, and of 140 mm of asphalt over 460 mm of crushed limestone in Borehole 5.

### Fill

Underlying the pavement structure in Borehole 3, and from ground surface in Boreholes 1, 2 and 4, miscellaneous soil and granular fill was encountered. The fill ranged in depth from 1.1 to 1.6 m( $\pm$ ) in Boreholes 1 and 2, respectively, and to depths of 3.3 and 4.8 m( $\pm$ ) in Boreholes 3 and 4.

The fill material was predominantly clayey silt with some sand and gravel. The upper fill in Borehole 3 extended to a depth of 1.6 m( $\pm$ ), and was underlain by a second road structure and clay fill. Buried topsoil was encountered at the base of the fill in Boreholes 3 and 4. The fill was stiff to firm, with Standard Penetration Resistance testing giving 'N' values between 6 and 15 blows for 30 cm. These results indicate some degree of compaction of the fill. Corresponding natural moisture contents were between 7 and 26%.

No index tests were carried out on the fill materials.

### Clayey Silt

Underlying the fill in Borehole 2, clayey silt was encountered extending to a depth of 5.6 m( $\pm$ ). The clayey silt was fissured and contained some silt seams, along with traces of sand and gravel. There may have been some cobbles at a depth of about 4.6 metres. The clayey silt was stiff to very stiff, with Standard Penetration Resistance testing giving 'N' values between 15 and 21 blows for 30 cm. Corresponding natural moisture contents were between 20 and 23%.

### Silty Clay/Clay

Below the fill and pavement structure in Boreholes 1, 3, 4 and 5, and underlying the clayey silt in Borehole 2, silty clay to clay was encountered. This deposit extended to between 7.1 and 8.3 m( $\pm$ ) in Boreholes 1 through 3, and to at least the maximum depths investigated in Boreholes 4 and 5. The material was typically brown, although in Borehole 2 it was grey. It changed color to grey at 9.1 m( $\pm$ ) in Borehole 4. The brown colour indicates desiccation and oxidation of the soil. It was fissured and laminated with traces of sand and gravel. Some shale inclusions were encountered in Borehole 1 at 6.4 m( $\pm$ ). The soil was firm to hard, with Standard Penetration Resistance testing giving 'N' values between 8 and 45 blows for 30 cm. Corresponding natural moisture contents were between 12 and 32%.

The results from the Atterberg Limit Tests performed on this material are plotted on Figure 1 on page A-13, and summarized as follows.

Index Properties	Range (%)
Moisture Content (w)	15 - 32
Liquid Limit ( $w_L$ )	26 - 57
Plastic Limit ( $w_p$ )	14 - 24
Plasticity Index ( $I_p$ )	11 - 33

From the plasticity chart, it is evident that the layer can be classified as a silty clay of low to high plasticity (CL, CI and CH). From the M.T.C. Soil Classification Manual (January 1980), these soils are anticipated to have medium to high dry strengths, medium to high toughness and very slow to no dilatancy.

Grain Size Distribution tests were carried out on these materials. The results of these tests are plotted separately for each individual sample tested and are appended in Appendix A.

Undrained Shear Strength of the soil was determined by an in-situ vane test and through Standard Penetration Resistance Testing results. The results are noted on the Logs of Boreholes in Appendix A. A summarized form of the in-situ vane test performed is presented as follows:

Undrained Shear Strength	$C_u$ (kPa)	Sensitivity
In-Situ Vane Test	32	2.2

The vane shear strength measured within this layer was 32 kPa, indicating a firm consistency. This layer has a sensitivity of 2.2 based on the measured undisturbed and remoulded vane strengths, indicating a normal silty clay.

#### Clayey Silt

Under the clay in Boreholes 1, 2 and 3, a layer of brown clayey silt was encountered extending to the maximum depths investigated. It contained till like zones and some cohesive seams. The soil was stiff to hard, with Standard Penetration Resistance testing giving 'N' values between 15 blows for 30 cm and 50 blows for 13 cm. Corresponding natural moisture contents were between 8 and 17%.

The results from the Atterberg Limit Tests performed on this material are plotted on Figure 1 on page A-13, and summarized as follows.

Index Properties	(%)
Moisture Content (w)	8 - 17
Liquid Limit ( $w_L$ )	21
Plastic Limit ( $w_p$ )	14
Plasticity Index ( $I_p$ )	7

From the plasticity chart, the soil encountered at depth in Boreholes 1 through 3 can be classified as an inorganic silt with traces of sand and gravel of slight plasticity (CL-ML). From the M.T.C. Soil Classification Manual (January 1980) these soils are anticipated to have medium to high dry strengths, medium toughness and very slow to no dilatancy.

Grain Size Distribution tests were carried out on these materials. The results of these tests are plotted separately for each sample tested and appended in Appendix A.

#### GROUNDWATER CONDITIONS

Groundwater conditions were observed through the measurement of water level in the open boreholes. Upon completion of the drilling procedures each of the Boreholes, with the exception of Borehole 4, was dry and open to the full depth investigated. The water level in Borehole 4, upon completion of the drilling procedure was at an elevation of 117.4 m. The following water levels were observed during the field investigation.

BH No.	Elevation of Water Level (m)	Depth (m)
1	Dry	N/A
2	Dry	N/A
3	Dry	N/A
4	117.4	0.7
5	Dry	N/A

The color change from brown to grey typically indicates the level below which the soils are permanently saturated. In those boreholes which were dry and open upon completion of drilling, the silt layer was generally moist to wet, with some saturated zones. Response time through the silts is generally not rapid, and no free groundwater was observed in the boreholes where the silt was encountered. However, we expect there would have been some seepage into the boreholes, had they been allowed to remain open for a period of time.

## **Part 2 - Foundation Design Report**

A geotechnical investigation was carried out for the installation of nine High Mast Lighting Poles along the Queen Elizabeth Highway, from Glendale Avenue to the Highway 405/QEW Interchange. The field work was carried out on 98 03 25. It consisted of advancing five boreholes to provide soil parameters for foundation design.

This report deals with the five westerly High Mast Lighting Poles, designated F1 through F5 by the consultant. The remaining four High Mast Lighting Poles (P1 through P4), are covered in AGRA Earth & Environmental Limited Report # 98050.

Table 1 on page 7 indicates the conditions anticipated at each of the five westerly High Mast Lighting Pole locations, along with the borehole number from which the pertinent soil parameters were obtained.

No significant grade changes are proposed at the HML locations. None of the HML Locations are on slopes.

### **DESIGN CONSIDERATIONS**

The High Mast Lighting foundations will be supported on a single concrete caisson and the design should be in accordance with the method described by Broms as per the following papers.

BROMS, B.B.: Lateral Resistance of Piles in Cohesive Soils, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 90, No. SM2, Paper No. 3825, March 1964.

BROMS, B.B.: Lateral Resistance of Piles in Cohesionless Soils, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 90, No. SM3, Paper No. 3909, May 1964.

BROMS, B.B.: Design of Laterally Loaded Piles, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 91, Paper No. SM3, May 1965.

The soil parameters provided in Table 1 are recommended for the design of the HML foundations. The following notation has been adopted:

$\phi$  = apparent angle of friction for cohesionless soils in degrees  
 $q_u$  = unconfined compressive strength in kPa ( $q_u = 2 \times C_u$ ) for cohesive soils  
 $\gamma$  = bulk unit weight in kN/m<sup>3</sup>

The  $\gamma$  values have been estimated. It is recommended that the  $c$  and  $\phi$  values through the top 1.2 metres be neglected, because of frost penetration.



CLOSURE

The Report Limitations, as quoted in the appendix, are an integral part of this report.

We trust this report is complete within our present terms of reference. If you have any questions, please do not hesitate to contact our office.

Yours very truly,

AGRA Earth & Environmental Limited

Submitted By:

Reviewed By:



Jane Doucette, P.Eng.

10 copies Client  
Encl.



Zuhtu Ozden, P.Eng.

Table 1: Location and Soil Parameters

High Mast Lighting Pole Location	E/P at HML Location (m)	BH	Elevation (m) From - To	Type of Soil	Denseness or Consistency	$q_u$ (kPa)	Moisture Content (%)	Bulk Unit Weight (kN/m <sup>3</sup> )	$\phi$ (Deg)
F5 Stn.10+060 Median between WB QEW and EB QEW	119.15	3	121.8 - 120.2	Mixed	Firm/Loose	-	22	18.0	
			120.3 - 118.4	Mixed	Stiff/Compact	50	25	18.0	
			118.4 - 117.8	Cohesive	Stiff	170	24	20.0	
			117.8 - 116.2	Cohesive	Hard	370	23	21.0	
			116.2 - 114.7	Cohesive	Stiff	150	25	20.0	
			114.7 - 113.6	Cohesive	Hard	500	14	22.0	
			113.6 - 112.2	Cohesive	Hard	600	17	23.0	
F4 Stn.20+148 Median between WB QEW and EB QEW	116.59	3	121.8 - 120.2	Mixed	Firm/Loose	-	22	18.0	
			120.3 - 118.4	Mixed	Stiff/Compact	50	25	18.0	
			118.4 - 117.8	Cohesive	Stiff	170	24	20.0	
			117.8 - 116.2	Cohesive	Hard	370	23	21.0	
			116.2 - 114.7	Cohesive	Stiff	150	25	20.0	
			114.7 - 113.6	Cohesive	Hard	500	14	22.0	
			113.6 - 112.2	Cohesive	Hard	600	17	23.0	
F3 Stn.19+976 Median between WB QEW and EB QEW	117.28	4	118.1 - 117.6	Non-cohesive	Loose/compact	-	22	18.0	33°
			117.6 - 113.3	Cohesive	Firm	60	24	20.0	
			113.1 - 110.9	Cohesive	Very Stiff	190	22	21.0	
			110.9 - 108.5	Cohesive	Stiff	130	29	20.0	
F2 Stn.19+813 Median between WB QEW and EB QEW	117.96	5	117.7 - 117.1	Non-cohesive	Loose/compact	-	-	18.0	33°
			117.1 - 116.4	Cohesive	Stiff	150	24	20.0	
			116.4 - 115.2	Cohesive	Hard	380	25	21.0	
			115.2 - 109.1	Cohesive	Very Stiff	220	28	20.0	
			109.1 - 108.1	Cohesive	Stiff	150	30	19.0	
F1 Stn.19+652 Median between WB QEW and EB QEW	116.72	5	117.7 - 117.1	Non-cohesive	Loose/compact	-	-	18.0	33°
			117.1 - 116.4	Cohesive	Stiff	150	24	20.0	
			116.4 - 115.2	Cohesive	Hard	380	25	21.0	
			115.2 - 109.1	Cohesive	Very Stiff	220	28	20.0	
			109.1 - 108.1	Cohesive	Stiff	150	30	19.0	

Note Stations taken from drawings provided for our use by Marshall Macklin Monaghan. The drawings are plan drawings for MTO project no. WP 134-92-00 and are designated as sheets E1 through E3.

## **APPENDIX A**

## GENERAL REPORT NOTES

### DEFINITIONS OF PENETRATION RESISTANCE

Standard penetration resistance 'N': -- The number of blows required to advance a standard split spoon sampler 30 cm into the subsoil, driven by means of a 63.5 kg hammer falling freely a distance of 70 cm.

Dynamic penetration resistance: -- The number of blows required to advance a 50 mm, 60 degree cone, fitted to the end of drill rods, 30 cm into the subsoil, the driving energy being 474.5 Joules per blow.

### SAMPLE TYPE ABBREVIATIONS USED IN BOREHOLE LOGS

S.S.	Split spoon	T.W.	Thinwall open	R.C.	Rock core
A.S.	Auger sample	T.P.	Thinwall piston	W.S.	Washed sample
	P.H.	Sample pushed hydraulically	P.M.	Sample pushed manually	

### SOIL TEST SYMBOLS USED IN BOREHOLE LOGS

○ Standard penetration resistance	▽ Laboratory vane	□ Unconfined compression
● Dynamic penetration resistance	△ Field vane	■ Undrained triaxial
	X Penetrometer	S Sensitivity

### CONVENTIONAL SOIL DESCRIPTIONS

#### COHESIVE (CLAYS ETC.)

Consistency	'N' blows/30cm	c kPa	Denseness	'N' blows/30 cm
Very Soft	0 - 2	0 - 12	Very Loose	0 - 4
Soft	2 - 4	12 - 24	Loose	4 - 10
Firm	4 - 8	24 - 48	Compact	10 - 30
Stiff	8 - 15	48 - 96	Dense	30 - 50
Very Stiff	15 - 30	96 - 191	Very Dense	>50
Hard	>30	> 191		

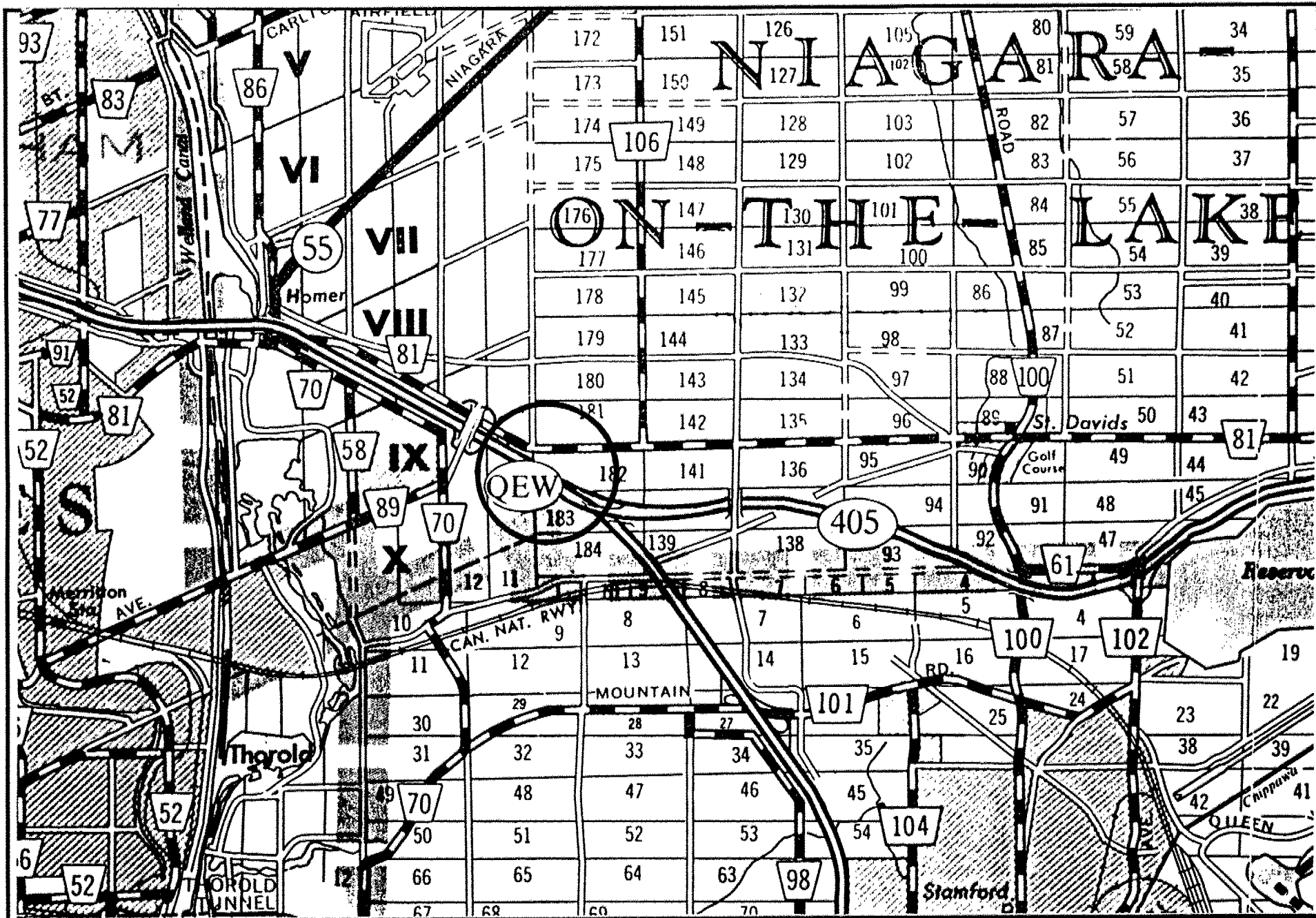
### ABBREVIATIONS FOR MOISTURE CONDITIONS

sdtpl - slightly drier than the plastic limit.  
dtpl - drier than the plastic limit.  
apl - about the plastic limit.

swtpl - slightly wetter than the plastic limit.  
wtpl - wetter than the plastic limit.  
mwtpl - much wetter than the plastic limit.

### NOTE

The soil conditions, profiles, comments, conclusions and recommendations found in this report are based upon the samples recovered during the field work. Soils are heterogeneous materials and, consequently, variations (possibly extreme) may be encountered at site locations away from boreholes. During construction, competent, qualified inspection personnel should verify that no significant variations exist from the conditions described in this report.

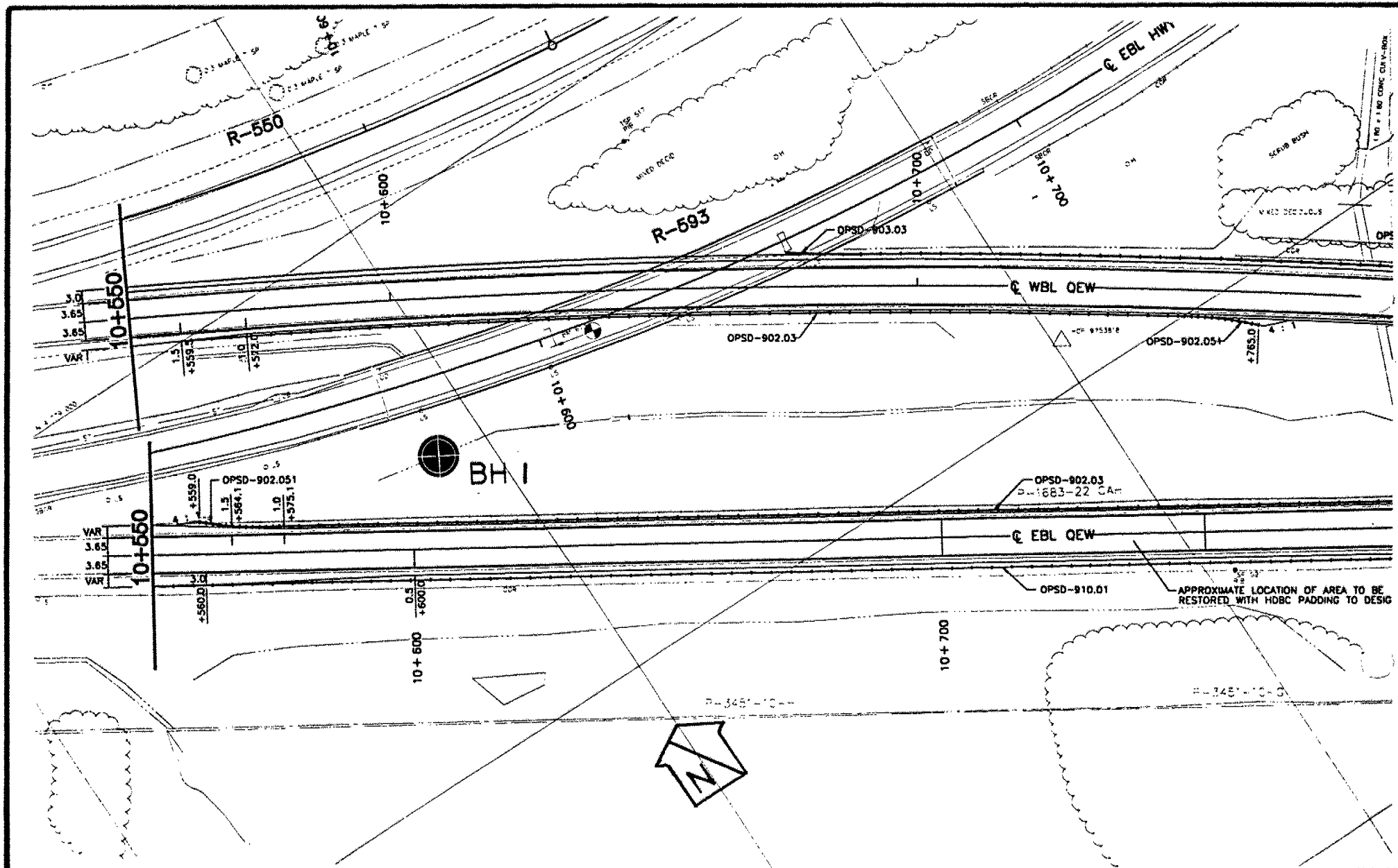


SCALE - n.t.s.

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KEY PLAN

A-2  
TG98051

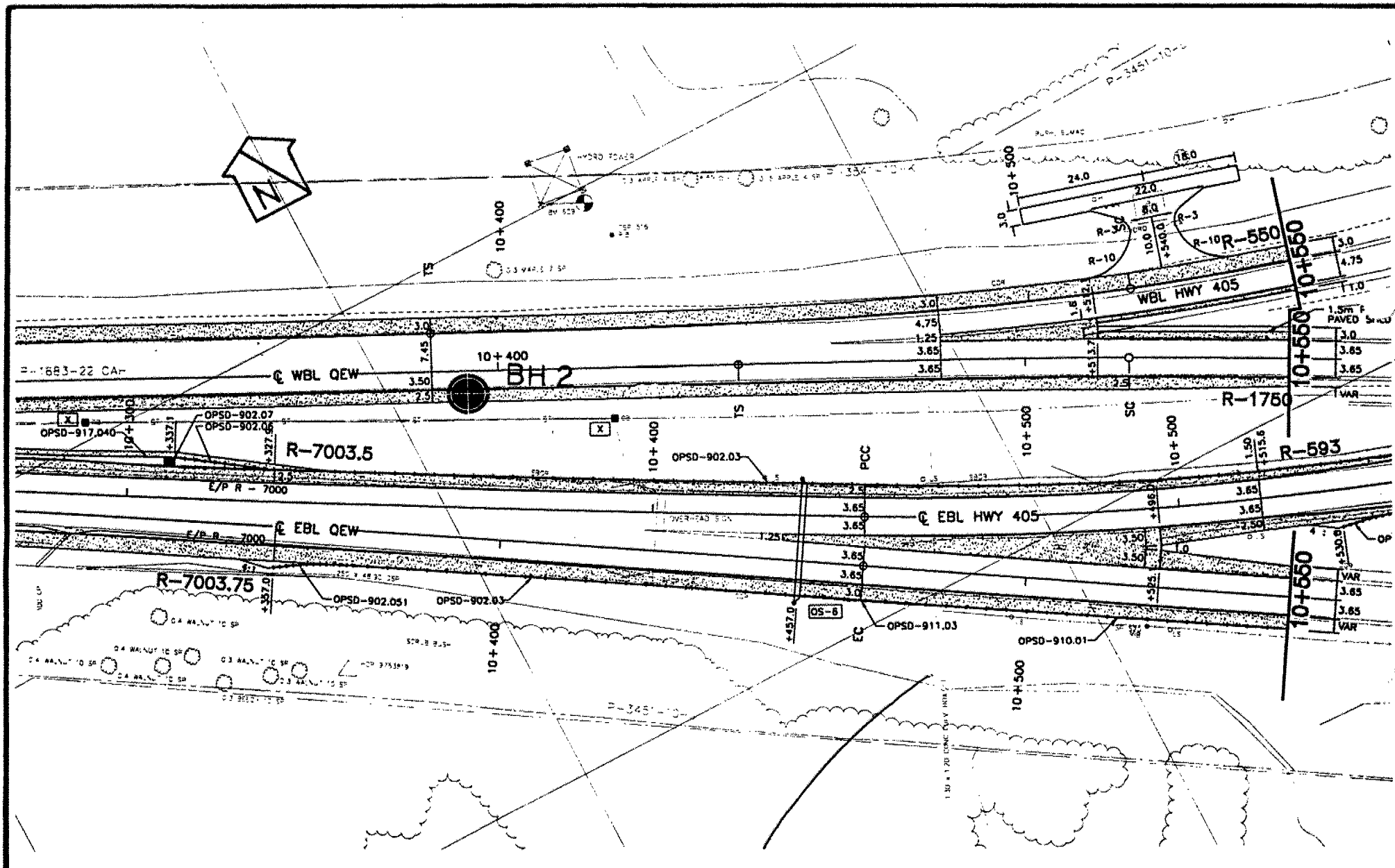


SCALE - 1" = 1000'

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BOREHOLE LOCATION PLAN

A-3  
TG98050

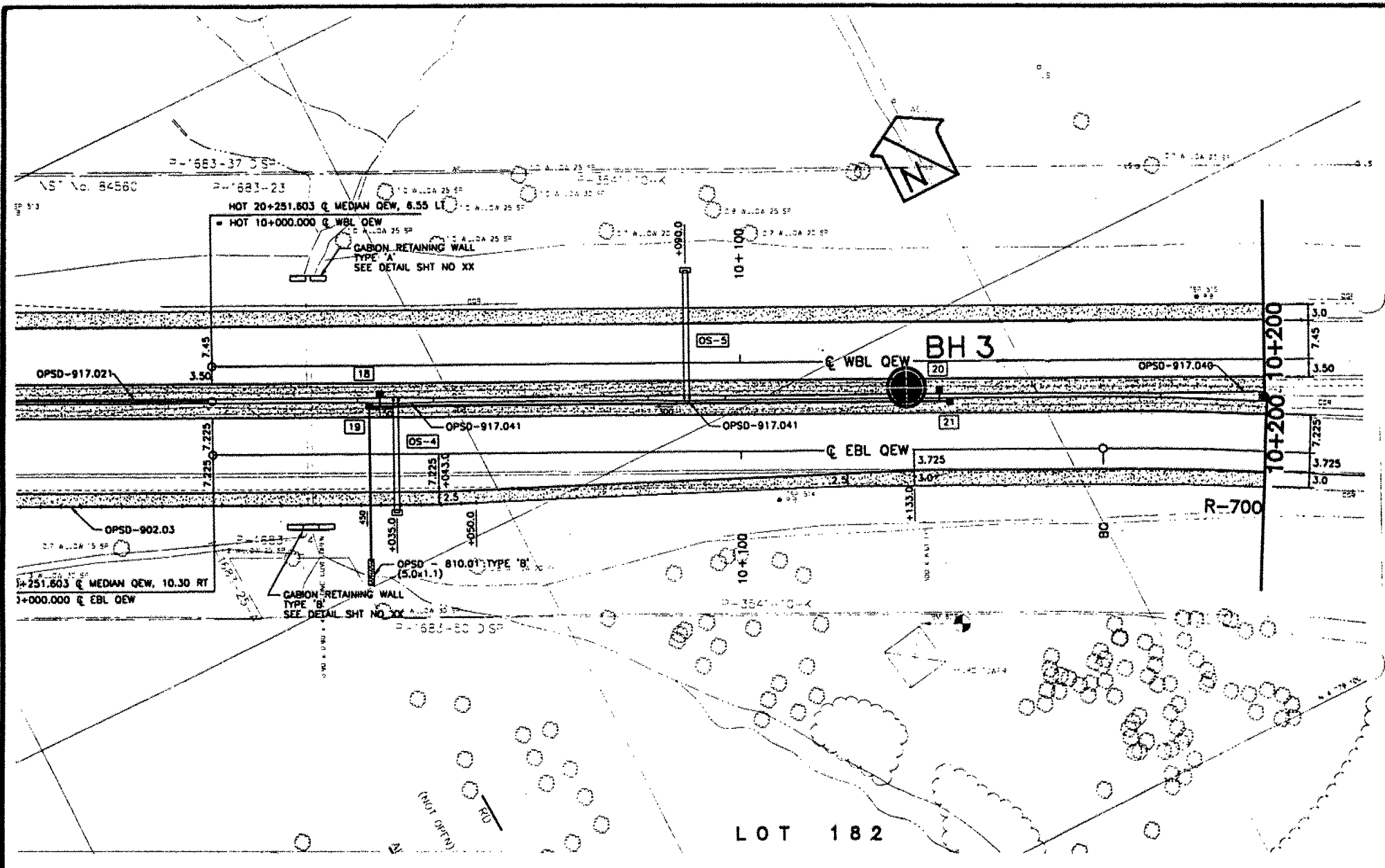


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BOREHOLE LOCATION PLAN

A-4  
TG98050



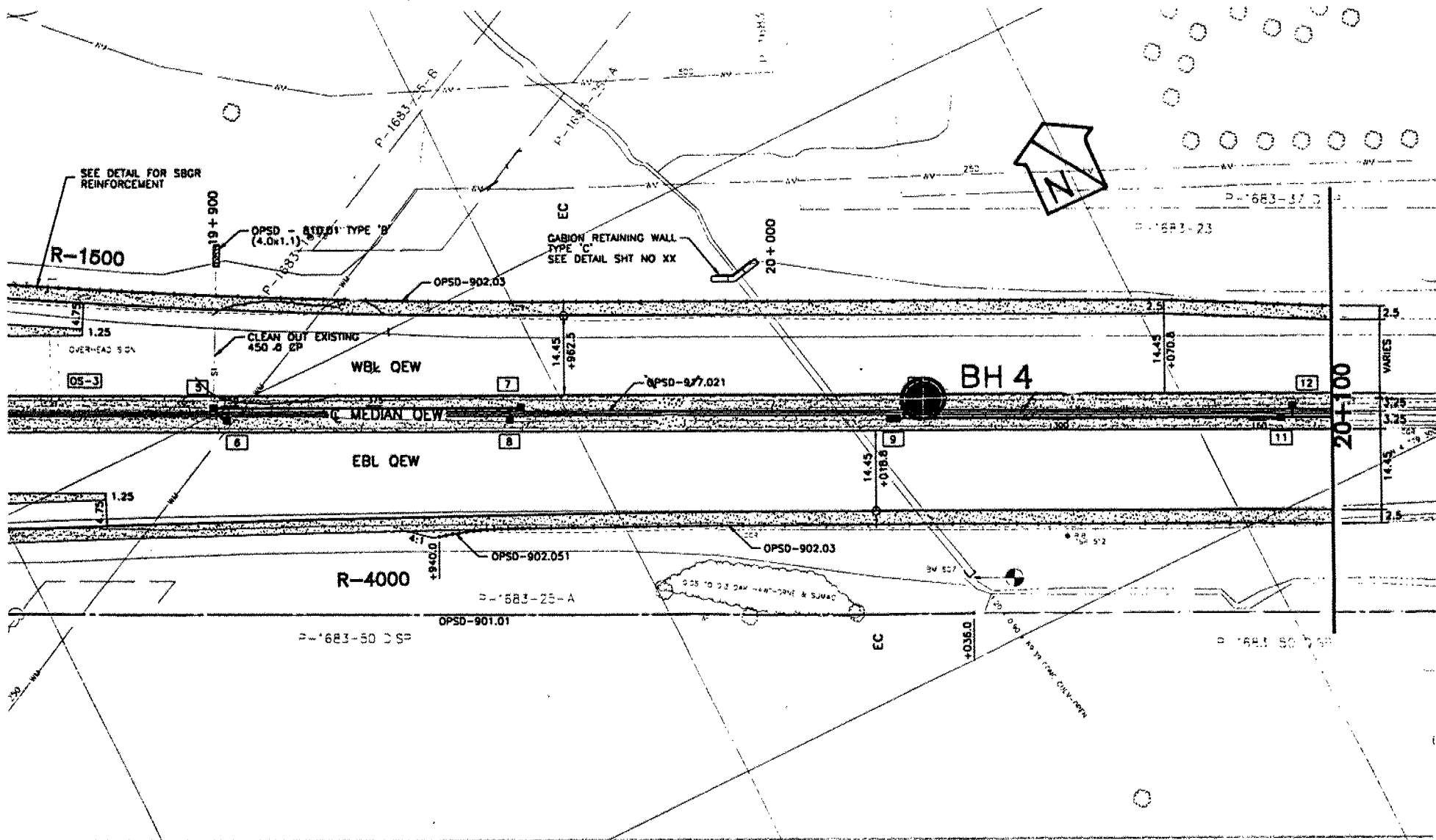
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BOREHOLE LOCATION PLAN

A-5  
T698050



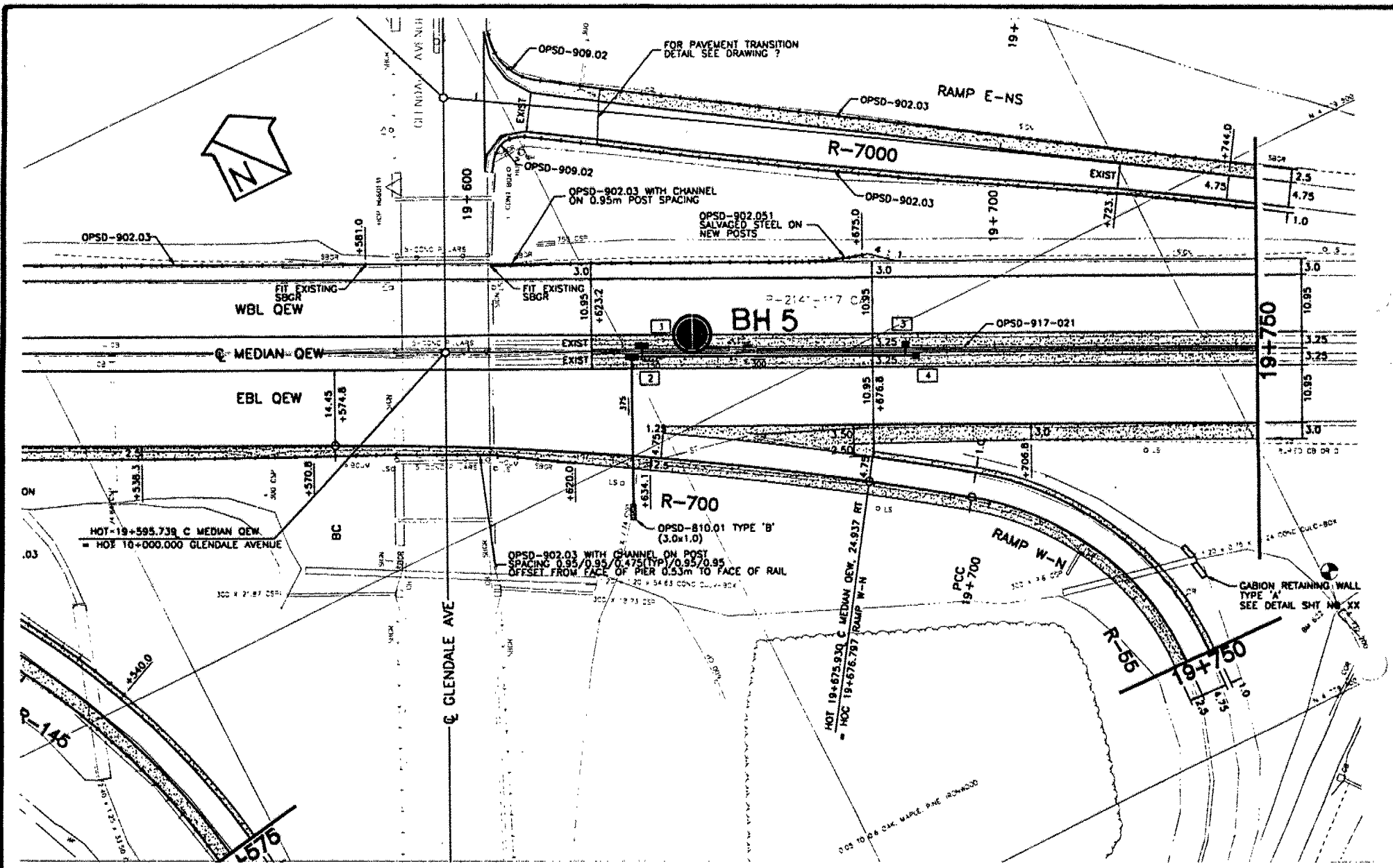


SCALE - 1"=1000'

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BOREHOLE LOCATION PLAN

A-6  
TG98051



SCALE-1:1000

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BOREHOLE LOCATION PLAN

A-7  
TG98051

**Borehole #: 1**

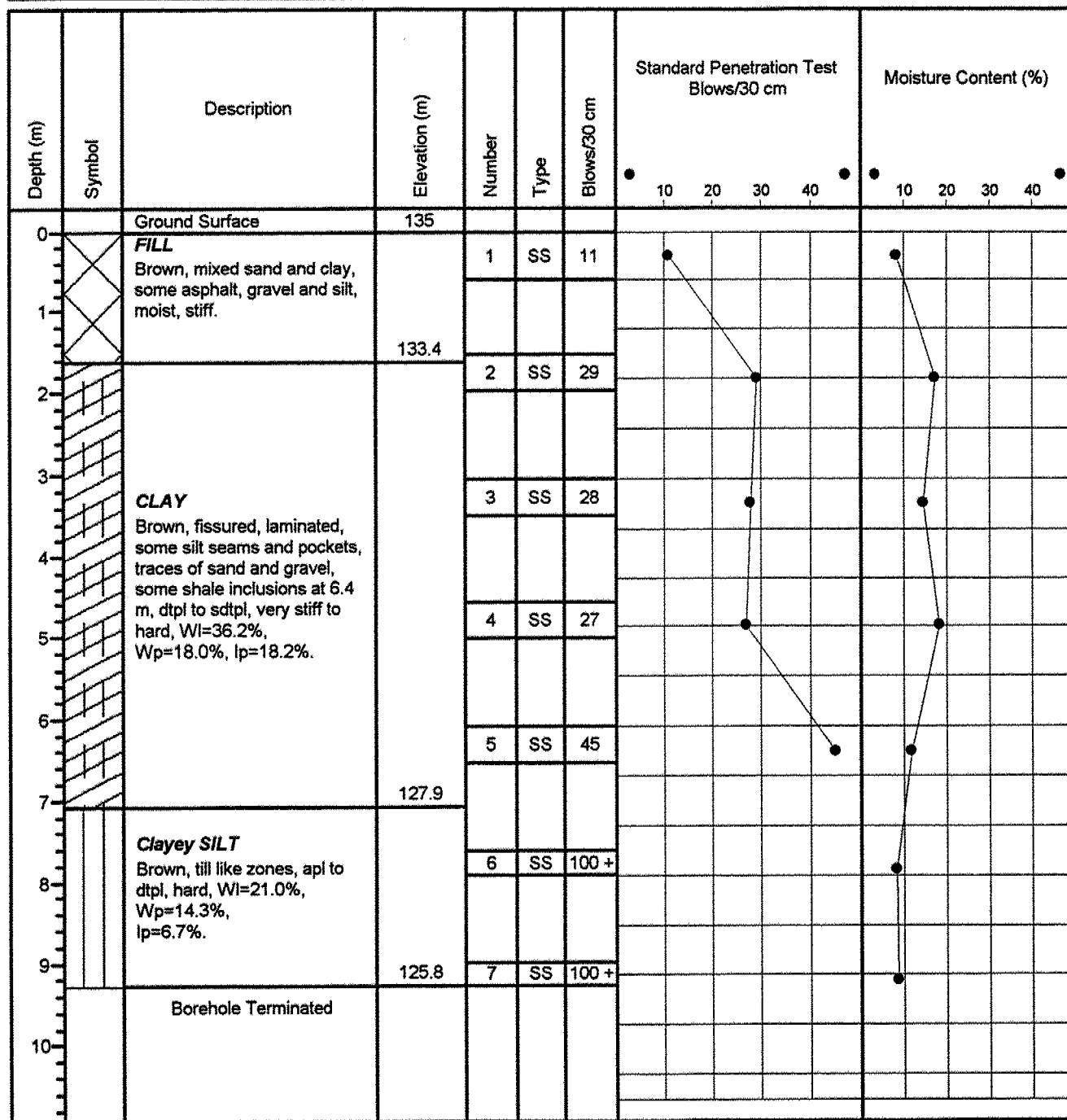
Project No: TG98051

Coordinates: N 4 778 954, E 333 191

Location: QEW/405, Niagara-On-The-Lake

Client: Totten Sims Hubicki

Prepared By: M. Leitch



**Borehole #: 2**

Project No: TG98051

Coordinates: N 4 779 074, E 333 012

Location: QE/W405, Niagara-On-The-Lake

Client: Totten Sims Hubicki

Prepared By: M. Leitch

Depth (m)	Symbol	Description	Elevation (m)	Number	Type	Blows/30 cm	Standard Penetration Test Blows/30 cm	Moisture Content (%)
0		Ground Surface	130.1					
0		<b>FILL</b> 60 cm of Crushed Limestone over Sandy Clay Fill, apl, very stiff.	129	1	SS	15		
1								
2				2	SS	18		
3		<b>Clayey SILT</b> Brown, fissured, grinding at 4.6 m possible cobbles, some silt seams, traces of sand and gravel, some saturated seams, apl to swtpl, very stiff.	124.5	3	SS	21		
4								
5				4	SS	15		
6		<b>Silty CLAY</b> Grey, some silt seams and zones, wtpl, firm. Vane at 6.7 m: S = 2.2 Shear = 32 kPa Remould = 14 kPa	122.2	5	SS	8		
7								
8		<b>Clayey SILT</b> Reddish brown, some till like zones, some silt zones, wtpl to apl, stiff to very stiff, Wl=26.2%, Wp=15.4%, Ip=10.8%.	120.5	6	SS	14		
9				7	SS	15		
10		Borehole Terminated						

Drilled by: Elite Drilling

Drill Method: Solid Stem Augers

Upon Completion: Borehole dry and open.

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Hole Size: 150 mm

Datum: Local Geodetic

Drill Date: 98 03 25

**Borehole #: 3**

Project No: TG98051

Coordinates: N 4 779 188, E 332 779

Location: QEW/405, Niagara-On-The-Lake

Client: Totten Sims Hubicki

Prepared By: M. Leitch

Depth (m)	Symbol	Description	Elevation (m)	Number	Type	Blows/30 cm	Standard Penetration Test Blows/30 cm	Moisture Content (%)
0		Ground Surface	121.8					
1		<b>FILL</b> 25 cm Asphalt over 10 cm Crushed Limestone over 25 cm of red coarse Sand over Clayey Fill, mixed with some gravel and silt, wtpl, firm.	120.2	1	SS	6		
2		<b>Old Road Structure</b> Asphalt over Crushed Limestone over brown Silty Clay Fill, apl, stiff over Buried Topsoil.	118.4	2	SS	14		
3				3	SS	13		
4								
5		<b>Silty CLAY</b> Brown, fissured, laminated, traces of sand and gravel, some saturated seams, some silt zones, apl to dtpl, stiff to hard.		4	SS	30		
6								
7								
8			113.5	5	SS	12		
9		<b>Clayey SILT</b> Brown, till like zones, some cohesive seams, sdtpl, hard.	112.2	6	SS	40		
10				7	SS	80		
		Borehole Terminated						

Drilled by: Elite Drilling

Drill Method: Solid Stem Augers

Upon Completion: Borehole dry and open.

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Hole Size: 150 mm

Datum: Local Geodetic

Drill Date: 98 03 25

**Borehole #: 4**

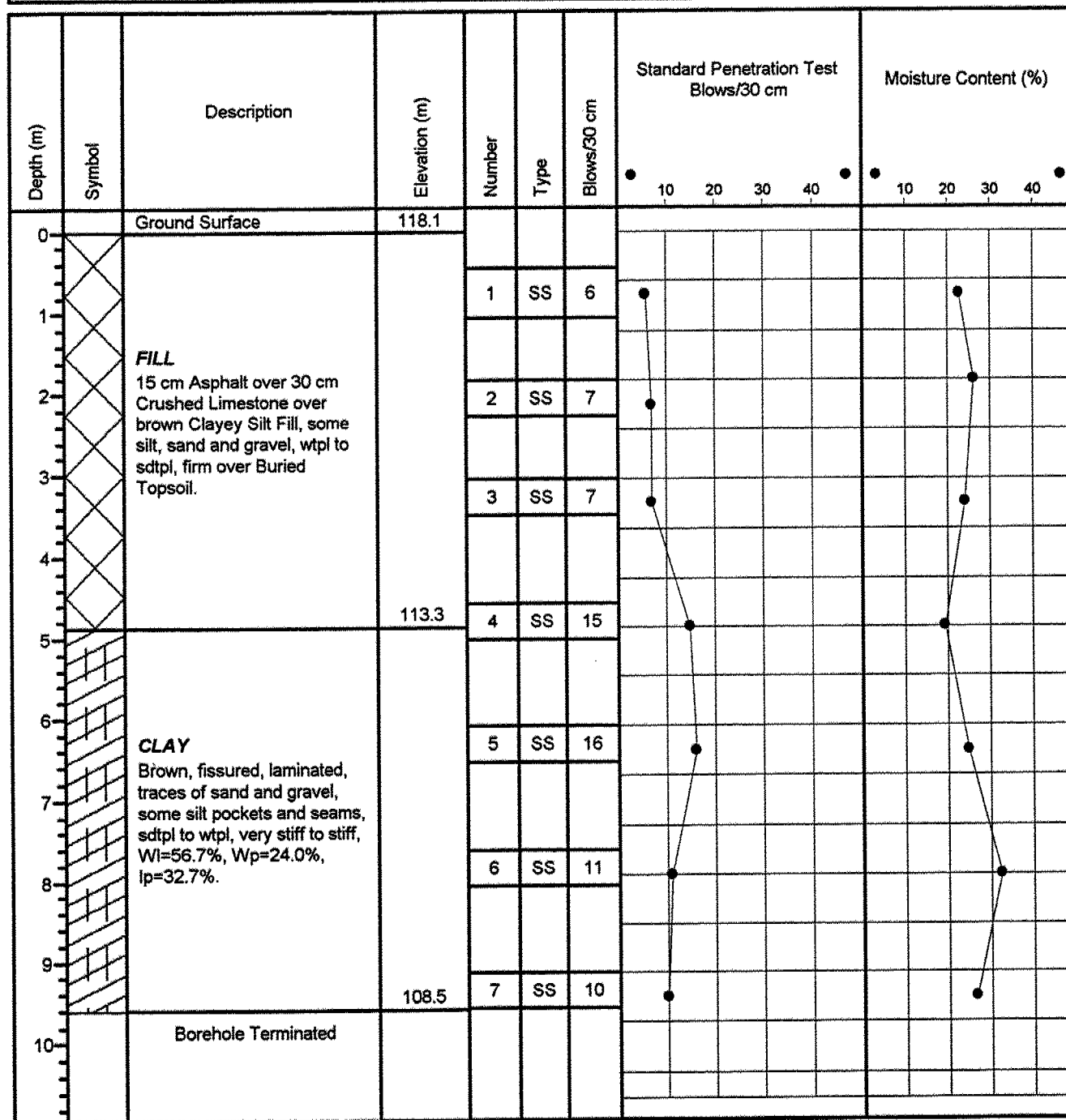
Project No: TG98051

Coordinates: N 4 779 342, E 332 558

Location: QEW/405, Niagara-On-The-Lake

Client: Marshall Macklin Monaghan

Prepared By: M. Leitch



Drilled by: Eastern Soils

Drill Method: Solid Stem Augers

Upon Completion: Water level at 0.7 m, caved at 6.1 m.

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Hole Size: 115 mm

Datum: Local Geodetic

Drill Date: 98 03 25

**Borehole #: 5**

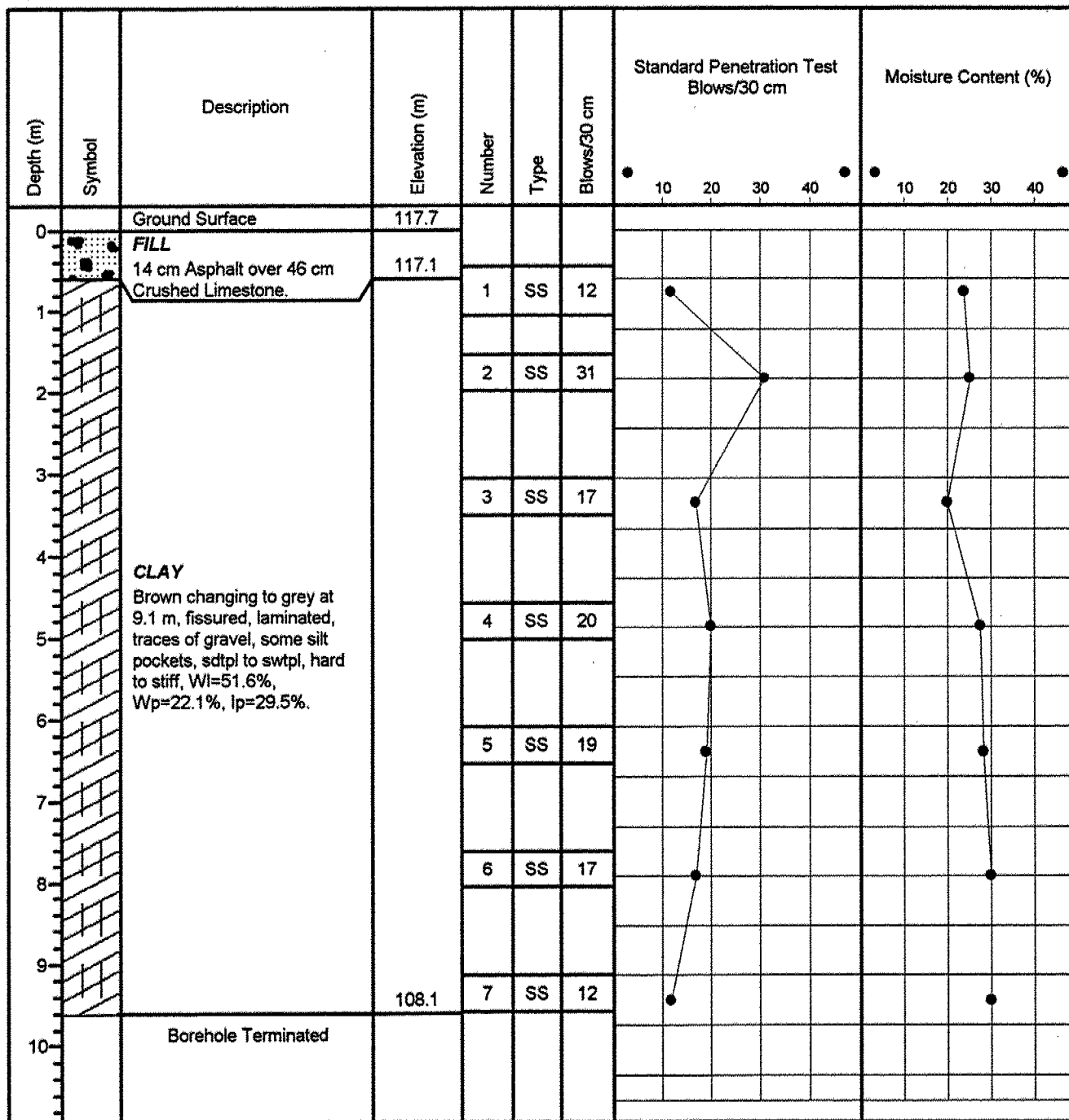
Project No: TG98051

Coordinates: N 4 779 515, E 332 113

Location: QEW/405, Niagara-On-The-Lake

Client: Marshall Macklin Monaghan

Prepared By: M. Leitch



Drilled by: Elite Drilling

Drill Method: Solid Stem Augers

Upon Completion: Borehole dry and open.

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Thorold, Ontario  
L2V 4Y6

Hole Size: 150 mm

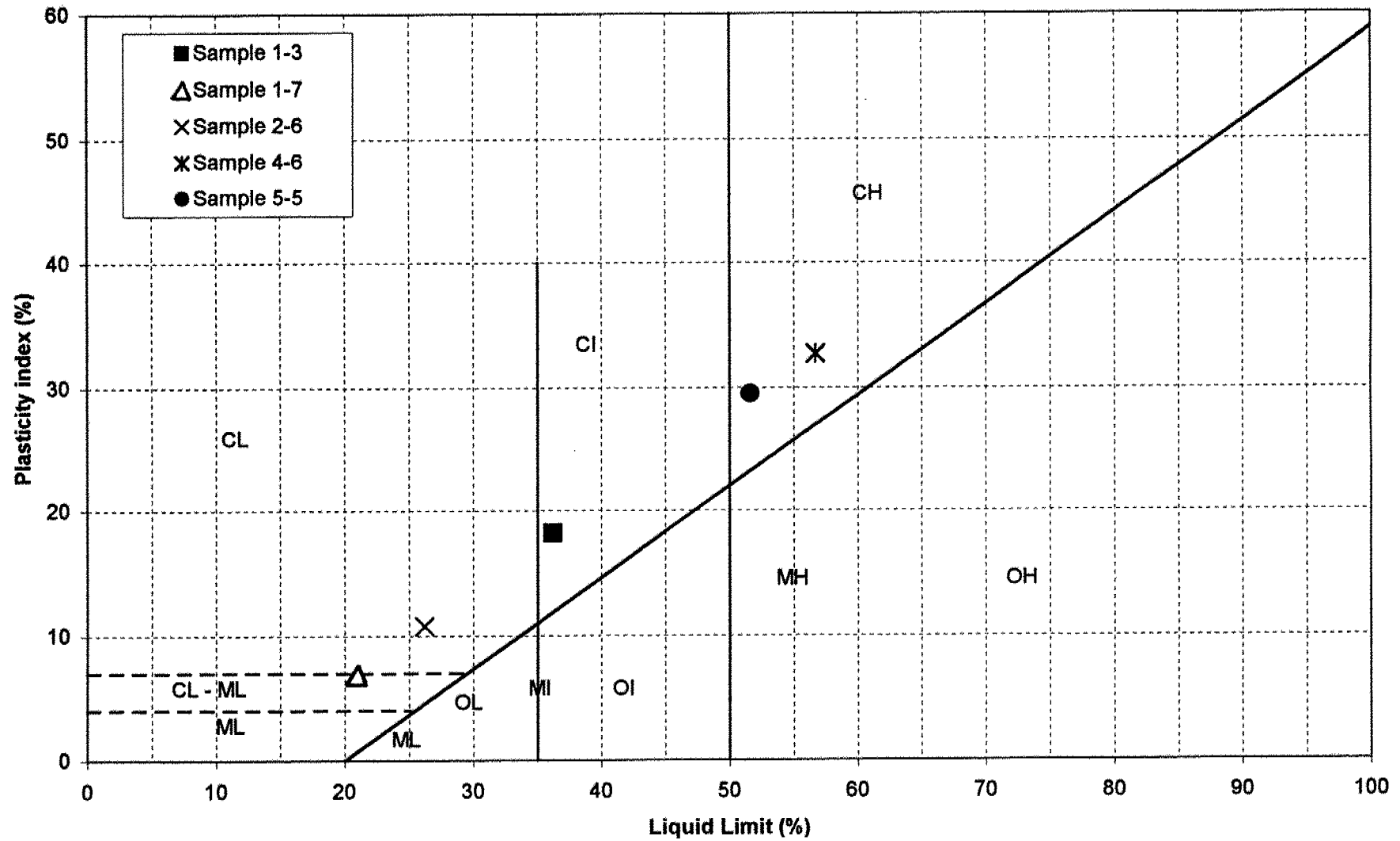
Datum: Local Geodetic

Drill Date: 98 03 25

# Plasticity Chart

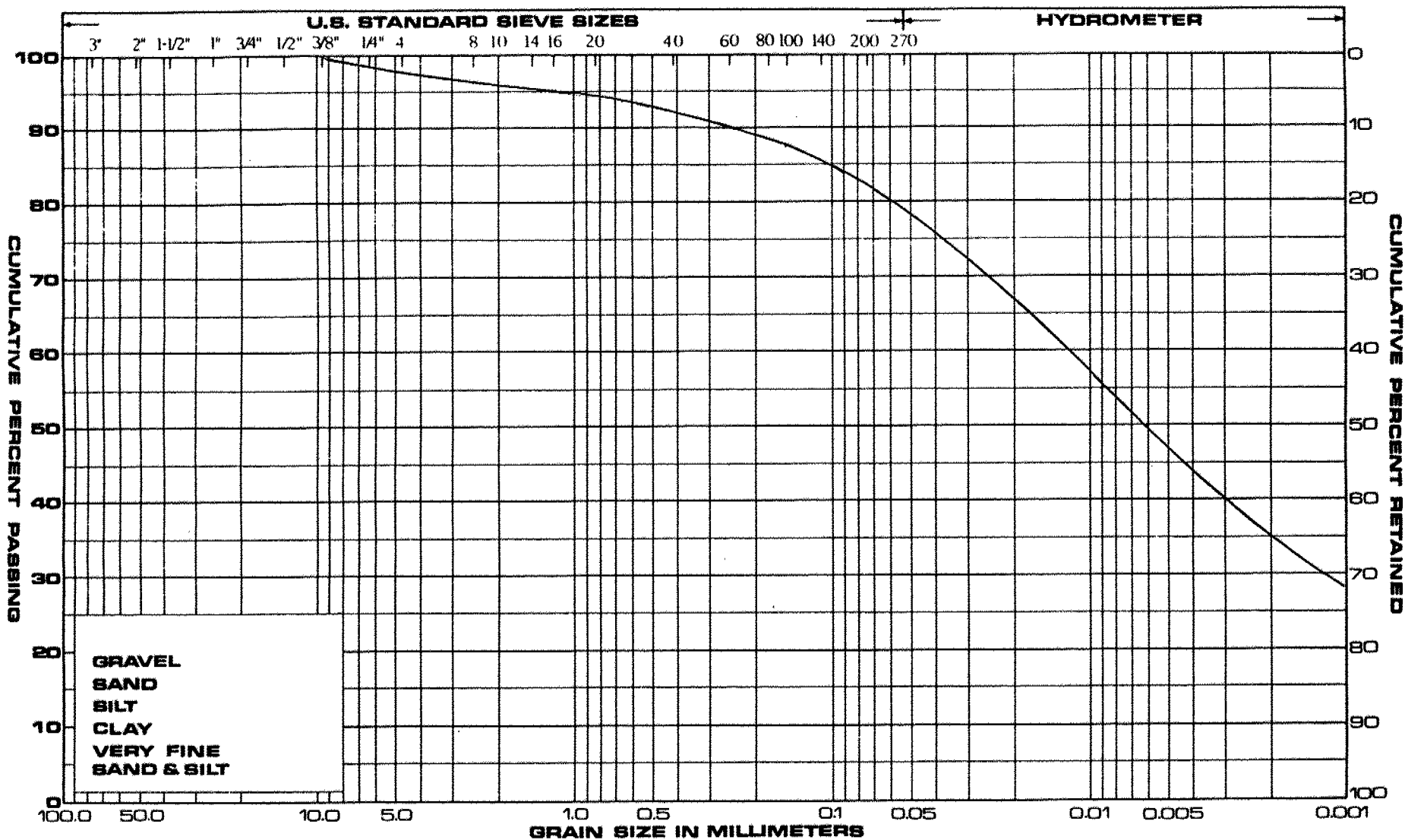
Figure 1

WP 134-92-00



A-13  
TG98051



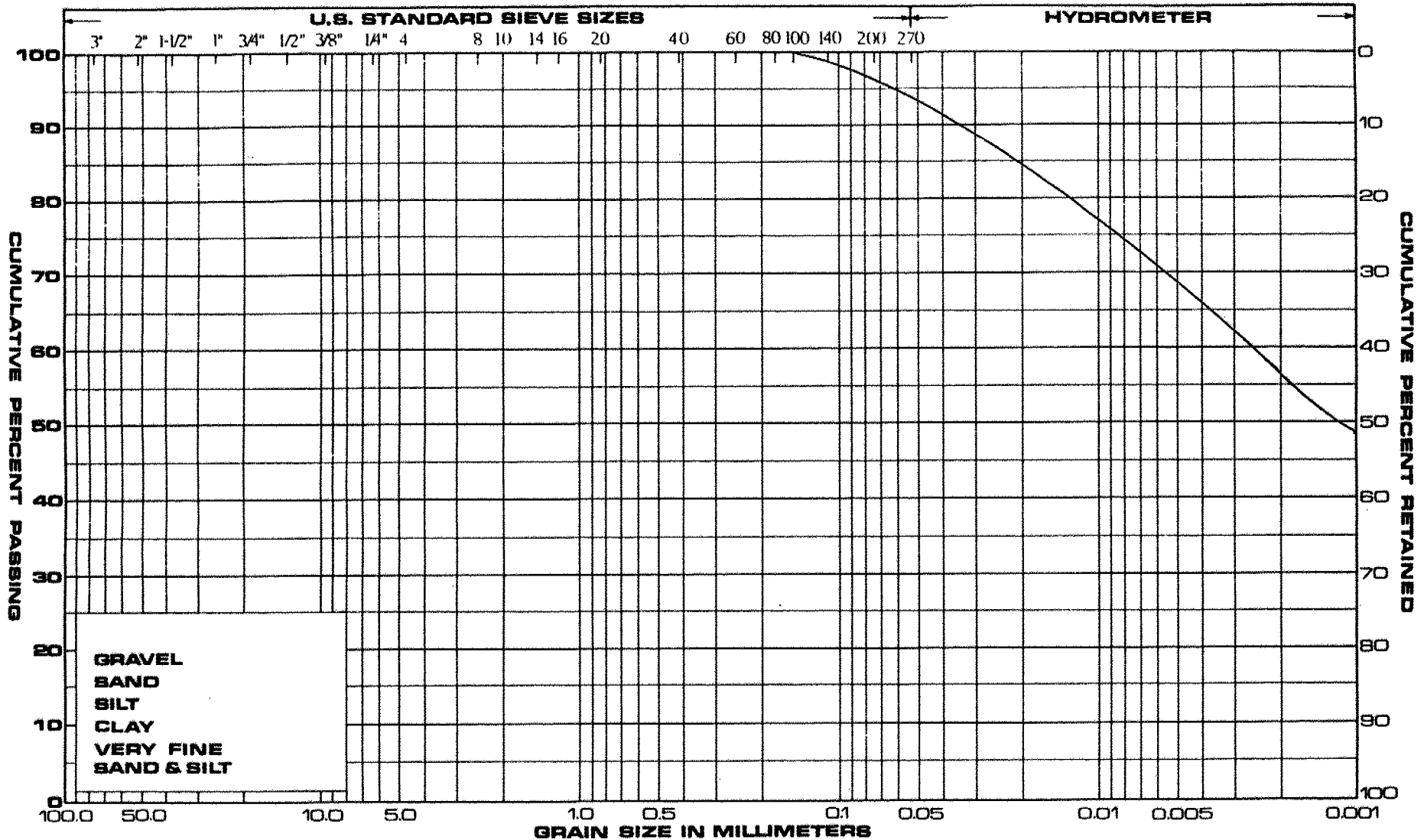


GRAVEL		COARSE	MEDIUM		FINE		SILT & CLAY			UNIFIED	
		SAND									
STONES	GRAVEL		COARSE	MEDIUM	FINE		COARSE	MEDIUM	FINE	CLAY	M.I.T.
			SAND					SILT			
	GRAVEL		COARSE	MED.	FINE	V. FINE	SILT		CLAY		U.S. BUREAU
		SAND									

JOB NAME MTO WP 132-92-00 JOB NO. TG98050 HOLE NO. 1 SAMPLE NO. 3

DEPTH 3.1 - 3.5 m REMARKS Clay of Medim Plasticity

# AGRA Earth & Environmental Ltd.



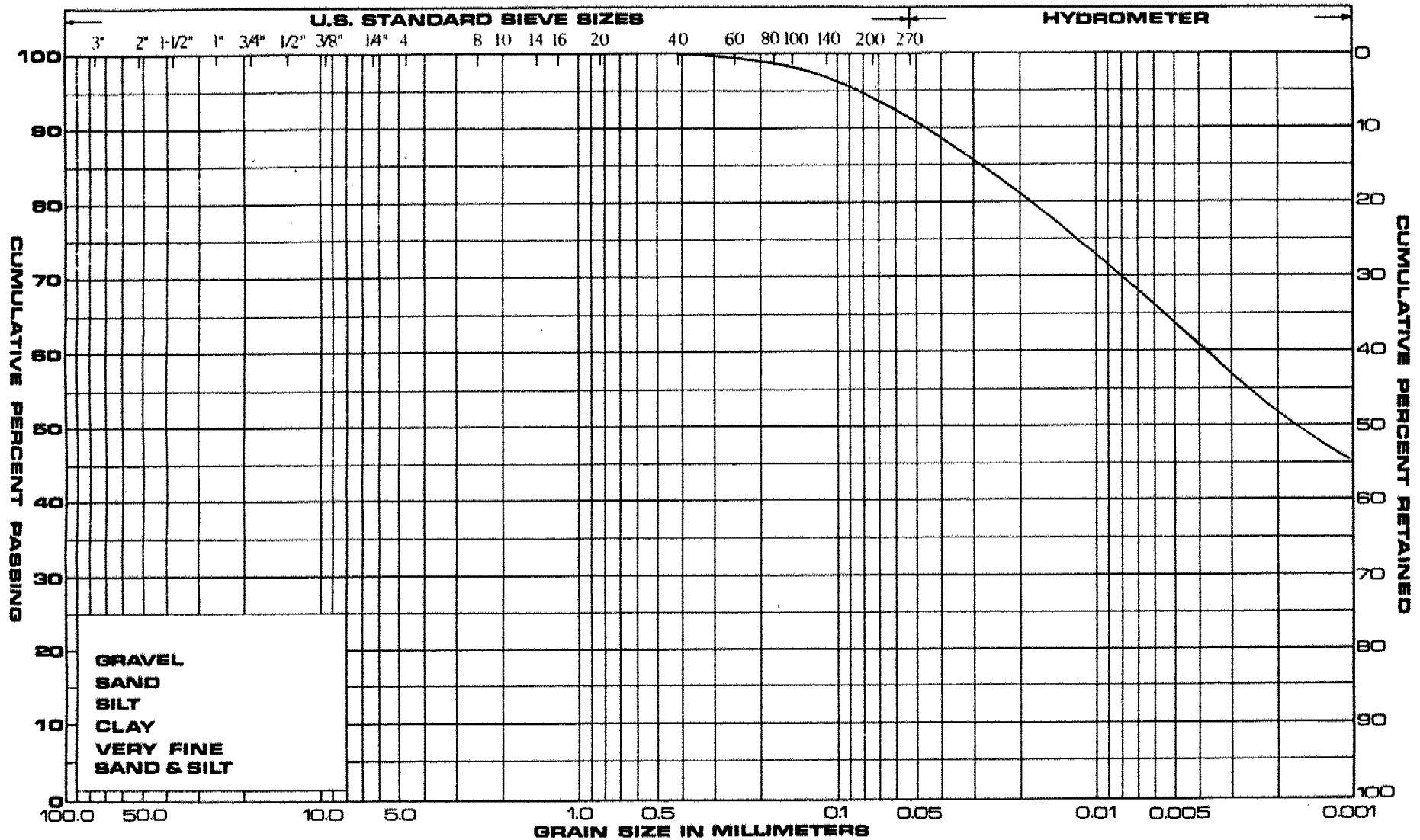
**PARTICLE SIZE DISTRIBUTION**

GRAVEL		COARSE	MEDIUM		FINE	SILT & CLAY				UNIFIED	
		SAND									
STONES	GRAVEL		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	CLAY	M.I.T.	
		SAND					SILT				
GRAVEL		COARSE	MED.	FINE	V. FINE	SILT		CLAY		U.S. BUREAU	
		SAND									

JOB NAME MTD WP 132-92-00 JOB NO. TC98051 HOLE NO. 4 SAMPLE NO. 6

DEPTH 7.6 - 8.1 m REMARKS Clay of High Plasticity

# AGRA Earth & Environmental Ltd.

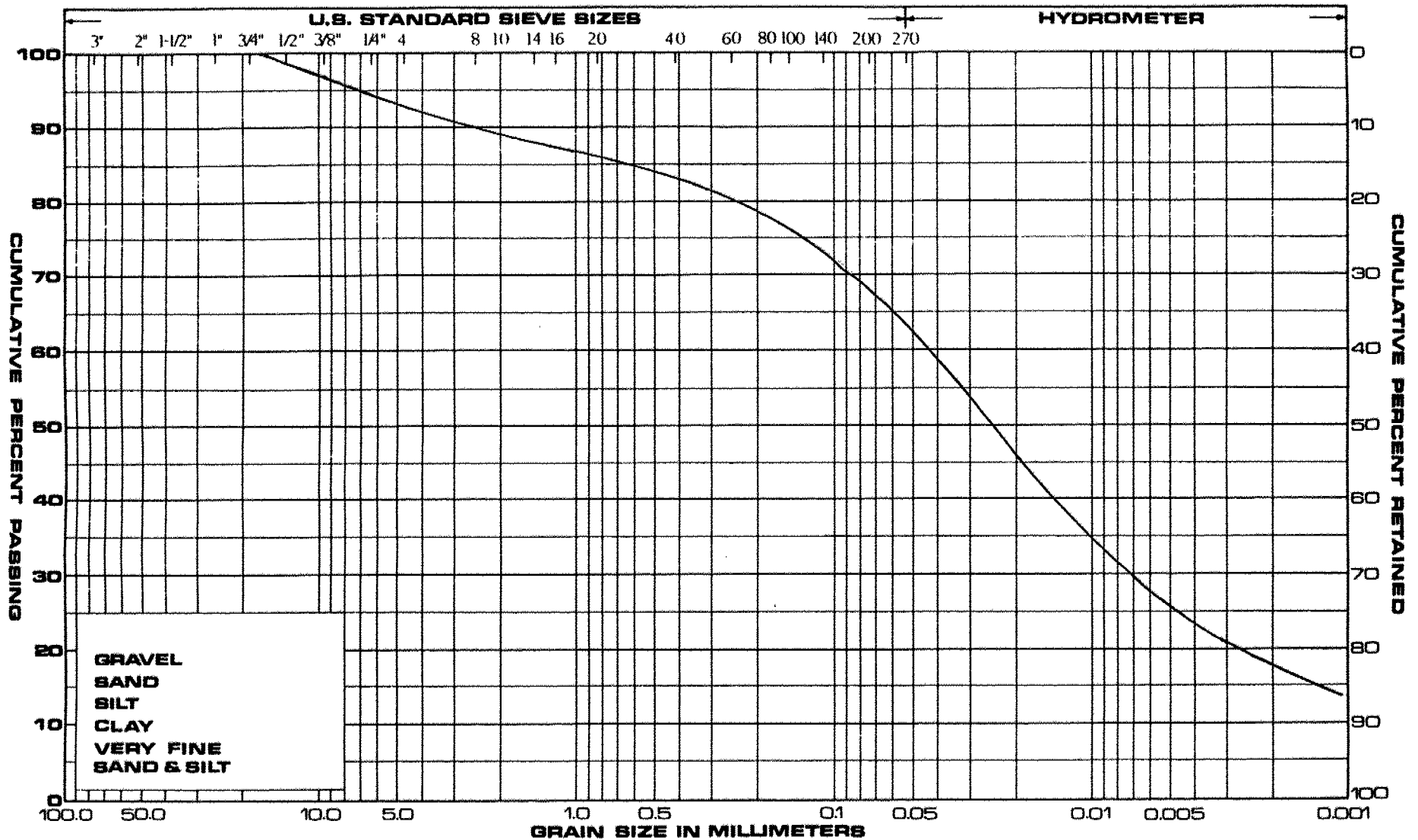


**PARTICLE SIZE DISTRIBUTION**

GRAVEL		COARSE SAND		MEDIUM SAND		FINE SAND		SILT & CLAY				UNIFIED	
GRAVEL		COARSE SAND		MEDIUM SAND		FINE SAND		COARSE SILT		FINE SILT		CLAY	M.I.T.
GRAVEL		COARSE SAND		MEDIUM SAND		FINE SAND		COARSE SILT		FINE SILT		CLAY	U.S. BUREAU
GRAVEL		COARSE SAND		MEDIUM SAND		FINE SAND		COARSE SILT		FINE SILT		CLAY	U.S. BUREAU

**JOB NAME** MTO WP 132-92-00    **JOB NO.** TG98051    **HOLE NO.** 5    **SAMPLE NO.** 5  
**DEPTH** 6.1 - 6.6 m    **REMARKS** Clay of High Plasticity

TG98050/51  
A-16



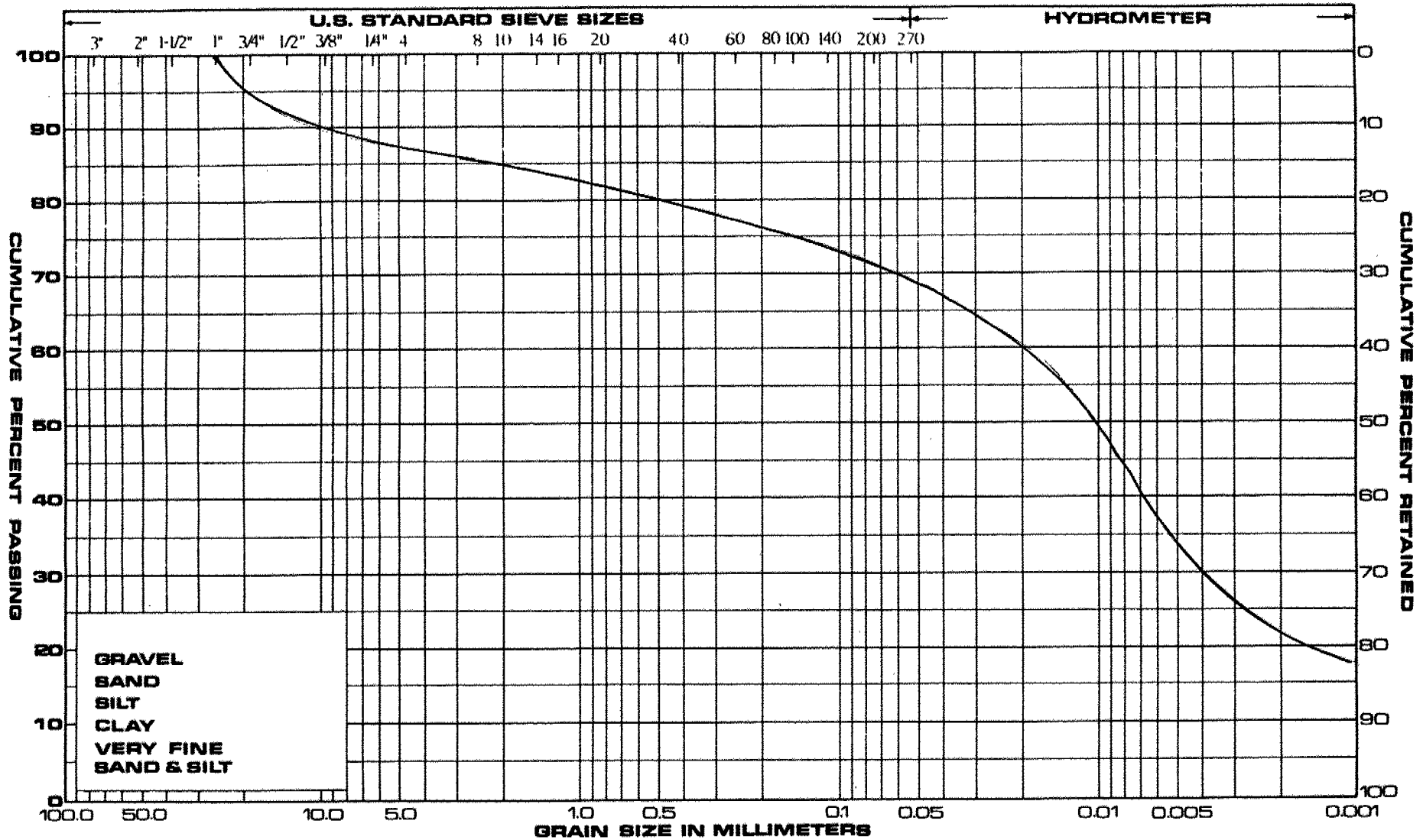
**PARTICLE SIZE DISTRIBUTION**

GRAVEL		COARSE	MEDIUM		FINE		SILT & CLAY				UNIFIED
		SAND									
STONES	GRAVEL		COARSE	MEDIUM	FINE		COARSE	MEDIUM	FINE	CLAY	M.I.T.
			SAND					SILT			
	GRAVEL		COARSE	MED.	FINE	V. FINE	BILT		CLAY		U.S. BUREAU
		SAND									

JOB NAME MTD WP 132-92-00 JOB NO. TG98050 HOLE NO. 1 SAMPLE NO. 7

DEPTH 9.1 - 9.3 m REMARKS Inorganic Silty Clay

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**PARTICLE SIZE DISTRIBUTION**

GRAVEL		COARSE	MEDIUM	FINE	SILT & CLAY				UNIFIED	
		SAND								
STONES	GRAVEL		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	CLAY	M.I.T.
			SAND			SILT				
	GRAVEL		COARSE	MED.	FINE	V. FINE	SILT		CLAY	U.S. BUREAU
		SAND								

JOB NAME MTO WP 132-92-00 JOB NO. TG98050 HOLE NO. 2 SAMPLE NO. 6

DEPTH 7.6 - 8.1 m REMARKS Inorganic Silty Clay

TG98050/51  
A-18

## **APPENDIX B**

## REPORT LIMITATIONS

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during the construction to confirm that the subsurface conditions across the site do not deviate materially from those encountered in the testholes.

The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AGRA Earth & Environmental Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.



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**GEOTECHNICAL INVESTIGATION  
HIGH MAST LIGHTING POLES  
WP 134-92-00 QUEEN ELIZABETH WAY/HIGHWAY 405  
DISTRICT 6, CENTRAL REGION**

**Submitted To:**

**Totten Sims Hubicki  
300 Water Street  
Whitby, Ontario  
L1N 9J2**

**Attention: Robert Koziol, P. Eng.**

**Submitted By:**

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S.S. #1, Thorold, Ontario  
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**June 15, 1998  
TG98050**



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## **Part I- Foundation Investigation Report**

### **INTRODUCTION**

A geotechnical investigation was carried out for the installation of High Mast Lighting Poles along the Queen Elizabeth Highway, from Glendale Avenue to the Highway 405/QEW Interchange, in the City of Niagara Falls as indicated on the Key Plan on page A-2.

A total of nine high mast lighting poles will be installed along this section of the QEW. The project has been divided into two portions, each portion being carried out by a different consultant. This report deals with the four most easterly High Mast Lighting Poles. Reference should be made to AGRA Earth & Environmental Limited Report #TG98051, in which the five westerly high mast lighting poles are dealt with.

For continuity, Part 1 of the report summarizes the factual information obtained from the field work carried out for all of the light poles, on 98 03 25. It consisted of advancing five boreholes to depths of between 9.3 and 9.6 metres, to provide soil parameters for foundation design. Borehole Location Plans are appended as pages A-3 to A-7 inclusive.

Each borehole was accompanied by Standard Penetration Resistance testing and moisture content determinations. In-situ vane testing was carried out in Borehole 2.

### **SITE DESCRIPTION**

The site is located along the centreline of the Queen Elizabeth Way, between Glendale Avenue and the Hwy. 405 Interchange, in the Town of Niagara-On-The-Lake. The topography in the immediate area is generally flat-lying to the north of the QEW. To the south lies the Niagara Escarpment.

Physiographically, the site is located in the region referred to as the Lake Iroquois Clay Plain. North of the escarpment, the indicated soils are stratified clays and silts, deposited by glacial Lake Warren and glacial Lake Iroquois.

Bedrock elevations in the site area vary from 86.6 m near Glendale Avenue to 100.0 m near the Hwy. 405 interchange, based on elevations taken from Bedrock Topography Map P.2400, issued in 1981 by the Ministry of Natural Resources. The bedrock in this area is anticipated to be reddish-brown shale of the Queenston Formation near Glendale Avenue, changing to limestone and dolostone of the Clinton and Cataract Groups towards the Hwy. 405 Interchange.

Maps showing the quaternary geology of the area under investigation indicate Halton Till and Bedrock of the Clinton and Cataract Groups to the south, near the face of the Escarpment. These soil types are confirmed by previous investigations performed in this area.

### **SUBSURFACE CONDITIONS**

The soil on this site generally consists of a clayey silt fill overlying clayey silt/silty clay. For this investigation, boreholes were put down to depths ranging from 9.3 m in Borehole 1, to 9.6 m in each of the other boreholes. The upper brown layer of the clayey silt/silty clay was generally harder near surface due to the effects of weathering and desiccation.

A description of the subsurface soil and groundwater conditions encountered in each of the boreholes, along with the results of Standard Penetration testing are plotted on the Logs of

Boreholes appended as pages A-8 through A-12. A summary of the subsurface conditions encountered is given below.

#### Pavement Structure

Boreholes 3 and 5 were put down through the existing partially paved shoulder along the centre median. The pavement structure consisted of 250 mm of asphalt over 100 mm of crushed limestone in Borehole 3, and of 140 mm of asphalt over 460 mm of crushed limestone in Borehole 5.

#### Fill

Underlying the pavement structure in Borehole 3, and from ground surface in Boreholes 1, 2 and 4, miscellaneous soil and granular fill was encountered. The fill ranged in depth from 1.1 to 1.6 m( $\pm$ ) in Boreholes 1 and 2, respectively, and to depths of 3.3 and 4.8 m( $\pm$ ) in Boreholes 3 and 4.

The fill material was predominantly clayey silt with some sand and gravel. The upper fill in Borehole 3 extended to a depth of 1.6 m( $\pm$ ), and was underlain by a second road structure and clay fill. Buried topsoil was encountered at the base of the fill in Boreholes 3 and 4. The fill was stiff to firm, with Standard Penetration Resistance testing giving 'N' values between 6 and 15 blows for 30 cm. These results indicate some degree of compaction of the fill. Corresponding natural moisture contents were between 7 and 26%.

No index tests were carried out on the fill materials.

#### Clayey Silt

Underlying the fill in Borehole 2, clayey silt was encountered extending to a depth of 5.6 m( $\pm$ ). The clayey silt was fissured and contained some silt seams, along with traces of sand and gravel. There may have been some cobbles at a depth of about 4.6 metres. The clayey silt was stiff to very stiff, with Standard Penetration Resistance testing giving 'N' values between 15 and 21 blows for 30 cm. Corresponding natural moisture contents were between 20 and 23%.

#### Silty Clay/Clay

Below the fill and pavement structure in Boreholes 1, 3, 4 and 5, and underlying the clayey silt in Borehole 2, silty clay to clay was encountered. This deposit extended to between 7.1 and 8.3 m( $\pm$ ) in Boreholes 1 through 3, and to at least the maximum depths investigated in Boreholes 4 and 5. The material was typically brown, although in Borehole 2 it was grey. It changed color to grey at 9.1 m( $\pm$ ) in Borehole 4. The brown colour indicates desiccation and oxidation of the soil. It was fissured and laminated with traces of sand and gravel. Some shale inclusions were encountered in Borehole 1 at 6.4 m( $\pm$ ). The soil was firm to hard, with Standard Penetration Resistance testing giving 'N' values between 8 and 45 blows for 30 cm. Corresponding natural moisture contents were between 12 and 32%.

The results from the Atterberg Limit Tests performed on this material are plotted on Figure 1 on page A-13, and summarized as follows.

Index Properties	Range (%)
Moisture Content (w)	15 - 32
Liquid Limit ( $w_L$ )	26 - 57
Plastic Limit ( $w_p$ )	14 - 24
Plasticity Index ( $I_p$ )	11 - 33

From the plasticity chart, it is evident that the layer can be classified as a silty clay of low to high plasticity (CL, CI and CH). From the M.T.C. Soil Classification Manual (January 1980), these soils are anticipated to have medium to high dry strengths, medium to high toughness and very slow to no dilatancy.

Grain Size Distribution tests were carried out on these materials. The results of these tests are plotted separately for each individual sample tested and are appended in Appendix A.

Undrained Shear Strength of the soil was determined by an in-situ vane test and through Standard Penetration Resistance Testing results. The results are noted on the Logs of Boreholes in Appendix A. A summarized form of the in-situ vane test performed is presented as follows:

Undrained Shear Strength	$C_u$ (kPa)	Sensitivity
In-Situ Vane Test	32	2.2

The vane shear strength measured within this layer was 32 kPa, indicating a firm consistency. This layer has a sensitivity of 2.2 based on the measured undisturbed and remoulded vane strengths, indicating a normal silty clay.

#### Clayey Silt

Under the clay in Boreholes 1, 2 and 3, a layer of brown clayey silt was encountered extending to the maximum depths investigated. It contained till like zones and some cohesive seams. The soil was stiff to hard, with Standard Penetration Resistance testing giving 'N' values between 15 blows for 30 cm and 50 blows for 13 cm. Corresponding natural moisture contents were between 8 and 17%.

The results from the Atterberg Limit Tests performed on this material are plotted on Figure 1 on page A-13, and summarized as follows.

Index Properties	(%)
Moisture Content (w)	8 - 17
Liquid Limit ( $w_L$ )	21
Plastic Limit ( $w_p$ )	14
Plasticity Index ( $I_p$ )	7

From the plasticity chart, the soil encountered at depth in Boreholes 1 through 3 can be classified as an inorganic silt with traces of sand and gravel of slight plasticity (CL-ML). From the M.T.C. Soil Classification Manual (January 1980) these soils are anticipated to have medium to high dry strengths, medium toughness and very slow to no dilatancy.

Grain Size Distribution tests were carried out on these materials. The results of these tests are plotted separately for each sample tested and appended in Appendix A.

#### GROUNDWATER CONDITIONS

Groundwater conditions were observed through the measurement of water level in the open boreholes. Upon completion of the drilling procedures each of the Boreholes, with the exception of Borehole 4, was dry and open to the full depth investigated. The water level in Borehole 4, upon completion of the drilling procedure was at an elevation of 117.4 m. The following water levels were observed during the field investigation.

BH No.	Elevation of Water Level (m)	Depth (m)
1	Dry	N/A
2	Dry	N/A
3	Dry	N/A
4	117.4	0.7
5	Dry	N/A

The color change from brown to grey typically indicates the level below which the soils are permanently saturated. In those boreholes which were dry and open upon completion of drilling, the silt layer was generally moist to wet, with some saturated zones. Response time through the silts is generally not rapid, and no free groundwater was observed in the boreholes where the silt was encountered. However, we expect there would have been some seepage into the boreholes, had they been allowed to remain open for a period of time.

## **Part 2 - Foundation Design Report**

A geotechnical investigation was carried out for the installation of nine High Mast Lighting Poles along the Queen Elizabeth Highway, from Glendale Avenue to the Highway 405/QEW Interchange. The field work was carried out on 98 03 25. It consisted of advancing five boreholes to provide soil parameters for foundation design.

This report deals with the four easterly High Mast Lighting Poles, designated P1 through P4 by the consultant. The remaining five High Mast Lighting Poles (F1 through F5), are covered in AGRA Earth & Environmental Limited Report # 98051.

Table 1 on page 7 indicates the conditions anticipated at each of the four most easterly High Mast Lighting Pole locations, along with the borehole number from which the pertinent soil parameters were obtained.

HML P4 is located near the base of the valley between two slopes. One slope is formed by the embankment of the EB Hwy 405 overpass, over the WB QEW. The other is the north slope of the EB QEW embankment. The maximum top of slope lies at about elevation 135.0 metres, at the south shoulder of EB Hwy 405. The bottom of the embankment lies at about elevation 129.0 metres. The proposed top of footing elevation lies at elevation 130.6 metres.

No slope instability was observed, and no surficial or deep-seated failures are anticipated. The slope of the embankment in the vicinity of the HML lies at about 1 vertical to 4 horizontal. Therefore, other than considerations through the zone of frost penetration, no reduction in soil parameters is considered to be necessary.

It should be noted that in the vicinity of HML P3, at Stn. 10+453 (E/B Hwy 405), the borehole conditions have been adjusted to reflect the presence of a concrete culvert immediately adjacent to the HML. We understand that the culvert invert lies at elevation 127.4 metres. All soils above this elevation are assumed to be fills. A Non Standard Special Provision appends as page C-1.

The median in the vicinity of HML P3 slopes from an elevation of about 132.4 metres at the north edge of EB Hwy 405, to 129.0 metres at the south edge of WB QEW. The proposed top of footing elevation lies at elevation 130.1 metres. The necessity for a reduction in soil parameters is not anticipated.

No significant grade changes are proposed in the vicinities of HML P2 or P1, nor are there any slopes.

### **DESIGN CONSIDERATIONS**

The High Mast Lighting foundations will be supported on a single concrete caisson and the design should be in accordance with the method described by Broms as per the following papers.

BROMS, B.B.: Lateral Resistance of Piles in Cohesive Soils, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 90, No. SM2, Paper No. 3825, March 1964.

BROMS, B.B.: Lateral Resistance of Piles in Cohesionless Soils, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 90, No. SM3, Paper No. 3909, May 1964.

BROMS, B.B.: Design of Laterally Loaded Piles, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 91, Paper No. SM3, May 1965.

The soil parameters provided in Table 1 are recommended for the design of the HML foundations. The following notation has been adopted:

$\phi$  = apparent angle of friction for cohesionless soils in degrees  
 $q_u$  = unconfined compressive strength in kPa ( $q_u = 2 \times C_u$ ) for cohesive soils  
 $\gamma$  = bulk unit weight in kN/m<sup>3</sup>

The  $\gamma$  values have been estimated. It is recommended that  $c$  and  $\phi$  values through the top 1.2 metres be neglected, because of frost penetration.

### CLOSURE

The Report Limitations, as quoted in the appendix, are an integral part of this report.

We trust this report is complete within our present terms of reference. If you have any questions, please do not hesitate to contact our office.

Yours very truly,

AGRA Earth & Environmental Limited

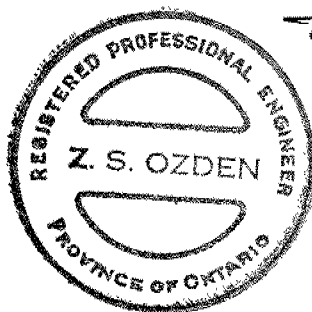
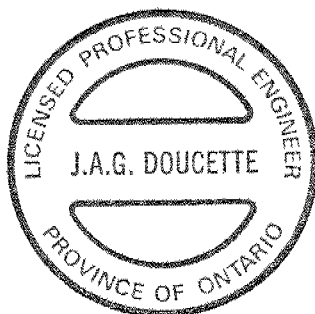
Submitted By:

Reviewed By:



Jane Doucette, P.Eng.

10 copies Client  
Encl.



Zuhtu Ozden, P.Eng.

**Table 1: Location and Soil Parameters**

High Mast Lighting Pole Location	Proposed Top of Footing (m)	BH	Elevation (m) From - To	Type of Soil	Denseness or Consistency	$q_u$ (kPa)	Moisture Content (%)	Bulk Unit Weight (kN/m <sup>3</sup> )	$\phi$ (Deg.)
P4 Stn. 10+ 595 Median between EB QEW and EB Hwy 405	130.60	1	135.0 - 133.4	Cohesive	Compact	50	8	18.0	
			133.4 - 129.5	Cohesive	Very Stiff	350	17	21.0	
			129.5 - 127.9	Cohesive	Hard	500	12	22.0	
			127.9 - 125.8	Cohesive	Hard	600	9	23.0	
P3 Stn. 10+ 455 Median between WB QEW and EB Hwy 405	130.10	2	130.1 - 129.5	Non-Cohesive	Compact	-	7	20.0	38°
			129.5 - 129.0	Cohesive	Stiff	50	-	18.0	
			129.0 - 124.5	Cohesive	Very Stiff	220	22	21.0	
			124.5 - 122.2	Cohesive	Firm	60	25	20.0	
			122.2 - 120.5	Cohesive	Stiff	180	15	21.0	
P2 Stn. 10+ 305 Median between WB QEW and EB Hwy 405	131.15	2	130.1 - 129.5	Non-Cohesive	Compact	-	7	20.0	38°
			129.5 - 129.0	Cohesive	Stiff	50	-	18.0	
			129.0 - 124.5	Cohesive	Very Stiff	220	22	21.0	
			124.5 - 122.2	Cohesive	Firm	60	25	20.0	
			122.2 - 120.5	Cohesive	Stiff	180	15	21.0	
P1 Stn. 10+200 Median between EB QEW and WB QEW	122.85	3	121.8 - 120.2	Mixed	Firm/Loose	-	22	18.0	
			120.3 - 118.4	Mixed	Stiff/Compact	50	25	18.0	
			118.4 - 117.8	Cohesive	Stiff	170	24	20.0	
			117.8 - 116.2	Cohesive	Hard	370	23	21.0	
			116.2 - 114.7	Cohesive	Stiff	150	25	20.0	
			114.7 - 113.6	Cohesive	Hard	500	14	22.0	
			113.6 - 112.2	Cohesive	Hard	600	17	23.0	

Note: Stations taken from drawings provided by Totten Sims Hubicki Associates. Contract Drawings for No. 98-52, WP 134-92-00, sheets C10 through C13.



## **APPENDIX A**

## GENERAL REPORT NOTES

### DEFINITIONS OF PENETRATION RESISTANCE

Standard penetration resistance 'N': -- The number of blows required to advance a standard split spoon sampler 30 cm into the subsoil, driven by means of a 63.5 kg hammer falling freely a distance of 70 cm.

Dynamic penetration resistance: -- The number of blows required to advance a 50 mm, 60 degree cone, fitted to the end of drill rods, 30 cm into the subsoil, the driving energy being 474.5 Joules per blow.

### SAMPLE TYPE ABBREVIATIONS USED IN BOREHOLE LOGS

S.S.	Split spoon	T.W.	Thinwall open	R.C.	Rock core
A.S.	Auger sample	T.P.	Thinwall piston	W.S.	Washed sample
P.H.	Sample pushed hydraulically	P.M.	Sample pushed manually		

### SOIL TEST SYMBOLS USED IN BOREHOLE LOGS

○ Standard penetration resistance	▽ Laboratory vane	□ Unconfined compression
● Dynamic penetration resistance	△ Field vane	■ Undrained triaxial
	X Penetrometer	S Sensitivity

### CONVENTIONAL SOIL DESCRIPTIONS

#### COHESIVE (CLAYS ETC.)

Consistency	'N' blows/30cm	c kPa	Denseness	'N' blows/30 cm
Very Soft	0 - 2	0 - 12	Very Loose	0 - 4
Soft	2 - 4	12 - 24	Loose	4 - 10
Firm	4 - 8	24 - 48	Compact	10 - 30
Stiff	8 - 15	48 - 96	Dense	30 - 50
Very Stiff	15 - 30	96 - 191	Very Dense	>50
Hard	>30	> 191		

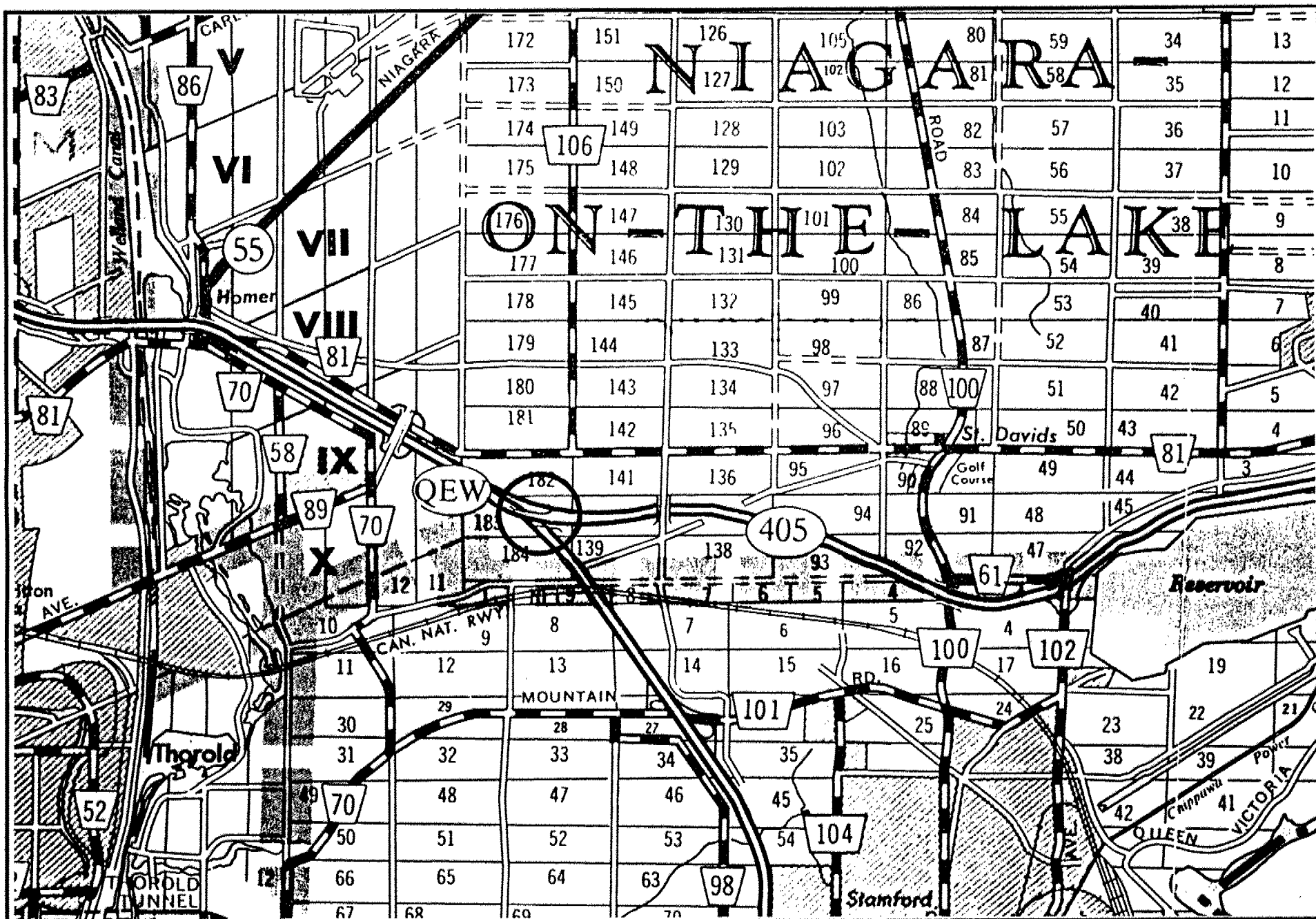
### ABBREVIATIONS FOR MOISTURE CONDITIONS

sdtp - slightly drier than the plastic limit.  
dtp - drier than the plastic limit.  
apl - about the plastic limit.

swt - slightly wetter than the plastic limit.  
wt - wetter than the plastic limit.  
mwt - much wetter than the plastic limit.

### NOTE

The soil conditions, profiles, comments, conclusions and recommendations found in this report are based upon the samples recovered during the field work. Soils are heterogeneous materials and, consequently, variations (possibly extreme) may be encountered at site locations away from boreholes. During construction, competent, qualified inspection personnel should verify that no significant variations exist from the conditions described in this report.

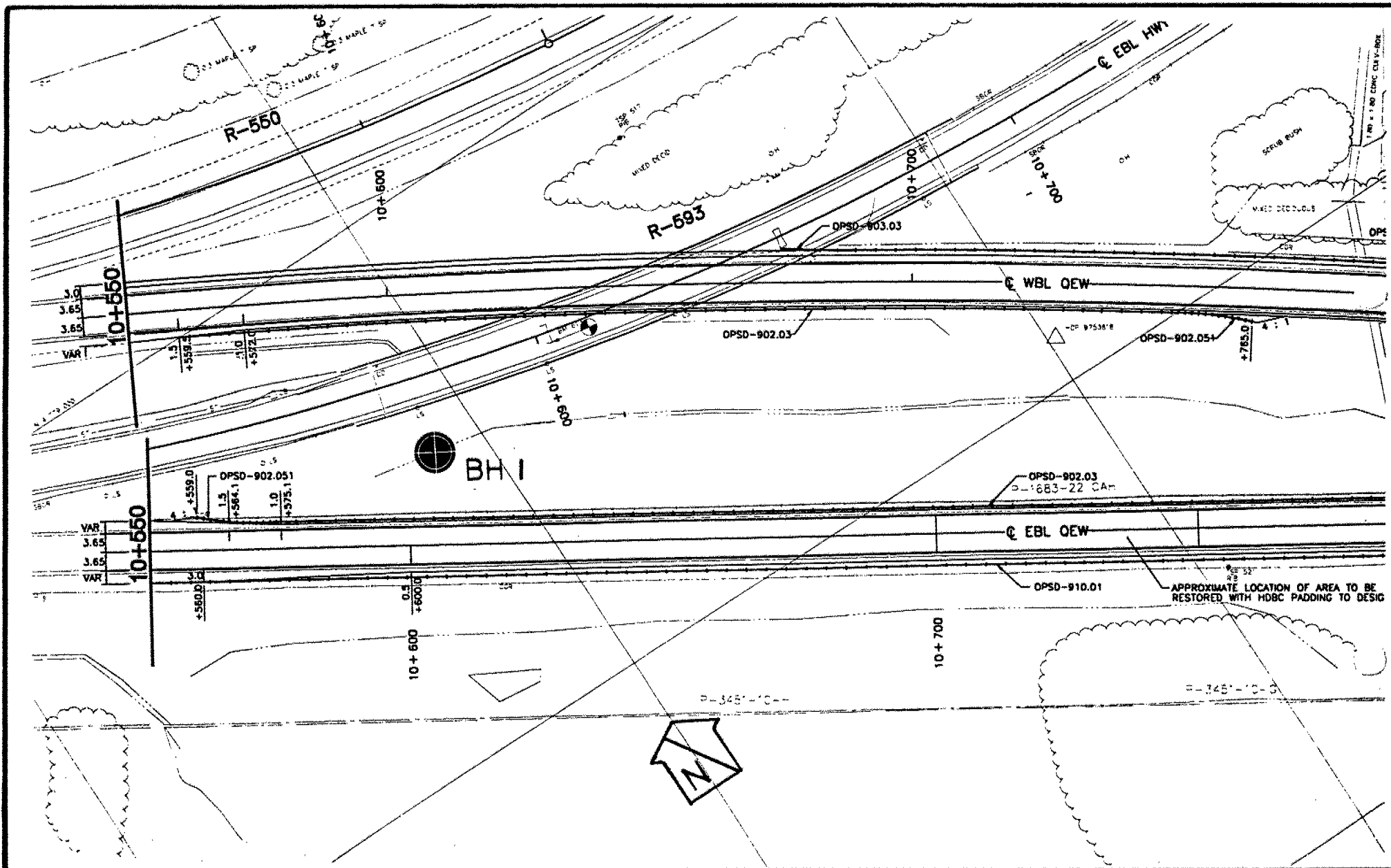


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KEY PLAN

A-2  
T698050

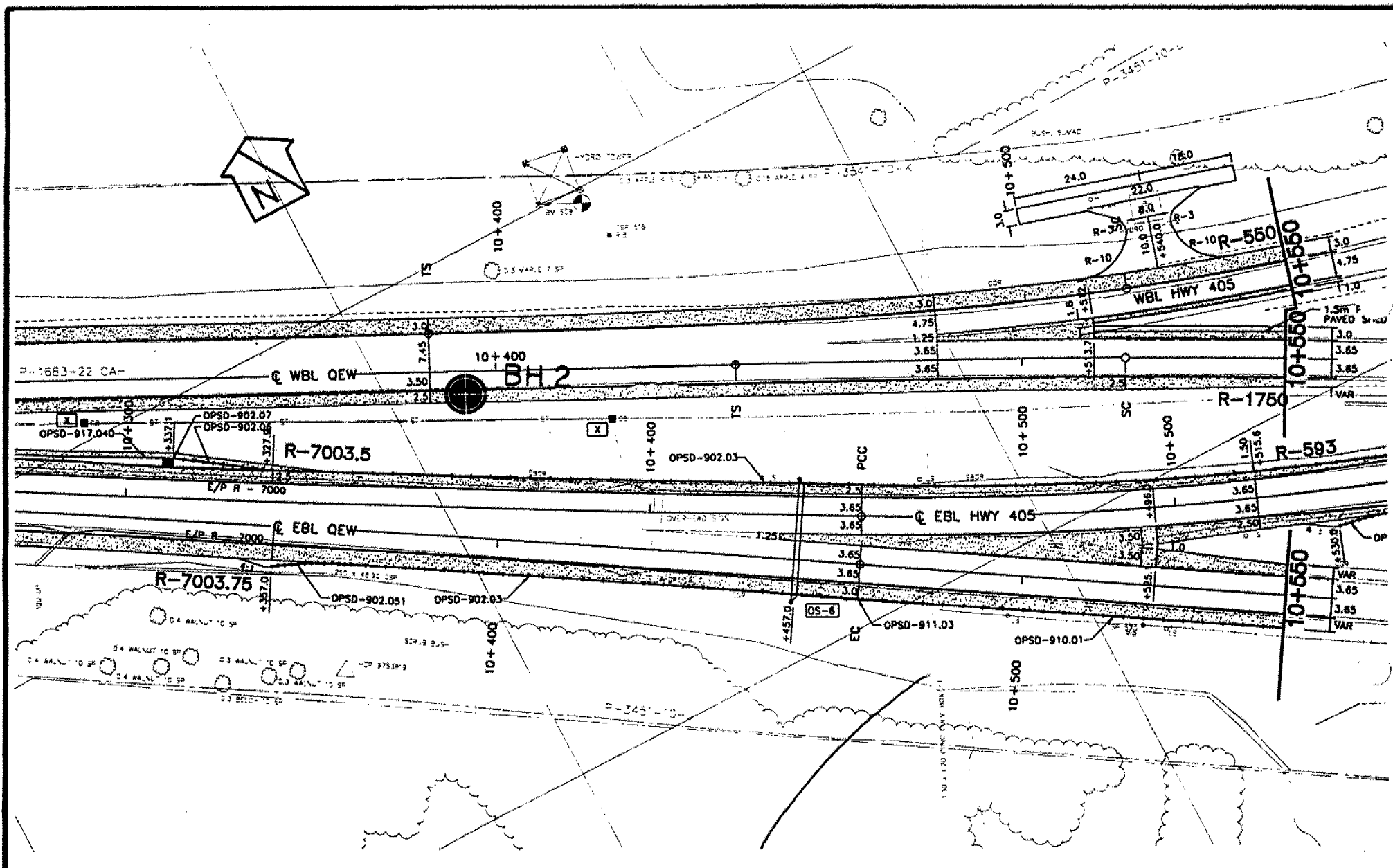


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 Unit #5  
 S.S. #1, Thorold, Ontario  
 L2V 4Y6

BOREHOLE LOCATION PLAN

A-3  
 T698050

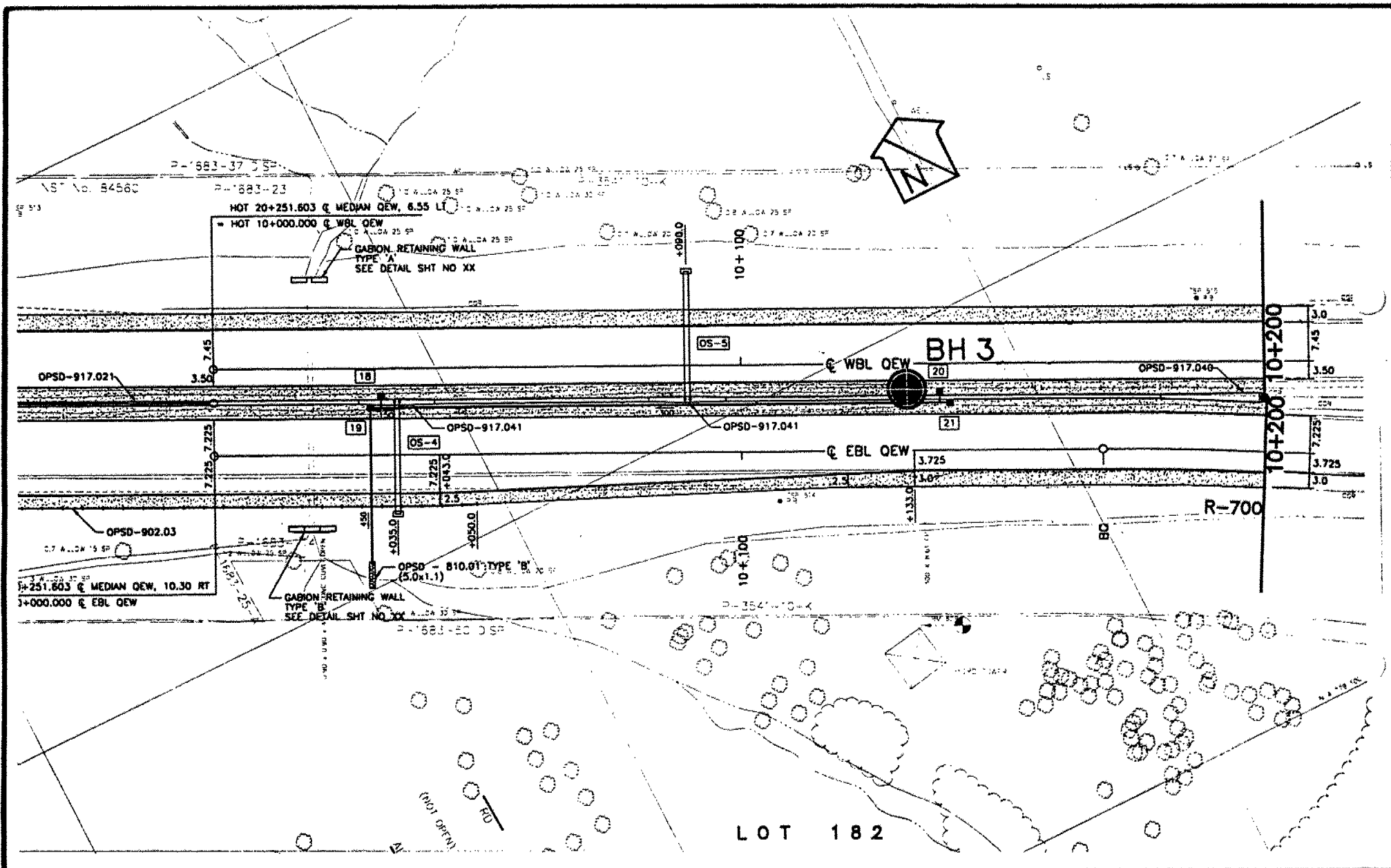


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Unit #1  
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L2V 4Y6

BOREHOLE LOCATION PLAN

A-4  
TG98050

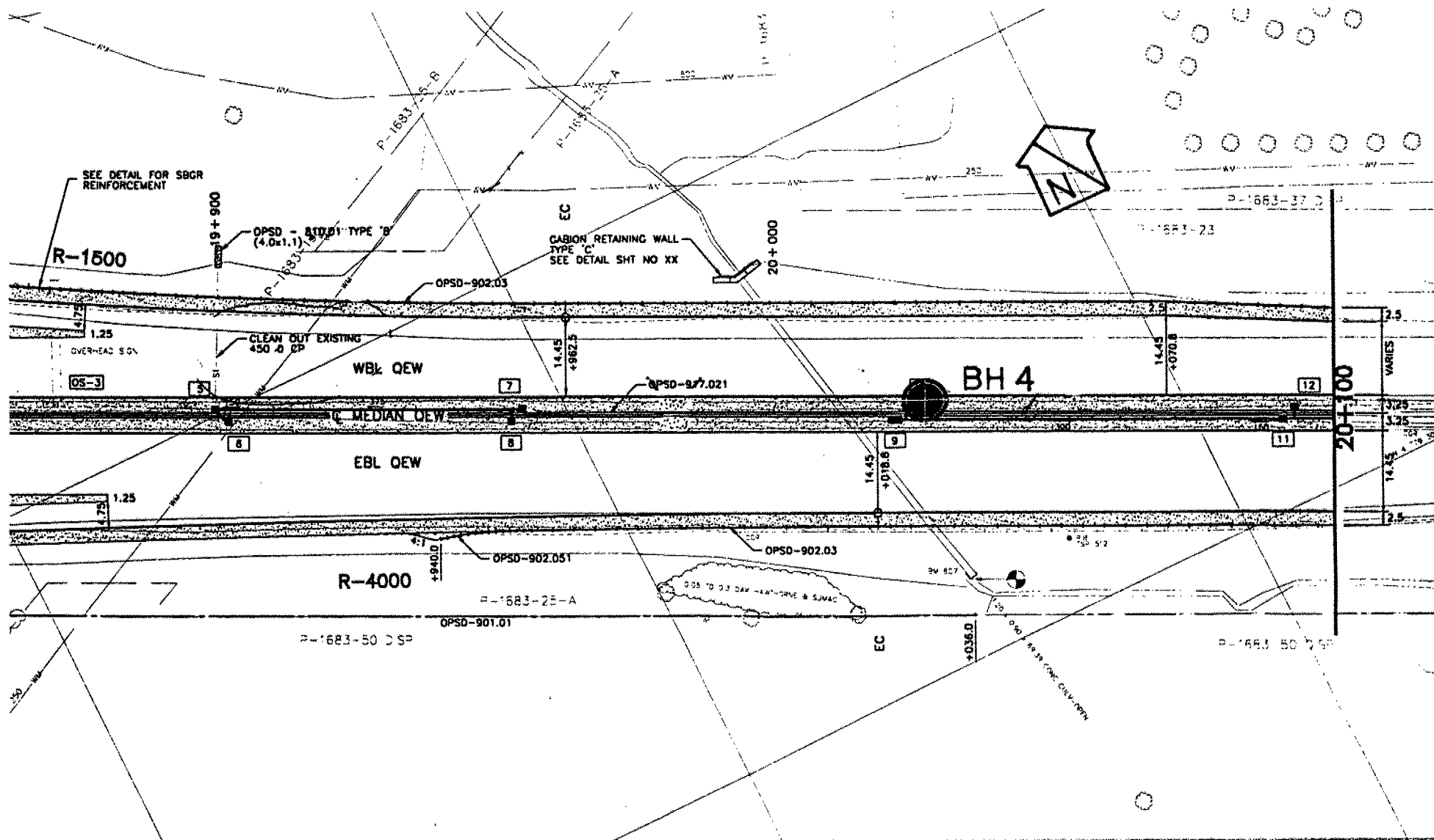


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 L2V 4Y6

BOREHOLE LOCATION PLAN

A-5  
 T698050

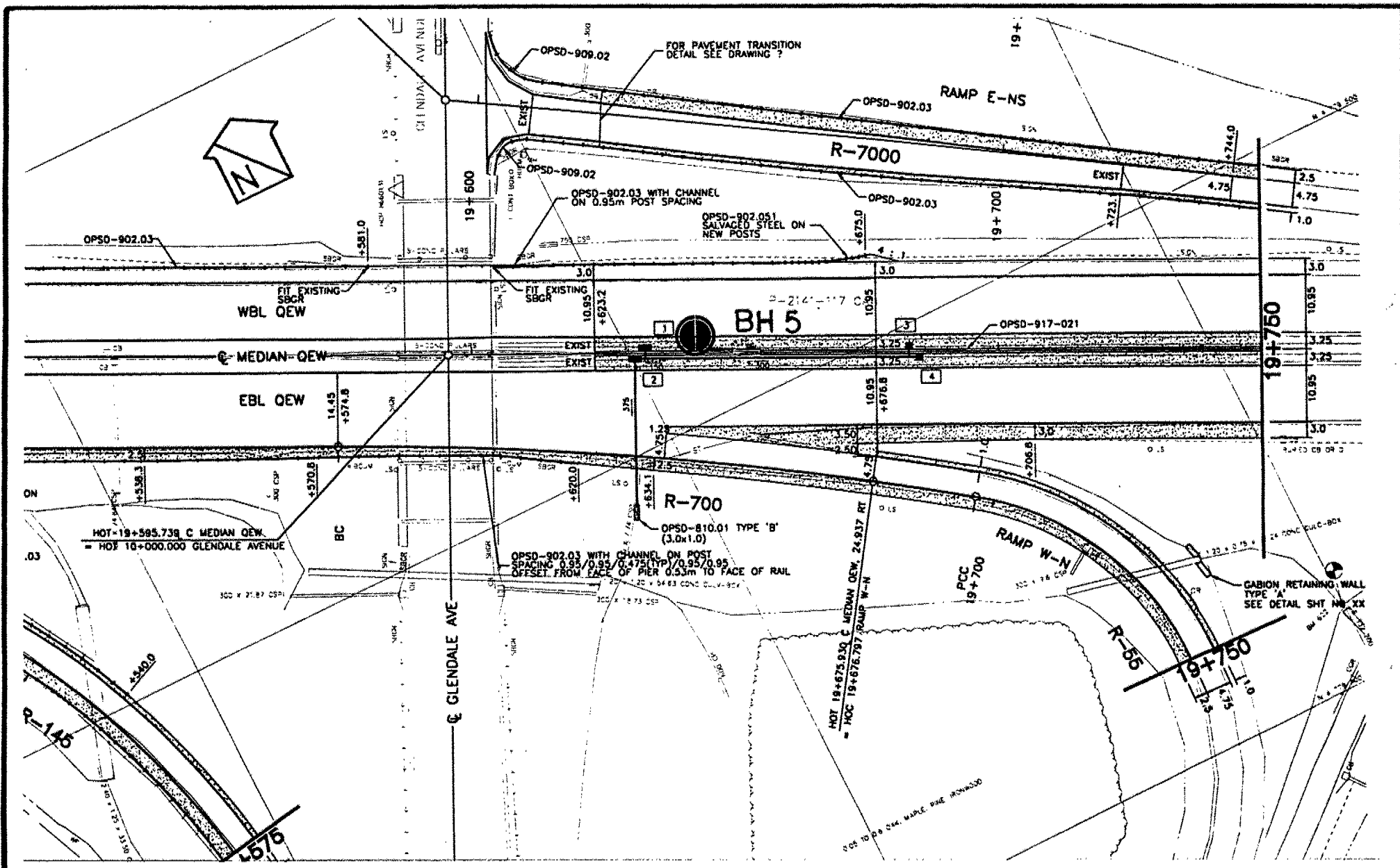


SCALE - 1"=1000

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3300 Merrittville Hwy.  
Unit #5  
S.S. #1, Thorold, Ontario  
L2V 4Y6

BOREHOLE LOCATION PLAN

A-6  
TG98051



SCALE-1:1000

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Unit #5  
S.S. #1, Thorold, Ontario  
L2V 4Y6

BOREHOLE LOCATION PLAN

A-7  
TG98051



**Borehole #: 1**

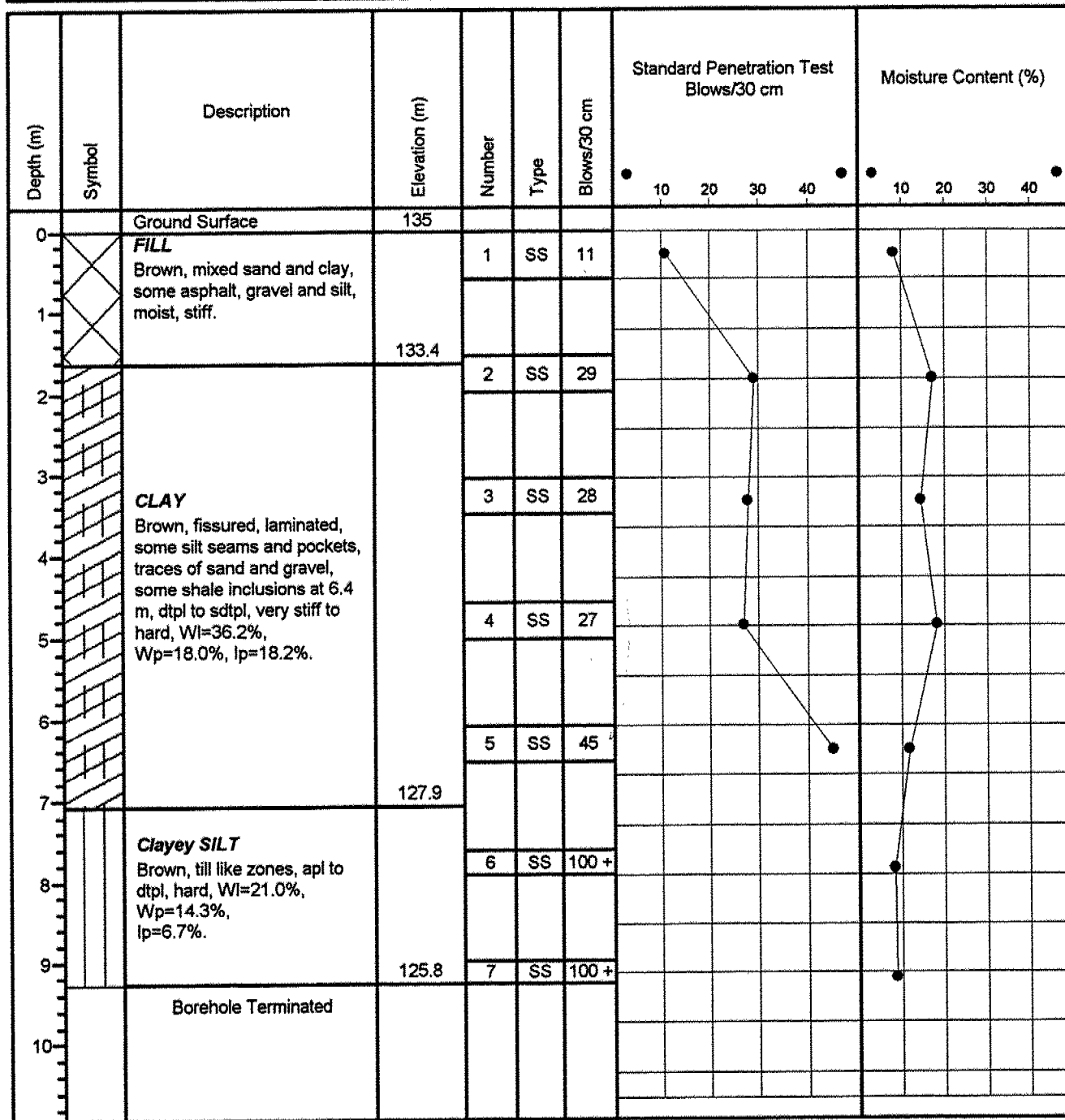
Project No: TG98050

Coordinates: N 4 778 954, E 333 191

Location: QEW/405, Niagara-On-The-Lake

Client: Totten Sims Hubicki

Prepared By: M. Leitch



**Borehole #: 2**

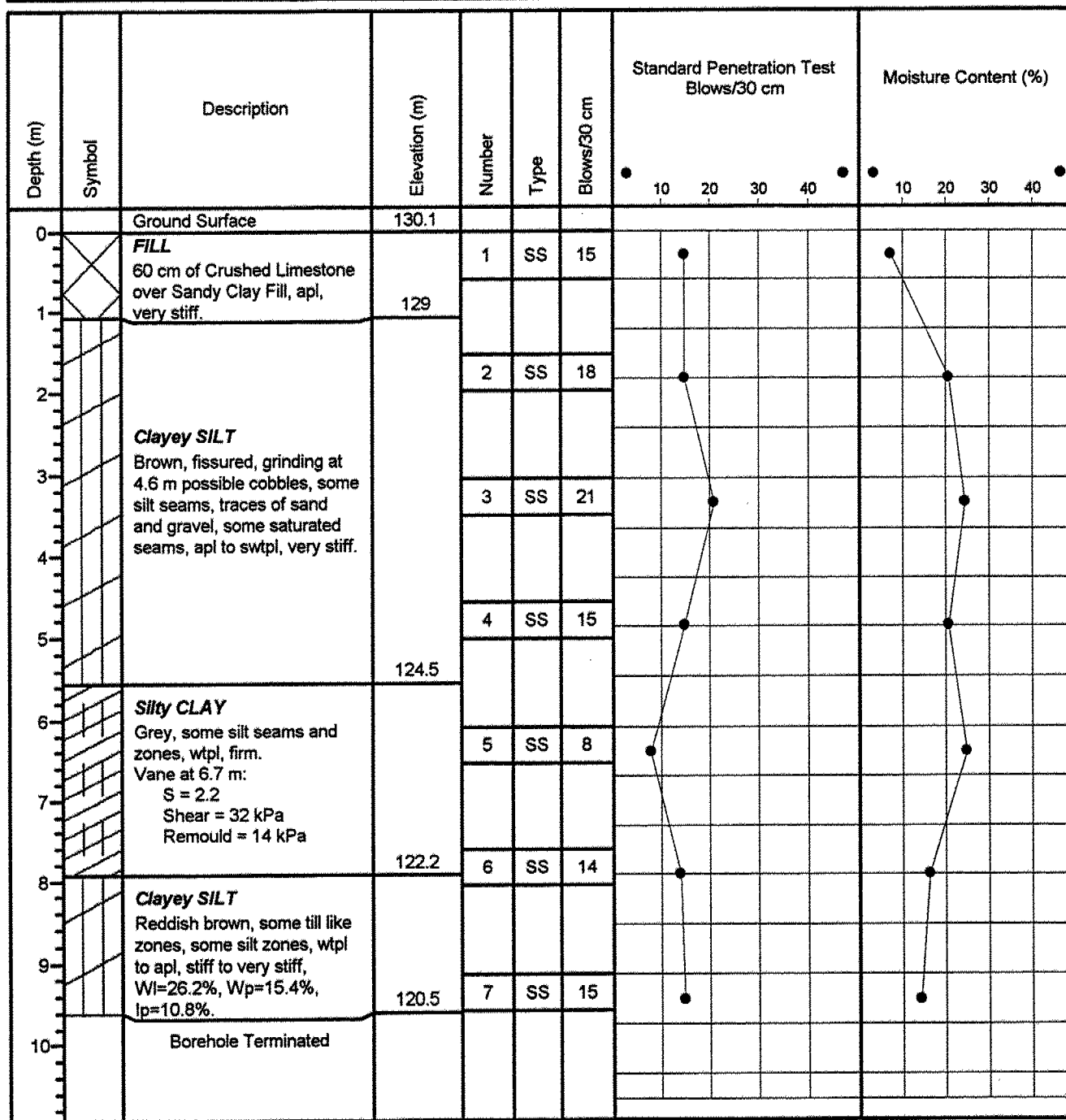
**Project No: TG98050**

**Coordinates: N 4 779 074, E 333 012**

**Location: QEW/405, Niagara-On-The-Lake**

**Client:** Totten Sims Hubicki

**Prepared By: M. Leitch**



**Drilled by: Elite Drilling**

**Drill Method: Solid Stem Augers**

**Upon Completion:** Borehole dry and open.

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Thorold, Ontario  
L2V 4Y6

**Hole Size: 150 mm**

Datum: Local Geodetic

Drill Date: 98 03 25

**Borehole #: 3**

Project No: TG98050

Coordinates: N 4 779 188, E 332 779

Location: QEW/405, Niagara-On-The-Lake

Client: Totten Sims Hubicki

Prepared By: M. Leitch

Depth (m)	Symbol	Description	Elevation (m)	Number	Type	Blows/30 cm	Standard Penetration Test Blows/30 cm	Moisture Content (%)
0		Ground Surface	121.8					
1		<b>FILL</b> 25 cm Asphalt over 10 cm Crushed Limestone over 25 cm of red coarse Sand over Clayey Fill, mixed with some gravel and silt, wtpl, firm.	120.2	1	SS	6		
2		<b>Old Road Structure</b> Asphalt over Crushed Limestone over brown Silty Clay Fill, apl, stiff over Buried Topsoil.	118.4	2	SS	14		
3				3	SS	13		
4								
5		<b>Silty CLAY</b> Brown, fissured, laminated, traces of sand and gravel, some saturated seams, some silt zones, apl to dtpl, stiff to hard.	113.5	4	SS	30		
6								
7								
8				5	SS	12		
9								
10				6	SS	40		
		<b>Clayey SILT</b> Brown, till like zones, some cohesive seams, sdtp, hard.	112.2					
				7	SS	80		
		Borehole Terminated						

Drilled by: Elite Drilling

Drill Method: Solid Stem Augers

Upon Completion: Borehole dry and open.

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Thorold, Ontario  
L2V 4Y6

Hole Size: 150 mm

Datum: Local Geodetic

Drill Date: 98 03 25

**Borehole #: 4**

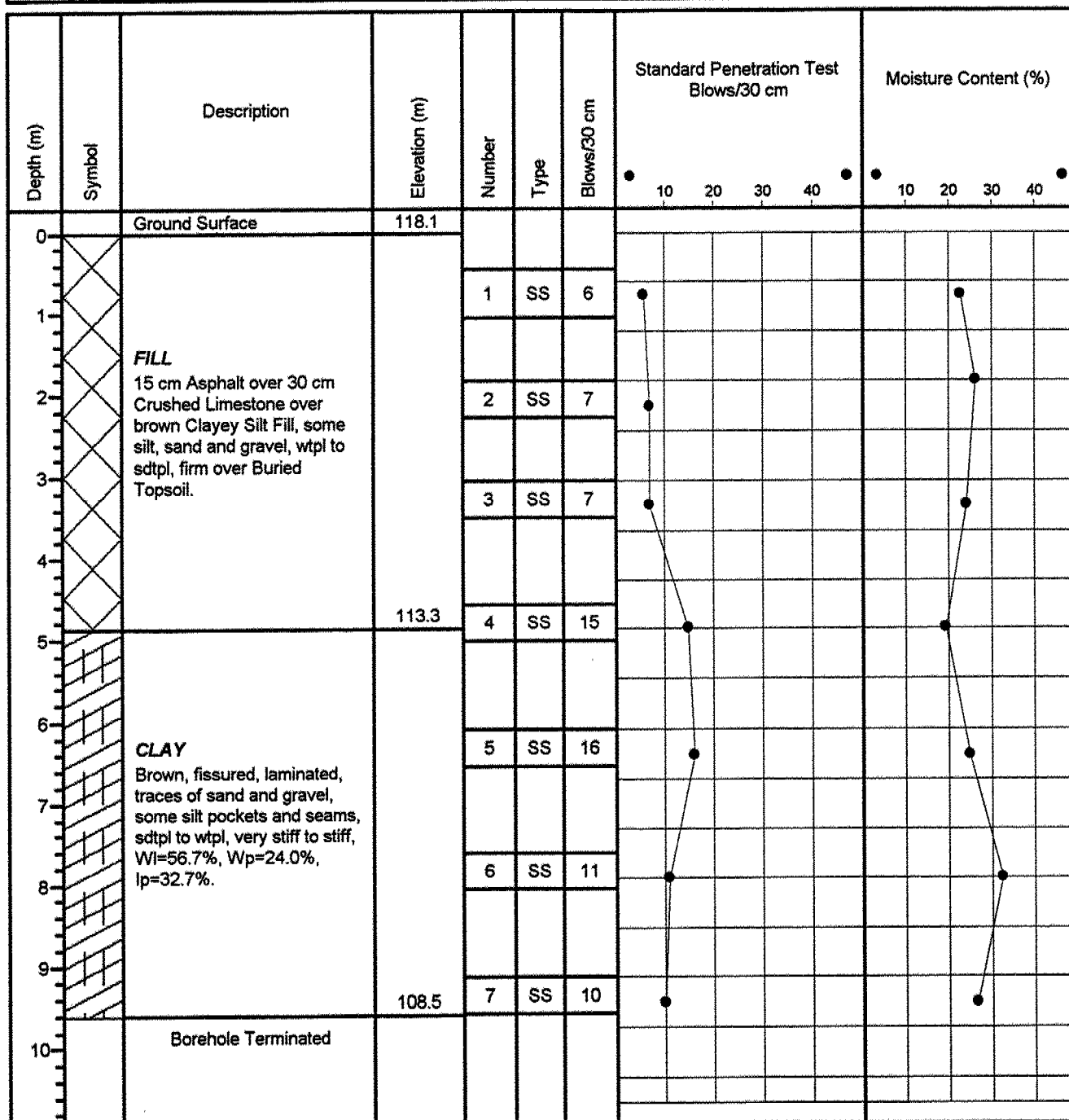
Project No: TG98050

Coordinates: N 4 779 342, E 332 558

Location: QEW/405, Niagara-On-The-Lake

Client: Marshall Macklin Monaghan

Prepared By: M. Leitch



Drilled by: Eastern Soils

Drill Method: Solid Stem Augers

Upon Completion: Water level at 0.7 m, caved at 6.1 m.

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Thorold, Ontario  
L2V 4Y6

Hole Size: 115 mm

Datum: Local Geodetic

Drill Date: 98 03 25

**Borehole #: 5**

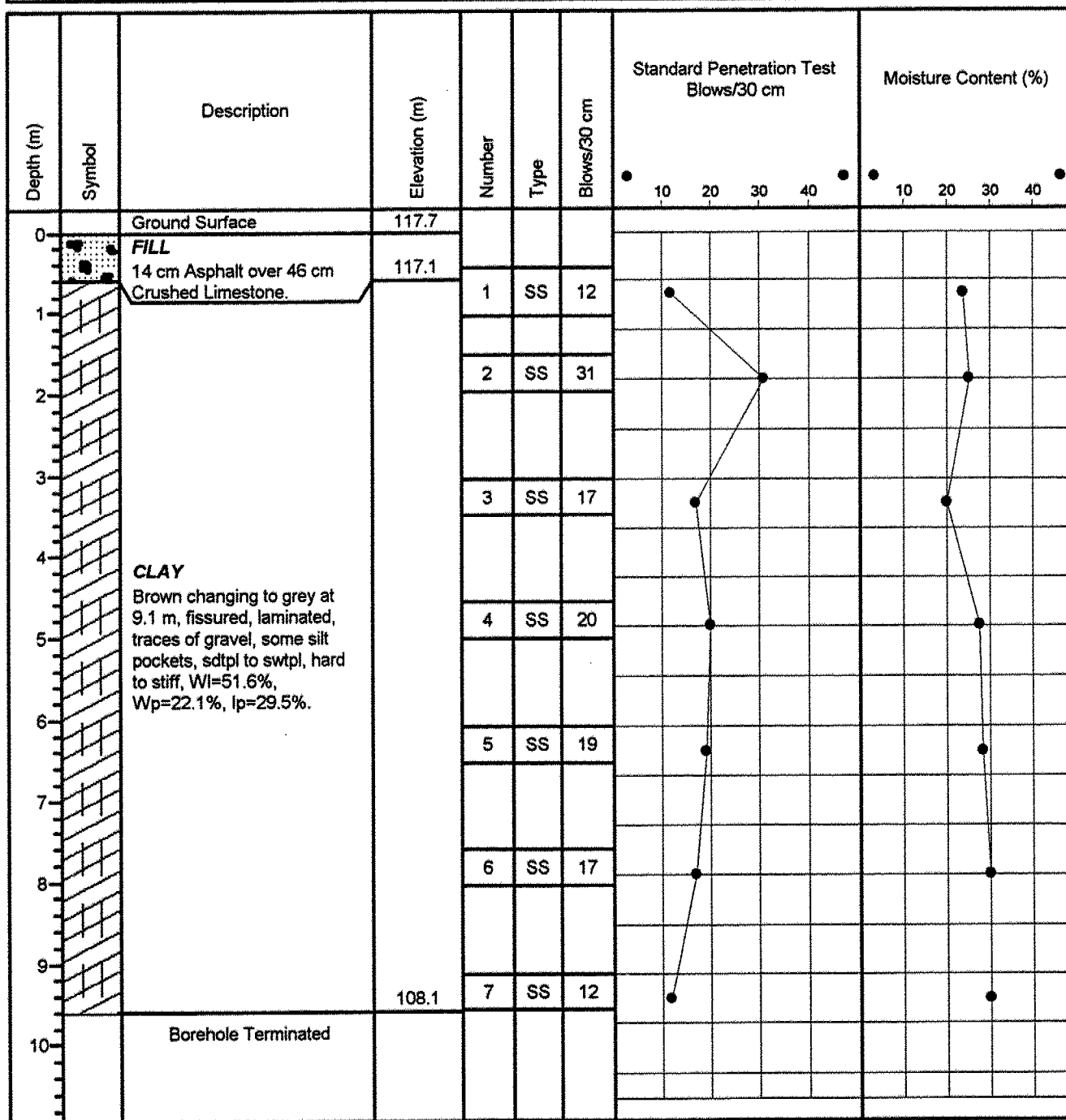
Project No: TG98050

Coordinates: N 4 779 515, E 332 113

Location: QEW/405, Niagara-On-The-Lake

Client: Marshall Macklin Monaghan

Prepared By: M. Leitch



Drilled by: Elite Drilling

Drill Method: Solid Stem Augers

Upon Completion: Borehole dry and open.

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Thorold, Ontario  
L2V 4Y6

Hole Size: 150 mm

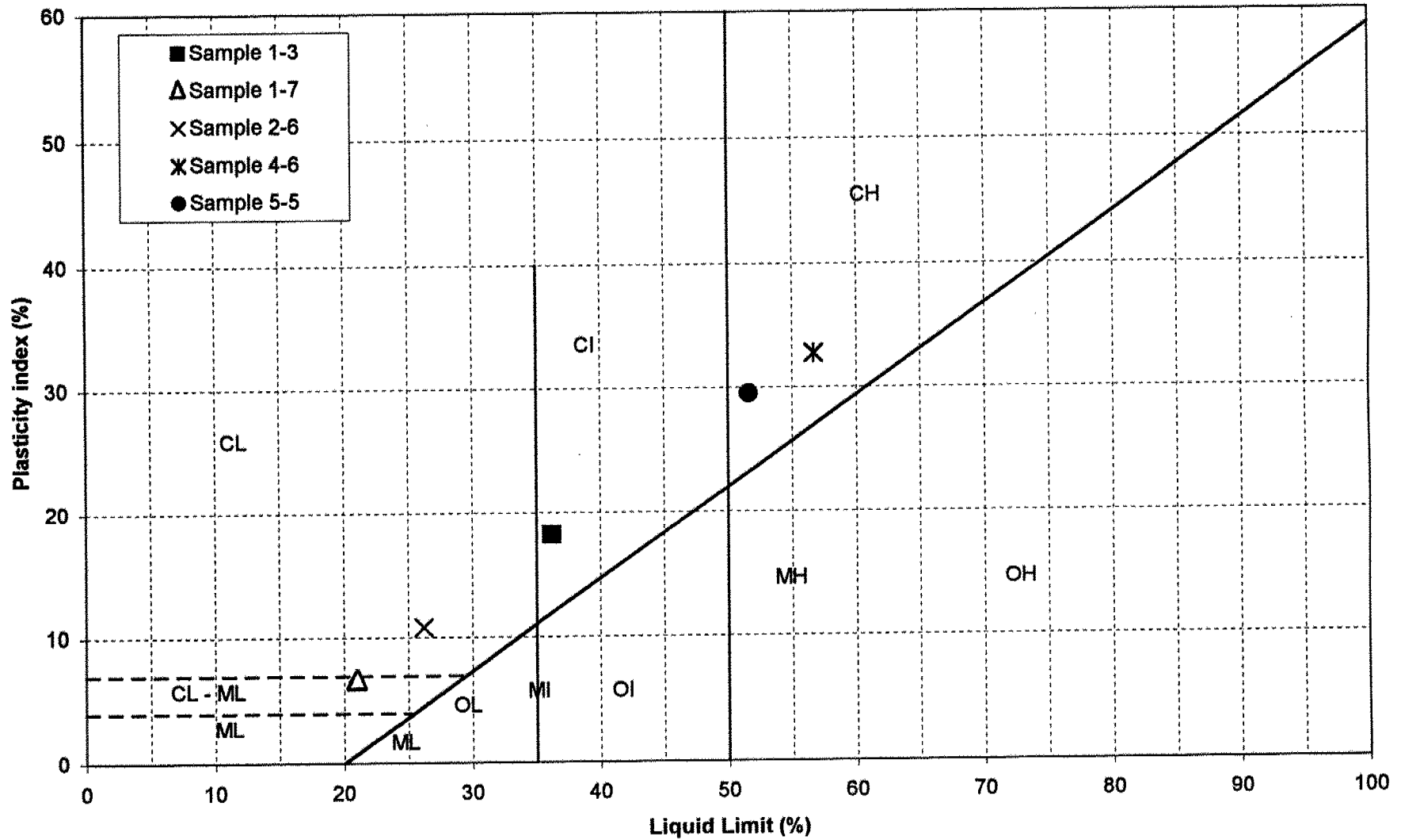
Datum: Local Geodetic

Drill Date: 98 03 25

# Plasticity Chart

Figure 1

WP 134-92-00



A-13  
TG98050

## **APPENDIX B**

## REPORT LIMITATIONS

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during the construction to confirm that the subsurface conditions across the site do not deviate materially from those encountered in the testholes.

The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AGRA Earth & Environmental Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.



## **APPENDIX C**

**NON-STANDARD SPECIFICATION (NSSP)  
HIGH MAST LIGHTING POLES**

The contractor must be aware that an existing concert box culvert is located in close proximity to the proposed foundation location of HML P3, at STATION 10+453 (E/B 405).

The dimensions of the concrete box culvert are given as 1.30m x 1.20m, and the invert is understood to be elevation 127.4 metres. The centreline of the culvert is indicated as lying 2.5 metres west of the proposed HML location.

The proposed top of footing elevation for the HML is 130.100 m. The existing ground surface elevation at the HML location is 131.4 m.