



October 20, 2016

## PRELIMINARY FOUNDATION INVESTIGATION REPORT

SUNNIDALE ROAD UNDERPASS, SITE NO. 30-173  
HIGHWAY 400 WIDENING  
FROM 1 KM SOUTH OF HIGHWAY 89 TO JUNCTION OF HIGHWAY 11  
MINISTRY OF TRANSPORTATION, ONTARIO  
W.O. 06-20016

**Submitted to:**

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**GEOCRES NO: 31D-665**

**Report Number:** 14-1111-0002-5

**Distribution:**

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REPORT





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**PRELIMINARY FOUNDATION REPORT - HIGHWAY 400  
SUNNIDALE ROAD UNDERPASS**

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# **PART A**

**PRELIMINARY FOUNDATION INVESTIGATION REPORT  
SUNNIDALE ROAD UNDERPASS – SITE NO. 30-173  
HIGHWAY 400 WIDENING  
FROM 1 KM SOUTH OF HIGHWAY 89 TO JUNCTION OF HIGHWAY 11  
MINISTRY OF TRANSPORTATION, ONTARIO  
W.O. 06-20016**



### 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. (now AECOM) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services in support of the preliminary design for the replacement of the Sunnidale Road Underpass in the City of Barrie. The proposed work is part of the preliminary and design-build ready design associated with the Highway 400 widening from 1 km south of Highway 89 to the junction of Highway 11 in Simcoe County, Ontario.

This report addresses the proposed replacement of the Sunnidale Road Underpass (MTO Structure Site No. 30-173) and the associated approach embankments only.

The terms of reference and scope of work for the foundation investigation are outlined in MTO's Request for Proposal, dated July 2013. Golder's scope of work for foundation engineering services associated with the Sunnidale Road Underpass replacement is contained in Section 5.8 of AECOM's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated January 20, 2014.

### 2.0 SITE DESCRIPTION

The Highway 400/Sunnidale Road Underpass is located in Barrie, Ontario and the existing bridge structure is a single-span rigid frame supported on spread footings. The total length of the bridge is approximately 29 m measured along the centerline of Sunnidale Road between abutments, and the total deck width is 12 m measured between fasciae.

The overall surface topography in the vicinity of the site is relatively flat and consists of residential areas to the east and west of Highway 400. At this structure site, Highway 400 has been constructed in a cut up to about 8.5 m deep and has an existing grade between about Elevation 248.5 m and 249 m, rising toward the north. The Sunnidale Road grade rises westward, from Elevations 255 m to 257 m, over Highway 400.

### 3.0 INVESTIGATION PROCEDURES

#### 3.1 Previous Borehole Investigation

Two boreholes were advanced at this site as part of a previous Golder's geotechnical investigation in 2001 (MTO, 2002) for the replacement of the existing Sunnidale Road Underpass structure, associated with the widening of Highway 400. Borehole B13-1 was advanced near the west abutment on Sunnidale Road, to a depth of about 12.4 m below ground surface; and Borehole B13-2 was advanced near the east abutment on Sunnidale Road, to a depth of about 13.4 m. The borehole locations are shown on Drawing 1.

Both boreholes were advanced using 108 mm diameter hollow stem augers and soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm outer diameter split-spoon sampler driven by a manual hammer in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586).

The water level in the open boreholes was observed during and following the drilling operations and a piezometer was installed in Borehole B13-2 to allow monitoring of the groundwater level at the site.

The borehole locations in MTM NAD83 northing and easting coordinates, ground surface elevations reference to Geodetic datum and drilled depths are summarized below.



## PRELIMINARY FOUNDATION REPORT - HIGHWAY 400 SUNNIDALE ROAD UNDERPASS

Borehole Number	Location (MTM NAD83)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m)	Easting (m)		
BH13-1	4,916,980.9	288,547.3	256.8	12.4
BH13-2	4,916,967.4	288,585.1	255.1	13.4

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

As delineated in *The Physiography of Southern Ontario*<sup>1</sup>, the section of Highway 400 from 6 km south of Highway 89 to the junction of Highway 11 traverses, generally in a south–north direction, the following physiographic regions: the Peterborough Drumlin Field; the Simcoe Lowlands; and the Simcoe Uplands. Along Highway 400, the Peterborough Drumlin Field is present from the southern limit of the project site to south of Line 13 of the Township of Bradford West Gwillimbury, as well as between about 1 km north of Highway 89 to about Essa Road. The Simcoe Lowlands covers the area from south of Line 13 to approximately 1 km north of Highway 89 and from about Essa Road to just north of Anne Street. The Simcoe Uplands extends from just north of Anne Street to beyond the northern limit of this project site.

The surficial soils in the Peterborough Drumlin Field, consist primarily of gravelly sand till or sand and gravel deposits. Deposits of silt, clay or peat may also be found in the low-lying areas between drumlins and eskers.

Along Highway 400, the Simcoe Lowlands include: the Holland River valley; the lowlands of the Lake Simcoe basin to the east; and the lowlands of the Nottawasaga basin to the west, which includes Innisfil Creek and the Nottawasaga River to the south and west of the project limits, respectively. The Lake Simcoe and Nottawasaga basins are connected by a flat floored valley through Barrie which extends from the shores of Kempenfelt Bay west generally along Highway 90. The Simcoe Lowlands are generally characterized by deep deposits of deltaic or lacustrine silts, sands and clays associated with glacial Lake Algonquin.

The Simcoe Uplands consist of till plains and ancient shorelines. The till deposits range from clayey to silty and generally become more sandy and containing more boulders in the north. The low-lying areas of this region may also contain shallow deposits of sand and gravel associated with former glacial lake shorelines.

### 4.2 Subsurface Conditions

The Record of Borehole sheets and laboratory testing results from the previous investigation are presented in Appendix A. The borehole locations are shown on Drawing 1 and stratigraphic profile and cross-section are shown on Drawings 1 and 2.

The results of the in situ field tests (i.e. SPT 'N'-values) carried out during the previous investigation as presented on the Record of Borehole sheets and in Section 4.2 are uncorrected. According to the Canadian Foundation Engineering Manual (*CFEM*, 2006), the energy delivered to the drill rod varies with the hammer release system, hammer type, anvil and operator characteristics.

<sup>1</sup> Chapman, L. J. and Putnam, D. F., 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey. Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000. Ontario Ministry of Natural Resources.



## **PRELIMINARY FOUNDATION REPORT - HIGHWAY 400 SUNNIDALE ROAD UNDERPASS**

The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic profile and cross-sections are inferred from observations of drilling progress and non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions at the site consist of a layer of asphalt and non-cohesive fill material associated with the existing Sunnidale Road approach embankments, underlain by a surficial deposit of silty sand underlain by a silty sand till deposit which in turn is underlain by a clayey silt till deposit and/or a silty sand to sand deposit which extends to the bottom of the borehole.

A detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

### **4.2.1 Asphalt**

An approximately 200 mm thick layer of asphalt was encountered at ground surface in Boreholes B13-1 and B13-2.

### **4.2.2 Sand and Gravel Fill**

A 7.1 m and 6.7 m thick deposit of fill comprised on sand and gravel, some cobbles was encountered below the asphalt in Boreholes B13-1 and B13-2 at Elevations 256.6 m and 254.9 m, respectively.

The SPT 'N'-values measured within the fill deposit range from 9 blows to 62 blows per 0.3 m of penetration, but are typically between 11 blows and 25 blows per 0.3 m of penetration, indicating a predominantly compact relative density, and dense to very dense zones.

### **4.2.3 Silty Sand**

A 1.1 m and 0.7 m thick deposit of silty sand, trace to some gravel, trace clay and trace wood fragments and organics was encountered below the fill in Boreholes B13-1 and B13-2 at Elevations 249.5 m and 248.2 m, respectively.

The SPT 'N'-values measured within the non-cohesive silty sand deposit are 19 blows and 31 blows per 0.3 m of penetration, indicating a compact to dense relative density.

The natural water content measured on samples of the silty sand deposit ranges from about 8 per cent to 10 per cent.

### **4.2.4 Silty Sand Till**

A 2.1 m and 1.5 m thick till deposit comprised of silty sand, trace to some gravel, trace clay was encountered below the silty sand deposit in Boreholes B13-1 and B13-2 at Elevations 248.4 m and 247.5 m, respectively.

In general, the SPT 'N'-values measured within the non-cohesive till deposit range from 84 blows per 0.3 m of penetration to 100 blows per 0.15 m of penetration, indicating a very dense relative density. However, it is noted



## PRELIMINARY FOUNDATION REPORT - HIGHWAY 400 SUNNIDALE ROAD UNDERPASS

that an SPT 'N'-value of 21 blows per 0.3 m of penetration was measured at the top of the till deposit in Borehole B13-2, indicating a compact relative density this zone of the till deposit.

The natural water content measured on two samples of the silty sand till deposit are about 7 per cent and 8 per cent.

The result of a grain size distribution test completed on a sample of the silty sand till from Borehole B13-1 is shown on Figure 1 in Appendix A.

### 4.2.5 Clayey Silt Till

A 1.9 m thick cohesive till deposit comprised of clayey silt, trace to some sand and gravel was encountered below the silty sand till deposit in Borehole B13-1 at Elevation 246.3 m and the borehole was terminated within the deposit.

The SPT 'N'-values measured within the cohesive till deposit generally are 102 blows per 0.3 m of penetration and 100 blows per 0.18 m of penetration, suggesting a hard consistency.

The natural water content measured on a sample of the clayey silt till is about 9 per cent.

An Atterberg limits test carried out on a sample of clayey silt till deposit measured a liquid limit of about 14 per cent, a plastic limit of about 11 per cent and a corresponding plastic index of about 3 per cent. The results of Atterberg limits test indicate that the till deposit is comprised of clayey silt of low plasticity to a silt of slight plasticity.

### 4.2.6 Silty Sand to Sand

A 4.3 m thick deposit of non-cohesive silty sand to sand, some silt, trace gravel was encountered below the silty sand till deposit in Borehole B13-2 at Elevation 246.0 m and the borehole was terminated within this deposit.

The SPT 'N'-values measured within the non-cohesive till deposit range from 69 blows to 129 blows per 0.3 m of penetration, and 100 blows per 0.15 m of penetration, indicating a very dense relative density.

The natural water content measured on samples of the silty sand to sand deposit ranges from about 17 per cent to 19 per cent.

The result of a grain size distribution test completed on a sample of the silty sand to sand deposit from Borehole B13-2 is shown on Figure 2 in Appendix A.

## 4.3 Groundwater Conditions

Borehole B13-1 was dry upon completion of drilling. A standpipe piezometer was installed in Borehole B13-2 located near the east abutment, and the groundwater level in the standpipe piezometer was measured at a depth of 9 m below ground surface, corresponding to Elevation 246.1 m, on March 15, 2001.

The water level at the site is expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring and periods of precipitation.





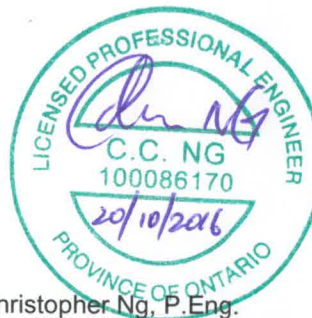
## PRELIMINARY FOUNDATION REPORT - HIGHWAY 400 SUNNIDALE ROAD UNDERPASS

### 5.0 CLOSURE

This report was prepared by Ms. Marzieh Kamranzadeh, M.Sc., EIT, a member of the geotechnical engineering group, and was reviewed by Mr. Christopher Ng, P.Eng., a senior geotechnical engineer and Associate of Golder. Mr. Jorge M. A. Costa, P.Eng., a Senior Consultant with Golder and Designated MTO Foundations Contact, conducted an independent quality control review of this report.

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Designated MTO Foundations Contact, Senior Consultant

MK/CN/JMAC/mck/mk

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## PRELIMINARY FOUNDATION REPORT - HIGHWAY 400 SUNNIDALE ROAD UNDERPASS

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### REFERENCES

Chapman, L. J., and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, 3<sup>rd</sup> Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.

Ministry of Transportation, Ontario. 2002. *Preliminary Foundation Investigation and Design Report Sunnidale Road Underpass, Structure Site 30-173; Highway 400 Widening from 1 km South of Highway 89 to Highway 11, G.W.P. 30-95-00*, GEOCRE No. 31D00-477, prepared by Golder Associates Ltd.

#### **ASTM International:**

ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

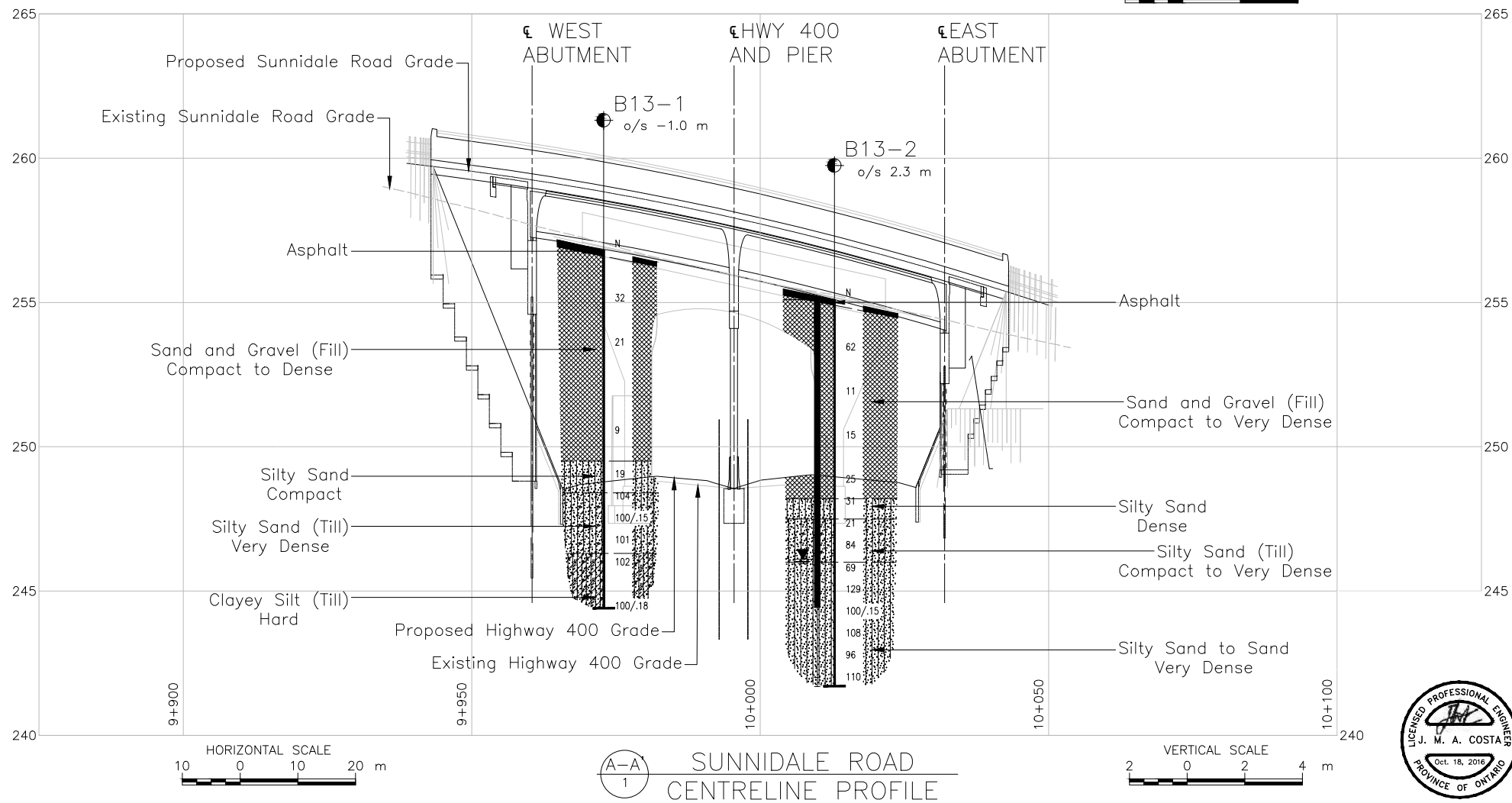
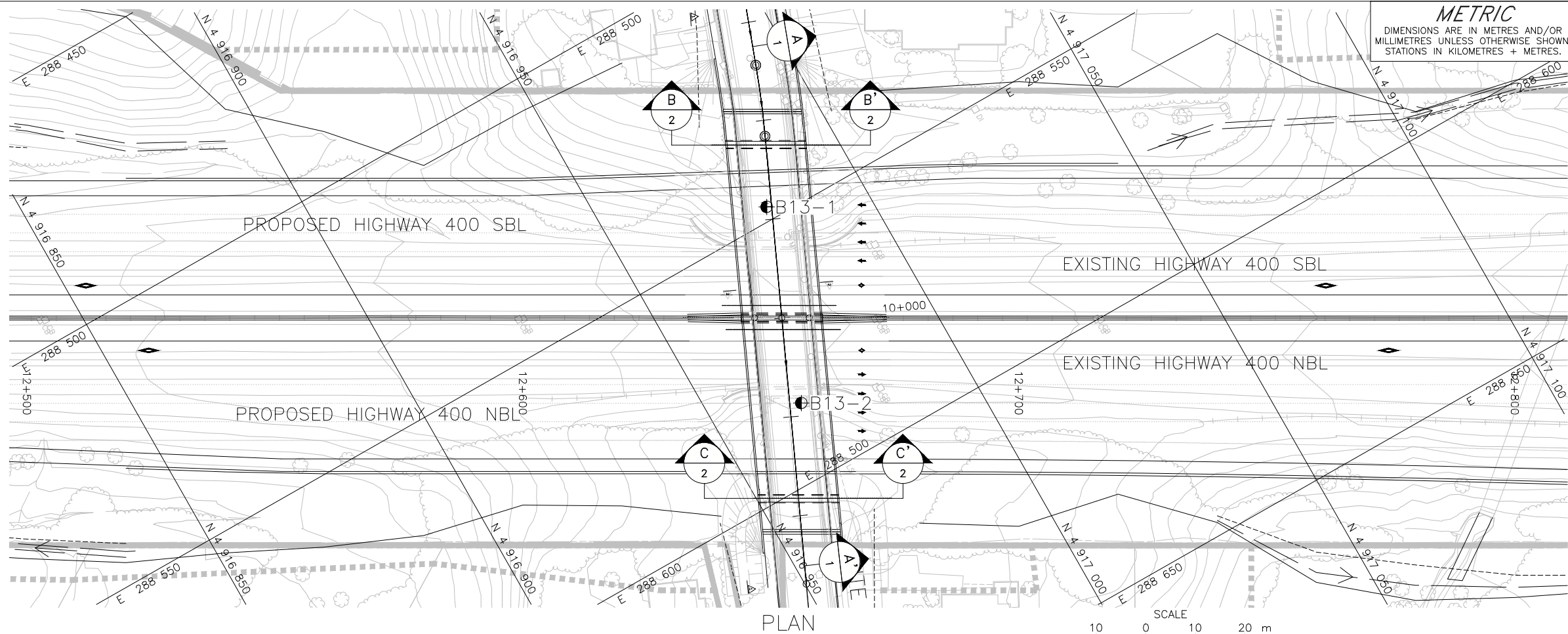


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**PRELIMINARY FOUNDATION REPORT - HIGHWAY 400  
SUNNIDALE ROAD UNDERPASS**

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# DRAWINGS



A-A  
1

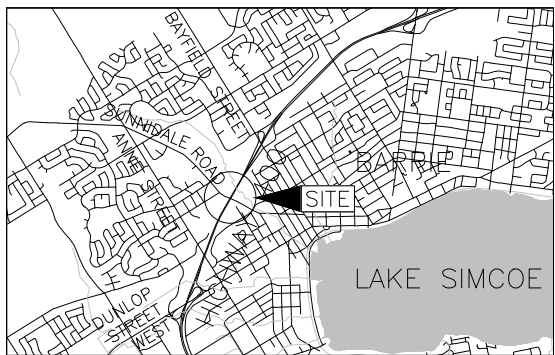
SUNNIDALE ROAD  
CENTRELINE PROFILE



**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No.  
GWP No. 06-20016

SUNNIDALE ROAD UNDERPASS  
HIGHWAY 400 WIDENING  
BOREHOLE LOCATIONS  
AND SOIL STRATA



KEY PLAN  
SCALE  
1 0 1 2 km

LEGEND

- Borehole - Previous Investigation (Geocres No. 31D-477)
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer (Mar. 15, 2001)

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
B13-1	256.8	4916980.9	288547.3
B13-2	255.1	4916967.4	288585.1

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

General arrangement, designs, base plans, profile and surface data provided in digital format by AECOM, drawing file nos. "01\_Sunnidale Road Underpass\_GA(2).dwg", received June 23, 2016, "X-Base\_All.dwg", received January 27, 2016, "X-Design\_4th Line\_Interim.dwg", received June 22, 2015, and "X-Surfaces.dwg", received April 14, 2015.

NO.	DATE	BY	REVISION
Geocres No. 31D-665			
HWY. 400		PROJECT NO. 14-1111-0002	
SUBM'D. BM	CHKD. CN	DATE: 7/21/2016	SITE: 30-173
DRAWN: MR	CHKD. MK	APPD. JMAC	DWG. 1

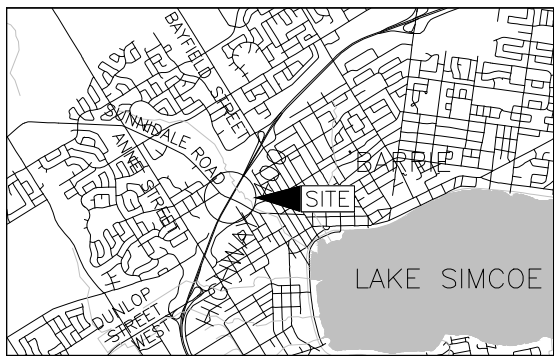
*METRIC*  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No. .  
GWP No. 06-20016

SUNNIDALE ROAD UNDERPASS  
HIGHWAY 400 WIDENING

SOIL STRATA

SHEET



KEY PLAN  
SCALE  
1 0 1 2 km

LEGEND

- Borehole - Previous Investigation (Geocres No. 31D-477)
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer (Mar. 15, 2001)

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
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B13-2	255.1	4916967.4	288585.1

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REFERENCE

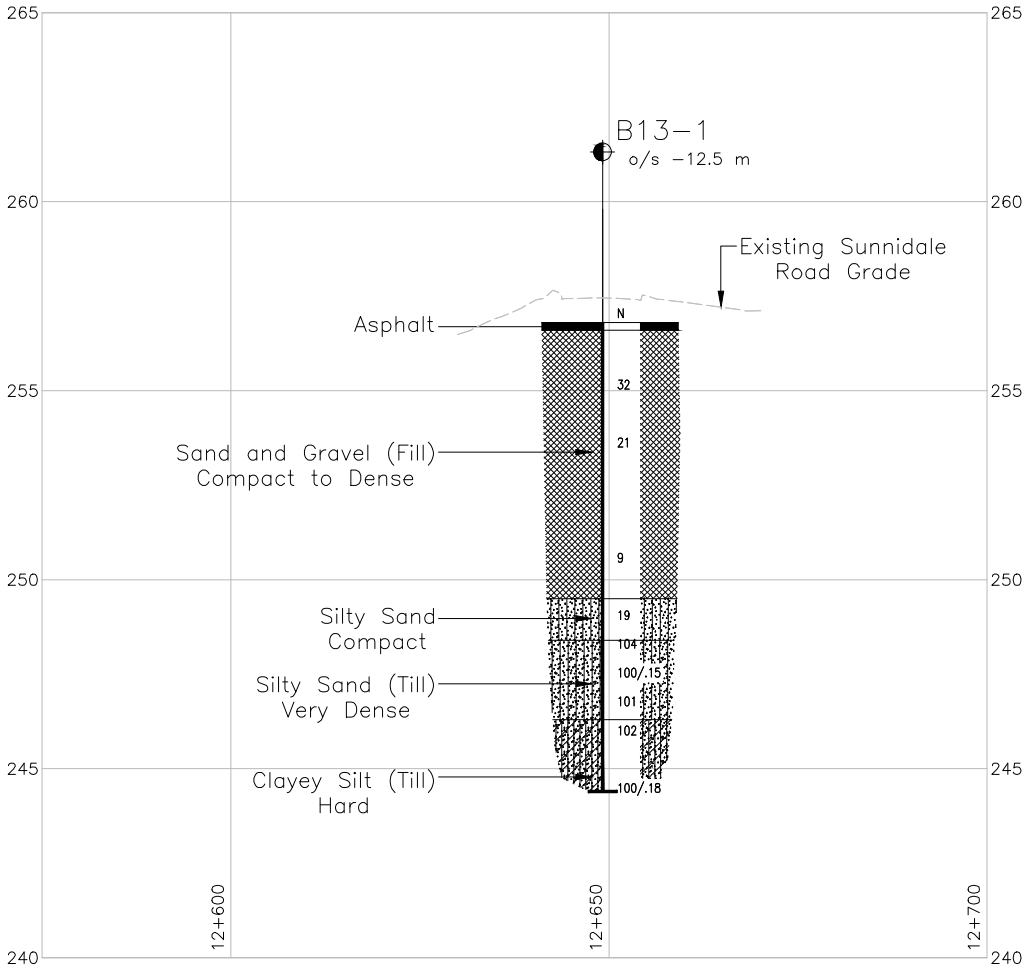
General arrangement, designs, base plans, profile and surface data provided in digital format by AECOM, drawing file nos. "01\_Sunnidale Road Underpass\_GA(2).dwg", received June 23, 2016, "X-Base\_All.dwg", received January 27, 2016, "X-Design\_4th Line\_Interim.dwg", received June 22, 2015, and "X-Surfaces.dwg", received April 14, 2015.

NO.	DATE	BY	REVISION
Geocres No. 31D-665			
HWY. 400		PROJECT NO. 14-1111-0002	DIST. .
SUBM'D. BM	CHKD. CN	DATE: 7/21/2016	SITE: 30-173
DRAWN: MR	CHKD. MK	APPD. JMAC	DWG. 2



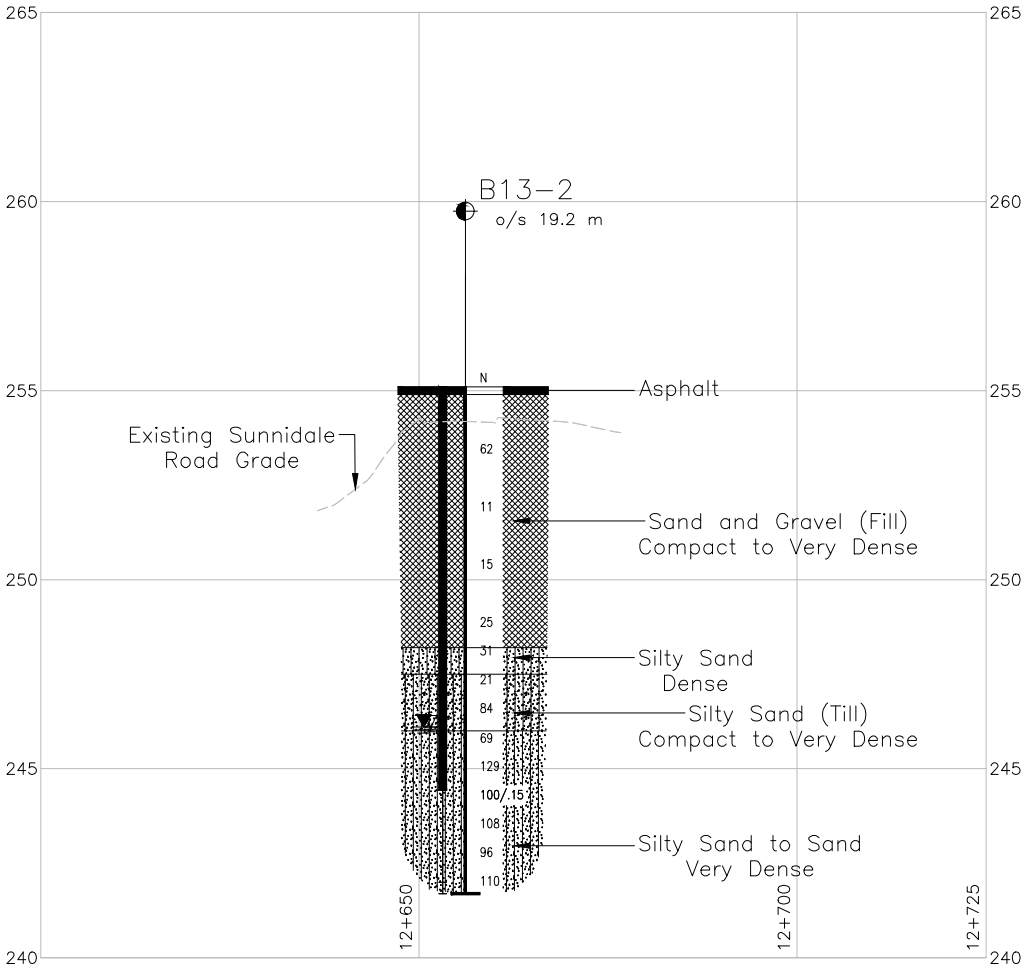
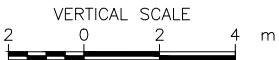
B-B WEST ABUTMENT CROSS-SECTION

1



C-C EAST ABUTMENT CROSS-SECTION

1





# **APPENDIX A**

**Record of Boreholes and Laboratory Test Results – Golder 2001  
Investigation (GEOCRES No. 31D-477)**

ON\_MOT 0011143F.GPJ ON\_MOT.GDT 14/1/02

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

PROJECT 001-1143F				RECORD OF BOREHOLE No B13-2				1 OF 1		METRIC				
W.P. 30-95-00				LOCATION N 4916967.4; E 288585.1				ORIGINATED BY PKS						
DIST SW HWY 400				BOREHOLE TYPE 108mm ID HOLLOW STEM AUGERS				COMPILED BY LCC						
DATUM Geodetic				DATE Feb.6-7/2001				CHECKED BY ASP						
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 + FIELD VANE ● QUICK TRIAXIAL X REMOULDED						
255.1	GROUND SURFACE													
0.0	Asphalt													
0.2	Sand and Gravel (Fill) Compact to very dense Brown Moist													
			1	SS	62									
			2	SS	11									
			3	SS	15									
			4	SS	25									
248.2														
6.9	Silty Sand, trace clay, some gravel, trace wood and organics Dense Brown Moist		5	SS	31									
247.5														
7.6	Silty Sand, trace clay, trace to some gravel (Till) Compact to very dense Brown Moist		6	SS	21									
			7	SS	84									
246.0														
9.1	Silty Sand to Sand, some silt, trace gravel Very dense Wet Brown		8	SS	69									0 85 15 0
			9	SS	129									
			10	SS	100/15									
			11	SS	108									
			12	SS	96									
	Thin silty clay layers present in Sample 13.		13	SS	110									
241.7														
13.4	END OF BOREHOLE													
	Notes: 1. Water level on completion of drilling at 11m depth (Elev.244.1m). 2. Water level in piezometer measured at 9m depth (Elev.246.1m) on March 15, 2001.													

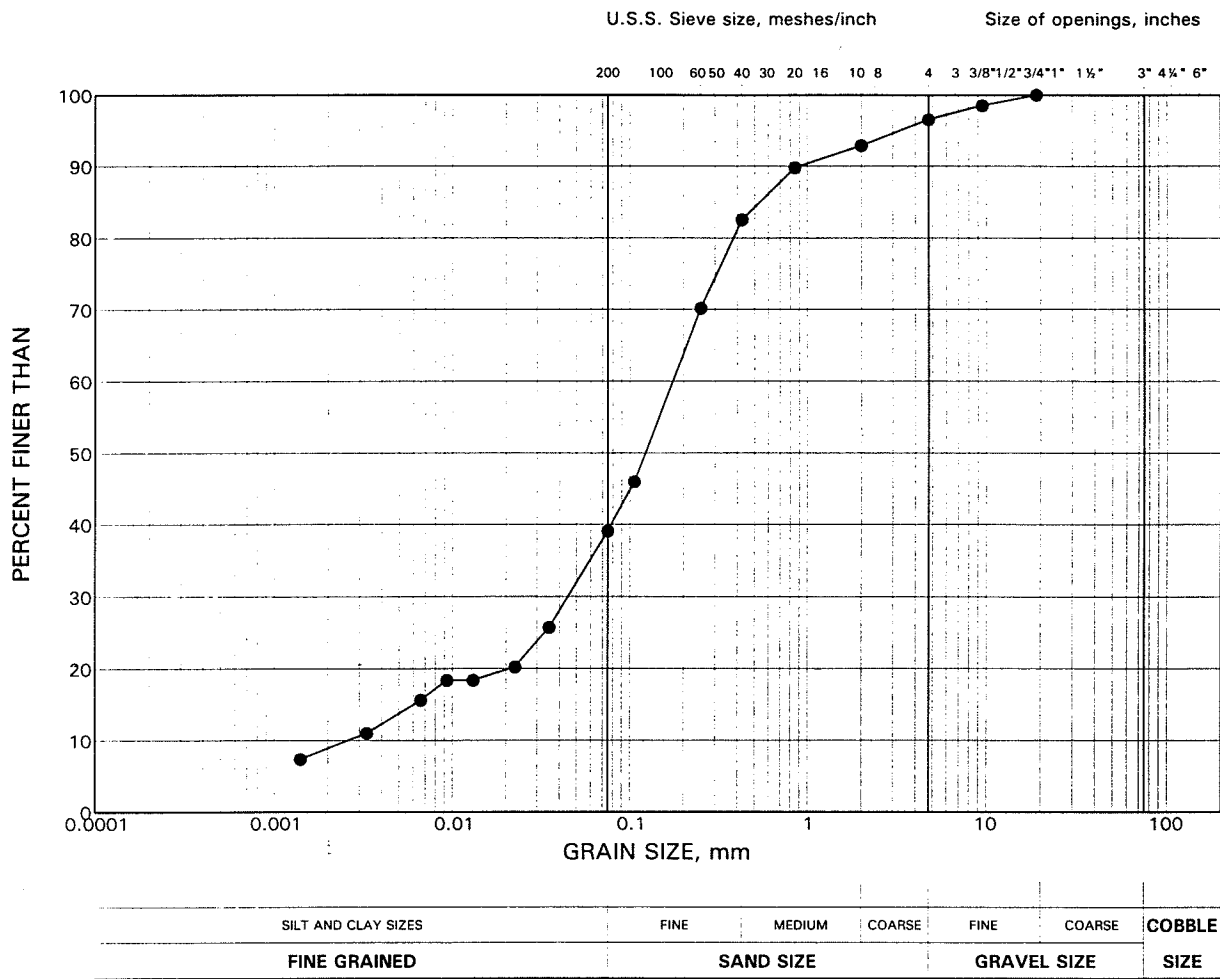
ON\_MOT 0011143F.GPJ ON\_MOT.GDT 14/1/02



# GRAIN SIZE DISTRIBUTION TEST RESULT

## Silty Sand Till

FIGURE 1



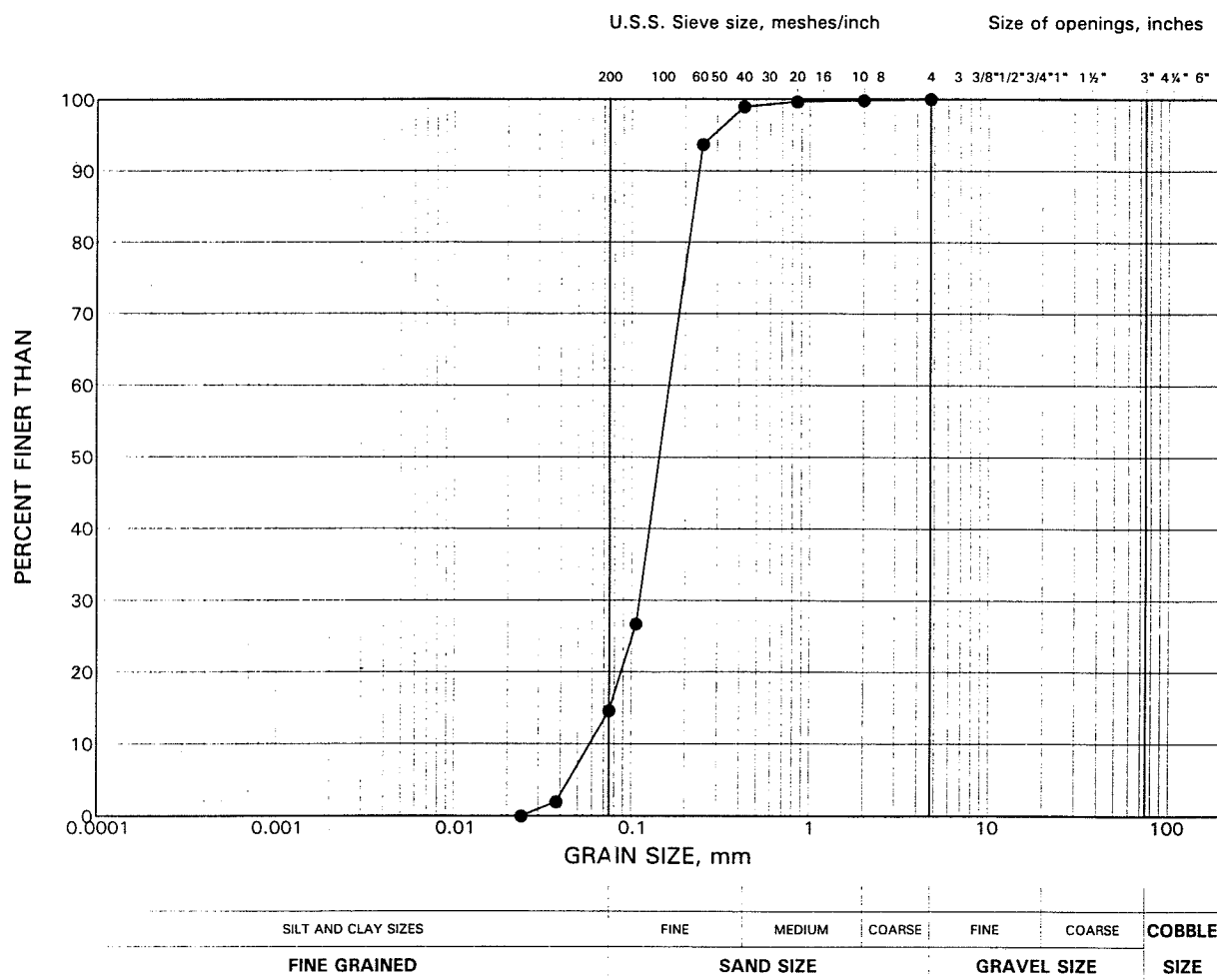
### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
•	B13-1	6	247.5

# GRAIN SIZE DISTRIBUTION TEST RESULT

Sand, some silt

FIGURE 2



## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
•	B13-2	8	245.6

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

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Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

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