



**Foundation Investigation and  
Design Report, Overhead Signs**  
Improvements to the Canadian Plaza  
of the Windsor-Detroit Tunnel  
Windsor, ON

G.W.P. 3032-06-00

Geocres No. 40J6-43

Project No. 165601256

October 2012

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**FOUNDATION INVESTIGATION REPORT**

For  
G.W.P. 3032-06-00

Overhead Sign Support  
Improvements to the Canadian Plaza of the Windsor-Detroit Tunnel  
City of Windsor

## **1.0 Introduction**

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Stantec Consulting Ltd. (Stantec) was retained by the Ontario Ministry of Transportation (MTO) to complete a Foundation Investigation and Design Report for the Detailed Design of the proposed improvements to the Canadian Plaza of the Windsor-Detroit Tunnel in Windsor, Ontario. The proposed improvements included three new overhead signs within the general area of the plaza.

This Foundation Investigation Report has been prepared specifically and solely for the proposed Overhead Sign supports.

Project Number: G.W.P. 3032-06-00

Project Location: Along Goyeau Street between Park Street East in the north and  
Tuscarora Street in the south, City of Windsor, Ontario

This work was carried out under Agreement Number 3010-E-0027 with Stantec Consulting Ltd., the Detailed Design Consultant for this project.

## **2.0 Site Description and Geology**

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### Site Location

The site location is shown on the Key Plan insert to Drawing No. 1 provided in Appendix A. The site is located along Goyeau Street between Park Street West (approximately 260 m north of Wyandotte Street East) and Tuscarora (approximately 150 m south of Wyandotte Street East) in the City of Windsor, Ontario.

### General Site Description

The site is developed and includes building facilities and paved surfaces, including roadway and parking areas. Drainage from the site is through catch basins along the roadways and in parking zones.



### Physiographic Description

The site is located within a physiographic region known as the St. Clair Clay Plains (Chapman and Putnam, 1984). The predominant sediment in this region consists essentially of clay till overlain by a shallow deposit of lacustrine clay. The overburden thickness in this region generally ranges between 30 to 60 m. The predominant bedrock in this region is limestone with possibly black shale in some areas.

The region has little relief and the surface drainage is mostly northward to Lake St. Clair.

## **3.0 Investigation Procedures**

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### **3.1 DRILLING INVESTIGATION**

The geotechnical investigation for the proposed Overhead Signs included four boreholes within the immediate vicinity of the proposed sign locations. The borehole locations represent a distance of less than 25 m from the proposed overhead sign support locations. These boreholes are designated BH11-3, BH11-9, BH11-10 and BH12-11, 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 September 30 and October 4 and 5, 2011, (Boreholes BH11-3, BH11-9 and BH11-10) and on July 26, 2012 (Borehole BH12-11). The boreholes were advanced with continuous flight hollow-stem augers using a D120 track-mounted drill rig equipped for soil and bedrock sampling (BH11-3, BH11-9 and BH11-10) and a D50 T with rubber tracks (BH12-11).

The subsurface stratigraphy encountered in each borehole was recorded in the field. Split spoon samples were collected at regularly spaced intervals during the course of Standard Penetration Testing (SPT) (ASTM, 1999). All samples recovered were returned to Stantec's Ottawa laboratory for detailed classification and testing.

In addition to SPT blow counts (N-Values), the undrained shear strength of the cohesive soils was measured by carrying out in situ field vane shear tests and in the case of very stiff samples was estimated using a pocket penetrometer on split spoon samples.

Groundwater water levels were measured in each borehole upon completion of drilling. A 50 mm diameter groundwater monitoring well was installed in Borehole BH11-10. The bottom 3 m of the well consisted of Schedule #40 slotted PVC screen. The screened section of the well was backfilled with silica sand and the remainder of the well backfilled with bentonite to the ground surface. The monitoring well was provided with a flush mount casing.

Boreholes were backfilled with auger cuttings mixed with bentonite. In pavement areas the boreholes were topped with cold patch asphalt.

### **3.2 LOCATION AND ELEVATION AND SURVEY**

The survey of the borehole locations was carried out by Stantec. The ground surface elevation at each borehole location was surveyed with reference to Geodetic datum to an accuracy of 0.1 m. Table 3.1 summarizes the location and elevation information for the boreholes included in this report.

**Table 3.1: Borehole Information Summary**

<b>Borehole</b>	<b>UTM Zone 17 Coordinates</b>		<b>Ground Elevation (m)</b>	<b>Total Depth (m)</b>	<b>End of Borehole Elevation (m)</b>	<b>No. of Soil Samples Collected</b>
	<b>Northing (m)</b>	<b>Easting (m)</b>				
11-3	4686737.4	332266.2	183.2	29.6	153.6	27
11-9	4686765.3	332295.6	183.2	9.8	173.4	13
11-10	4686906.4	332263.1	183.3	9.1	174.2	11
12-11	4686654.0	332346.2	183.6	10.4	173.2	13

### **3.3 LABORATORY TESTING**

All samples were subjected to a detailed visual examination by a Geotechnical Engineer.

The geotechnical laboratory testing program is summarized in the following Table 3.2.

**Table 3.2: Geotechnical Laboratory Testing Program**

<b>Test Description</b>	<b>Number of Tests</b>
Moisture Content	62
Atterberg Limits	13
Grain Size Distribution	15

It is noted that where a value is provided for the percent of clay sized particles, the value represents the percent finer than a nominal size of 0.002 mm.

Two samples were tested for pH, soluble sulphate content, chloride content and resistivity.

Samples remaining after testing will be placed in storage until one year after issuance of the final report. After the storage period, the samples will be discarded.

## **4.0 Subsurface Conditions**

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### **4.1 GENERAL**

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 pavement structure and variable layers of fill material over a clay till. The surficial material included asphalt pavement in three boreholes and a sand and gravel fill in the remaining borehole.

As the three sign locations are spread over a distance of greater than 300 m, the descriptions below are separated by the proposed overhead sign location.

### **4.2 OVERHEAD SIGN 1, CANTILEVER (NEXUS ONLY ENTRANCE): BH11-10**

#### Pavement Structure

The pavement structure at borehole BH11-10 consisted of 100 mm of asphaltic concrete over 100 mm of sand and crushed gravel fill.

Grain size distribution test carried out on the sand and crushed gravel fill immediately beneath the asphalt indicated 28% gravel, 55% sand and 17% fines (silt and clay). The grain size distribution plot is indicated on Figure 1a in Appendix C.

#### Fill Material

A fill material was encountered beneath the pavement structure consisting of a sand with organics and trace gravel. The fill was 1.32 m thick and its bottom elevation was at 181.8 m.

The Standard Penetration Test (SPT) N-Values for the fill material in this borehole were 6 and 8 per 0.3 m suggesting a loose state.

Moisture content tests carried out on a fill sample indicated moisture contents of 24%.

#### Clay Till

A silty clay with sand till deposit was encountered immediately beneath the fill. This deposit extended to the termination depth of 9.1 m in borehole BH11-10 (elevation of 174.2 m).

The top 3.7 m of the till was oxidized and forms a crust over the deeper unaltered deposit. The base of the crust is estimated to be at a depth of 5.3 m corresponding to an elevation of 178.0 m Geodetic. SPT N-values within the crust ranged from 6 to 21. The undrained shear strength of the crust estimated using a pocket penetrometer ranged between 165 and 225 kPa.

Beneath the clay crust, the strength of the clay gradually decreases. SPT N-values ranged from 7 to 10 and in situ field vane test yielded an undrained shear strength estimate of 80 kPa.

Moisture content tests were carried out on nine samples of the clay till layer. Grain size analysis and Atterberg limits tests were completed for two samples. The results are as follows:

Gravel	0 and 3%
Sand	24 and 25%
Silt	45 and 44%
Clay	31 and 28%
Liquid Limit	30 and 26
Plastic Limit	15 and 13
Moisture Content	13 to 18%

The result of the laboratory test indicates that the clay till deposit can be classified as CL (silty clay with sand). The grain size distribution plots for this layer are provided on Figure 1a in Appendix C. The Plasticity Chart is provided on Figure 1b.

#### **4.3 OVERHEAD SIGN 2, TRI-CHORD (PLAZA ENTRANCE): BH11-3 & BH11-9**

##### **Borehole BH11-3 – West of Goyeau Street**

###### **Pavement Structure**

The pavement structure at borehole BH11-3 included 100 mm of asphaltic concrete over 400 mm of well graded gravel with sand.

###### **Fill Material**

Approximately 2.8 m thick layer of fill was encountered immediately beneath the asphalt pavement. The fill consisted of clayey gravel with sand with pieces of concrete and brick. The fill extended to a depth of 3.3 m with a base elevation of 179.9 m.

The Standard Penetration Test (SPT) blow count (N-value) per 0.3 m penetration ranged from 3 to 10.

Moisture content tests carried out on four samples of the fill in this borehole indicated moisture contents between 11 and 18%.

Grain size distribution test carried out on one sample of the fill in this borehole indicated 35% gravel, 33% sand and 32% fines (silt and clay). The grain size distribution plot is indicated on Figure 2a in Appendix C.

### Clay Till

A silty clay with sand to sandy clay till deposit was encountered immediately beneath the fill. This deposit extended to the termination depth of 29.6 m in borehole BH11-3 (elevation of 153.6 m).

The top 1.2 m of the till was oxidized and forms a crust over the deeper unaltered deposit. The base of the crust is estimated to be at an approximate elevation of 178.7 m geodetic. SPT N-values within the crust ranged from 17 to 20. The undrained shear strength of the crust was estimated at 185 and 210 kPa.

Beneath the clay crust, the strength of the clay gradually decreases; however, below a depth of 25 m (elevation 158.2 m) the soil strength increases, becoming very stiff. Between depths of 4.5 m and 25 m (elevation 178.7 to 158.2 m), the SPT N-values ranged from 3 to 12 and in situ field vane test yielded an undrained shear strength estimate of between 63 and 94 kPa. Below elevation of 158.2 m, the N-values ranged from 21 to 24 with estimated undrained shear strength of 110 and 112 kPa.

Moisture content tests were carried out on 21 samples of the till layer in this borehole. Grain size analysis and Atterberg limits tests were completed for five samples. The results are as follows:

Gravel	1 to 11%
Sand	4 to 33%
Silt	40 to 44%
Clay	15 to 53%
Liquid Limit	22 to 42
Plastic Limit	12 to 13
Moisture Content	13 to 33%

The result of the laboratory test indicates that the clay till deposit can be classified as CL (silty clay with sand). The grain size distribution plots for this layer are provided on Figure 2a in Appendix C. The Plasticity Chart is shown on Figure 2b.

### **Borehole BH11-9 – East of Goyeau Street**

#### Fill Material

Approximately 900 mm thick layer of fill was encountered in this borehole. The top 200 mm of the fill consisted of gravel with sand with the lower 700 mm consisting mainly of sandy silty clay with trace organics. The fill extended to base elevation of 182.3 m. The Standard Penetration Test (SPT) blow count (N-value) per 0.3 m penetration was 2 and 8.

The moisture content of the fill was approximately 22%.

### Clay Till

A silty clay with sand till deposit was encountered immediately beneath the fill. This deposit extended to the termination depth of 9.8 m in borehole BH11-9 (elevation of 173.4 m).

The top 3.5 m of the till was oxidized and forms a crust over the deeper unaltered deposit. The base of the crust is estimated to be at a depth of 4.4 m or an approximate elevation of 178.8 m geodetic. SPT N-Values within the crust ranged from 7 to 22. The undrained shear strength of the crust was estimated at 150 and 225 kPa.

Beneath the clay crust, the strength of the clay gradually decreases. SPT N-values ranged from 7 to 11 and in situ field vane test yielded an undrained shear strength estimate of 52 kPa and 85 kPa.

Moisture content tests were carried out on 12 samples of the clay till layer. Grain size analysis and Atterberg limits tests were completed for two samples. The results are as follows:

Gravel	1 and 4%
Sand	25 and 26%
Silt	42%
Clay	32 and 28%
Liquid Limit	29 and 27
Plastic Limit	13 and 14
Moisture Content	13 to 19%

The result of the laboratory test indicates that the clay till deposit can be classified as CL (silty clay with sand). The grain size distribution plots for this layer are provided on Figure 3a in Appendix C. The Plasticity Chart is shown on Figure 3b.

## **4.4 OVERHEAD SIGN 3, CANTILEVER (GOYEAU STREET): BH12-11**

### Pavement Structure

The pavement structure at borehole BH 12-11 included 50 mm of asphaltic concrete over 150 mm of sand and gravel.

### Fill Material

Approximately 1.9 m thick layer of fill was encountered immediately beneath the asphalt pavement. The fill consisted of silty clay with sand and trace gravel. The fill extended to a depth of 2.1 m or approximate elevation of 181.5 m.

The Standard Penetration Test (SPT) N-Values for the fill material in this borehole were 15 and 20 per 0.3 m suggesting a compact state.

Moisture content tests carried out on three samples of the fill encountered in this borehole indicated a moisture content range of 5 to 13%.

Grain size distribution test carried out on the silty clay with sand fill layer indicated 3% gravel, 24% sand, 43% silt and 30% clay.

Atterberg limits tests carried out on one sample of the fill produced plastic limit and liquid limit of 10 and 29, respectively.

The grain size distribution plot for a sample of the fill layer in this borehole is provided on Figure 4a in Appendix C.

#### Clay Till

A silty clay with sand till deposit was encountered immediately beneath the fill. This deposit extended to the termination depth of 10.4 m in borehole BH12-11 (elevation of 173.2 m).

The top 3.1 m of the till was oxidized and forms a crust over the deeper unaltered deposit. The base of the crust is estimated to be at a depth of 5.3 m or at an approximate elevation of 178.4 m geodetic. SPT N-Values within the crust ranged from 15 to 23.

Beneath the clay crust, the strength of the clay gradually decreases. SPT N-values ranged from 5 to 10 and in situ field vane test yielded an undrained shear strength estimate of 95 kPa to greater than 110 kPa.

Moisture content test was carried out on ten samples of the clay till layer. Grain size analysis and Atterberg limits tests were completed for three samples. The results are as follows:

Gravel	1 to 5%
Sand	26 to 33%
Silt	42 to 48%
Clay	18 to 28%
Liquid Limit	21 to 30
Plastic Limit	10 to 12
Moisture Content	14 to 17%

The result of the laboratory test indicates that the clay till deposit can be classified as CL (silty clay with sand). The grain size distribution plots for this layer are provided on Figure 4a in Appendix C. The Plasticity Chart is shown on Figure 4b.

## **4.5 BEDROCK**

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

## **4.6 GROUNDWATER**

A groundwater monitoring well was installed BH11-10 in October 5, 2011. No standing water was observed in this monitoring well on October 6, 2011. It is noted that the groundwater level in this monitoring well was measured one day after installation and likely did not have sufficient time to stabilize. Groundwater was not encountered during drilling in all other boreholes advanced for the overhead signs.

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

#### **4.7 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**

<b>Borehole No</b>	<b>Sample No.</b>	<b>Depth (m)</b>	<b>pH</b>	<b>Chloride (µg/g)</b>	<b>Sulphate (µg/g)</b>	<b>Resistivity (Ohm-m)</b>
BH11-10	SS-3	1.52 – 2.13	7.4	1200	99	6.8
BH12-11	SS-4	2.29 – 2.90	7.6	47	53	40

#### **5.0 Miscellaneous**

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The field work was carried out under the supervision of Mr. Dan Stunden, CET, Senior Technologist, and Jason Hopwood-Jones, Engineering Technician, under the direction of Chris McGrath, P.Eng., Geotechnical Engineer.

MultiVIEW Locates Inc. of Mississauga, Ontario, and USL1 Inc. of Ottawa, Ontario, carried out the private and public utility locates for the boreholes.

The D90 drilling equipment was supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. The D50 T drilling equipment was supplied and operated by London Soil Test Ltd. of Dundalk, 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., P.Eng. and reviewed by Chris McGrath, P.Eng., and Raymond Haché, M.Sc., P.Eng., MTO Designated Principal Contact.



## 6.0 Closure

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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.**

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Geotechnical Engineer



Chris McGrath, P.Eng.  
Associate, Senior Geotechnical Engineer



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



FOUNDATION DESIGN REPORT – Overhead Signs  
For  
G.W.P. 3032-06-00  
  
Overhead Sign Support  
Improvements to the Canadian Plaza of the Windsor-Detroit Tunnel  
City of Windsor

## **7.0 Discussion**

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### **7.1 PROJECT DESCRIPTION & BACKGROUND**

Three Overhead Signs are being installed as part of the proposed improvements to the Canadian Plaza of the Windsor-Detroit Tunnel in Windsor, Ontario. The locations of the proposed Overhead Signs are indicated on Drawing 1 in Appendix A.

This section presents the geotechnical recommendations for the design and construction of the proposed sign foundations.

The proposed Overhead Signs support types are summarized below:

<b>Sign</b>	<b>Description / Location</b>	<b>Sign Support Type</b>	<b>Boreholes</b>
Overhead Sign 1	Nexus entrance	Cantilever	BH11-10
Overhead Sign 2	Plaza Entrance	Tri-chord	BH11-3 & BH11-9
Overhead Sign 3	Goyeau Street, approximately 90 m south of Wyandotte Street East	Cantilever	BH12-11

It is assumed that the proposed sign supports are to be designed and constructed in accordance with the MTO Sign Support Manual (2011).

### **7.2 RECOMMENDATIONS FOR FOUNDATIONS**

Design frost depth for foundations based on OPSD 3090.101 is 1.0 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.

It is noted that at the frost penetration depth, the site soil can provide the minimum required passive earth pressure of 68 kPa required according to Section 5.1.5 of the MTO Sign Support Manual (2011) for footings built by placing steel columns in concrete fill holes.

The strength parameters for the site soils exceed the “assumed soil parameters below the frost layer” stated in the Sign Support Manual (2011) for the MTO Cantilever Static Sign Support and Tri-Chord Station Sign Support standard details. Therefore footings can be designed using the standard details shown on Drawings SS118-3 for both Cantilever and Tri-chord Static sign supports. A copy is provided in Appendix D. Copies of the General Arrangement for both sign support types are also included in Appendix D.

Should a more site specific design proceed, the recommended geotechnical 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 (1.0 m) should not be relied upon for geotechnical resistance.

For design purposes, the groundwater level should be assumed at ground surface. This condition may occasionally occur during specific spring thaw periods accompanied by heavy rainfalls.

### **7.3 UNWATERING**

Groundwater levels were not observed in the boreholes during drilling. Groundwater control measures are not anticipated to be required.

Should unwatering be required at any of the sign locations, it may be carried out with sump and pump techniques.

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 included sand and silt with gravel with little or no cohesion. As a result, where excavations 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 in these cases.

Footings for the proposed sign support should be installed in accordance with SS118-3.

### **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 in contact with soil and groundwater at the site. The maximum concentration of soluble sulphate was 99 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. 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 7.6 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**

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ASTM. 1999. Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). ASTM International, West Conshohocken, PA.

ASTM. 2000. Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) (ASTM D2487). ASTM International, West Conshohocken, PA.

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). 2011. Sign Support Manual. Engineering Standards Branch, Bridge Office, Toronto, Ontario. April 2011.

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## 9.0 Closure

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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 was prepared by Simon Gudina and Chris McGrath, and reviewed by Raymond Haché.

Respectfully submitted,

**STANTEC CONSULTING LTD.**

Simon Gudina, Ph.D., P.Eng.  
Geotechnical Engineer



Chris McGrath, P.Eng.  
Associate, Senior Geotechnical Engineer



Raymond Haché, M.Sc., P.Eng.  
Designated Principal MTO Foundation Contact

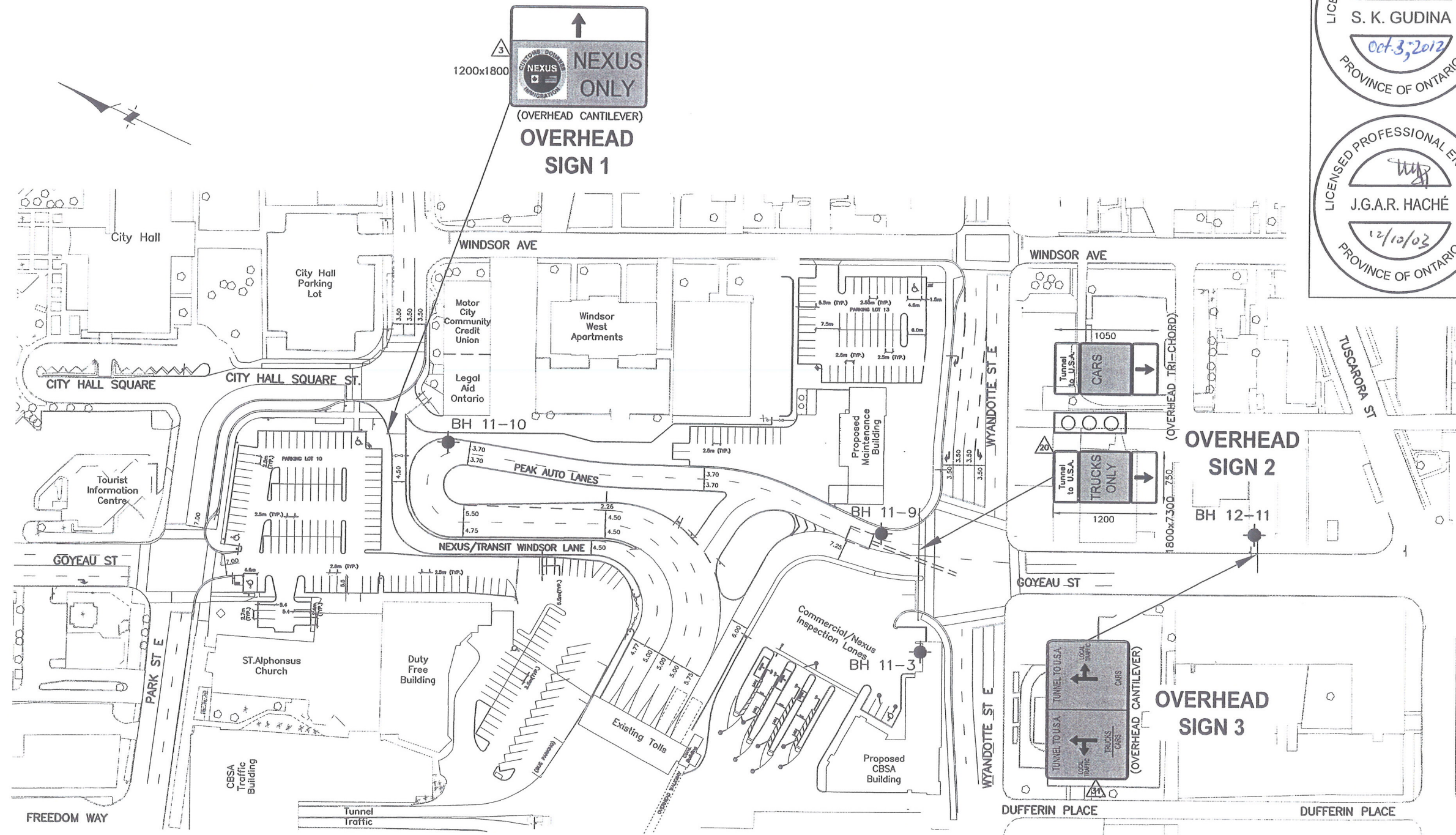


# **APPENDIX A**

Drawings No. 1 – Borehole Location Plan



DRAWING NAME: 185601256-1\_LCHSign.dwg  
CREATED BY: GBB  
MODIFIED: 2012-10-01  
T:\Autocad\Drawings\Project Drawings\185601256-1\_LCHSign.dwg (SCALE 1500)  
Printed: Oct 02, 2012  
PE-D-707  
BB-05  
MINISTRY OF TRANSPORTATION, ONTARIO



METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

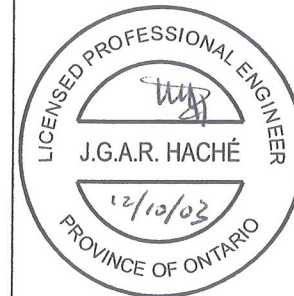
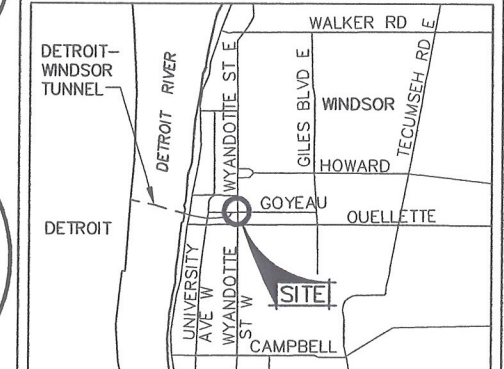


PLATE No  
**CONT** 2012-3015  
**WP** 3032-06-00

WINDSOR-DETROIT TUNNEL PLAZA  
WINDSOR, ONTARIO  
BOREHOLE LOCATIONS



**SHEET**



KEY PLAN  
1 km 0 1 2 km

LEGEND			
Borehole			
No	ELEVATION	UTM ZONE 17 NORTH	COORDINATES EAST
11-3	183.2	4 686 737.4	332 266.2
11-9	183.2	4 686 765.3	332 295.6
11-10	183.3	4 686 906.4	332 263.1
12-11	183.6	4 686 654.0	332 346.2

**NOTE**  
This drawing is for subsurface information only.  
Surface details and features are for conceptual illustration.

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	
GEOCES No		40J6-43					
HWY No		SUBM'D SG	CHECKED	DATE	12/08/08	DIST	
DRAWN	GBB	CHECKED		APPROVED	SG	SITE	
						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	Igneous Bedrock	Meta- morphic Bedrock	Sedi- mentary 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
$\gamma$	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



# RECORD OF BOREHOLE No BH 11-3

1 OF 3

METRIC

W.P. 3032-06-00 LOCATION Windsor - Detroit Tunnel Plaza, Windsor, ON N: 4 686 737 E: 332 266 ORIGINATED BY DS

DIST HWY BOREHOLE TYPE Hollow Stem Augers, Split Spoon Sampler, Shelby Tubes COMPILED BY JF/KKB

DATUM Geodetic DATE 2011 09 30 - 2011 09 30 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	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
183.2	Asphalt						20 40 60 80 100								GR SA SI CL		
183.0	100 mm ASPHALT						183										
182.7	FILL: well graded gravel with sand (GW) Brown		1	SS	7												
182.5	FILL: clayey gravel with sand (GC), with concrete and brick pieces  Brown		2	SS	9		182										
			3	SS	10										35 33 (32)		
			4	SS	3		181										
179.9	- Red brick pieces						180								PP = 185 kPa		
3.3	Silty clay with sand (CL), TILL  Very stiff  Brown (crust)		5	SS	17										2 26 42 30		
			6	SS	20		179								PP = 210 kPa		
178.7	Silty clay with sand to sandy clay (CL), TILL														PP = 225 kPa		
4.5	Stiff  Grey		7	SS	8		178										
			8	ST													
	- 200 mm sand layer, wet		9	SS	8		177										
			10	SS	7		176										
			11	BS			175										
			12	SS	10												
			13	BS			174										

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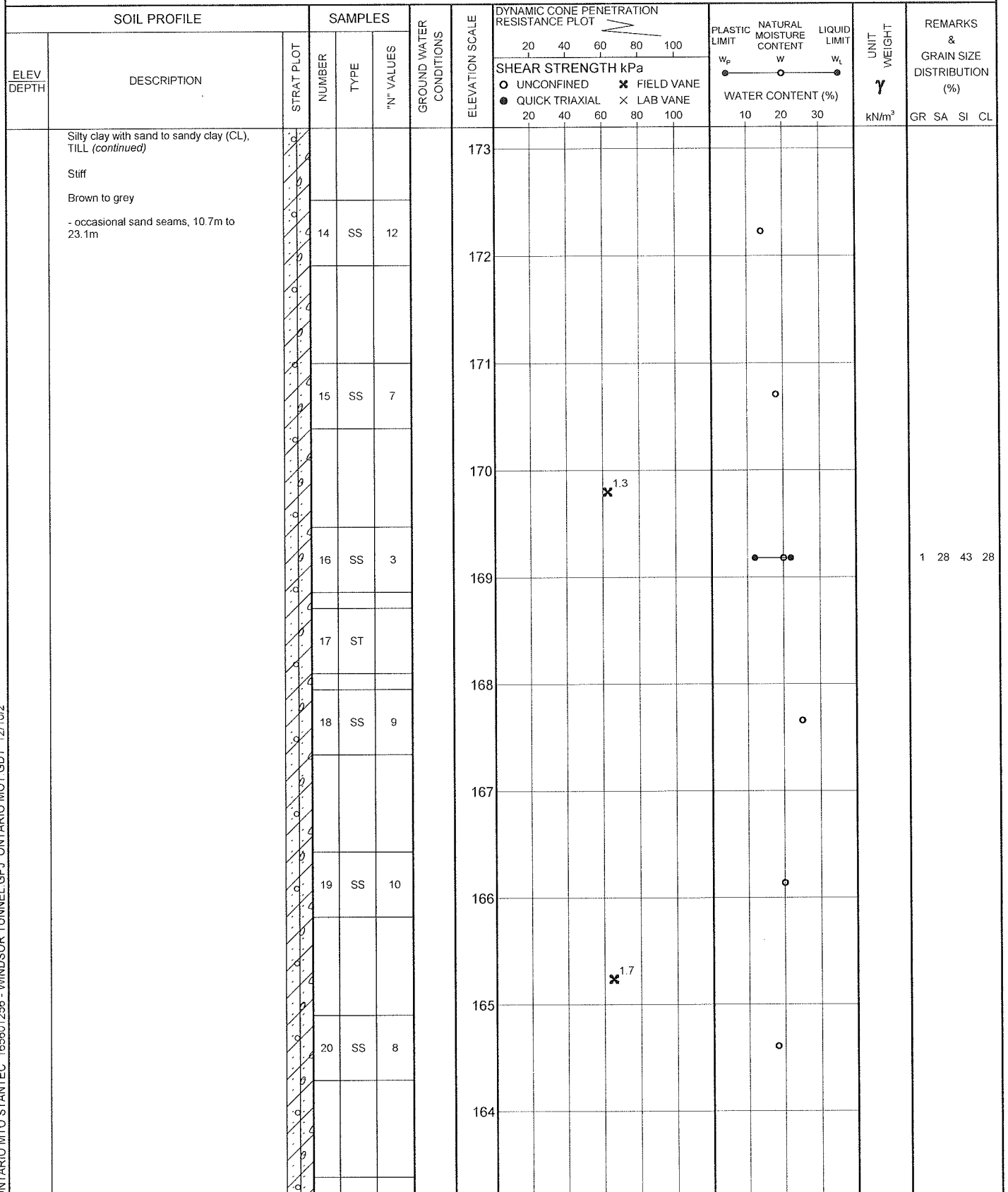
×<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○<sup>3%</sup> STRAIN AT FAILURE

# RECORD OF BOREHOLE No BH 11-3

2 OF 3

METRIC

W.P. 3032-06-00 LOCATION Windsor - Detroit Tunnel Plaza, Windsor, ON N: 4 686 737 E: 332 266 ORIGINATED BY DS  
 DIST HWY BOREHOLE TYPE Hollow Stem Augers, Split Spoon Sampler, Shelby Tubes COMPILED BY JF/KKB  
 DATUM Geodetic DATE 2011 09 30 - 2011 09 30 CHECKED BY CM



Continued Next Page

$\times 3, \times 3$  Numbers refer to Sensitivity  $\circ$  3% STRAIN AT FAILURE

## METRIC

W.P.	3032-06-00	LOCATION	Windsor - Detroit Tunnel Plaza, Windsor, ON	N: 4 686 737 E: 332 266	ORIGINATED BY	DS	
DIST		HWY		BOREHOLE TYPE	Hollow Stem Augers, Split Spoon Sampler, Shelby Tubes	COMPILED BY	JF/KKB
DATUM	Geodetic	DATE	2011 09 30 - 2011 09 30		CHECKED BY	CM	

[illegible]

ONTARIO MTO STANTEC 165601256 - WINDSOR TUNNEL.GPJ ONTARIO MOT.GDT 12/10/2

$\times^3, \times^3$ : Numbers refer to Sensitivity
 
 $\bigcirc^{3\%}$ : STRAIN AT FAILURE

## METRIC

W.P.	3032-06-00	LOCATION	Windsor - Detroit Tunnel Plaza, Windsor, ON	N: 4 686 765 E: 332 296	ORIGINATED BY	DS	
DIST		HWY		BOREHOLE TYPE	Hollow Stem Augers, Split Spoon Sampler	COMPILED BY	KKB
DATUM	Geodetic	DATE	2011 10 04 - 2011 10 04		CHECKED BY	CM	

[illegible]

$\times^3, \times^3$ : Numbers refer to Sensitivity       $\bigcirc^{3\%}$  STRAIN AT FAILURE

# RECORD OF BOREHOLE No BH 11-10

1 OF 1

METRIC

W.P. 3032-06-00 LOCATION Windsor - Detroit Tunnel Plaza, Windsor, ON N: 4 686 906 E: 332 263 ORIGINATED BY DS  
 DIST HWY BOREHOLE TYPE Hollow Stem Augers, Split Spoon Sampler COMPILED BY KKB  
 DATUM Geodetic DATE 2011 10 05 - 2011 10 05 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	✕ FIELD VANE ✕ LAB VANE						
183.3	Asphalt						20 40 60 80 100								
180.0	100 mm ASPHALT						20 40 60 80 100								
180.0	FILL : sand and crushed gravel, brown														
180.2	FILL : sand with organics, trace gravel														
	Dark brown to black, moist		1	SS	6									28 55 (17)	
			2	SS	8										
181.8	Silty clay with sand (CL), TILL														
1.5	Very stiff		3	SS	6									PP = 165 kPa	
	Brown, moist (crust)		4	SS	9									0 24 45 31 PP = 225 kPa	
			5	SS	21									PP = 225 kPa	
			6	SS	20									PP = 225 kPa	
			7	SS	13									PP = 190 kPa	
178.0	Silty clay with sand (CL), TILL														
5.3	Stiff to very stiff		8	SS	10									3 25 44 28 PP = 140 kPa	
	Grey, moist		9	SS	8										
			10	SS	7										
			11	BS											
	- No sample collected; borehole advanced to 9.1 m for well installation														
174.2	End of borehole														
9.1	No groundwater observed in monitoring well on 2011/10/06														

ONTARIO MTO STANTEC 165601256 - WINDSOR TUNNEL GPJ ONTARIO MOT GDT 12/10/2



# RECORD OF BOREHOLE No BH 12-11

1 OF 2

METRIC

W.P. 3032-06-00 LOCATION Windsor - Detroit Tunnel Plaza, Windsor, ON N: 4 686 654 E: 332 346 ORIGINATED BY JHJ  
 DIST HWY BOREHOLE TYPE Hollow Stem Augers, Split Spoon Sampler COMPILED BY KKB  
 DATUM Geodetic DATE 2012 07 26 - 2012 07 26 CHECKED BY SG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
183.6	Asphalt							20 40 60 80 100						
183.6	50 mm ASPHALT							20 40 60 80 100						
183.4	FILL : Sand and gravel, trace silt Brown													
183.4	FILL : Silty clay (CL) with sand, trace gravel Brown		1	BS			183							
			2	SS	15									3 24 43 30
			3	SS	20		182							
181.5	Silty clay with sand (CL), trace gravel, TILL Very stiff Brown (crust)		4	SS	18		181							
			5	SS	23		180							3 26 43 28
			6	SS	15		179							
			7	SS	18		178							
178.4	Silty clay with sand (CL), trace gravel, TILL Stiff to firm Grey		8	SS	9		177							5 26 42 27
			9	SS	10		176							
			10	SS	5		175							
			11	SS			174							1 33 48 18
			12	SS	7									
	- Undrained shear strength (S <sub>u</sub> ) > 110 kPa at 8.8 m													

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✕ 3, ✕ 3

Numbers refer to Sensitivity


○ 3% STRAIN AT FAILURE

# RECORD OF BOREHOLE No BH 12-11

2 OF 2

METRIC

W.P. 3032-06-00 LOCATION Windsor - Detroit Tunnel Plaza, Windsor, ON N: 4 686 654 E: 332 346 ORIGINATED BY JHJ  
DIST HWY BOREHOLE TYPE Hollow Stem Augers, Split Spoon Sampler COMPILED BY KKB  
DATUM Geodetic DATE 2012 07 26 - 2012 07 26 CHECKED BY SG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	● QUICK TRIAXIAL	✕ FIELD VANE	✕ LAB VANE						
							20	40	60	80	100						
173.2			13	SS													
10.4	End of Borehole																

## **APPENDIX C**

Laboratory Test Results

Figures 1 – 4: Grain Size Distribution Plots and Plasticity Charts

# Unified Soil Classification System

CLAY & SILT	SAND				Gravel	
	Fine	Medium	Coarse	Fine	Coarse	

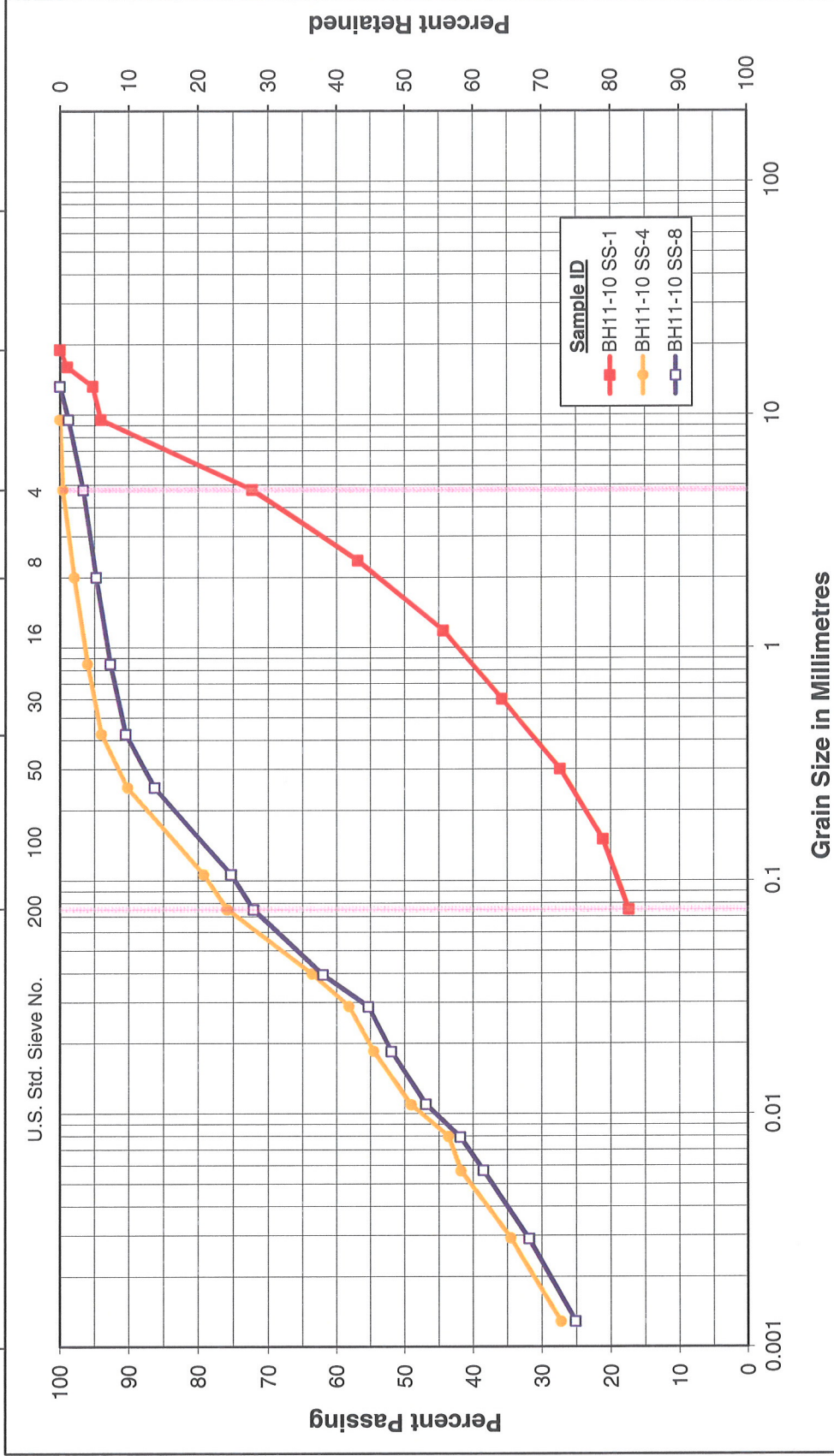


Figure No. 1a

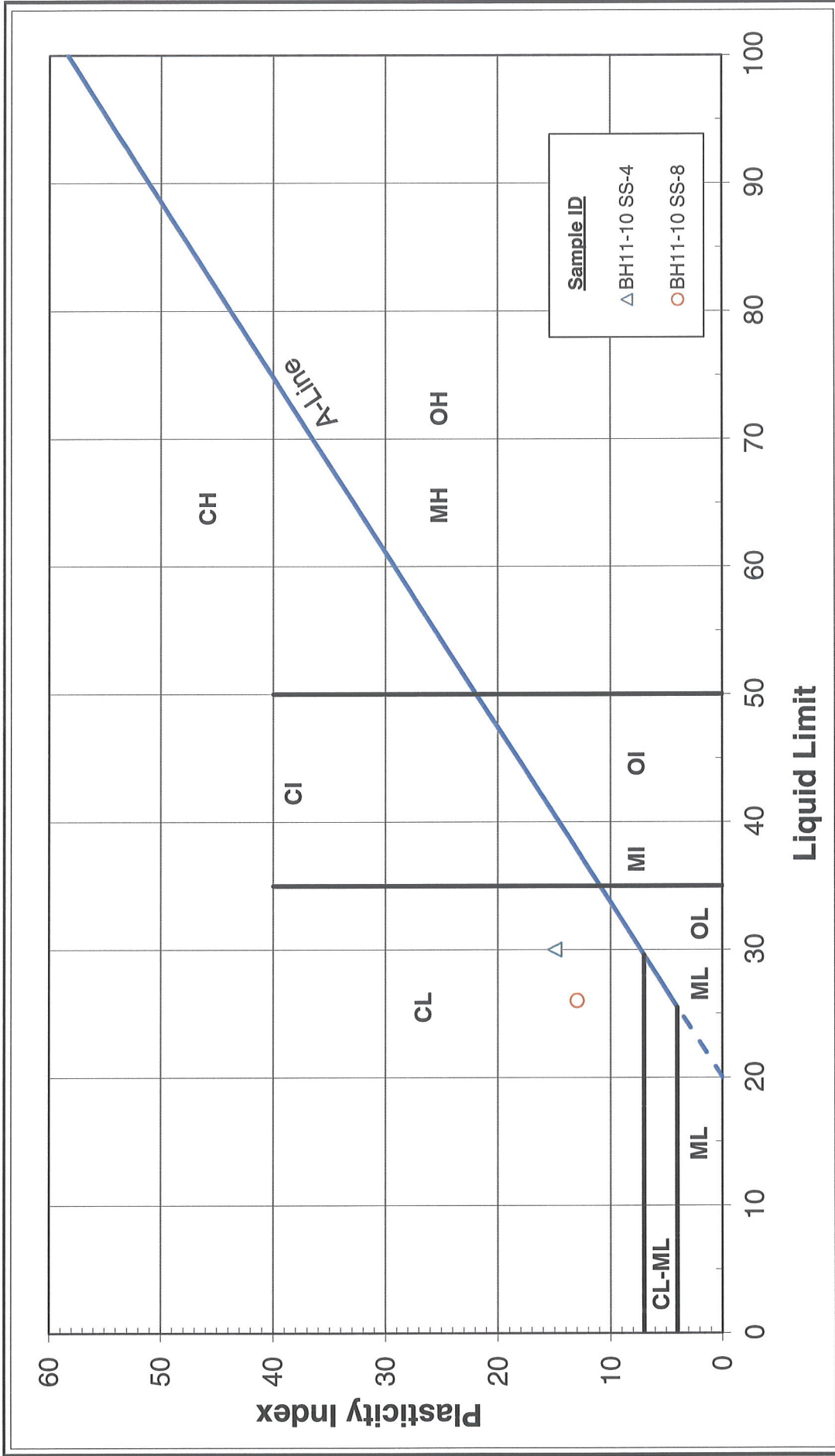
## GRAIN SIZE DISTRIBUTION

Overhead Sign 1 - Nexus Only Entrance

Project No. 165601256  
GWP No. 3032-06-00



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Stantec

# PLASTICITY CHART

Overhead Sign 1 - Nexus Only Entrance

Figure No. 1b

Project No. 165601256

GWP No. 3032-06-00



# Unified Soil Classification System

CLAY & SILT	SAND				Gravel	
	Fine	Medium	Coarse	Fine	Coarse	

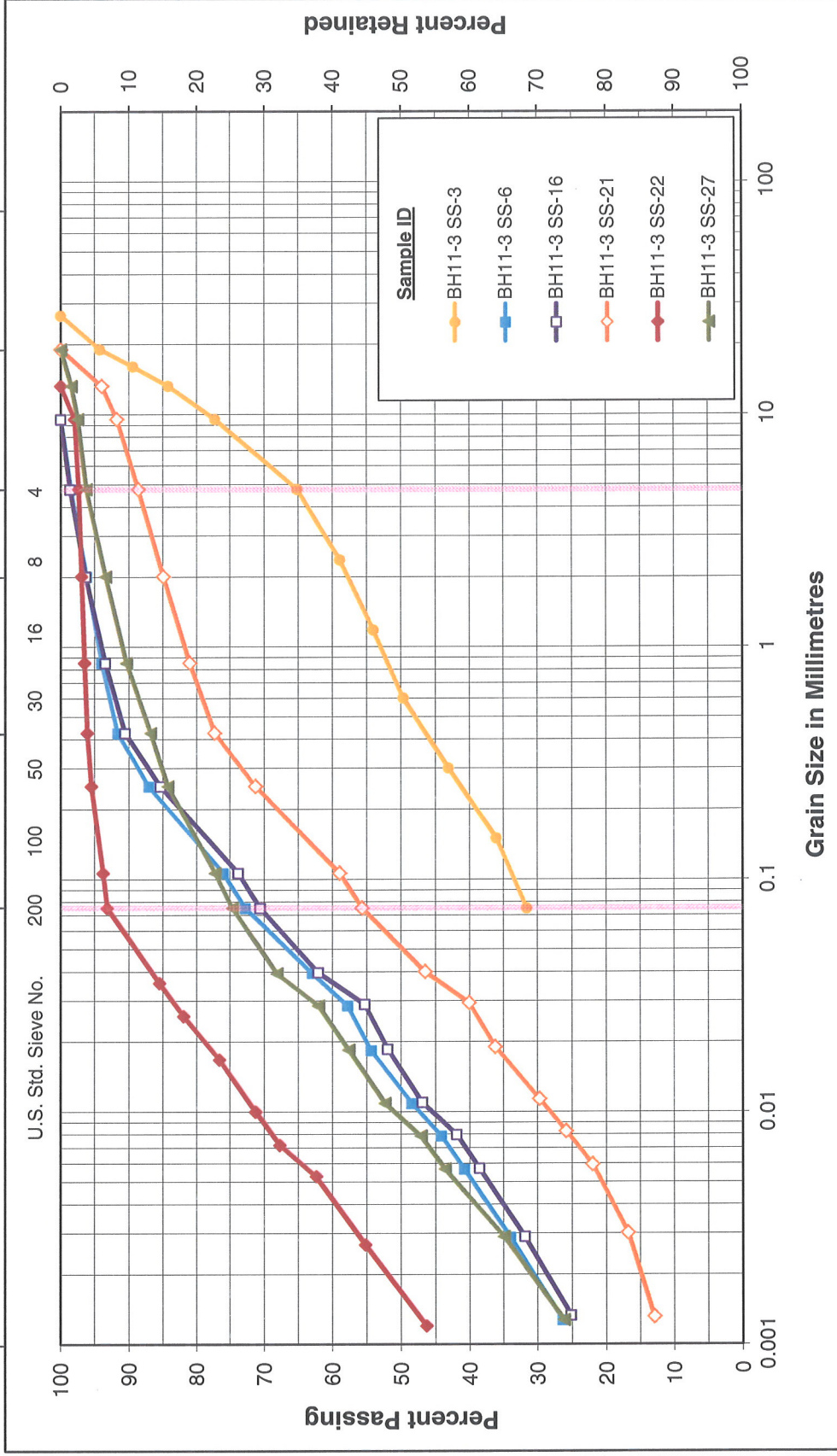


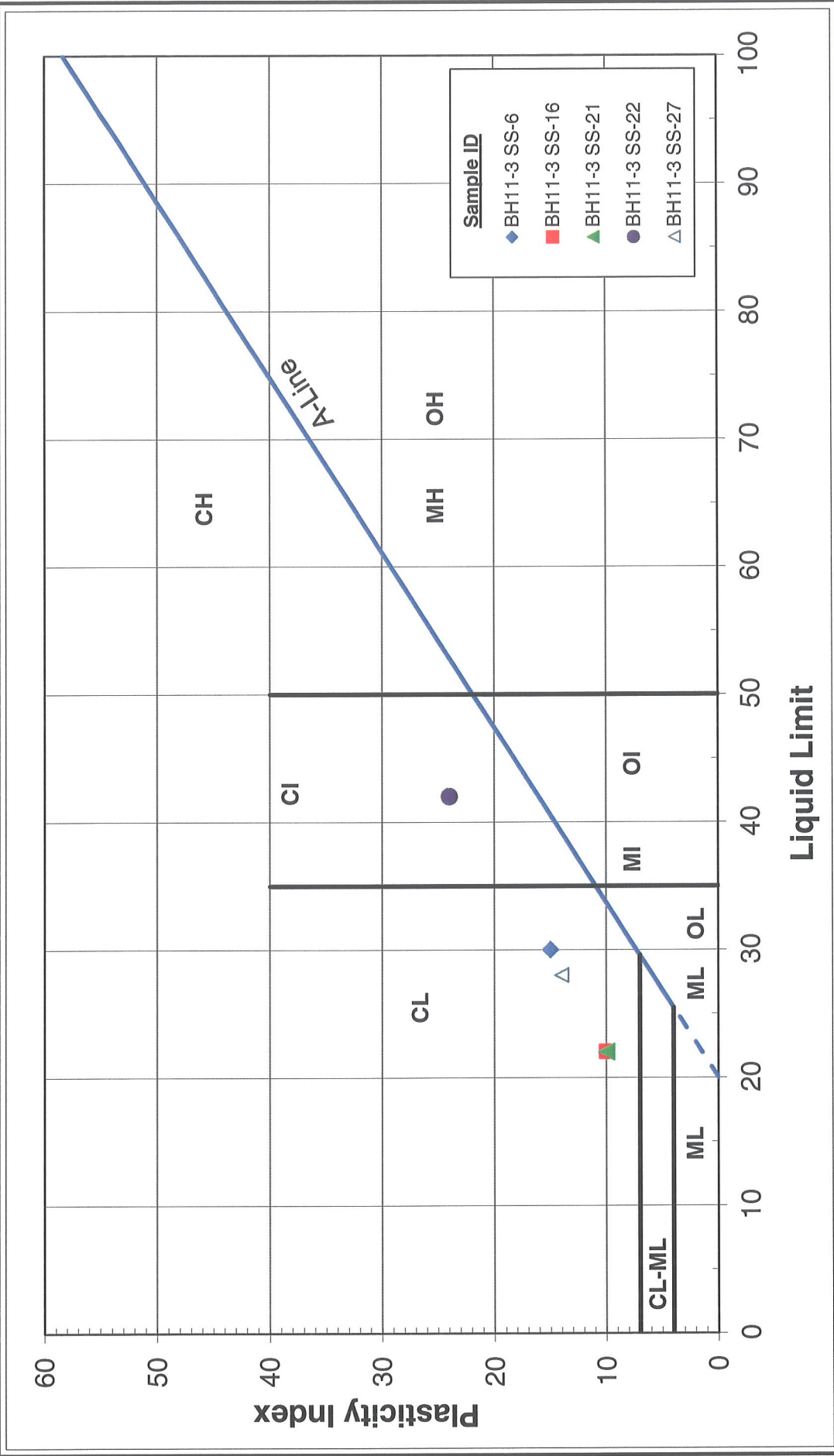
Figure No. 2a

## GRAIN SIZE DISTRIBUTION

Overhead Sign 2 - Plaza Entrance West Support

Project No. 165601256  
GWP No. 3032-06-00





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# PLASTICITY CHART

Overhead Sign 2 - Plaza Entrance West Support

Figure No. 2b

Project No. 165601256

GWP No. 3032-06-00

# Unified Soil Classification System

CLAY & SILT	SAND				Gravel	
	Fine	Medium	Coarse		Fine	Coarse

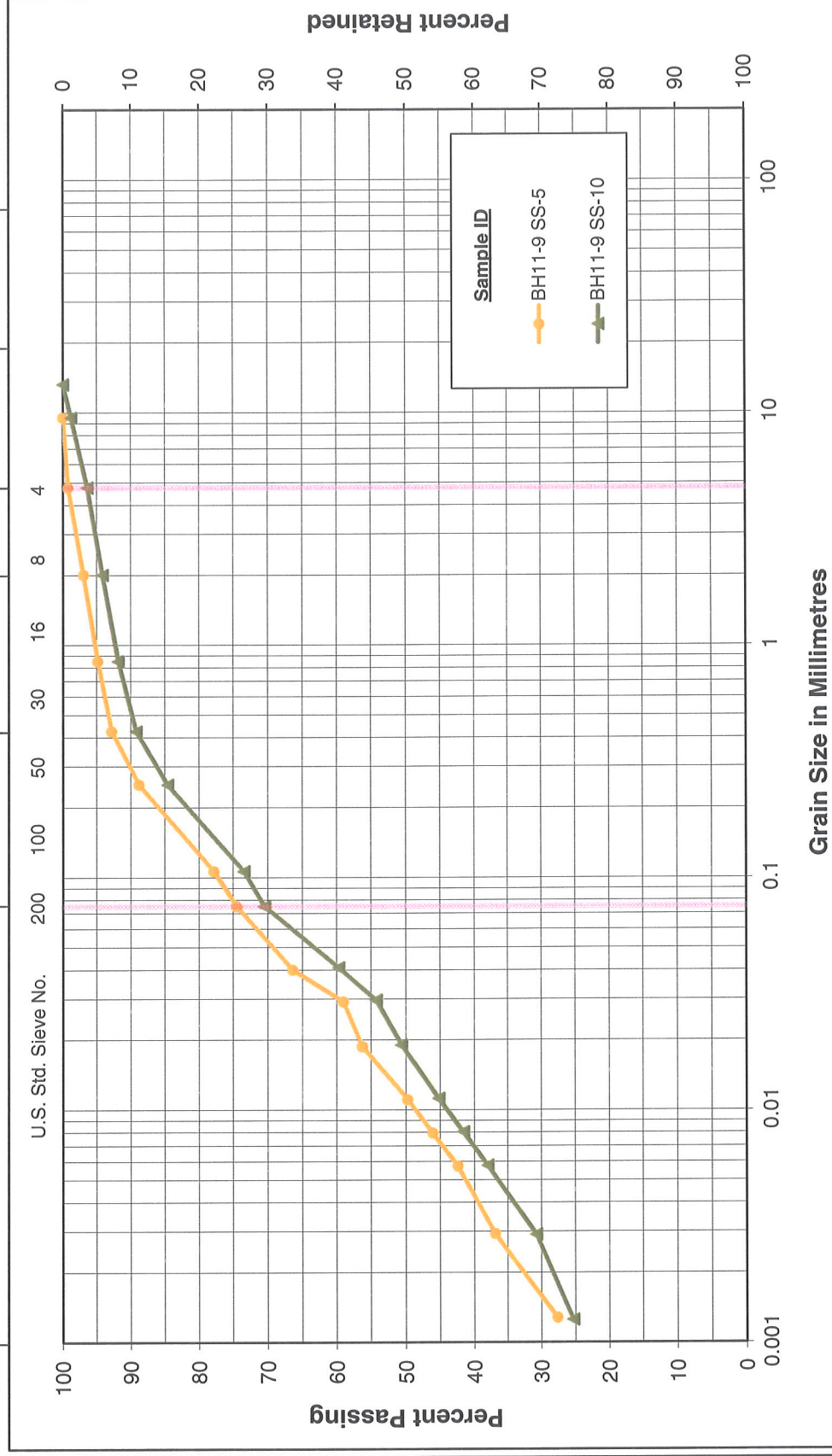


Figure No. 3a

Project No. 165601256  
GWP No. 3032-06-00

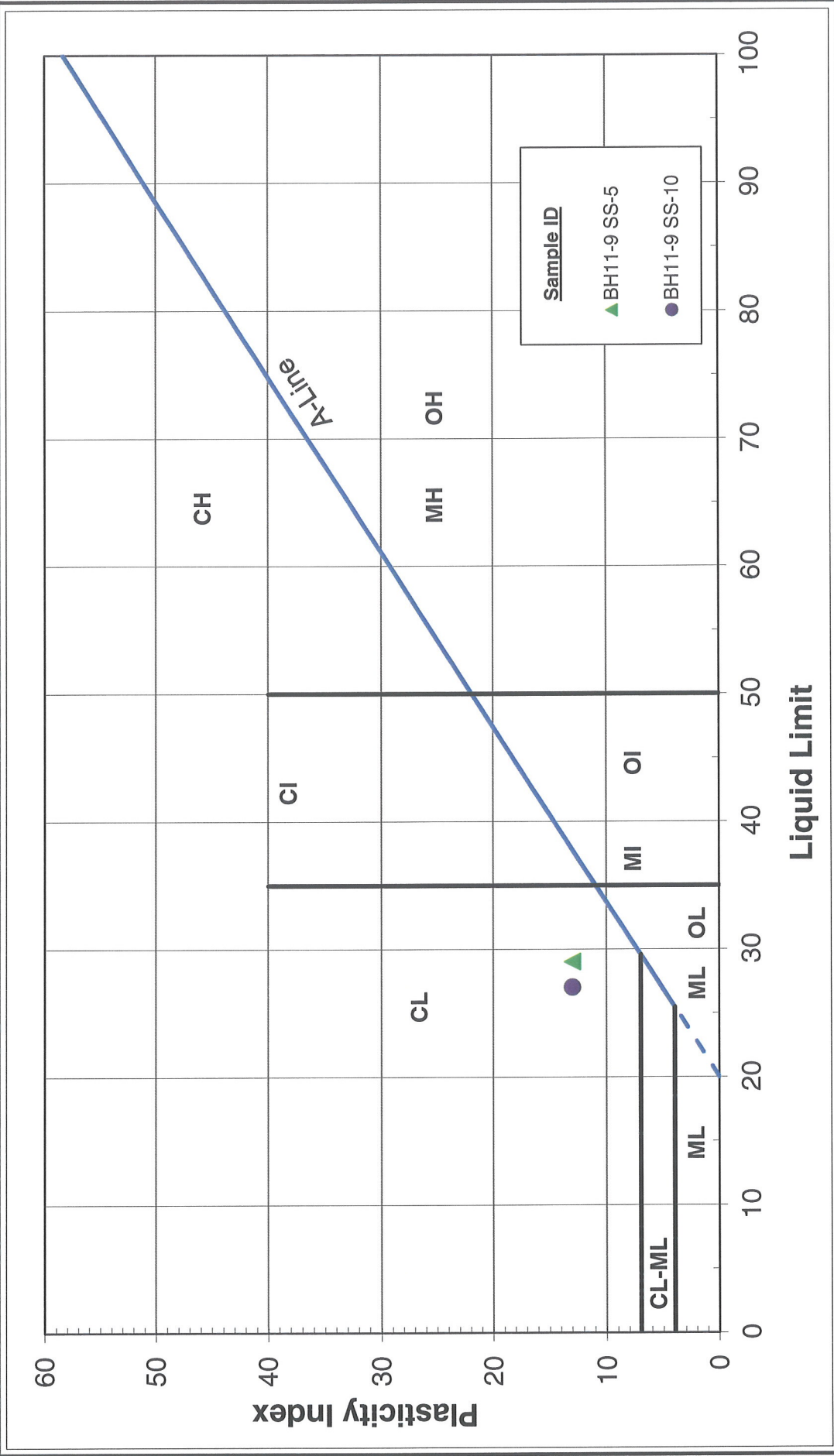
## GRAIN SIZE DISTRIBUTION

Overhead Sign 2 - Plaza Entrance East Support



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# PLASTICITY CHART

Overhead Sign 2 - Plaza Entrance East Support

Figure No. 3b

Project No. 165601256

GWP No. 3032-06-00

# Unified Soil Classification System

CLAY & SILT	SAND			Gravel	
	Fine	Medium	Coarse	Fine	Coarse

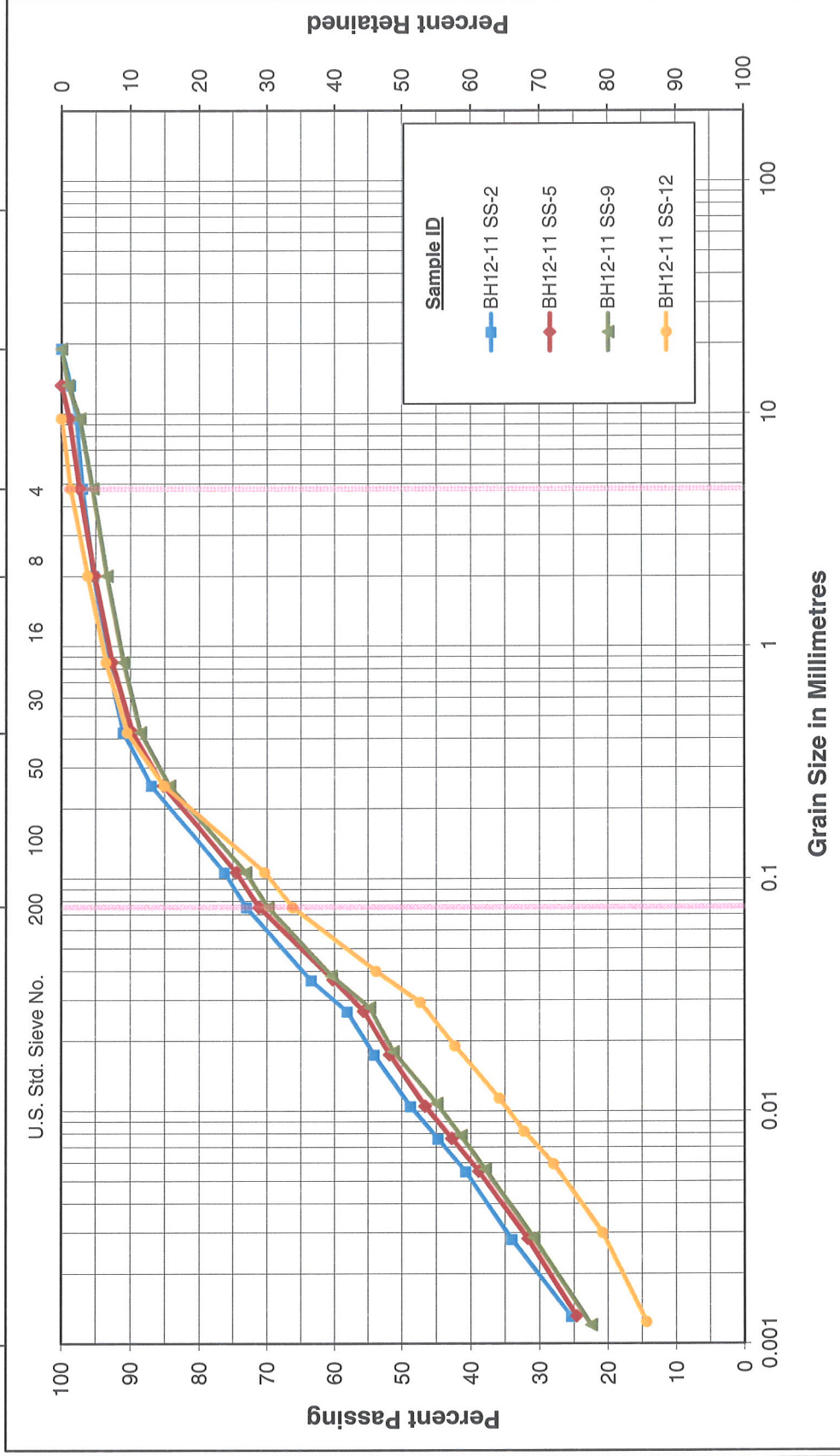


Figure No. 4a

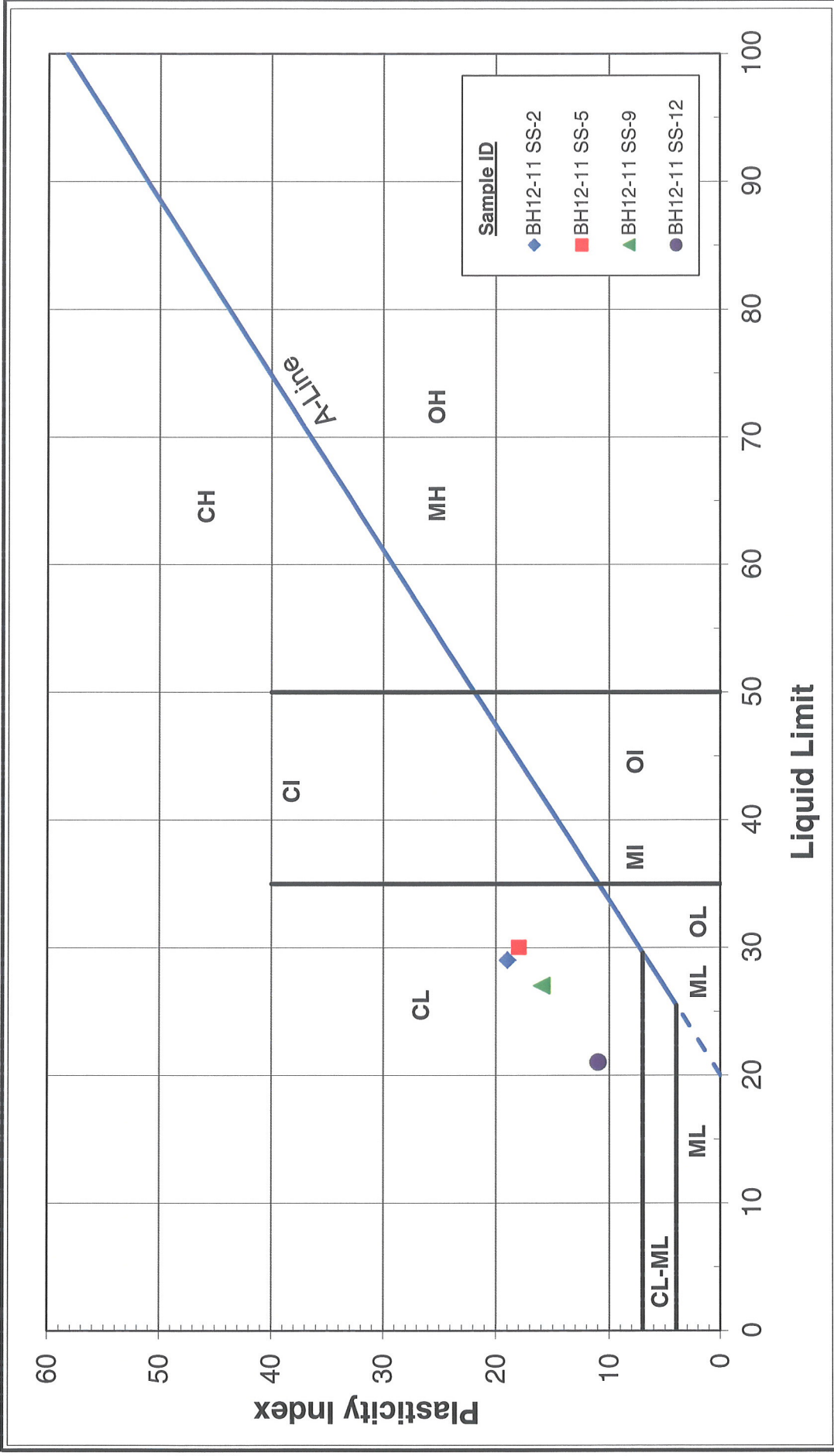
Project No. 165601256  
GWP No. 3032-06-00

## GRAIN SIZE DISTRIBUTION

Overhead Sign 3 - Goyeau Street



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# PLASTICITY CHART

Overhead Sign 3 - Goyeau Street

Figure No. 4b

Project No. 165601256  
GWP No. 3032-06-00

## **APPENDIX D**

SS118-3 Static Sign Support Footing Details (Ground Mounted)

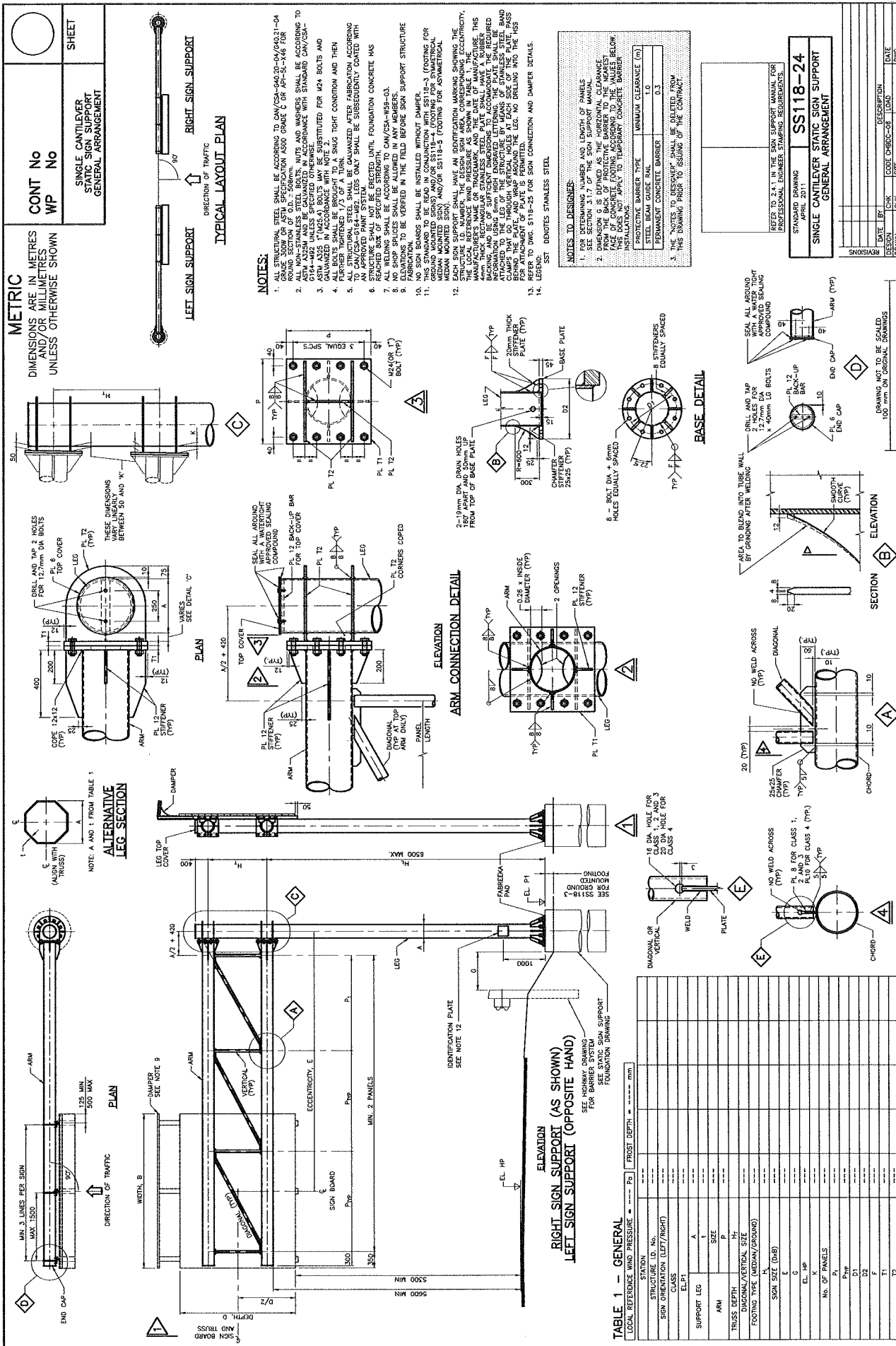
SS118-24 Cantilever Static Sign Support General Arrangement

SS118-26 Tri-Chord Static Sign Support General Arrangement

Table 1: Recommended Design Parameters at Proposed Overhead Sign Support  
Locations







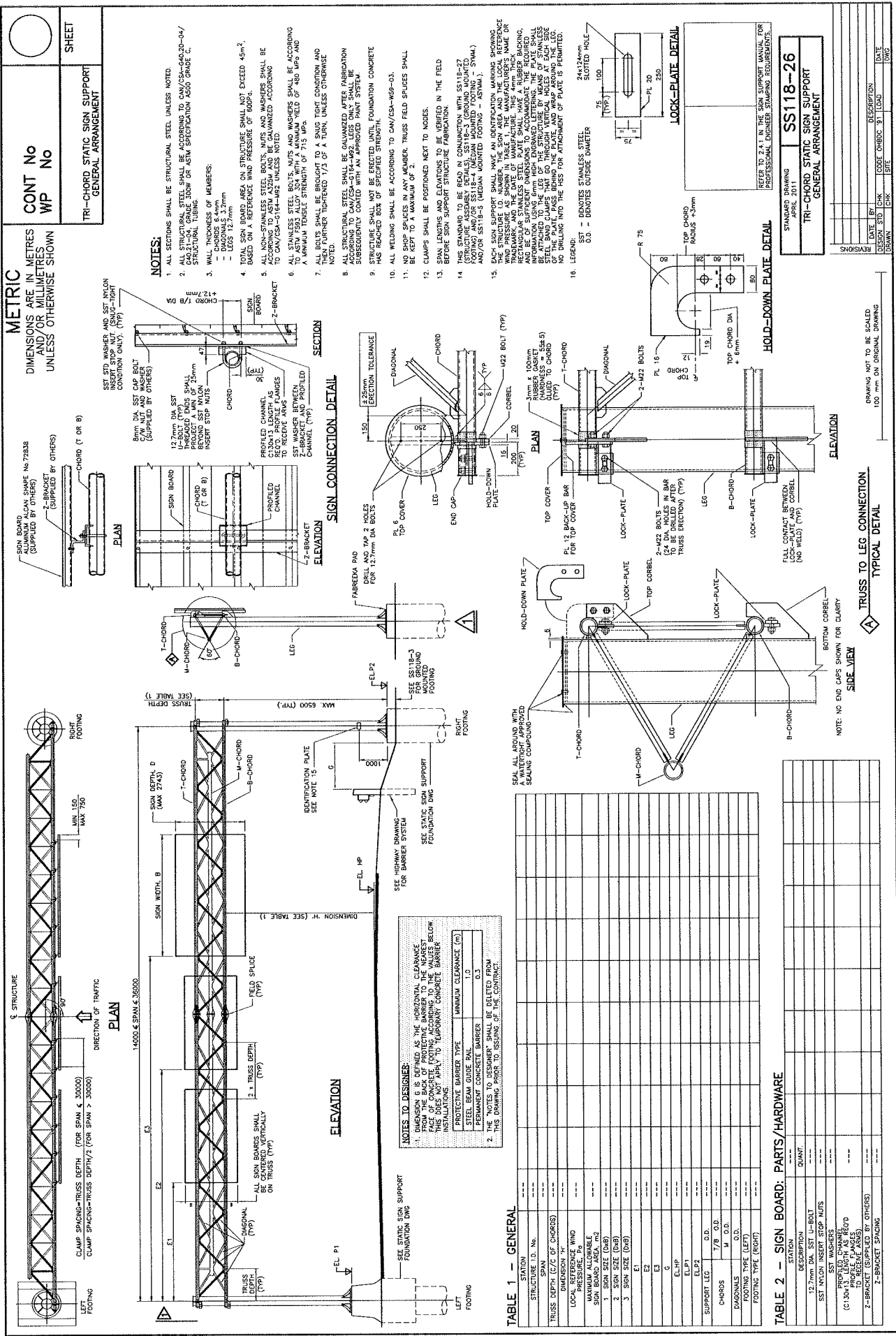


TABLE 1 - GENERAL

[illegible]

**TABLE 2 - SIGN BOARD: PARTS/HARDWARE**

[illegible]

**Table 1: Recommended Design Parameters at Proposed Overhead Sign Support Foundations**

Borehole	Sign Location	Soil Layer	Geodetic Elevation of Layer (m)		Undrained Condition $S_u$ (kPa)	Average N Per 0.3 m	Unit Weight ( $kN/m^3$ )	Drained Condition $\phi$ ( $^\circ$ )	$K_a$	$K_o$	$K_p$
			Start	End							
BH11-10	Overhead Sign 1 (Nexus Only)	Asphalt	183.3	183.2	-	-	-	-	-	-	-
		Fill: sand and gravel over sand	183.2	181.8	-	7	20	32	0.31	0.47	3.25
		Clay with Sand Till (crust)	181.8	178.0	150.0	14	22	30	0.33	0.50	3.00
BH11-3	Overhead Sign 2 Plaza Entrance West Support	Silty Clay with Sand Till	178.0	174.2	80.0	8	21.5	30	0.33	0.50	3.00
		Asphalt	183.2	183.1	-	-	-	-	-	-	-
		Fill: Gravel with Sand and Clay	183.1	179.9	-	7	20	32	0.31	0.47	3.25
BH11-9	Overhead Sign 2 Plaza Entrance East Support	Clay with Sand Till (crust)	179.9	178.7	150.0	18	22	30	0.33	0.50	3.00
		Silty Clay with Sand Till	178.7	174.0	80.0	8	21.5	30	0.33	0.50	3.00
		Fill: Gravel with Sand and Clay	183.2	182.3	-	5	20	32	0.31	0.47	3.25
BH12-11	Overhead Sign 3 Goyeau Street	Clay with Sand Till (crust)	182.3	178.8	150.0	15	22	30	0.33	0.50	3.00
		Silty Clay with Sand Till	178.8	173.4	70.0	8	21.5	30	0.33	0.50	3.00
		Asphalt	183.6	183.5	-	-	-	-	-	-	-
BH12-11	Overhead Sign 3 Goyeau Street	Fill: Sand/Gravel over Silty Clay	183.5	181.5	-	17	22	32	0.31	0.47	3.25
		Clay with Sand Till (crust)	181.5	178.4	150.0	18	22	30	0.33	0.50	3.00
		Silty Clay with Sand Till	178.4	174.8	80.0	8	21.5	30	0.33	0.50	3.00
BH12-11	Overhead Sign 3 Goyeau Street	Silty Clay with Sand Till	174.8	173.2	100.0	N/O	21.5	30	0.33	0.50	3.00

**Notes:**

For drained condition analysis, for clays  $S_u = 0$

For undrained condition analysis, for clays  $\phi = 0$

\* For fills  $\phi$  applies to both drained and undrained conditions

Depth of frost penetration for Windsor, ON,  $f = 1.0$  m

$S_u$  = Undrained Shear Strength

$K_a$  = Coefficient of Active Earth Pressure

$K_o$  = Coefficient of Earth Pressure at Rest

$K_p$  = Coefficient of Passive Earth Pressure

Soils above the frost penetration depth of 1.0 should not be relied upon for lateral resistance.

For design purposes groundwater should be assumed to be at ground surface.

N/O - SPT N-value was not obtained; only field vane test was carried out.

V:\01224\active\other\_pc\_projects\165601256\Overhead Signs\Report\Table\_Design Parameters- Aug2\_ 2012.xls