



**Foundation Investigation and
Design Report**
Highway 6 (Hanlon Expressway) and
Laird Road Interchange, Signs
City of Guelph

G.W.P. 3002-05-00

Geocres No. 40P8-198

Job No. 165000749

July 2011

Table of Contents

1.0 INTRODUCTION	1
2.0 SITE DESCRIPTION AND GEOLOGY	1
3.0 METHOD OF INVESTIGATION	2
3.1 DRILLING INVESTIGATION	2
3.2 LAYOUT AND SURVEY	2
3.3 LABORATORY TESTING	3

4.0 SUBSURFACE CONDITIONS	3
4.1 STATION 14+251, BH 11-1	4
4.2 STATION 15+251, BH 11-2	4
4.3 STATION 16+228, BH 11-3	5
4.4 STATION 17+228, BH 11-4	6
4.5 CHEMICAL TEST RESULTS	6
4.6 BEDROCK	7
4.7 GROUNDWATER	7

5.0 MISCELLANEOUS	7
6.0 CLOSURE	8
7.0 DISCUSSION	9
7.1 PROJECT DESCRIPTION & BACKGROUND	9
7.2 RECOMMENDATIONS FOR FOUNDATIONS	9
7.3 UNWATERING	10
7.4 CONTRUCTION RECOMMENDATIONS	10
7.5 CEMENT TYPE AND CORROSION PROTECTION	10

8.0 REFERENCES	11
9.0 CLOSURE	12

Table of Contents

List of Tables

Table 3.1: Borehole Information Summary.....	3
Table 4.1: Results of Chemical Analysis	6
Table 4.2: Inferred Groundwater Level Readings (time of drilling).....	7

List of Appendices

APPENDIX A

Drawings No. 1 – Borehole Location Plan

APPENDIX B

Symbols and Terms Used on Borehole and Test Pit Records
Borehole Records

APPENDIX C

Laboratory Test Results
Grain Size Distribution Plots
Plasticity Chart

APPENDIX D

SS118-30 Steel Column Breakaway Sign Supports
Recommended Design Parameters

FOUNDATION INVESTIGATION REPORT

For
G.W.P 3002-05-00

Highway 6 (Hanlon Expressway) and Laird Road Interchange - Signs
City of Guelph

1.0 Introduction

Stantec Consulting Ltd. (Stantec) was retained by the Ministry of Transportation, Ontario (MTO) to undertake the detailed design of a grade separated interchange at Highway 6 (Hanlon Expressway) and Laird Road in the City of Guelph, Ontario. This report contains the results of the geotechnical investigation carried out at the proposed locations of four 'ground-mounted' signs along Highway 6 in the vicinity of the new interchange.

This Foundation Investigation Report has been prepared specifically and solely for the signs related to the proposed interchange.

Project Number: G.W.P.: 3002-05-00

Project Location: Highway 6 (Hanlon Expressway) between 1.5 km north and south of Laird Road , Guelph

The work was carried out under Agreement Number 3009-E-0003 with Stantec Consulting Ltd., the Detailed Design Consultant for this project.

2.0 Site Description and Geology

Site Location

The site location is shown on the Key Plan inset to Drawing No. 1, provided in Appendix A. It should be noted that for project orientation purposes, Highway 6 will be assumed to run north-south at the project location, with chainage increasing from south to north.

General Site Description

The locations for the proposed ground-mounted signs are within approximately 1.5 km north and south of the existing Highway 6 – Laird Road intersection and are spaced approximately 1 km from each other. Two signs are located approximately 500 m north and south of the intersection while the other two are located a further 1 km from these.

Drainage for the highway at the sign locations is through roadside ditching.

Physiographic Description

The site is located within a physiographic region known as the Guelph Drumlin Field (Chapman and Putnam, 1984). The drumlins were caused by the ice thrust which radiated from the western end of the Lake Ontario basin. The dominant soil materials of the drumlins are the stony tills and deep gravel terraces of the old meltwater spillways. The intervening low grounds largely contain fluvial materials. The till is considered to be loamy and calcareous, derived mostly from dolostone of the Amabel Formation. The till also contains fragments of the underlying bedrock and consequently is pale brown in colour.

In the vicinity of the project site the terrain is fairly flat.

3.0 Method of Investigation

3.1 DRILLING INVESTIGATION

The geotechnical investigation for the proposed highway signs included four boreholes along Highway 6 in the immediate vicinity of the proposed signs, i.e., one borehole at each sign location. These boreholes are designated BH11-1 through BH11-4 and are shown on the Borehole Location Plan, Drawing No. 1 in Appendix A.

Prior to carrying out the investigation, Stantec contacted the public utility authorities to clear the borehole locations of both private and public utilities.

The field drilling program was carried out on April 11 and 12, 2011. The boreholes were advanced with continuous flight hollow stem augers using a D120 track-mounted drill rig equipped for soil and bedrock sampling.

The subsurface stratigraphy encountered in each borehole was recorded in the field by an experienced Stantec engineering technologist. Split spoon samples were collected at regularly spaced intervals (every 760 mm for up to 6 m below existing ground surface and every 1.5 m for deeper strata). All samples recovered were returned to Stantec's Ottawa laboratory for detailed classification and testing.

Groundwater water levels were measured in each borehole upon completion of drilling. The boreholes were backfilled immediately after drilling with drill cuttings placed to match the observed stratigraphy and compacted in place.

3.2 LAYOUT AND SURVEY

The ground surface elevation along with the northing and easting at each borehole location was surveyed by Callon Dietz of London, Ontario, on May 18, 2011 with reference to a Geodetic

Benchmark. Table 3.1 summarizes the information pertaining to the four boreholes included in this report.

Table 3.1: Borehole Information Summary

	Boreholes			
	11-1	11-2	11-3	11-4
MTM Zone 10 Coordinates				
Northing	4815933	4816654	4817313	4818031
Easting	248190	247498	246769	246071
Station	14+251	15+251	16+228	17+228
Offset (looking north on Hwy 6), m	23.5 Rt	34.0 Rt	31.0 Lt	20.0 Lt
Ground Surface Elevation, m	343.2	333.4	325.7	320.0
Total Depth Drilled, m	9.8	11.3	11.3	8.1
End of Borehole Elevation, m	333.4	322.1	314.4	311.9
Depth Augered, m	9.8	11.3	11.3	8.1
Number of Soil Samples	11	12	12	10

Notes: (1) Rt = right, and Lt = left of centreline; stations and offsets refer to chainage on Highway 6.

(2) No bedrock coring was carried out in any of the boreholes.

3.3 LABORATORY TESTING

All samples were taken to Stantec's Ottawa laboratory where they were subjected to a detailed visual examination by a Geotechnical Engineer. Routine soil testing was carried out on selected soil samples. The tests carried out included grain size analysis (13 samples), Atterberg limits testing (2 samples) and moisture content testing (all 45 retrieved samples). Two samples were submitted to Parcel Laboratories of Ottawa for analysis of pH, soluble sulphate content, chloride content and resistivity.

Samples remaining after testing will be placed in storage for a period of one year after issuance of the final report. After the storage period, the samples will be discarded unless we are directed otherwise by MTO.

4.0 Subsurface Conditions

The subsurface conditions observed in the boreholes included in this report are presented in detail on the Borehole Records provided in Appendix B. An explanation of the symbols and terms used to describe the Borehole Records is also provided in Appendix B.

In general, the subsurface stratigraphy consisted of topsoil or fill over sandy silt to silty sand till over sand over a till deposit with heterogeneous mixture of silt, sand and gravel.

As the four signs are spread over a distance of 3 km, the descriptions below are separated by location.

4.1 STATION 14+251, BH 11-1

Four soil strata were observed at this location.

A 0.5 m thick layer of topsoil was noted at ground surface extending to elevation 342.8 m.

A 2.5 m thick layer of sandy silt was observed beneath the topsoil and extended down to elevation 340.2 m. The Standard Penetration Test blow count (N-value) per 0.3 m penetration ranged from 30 to 55 suggesting a dense to very dense state. The moisture content of this material ranged from 7 to 13%. Grain size distribution analysis carried out on one representative sample indicated 13% gravel, 34% sand and 53% fines (silt and clay). The grain size distribution plot of the sample obtained from this layer is provided on Figure 1 in Appendix C. The material can be classified as ML.

A 2.9 m thick layer of clayey silt was observed beneath the sandy silt and extended down to elevation 337.3 m. The N-value ranged from 39 to 44 blows per 0.3 m penetration suggesting a dense state. The moisture content of this material ranged from 15% to 19%. An Atterberg Limit Test yielded a Liquid Limit of 21% and a Plastic Limit of 16%. Grain size distribution analysis carried out on one representative sample indicated 0% gravel, 2% sand and 98% fines (silt and clay). The grain size distribution plot of the sample obtained from this layer is provided on Figure 1 in Appendix C. The Atterberg Limit Results are on Figure 2 in Appendix C. The material can be classified as CL-ML.

A silty sand with gravel (till) was observed beneath the clayey silt and extended down 3.9 m to borehole termination at elevation 333.4 m. The N-value ranged from 101 to 175 blows per 0.3 m penetration suggesting a very dense state. The moisture content of this material ranged from 7 to 8%. Grain size distribution analysis carried out on one representative sample indicated 18% gravel, 43% sand and 39% fines (silt and clay). The grain size distribution plot of the sample obtained from this layer is provided on Figure 1 in Appendix C. The material can be classified as SM. It is noted that although not specifically encountered in the borehole, cobbles and boulders should be anticipated in the glacial till due to its depositional history.

4.2 STATION 15+251, BH 11-2

Four soil strata were observed at this location.

A 1.5 m thick layer of sandy silt fill was noted at ground surface extending to elevation 331.9 m. The N-value ranged from 7 to 10 blows per 0.3 m penetration suggesting a loose state. The moisture content of this material ranged from 16 to 19%.

A 6.1 m thick layer of silty sand with gravel was observed beneath the fill and extended down to elevation 325.8 m. The Standard Penetration Test blow count (N-value) per 0.3 m penetration ranged from 30 to 78 suggesting a dense to very dense state. The moisture content of this

material ranged from 3% to 7%. Grain size distribution analysis carried out on two representative samples indicated 39% and 41% gravel, 43% and 43% sand and 16% and 18% fines (silt and clay). The grain size distribution plot of the sample obtained from this layer is provided on Figure 3 in Appendix C. The material can be classified as SM.

A 3.4 m thick layer of silty sand was observed beneath the silty sand with gravel and extended down to elevation 322.4 m. The N-value ranged from 19 to 29 blows per 0.3 m penetration suggesting a compact state. The moisture content of this material ranged from 15% to 20%. Grain size distribution analysis carried out on one representative sample indicated 1% gravel, 77% sand and 22% fines (silt and clay). The grain size distribution plot of the sample obtained from this layer is provided on Figure 3 in Appendix C. The material can be classified as SM.

A silty sand with gravel (till) was observed beneath the silty sand and extended down 0.3 m to borehole termination at elevation 322.1 m. The N-value was 20 blows per 0.3 m penetration suggesting a compact state. The moisture content of this material was 20%. The material can be classified as SM. It is noted that although not specifically encountered in the borehole, cobbles and boulders should be anticipated in the glacial till due to its depositional history.

4.3 STATION 16+228, BH 11-3

Five soil strata were observed at this location.

A 0.6 m thick layer of topsoil was noted at ground surface extending to elevation 325.1 m.

A 2.5 m thick layer of well graded gravel with silt and sand was observed beneath the topsoil and extended down to elevation 322.6 m. The N-value ranged from 24 to 67 blows per 0.3 m penetration suggesting a compact to very dense state. The moisture content of this material ranged from 7 to 12%. Grain size distribution analysis carried out on one representative sample indicated 49% gravel, 41% sand and 10% fines (silt and clay). The grain size distribution plot of the sample obtained from this layer is provided on Figure 4 in Appendix C. The material can be classified as GW-GM. Cobbles were noted to be present in this layer.

A 2.4 m thick layer of poorly graded sand with silt and gravel was observed beneath the well graded gravel with silt and sand and extended down to elevation 320.2 m. The N-value ranged from 13 to 25 blows per 0.3 m penetration suggesting a compact state. The moisture content of this material ranged from 8 to 14%. Grain size distribution analysis carried out on one representative sample indicated 21% gravel, 69% sand and 10% fines (silt and clay). The grain size distribution plot of the sample obtained from this layer is provided on Figure 4 in Appendix C. The material can be classified as SP-SM.

A 2.1 m thick layer of silt was observed beneath the poorly graded sand with silt and gravel and extended down to elevation 318.1 m. The N-value ranged from 25 to 27 blows per 0.3 m penetration suggesting a compact state. The moisture content of this material ranged from 12% to 20%. An Atterberg Limit Test indicated that the material was non-plastic. Grain size distribution analysis carried out on one representative sample indicated 1% gravel, 1% sand

and 98% fines (silt and clay). The grain size distribution plot of the sample obtained from this layer is provided on Figure 4 in Appendix C. The material can be classified as ML.

A silty sand with gravel (till) was observed beneath the silt and extended down 3.7 m to borehole termination at elevation 314.4 m. The N-value ranged from 21 to 47 blows per 0.3 m penetration suggesting a compact to dense state. The moisture content of this material ranged from 13 to 20%. Grain size distribution analysis carried out on one representative sample indicated 34% gravel, 35% sand and 31% fines (silt and clay). The grain size distribution plot of the sample obtained from this layer is provided on Figure 4 in Appendix C. The material can be classified as SM. It is noted that although not specifically encountered in the borehole, cobbles and boulders should be anticipated in the glacial till due to its depositional history.

4.4 STATION 17+228, BH 11-4

Two soil strata were observed at this location.

A 3.1 m thick layer of poorly graded gravel with silt and sand fill was noted at ground surface extending to elevation 316.9 m. The N-value ranged from 14 to 53 blows per 0.3 m penetration suggesting a compact to very dense state. The moisture content of this material ranged from 7 to 10%. Grain size distribution analysis carried out on a representative sample indicated 58% gravel, 31% sand and 11% fines (silt and clay). The grain size distribution plot of the sample obtained from this layer is provided on Figure 5 in Appendix C.

A sandy silt to silty sand some gravel (till) was observed beneath the fill and extended down 5.0 m to borehole termination at elevation 311.9 m. The N-value ranged from 20 to 180 blows per 0.3 m penetration suggesting a compact to very dense state. The moisture content of this material ranged from 7% to 14%. Grain size distribution analysis carried out on two representative samples indicated 12% and 15% gravel, 33% and 39% sand and 55% and 46% fines (silt and clay). The grain size distribution plot of the sample obtained from this layer is provided on Figure 5 in Appendix C. The material can be classified as ML to SM. It is noted that although not specifically encountered in the borehole, cobbles and boulders should be anticipated in the glacial till due to its depositional history.

4.5 CHEMICAL TEST RESULTS

Two soil samples were submitted to Paracel Laboratories in Ottawa, Ontario, for analysis of pH, water soluble sulphates and chloride concentrations, and resistivity. The analysis results are provided in Table 4.1.

Table 4.1: Results of Chemical Analysis

Borehole No	Sample No.	Depth (m)	pH	Chloride (µg/g)	Sulphate (µg/g)	Resistivity (Ohm-m)
BH11-1	SS-2	0.76-1.37	7.9	132	17	30
BH11-4	SS-3	1.52-2.13	7.9	188	27	23

4.6 BEDROCK

Bedrock was not encountered within the depth of exploration during this investigation.

4.7 GROUNDWATER

Groundwater observations were made during drilling in all the boreholes. The observed groundwater elevations were not confirmed as stabilized, and hence, were designated as 'inferred'. These inferred groundwater level readings are summarized in Table 4.2.

Table 4.2: Inferred Groundwater Level Readings (time of drilling)

Borehole No	Ground Surface Elevation (m)	Groundwater	
		Depth (m)	Elevation (m)
BH11-1	343.2	*	*
BH11-2	333.4	7.6	325.8
BH11-3	325.8	1.5	324.3
BH11-4	320.0	2.3	317.7

Note: *Groundwater was not encountered in this borehole during investigation.

Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

5.0 Miscellaneous

The field work was carried out under the supervision of Mr. Dan Stunden, CET, Senior Technologist, under the direction of Paul Carnaffan, M.Eng., P.Eng., Geotechnical Engineer.

The truck mounted drilling equipment was supplied and operated by Walker Drilling of Utopia, Ontario.

Geotechnical laboratory testing was carried out at the Stantec Ottawa laboratory. Chemical testing on soil samples was carried out by Paracel Laboratories in Ottawa.

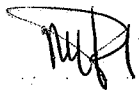
This report was prepared by Simon Gudina, Ph.D., and reviewed by Fred Griffiths, Ph.D., P.Eng., and Raymond Haché, M.Sc., P.Eng., MTO Designated Principal Contact.

6.0 Closure

A subsurface investigation is a limited sampling of a site. The subsurface conditions given herein are based on information gathered at the specific borehole locations and timeframe described herein. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

Respectively Submitted;

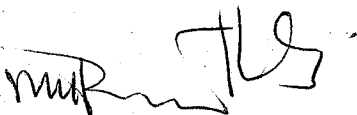
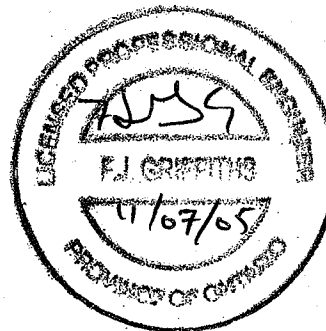
STANTEC CONSULTING LTD.



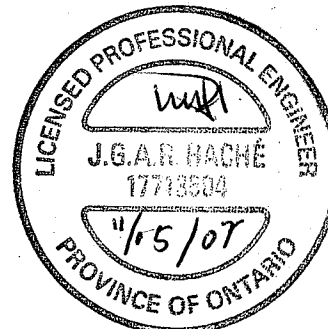
Simon Gudina, Ph.D.



Fred J. Griffiths, Ph.D., P.Eng.
Principal and Senior Geotechnical Engineer



Raymond Haché, M.Sc., P.Eng.
Central Canada Practice Lead and
Designated Principal MTO Foundation Contact



FOUNDATION DESIGN REPORT – Signs
For
G.W.P. 3002-05-00

Highway 6 (Hanlon Expressway) Interchange
City of Guelph

7.0 Discussion

7.1 PROJECT DESCRIPTION & BACKGROUND

Four ground-mounted signs are being installed along Highway 6 as part of the proposed Highway 6 – Laird Road Interchange in Guelph, Ontario. Two signs each, located approximately 0.5 and 1.5 km north and south of the proposed interchange, are proposed to be erected.

This section presents the geotechnical recommendations for the design and construction of the four proposed sign foundations along Highway 6.

It is assumed that the signs will have steel column breakaway supports in accordance with the MTO Sign Support Manual, 2004.

7.2 RECOMMENDATIONS FOR FOUNDATIONS

Design frost depth for foundations based on OPSD 3090.101 is 1.4 m.

The MTO Sign Support Manual is applicable to this site since the following conditions were not observed:

- Bedrock at or near the surface;
- Footing located in rock fill; and
- Soil exceptionally soft or loose.

The proposed footing depths and the post sizes have not been finalized yet, however, it is noted that at the frost penetration depth, the site soil can provide the minimum required passive earth pressure of 68 kPa according to MTO Sign Support Manual 2004. Footings could therefore be designed using the standard details shown on Drawing SS118-30. A copy is provided in Appendix D.

Should a more site specific design proceed, the recommended design parameters for the proposed sign support foundations are provided in Table 1 in Appendix D. It is noted that the soils above the frost penetration depth of 1.4 m and the loose fill encountered in BH 11-2 should

not be relied upon for geotechnical lateral resistance. For design purposes, the groundwater level should be assumed to be at 1.5 m below ground surface.

7.3 UNWATERING

Groundwater levels were observed in the boreholes during drilling (see Table 4.2).

No groundwater was observed in BH11-1. In BH11-2, the groundwater level was observed at approximate depth of 7.6 m from the existing ground surface. Groundwater control measures are not anticipated to be required for these two locations.

The groundwater level in BH11-3 was the shallowest (approximately 0.9 m below the bottom of topsoil). This location will require unwatering which may be carried out with sump and pump techniques.

In BH11-4, the groundwater was observed at approximate depth of 2.3 m below existing ground surface and unwatering is not required for this location. It is noted that the contractor will be responsible to protect the site from the effects of runoff and precipitation.

7.4 CONSTRUCTION RECOMMENDATIONS

In all the four boreholes, the soil conditions encountered within the anticipated footing depth consist of sand and silt with gravel with little or no cohesion. As a result, where they extend below the water table the holes are not expected to remain open for any period of time. Consequently, the use of casing may be necessary.

At Borehole BH11-3 cobbles were encountered during drilling. Provided that the cobbles are less than about 40% of the footing diameter, the construction auger should be able to extract them. Should larger cobbles or boulders be encountered, the contractor will be required to break them prior to extraction. Although it is anticipated that the liner will trail the footing auger, the contractor should anticipate some difficult driving conditions to advance the liner where cobbles are encountered.

Footings for the proposed sign support should be installed in accordance with SS118-30.

7.5 CEMENT TYPE AND CORROSION PROTECTION

Two samples of the soil in the vicinity of the anticipated footings for the sign support were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate and chloride concentrations, and resistivity. The analysis results are summarized in Table 4.1.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected on concrete, if any, in contact with soil and groundwater at the site. The maximum concentration of soluble sulphate was 27 µg/g. Soluble sulphate concentrations less than 1000 µg/g generally indicate that a low degree of sulphate attack is expected on concrete in contact with soil and groundwater. If needed, Type GU (General Use) Portland Cement should therefore be suitable for use in concrete at this site.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The maximum reported soil pH was 7.9 which is within what is considered the normal range for soil pH of 5.5 to 9.0. The pH levels of the tested soil do not indicate a highly corrosive environment. The test results provided in the Table 4.1 may be used to aid in the selection of coatings and corrosion protection systems for buried steel objects.

8.0 References

Chapman, L.J., and Putnam, D.F. 1984. The physiography of Southern Ontario, Ontario Geological Survey Special Volume 2. Ontario Research Foundation, Toronto, Ontario.

Ontario Ministry of Transportation (MTO). 2004. Sign Support Manual. Engineering Standards Branch, Bridge Office, Toronto, Ontario. August 2004.

9.0 Closure

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review our recommendations when the drawings and specifications are complete.

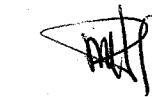
A soil investigation is a limited sampling of a site. The conclusions given herein are based on information gathered at the specific borehole locations. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information and its effects on the above recommendations.

We trust the information presented herein meets your present requirements. Should you have any questions or require additional information, please do not hesitate to contact us.

This report has been prepared by Simon Gudina. Technical review was carried out by Fred Griffiths and Raymond Haché.

Respectfully submitted,

STANTEC CONSULTING LTD.



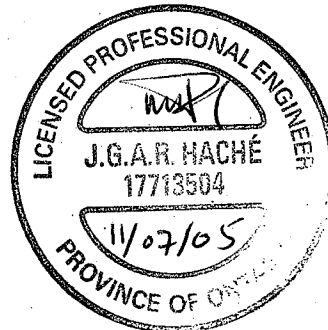
49 Simon Gudina, Ph.D.



Fred J. Griffiths, Ph.D., P.Eng.
Principal and Senior Geotechnical Engineer



Raymond Haché, M.Sc., P.Eng.
Central Canada Practice Lead and
Designated Principal MTO Foundation Contact



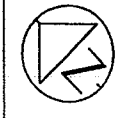
APPENDIX A

Drawings No. 1 – Borehole Location Plan

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MODIFIED: 11/07/04
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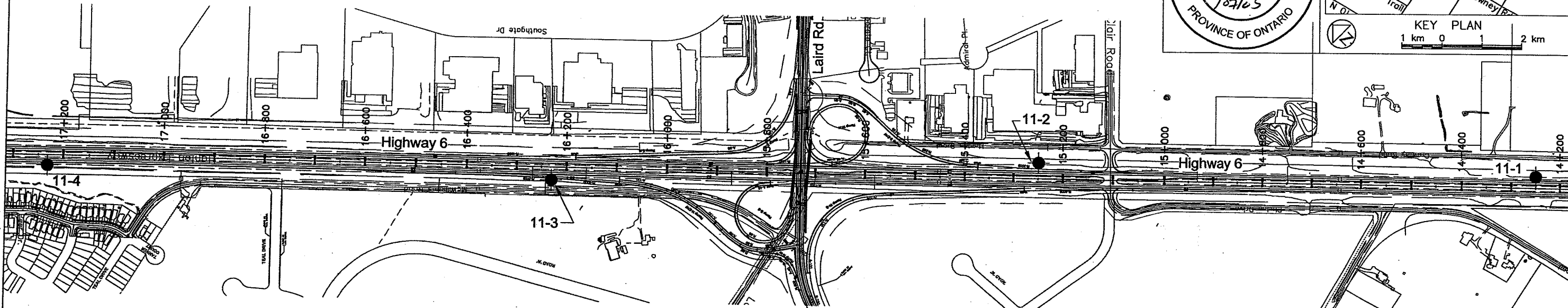
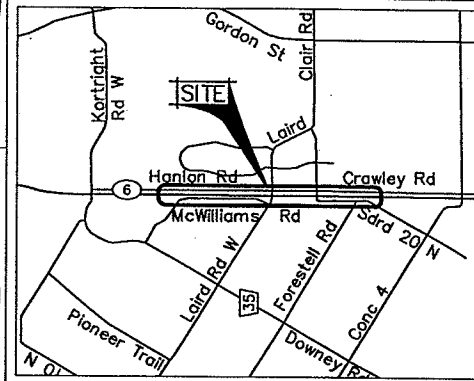
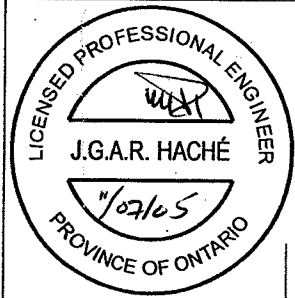
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No
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WP 3002-05-00



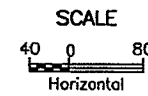
HIGHWAY 6
STA 14+251 to STA 17+228
BOREHOLE LOCATION

SHEET



LEGEND			
Bore Hole			
No	ELEVATION	MTM ZONE 10 COORDINATES NORTH	EAST
11-1	343.2	4 815 933	248 190
11-2	333.4	4 816 654	247 498
11-3	325.7	4 817 313	246 769
11-4	320.0	4 818 031	246 071

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



REVISIONS			
DATE	BY	DESCRIPTION	
GEOCRES No 40P8-198			
HWY No 6			DIST
SUBM'D SG	CHECKED	DATE 2011-07-04	SITE
DRAWN GBB	CHECKED	APPROVED	DWG 1

APPENDIX B

Symbols and Terms Used on Borehole Records

Borehole Records

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

<i>Topsoil</i>	- mixture of soil and humus capable of supporting vegetative growth
<i>Peat</i>	- mixture of visible and invisible fragments of decayed organic matter
<i>Till</i>	- unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

<i>Desiccated</i>	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
<i>Fissured</i>	- having cracks, and hence a blocky structure
<i>Varved</i>	- composed of regular alternating layers of silt and clay
<i>Stratified</i>	- composed of alternating successions of different soil types, e.g. silt and sand
<i>Layer</i>	- > 75 mm in thickness
<i>Seam</i>	- 2 mm to 75 mm in thickness
<i>Parting</i>	- < 2 mm in thickness

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

<i>Trace, or occasional</i>	Less than 10%
<i>Some</i>	10-20%
<i>Frequent</i>	> 20%

Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value (also known as N-Index). A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
<i>Very Loose</i>	<4
<i>Loose</i>	4-10
<i>Compact</i>	10-30
<i>Dense</i>	30-50
<i>Very Dense</i>	>50

Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests.

Consistency	Undrained Shear Strength	
	kips/sq.ft.	kPa
<i>Very Soft</i>	<0.25	<12.5
<i>Soft</i>	0.25 - 0.5	12.5 - 25
<i>Firm</i>	0.5 - 1.0	25 - 50
<i>Stiff</i>	1.0 - 2.0	50 - 100
<i>Very Stiff</i>	2.0 - 4.0	100 - 200
<i>Hard</i>	>4.0	>200



ROCK DESCRIPTION

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	<i>Very Poor</i>
25-50	<i>Poor</i>
50-75	<i>Fair</i>
75-90	<i>Good</i>
90-100	<i>Excellent</i>

Rock quality classification is based on a modified core recovery percentage (RQD) in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures. The terminology describing rock mass quality based on RQD is subjective and is underlain by the presumption that sound strong rock is of higher engineering value than fractured weak rock.

Terminology describing rock mass:

Spacing (mm)	Joint Classification	Bedding, Laminations, Bands
> 6000	<i>Extremely Wide</i>	-
2000-6000	<i>Very Wide</i>	<i>Very Thick</i>
600-2000	<i>Wide</i>	<i>Thick</i>
200-600	<i>Moderate</i>	<i>Medium</i>
60-200	<i>Close</i>	<i>Thin</i>
20-60	<i>Very Close</i>	<i>Very Thin</i>
<20	<i>Extremely Close</i>	<i>Laminated</i>
<6	-	<i>Thinly Laminated</i>

Terminology describing rock strength:

Strength Classification	Unconfined Compressive Strength (MPa)
<i>Extremely Weak</i>	< 1
<i>Very Weak</i>	1 – 5
<i>Weak</i>	5 – 25
<i>Medium Strong</i>	25 – 50
<i>Strong</i>	50 – 100
<i>Very Strong</i>	100 – 250
<i>Extremely Strong</i>	> 250

Terminology describing rock weathering:

Term	Description
<i>Fresh</i>	No visible signs of rock weathering. Slight discolouration along major discontinuities
<i>Slightly Weathered</i>	Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured.
<i>Moderately Weathered</i>	Less than half the rock is decomposed and/or disintegrated into soil.
<i>Highly Weathered</i>	More than half the rock is decomposed and/or disintegrated into soil.
<i>Completely Weathered</i>	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.



STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel



Sand



Silt



Clay



Organics



Asphalt



Concrete



Fill



Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT



measured in standpipe, piezometer, or well



inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and N-values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N value corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to A size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
y	Unit weight
G _s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q _u	Unconfined compression
I _p	Point Load Index (I _p on Borehole Record equals I _p (50) in which the index is corrected to a reference diameter of 50 mm)

↓	Single packer permeability test; test interval from depth shown to bottom of borehole
↑	Double packer permeability test; test interval as indicated
○	Falling head permeability test using casing
▽	Falling head permeability test using well point or piezometer



Stantec

RECORD OF BOREHOLE No BH 11-1

1 OF 1

METRIC

W.P. 3002-05-00 LOCATION 14+251 23.5m Rt CL N: 4 815 933 E: 248 190 ORIGINATED BY DS
 DIST HWY 6 BOREHOLE TYPE Splittings, Hollow Stem Augers COMPILED BY JF
 DATUM Geodetic DATE 2011 04 12 - 2011 04 12 CHECKED BY SG

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			SHEAR STRENGTH kPa					
								○ UNCONFINED	× FIELD VANE	○ QUICK TRIAXIAL			× LAB VANE
343.2							20	40	60	80	100		
0.0	TOPSOIL		1	SS	4								
342.7													
0.5	SANDY SILT (ML) Dense to very dense Brown		2	SS	55								
			3	SS	30								13 34 (53)
			4	SS	31								
340.2													
3.0	CLAYEY SILT (CL-ML) Dense Brown		5	SS	39								
			6	SS	39								
			7	SS	44								0 2 77 21
			8	SS	43								
337.3													
5.9	Silty sand (SM) with gravel, TILL Very dense Moist Brown		9	SS	119								
			10	SS	175								18 43 (39)
			11	SS	101								
333.4													
9.8	End of Borehole Groundwater not observed during drilling												

ONTARIO MTO STANTEC 16500749 - HWY 6 & LAIRD RD.GPJ ONTARIO MOT.GDT 6/7/11

RECORD OF BOREHOLE No BH 11-2

1 OF 1

METRIC

W.P. 3002-05-00 LOCATION 15+251 34.0m Rt CL N: 4 816 654 E: 247 498 ORIGINATED BY DS
 DIST HWY 6 BOREHOLE TYPE Splitterspoons, Hollow Stem Augers COMPILED BY JF
 DATUM Geodetic DATE 2011 04 11 - 2011 04 11 CHECKED BY SG

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			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								○ UNCONFINED	✕ FIELD VANE							● QUICK TRIAXIAL	✕ LAB VANE	
333.4							20	40	60	80	100	10	20	30	kN/m ³	GR SA SI CL		
0.0	Sandy silt, FILL		1	SS	10													
	Loose																	
	Moist																	
	Dark brown		2	SS	7													
331.9																		
1.5	SILTY SAND (SM), with gravel		3	SS	36													
	Dense to very dense																	
	Moist																	
	Brown			4	SS	52											41 43 (16)	
				5	SS	78												
				6	SS	52												
			7	SS	41													
			8	SS	54											39 43 (18)		
			9	SS	30													
325.8																		
7.6	SILTY SAND (SM)		10	SS	19													
	Compact																	
	Wet																	
	Brown																	
			11	SS	29											1 77 (22)		
322.4			12	SS	20													
11.0	Silty SAND (SM) with gravel, TILL																	
322.1	Compact																	
11.3	Wet																	
	Grey																	
	End of Borehole																	
	Groundwater observed at elevation 325.8 m during drilling																	

×³, ×³: Numbers refer to
Sensitivity

○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 11-3

1 OF 1

METRIC

W.P. 3002-05-00 LOCATION 16+228 31.0m Lt CL N: 4 817 313 E: 246 769 ORIGINATED BY DS
 DIST HWY 6 BOREHOLE TYPE Splittings, Hollow Stem Augers COMPILED BY JF
 DATUM Geodetic DATE 2011 04 11 - 2011 04 11 CHECKED BY SG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								○ UNCONFINED ✕ FIELD VANE ● QUICK TRIAXIAL ✕ LAB VANE							W _p W W _L		
							20 40 60 80 100						10 20 30	GR SA SI CL			
325.7 0.0	TOPSOIL		1	SS	11		325										
325.1 0.6	Well-graded GRAVEL WITH SILT AND SAND (GW-GM), Compact to very dense Moist to wet - some cobbles		2	SS	67		324										49 41 (10)
			3	SS	51		323										
			4	SS	24		322										
322.6 3.1	Poorly graded SAND WITH SILT AND GRAVEL (SP-SM) Compact Wet Brown		5	SS	25		321										
			6	SS	13		320										21 69 (10)
			7	SS	25		319										
320.2 5.5	SILT (ML) Compact Moist to wet Grey		8	SS	25		318										1 1 (98) NP
			9	SS	27		317										
318.1 7.6	Silty sand (SM) with gravel, TILL Compact to dense Brown		10	SS	36		316										
			11	SS	21		315										
			12	SS	47												34 35 (31)
314.4 11.3	End of Borehole Groundwater observed at elevation 324.3 m during drilling NP = Non-plastic																

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RECORD OF BOREHOLE No BH 11-4

1 OF 1

METRIC

W.P. 3002-05-00 LOCATION 17+228 20.0m Lt CL N: 4 818 031 E: 246 071 ORIGINATED BY DS
 DIST HWY 6 BOREHOLE TYPE Splitterspoons, Hollow Stem Augers COMPILED BY JF
 DATUM Geodetic DATE 2011 04 12 - 2011 04 12 CHECKED BY SG

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			SHEAR STRENGTH kPa								
								20 40 60 80 100								
320.0																
0.0	Poorly-graded gravel with silt and sand (GP-GM), FILL		1	SS	14											
	Compact to very dense															
	Moist															
	Brown		2	SS	52		319									
		3	SS	39	318											
		4	SS	53											58 31 (11)	
316.9																
3.1	Sandy silt (ML) to silty sand (SM), some gravel, TILL		5	SS	20		317									
	Compact to very dense															
	Moist															
	Grey		6	SS	49	316									12 33 (55)	
			7	SS	80	315										
			8	SS	104	314										
		9	SS	103										15 39 (46)		
						</										

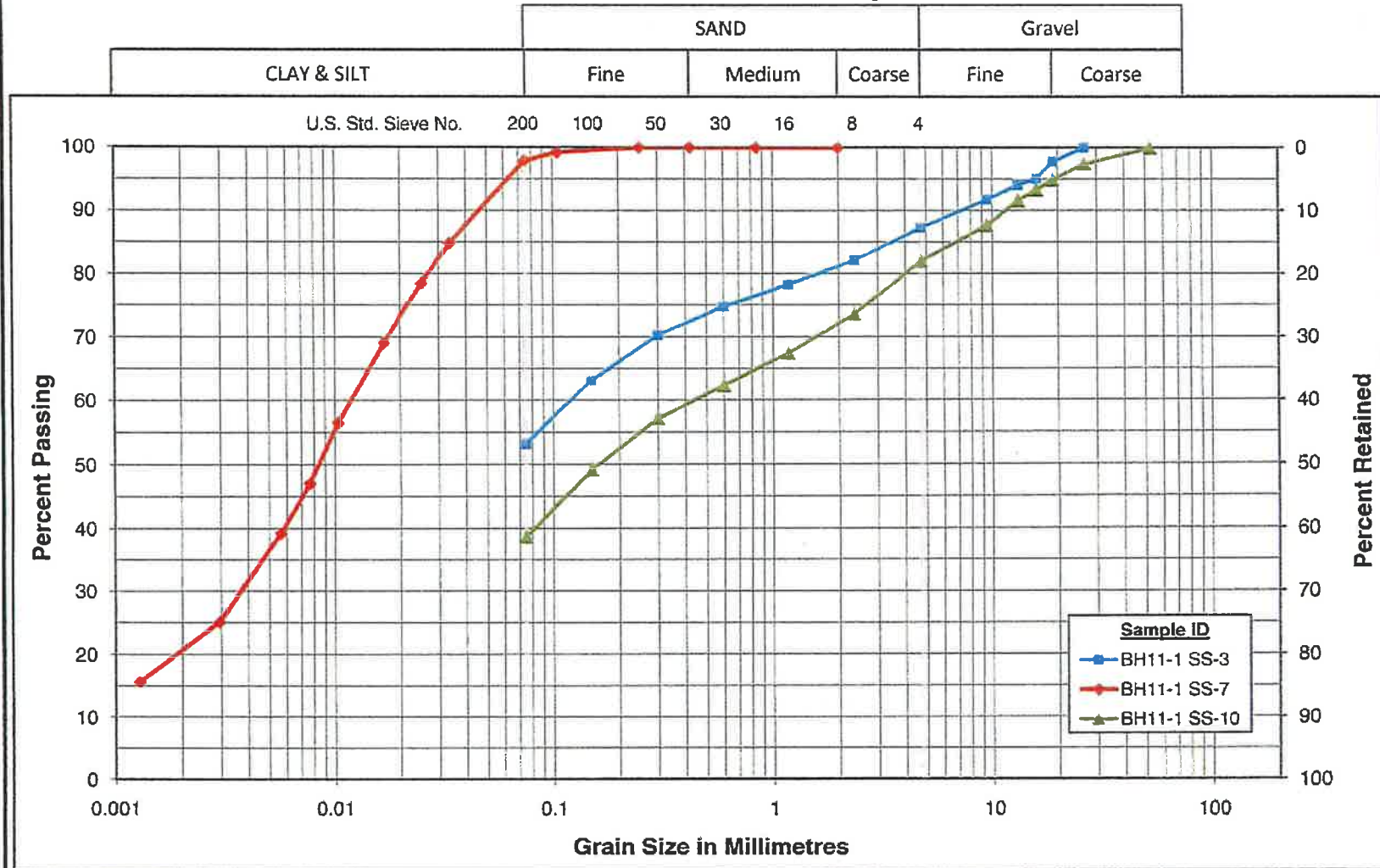
ONTARIO MTO STANTEC 165000749 - HWY 6 & LAIRD RD.GPJ ONTARIO MOT.GDT 8/7/11

APPENDIX C

Laboratory Test Results

Figures 1 – 5: Grain Size Distribution Plots and Plasticity Chart

Unified Soil Classification System

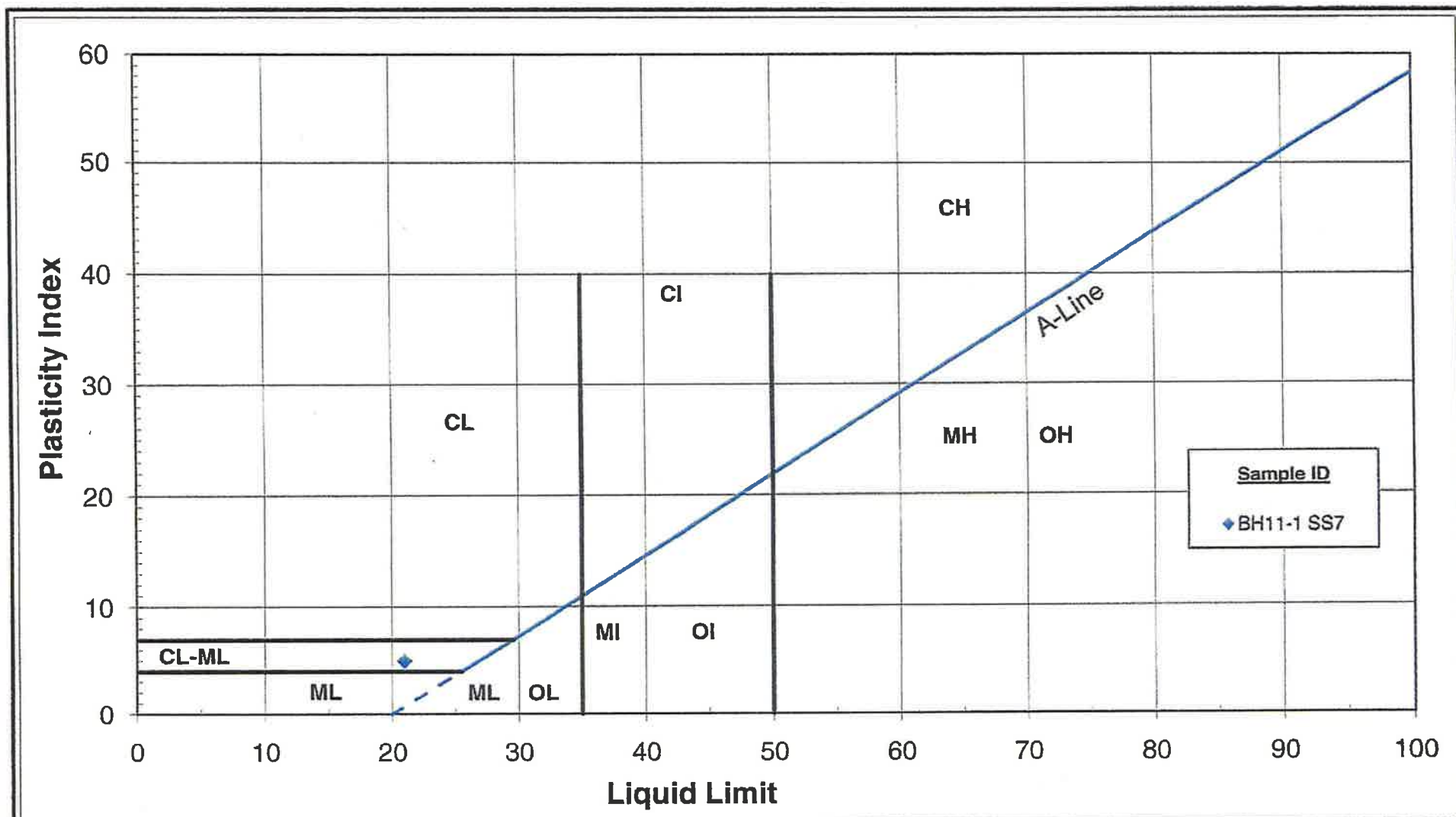


GRAIN SIZE DISTRIBUTION

Station 14 + 251, BH 11-1

Figure No. 1

Project No. 165000749

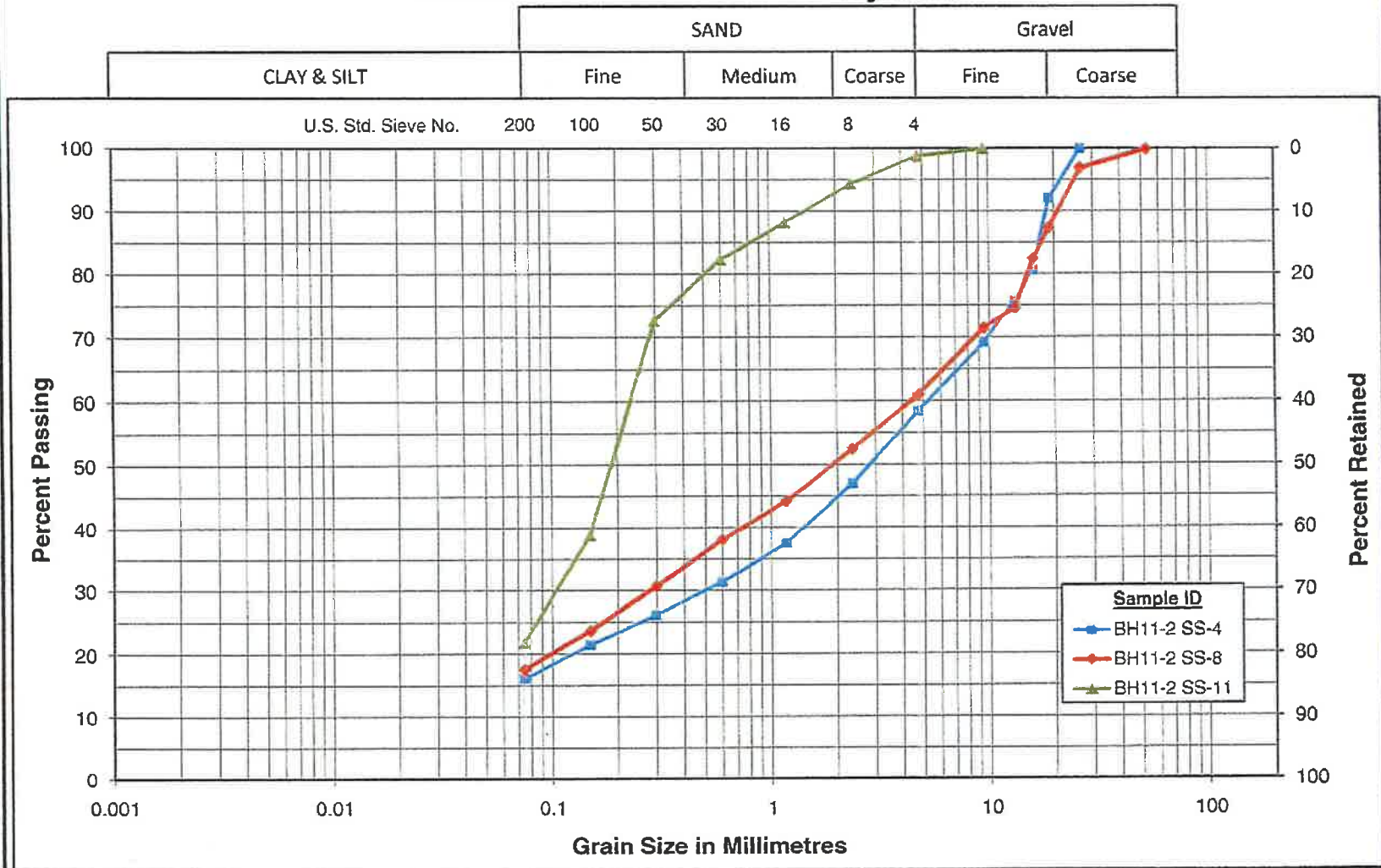


PLASTICITY CHART

Figure No. 2

Project No. 165000749

Unified Soil Classification System



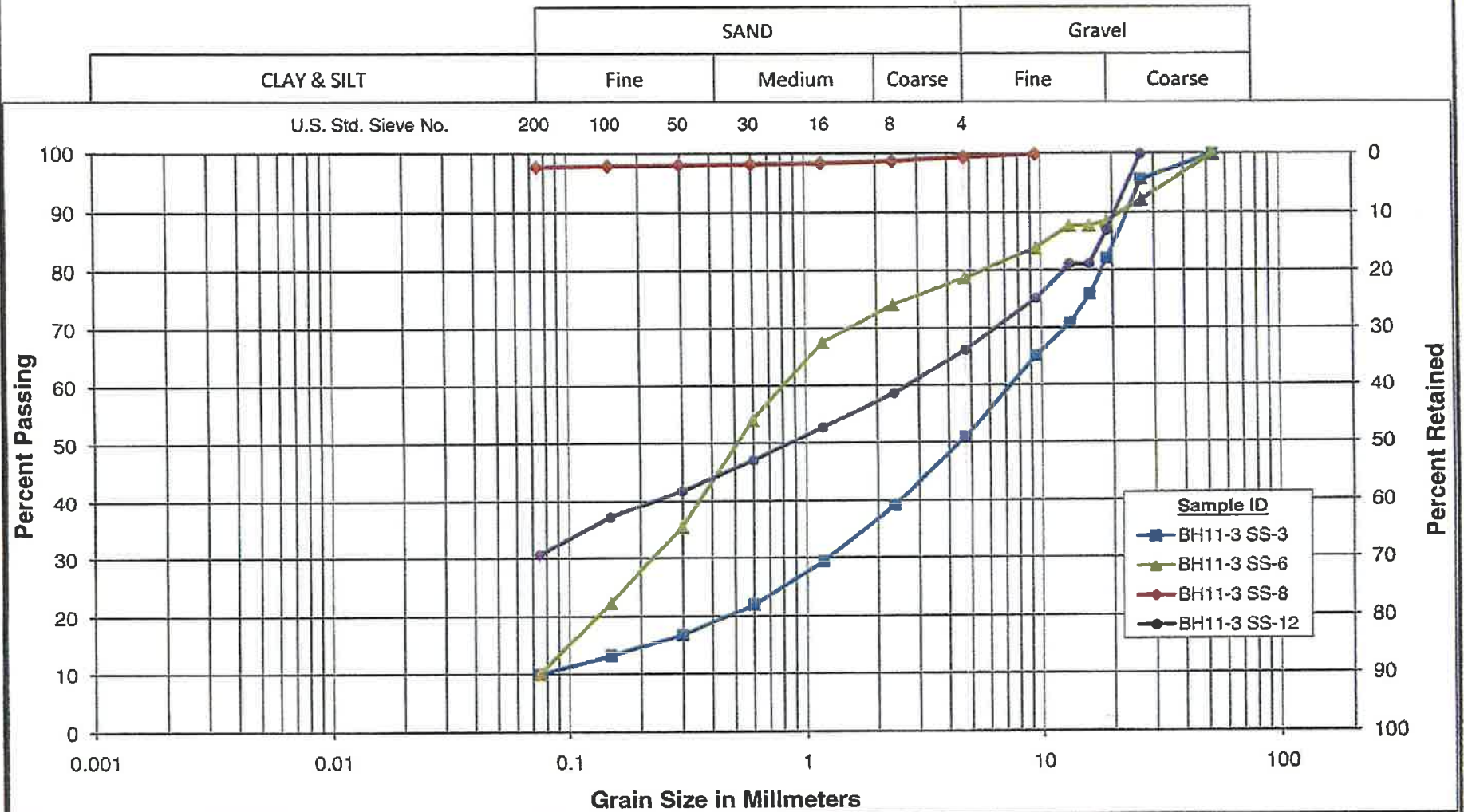
GRAIN SIZE DISTRIBUTION

Station 15 + 251, BH 11-2

Figure No. 3

Project No. 165000749

Unified Soil Classification System



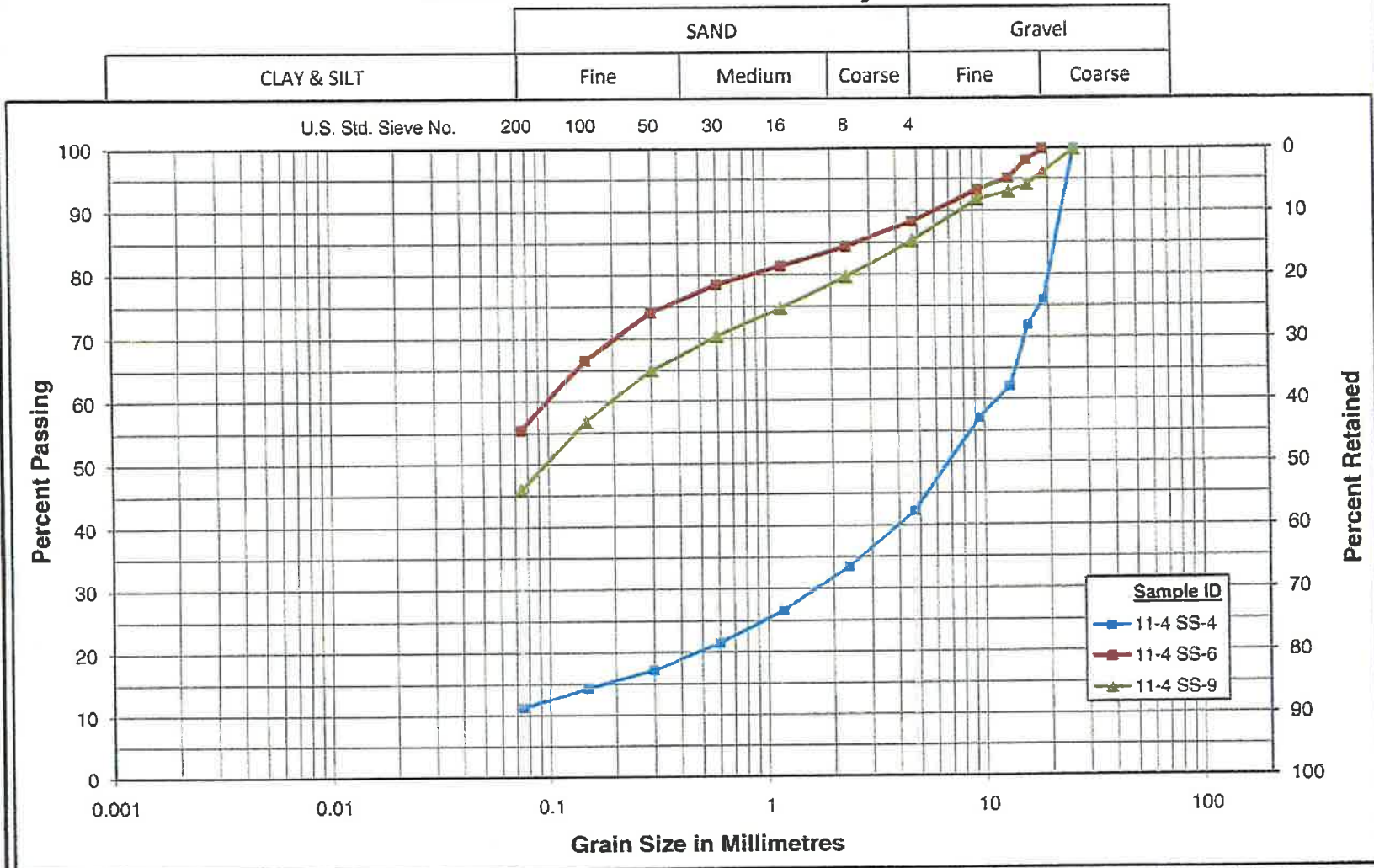
GRAIN SIZE DISTRIBUTION

Station 16 + 228, BH 11-3

Figure No. 4

Project No. 165000749

Unified Soil Classification System



GRAIN SIZE DISTRIBUTION

Station 17 + 228, BH 11-4

Figure No. 5

Project No. 165000749

APPENDIX D

SS118-30 Steel Column Breakaway Sign Supports

Table 1: Recommended Design Parameters



Table 1: Recommended Design Parameters at Proposed Sign Support Foundations

Borehole	Location (Station)	Soil Layer	Geodetic Elevation of Layer (m)		Average N Per 0.3 m	Unit Weight (kN/m ³)	Angle of Internal Friction ϕ (°)	K _a	K _o	K _p
			Start	End						
BH11-1	14+251	Sandy Silt	342.7	340.2	39	20	33	0.29	0.46	3.39
		Clayey Silt	340.2	337.3	41	19	28	0.36	0.53	2.77
		Silty Sand with Gravel Till	337.3	333.4	>100	22	35	0.27	0.43	3.69
BH11-2	15+251	Sandy Silt Fill	333.4	331.9	9	19	N/A (see notes)	N/A	N/A	N/A
		Silty Sand with Gravel	331.9	325.8	49	21	35	0.27	0.43	3.69
		Silty Sand	325.8	322.4	23	20	34	0.28	0.44	3.54
		Silty Sand with Gravel Till	322.4	322.1	20	20	33	0.29	0.46	3.39
BH11-3	16+228	Gravel with Silt & Sand	325.1	322.6	47	21	35	0.27	0.43	3.69
		Sand with Silt & Gravel	322.6	320.2	21	20	33	0.29	0.46	3.39
		Silt	320.2	318.1	26	20	31	0.32	0.48	3.12
		Silty Sand with Gravel Till	318.1	314.4	35	21	35	0.27	0.43	3.69
BH11-4	17+228	Gravel with Silt & Sand Fill	320.0	316.9	40	21	35	0.27	0.43	3.69
		Sandy Silt to Silty Sand Till	316.9	311.9	89	22	35	0.27	0.43	3.69

Notes:

Depth of frost penetration, $f = 1.4$ m

Soils above the frost penetration depth of 1.4 m should not be relied upon for lateral resistance.

The loose sandy silt fill from el. 333.4 m to 331.9 m in BH 11-2 should not be relied upon for lateral resistance.

For design purposes groundwater should be assumed to be at a depth of 1.5 m.

K_a = Coefficient of Active Earth Pressure

K_o = Coefficient of Earth Pressure at Rest

K_p = Coefficient of Passive Earth Pressure

A maximum angle of internal friction (ϕ) of 35° was used to account for soil loosening anticipated as a result of construction augering.

Stations are measured along Highway 6 centreline and increase going north.