

**FOUNDATION INVESTIGATION AND DESIGN REPORT  
HIGH FILLS  
HIGHWAY 403 AND OAK PARK ROAD  
INTERCHANGE IMPROVEMENTS  
GWP 3950-01-00, AGREEMENT NO. 3005-E-0067  
MINISTRY OF TRANSPORTATION - WEST REGION**

Submitted to:

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## TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
 <b>PART A – FOUNDATION INVESTIGATION REPORT</b>	
1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION.....	2
2.1 Site Geology .....	2
3.0 INVESTIGATION PROCEDURES.....	4
4.0 SUBSURFACE CONDITIONS.....	6
4.1 Site Stratigraphy .....	6
4.2 Proposed E-N/S Ramp (10+145 to 10+360) .....	6
4.2.1 Topsoil and Fill.....	6
4.2.2 Silt.....	7
4.2.3 Upper Sand and Gravel .....	7
4.2.4 Sandy Silt.....	7
4.2.5 Sand .....	7
4.2.6 Lower Sand and Gravel .....	8
4.3 E-N Ramp (10+285 to 10+365) .....	8
4.3.1 Silt.....	8
4.3.2 Sand and Gravel.....	8
4.3.3 Sandy Silt.....	8
4.3.4 Sand .....	8
4.4 S-W Ramp (10+055 to 10+170 and 10+215 to 10+245) .....	9
4.4.1 Topsoil and Fill.....	9
4.4.2 Upper Sand and Gravel .....	9
4.4.3 Sand .....	9
4.4.4 Sandy Silt.....	10
4.4.5 Lower Sand and Gravel .....	10
4.5 N-W Ramp (10+160 to 10+180 and 10+240 to 10+305) .....	10
4.5.1 Topsoil .....	10
4.5.2 Sand and Gravel.....	10
4.5.3 Sand .....	10
4.5.4 Sandy Silt.....	11
4.6 N-E Ramp (10+230 to 10+260) .....	11
4.6.1 Topsoil .....	11
4.6.2 Silt.....	11
4.6.3 Sand and Gravel.....	11
4.6.4 Sand .....	11
4.7 W-N/S Ramp (10+050 to 10+135).....	12

## TABLE OF CONTENTS CONTINUED

4.7.1	Topsoil .....	12
4.7.2	Sandy Silt.....	12
4.7.3	Sand .....	12
4.7.4	Sandy Silt Till .....	12
4.8	Groundwater Conditions.....	12
5.0	MISCELLANEOUS.....	14

## PART B – FOUNDATION DESIGN REPORT

6.0	ENGINEERING RECOMMENDATIONS .....	15
6.1	General.....	15
6.2	Ramp Construction.....	15
6.2.1	E-N/S Ramp (10+145 to 10+360) .....	15
6.2.2	E-N Ramp (10+285 to 10+365) .....	15
6.2.3	S-W Ramp (10+055 to 10+170 and 10+215 to 10+245) .....	16
6.2.4	N-W Ramp (10+160 to 10+180 and 10+240 to 10+305) .....	16
6.2.5	N-E Ramp (10+230 to 10+260) .....	16
6.2.6	W-N/S Ramp (10+050 to 10+135) .....	16
6.3	Existing Ramps.....	16
6.4	Subgrade Preparation and Embankment Construction .....	17
6.5	Settlement .....	17
6.6	Stability .....	18
6.7	Excavations and Temporary Cut Slopes .....	18
7.0	CLOSURE .....	19

LIST OF ABBREVIATIONS

LIST OF SYMBOLS

RECORD OF BOREHOLE SHEETS

FIGURE 1 - Key Plan

DRAWING 1 - Borehole Locations

DRAWINGS 2 to 6 - Soil Strata

APPENDIX A - Laboratory Test Data

APPENDIX B – Site Photographs

# **PART A – FOUNDATION INVESTIGATION REPORT**

## **HIGH FILLS**

**HIGHWAY 403 AND OAK PARK ROAD INTERCHANGE IMPROVEMENTS  
GWP 3950-01-00, AGREEMENT NO. 3005-E-0067  
MINISTRY OF TRANSPORTATION - SOUTHWESTERN REGION**

## 1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) has been retained by Dillon Consulting Limited (Dillon) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations as part of the detail design work for GWP 3950-01-00. The detail design for the interchange improvements at the Highway 403 and Oak Park Road Interchange includes:

- Reconstruction of the interchange to a Parclo A-4;
- Widening of Oak Park Road;
- Conventional illumination;
- Signalization at the W-N/S and E-N/S Ramp terminals;
- Retaining walls at both the Oak Park Road Underpass and the Trans Canada Trail Underpass; and,
- Rehabilitation of the Oak Park Road Underpass structure.

This report was prepared for the design of high fills for the new ramps at the Oak Park Road Interchange. The proposed change in interchange layout from the existing diamond configuration to a Parclo A-4 configuration will require construction of eight new ramps, six of which have segments where the fill heights will exceed 4.0 metres. The new E-N/S, E-N, S-W, N-W, N-E and W-N/S ramps will have segments with fill heights up to approximately 9 metres.

The purpose of the foundation investigation is to determine the subsurface conditions at the locations of the proposed works by drilling boreholes and carrying out in situ testing and laboratory testing on selected samples. The terms of reference for the scope of work are outlined in the MTO's Request for Proposal and Golder Associates' proposal P61-3107 dated October 17, 2007. The work was carried out in accordance with our revised Quality Control Plan for Foundation Engineering dated January 30, 2008.

Dillon provided Golder Associates with preliminary drawings for this project in digital format.

## **2.0 SITE DESCRIPTION**

Detail design of the reconstruction of the Highway 403 and Oak Park Road Interchange to a Parclo A-4 configuration is the focus of GWP 3950-01-00. This improvement will require widening of Oak Park Road, construction of retaining walls at the Oak Park Road Underpass (Site 1-139) and Trans Canada Trail Underpass (Site 1-158) and illumination and traffic control improvements. Eight new ramps will be constructed for the reconfigured interchange. The new E-N/S, E-N, S-W, N-W, N-E and W-N/S ramps have segments where high fills will be constructed.

The site is situated in Brantford, Ontario approximately 1 kilometre east of the Grand River and 3.2 kilometres west of Paris Road. The site location is shown in the Key Plan, Figure 1. Site photographs are presented in Appendix B.

Highway 403 is a divided highway with two lanes and a speed change lane in each direction. The existing interchange with Oak Park Road is currently a diamond configuration. Oak Park Road is a two lane undivided road. The topography within the project area features gentle slopes with elevations ranging between 235 and 244 metres. The interchange area is surrounded by former gravel pits. Highway 403 within the interchange area was constructed in a large cut area. Land use is predominantly industrial and commercial. South of Highway 403, the former pits have been redeveloped into the North West Industrial Subdivision. North of Highway 403, the Oak Park North Industrial Subdivision is being developed.

### **2.1 Site Geology**

The Oak Park Road Interchange is situated in the physiographic region of southern Ontario known as the Norfolk Sand Plain<sup>1</sup>. This wedge shaped area extends from the shoreline of Lake Erie to Brantford. Sand and silt was deposited as a delta in glacial Lakes Whittlesey and Warren when meltwater discharge from the Grand River entered the lakes between the icefront and the moraines to the northwest. The Galt Moraine and other nearby moraines are partly buried by sand.

The surficial soils are primarily composed of glaciofluvial outwash and deltaic deposits of gravel and gravely sand. In several places, the gravely deposits are overlain by several metres of sand.

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<sup>1</sup> L.J. Chapman and D.F. Putnam: The Physiography of Southern Ontario, Third Edition. Ontario Geological Survey, Special Volume 2, 1984.

These outwash deposits are derived from meltwaters of the Wentworth Ice. The largest gravel masses are found in Brantford and Paris.<sup>2</sup>

The underlying bedrock surface lies between elevations 198 and 213 metres.<sup>3</sup> The bedrock is reported to be tan dolomite and grey mudstone of the Salina Formation.<sup>4</sup>

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<sup>2</sup> Ontario Department of Mines and Northern Affairs: Pleistocene Geology of the Brantford Area, Southern Ontario, 1972. Preliminary Map 2240. Scale 1:63, 360.

<sup>3</sup> Karrow, P.F. and Sprague, D.J.: Bedrock Topography Series, Brantford Area, Southern Ontario, 1975. Preliminary Map 1049. Ontario Division of Mines. Scale 1:50, 000.

<sup>4</sup> Sandford, B.V. Bedrock Geology Toronto-Windsor Area. 1969. Geological Survey of Canada Map 1263 A. Scale 1:250, 000.

### 3.0 INVESTIGATION PROCEDURES

The field investigation consisted of drilling thirteen boreholes, numbered 201 to 213, to depths of 4.3 to 8.1 metres. The boreholes were drilled from June 13 to July 16, 2008 in high fill locations along the new E-N/S, E-N, S-W, N-W, N-E and W-N/S ramps.

The approximate limits of the high fill sections are:

- |              |                                       |
|--------------|---------------------------------------|
| • E-N/S Ramp | 10+145 to 10+360                      |
| • E-N Ramp   | 10+285 to 10+365                      |
| • S-W Ramp   | 10+055 to 10+170 and 10+215 to 10+245 |
| • N-W Ramp   | 10+160 to 10+180 and 10+240 to 10+305 |
| • N-E Ramp   | 10+230 to 10+260                      |
| • W-N/S Ramp | 10+050 to 10+135                      |

The investigation was carried out using an all-terrain vehicle mounted CME 750 and a track mounted power auger supplied and operated by a specialist drilling contractor. Samples of the overburden were obtained at 0.75 metre intervals to a depth of 6 metres, then at 1.5 metre intervals below this depth. Sampling was carried out using 50 millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test (SPT) procedures. Groundwater conditions in the boreholes were observed throughout the drilling operations and these observations are provided on the corresponding Record of Borehole sheets. All of the boreholes were backfilled in accordance with current MTO recommended procedures and Ontario Regulation 128/03. Temporary traffic control was carried out in accordance with the Ontario Traffic Manual, Temporary Conditions, Book 7, dated March 2001.

The field work was supervised on a full-time basis by experienced members of our engineering staff who arranged for utility locates, directed the drilling, sampling and in-situ testing operations, logged the boreholes, cared for the samples obtained and determined the borehole elevations based on survey information provided by others. The soil samples were identified in the field, placed in labelled containers and transported to Golder's London laboratory for further examination and routine testing. Index and classification tests consisting of water content determinations and grain size distribution analyses were carried out on selected samples. The results of the field and laboratory testing are given on the Record of Borehole sheets and in Appendix A. The locations of the boreholes are noted below and are shown on the Record of Borehole sheets and in plan on Drawing 1.

The borehole locations, ground surface elevations and depths of the boreholes are summarized as follows:

SITE	BOREHOLE	BOREHOLE LOCATION		GROUND SURFACE ELEVATION (m)	BOREHOLE DEPTH (m)
		NORTHING (m)	EASTING (m)		
E-N/S Ramp	201	4 781 416.5	236 658.9	237.56	8.08
	202	4 781 394.7	236 696.7	236.71	8.08
	203	4 781 376.3	236 739.4	236.54	5.03
	204	4 781 364.0	236 793.6	236.20	6.55
	205	4 781 349.2	236 810.6	235.89	6.55
E-N Ramp	201	4 781 416.5	236 658.9	237.56	8.08
S-W Ramp	202	4 781 394.7	236 696.7	236.71	8.08
	206	4 781 363.6	236 719.3	237.96	6.55
	207	4 781 302.1	236 746.5	237.62	5.03
N-W Ramp	208	4 781 341.6	236 658.9	241.38	4.27
	209	4 781 249.1	236 482.2	236.54	6.55
	210	4 781 223.7	236 434.6	235.22	6.55
N-E Ramp	211	4 781 179.3	236 570.7	236.36	5.03
	212	4 781 174.1	236 542.1	235.91	5.79
W-N/S Ramp	213	4 781 124.4	236 346.7	234.51	4.82

## **4.0 SUBSURFACE CONDITIONS**

### **4.1 Site Stratigraphy**

The detailed subsurface soil and groundwater conditions encountered in the boreholes together with the results of the field and laboratory testing are shown on the Record of Borehole sheets. The stratigraphic boundaries shown on the borehole sheets are inferred from non-continuous sampling and, therefore, may represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations.

The locations and elevations of the boreholes and interpreted stratigraphic profiles are shown on the attached Drawings 1 to 6. A detailed description of the subsurface conditions encountered in the boreholes for this investigation is provided on the Record of Borehole sheets and is summarized in the following sections. The discussion proceeds by ramp and embankment location. The stratigraphy in the Oak Park Road Interchange area typically consisted of surficial topsoil overlying granular deposits. The granular deposits were found to be predominantly sand and gravel and sands interlayered with sandy silt and silt. The groundwater table was encountered between elevation 232 and 233 metres. Construction of the interchange resulted in deep cuts adjacent to the four existing ramps. The high fills for the proposed ramps will fill in portions of these presently excavated areas.

### **4.2 Proposed E-N/S Ramp (10+145 to 10+360)**

Boreholes 201 to 205 were advanced in this section of the E-N/S ramp. The stratigraphic profile is shown on Drawing 2.

#### **4.2.1 Topsoil and Fill**

Topsoil layers 70 to 300 millimetres thick were encountered at the surface of boreholes 203 to 205, inclusive.

Fill materials were found at the ground surface in borehole 202. The upper 2.1 metres of fill consisted of silty sand and gravel with N values, as determined in the standard penetration testing, of 49 and over 100 blows per 0.3 metres. The lower 0.8 metres of fill was sand and gravel with trace amounts of asphalt and cobbles. The water content of the upper fill was 4 and 6 per cent. The lower fill layer was very dense with an N value of 65 blows per 0.3 metres and a water content of 7 per cent.

#### **4.2.2 Silt**

Silt was encountered at the ground surface in borehole 201 only. The silt layer was 0.3 metres thick.

#### **4.2.3 Upper Sand and Gravel**

The upper sand and gravel deposits were found beneath the silt and sandy silt layers in borehole 201 from elevation 237.3 metres and 235.1 metres, respectively, beneath the fill in borehole 202 from elevation 233.8 metres, below the sand in borehole 203 from elevation 232.9 metres and below the topsoil in boreholes 204 and 205 from about elevation 235.8 metres. The upper sand and gravel layers were 1.1 to 4.9 metres thick. The upper sand and gravel contains cobbles and boulders.

The upper sand and gravel was compact to very dense with N values ranging from 23 to over 100 blows per 0.3 metres. Natural water contents varied between 2 and 14 per cent and averaged 7 per cent. The results of grain size testing on samples of the upper sand and gravel recovered from the standard penetration testing are presented on Figure A-1 in Appendix A.

#### **4.2.4 Sandy Silt**

Sandy silt was found beneath an upper sand and gravel layer in borehole 201 from elevation 236.2 metres and beneath the topsoil in borehole 203 from elevation 236.4 metres. The sandy silt layers were 0.5 to 1.1 metres thick. Cobbles and boulders were encountered in the sandy silt layer in borehole 201.

The sandy silt is compact to very dense with N values of 13 and over 100 blows per 0.3 metres. Water contents of 10 and 11 per cent were measured on samples of the sandy silt.

#### **4.2.5 Sand**

Sand layers were found beneath the upper sand and gravel in boreholes 201, 202, 204 and 205 from elevation 230.9 and 231.5 metres, and below the sandy silt in borehole 203 from elevation 235.9 metres. The sand in borehole 203 contained cobbles. Where fully penetrated in boreholes 202, 203 and 205, the sand layers were 0.8 to 3.1 metres thick. Boreholes 201 and 204 were terminated in the sand layers.

The sand is loose to very dense with N values of 9 to greater than 100 blows per 0.3 metres. The sand had water contents of 3 to 18 per cent. The grain size distributions of two samples of sand are presented on Figure A-4.

#### **4.2.6 Lower Sand and Gravel**

A lower sand and gravel deposit was found beneath the sand in boreholes 202 and 205 from elevations 230.8 metres and 230.7 metres respectively. The lower sand and gravel is compact to dense with N values of 16 to 49 blows per 0.3 metres. Boreholes 202 and 205 were terminated in the lower sand and gravel after exploring for 1.4 to 2.1 metres. Water contents in the lower sand and gravel varied between 11 and 14 per cent.

### **4.3 E-N Ramp (10+285 to 10+365)**

Borehole 201 was advanced in the high fill section of the E-N ramp. A separate stratigraphic profile was not drawn for this ramp as the deep fill section is essentially an extension of the deep fill adjacent to the bullnose of the E-N/S ramp. The reader is referred to Drawing 2 for the stratigraphic profile.

#### **4.3.1 Silt**

A 0.3 metre thick layer of silt was encountered at the surface of borehole 201.

#### **4.3.2 Sand and Gravel**

Layers of sand and gravel were encountered in borehole 201 below the silt at elevation 237.3 metres and below the sandy silt from elevation 235.1 metres. Cobbles and boulders were present in the lower sand and gravel layer.

The sand and gravel is compact to dense but generally very dense with N values ranging from 23 to over 100 blows per 0.3 metres. Water contents in the sand and gravel were 3 to 12 per cent.

The results of grain size testing of a sample of sand and gravel are shown on Figure A-1.

#### **4.3.3 Sandy Silt**

Sandy silt with cobbles and boulders was found between the sand and gravel layers from elevation 236.2 metres. The sandy silt layer is 1.1 metres thick with N values of 13 blows and over 100 blows per 0.3 metres. Water contents of 10 and 11 per cent were measured for the sandy silt samples.

#### **4.3.4 Sand**

Borehole 201 was terminated in sand after exploring it for some 1.4 metres from elevation 230.9 metres. The sand is very dense with N values of 56 and over 100 blows per 0.3 metres. Water

contents in the sand were 13 and 15 per cent. The grain size distribution of a sample of sand from borehole 201 is presented on Figure A-4.

#### **4.4 S-W Ramp (10+055 to 10+170 and 10+215 to 10+245)**

Boreholes 202, 206 and 207 were drilled in the high fills areas of the S-W ramp. The stratigraphic profile is presented on Drawing 3.

##### **4.4.1 Topsoil and Fill**

Topsoil layers 150 millimetres thick were present at the surface of boreholes 206 and 207.

Fill materials were found at the surface of borehole 202. The upper 2.1 metres of fill consisted of silty sand and gravel with N values of 49 and over 100 blows per 0.3 metres. The lower 0.8 metres of fill was sand and gravel with trace amounts of asphalt and cobbles. The water content of the upper fill was 4 and 6 per cent. The lower fill layer was very dense with an N value of 65 blows per 0.3 metres and a water content of 7 per cent.

##### **4.4.2 Upper Sand and Gravel**

Upper sand and gravel layers were found beneath the fill in borehole 202 from elevation 233.8 metres, below the topsoil in boreholes 206 and 207 from elevations 237.5 and 237.8 metres, below the sand in borehole 206 from elevation 234.5 metres and beneath the sandy silt in borehole 207 from elevation 234.7 metres. Cobbles were present in the upper sand and gravel.

The upper sand and gravel was dense to very dense with N values of 39 to over 100 blows per 0.3 metres. Water contents of samples of upper sand and gravel varied from 1 to 14 per cent.

The results of the grain size testing on samples of sand and gravel from boreholes 202 and 206 are presented on Figures A-1 and A-2.

##### **4.4.3 Sand**

Sand was encountered between the upper sand and gravel layers in boreholes 202 and 206 from elevation 231.5 to 235.1 metres. The sand layers were 0.6 to 0.8 metres thick. The sand was compact to very dense with N values of 28 and over 100 blows per 0.3 metres. Water contents of 5 and 17 per cent were measured on the sand samples.

#### **4.4.4 Sandy Silt**

Between the upper sand and gravel layers in borehole 207 at elevation 235.3 metres, a 0.6 metre thick layer of sandy silt was found. The sandy silt had an N value of 79 blows per 0.3 metres and a water content of 17 per cent. The gradation of a sample of sandy silt is presented in Figure A-3.

#### **4.4.5 Lower Sand and Gravel**

A lower sand and gravel layer was encountered in borehole 202 below the sand from elevation 230.8 metres. The lower sand and gravel is dense with N values of 36 to 49 blows per 0.3 metres. Water contents in the lower sand and gravel ranged from 13 to 14 per cent.

The results of grain size testing on representative samples of sand and gravel are presented on Figure A-1.

### **4.5 N-W Ramp (10+160 to 10+180 and 10+240 to 10+305)**

Boreholes 208 to 210 were drilled in the areas where high fills are to be constructed along the S-W ramp. The stratigraphy along the S-W ramp is shown in profile on Drawing 4.

#### **4.5.1 Topsoil**

Topsoil was encountered at the surface of boreholes 208 to 210, inclusive. The topsoil layers were 70 to 150 millimetres thick.

#### **4.5.2 Sand and Gravel**

Sand and gravel with cobbles was encountered beneath the topsoil in all three boreholes from elevations 235.2 to 241.2 metres, below the sandy silt in borehole 208 from elevation 237.9 metres, and below the upper sand layer in borehole 210 from elevation 231.6 metres. The sand and gravel is loose to very dense but typically dense with N values of 7 to over 100 blows per 0.3 metres. Water contents in the sand and gravel ranged from 3 to 24 per cent.

The results of grain size testing on representative samples of sand and gravel are presented on Figure A-2.

#### **4.5.3 Sand**

Sand was found below the sand and gravel layer in borehole 209 from elevation 231.4 metres and interlayered with the sand and gravel in borehole 210 from elevations 234.5 metres and 230.0

metres. N values in the sand vary from 20 to 63 blows per 0.3 metres. Water contents of 12 to 18 per cent were measured in the sand samples retrieved from the standard penetration testing.

The grain size distribution curves for samples of sand are shown on Figure A-4.

#### **4.5.4 Sandy Silt**

A 0.5 metre thick layer of sandy silt was encountered from elevation 238.3 metres between the sand and gravel layers in borehole 208. The sandy silt was loose with an N value of 9 blows per 0.3 metres.

### **4.6 N-E Ramp (10+230 to 10+260)**

Boreholes 211 and 212 were drilled in the high fill section of the N-E ramp. A stratigraphic profile is shown on Drawing 5.

#### **4.6.1 Topsoil**

Topsoil layers 120 and 150 millimetres thick were found at the surface of boreholes 211 and 212, respectively.

#### **4.6.2 Silt**

The topsoil in borehole 212 was underlain by a 0.3 metre thick layer of silt from elevation 235.8 metres.

#### **4.6.3 Sand and Gravel**

Sand and gravel was encountered beneath the topsoil in borehole 211 from elevation 236.2 metres, below the silt in borehole 212 from elevation 235.5 metres and below the upper sand in borehole 212 from elevation 232.3 metres. The sand and gravel is very dense with N values of 54 to over 100 blows per 0.3 metres. Water contents in the sand and gravel ranged from 2 to 20 per cent. The grain size distribution curve for a sample of sand and gravel from borehole 212 is shown on Figure A-2.

#### **4.6.4 Sand**

Sand layers were found in borehole 211 from elevation 232.7 metres and in borehole 212 from elevation 233.8 and 231.5 metres. The sand is compact to very dense with N values of 20 to 120 blows per 0.3 metres. Water contents of 10 to 22 per cent were measured in the samples of sand. The grain size distribution curves for samples of sand are shown on Figure A-4.

#### 4.7 W-N/S Ramp (10+050 to 10+135)

A single borehole, borehole 213, was drilled in this location. The stratigraphic profile for the W-N/S ramp is shown on Drawing 6.

##### 4.7.1 Topsoil

A 120 millimetre thick layer of topsoil was encountered at the ground surface at borehole 213.

##### 4.7.2 Sandy Silt

The topsoil was underlain by sandy silt from elevation 234.4 metres.

##### 4.7.3 Sand

Sand was found beneath the sandy silt from elevation 234.0 metres. The sand was compact to very dense with N values ranging from 16 to 74 blows per 0.3 metres. The water content of the sand varied from 10 to 25 per cent. The grain size distribution curve for a sample of sand from borehole 213 is presented on Figure A-4.

##### 4.7.4 Sandy Silt Till

Borehole 213 was terminated in a sandy silt till deposit which was encountered from elevation 230.3 metres. The sandy silt till was very dense with an N value of over 100 blows per 0.3 metres. The water content of the sandy silt till was 7 per cent.

#### 4.8 Groundwater Conditions

Groundwater conditions were observed in the boreholes during and upon completion of drilling. Standpipes were installed in boreholes 206, 209 and 212. Details of the groundwater conditions encountered and subsequently measured in the installations are provided on the Record of Borehole sheets and are summarized below.

BOREHOLE	GROUND SURFACE ELEVATION	ENCOUNTERED GROUNDWATER LEVEL		INSTALLATION	MEASURED GROUNDWATER LEVEL			
		Depth	Elevation		July 16, 2008		July 25, 2008	
					Depth	Elevation	Depth	Elevation
	(m)	(m)	(m)		(m)	(m)	(m)	(m)
201	237.56	3.8	233.8	-	-	-	-	-
202	236.71	3.0	233.7	-	-	-	-	-
203	236.54	4.6	232.0	-	-	-	-	-
204	236.20	3.2	233.0	-	-	-	-	-
205	235.89	3.0	232.8	-	-	-	-	-
206	237.96	4.6	233.4	Standpipe	4.72	233.24	4.29	233.67

BOREHOLE	GROUND SURFACE ELEVATION	ENCOUNTERED GROUNDWATER LEVEL		INSTALLATION	MEASURED GROUNDWATER LEVEL			
		Depth	Elevation		July 16, 2008		July 25, 2008	
					Depth	Elevation	Depth	Elevation
	(m)	(m)	(m)		(m)	(m)	(m)	(m)
207	237.62	4.6	233.0	-	-	-	-	-
208	241.38	Dry	Dry	-	-	-	-	-
209	236.54	3.0	233.5	Standpipe	3.07	233.47	2.99	233.55
210	235.22	2.3	232.9	-	-	-	-	-
211	236.36	3.0	233.3	-	-	-	-	-
212	235.91	3.0	232.9	Standpipe	2.39	233.52	2.41	232.50
213	234.51	1.4	233.1	-	-	-	-	-

With the exception of borehole 208, which did not extend below the groundwater level, all of the boreholes encountered groundwater between elevation 232.0 and 233.8 metres or at depths of 1.4 to 4.6 metres below the existing ground surface. The most recent readings in the standpipes were obtained on July 25, 2008, some three to five weeks after the standpipes had been installed. The groundwater level was measured between elevation 233.50 and 233.55 metres on that date.

The groundwater levels are expected to fluctuate seasonally and are expected to be higher during periods of sustained precipitation or during spring melt conditions.

## **5.0 MISCELLANEOUS**

The current investigation was carried out using equipment supplied and operated by Lantech Drilling Services Inc., and London Soil Test Ltd., both of which are Ontario Ministry of Environment licensed well contractors. The field operations were supervised by Mr. Tyson Pitt, E.I.T. and Mr. Michael Arthur under the direction of Mr. David J. Mitchell.

The laboratory testing was carried out at Golder's London laboratory under the direction of Mr. Chris M. Sewell. This laboratory is an accredited participant in the MTO Soil and Aggregate Proficiency Program and is certified by the Canadian Council of Independent Laboratories for testing Types C and D aggregates.

This report was prepared by Ms. Dirka U. Prout, P. Eng. under the direction of the Project Manager, Mr. Philip R. Bedell, P. Eng. This report was reviewed by Mr. Fintan J. Heffernan, P. Eng., the Designated MTO Contact and Quality Control Auditor for this assignment.

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## **PART B – FOUNDATION DESIGN REPORT**

### **HIGH FILLS**

**HIGHWAY 403 AND OAK PARK ROAD INTERCHANGE IMPROVEMENTS**

**GWP 3950-01-00, AGREEMENT NO. 3005-E-0067**

**MINISTRY OF TRANSPORTATION - SOUTHWESTERN REGION**

## **6.0 ENGINEERING RECOMMENDATIONS**

### **6.1 General**

This section of the report provides our recommendations on the foundation aspects of the design of the high fills for the new E-N/S, E-N, S-W, N-W, N-E and W-N/S ramps which have been proposed for the Highway 403/Oak Park Road Interchange. The recommendations are based on our interpretation of the factual information obtained during the investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

As noted in Section 4.1, the areas of the high fills are located in depressions which were excavated during construction of the existing interchange. In all cases, the proposed fills will remain well below the elevation of the original ground surface in the area of the interchange.

### **6.2 Ramp Construction**

#### **6.2.1 E-N/S Ramp (10+145 to 10+360)**

Design drawings provided by Dillon indicate that the fills for the new E-N/S ramp will be up to 8.6 metres high, as shown on Drawing 2. Much of this ramp will be constructed in fill. The borehole data indicates that the subsurface conditions within the subject section typically consist of surficial topsoil and a localized deposit of fill associated with the backfilling of a gravel pit underlain by compact to very dense sand and gravel interlayered with loose to very dense sand. Infrequent silt and sandy silt layers were also encountered. The groundwater level is expected to be between elevation 233 and 234 metres.

#### **6.2.2 E-N Ramp (10+285 to 10+365)**

This new fill for the ramp will be up to some 8.4 metres in height adjacent to the bullnose where the new E-N/S ramp will divide into the E-S and E-N ramps. The borehole advanced in this area encountered surficial topsoil underlain by compact to very dense but typically very dense sand and gravel with silt, sandy silt and sand layers. The groundwater level is inferred to be at approximately elevation 234 metres.

### **6.2.3 S-W Ramp (10+055 to 10+170 and 10+215 to 10+245)**

The two fill sections along the S-W ramp will be separated by a cut section where the existing E-N/S ramp intersects the proposed alignment. In the two high fill sections, the maximum fill heights will be in the order of 5.7 to 6.2 metres, as shown on Drawing 3. The soil stratigraphy is surficial topsoil overlying an extensive deposit of dense to very dense sand and gravel. The sand and gravel deposit is interlayered with a 0.6 metre thick layer of very dense sandy silt to sand from approximately elevation 235 metres. The groundwater level was measured at approximately elevation 234 metres on July 25, 2008.

### **6.2.4 N-W Ramp (10+160 to 10+180 and 10+240 to 10+305)**

The N-W ramp will have two fill sections with a maximum height of about 5.4 metres flanking each side of the existing N/S-W ramp, as shown on Drawing 4. The borehole information indicates that the soils generally consist of surficial topsoil underlain by loose to very dense but typically dense sand and gravel with compact to dense sand layers. The groundwater level was measured at approximately elevation 234 metres on July 25, 2008.

### **6.2.5 N-E Ramp (10+230 to 10+260)**

The fill section along the N-E ramp will be situated just prior to the eastbound Highway 403 speed change lane. Fill heights for the proposed ramp will be up to approximately 4.5 metres, as shown on Drawing 5. The stratigraphy generally consists of surficial topsoil overlying very dense sand and gravel over very dense sand from 233 to 234 metres. The groundwater level was measured near elevation 233 metres on July 25, 2008.

### **6.2.6 W-N/S Ramp (10+050 to 10+135)**

The maximum fill height along the W-N/S ramp will be approximately 4 metres. It was noted in the field that there is a low area in the vicinity of borehole 213. The stratigraphy generally consists of surficial topsoil and sandy silt overlying sand to approximately elevation 230 metres. The sand was underlain by sandy silt till. The inferred groundwater level is 233 metres.

## **6.3 Existing Ramps**

Highway 403 in the vicinity of Oak Park Road was constructed in a cut some 8.2 to 10.7 metres below the original ground level that had elevations ranging approximately between 249 and 251

metres. Oak Park Road at Highway 403 was also constructed in a cut some 2 to 4 metres below the original ground level.<sup>1</sup>

#### **6.4 Subgrade Preparation and Embankment Construction**

All surficial topsoil, organic, loose, soft and/or otherwise deleterious materials should be stripped from areas of proposed embankment construction. The exposed subgrade should be proofrolled prior to fill placement under the direction of qualified geotechnical personnel. In areas where the new ramps cross existing ramps, all surficial topsoil and deleterious materials should be removed from the existing embankment slopes. Grading and embankment construction should be conducted in accordance with MTO Special Provision 206S03.

Except for the top 0.5 metres, where Granular B Type III should be placed, the embankment fills should consist of an approved granular borrow such as Select Subgrade Material (SSM) or Granular B Type I.

Embankment fill materials should be placed in maximum 300 millimetre thick loose lifts and properly benched into the existing embankments in accordance with Ontario Provincial Standard Drawing (OPSD) 208.010 and compacted. Upon completion of filling to the pavement subgrade level, the embankment side slopes should be trimmed to a final inclination of two horizontal to one vertical or flatter. Embankment fills greater than 8 metres in height should be provided with a minimum 2 metre wide bench at mid-height.

#### **6.5 Settlement**

The maximum settlements due to construction of the new ramps were estimated using the empirical Hough (1959) method. The field N values were corrected for overburden pressure using the Liao and Whitman (1986) correction. Total estimated settlements for all six ramps are less than 15 millimetres. Differential settlements in the order of 5 millimetres may occur near Stations 10+210 and 10+170 on the S-W ramp where the existing E-N/S ramp intersects the proposed alignment.

All settlement is expected to be within the MTO's tolerances for construction of this nature and complete by the end of construction due to the cohesionless nature of the underlying soils. The estimated maximum settlements for each ramp with high fills are summarized in the following table:

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<sup>1</sup> MTO Geocres Report No. 40P1-56. Foundation Investigation Report For Proposed Underpass of Hwy. #403 Line 'K' At Brant County Road #27, 2.0 Mi. West of Hwy. 2, West Limit, District #4, Hamilton, W.O. 71-11111 – W.P. 157-60, dated February 18, 1972.

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<u>Ramp</u>	<u>Maximum Fill Height</u> (m)	<u>Maximum Estimated Settlement</u> (mm)
E-N/S	8.6	12
E-N	8.4	10
S-W	6.2	8
N-W	5.4	15
N-E	4.5	5
W-N/S	4.0	12

## **6.6 Stability**

Embankments constructed as outlined above will have a factor of safety of greater than 1.3 against instability for side slopes of 2 horizontal to 1 vertical and up to 10 metres in height.

## **6.7 Excavations and Temporary Cut Slopes**

All excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Ontario Occupational Health and Safety Act and Regulations For Construction Projects. The fill materials at this site would be classified as Type 3 soils as would any granular materials below the groundwater level. The native granular materials above the groundwater table and properly dewatered cohesionless materials would be classified as Type 1 or 2 soils depending on the density. Excavations are not expected to extend below the groundwater table.

## **7.0 CLOSURE**

This report was prepared by Ms. Dirka U. Prout, P.Eng. under the direction of the Project Manager, Mr. Philip R. Bedell, P. Eng. This report was reviewed by Mr. Fintan J. Heffernan, P.Eng., the Designated MTO Contact and Quality Control Auditor for this assignment.

### **GOLDER ASSOCIATES LTD.**

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Designated MTO Contact

DUP/PRB/FJH/cr  
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## LIST OF ABBREVIATIONS

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

### I. SAMPLE TYPE

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

### III. SOIL DESCRIPTION

#### (a) Cohesionless Soils

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

### II. PENETRATION RESISTANCE

#### Standard Penetration Resistance (SPT), N:

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

#### Consistency

	<u>kPa</u>	<u>psf</u>
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

#### (b) Cohesive Soils

#### Dynamic Cone Penetration Resistance; $N_d$ :

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

**PH:** Sampler advanced by hydraulic pressure

**PM:** Sampler advanced by manual pressure

**WH:** Sampler advanced by static weight of hammer

**WR:** Sampler advanced by weight of sampler and rod

#### Piezo-Cone Penetration Test (CPT)

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

### IV. SOIL TESTS

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

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

## LIST OF SYMBOLS

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

### I. General

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

### II. STRESS AND STRAIN

$\gamma$	shear strain
$\Delta$	change in, e.g. in stress: $\Delta \sigma$
$\epsilon$	linear strain
$\epsilon_v$	volumetric strain
$\eta$	coefficient of viscosity
$\nu$	poisson's ratio
$\sigma$	total stress
$\sigma'$	effective stress ( $\sigma' = \sigma - u$ )
$\sigma'_{vo}$	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
$\sigma_{oct}$	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
$\tau$	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

### III. SOIL PROPERTIES

#### (a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
$\gamma'$	unit weight of submerged soil ( $\gamma' = \gamma - \gamma_w$ )
$D_R$	relative density (specific gravity) of solid particles ( $D_R = \rho_s / \rho_w$ ) (formerly $G_s$ )
e	void ratio
n	porosity
S	degree of saturation

#### (a) Index Properties (continued)

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

#### (b) Hydraulic Properties

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

#### (c) Consolidation (one-dimensional)

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

#### (d) Shear Strength

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

- Notes:**
- 1  $\tau = c' + \sigma' \tan \phi'$
  - 2 shear strength = (compressive strength)/2
  - \* density symbol is  $\rho$ . Unit weight symbol is  $\gamma$  where  $\gamma = \rho g$  (i.e. mass density x acceleration due to gravity)

PROJECT 07-1130-204-1		<b>RECORD OF BOREHOLE No 201</b>		1 OF 1	<b>METRIC</b>
G.W.P. 3950-01-00		LOCATION N 4781416.5 ; E 236658.9		ORIGINATED BY TP	
DIST _____ HWY 403		BOREHOLE TYPE Power Auger (HOLLOW STEM)		COMPILED BY BRS	
DATUM GEODETIC		DATE June 13, 2008		CHECKED BY _____	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL LIMIT   MOISTURE   CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR   SA   SI   CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20   40   60   80   100	20   40   60   80   100	w <sub>p</sub> w   w <sub>L</sub>							
237.56	GROUND SURFACE																
0.00	SILT, some sand, trace gravel Brown																
0.30	SAND AND GRAVEL, some silt Compact Brown		1	SS	23												
236.19																	
1.37	SANDY SILT, trace clay, some gravel, with cobbles and boulders Compact to very dense Brown		2	SS	13												
235.12			3	SS	51/ 100mm												
2.44	SAND AND GRAVEL, trace silt with cobbles and boulders Very dense Brown		4	SS	50												
			5	SS	57/ 150mm												
			6	SS	74												
			7	SS	50/ 150mm												
			8	SS	61												
230.85																	
6.71	SAND, trace silt, trace gravel Very dense Brown		9	SS	74/ 225mm												
229.48			10	SS	56												
8.08	END OF BOREHOLE																
	Groundwater encountered at about elev. 233.8m during drilling June 13, 2008.																

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**RECORD OF BOREHOLE No 202**

1 OF 1

**METRIC**

PROJECT 07-1130-204-1  
G.W.P. 3950-01-00 LOCATION N 4781394.7 ; E 236696.7 ORIGINATED BY TP  
DIST HWY 403 BOREHOLE TYPE Power Auger (HOLLOW STEM) COMPILED BY BRS  
DATUM GEODETIC DATE June 16, 2008 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20   40   60   80   100					w <sub>P</sub> w                      w <sub>L</sub>				
236.71	GROUND SURFACE																
0.00	FILL, silty sand and gravel Dense to very dense Brown		1	SS	49		236						○				
			2	SS	100/ 200mm		235						○				
234.58																	
2.13	FILL, sand and gravel, trace asphalt, with cobbles Very dense Brown		3	SS	65		234						○				
233.81																	
2.90	SAND AND GRAVEL, trace silt, with cobbles Dense to very dense Brown		4	SS	56		233						○				
			5	SS	39												
			6	SS	70		232						○				
231.53																	
5.18	SAND, trace silt, trace gravel Compact Brown		7	SS	28		231						○			28   65   (7)	
230.77																	
5.94	SAND AND GRAVEL, trace silt Dense Brown		8	SS	49		230						○				
			9	SS	36								○			29   65   (6)	
			10	SS	47		229						○				
228.63																	
8.08	END OF BOREHOLE																
	Groundwater encountered at about elev. 233.7m during drilling June 16, 2008.																

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

**RECORD OF BOREHOLE No 203**

1 OF 1

**METRIC**

PROJECT 07-1130-204-1

G.W.P. 3950-01-00

LOCATION N 4781376.3 ; E 236739.4

ORIGINATED BY TP

DIST HWY 403

BOREHOLE TYPE Power Auger (HOLLOW STEM)

COMPILED BY BRS

DATUM GEODETIC

DATE June 16, 2008

CHECKED BY

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			20	40	60	80	100					
236.54	GROUND SURFACE																
0.00	TOPSOIL, silty Brown																
0.15																	
235.93	SANDY SILT, some gravel Brown						236										
0.61																	
	SAND, fine, some silt, some gravel, with cobbles Loose to dense Brown		1	SS	39												
							235										
			2	SS	19												
			3	SS	9		234										
			4	SS	27												
232.88							233										
3.66	SAND AND GRAVEL, trace silt, with cobbles and boulders Very dense Brown		5	SS	100/ 50mm												
			6	SS	68		232										
231.51																	
5.03	END OF BOREHOLE																
	Groundwater encountered at about elev. 232.0m during drilling June 16, 2008.																

PROJECT 07-1130-204-1		<b>RECORD OF BOREHOLE No 204</b>		1 OF 1	<b>METRIC</b>
G.W.P. 3950-01-00		LOCATION N 4781364.0 ; E 236793.6		ORIGINATED BY TP	
DIST _____ HWY 403		BOREHOLE TYPE Power Auger (HOLLOW STEM)		COMPILED BY BRS	
DATUM GEODETIC		DATE June 16, 2008		CHECKED BY _____	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL LIMIT   MOISTURE   LIQUID CONTENT   LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×	LAB VANE	w <sub>p</sub>	w		w <sub>L</sub>			
236.20	GROUND SURFACE																			
0.00	TOPSOIL, silty Brown																			
0.30	SAND AND GRAVEL, trace to some silt, with cobbles Very dense Brown		1	SS	79															
			2	SS	100/ 150mm															
			3	SS	87															
			4	SS	101															
			5	SS	105/ 75mm															
			6	SS	62															
231.02	SAND, trace silt, trace gravel Compact to very dense Brown		7	SS	57															
5.18			8	SS	28															
229.65	END OF BOREHOLE																			
6.55	Groundwater encountered at about elev. 233.0m during drilling June 16, 2008.																			


PROJECT 07-1130-204-1		<b>RECORD OF BOREHOLE No 205</b>		1 OF 1 <b>METRIC</b>	
G.W.P. 3950-01-00		LOCATION N 4781349.2;E 236810.6		ORIGINATED BY TP	
DIST _____ HWY 403		BOREHOLE TYPE Power Auger (HOLLOW STEM)		COMPILED BY BRS	
DATUM GEODETIC		DATE June 16, 2008		CHECKED BY _____	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL LIMIT   MOISTURE   CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					w <sub>p</sub>	w	w <sub>L</sub>		GR	SA	SI	CL
					○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					WATER CONTENT (%)										
235.89	GROUND SURFACE					▽														
0.07	TOPSOIL, sandy Brown SAND AND GRAVEL, some silt, with cobbles Dense to very dense Brown		1	SS	74									○						
			2	SS	54									○					48	40   (12)
			3	SS	65									○						
			4	SS	46															
			5	SS	100										○					
231.47			6	SS	44														50	39   (11)
4.42	SAND, fine to medium, trace silt Dense Brown		7	SS	16										○					
230.71	SAND AND GRAVEL, trace silt Compact Brown		8	SS	16															
229.34	END OF BOREHOLE																			
6.55	Groundwater encountered at about elev. 232.8m during drilling June 16, 2008.																			

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PROJECT <u>07-1130-204-1</u>		<b>RECORD OF BOREHOLE No 207</b>		1 OF 1		<b>METRIC</b>	
G.W.P. <u>3950-01-00</u>		LOCATION <u>N 4781302.1;E 236746.5</u>		ORIGINATED BY <u>TP</u>			
DIST <u>          </u> HWY <u>403</u>		BOREHOLE TYPE <u>Power Auger (HOLLOW STEM)</u>		COMPILED BY <u>BRS</u>			
DATUM <u>GEODETIC</u>		DATE <u>June 18, 2008</u>		CHECKED BY <u>          </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT $\gamma$ 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					W <sub>p</sub>	W	W <sub>L</sub>		
237.62	GROUND SURFACE																
0.00	TOPSOIL, silty																
0.15	Brown																
	SAND AND GRAVEL, trace silt, with cobbles		1	SS	109/175mm												
	Very dense		2	SS	103/150mm												
	Brown																
235.33																	
2.29	SANDY SILT, trace clay, trace gravel																
	Very dense	3	SS	79													
	Brown																
234.72																	
2.90	SAND AND GRAVEL, trace silt, with cobbles																
	Very dense	4	SS	124/225mm													
	Brown																
		5	SS	100/150mm													
		6	SS	66													
232.59																	
5.03	END OF BOREHOLE																
	Groundwater encountered at about elev. 233.0m during drilling on June 18, 2008.																

LDN\_MTO\_01 0711302041.GPJ LDN\_MTO.GDT 10/14/08

PROJECT <u>07-1130-204-1</u>		<b>RECORD OF BOREHOLE No 208</b>		1 OF 1 <b>METRIC</b>	
G.W.P. <u>3950-01-00</u>		LOCATION <u>N 4781341.6 ;E 236533.2</u>		ORIGINATED BY <u>TP</u>	
DIST <u>          </u> HWY <u>403</u>		BOREHOLE TYPE <u>Power Auger (HOLLOW STEM)</u>		COMPILED BY <u>BRS</u>	
DATUM <u>GEODETIC</u>		DATE <u>June 18, 2008</u>		CHECKED BY <u>          </u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					w <sub>p</sub>	w	w <sub>L</sub>		GR	SA	SI	CL
					○ UNCONFINED                      + FIELD VANE ● QUICK TRIAXIAL                  × LAB VANE					WATER CONTENT (%)										
241.38	GROUND SURFACE						20	40	60	80	100									
0.00	TOPSOIL, silty																			
0.15	Brown																			
	SAND AND GRAVEL, some silt, with cobbles		1	SS	54										○			66	22   (12)	
	Loose to very dense																			
	Brown		2	SS	18															
			3	SS	7										○					
238.33																				
3.05	SANDY SILT, some gravel		4	SS	9															
237.87	Loose																			
3.51	Brown																			
	SAND AND GRAVEL, with cobbles																			
	Dense																			
	Brown		5	SS	32										○					
237.11																				
4.27	END OF BOREHOLE																			
	Borehole dry during drilling on June 18, 2008.																			

LDN\_MTO\_01\_0711302041.GPJ LDN\_MTO.GDT 10/14/08

**RECORD OF BOREHOLE No 209**

1 OF 1

**METRIC**

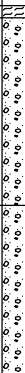


PROJECT 07-1130-204-1  
G.W.P. 3950-01-00 LOCATION N 4781249.1 ; E 236482.2 ORIGINATED BY TP  
DIST HWY 403 BOREHOLE TYPE Power Auger (HOLLOW STEM) COMPILED BY BRS  
DATUM GEODETIC DATE June 19, 2008 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W <sub>P</sub> W      W <sub>L</sub>							
								○ UNCONFINED      + FIELD VANE	WATER CONTENT (%)								
						● QUICK TRIAXIAL      × LAB VANE	20   40   60   80   100	20   40   60   80   100	10   20   30				GR	SA	SI	CL	
236.54	GROUND SURFACE																
0.00	TOPSOIL, silty Brown																
0.15	SAND AND GRAVEL, trace silt, with cobbles Compact to very dense Brown																
			1	SS	92		Backfill										
							Bentonite										
			2	SS	85							○					
			3	SS	109/ 150mm												
			4	SS	53		Backfill					○					39 53 (8)
			5	SS	17							○					
			6	SS	33								○				
231.36							Standpipe										
5.18	SAND, trace silt, some gravel Dense to very dense Brown		7	SS	44							○					17 77 (6)
			8	SS	63							○					
229.99	END OF BOREHOLE																
6.55	Groundwater encountered at about elev. 233.5m during drilling June 19, 2008.  Water level measured at elev. 233.47m in standpipe on July 16, 2008.  Water level measured at elev. 233.55m in standpipe on July 25, 2008.																

PROJECT 07-1130-204-1		<b>RECORD OF BOREHOLE No 210</b>		1 OF 1	<b>METRIC</b>
G.W.P. 3950-01-00		LOCATION N 4781223.7 ; E 236434.6		ORIGINATED BY TP	
DIST _____ HWY 403		BOREHOLE TYPE Power Auger (HOLLOW STEM)		COMPILED BY BRS	
DATUM GEODETIC		DATE June 19, 2008		CHECKED BY _____	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL LIMIT   MOISTURE   CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	w <sub>p</sub>	w	w <sub>L</sub>		GR	SA	SI	CL
								SHEAR STRENGTH kPa ○ UNCONFINED                      + FIELD VANE ● QUICK TRIAXIAL                × LAB VANE					WATER CONTENT (%)							
235.22	GROUND SURFACE					▽	235													
0.07	TOPSOIL, silty Brown						234													
234.46	SAND AND GRAVEL, with cobbles Brown						233													
0.76	SAND, trace silt, trace gravel Compact to dense Brown		1	SS	41		232													
			2	SS	20		231													
			3	SS	22		230													
			4	SS	34		229													
231.56	SAND AND GRAVEL, trace silt, with cobbles Dense Brown		5	SS	42															
3.66			6	SS	35															
230.04	SAND, trace gravel Compact to dense Brown		7	SS	28															
5.18			8	SS	45															
228.67	END OF BOREHOLE																			
6.55	Groundwater encountered at about elev. 232.9m during drilling on June 19, 2008.																			

PROJECT 07-1130-204-1		<b>RECORD OF BOREHOLE No 211</b>		1 OF 1 <b>METRIC</b>	
G.W.P. 3950-01-00		LOCATION N 4781179.3 ; E 236570.7		ORIGINATED BY TP	
DIST _____ HWY 403		BOREHOLE TYPE Power Auger (HOLLOW STEM)		COMPILED BY BRS	
DATUM GEODETIC		DATE July 3, 2008		CHECKED BY _____	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED                      + FIELD VANE ● QUICK TRIAXIAL                × LAB VANE					W <sub>p</sub>	W	W <sub>L</sub>		GR	SA	SI	CL
236.36	GROUND SURFACE																			
0.00	TOPSOIL, silty, some sand Brown																			
0.12	SAND AND GRAVEL, some silt Very dense Brown		1	SS	66															
			2	SS	102/ 150mm															
234.38	SAND AND GRAVEL, trace silt, with cobbles Very dense Brown		3	SS	97/ 75mm															
			4	SS	87															
232.70																				
3.66	SAND, fine to medium, trace gravel Compact to dense Brown		5	SS	35															
			6	SS	20															
231.33	END OF BOREHOLE																			
5.03	Groundwater encountered at about elev. 233.3m during drilling on July 3, 2008.																			

LDN\_MTO\_01 0711302041.GPJ LDN\_MTO.GDT 10/14/08

**RECORD OF BOREHOLE No 212**

1 OF 1

**METRIC**

PROJECT 07-1130-204-1  
G.W.P. 3950-01-00 LOCATION N 4781174.1 ; E 236542.1 ORIGINATED BY TP  
DIST HWY 403 BOREHOLE TYPE Power Auger (HOLLOW STEM) COMPILED BY BRS  
DATUM GEODETIC DATE July 3, 2008 CHECKED BY

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	× LAB VANE					
235.91	GROUND SURFACE															
0.00	TOPSOIL, sandy, some silt Brown															
0.15																
235.45	SILT, trace sand, trace gravel Brown															
0.46	SAND AND GRAVEL, trace to some silt Very dense Brown		1	SS	90											
			2	SS	66											
233.78																
2.13	SAND, fine to medium , trace to some gravel, trace silt Very dense Brown		3	SS	65											
			4	SS	56											
232.25																
3.66	SAND AND GRAVEL, trace silt Very dense Brown		5	SS	54											
231.49																
4.42	SAND, fine to medium, trace silt Very dense Brown		6	SS	100											
230.12			7	SS	120											
5.79	END OF BOREHOLE															
	Groundwater encountered at about elev. 232.9m during drilling July 3, 2008.															
	Water level measured at elev. 233.52m in standpipe on July 16, 2008.															
	Water level measured at elev. 232.50m in standpipe on July 25, 2008.															

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

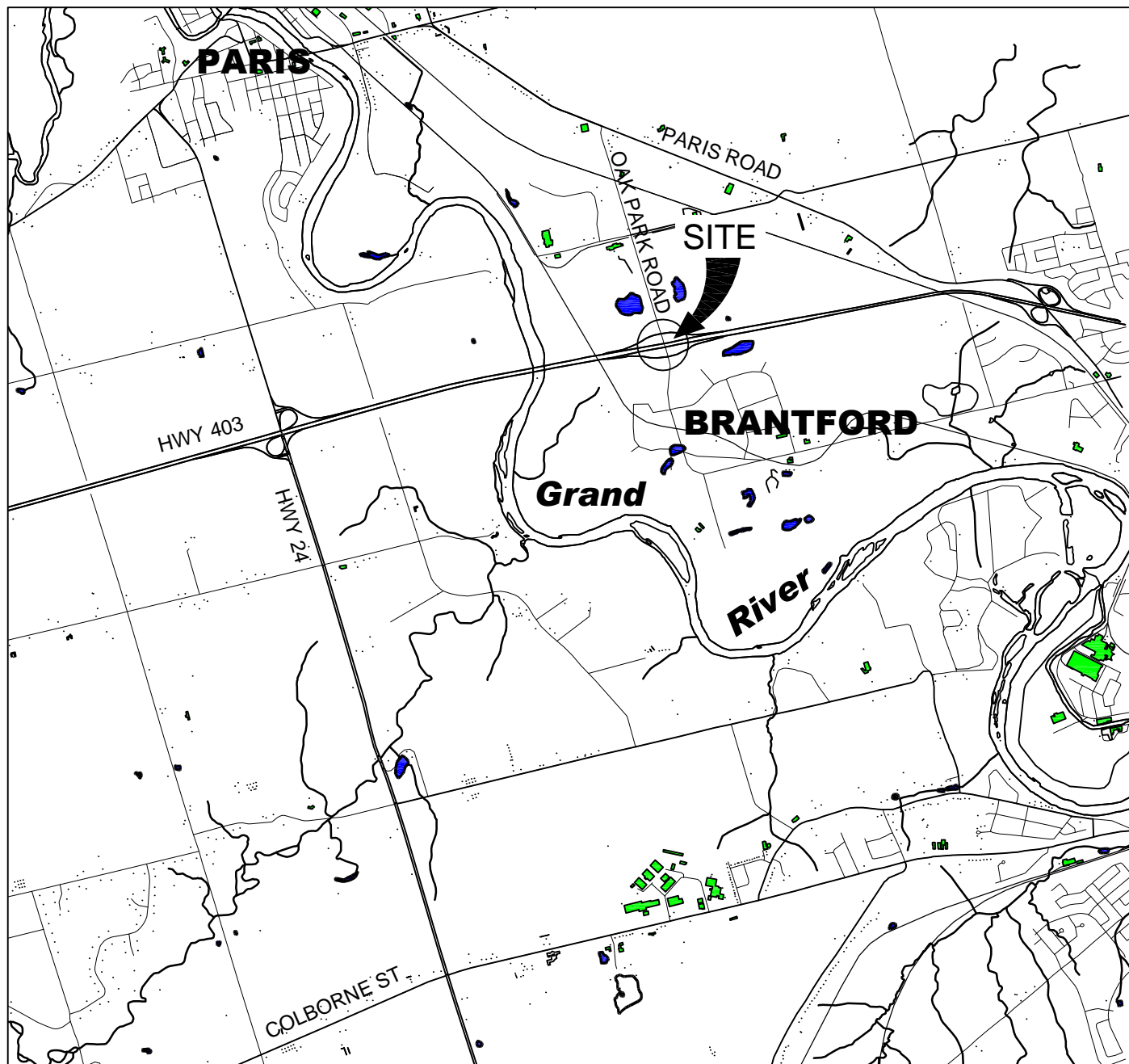
**RECORD OF BOREHOLE No 213**

1 OF 1

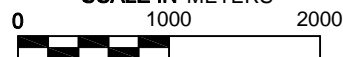
**METRIC**

PROJECT 07-1130-204-1  
G.W.P. 3950-01-00 LOCATION N 4781124.4 ; E 236346.7 ORIGINATED BY TP  
DIST HWY 403 BOREHOLE TYPE Power Auger (HOLLOW STEM) COMPILED BY BRS  
DATUM GEODETIC DATE July 16, 2008 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
234.51	GROUND SURFACE						234	20 40 60 80 100					1 95 (4)	
0.00	TOPSOIL, silty Brown							20 40 60 80 100		10 20 30				
0.12														
233.96	SANDY SILT, trace gravel Brown													
0.55	SAND, fine to medium, trace silt Compact to very dense Brown		1	SS	26									
			2	SS	16		233							
			3	SS	19		232							
			4	SS	19		231							
230.31			5	SS	74									
4.20	SANDY SILT, trace clay, trace to some gravel, (TILL) Very dense Brown						230							
229.69			6	SS	60/100mm									
4.82	END OF BOREHOLE													
	Groundwater encountered at about elev. 233.1m during drilling July 3, 2008.													



SCALE IN METERS



1:50000

PROJECT HIGH FILLS  
HIGHWAY 403 & OAK PARK ROAD INTERCHANGE  
IMPROVEMENTS  
GWP 3950-01-00

TITLE

## KEY PLAN



PROJECT No. 07-1130-204-1

FILE No. 0711302041-F02001

CADD WDF Aug. 29/08

SCALE AS SHOWN REV. 0

FIGURE 1

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

CONT No.  
WP No. 3950-01-00

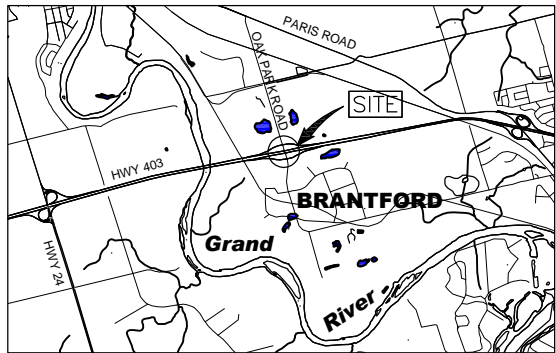


SHEET

**HIGH FILLS**  
HIGHWAY 403 AND OAK PARK ROAD  
INTERCHANGE IMPROVEMENTS  
BOREHOLE LOCATIONS



**Golder Associates Ltd.**  
LONDON, ONTARIO, CANADA



KEY PLAN

SCALE IN KILOMETRES  
0 1 2

LEGEND

Borehole - Current Investigation

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
201	237.56	4 781 416.5	236 658.9
202	236.71	4 781 394.7	236 696.7
203	236.54	4 781 376.3	236 739.4
204	236.20	4 781 364.0	236 793.6
205	235.89	4 781 349.2	236 810.6
206	237.96	4 781 363.6	236 719.3
207	237.62	4 781 302.1	236 746.5
208	241.38	4 781 341.6	236 533.2
209	236.54	4 781 249.1	236 482.2
210	235.22	4 781 223.7	236 434.6
211	236.36	4 781 179.3	236 570.7
212	235.91	4 781 174.1	236 542.1
213	234.51	4 781 124.4	236 346.7

NOTES

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

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

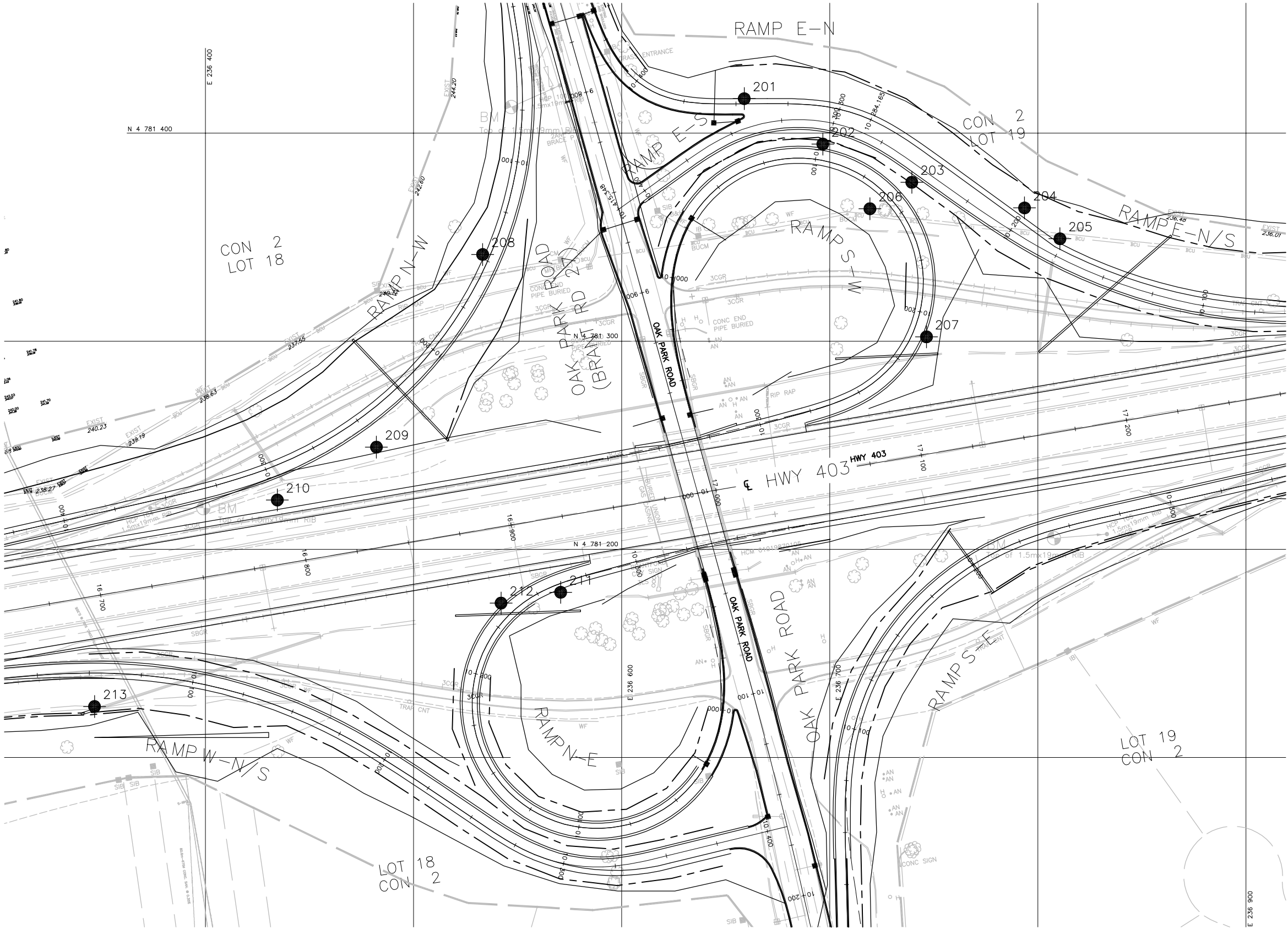
REFERENCE

Base plans provided in digital format by Dillon Consulting Limited.

NO.	DATE	BY	REVISION
Geocres No.	40P1-97		
HWY.	403	PROJECT NO.	07-1130-204-1
SUBM'D.	DUP	CHKD.	DATE: OCT. 8/08
DRAWN:	LMK	CHKD.	APPD.
			DWG. 1

PLAN

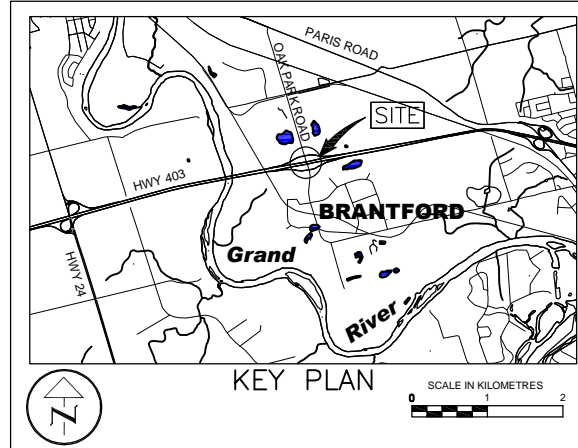
SCALE  
0 20 m



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

CONT No.  
WP No. 3950-01-00

**HIGH FILLS**  
HIGHWAY 403 AND OAK PARK ROAD  
INTERCHANGE IMPROVEMENTS  
SOIL STRATA



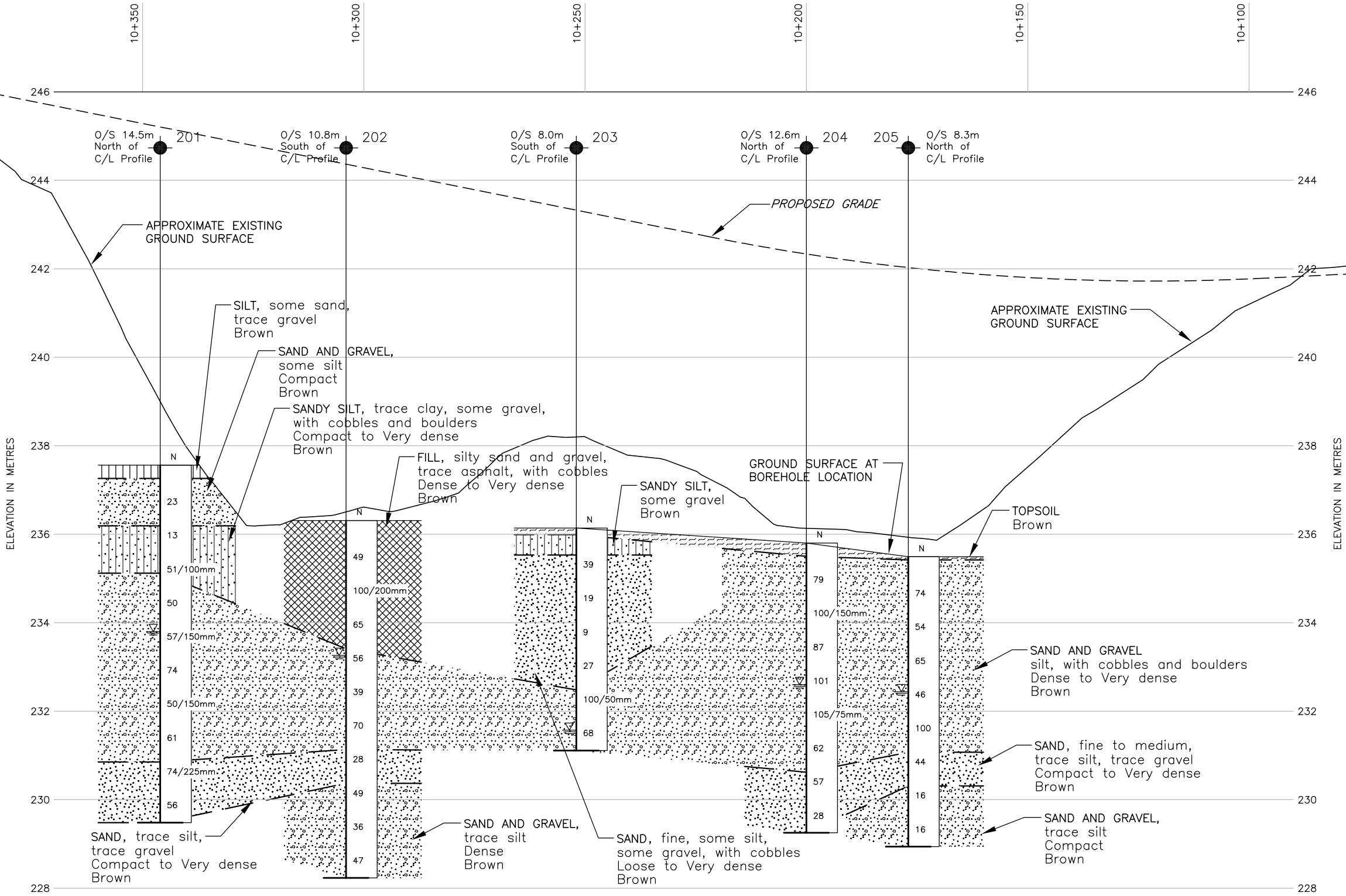
LEGEND			
	Borehole - Current Investigation		
N	Standard Penetration Test Value		
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)		
DRY	Borehole dry during drilling		
	WL upon completion of drilling		
	WL measured July, 2008.		

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
201	237.56	4 781 416.5	236 658.9
202	236.71	4 781 394.7	236 696.7
203	236.54	4 781 376.3	236 739.4
204	236.20	4 781 364.0	236 793.6
205	235.89	4 781 349.2	236 810.6

**NOTES**  
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**REFERENCE**  
Base plans provided in digital format by Dillon Consulting Limited.

Geocres No. 40P1-97			
NO.	DATE	BY	REVISION
HWY.	403	PROJECT NO. 07-1130-204-1	
SUBM'D.	DUP	CHKD.	DATE: OCT. 8/08
DRAWN:	LMK	CHKD.	APPD.
DIST.			SITE: 1-139
DWG.			2



PROFILE ALONG E-N/S RAMP



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

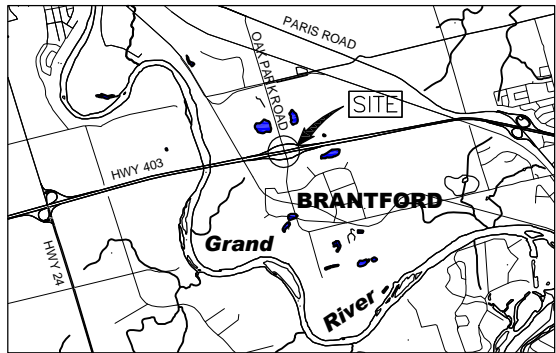
CONT No.  
WP No. 3950-01-00

**HIGH FILLS**  
HIGHWAY 403 AND OAK PARK ROAD  
INTERCHANGE IMPROVEMENTS  
SOIL STRATA

SHEET



**Golder Associates Ltd.**  
LONDON, ONTARIO, CANADA



LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- DRY Borehole dry during drilling
- WL upon completion of drilling
- WL measured July, 2008.
- Seal
- Piezometer

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
202	236.71	4 781 394.7	236 696.7
206	237.96	4 781 363.6	236 719.3
207	237.62	4 781 302.1	236 746.5

NOTES

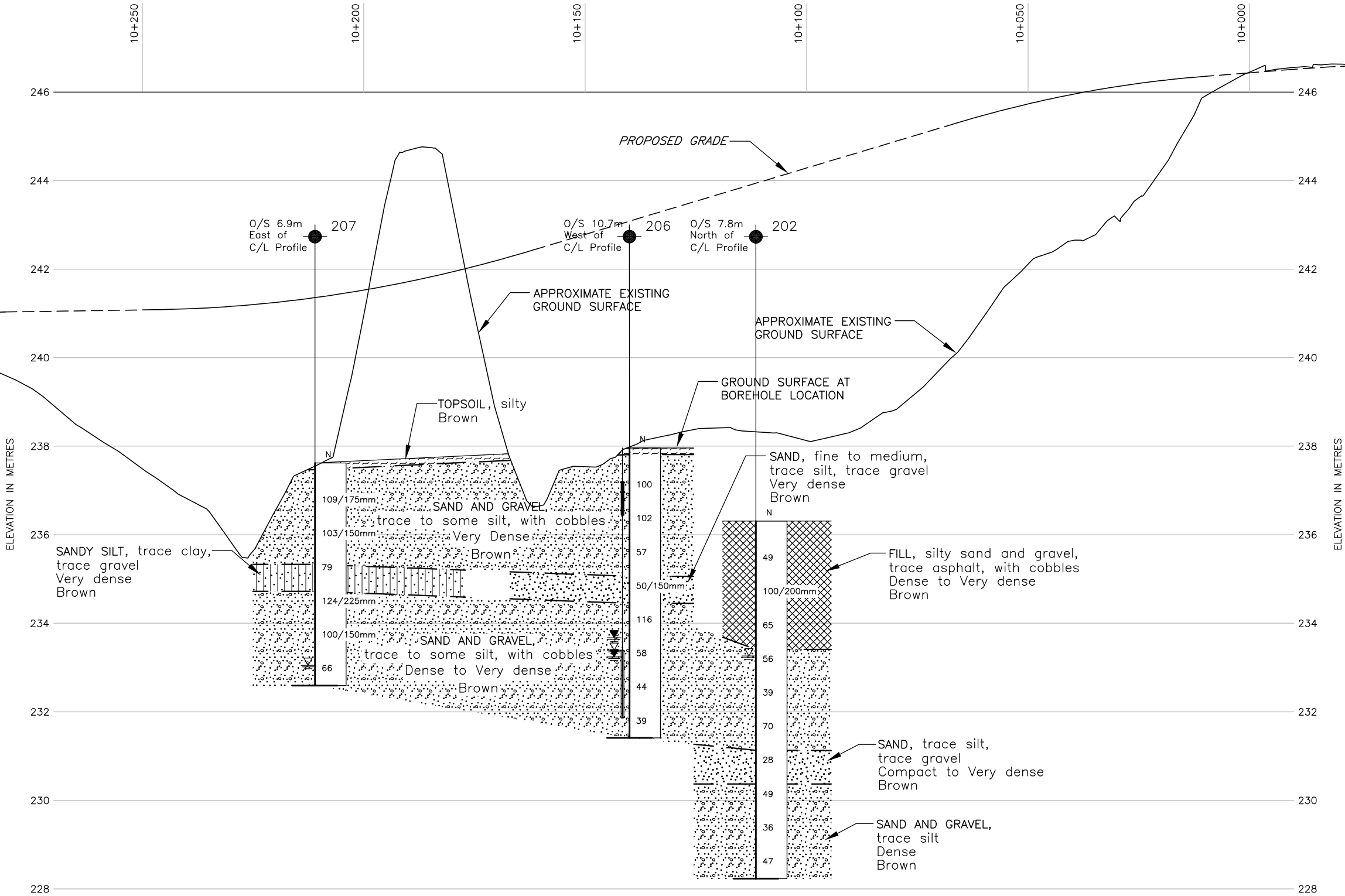
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REFERENCE

Base plans provided in digital format by Dillon Consulting Limited.

NO.	DATE	BY	REVISION
Geocres No.	40P1-97		
HWY.	403	PROJECT NO.	07-1130-204-1
SUBM'D.	DUP	CHKD.	DATE: OCT. 8/08
DRAWN:	LMK	CHKD.	APPD.
			DWG. 3



PROFILE ALONG S-W RAMP



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

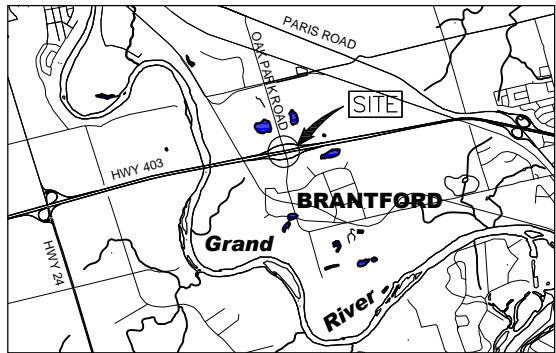
CONT No.  
WP No. 3950-01-00

**HIGH FILLS**  
HIGHWAY 403 AND OAK PARK ROAD  
INTERCHANGE IMPROVEMENTS  
SOIL STRATA

SHEET



**Golder Associates Ltd.**  
LONDON, ONTARIO, CANADA



KEY PLAN

LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- DRY Borehole dry during drilling
- WL upon completion of drilling
- WL measured July, 2008.
- Seal
- Piezometer

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
208	241.38	4 781 341.6	236 533.2
209	236.54	4 781 249.1	236 482.2
210	236.22	4 781 223.7	236 434.6

NOTES

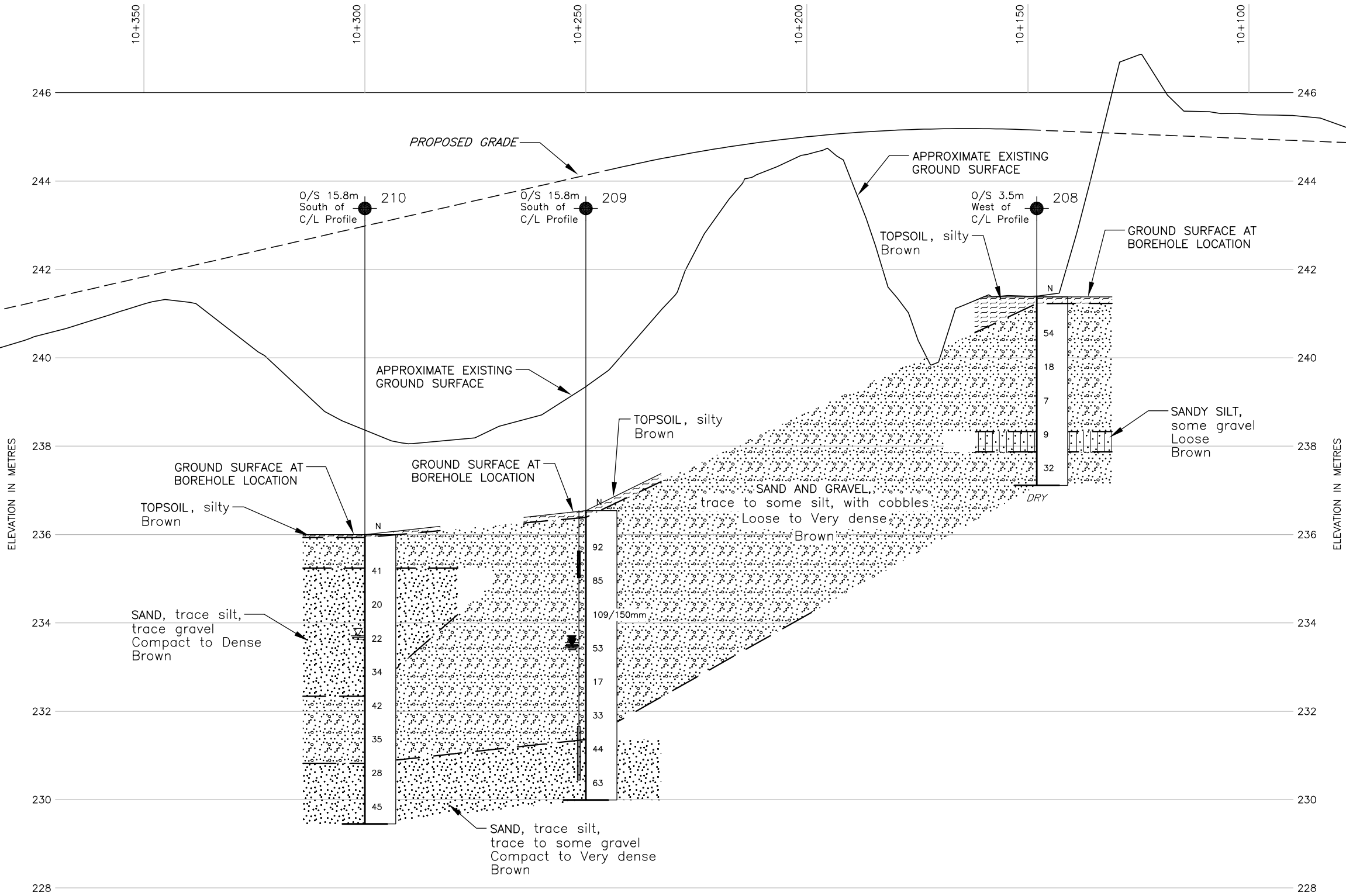
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

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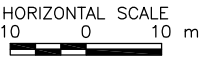
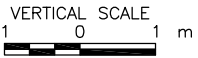
REFERENCE

Base plans provided in digital format by Dillon Consulting Limited.

NO.	DATE	BY	REVISION
Geocres No.	40P1-97		
HWY.	403	PROJECT NO.	07-1130-204-1
SUBM'D.	DUP	CHKD.	DATE: OCT. 8/08
DRAWN:	LMK	CHKD.	APPD.
			DWG. 4



PROFILE ALONG N-W RAMP



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

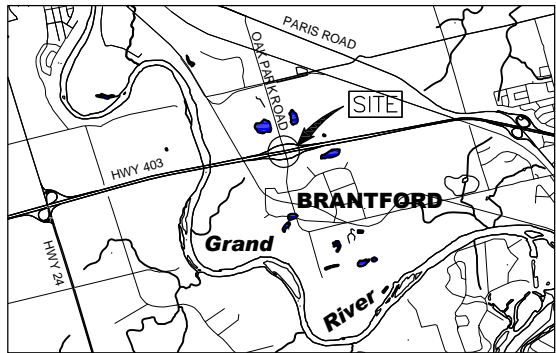
CONT No.  
WP No. 3950-01-00

**HIGH FILLS**  
HIGHWAY 403 AND OAK PARK ROAD  
INTERCHANGE IMPROVEMENTS  
SOIL STRATA

SHEET



**Golder Associates Ltd.**  
LONDON, ONTARIO, CANADA



KEY PLAN

SCALE IN KILOMETRES  
0 1 2

LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- DRY Borehole dry during drilling
- WL upon completion of drilling
- WL measured July, 2008.
- Seal
- Piezometer

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
211	236.36	4 781 179.3	236 570.7
212	235.91	4 781 174.1	236 542.1

NOTES

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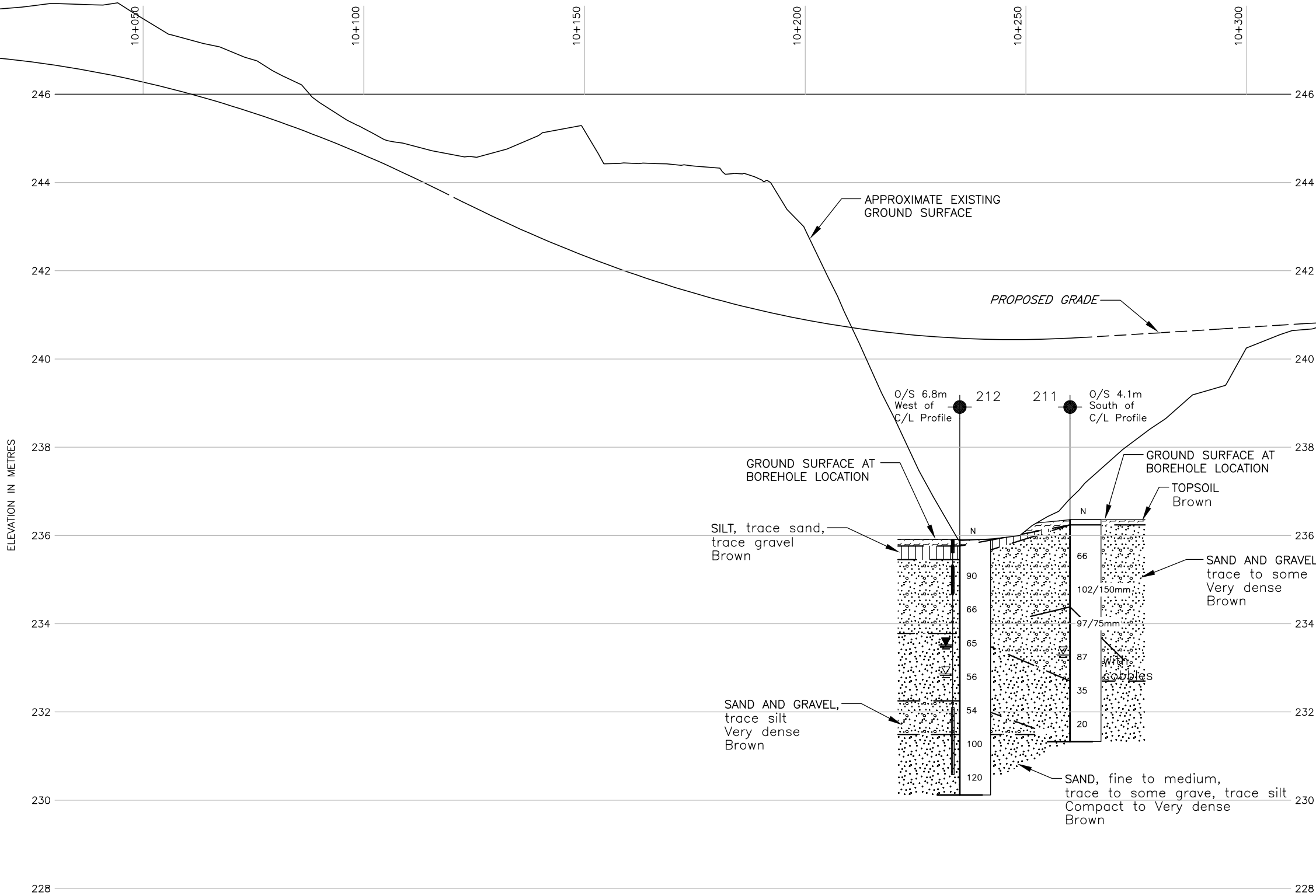
REFERENCE

Base plans provided in digital format by Dillon Consulting Limited.

PROFILE ALONG N-E RAMP

VERTICAL SCALE  
1 0 1 m

HORIZONTAL SCALE  
10 0 10 m

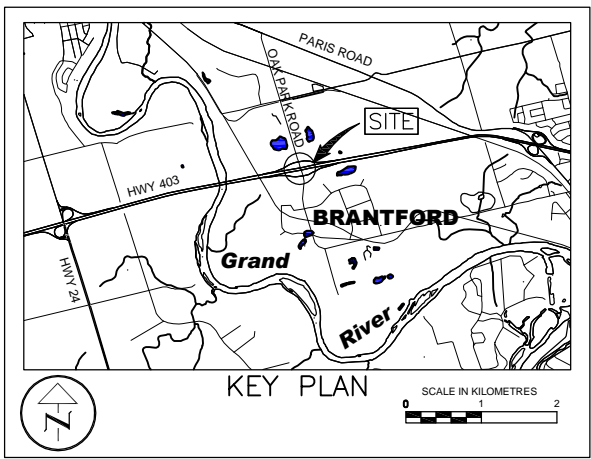


**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.


CONT No.  
WP No. 3950-01-00

HIGH FILLS  
HIGHWAY 403 AND OAK PARK ROAD  
INTERCHANGE IMPROVEMENTS  
SOIL STRATA

 **Golder Associates Ltd.**  
LONDON, ONTARIO, CANADA




LEGEND


 Borehole - Current Investigation

N Standard Penetration Test Value

16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)

DRY Borehole dry during drilling

 WL upon completion of drilling

 WL measured July, 2008.

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
213	234.51	4 781 124.4	236 346.7

**NOTES**

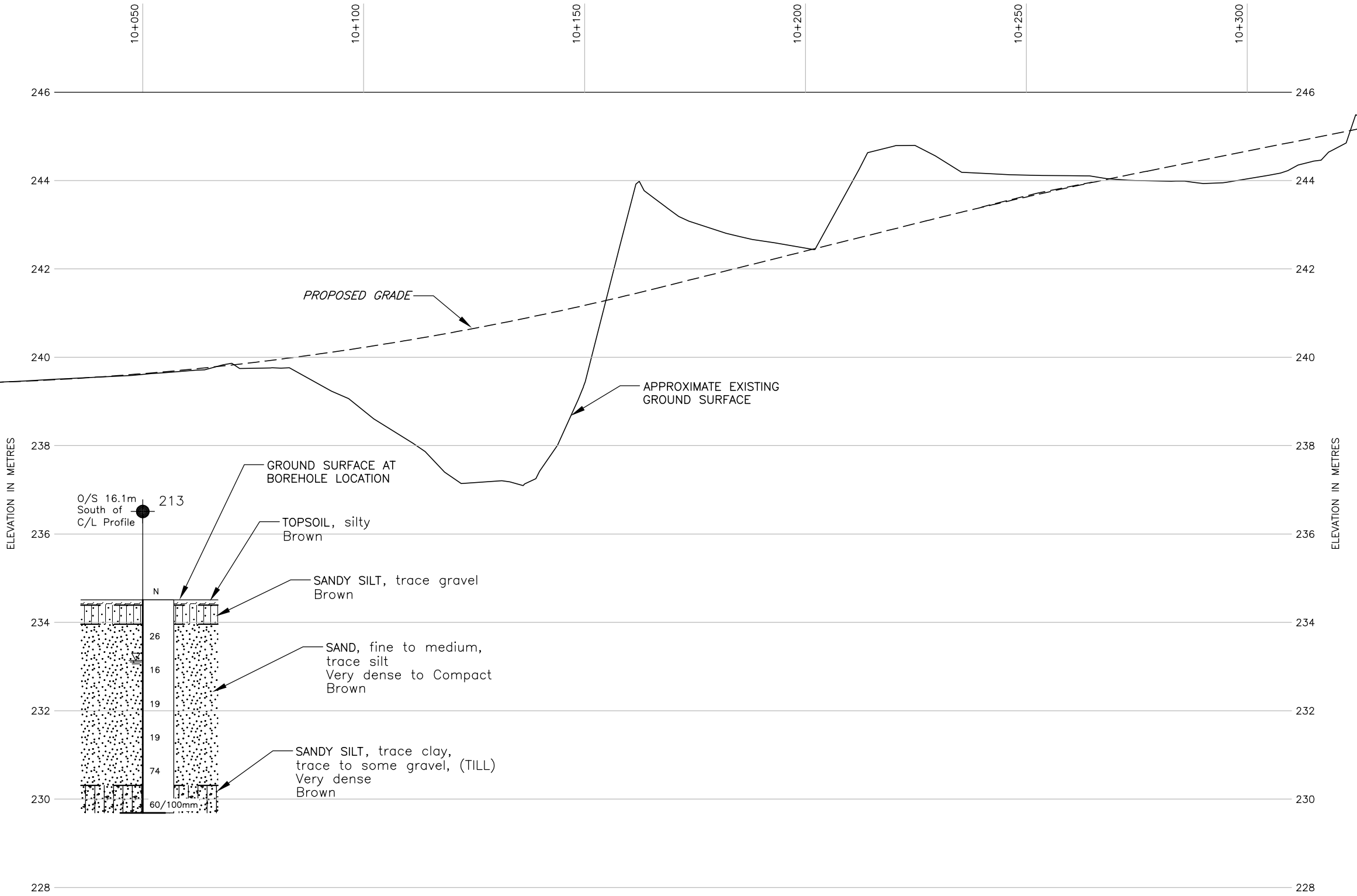
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

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

**REFERENCE**

Base plans provided in digital format by Dillon Consulting Limited.

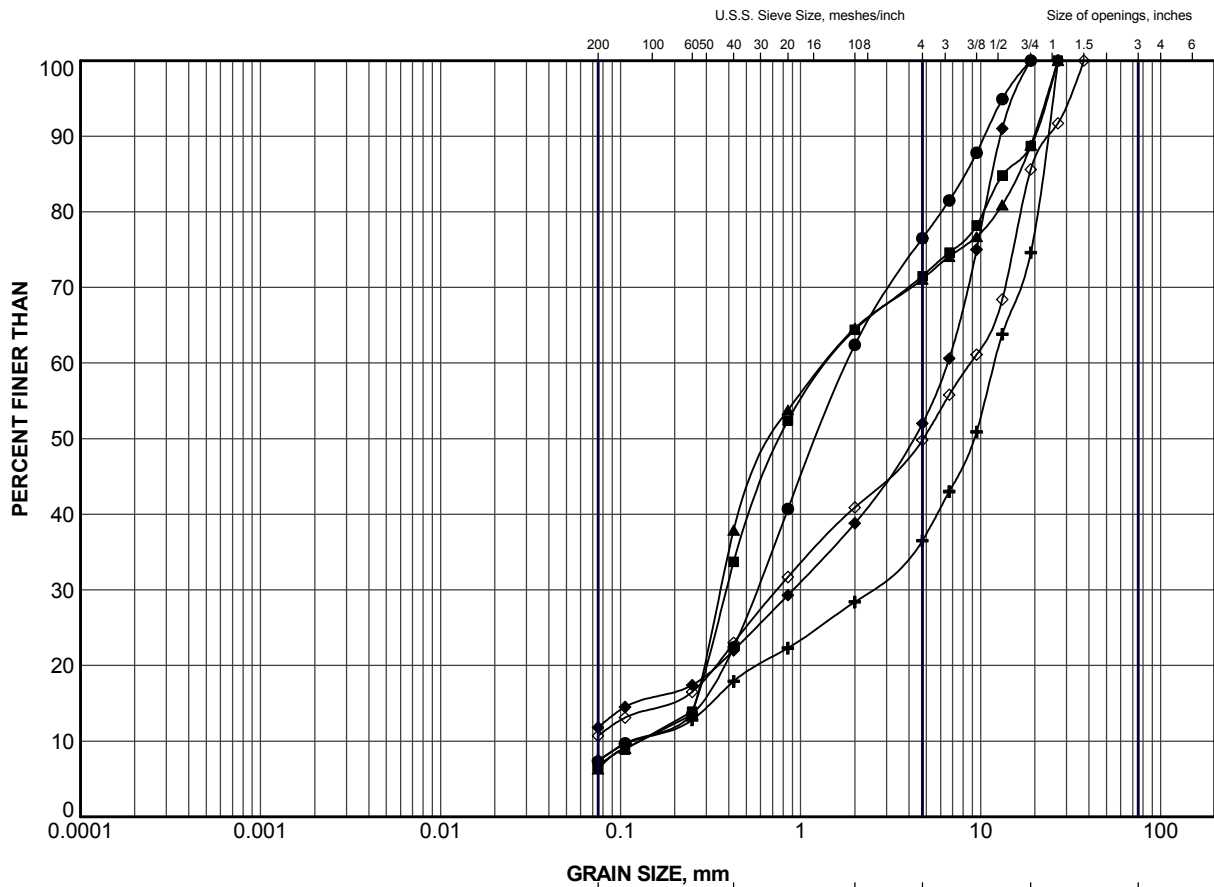
NO.	DATE	BY	REVISION
Geocres No. 40P1-97			
HWY.	403	PROJECT NO.	07-1130-204-1 DIST.
SUBM'D.	DUP	CHKD.	DATE: OCT. 8/08 SITE: 1-139
DRAWN:	LMK	CHKD.	APPD. DWG. 6



PROFILE ALONG W-N/S RAMP



**APPENDIX A**  
**LABORATORY TEST DATA**

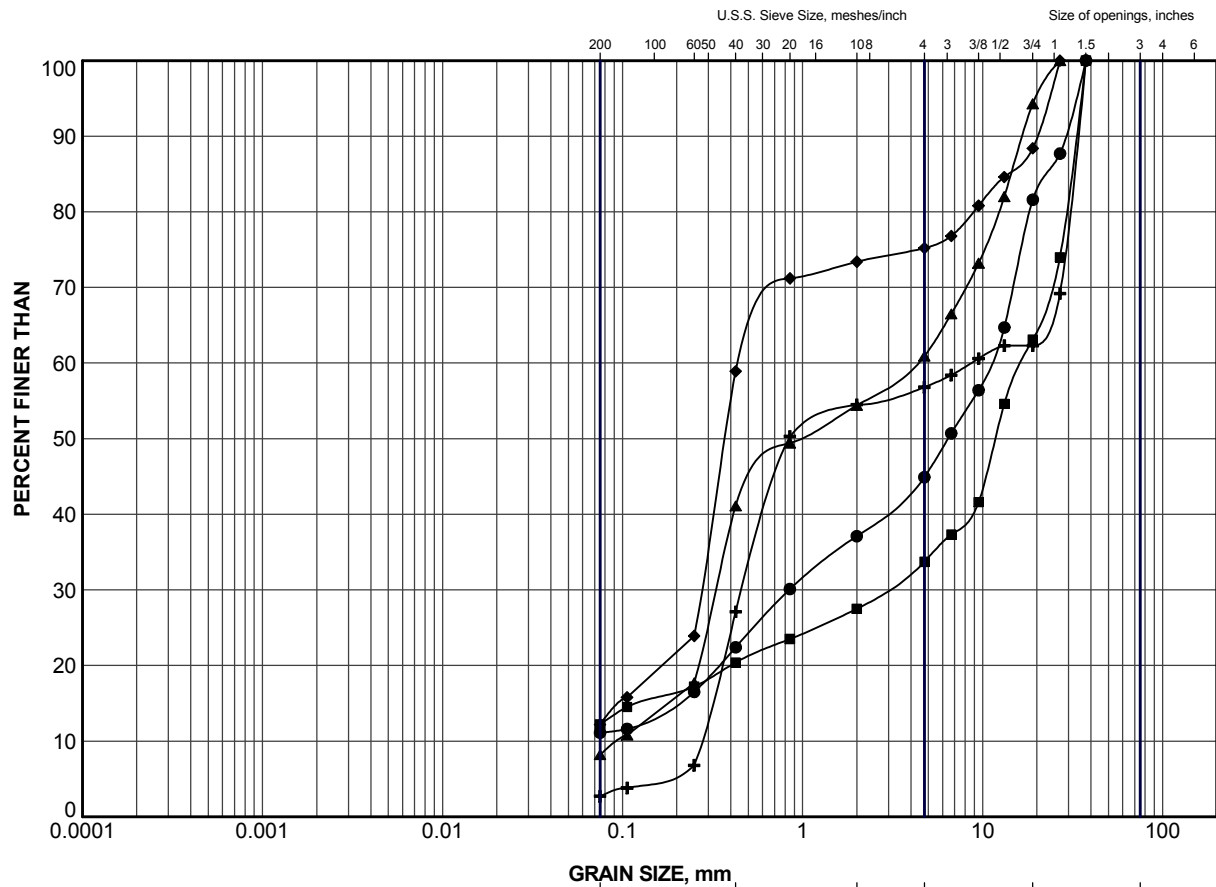


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	201	6	232.8
■	202	6	231.9
▲	202	9	229.6
+	204	3	233.7
◆	205	2	234.1
◇	205	5	231.9

PROJECT		HIGH FILLS HIGHWAY 403 & OAK PARK ROAD INTERCHANGE IMPROVEMENTS GWP 3950-01-00			
TITLE		GRAIN SIZE DISTRIBUTION SAND and GRAVEL			
PROJECT No.		07-1130-204-1		FILE No. 0711302041-R020A1	
DRAWN		LMK		Aug 29/08	
CHECK					
Golder Associates LONDON, ONTARIO		SCALE N/A REV.			
		FIGURE A-1			

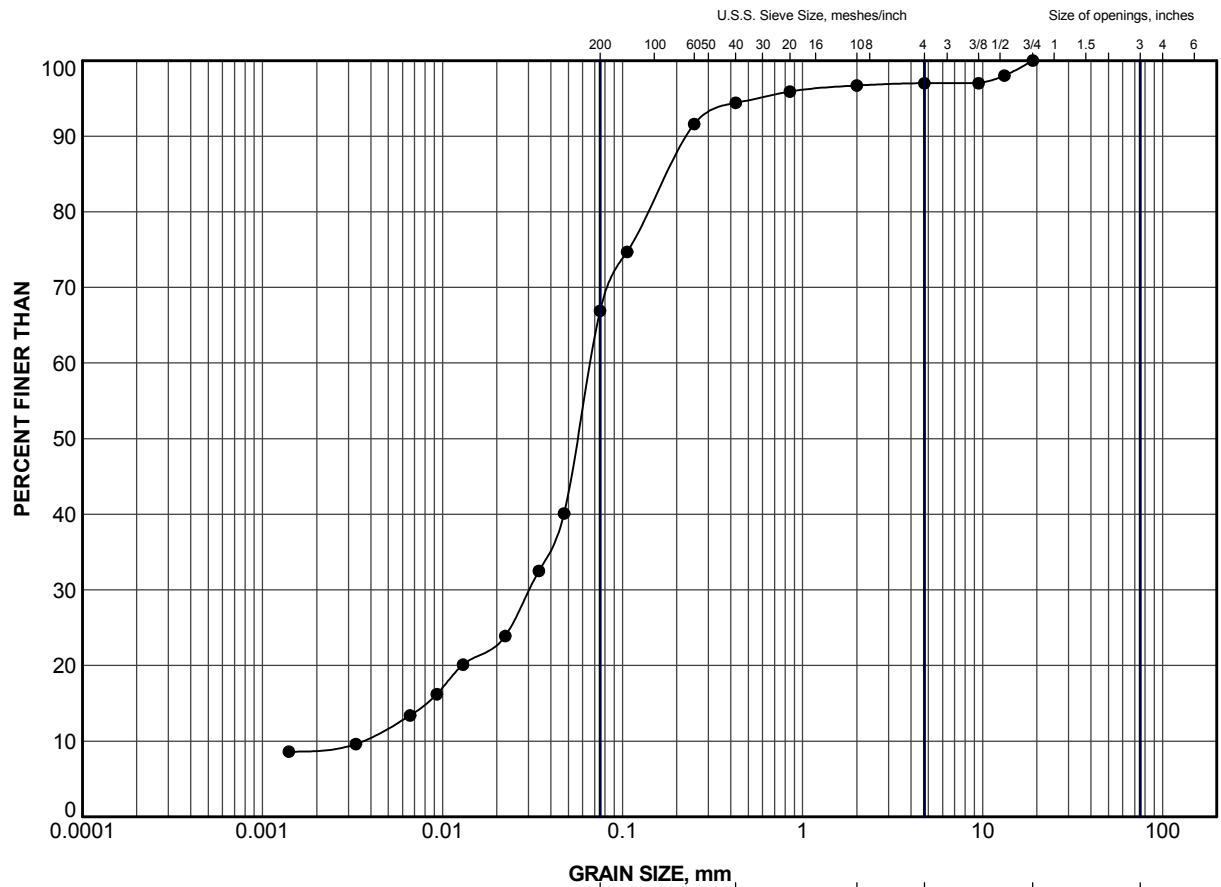


CLAY AND SILT	SAND SIZE, mm			GRAVEL SIZE, mm		Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	206	5	233.9
■	208	1	240.4
▲	209	4	233.3
+	210	5	231.2
◆	212	2	234.2

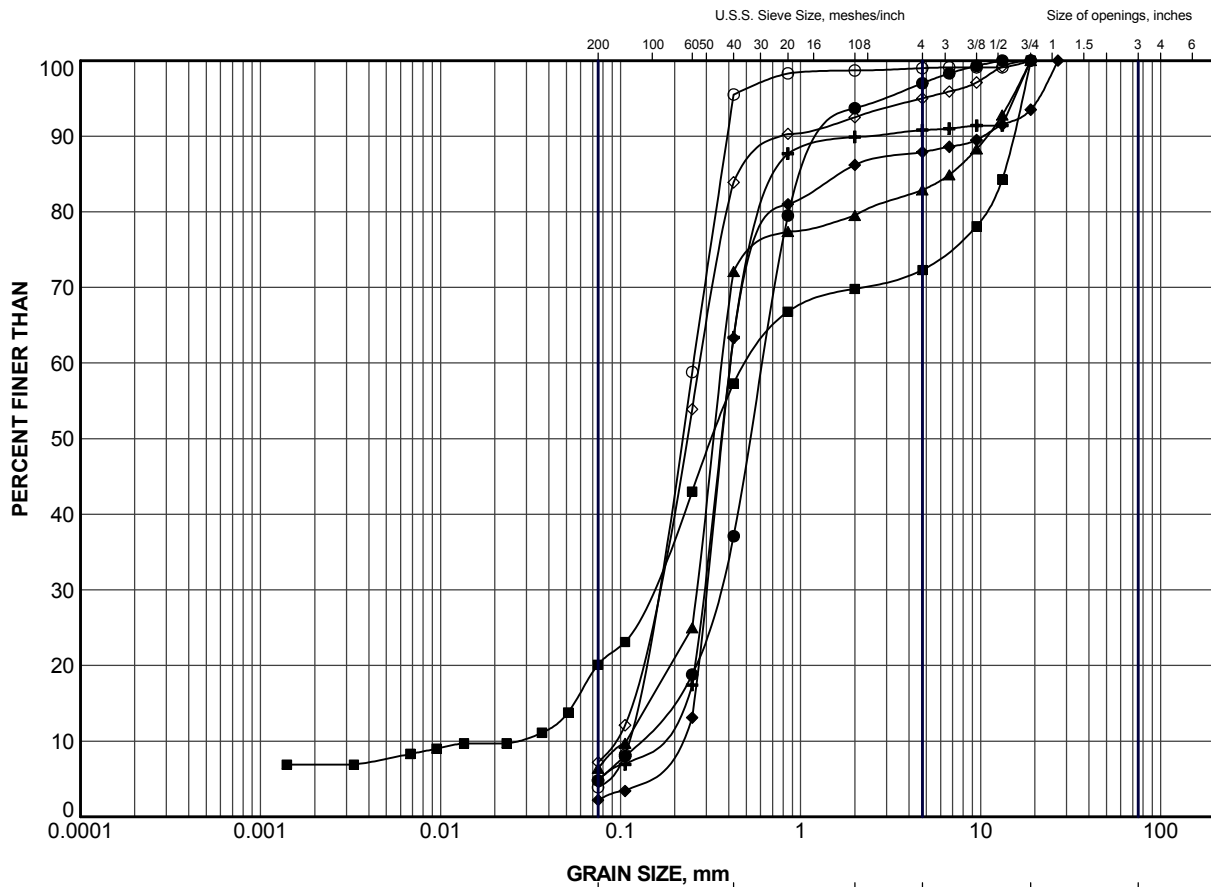
PROJECT		HIGH FILLS HIGHWAY 403 & OAK PARK ROAD INTERCHANGE IMPROVEMENTS GWP 3950-01-00			
TITLE		<b>GRAIN SIZE DISTRIBUTION</b> <b>SAND and GRAVEL</b>			
PROJECT No.		07-1130-204-1		FILE No. 0711302041-R020A2	
DRAWN		LMK		Aug 29/08	
CHECK					
 <b>Golder Associates</b> LONDON, ONTARIO		<b>FIGURE A-2</b>			



CLAY AND SILT		SAND SIZE			GRAVEL SIZE		Cobble Size
		fine	medium	coarse	fine	coarse	

LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	207	3	235.1

PROJECT		HIGH FILLS HIGHWAY 403 & OAK PARK ROAD INTERCHANGE IMPROVEMENTS GWP 3950-01-00			
TITLE		<b>GRAIN SIZE DISTRIBUTION</b> <b>SANDY SILT</b>			
 <b>Golder Associates</b> LONDON, ONTARIO	PROJECT No.	07-1130-204-1	FILE No.	0711302041-R020A3	
	DRAWN	LMK	Aug 29/08	SCALE	N/A
	CHECK			REV.	
				<b>FIGURE A-3</b>	



GRAVEL SIZE, mm						Cobble Size
CLAY AND SILT	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	201	9	230.5
■	203	3	234.0
▲	209	7	231.0
+	210	2	233.5
◆	211	5	232.3
◇	212	6	231.1
○	213	3	232.0

PROJECT		HIGH FILLS HIGHWAY 403 & OAK PARK ROAD INTERCHANGE IMPROVEMENTS GWP 3950-01-00			
TITLE		GRAIN SIZE DISTRIBUTION SAND			
PROJECT No.		07-1130-204-1		FILE No. 0711302041-R020A4	
DRAWN		LMK		Aug 29/08	
CHECK					
Golder Associates LONDON, ONTARIO		SCALE N/A REV.			
		FIGURE A-4			

**APPENDIX B**  
**SITE PHOTOGRAPHS**

**SITE PHOTOGRAPHS**  
**GWP 3950-01-00**



Photo 1 – W-N/S ramp – looking east



Photo 2 – N/S-E ramp – looking east