

**FOUNDATION INVESTIGATION AND DESIGN REPORT  
OVERHEAD AND VARIABLE MESSAGE SIGNS  
HIGHWAY 417 WIDENING  
NICHOLAS STREET TO O.R.174  
OTTAWA, ONTARIO  
G.W.P. 4091-07-00 and 4320-06-00**

**Geocres Number: 31G5-249**

**Report to**

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**PART 1: FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the factual findings from a foundation investigation conducted in Ottawa, Ontario, at the location of eighteen proposed Overhead Signs (OHS) and five proposed Variable Message Signs (VMS) to be installed along Highway 417, between Parkdale Avenue and Walkley Road, and along O.R.174, between Highway 417-O.R.174 Interchange and east of Blair Road. These proposed signs are associated with the proposed widening works of Highway 417 between Nicholas Street and O.R.174.

The purpose of this investigation was to determine the subsurface conditions at the proposed OHS and VMS locations and, based on this data, to provide borehole location drawings, records of boreholes, laboratory test results and a written description of the subsurface conditions.

The locations of these twenty three OHSs and VMSs were defined by McCormick Rankin Corporation (MRC) between November 8, 2011 and April 5, 2012. Four of the proposed signs are located between Nicholas Street and Riverside Drive and eleven of the signs are located between Riverside Drive and O.R. 174. There are three signs proposed between the Highway 417 – O.R.174 Interchange to east of Blair Road and four signs proposed between the interchange and Walkley Road. One of the proposed signs is located between Parkdale Avenue and Nicholas Street, near Bayswater Avenue.

Fifteen of the proposed OHSs will be double vertical support signs requiring two separate foundations while three of the proposed OHSs will be single vertical support signs requiring a single foundation. All five proposed VMSs will be double vertical support signs.

Thurber carried out the investigation as a sub-consultant to MRC, under the Ministry of Transportation Ontario (MTO) Agreement No. 4009-E-0007.

## **2 SITE DESCRIPTION**

The existing Highway 417 is a three to four lane divided highway. The widening of Highway 417 from Nicholas Street to O.R.174 includes the installation of new signs (OHS and VMS) along Highway 417, from Nicholas Street to Walkley Road, and along the westbound lane of O.R.174, from the Highway 417-O.R.174 Interchange to east of Blair Road. One VMS is proposed between Parkdale Avenue and Nicholas Street, near Bayswater Avenue, and is located beyond the extent of the Highway 417 widening works.

The proposed OHS and VMS are generally located within the main project area of widening works. The signs are proposed along approximately 10.8 km of roadway, comprising Highway 417 and O.R.174, with the exception of VMS-1, which is located west of the main project area. For reporting purposes, the site has been divided into the following five sub-sections:

1. Highway 417 from Nicholas Street to Riverside Drive (GWP 4091-07-00)
2. Highway 417 from Riverside Drive to O.R.174 (GWP 4320-06-00)
3. O.R.174 from Highway 417-O.R.174 Interchange to East of Blair Road
4. Highway 417 from Highway 417-O.R.174 Interchange to Walkley Road
5. Highway 417 from Parkdale to Nicholas Street, near Bayswater Avenue

The lands along Highway 417 between Nicholas Street and O.R.174 primarily comprise commercial and industrial developments. Along the rest of the site, the lands comprise mainly of residential and undeveloped parklands.

The site lies within the Ottawa Valley Clay Plains physiographic region, a clay plains interrupted by ridges of sand or rock. Between Nicholas Street and O.R.174, the bedrock consists of the Carlsbad Formation, comprising dark grey shale interbedded with calcareous siltstone and limestone. Along O.R.174 to the east of the Highway 417 interchange, the bedrock consists of the Billings Formation, a dark brown to black shale with laminations of calcareous siltstone. Near the Bayswater Avenue location, the bedrock consists of limestone of the Lindsay Formation.

### 3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing at the proposed OHS and VMS locations were carried out between February 6 and May 4, 2012. One borehole was drilled in the proximity of each proposed OHS and VMS foundation location, totalling forty-three (43) boreholes. These boreholes are identified as OHS-01L and OHS-01R to OHS-18; the suffix 'L' indicates the left vertical support foundation and the suffix 'R' indicates the right vertical support foundation. Where there are no suffixes on the borehole identification, this indicates a single vertical support foundation. The same identification scheme was applied to the boreholes for VMSs.

A summary of the proposed signs and the relevant boreholes is presented in Table 3.1, below. The Record of Borehole Sheets and laboratory test results for the boreholes drilled at the proposed sign locations are included in Appendices A through E.

The approximate locations of the boreholes are shown on the drawings included in Appendix G.

**Table 3.1 – Proposed Sign Locations**

Location	Signs	Relevant Boreholes	Appendix
Highway 417: Nicholas Street to Riverside Drive	OHS-1 OHS-2 OHS-3 OHS-4	OHS-01L & OHS-01R OHS-02L & OHS-02R OHS-03L & OHS-03R OHS-04L & OHS-04R	A
Highway 417: Riverside Drive to O.R.174	OHS-5 OHS-6 OHS-7 OHS-8 OHS-9 OHS-10 OHS-11 OHS-12 OHS-13 VMS-2 VMS-3	OHS-05L & OHS-05R OHS-06L & OHS-06R OHS-07L & OHS-07R OHS-08L & OHS-08R OHS-09L & OHS-09R OHS-10L & OHS-10R OHS-11L & OHS-11R OHS-12L & OHS-12R OHS-13 VMS-2L & VMS-2R VMS-3L & VMS-3R	B
O.R.174: Hwy 417-O.R.174 Interchange to east of Blair Road	OHS-14 OHS-18 VMS-5	OHS-14L & OHS-14R OHS-18 VMS-5L & VMS-5R	C
Highway 417: Hwy 417-O.R.174 Interchange to Walkley Road	OHS-15 OHS-16 OHS-17 VMS-4	OHS-15L & OHS-15R OHS-16L & OHS-16R OHS-17 VMS-4L & VMS-4R	D
Highway 417: Parkdale Avenue to Nicholas Street, near Bayswater Avenue	VMS-1	VMS-1L & VMS-1R	E

During the course of our investigation eight of the boreholes were relocated from the proposed locations due to the presence of existing utilities. A list of these relocated boreholes is presented below along with the existing utility which obstructed the drilling. This list is for reference only and valid utility locates will be required at the time of construction. It must be noted that the ground elevation and subsurface conditions may vary between the sign and borehole locations.

**Table 3.2 – Relocated Boreholes due to Existing Utilities Obstructing Drilling**

<b>Relocated Boreholes</b>	<b>Distance Relocated (m)</b>	<b>Existing Utility Obstructing Drilling</b>
OHS-03L	6m north	Enbridge Gas Main
OHS-04R	4m north	MTO Storm Sewer
VMS-02R	2m south	MTO Electrical
OHS-05R	2m east	City of Ottawa Electrical
OHS-06L	5.5m east, 1m south	Deep ditch
OHS-07L	12m south	Deep ditch
OHS-10L	5m south	City of Ottawa water main
OHS-13	2m north	Culvert

The forty-three boreholes were drilled to depths of 4.2 m to 7.6 m. Bedrock was encountered in twenty-five of the forty-three boreholes drilled for OHSs and VMSs foundations. Of these twenty-five boreholes, bedrock was proven by coring in twelve boreholes, bedrock was penetrated with augers in five boreholes, and eight boreholes were terminated in shale or on probable bedrock encountered at or below the programmed depth of exploration. Where bedrock was proven by coring, 2.6 m to 3.3 m of bedrock was cored. In the five boreholes penetrating bedrock without coring, augers were used to advance the boreholes the final 1.0 m to 2.4 m to the programmed depth in consideration of the highly weathered nature of the bedrock and lane closure timing restrictions.

The borehole locations were marked in the field by MMM Group and utility clearances were obtained by Underground Service Locators (USL) prior to commencement of drilling operations.

The drilling was carried out using both track-mounted and truck-mounted drill rigs. A combination of hollow-stem auger drilling techniques and NQ coring methods were used to advance the boreholes. Overburden samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). All rock cores were logged, and the Total Core Recovery

(TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil and bedrock samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions observed in the open boreholes during the drilling operations were recorded. Standpipe piezometers consisting of 19 mm diameter PVC pipe with slotted screen were installed in fifteen selected boreholes for long term monitoring of groundwater levels. The installation details of the piezometers along with the backfill details for the boreholes without a piezometer installation are summarised in Table 3.3. Following the final water level reading, the piezometers will be decommissioned in general accordance with MOE Regulation 903.

**Table 3.3 – Piezometer Installation and Borehole Completion Details**

<b>Borehole Number</b>	<b>Piezometer Tip Depth / Elevation (m)</b>	<b>Completion Details</b>
OHS-01L	5.4 / 55.6	Backfilled with gravel from core barrel from 6.3 m to 5.4 m. Filter sand from 5.4 m to 2.4 m, bentonite from 2.4 m to 1.8 m, then cuttings to surface.
OHS-01R	None Installed	Backfilled with bentonite holeplug from 6.7 m to 2.1 m, cuttings from 2.1 m to 0.15 m, then asphalt to surface.
OHS-02L	None Installed	Backfilled with bentonite holeplug from 6.7 m to 2.4 m, cuttings from 2.4 m to 0.15 m, then asphalt to surface.
OHS-02R	6.7 / 53.0	Filter sand from 6.7 m to 4.3 m, bentonite from 4.3 m to 3.4 m, cuttings from 3.4 m to 1.2 m, then holeplug to surface.
OHS-03L	6.1 / 54.1	Filter sand from 6.1 m to 3.4 m, bentonite from 3.4 m to 2.7 m, holeplug and cuttings from 2.7 m to 0.6 m, then sand to surface.
OHS-03R	None Installed	Backfilled with bentonite holeplug from 6.5 m to 2.4 m, cuttings from 2.4 m to 0.15 m, then asphalt to surface.
OHS-04L	None Installed	Backfilled with bentonite holeplug from 6.7 m to 2.7 m, cuttings from 2.7 m to 0.15 m, then asphalt to surface.
OHS-04R	5.7 / 54.4	Filter sand from 5.5 m to 3.4 m, bentonite holeplug from 3.4 m to 0.6 m, then cuttings to surface
OHS-05L	None Installed	Backfilled with bentonite holeplug from 5.3 m to 0.8 m, concrete from 0.8 m to 0.15 m, then asphalt

<b>Borehole Number</b>	<b>Piezometer Tip Depth / Elevation (m)</b>	<b>Completion Details</b>
		to surface.
OHS-05R	None Installed	Backfilled with bentonite holeplug from 4.5 m to 0.1 m, then asphalt to surface.
OHS-06L	6.1 / 56.6	Filter sand from 6.1 m to 5.3 m, bentonite holeplug from 5.3 m to 2.7 m, cuttings from 2.7 m to 0.9 m, then holeplug to surface.
OHS-06R	7.6 / 55.3	Filter sand from 7.6 m to 5.8 m, bentonite holeplug from 5.8 m to 3.2 m, cuttings from 3.2 m to 0.3 m, then holeplug to surface.
OHS-07L	6.1 / 54.8	Filter sand from 6.1 m to 4.3 m, bentonite holeplug from 4.3 m to 3.4 m, cuttings from 3.4 m to 0.3 m, sand from 0.3 m to 0.15 m, then asphalt to surface.
OHS-07R	None Installed	Backfilled with bentonite holeplug from 6.1 m to 0.1 m, then asphalt to surface.
OHS-08L	None Installed	Backfilled with bentonite holeplug from 6.1 m to 1.8 m, cuttings from 1.8 m to 0.15 m, then asphalt to surface.
OHS-08R	None Installed	Backfilled with bentonite holeplug from 6.2 m to 0.15 m, then asphalt to surface.
OHS-09L	None Installed	Backfilled with bentonite holeplug to 2.1 m, cuttings from 2.1 m to 0.15 m, then asphalt to surface.
OHS-09R	3.1 / 66.1	Backfilled with bentonite from 6.3 m to 3.1 m. Filter sand from 3.1 m to 1.2 m, bentonite holeplug from 1.2 m to 0.6 m, then sand to surface.
OHS-10L	None Installed	Backfilled with bentonite holeplug to 3.0 m, cuttings from 3.0 m to 0.15 m, then asphalt to surface.
OHS-10R	3.1 / 64.7	Backfilled with bentonite from 6.1 m to 3.1 m. Filter sand from 3.1 m to 1.2 m, bentonite holeplug from 1.2 m to 0.6 m, then sand to surface.
OHS-11L	None Installed	Backfilled with bentonite holeplug from 6.1 m to 1.2 m, cuttings from 1.2 m to 0.15 m, then asphalt to surface.
OHS-11R	None Installed	Backfilled with bentonite holeplug from 6.4 m to 0.9 m, cuttings from 0.9 m to 0.15 m, then asphalt to surface.
OHS-12L	None Installed	Backfilled with bentonite holeplug from 6.1 m to 2.3 m, cuttings from 2.3 m to 0.15 m, then asphalt to surface.
OHS-12R	6.3 / 65.4	Filter sand from 6.3 m to 3.8 m, bentonite holeplug from 3.8 m to 1.5 m, cuttings from 1.5 m to 0.6 m,

<b>Borehole Number</b>	<b>Piezometer Tip Depth / Elevation (m)</b>	<b>Completion Details</b>
		then holeplug to surface.
OHS-13	None Installed	Backfilled with bentonite holeplug from 6.1 m to 1.5 m, then cuttings to surface.
OHS-14L	None Installed	Borehole sloughed from 6.2m to 2.1 m. Backfilled with bentonite holeplug from 2.1 m to surface.
OHS-14R	6.1 / 62.1	Slough from 6.2 m to 2.4 m, bentonite holeplug from 2.4 m to 0.3 m, then sand to surface.
OHS-15L	None Installed	Backfilled with bentonite holeplug from 6.7 m to 2.1 m, cuttings from 2.1 m to 0.15 m, then asphalt to surface.
OHS-15R	None Installed	Backfilled with bentonite holeplug from 6.7 m to 2.1 m, cuttings from 2.1 m to 0.15 m, then asphalt to surface.
OHS-16L	None Installed	Backfilled with bentonite holeplug from 6.7 m to 2.4 m, cuttings from 2.4 m to 0.15 m, then asphalt to surface.
OHS-16R	6.4 / 66.9	Filter sand from 6.4 m to 4.9 m, then cuttings to surface.
OHS-17	None Installed	Backfilled with bentonite holeplug from 6.7 m to 2.7 m, then cuttings from 2.7 m to surface.
OHS-18	3.1 / 68.2	Backfilled with bentonite from 6.3 m to 3.1 m. Filter sand from 3.1 m to 1.2 m, bentonite holeplug from 1.2 m to 0.6 m, then sand to surface.
VMS-1L	None Installed	Backfilled with bentonite holeplug from 6.7 m to 0.3 m, concrete from 0.3 m to 0.15 m, then asphalt to surface.
VMS-1R	None Installed	Backfilled with bentonite holeplug from 6.7 m to 0.3 m, concrete from 0.3 m to 0.15 m, then asphalt to surface.
VMS-2L	None Installed	Backfilled with bentonite holeplug from 5.5 m to 1.2 m, cuttings from 1.2 m to 0.15 m, then asphalt to surface.
VMS-2R	None Installed	Backfilled with bentonite holeplug from 5.9 m to 1.1 m, then cuttings to surface.
VMS-3L	None Installed	Backfilled with bentonite holeplug from 4.2 m to 0.9 m, cuttings from 0.9 m to 0.15 m, then asphalt to surface.
VMS-3R	None Installed	Backfilled with bentonite holeplug from 4.8 m to 0.15 m, then asphalt to surface.
VMS-4L	None Installed	Backfilled with bentonite holeplug from 6.7 m to 1.5 m, then cuttings to surface.

<b>Borehole Number</b>	<b>Piezometer Tip Depth / Elevation (m)</b>	<b>Completion Details</b>
VMS-4R	5.5 / 60.0	Slough from 6.7 m to 5.2 m. Filter sand from 5.2 m to 4.6 m, then cuttings to surface.
VMS-5L	6.7 / 62.8	Slough from 7.0 m to 6.7 m. Filter sand from 6.7 m to 4.3 m, bentonite holeplug from 4.3 m to 3.7 m, cuttings from 3.7 m to 0.9 m, then holeplug to surface.
VMS-5R	None Installed	Backfilled with cuttings from 7.0 m to 1.5 m, bentonite holeplug from 1.5 m to 0.3 m, then sand to surface.

#### **4 LABORATORY TESTING**

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing, where appropriate. The results of these tests are presented on the Record of Borehole Sheets included in Appendices A to E.

Point load tests were carried out on selected samples of intact bedrock core to assist in evaluation of the unconfined compressive strength (UCS) of the bedrock. Results of the point load tests are included as average UCS per core run on the Record of Borehole Sheets in Appendices A to E.

#### **5 DESCRIPTION OF SUBSURFACE CONDITIONS**

Reference is made to the Record of Borehole Sheets included in Appendices A to E. Descriptions of the stratigraphy encountered in the boreholes drilled along Highway 417, from Nicholas Street to Walkley Road, and along O.R.174, from Highway 417 to east of Blair Road, are given in the following paragraphs. A brief description of the stratigraphy encountered near Bayswater Avenue on Highway 417, between Parkdale and Nicholas Street, is also included. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

##### **5.1 HWY 417 from Nicholas Street to Riverside Drive (Boreholes OHS-01L/01R, 02L/02R, 03L/03R, 04L/04R)**

The stratigraphy encountered in the boreholes generally consisted of a topsoil layer or pavement structure overlying fill comprising sand, gravelly sand, and/or silty sand to sandy silt, underlain by sand to sand and gravel and/or silty sand till. Bedrock was encountered below the till at two locations. The fill depths varied from 2.1 to 4.6 m.



### **5.1.1 Topsoil**

A thin layer of topsoil was encountered at surface in four boreholes drilled off of Highway 417 between Nicholas Street and Riverside Drive. The boreholes were Boreholes OHS-01L, OHS-02R, OHS-03L and OHS-04R.

The thickness of the topsoil ranged from 75 mm to 300 mm.

### **5.1.2 Pavement (Asphalt and Concrete)**

Asphalt was encountered at surface in the four boreholes (Boreholes OHS-01R, OHS-02L, OHS-03R, and OHS-04L) drilled along the existing Highway 417. In all four of these boreholes, concrete was encountered below the asphalt.

The thickness of the asphalt ranged from 50 mm to 75 mm and the thickness of the concrete ranged from 225 mm to 325 mm.

### **5.1.3 Sand Fill**

Sand fill was encountered in all of the boreholes drilled between Nicholas Street and Riverside Drive, except for Borehole OHS-02R. The sand fill was encountered below the topsoil in Boreholes OHS-01L, OHS-03L, and OHS-04L and below the pavement in Boreholes OHS-01R, OHS-02L, OHS-03R, and OHS-04L. The sand fill was typically fine to medium grained and light brown to brown. The sand fill contained trace to some gravel and silt.

The thickness of the sand fill ranged from 0.3 m to 3.7 m, with the lower boundary of the sand fill encountered at depths of 0.6 m to 4.0 m (Elevation 60.2 to 57.1). The sand fill was thickest in Boreholes OHS-03R and OHS-04L, located on the approach embankments to the Hurdman Bridge over the Rideau River.

SPT N-values recorded in the sand fill ranged from 8 blows for 0.3 m penetration to 50 blows for 0.15 m penetration, but typically the sand fill had a compact to dense relative density.

Moisture contents of samples of the sand fill ranged from 2 to 11%.

One sample of the sand fill underwent laboratory grain size analysis testing, the results of which are summarized below. The results are also presented on the Record of Borehole Sheets included in Appendix A and the grain size distribution curve for this sample is plotted on Figure A1, Appendix A.

Gravel %	9
Sand %	74
Silt & Clay %	17

#### **5.1.4 Gravelly Sand Fill**

Gravelly sand fill was encountered below the sand fill in Boreholes OHS-01L and OHS-04R, and below the topsoil in Borehole OHS-02R. The gravelly sand fill was typically brown and contained some silt and trace clay. The gravelly sand fill encountered below topsoil in Borehole OHS-02R, contained trace organics. The gravelly sand fill encountered in Borehole OHS-01L had a strong hydrocarbon odour and black staining. Due to the presence of probable contaminants, the samples collect from Borehole OHS-01L did not undergo routine laboratory testing.

The thickness of the gravelly sand fill ranged from 0.7 m to 2.5 m, with the lower boundary of the fill encountered at depths of 1.2 m to 4.6 m (Elevation 59.5 to 55.5).

SPT N-values recorded in the gravelly sand fill ranged from 10 blows for 0.3 m penetration to 50 blows for 0.15 m penetration, indicating a compact to very dense relative density.

The moisture content of samples of the gravelly sand fill ranged from 9% to 16%.

One sample of the gravelly sand fill underwent laboratory grain size analysis testing, the results of which are summarized below. The results are also presented on the Record of Borehole Sheets included in Appendix A and the grain size distribution curve for this sample is plotted on Figure A2 of Appendix A.

Gravel %	20
Sand %	53
Silt %	18
Clay %	9

#### **5.1.5 Sandy Silt to Silty Sand Fill**

Sandy silt to silty sand fill was encountered below the gravelly sand fill in Boreholes OHS-01L and OHS-02R and below the sand fill in Boreholes OHS-02L and OHS-03L. The sandy silt to silty sand fill was brown and grey and contained trace to some clay, trace to some gravel, and occasional shale pieces.

The thickness of the sandy silt to silty sand fill ranged from 0.9 m to 2.4 m, with the lower boundary of this fill encountered at depths of 2.1 m to 3.7 m (Elevation 58.0 to 57.2).

SPT N-values recorded in the sandy silt to silty sand fill ranged from 6 to 79 blows for 0.3 m penetration, indicating the fill was loose to very dense in terms of relative density.

Moisture contents of samples of the sandy silt to silty sand fill ranged from 6 to 11%.

Two samples of the sandy silt to silty sand fill underwent laboratory grain size analysis testing, the results of which are summarized below. The results are also presented on the Record of Borehole Sheets included in Appendix A and the grain size distribution curves for these samples are plotted on Figure A3, Appendix A.

Gravel %	5 to 6
Sand %	59 to 63
Silt %	22 to 28
Clay %	8 to 9

#### **5.1.6 Sand, Gravelly Sand to Sand and Gravel**

Native sand, gravelly sand to sand and gravel was encountered in Boreholes OHS-01L, OHS-01R, OHS-03R and OHS-04L. The native sand, gravelly sand to sand and gravel was brown to grey and contained some silt and trace to some clay. A deposit of gravel and cobbles was encountered locally in Borehole OHS-01L beneath this native layer at a depth of 4.1 m (Elevation 56.9). Coring techniques were required to advance through this deposit and core recovery was generally poor. Cobbles up to 170 mm in size were observed.

The thickness of the sand, gravelly sand to sand and gravel layer ranged from 1.0 m to 2.4 m, with the lower boundary of this layer encountered at depths of 4.1 m to 5.0 m (Elevation 56.9 to 55.3). Borehole OHS-1L was terminated within the underlying deposit of gravel and cobbles at depth of 6.3 m (Elevation 54.7).

SPT N-values recorded in the sand, gravelly sand to sand and gravel layer ranged from 13 to 24 blows for 0.3 m penetration, indicating a compact relative density.

The moisture content of samples of the gravelly sand to sand and gravel ranged from 4% to 21%.

One sample of the gravelly sand underwent laboratory grain size analysis testing, the results of which are summarized below. The results are also presented on the Record of Borehole sheets included in Appendix A and the grain size distribution curve for this sample is plotted on Figure A4, Appendix A.

Gravel %	24
Sand %	57
Silt %	13
Clay %	6

### 5.1.7 Silty Clay

A layer of silty clay was encountered locally in OHS-04L below the sand layer. The silty clay was dark brown and contained some sand.

This layer of clay was 1.8 m thick, with the lower boundary of the clay encountered at a depth of 6.1 m (Elevation 54.7).

An SPT N-value of 19 blows for 0.3 m penetration was recorded in the clay, indicating a very stiff consistency. The moisture content of a sample of the clay was 8%.

One sample of the silty clay underwent laboratory grain size analysis and Atterberg Limits testing and the results are summarized below. The results are also presented on the Record of Borehole Sheets included in Appendix A. The grain size distribution curve for this sample is plotted on Figure A5 and the result of the Atterberg Limits test is plotted on Figure A7.

Gravel %	0
Sand %	15
Silt %	45
Clay %	40
Liquid Limit %	53
Plastic Limit %	27
Plasticity Index %	26

The result of the Atterberg Limits test indicates that the silty clay is highly plastic with a group symbol of CH.

### 5.1.8 Silty Sand Till

Silty sand till was encountered below the fill in Boreholes OHS-02L, OHS-02R, OHS-03L and OHS-04R, below the native gravelly sand, and sand and gravel layer in Boreholes OHS-01R and OHS-03R, and beneath the silty clay in Borehole OHS-04L. The silty sand till was grey and contained trace to some clay and gravel, and occasional shale fragments.

The silty sand till was encountered at depths of 2.1 m to 6.1 m (Elevation 57.6 to 54.7). The till was fully penetrated in only two of boreholes and was 0.4 m to 1.4 m thick, with the lower boundary encountered at depths of 5.0 m and 6.4 m (Elevations 55.1 and 54.7). Five of the boreholes were terminated within the till at depths of 6.3 m to 6.7 m (Elevation 54.3 to 53.0).

SPT N-values recorded in the till typically ranged from 10 blows for 0.3 m penetration to 50 blows for 0.075 m penetration, indicating a compact to dense relative density. A localized

SPT-N value of 7 blows per 0.3 m penetration was recorded at the upper boundary in Borehole OHS-03L, indicating a loose condition.

The natural moisture content of samples of the till ranged from 3% to 26% but was typically between 8% and 15%.

Three samples of the till underwent laboratory gradation analysis and one sample of the till was sufficiently plastic for Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole Sheets included in Appendix A. The grain size distribution curves are plotted on Figure A6 and the Atterberg Limit curve is plotted on Figure A8 of Appendix A.

Gravel %	7 to 16
Sand %	37 to 57
Silt %	24 to 32
Clay %	12 to 15
Liquid Limit %	22
Plastic Limit %	13
Plasticity Index %	9

The above results indicate that at some locations the till is of low plasticity with a group symbol of CL.

It should be noted that glacial tills are known to contain cobbles and boulders.

### 5.1.9 Bedrock

Bedrock was encountered below the silty sand till in Boreholes OHS-03R and OHS-04R. The bedrock was described as highly weathered grey shale. The depths and elevations at which bedrock was encountered are summarized in Table 5.1. Borehole OHS-04R was extended 1.1 m into the bedrock by augering.

**Table 5.1 – Depths and Elevations of Bedrock Surface**

Borehole	Bedrock Surface	
	Depth (m)	Elevation (m)
OHS-03R	6.4	54.7
OHS-04R	5.0	55.1

#### 5.1.10 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. Four standpipe piezometers were installed in Boreholes OHS-01L, OHS-02R, OHS-03L, and OHS-04R, between Nicholas Street and Riverside Drive, to monitor water levels after completion of drilling.

Piezometer readings and open borehole measurements indicate that groundwater level between Nicholas Street and Riverside Drive was at depths of 2.5 m to 5.8 m (Elevation 55.2 to 57.6). The water levels measured in the piezometer and open boreholes during drilling are summarized in Table 5.2.

**Table 5.2 – Water Level Measurements**

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
OHS-01L	20-Mar-2012	4.6	56.4	Piezometer
	2-May-2012	5.8	55.2	
OHS-02L	21-Mar-2012	3.7	57.3	Open Borehole
OHS-02R	21-Mar-2012	4.0	55.7	Piezometer
OHS-03L	20-Mar-2012	3.8	56.4	Piezometer
	2-May-2012	3.2	57.0	
OHS-03R	20-Mar-2012	3.7	57.4	Open Borehole
OHS-04R	27-Mar-2012	2.5	57.6	Piezometer

The values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

#### 5.2 HWY 417 from Riverside Drive to O.R.174 (Boreholes OHS-5L/5R to OHS-13, VMS-2L/2R and VMS-3L/3R)

The stratigraphy encountered in the boreholes generally consisted of a surficial topsoil layer or pavement structure overlying various fill materials (typically sand to sandy silt, locally gravel to clayey silt) underlain by silty to gravelly sand and/or silty sand to clayey silt till. Bedrock was encountered in all but one borehole. The fill depths ranged from 0.9 to 4.7 m.

### **5.2.1 Topsoil**

A thin layer of topsoil was encountered at ground surface in six of the twenty-one boreholes drilled along Highway 417 between Riverside Drive and O.R.174 (Boreholes OHS-06L, OHS-06R, OHS-09R, OHS-10R, OHS-12R, OHS-13).

At these locations, the thickness of the topsoil ranged from 50 mm to 200 mm.

### **5.2.2 Asphalt (and Concrete)**

Asphalt was encountered at ground surface in fourteen boreholes which were drilled on the pavement of Highway 417 or interchange ramps. At these borehole locations, the thickness of the asphalt ranged from 25 mm to 150 mm.

A layer of concrete was encountered directly below the asphalt in Borehole VMS-3R. The concrete was 225 mm thick.

### **5.2.3 Sand Fill**

Sand fill was encountered in fifteen of the boreholes drilled along Highway 417 from Riverside Drive to O.R.174. Typically, the sand fill was encountered immediately below the asphalt and topsoil. The exception is Borehole VMS-2R where sand fill was encountered at surface. In Borehole OHS-11L, the sand fill was encountered at a depth of 2.3 m. The sand fill was brown to grey and contained some silt, trace gravel to gravelly, trace to some clay, occasional shale fragments and occasional cobbles.

The thickness of the sand fill ranged from 0.6 m to 3.3 m, with the lower boundary of the sand fill encountered at depths of 0.8 m to 3.4 m (Elevation 70.2 to 58.4). In general, the sand fill was thickest in the vicinity of St. Laurent Boulevard. A layer of clayey silt fill was encountered within the sand fill in Borehole OHS-12L.

SPT N-values recorded in the sand fill ranged from 7 blows for 0.3 m penetration to 100 blows for 0.075 m penetration, indicating a loose to very dense relative density. In general, SPT N-values ranged from 14 to 49 blows for 0.3 m penetration, indicating a compact to dense relative density. Some high SPT N-values with penetration depths less than 0.3 m indicate the proximity of the bedrock interface beneath the fill.

Moisture contents of samples of the sand fill ranged from 1% to 16%. Typically, the low moisture contents recorded were for samples collected immediately below the asphalt surface.

Two samples of the sand fill underwent laboratory gradation analysis testing. The results of this testing are presented on the Record of Borehole Sheets included in Appendix B and the

grain size distribution curves for these samples are plotted on Figure B1, Appendix B. The results of these tests are as follows:

Grave l%	20 to 22
Sand %	54 to 61
Silt %	14 to 17
Clay %	3 to 9

#### **5.2.4 Gravelly Sand to Gravel Fill**

Granular fill consisting of gravelly sand to gravel was encountered in five boreholes (Boreholes OHS-06L, OHS-07L, OHS-10R, OHS-11L, and OHS-12R). This granular fill was encountered below the asphalt or topsoil in three of the boreholes. The exceptions are Borehole OHS-10R, where the gravelly sand fill was encountered at depth of 0.8 m, and Borehole OHS-12R, where the gravel fill was encountered beneath the sand fill. The fill was brown and contained trace to some silt and varying amounts of sand and gravel.

The thickness of the gravelly sand to gravel fill ranged from 0.2 m to 1.0 m, with the lower boundary of this layer encountered at depths of 0.3 m to 2.3 m (Elevation 70.2 to 59.8).

SPT N-values recorded in the gravelly sand to gravel fill ranged from 8 to 19 blows for 0.3 m penetration, indicating a loose to compact relative density.

The moisture content of samples of the granular fill ranged from 5% to 12%.

#### **5.2.5 Silty Sand to Silt Fill**

A layer of fill varying from silty sand to silt was encountered in thirteen boreholes (Boreholes OHS-05L/R, OHS-06L/R, OHS-07L/R, OHS-08R, OHS-09R, OHS-10L/R, OHS-11L and VMS-2L/R). This fill was typically encountered directly below the asphalt, topsoil and sand fill but was encountered below the sand and gravel fill in Boreholes OHS-06L and OHS-11L, and below clayey silt fill in Boreholes OHS-07L and VMS-2R. The layer of fill was brown to grey and contained trace to some gravel, trace to some clay, occasional shale fragments, and occasional cobbles.

The thickness of the layer ranged from 0.6 m to 2.9 m, with the lower boundary encountered at depths of 0.8 m to 4.7 m (Elevation 69.0 to 57.2).

SPT N-values typically ranged from 13 to 61 blows for 0.3 m penetration, indicating a compact to very dense condition. A SPT N-value of 84 blows for 0.275 m penetration recorded in Borehole OHS-5L reflects the proximity to the underlying bedrock interface.



Localised SPT N- values of 6 and 9 blows for 0.3 m penetration were recorded in the fill directly beneath the topsoil, indicating a loose condition.

Moisture contents of samples of the silty sand fill ranged from 2% to 40%. Typically, moisture contents were less than 20%.

Seven samples taken from this layer underwent laboratory gradation analysis testing and two samples of the fill exhibited sufficient plasticity to undergo Atterberg Limits testing. The results of this testing are presented on the Record of Borehole Sheets included in Appendix B. The grain size distribution curves for these samples are plotted on Figures B2, B3 and B4 and results of the Atterberg Limits testing are plotted on Figure B9. The results of these tests are as follows:

	<u>Silty Sand to Silt &amp; Sand Fill</u>	<u>Sandy Silt Fill</u>	<u>Silt</u>
Gravel %	1 to 16	0	0
Sand %	41 to 61	30	14
Silt %	21 to 40	53	75
Clay %	6 to 21	17	11
Liquid Limit %	21		
Plastic Limit %	11 to 14		
Plasticity Index %	7 to 10		

The results of this Atterberg Limits tests indicate that locally, the fill contains zones of low plasticity with a group symbol of CL.

#### **5.2.6 Clayey Silt to Silty Clay Fill**

Layers of clayey silt to silty clay fill were encountered locally in boreholes OHS-06L, OHS-07L, OHS-11R, OHS-12L and VMS-2R. The cohesive fill was encountered below the sand fill, silty sand fill, and gravelly sand fill described above. The clayey silt to silty clay fill was brown to dark grey and contained trace to some gravel and some sand to sandy.

The thickness of the clayey silt to silty clay fill ranged from 0.4 m to 1.6 m, with the lower boundary of this fill encountered at a depth of 1.5 m to 4.6 m (Elevation 69.9 to 57.9).

SPT N-values recorded in the clay/silt fill typically ranged from 10 to 46 blows for 0.3 m penetration, indicating a stiff to hard consistency. A SPT N-value of 100 blows for 0.07 m penetration was recorded in Borehole OHS-11R near the bedrock interface.

The moisture content of samples of the clay/silt fill typically ranged from 10% to 15%, with two outliers at 24% and 34%.

One sample of the silty clay fill underwent laboratory gradation analysis and Atterberg Limits testing. The results of this testing are presented on the Record of Borehole Sheets included in Appendix B and the grain size distribution curve for this sample is plotted on Figure B5, Appendix B. The results of the Atterberg Limits tests are plotted on Figure B10. The results of these tests are as follows:

Gravel %	5
Sand %	24
Silt %	40
Clay %	31
Liquid Limit %	31
Plastic Limit %	14
Plasticity Index %	17

The results of the Atterberg Limits test indicate that the fill has a low plasticity with a group symbol of CL.

#### **5.2.7 Silty Sand to Gravelly Sand**

A layer of native material varying from silty sand to gravelly sand was encountered in five boreholes, OHS-06R, OHS-08L, OHS-08R, OHS-09R and OHS-13. This native material was encountered beneath the fill layer in Boreholes OHS-09R and OHS-13, and at depth in Boreholes OHS-06R, OHS-08L, and OHS-08R. This layer of native silty sand to gravelly sand was brown to grey and contained some silt to silty, trace gravel to gravelly, trace clay, and occasional cobbles.

The thickness of the layer ranged from 0.6 m to 2.0 m, with the lower boundary encountered at depths of 2.4 m to 7.6 m (Elevation 66.8 to 55.3).

SPT N-values recorded ranged from 36 blows for 0.3 m penetration to 100 blows for 0.15 m penetration, indicating a dense to very dense relative density. A SPT-N value of 9 blows for 0.3 m penetration was recorded in Borehole OHS-09R, indicating a localised loose condition.

The moisture content of the samples ranged from 6% to 21%, typically less than 14%.

Gradation analysis was carried out on one sample and results are summarised below and also presented on the Record of Borehole Sheets included in Appendix B. Figure B6 shows the grain size distribution curves for this sample.

Gravel %	0
Sand %	61
Silt %	32
Clay %	7

It is noted that the sand heaved into the hollow stem augers due to hydraulic imbalance after advancing to 4.5 m depth in Borehole OHS-13.

#### **5.2.8 Clayey Silt Till**

Clayey silt till was encountered in three boreholes. The clayey silt till was encountered beneath the fill layer in Boreholes OHS-07R and OHS-12R, and at depth of 6.1 m in Borehole OHS-06L. The clayey silt till was brown to dark grey and contained some sand and trace gravel.

The thickness of the clayey silt till ranged from 0.3 m to 0.7 m, with the lower boundary of the clayey silt till encountered at depths of 2.7 m to 6.4 m (Elevation 69.0 to 56.3).

SPT N-values recorded in the clayey silt till ranged from 15 blows for 0.3 m penetration to 66 blows for 0.175 m penetration, indicating a stiff to hard consistency.

The moisture content of samples of the clayey silt till ranged from 8% to 11%.

#### **5.2.9 Sandy Silt to Silty Sand Till**

Sandy silt to silty sand till was encountered in twelve boreholes. Typically, the sandy silt to silty sand till was encountered below the fill deposits. In Boreholes OHS-07R and OHS-09R, the till was encountered below a layer of native clayey silt till and silty sand, respectively. The sandy silt to silty sand till was dark brown to dark grey and contained trace gravel and trace to some clay.

The thickness of the till layer typically ranged from 0.2 m to 3.0 m, with the lower boundary of the till encountered at depths of 1.8 m to 7.0 m (Elevation 68.1 to 54.6). Borehole OHS-07L was terminated within the till at a depth of 6.1 m (Elevation 54.8).

SPT N-values recorded in the till ranged from 4 blows for 0.3 m penetration to 50 blows for 0.025 m penetration, indicating a loose to very dense relative density. In general, the till had

a compact to dense relative density. SPT N-values that were recorded for less than 0.3 m penetration may reflect the presence of cobbles or the till-bedrock interface.

The moisture content of samples of the till ranged from 3% to 13%.

Seven samples of the silty sand to sandy silt till underwent gradation analysis testing and one sample also underwent Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole Sheets included in Appendix B. The grain size distribution curves for these samples are plotted on Figures B7 and B8 and the results of the Atterberg Limits testing are plotted in Figure B11 of Appendix B.

Gravel%	1 to 9
Sand%	47 to 58
Silt%	25 to 30
Clay%	13 to 18
Liquid Limit %	21
Plastic Limit %	13
Plasticity Index %	8

The results of this Atterberg Limits test indicate that locally, the silty sand to sandy silt till contains zones of low plasticity with a group symbol of CL.

It should be noted that glacial tills are known to contain cobbles and boulders.

#### **5.2.10 Bedrock**

Bedrock was encountered in all the boreholes except for Borehole OHS-07L which was terminated within the till. Bedrock at the site was proven by a combination of coring and augering techniques depending on rock quality. Rock coring was undertaken in ten boreholes where 2.6 m to 3.3 m long rock cores were obtained. In four of the boreholes (OHS-08L, OHS-09L, OHS-12L, and OHS-13), the boreholes were extended 1.0 to 2.4 m into bedrock using augers due to the highly weathered nature of the bedrock encountered. In five of the boreholes, probable bedrock was encountered at the completion depth of the borehole. The depths and elevations at which bedrock was encountered are summarized in Table 5.3.

The bedrock was described as laminated grey shale and typically contains hard limestone interbeds up to 50 mm in thickness. The shale was generally described as highly weathered to fresh, with the amount of weathering decreasing with depth. Occasional vertical fractures, rubbles zones, and clay seams were observed in the bedrock cores. Total Core Recovery (TCR) in the bedrock ranged from 83 % to 100% and was typically 100%. The RQD values

ranged from 0 to 100%, indicating a widely variable rock quality ranging from very poor to excellent. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, was also quite variable and ranged from 0 to greater than 25. Typically, the FI was less than 10 in most boreholes.

The estimated unconfined compressive strength (UCS) of the rock, interpreted from point load tests conducted on intact rock cores, ranged from 1 to 70 MPa, indicating a variable rock strength. Typically, UCS values ranged from about 10 to 30 MPa, which is indicative of weak to medium strong rock strength classification. Higher rock strengths may be obtained in the hard limestone interbeds.

**Table 5.3 – Depths and Elevations of Bedrock Surface**

Borehole	Bedrock Surface		Comments
	Depth (m)	Elevation (m)	
OHS-5L	2.0	57.6	Cored 3.3 m
OHS-5R	1.8	58.0	Cored 2.7 m
OHS-6L	6.4	56.3	Inferred
OHS-6R	7.6	55.3	Inferred
OHS-7R	6.1	54.6	Inferred
OHS-8L	5.1	58.3	Augered 1.0 m
OHS-8R	6.1	57.6	Inferred
OHS-9L	3.7	65.9	Augered 2.4 m
OHS-9R	3.0	66.2	Cored 3.3 m
OHS-10L	6.1	63.4	Inferred
OHS-10R	3.0	64.8	Cored 3.0 m
OHS-11L	3.1	68.2	Cored 3.0 m
OHS-11R	3.1	68.6	Cored 3.3 m
OHS-12L	4.2	68.1	Augered 1.9 m
OHS-12R	2.7	69.0	Cored 3.6 m
OHS-13	5.1	61.8	Augered 1.0 m
VMS-2L	2.2	57.5	Cored 3.1 m
VMS-2R	2.3	57.2	Cored 2.9 m
VMS-3L	1.0	65.9	Cored 3.1 m
VMS-3R	0.9	66.2	Cored 3.3 m

### 5.2.11 Groundwater Conditions

Water level was observed in Borehole OHS-13 upon completion of drilling. Six standpipe piezometers were installed between Riverside Drive and O.R.174, to monitor water levels after completion of drilling.

Piezometer readings and open borehole measurements indicate groundwater along the site to vary between depths of 1.8 m and 5.0 m (Elevation 57.9 to 68.7). The water levels measured in the piezometer and open boreholes are summarized in Table 5.4.

**Table 5.4 – Water Level Measurements**

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
OHS-6L	2-May-2012	3.0	59.7	Piezometer
OHS-6R	27-Mar-2012	2.0	60.9	Piezometer
	2-May-2012	5.0	57.9	Piezometer
OHS-7L	22-Mar-2012	2.2	58.7	Piezometer
OHS-9R	22-Mar-2012	2.0	67.2	Piezometer
OHS-10R	1-May-2012	2.0	65.8	Piezometer
OHS-12R	22-Mar-2012	4.1	67.6	Piezometer
	1-May-2012	3.0	68.7	Piezometer
OHS-13	30-Mar-2012	1.8	65.1	Open Borehole

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

### 5.3 O.R.174 from HWY 417- O.R. 174 Interchange to East of Blair Road (Boreholes OHS-14L/14R, OHS-18, VMS-5L/5R)

The stratigraphy encountered in the boreholes drilled at these sign locations varied from site to site. At OHS-14, the stratigraphy consisted of a layer of topsoil over gravelly to silty sand fill, underlain by a sand deposit and sandy silt till, over probable bedrock. At OHS-18, sand and gravel fill and silty sand fill were encountered over clayey silt and shale bedrock. At VMS-5, the stratigraphy consisted of a layer of topsoil or gravelly sand fill underlain by silty clay to the full depth of exploration.

### **5.3.1 Topsoil**

A thin layer of topsoil was encountered at ground surface in three of the five boreholes drilled along O.R.174 (Boreholes OHS-14L, OHS-14R, and VMS-5L).

The thickness of the topsoil ranged from 75 mm to 100 mm.

### **5.3.2 Gravelly Sand to Sand and Gravel Fill**

Gravelly sand to sand and gravel fill was encountered in four boreholes. The fill was encountered at ground surface in Boreholes OHS-18 and VMS-5R and below the topsoil in Boreholes OHS-14L and OHS-14R. The gravelly sand to sand and gravel contained trace to some silt and was brown to grey.

The thickness of the gravelly sand to sand and gravel fill ranged from 0.5 m to 2.6 m, with the lower boundary of this layer encountered at depths of 0.6 m to 2.7 m (Elevation 70.7 to 65.1).

SPT N-values recorded in the gravelly sand to sand and gravel fill ranged from 9 blows for 0.3 m penetration to 50 blows for 0.15 m penetration, indicating a variable relative density. In general, the gravelly sand to sand and gravel fill had SPT N-values between 13 and 36 blows for 0.3 m penetration, indicating a compact to dense relative density. The high blow counts with penetration depth less than 0.3 m may indicate probable cobbles or boulders within the fill.

Moisture contents of samples of the gravelly sand to sand and gravel fill ranged from 6% to 23%. The higher moisture contents are believed to reflect a frozen condition at the time of sampling.

### **5.3.3 Silty Sand Fill**

A layer of silty sand fill was encountered in two boreholes, OHS-14R and OHS-18, below the gravelly sand to sand and gravel fill. The silty sand fill contained trace to some gravel and some clay and was brown to orangey brown.

The silty sand fill was 2.3 m thick in Borehole OHS-14R and 0.6 m thick in Borehole OHS-18. The lower boundary of the silty sand fill was encountered at a depth of 2.9 m and 2.1 m in Boreholes OHS-14R and OHS-18, respectively (Elevation 65.3 and 69.2).

SPT N-values recorded in the silty sand fill ranged from 12 to 32 blows for 0.3 m penetration, indicating a compact to dense relative density.

Moisture contents of samples of the silty sand fill ranged from 19% to 24%.

Two samples of the silty sand fill underwent laboratory gradation analysis, the results of which are summarized below. These results are also presented on the Record of Borehole Sheets included in Appendix C and the grain size distribution curves for these samples are plotted on Figure C1, Appendix C.

Gravel%	0 to 13
Sand%	48 to 61
Silt%	27 to 28
Clay%	11 to 12

#### **5.3.4 Clayey Silt**

A thin layer of light brown clayey silt was encountered locally in Borehole OHS-18 at a depth of 2.1 m.

The clayey silt layer was 0.9 m thick with its lower boundary at a depth of 3.0 m (Elevation 68.3)

A SPT-N value of 50 blows for 0.125 m penetration was recorded in Borehole OHS-18. This high value may indicate the probable presence of shale fragments, cobbles or boulders within the layer.

The moisture content of a sample of the clayey silt was measured to be 23%.

#### **5.3.5 Sand**

A layer of native sand was encountered in Boreholes OHS-14L and OHS-14R below the fill layer. The native sand was brown to grey, medium grained and contained trace gravel and trace silt and clay.

The layer of sand was 2.0 m thick in Borehole OHS-14L and 2.6 m thick in Borehole OHS-14R, with the lower boundary of the layer encountered at depths of 4.7 m and 5.5 m, respectively (Elevation 63.1 and 62.7).

SPT N-values recorded in the native sand ranged from 5 to 8 blows for 0.3 m penetration, indicating a loose relative density.

The moisture content of samples of the sand ranged from 16% to 22%.

One sample of the sand underwent laboratory grain size analysis testing, the results of which are summarized below. The results are also presented on the Record of Borehole Sheets included in Appendix C and the grain size distribution curve for this sample is plotted on Figure C2 in Appendix C.



Gravel%	2
Sand%	94
Silt & Clay%	4

The sidewalls in Borehole OHS-14 caved in the sand after removal of the hollow stem augers.

### **5.3.6 Sandy Silt Till**

Sandy silt till was encountered below the native sand in Boreholes OHS-14L and OHS-14R. The sandy silt till was dark brown to grey and contained some clay, some gravel, and occasional shale pieces.

The sandy silt till was 1.5 m thick in Borehole OHS-14L and 0.7 m thick in Borehole OHS-14R. The lower boundary of the sandy silt till was encountered at a depth of 6.2 m in both boreholes (Elevation 61.6 and 62.0). Both of these boreholes were terminated upon probable bedrock at the lower boundary of the layer.

SPT N-values recorded in the sandy silt till ranged from 28 blows for 0.3 m penetration to 50 blows for 0.075 m penetration, indicating a compact to very dense relative density. The SPT N-values recorded for less than 0.3 m penetration occurred at the lower boundary of the layer on probable bedrock.

The natural moisture content of one sample of the sandy silt till was measured to be 7%.

It should be noted that glacial tills are known to contain cobbles and boulders.

### **5.3.7 Silty Clay**

A deposit of silty clay was encountered below the topsoil in Borehole VMS-5L and below the sand fill in Borehole VMS-5R. The silty clay was light brown to grey and contained trace silt seams.

The silty clay was not fully penetrated in these boreholes, both of which were terminated at a depth of 7.0 m (Elevation 62.5 and 64.6).

SPT N-values recorded in the silty clay ranged from 0 to 10 blows for 0.3 m penetration, indicating a variable consistency ranging from very soft to stiff. The silty clay layer is typically very soft except for the upper 3.0 m of the silty clay in Borehole VMS-5R where SPT N-values of 6 to 10 blows for 0.3 m penetration were recorded.

In situ vane shear testing was carried out in the silty clay layer. Undrained shear strengths of 15 to 22 kPa were recorded in the lower part of the borehole. One value of 40 kPa was measured near 4 m depth in Borehole VMS-5R.

The moisture content of samples of the silty clay ranged from 29 to 75%. In general, the moisture content of the silty clay increased with depth.

Two samples of the silty clay underwent laboratory gradation analysis and Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole Sheets included in Appendix C and the grain size distribution curves for these samples are plotted on Figure C3. The results of the Atterberg Limits tests are plotted on Figure C4 of Appendix C.

Gravel %	0
Sand%	0
Silt%	23 to 26
Clay%	74 to 77
Liquid Limit %	69 to 73
Plastic Limit %	27 to 29
Plasticity Index %	40 to 46

The results of the Atterberg Limits tests indicate that the silty clay is highly plastic with a group symbol of CH.

### 5.3.8 Bedrock

Bedrock was confirmed below the clayey silt encountered in Borehole OHS-18. Bedrock was proven by coring 3.3 m at this location. In Boreholes OHS-14L and OHS-14R, the depth of bedrock was inferred from split-spoon refusal and the presence of shale fragments in the collected samples. The depths and elevations at which bedrock and probable bedrock were encountered are summarized in Table 5.5.

The bedrock was described as laminated grey shale and typically contained hard limestone interbeds up to 50 mm in thickness. The shale was generally described as fresh. Occasional vertical fractures and rubble zones were observed in the bedrock cores. Total Core Recovery (TCR) in the bedrock ranged from 25 % to 100% and increased with depth. The RQD values ranged from 0 to 62%, indicating a variable rock quality ranging from very poor to fair. The RQD values also increased with depth. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 1 to 8.

**Table 5.5 – Depths and Elevations of Bedrock Surface**

Borehole	Bedrock Surface	
	Depth (m)	Elevation (m)
OHS-14L	6.2*	61.6
OHS-14R	6.2*	62.0
OHS-18	3.0	68.3

*\*Bedrock surface inferred from split spoon refusal and samples collected*

The estimated unconfined compressive strength of the rock, interpreted from point load tests conducted on intact rock cores, ranged from 49 to 109 MPa, indicating a medium strong to very strong rock strength classification. These values are likely influenced by the presence of stronger limestone interbeds.

### 5.3.9 Groundwater Conditions

Groundwater levels were observed in the boreholes during and upon completion of drilling. Three standpipe piezometers were installed along O.R.174, in Boreholes OHS-14R, OHS-18, and VMS-5L, to monitor water levels after completion of drilling.

Piezometer readings and open borehole measurements indicate groundwater levels to be at depths of 0.7 m to 2.3 m (Elevation 65.7 to 70.2). The water levels measured in the open boreholes and piezometers are summarized in Table 5.6.

**Table 5.6 – Water Level Measurements**

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
OHS-14L	10-Mar-2012	2.1	65.7	Borehole sloughed upon completion
OHS-14R	11-Mar-2012	2.3	65.9	Open Borehole Piezometer
	29-Mar-2012	0.7	67.5	
OHS-18	29-Mar-2012	1.1	70.2	Piezometer
VMS-5L	28-Mar-2012	1.5	68.0	Piezometer

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

#### **5.4 HWY 417 from Highway 417-O.R.174 Interchange to Walkley Road (Boreholes OHS-15L/15R, OHS-16L/16R, OHS-17 and VMS-4L/4R)**

The stratigraphy encountered in Boreholes OHS-15L/15R and OHS-16L/16R drilled on an existing high fill embankment typically consisted of a pavement structure or silty sand fill overlying shale fill. Sand/silt till was encountered below the fill in two boreholes. At the other sign locations, the stratigraphy consisted of topsoil and/or sand fill overlying silty clay, underlain by sandy silt, silty sand till and sand.

##### **5.4.1 Topsoil**

A thin layer of topsoil was encountered at surface in three of the seven boreholes drilled along Highway 417 from Highway 417-O.R.174 Interchange to Walkley Road (Boreholes OHS-16R, OHS-17, and VMS-4R). The thickness of the topsoil ranged from 50 mm to 200 mm.

##### **5.4.2 Asphalt**

Asphalt was encountered at ground surface in three boreholes (Boreholes OHS-15L, OHS-15R, and OHS-16L). These boreholes were located on the shoulders of the existing WB lanes of Highway 417.

The thickness of the asphalt ranged from 75 mm to 90 mm.

##### **5.4.3 Sand Fill**

Sand fill was encountered at surface in Borehole VMS-4L, below the asphalt in Boreholes OHS-15L, OHS-15R, and OHS-16L, and below the topsoil in Borehole VMS-4R. The sand fill was brown and grey and contained trace gravel to gravelly and some silt. Silty sand fill was encountered below the topsoil in Borehole OHS-16R.

The thickness of the sand fill ranged from 0.6 m to 1.6 m, with the lower boundary of the sand fill encountered at a depth of 0.7 m to 1.8 m (Elevations 74.1 to 64.6).

SPT N-values recorded in the sand fill ranged from 13 to 44 blows for 0.3 m penetration, indicating a compact to dense relative density.

Moisture contents of samples of the sand fill ranged from 1 to 8%.

##### **5.4.4 Shale Fill**

Shale fill was encountered in Boreholes OHS-15L, OHS-15R, OHS-16L, and OHS-16R beneath the sand fill and topsoil. The fill was brown and grey and contained trace clay. Two

clayey silt zones (700 mm and 600 mm thick) were encountered within this fill in Borehole OHS-16L at depths of 1.7 m and 3.1 m (Elevations 73.1 and 71.7).

This fill was fully penetrated in two of the four boreholes (OHS-15L and OHS-15R) and was 5.2 m to 5.4 m thick, with the lower boundary of the fill encountered at depths of 6.4 m and 6.1 m (Elevations 64.0 and 62.6). In Boreholes OHS-16L and OHS-16R, the boreholes were both terminated within the fill at a depth of 6.7 m (Elevation 68.1 and 66.6).

SPT N-values recorded in the shale fill ranged from 9 to 58 blows for 0.3 m penetration, indicating a loose to very dense relative density. In general, the fill had a compact to dense relative density.

The moisture content of samples of the embankment fill ranged from 4% to 26%, typically less than 10%.

Four samples of the fill material underwent laboratory grain size analysis testing, the results of which are summarized below. The results are also presented on the Record of Borehole Sheets included in Appendix D and the grain size distribution curves for these samples are plotted on Figures D1 and D2, Appendix D.

Gravel %	5 to 32
Sand %	44 to 59
Silt %	14 to 36
Clay %	4 to 17

Shale fill often contains chunks and slabs of harder rock materials such as limestone.

#### **5.4.5 Silty Clay**

A deposit of silty clay was encountered below the topsoil in Borehole OHS-17 and below the sand fill in Boreholes VMS-4L and VMS-4R. The silty clay contained no to trace sand and was brown to grey.

The thickness of the silty clay ranged from 3.5 m to 4.4 m, with the lower boundary of the silty clay encountered at depths of 4.4 m to 4.9 m (Elevations 62.7 to 61.1).

SPT N-values recorded in the silty clay ranged from 3 to 21 blows for 0.3 m penetration, indicating a soft to very stiff consistency. In general, the silty clay had a firm to stiff consistency.

Moisture contents of samples of the silty clay ranged from 20% to 46%.

Three samples of the silty clay underwent laboratory grain size analysis and Atterberg Limits testing. These results are presented on the Record of Borehole Sheets included in Appendix D. The grain size distribution curves for these samples are plotted on Figure D3 and the results of the Atterberg Limits tests are plotted on Figure D5. The results of these tests are as follows:

Gravel %	0
Sand %	0 to 2
Silt %	18 to 45
Clay %	55 to 80
Liquid Limit %	46 to 63
Plastic Limit %	21 to 24
Plasticity Index %	25 to 39

The results of the Atterberg Limits tests indicate that the silty clay is of intermediate to high plasticity with group symbol CI-CH.

#### **5.4.6 Sandy Silt to Silty Sand Till**

Sandy silt to silty sand till was encountered below the fill layer in Boreholes OHS-15L and OHS-15R, and below the silty clay in Boreholes VMS-4L and VMS-4R. The sandy silt to silty sand till was dark brown to grey and contained some clay to clayey and trace gravel.

The till was fully penetrated in Boreholes VMS-4L and VMS-4R but not in Boreholes OHS-15L and OHS-15R. Where fully penetrated, the thickness of the silty sand to sandy silt till ranged from 1.1 m to 1.2 m, with the lower boundary of the till encountered at depths of 6.1 m and 5.5 m (Elevations 60.2 and 60.0). Boreholes OHS-15L and OHS-15R were both terminated at a depth of 6.7 m (Elevations 63.7 and 62.0) within the till.

SPT N-values recorded in the sandy silt to silty sand till ranged from 5 to 30 blows for 0.3 m penetration, indicating a loose to compact relative density.

The natural moisture content of samples of the sandy silt to silty sand till ranged from 10% to 24%.

Two samples of the silty sand to sandy silt till underwent laboratory gradation analysis, the results of which are summarized below. These results are also presented on the Record of Borehole Sheets in Appendix D and the grain size distribution curves for these samples are plotted on Figure D4 of Appendix D.

Gravel %	0 to 1
Sand %	44 to 49
Silt %	26 to 37
Clay %	14 to 29

#### **5.4.7 Sandy Silt**

A layer of sandy silt was encountered locally in Borehole OHS-17, below the silty clay. The sandy silt was grey and contained trace clay and trace gravel.

The layer of sandy silt was 1.5 m thick, with the lower boundary of this layer encountered at a depth of 6.1 m (Elevation 61.2).

An SPT N-value of 17 blows for 0.3 m penetration was recorded in the sandy silt, indicating a compact condition.

The moisture content of one sample of the sandy silt was measured to be 13%.

#### **5.4.8 Sand**

A layer of native sand was encountered below the sandy silt in Borehole OHS-17 and below the silty sand till in Boreholes VMS-4L and VMS-4R. The sand was grey to brown, typically medium to coarse grained and contained trace gravel to gravelly.

The sand was not fully penetrated and all three boreholes were terminated within the sand at a depth of 6.7 m (Elevation 60.6 to 58.8).

SPT N-values recorded in the native sand ranged from 6 to 26 blows for 0.3 m penetration, indicating a loose to compact relative density.

The moisture content of samples of the sand ranged from 10% to 26%.

The sidewalls of Borehole VMS-4R caved in the sand upon removal of the hollow stem augers.

#### **5.4.9 Groundwater Conditions**

Water levels were observed in the boreholes during and upon completion of drilling. Two standpipe piezometers were installed at the sites, in Boreholes OHS-16R and VMS-4R, to monitor water levels after completion of drilling.

Piezometer readings and open borehole measurements indicate groundwater levels to be at depths of 1.0 m to 6.4 m (Elevation 67.2 to 63.2). The water levels measured in the

piezometer are summarized in Table 5.7, along with the measurements in the open boreholes upon completion of drilling.

**Table 5.7 – Water Level Measurements**

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
OHS-15L	8-Mar-2012	6.4	64.0	Open Borehole
OHS-15R	29-Mar-2012	5.5	63.2	Open Borehole
OHS-16R	1-May-2012	6.1	67.2	Piezometer
OHS-17	29-Mar-2012	1.0	66.3	Open Borehole
VMS-4R	28-Mar-2012	1.2	64.3	Piezometer

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

## **5.5 HWY 417 near Bayswater Avenue (Boreholes VMS-1L and VMS-1R)**

Two boreholes, identified as VMS-1L and VMS-1R, were drilled on the pavement of Highway 417 near Bayswater Avenue. Borehole VMS-1L was drilled on the right shoulder of the WB lanes of Highway 417 and Borehole VMS-1R was drilled on the left shoulder of the EB lanes.

The stratigraphy encountered at this site consisted of a pavement structure overlying sand fill, silty sand to sandy silt fill, and clayey silt fill, underlain by gravelly sand (in one borehole) and silty sand till.

### **5.5.1 Asphalt and Concrete**

Asphalt was encountered at surface in both Boreholes VMS-1L and VMS-1R, which were drilled on the shoulder pavement of Highway 417. The asphalt was 100 mm thick.

A layer of concrete was encountered below the asphalt in Borehole VMS-1L. The concrete was 150 mm thick.



### 5.5.2 Sand Fill

Sand fill was encountered below the asphalt in Borehole VMS-1R and below the concrete in Borehole VMS-1L. The sand fill was brown and contained trace to some gravel and silt, and some clay.

The sand fill was 2.1 m thick in Borehole VMS-1L and 1.4 m thick in Borehole VMS-1R. The lower boundary of the sand fill was encountered at depths of 2.4 m and 1.5 m (Elevation 73.6 and 74.2).

SPT N-values recorded in the sand fill ranged from 22 to 40 blows for 0.3 m penetration, indicating a compact to dense relative density.

Moisture contents of samples of the sand fill ranged from 3 to 8%.

One sample of the sand fill was selected for laboratory gradation analysis. The results of this test are summarized below and these results are also presented on the Record of Borehole Sheets included in Appendix E. The grain size distribution curve for this sample is plotted on Figure E1 of Appendix E.

Gravel %	16
Sand %	71
Silt & Clay %	13

### 5.5.3 Sandy Silt to Silty Sand Fill

Sandy silt to silty sand fill was encountered below the sand fill in Boreholes VMS-1L and VMS-1R. The sandy silt to silty sand fill was brown to dark grey and contained trace gravel and trace clay.

This fill was 0.6 m thick in Borehole VMS-1L and 1.5 m thick in Borehole VMS-1R. The lower boundary of the layer was encountered at a depth of 3.0 m in both boreholes (Elevations 73.0 and 72.7).

SPT N-values recorded in the sandy silt to silty sand fill ranged from 17 to 41 blows for 0.3 m penetration, indicating a compact to dense relative density.

Moisture contents of samples of the sandy silt to silty sand fill ranged from 9% to 11%.

One sample of the silty sand fill underwent laboratory gradation analysis, the results of which are summarized below. These results are also presented on the Record of Borehole Sheets included in Appendix E and the grain size distribution curve for this sample is plotted on Figure E2 of Appendix E.

Gravel %	3
Sand %	65
Silt %	23
Clay %	9

#### **5.5.4 Clayey Silt Fill**

Clayey silt fill was encountered below the silty sand fill in both boreholes. The clayey silt fill was brown and contained some sand and trace gravel. Occasional sand seams were also observed in the clayey silt fill. Concrete rubble (150 mm) and a small piece of steel (possible hinge) were encountered within the clayey silt fill in Borehole VMS-1R at a depth of 4.0 m.

The clayey silt fill was 1.6 m thick in both boreholes, with the lower boundary of the clayey silt fill encountered at a depth of 4.6 m (Elevations 71.4 and 71.1).

SPT N-values of 11 and 15 blows for 0.3 m penetration were recorded in the clayey silt fill. These N-values indicate the clayey silt fill has a stiff consistency.

The moisture content of samples of the clayey silt fill ranged from 17% to 19%.

#### **5.5.5 Gravelly Sand**

A layer of brown gravelly sand was encountered in Borehole VMS-1R below the clayey silt fill. The gravelly sand contained trace of silt.

This layer was 0.9 m thick, with the lower boundary of the gravelly sand encountered at a depth of 5.5 m (Elevation 70.2).

An SPT N-value of 28 blows for 0.3 m penetration was recorded in the gravelly sand, indicating a compact condition.

The moisture content of one sample of the gravelly sand was 9%.

#### **5.5.6 Silty Sand Till**

Silty sand till was encountered below the clayey silt fill in Borehole VMS-1L and below the gravelly sand layer in Borehole VMS-1R. The silty sand till was brown and contained trace to some gravel and trace clay.

The silty sand till was not fully penetrated in either of the boreholes. Borehole VMS-1L was terminated at a depth of 6.7 m (Elevation 69.3) and the till was at least 2.1 m thick. In Borehole VMS-1R, the silty sand till is at least 1.2 m thick at a termination depth of 6.7 m (Elevation 69.0).

SPT N-values recorded in the silty sand till ranged from 18 to 36 blows for 0.3 m penetration, indicating a compact to dense relative density.

The natural moisture content of samples of the silty sand till ranged from 8% to 11%.

One sample of the silty sand till underwent laboratory gradation analysis the results of which are summarized below. These results are also presented on the Record of Borehole Sheets included in Appendix E and the grain size distribution curve for this sample is plotted on Figure E3 of Appendix E.

Gravel %	16
Sand %	55
Silt %	22
Clay %	7

#### **5.5.7 Groundwater Conditions**

Water levels were observed in the open boreholes upon completion of drilling. Borehole VMS-1L was dry and water was observed at a depth of 6.7 m (Elevation 69.0), at the base of the borehole, in Borehole VMS-1R.

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

## **6 MISCELLANEOUS**

Hollow stem augers were used to advance the boreholes and therefore monitoring of the stability of the borehole sidewalls in cohesionless soils was not possible during drilling. In general, the borehole sidewalls remained upright (no cave) upon removal of the augers, except where noted in the soil descriptions above.

Borehole locations were established based on information received from MRC and were marked out in the field by surveyors from the MMM Group. Where a borehole was relocated from the marked location, field measurements were made regarding the offset and elevation differences between the marked location and the drilled location, and the as-drilled coordinates and elevations were established and reported.

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied both track-mounted and truck-mounted drill rigs and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised by Ms. Eckie Siu, Mr. Ryan Kromer, E.I.T., and Mr. George Azzopardi of Thurber.



Overall supervision of the field program was conducted by Ms. Lindsey Blaine, E.I.T. Interpretation of the data and preparation of the report were carried out by Ms. Lindsey Blaine, E.I.T and Ms. Mei Cheong, M.Phil.

The report was reviewed by Mr. M.R. Anderson, P.Eng., M.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

**Thurber Engineering Ltd.**

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**FOUNDATION INVESTIGATION AND DESIGN REPORT  
OVERHEAD AND VARIABLE MESSAGE SIGNS  
HIGHWAY 417 WIDENING  
NICHOLAS STREET TO O.R.174  
OTTAWA, ONTARIO  
G.W.P. 4091-07-00 and 4320-06-00**

**Geocres Number: 31G5-249**

**PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS**

**7 GENERAL**

This report presents interpretation of the geotechnical data in the factual report and presents foundation design recommendations for the eighteen proposed overhead signs (OHS) and five variable message signs (VMS). The proposed OHS and VMS are located along Highway 417 and O.R. 174, and form part of the widening works of Highway 417 between Nicholas Street and O.R. 174, Ottawa, Ontario.

The discussion and recommendations presented in this report are based on the factual data obtained during the course of the investigation. The sign locations and plans used for preparation of this report were provided by McCormick Rankin Corporation (MRC).

**8 SIGN SUPPORT DESIGN RECOMMENDATIONS**

**8.1 Foundation Design Parameters**

The foundation design for the OHS and VMS should be carried out in accordance with the following documents:

- Ministry of Transportation, Ontario (2007) “Sign Support Manual”, Engineering Standards Branch, Bridge Office
- Canadian Highway Bridge Design Code and Commentary (2006)

As per the Sign Support Manual, the proposed OHS and VMS installations will typically be supported on two caissons. The signs designated OHS-13, OHS-17 and OHS-18 will be supported on one caisson.

A borehole was drilled at each foundation location for the proposed OHS and VMS. Tables 1 to 2, which are presented immediately following the text of this report, provide a listing of boreholes and geotechnical parameters relevant to the design of each OHS and VMS.

The depth of shale bedrock varies on the project and was encountered at depths of 0.9 m to 7.6 m. The shale bedrock is at depths of about 3 m or less at the proposed locations of OHS-5, OHS-9 to OHS-12, OHS-18, VMS-2 and VMS-3.

In general, the conditions at these sites meet or exceed the geotechnical parameters assumed in the Sign Support Manual and the standard foundation design is considered appropriate. However at the proposed locations of VMS-5L and VMS-5R, the undrained shear strength ( $c_u$ ) of the soil is below the minimum values assumed in the manual of 50 kPa in the upper two-thirds and 25 kPa in the lower third of the caisson. The undrained shear strength in zones of the clay at the proposed locations of OHS-17 and VMS-4R may also be below the minimum assumed values, subject to the position along the design caisson length. The structural resistance of the caissons must be reviewed by the structural designer to confirm the feasibility of the standard foundation design and prepare a modified design where necessary.

The lateral resistance of the caisson may be calculated using a value for the coefficient of horizontal subgrade reaction ( $k_s$ ) and ultimate lateral resistance ( $p_{ult}$ ) as follows:

$$\begin{aligned} k_s &= n_h z / D \quad (\text{kN/m}^3) && \text{for cohesionless soils} \\ &= 67 c_u / D \quad (\text{kN/m}^3) && \text{for cohesive soils and shale} \\ p_{ult} &= 3 \gamma z K_p \quad (\text{kPa}) && \text{for cohesionless soils} \\ &= 2 c_u \quad (\text{kPa}) \text{ at the surface, increasing linearly to} \\ &\quad 9 c_u \quad (\text{kPa}) \text{ at a depth of three caisson diameters (D), and} \\ &\quad 9 c_u \text{ below this depth} && \text{for cohesive soils (kPa)} \\ &= 6 c_u \quad (\text{kPa}) && \text{for shale} \end{aligned}$$

where

$$\begin{aligned} z &= \text{depth of embedment of caisson (m)} \\ D &= \text{caisson diameter (m)} \\ n_h &= \text{coefficient of horizontal subgrade reaction (kN/m}^3\text{)} \\ c_u &= \text{undrained shear strength (kPa)} \\ \gamma &= \text{bulk unit weight, use submerged unit weight below water table (kN/m}^3\text{)} \\ K_p &= \text{passive earth pressure coefficient} \end{aligned}$$

The recommended design parameters for use in the above equations are presented in Tables 1 and 2.

The above equations and recommended parameters may be used to analyze the interaction between a pile and the surrounding soil. The lateral pressures obtained from the analysis should not exceed the ultimate lateral resistance.

The spring constant,  $K$ , for analysis may be obtained by the expression,  $K = k_s * L * D$  (kN/m), where  $k_s$  is the coefficient of horizontal subgrade reaction (kN/m<sup>3</sup>),  $D$  is the pile width (m) and  $L$  is the length (m) of the pile segment or element used in the analysis. The ultimate lateral resistance on any one segment of pile,  $P_{ult}$ , may be obtained from the expression,  $P_{ult} = p_{ult} * L * D$ . This represents the ultimate load at which the soil fails and will not support any additional load at greater displacements.

Where downward sloping ground exists in front of a caisson, reduction of lateral passive resistance should be taken into account during design. For foundation design at the caissons, it can be assumed that full lateral resistance can only be mobilized where the width of the soil in front of the caisson is equal to or greater than approximately 4 times the diameter of the caissons. The mobilized passive resistance for sloping ground in front of a caisson can be estimated using the following reduction factors:

**Table 8.1 - Slope Reduction Factors**

<b>Slope Inclination</b>	<b>Passive Resistance Reduction Factor</b>
2H : 1V	0.60
2.5H : 1V	0.65
3H : 1V	0.70
4H : 1V	0.75

Where designing for portions of the caissons below the groundwater level in cohesionless soils (sands and silts), the submerged soil unit weight,  $\gamma'$ , should be used. The required embedment depth of the caisson will be governed by lateral loads, including wind loads acting on the pole. The length of the caisson should also be sufficient to counteract frost-jacking forces.

The depth of frost penetration at the site is 1.8 m. Accordingly, all adhesion/ skin friction or passive resistance within the top 1.8 m of overburden should be neglected in foundation design.

## **8.2 Caisson Installation**

Caisson installation should generally be carried out in accordance with OPSS 631 and OPSS 903.

The contract documents should contain an NSSP alerting the contract bidders of the specific aspects relating to caisson construction for OHS and VMS foundation supports at this site. Suggested wording for this NSSP is provided in Appendix F.

Caisson installation equipment must be able to auger or core into weak to moderately strong shale bedrock with hard limestone interbeds, and handle and remove cobbles and boulders in the fill and till deposits.

The bedrock elevations may vary within short distances. The depth to rock at the location of the sign support may therefore be greater or less than that indicated by the borehole findings. The potential for encountering a sloping bedrock surface should also be anticipated.

Steel liners should be provided during caisson installation to support the sidewalls, minimise groundwater inflow and enable machine-cleaning of the base. Groundwater was observed in the boreholes during the field investigation at depths of 0.7 m to 6.7 m (Elevations 55.2 to 70.2) along the site.

Caissons should be backfilled with concrete within 8 hours of excavation to minimize softening of the shale bedrock and silty or cohesive soils. Suggested wording in this regard is included in the NSSP provided in Appendix F.

## **8.3 Construction Concerns**

Concerns during caisson construction mainly involve the handling and removal of cobbles or boulders, possible soil sloughing and water seepage from caisson sidewalls, augering and/ or coring of weak to moderately strong shale bedrock with hard limestone interbeds, and a variable bedrock surface elevation. Softening of the native clay and shale, where encountered, over prolonged exposure after excavation is also a concern.



## 9 CLOSURE

Engineering analysis and preparation of the report were carried out by Ms. Mei T. Cheong, M.Phil.

The report was reviewed by Mr. Murray R. Anderson, P.Eng., M.Eng., and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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**TABLE 1 FOUNDATION DESIGN PARAMETERS  
OVERHEAD SIGNS  
HIGHWAY 417 WIDENING**

Pole Number	Reference Borehole	Reference Simplified Subsurface Stratigraphy For Design	Depth Below Existing Ground Surface (m)	Foundation Design Parameters							
				$\phi'$ (deg.)	$n_h$ (MN/m <sup>3</sup> )	$c_u$ (kPa)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$K_p$	Groundwater	
										Depth <sup>#</sup> (m)	Elev. (m)
OHS-1	OHS-1L	Sand (Fill)	0.2 – 0.8	30	3.0	-	21	-	3.0	4.6	56.4**
		Gravelly Sand (Fill)	0.8 – 1.5	30	4.0	-	21	-	3.0		
		Sandy Silt (Fill)	1.5 – 3.0	30	3.0	-	20	-	3.0		
		Gravelly Sand	3.0 – 4.1	32	5.0	-	21	-	3.3		
		Gravel and Cobbles	4.1 – 4.6	32	5.0	-	21	-	3.3		
		Gravel and Cobbles	4.6 – 6.3	32	4.0	-	-	11	3.3		
	OHS-1R	Sand (Fill)	0.4 – 2.4	32	5.0	-	21	-	3.3	3.7	56.4
		Gravelly Sand	2.4 – 3.7	33	6.0	-	21	-	3.4		
		Gravelly Sand	3.7 – 4.8	33	4.0	-	-	11	3.4		
		Silty Sand (Till)	4.8 – 6.7	35	6.0	-	-	11	3.7		
OHS-2	OHS-2L	Sand (Fill)	0.4 – 1.7	32	5.0	-	21	-	3.3	3.7	57.3*
		Silty Sand (Fill)	1.7 – 3.7	32	5.0	-	21	-	3.3		
		Silty Sand Till	3.7 – 6.7	32	4.0	-	-	11	3.3		
	OHS-2R	Gravelly Sand (Fill)	0.1 – 1.2	30	3.0	-	21	-	3.0	4.0	55.7**
		Silty Sand (Fill)	1.2 – 2.1	30	3.0	-	21	-	3.0		
		Silty Sand Till	2.1 – 4.0	32	5.0	-	21	-	3.3		
		Silty Sand Till	4.0 – 6.7	32	4.0	-	-	11	3.3		

Notes:

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- # Depth below existing grade  
\* Groundwater level based on open borehole measurement  
\*\* Groundwater level based on piezometer readings

## Overhead Signs

Highway 417 Widening –Nicholas Street to O.R. 174

Pole Number	Reference Borehole	Reference Simplified Subsurface Stratigraphy For Design	Depth Below Existing Ground Surface (m)	Foundation Design Parameters							
				$\phi'$ (deg.)	$n_h$ (MN/m <sup>3</sup> )	$c_u$ (kPa)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$K_p$	Groundwater	
										Depth <sup>#</sup> (m)	Elev. (m)
OHS-3	OHS-3L	Sand (Fill)	0.3 – 0.6	30	3.0	-	21	-	3.0	3.8	56.4**
		Sandy Silt (Fill)	0.6 – 3.0	30	3.0	-	21	-	3.0		
		Silty Sand Till	3.0 – 3.8	32	5.0	-	21	-	3.3		
		Silty Sand Till	3.8 – 6.3	32	4.0	-	-	11	3.3		
	OHS-3R	Sand (Fill)	0.3 – 3.7	32	5.0	-	21	-	3.3	3.7	57.4*
		Sand (Fill)	3.7 – 4.0	32	4.0	-	-	11	3.3		
		Sand and Gravel	4.0 – 5.0	32	4.0	-	-	11	3.3		
		Sandy Silt Till	5.0 – 6.4	32	4.0	-	-	11	3.3		
		Shale Bedrock	6.4	-	-	400	-	-	-		
OHS-4	OHS-4L	Sand (Fill)	0.4 – 3.0	32	5.0	-	21	-	3.3	3.2	57.6
		Sand	3.0 – 4.3	32	4.0	-	-	11	3.3		
		Silty Clay	4.3 – 6.1	-	-	100	-	10	3.0		
		Silty Sand Till	6.1 – 6.7	35	7.0	-	-	11	3.7		
	OHS-4R	Sand (Fill)	0.1 – 2.1	30	3.0	-	21	-	3.0	2.5	57.6**
		Gravelly Sand (Fill)	2.1 – 2.5	30	3.0	-	21	-	3.0		
		Gravelly Sand (Fill)	2.5 – 4.6	30	2.0	-	-	11	3.0		
		Silty Sand Till	4.6 – 5.0	35	7.0	-	-	11	3.7		
OHS-5	OHS-5L	Shale Bedrock	5.0	-	-	400	-	11	-	0.6	59.0
		Silty Sand (Fill)	0.1 – 0.6	32	5.0	-	21	-	3.3		
		Silty Sand (Fill)	0.6 – 2.0	32	4.0	-	-	11	3.3		
	OHS-5R	Shale Bedrock	2.0	-	-	400	-	-	-	0.8	59.0
		Silty Sand (Fill)	0.0 – 0.8	30	3.0	-	21	-	3.0		
		Silty Sand (Fill)	0.8 – 1.6	30	2.0	-	-	11	3.0		
		Sandy Silt Till	1.6 – 1.8	32	4.0	-	-	11	3.3		
		Shale Bedrock	1.8	-	-	400	-	-	-		

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# Overhead Signs

Highway 417 Widening –Nicholas Street to O.R. 174

Pole Number	Reference Borehole	Reference Simplified Subsurface Stratigraphy For Design	Depth Below Existing Ground Surface (m)	Foundation Design Parameters							
				$\phi'$ (deg.)	$n_h$ (MN/m <sup>3</sup> )	$c_u$ (kPa)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$K_p$	Groundwater	
										Depth <sup>#</sup> (m)	Elev. (m)
OHS-6	OHS-6L	Silty Sand (Fill)	0.1 – 1.8	32	5.0	-	21	-	3.3	1.8	60.9
		Silty Sand (Fill)	1.8 – 3.0	32	4.0	-	-	11	3.3		
		Clayey Silt (Fill)	3.0 – 4.6	30	2.0	-	-	10	3.0		
		Sandy Silt (Till)	4.6 – 6.1	35	6.0	-	-	11	3.7		
		Clayey Silt (Till)	6.1 – 6.4	35	6.0	-	-	11	3.7		
		Shale Bedrock	6.4	-	-	400	-	-	-		
	OHS-6R	Sand (Fill)	0.1 – 1.7	30	3.0	-	21	-	3.0	2.0	60.9**
		Silty Sand (Fill)	1.7 – 2.0	30	3.0	-	21	-	3.0		
		Silty Sand (Fill)	2.0 – 3.1	30	2.0	-	-	11	3.0		
		Sandy Silt (Fill)	3.1 – 4.6	30	2.0	-	-	11	3.0		
		Silty Sand (Till)	4.6 – 7.0	32	4.0	-	-	11	3.3		
		Sand	7.0- 7.6	35	7.0	-	-	11	3.7		
		Shale Bedrock	7.6	-	-	400	-	-	-		
	OHS-7L	Gravelly Sand (Fill)	0.2 – 1.1	30	3.0	-	21	-	3.0	2.2	58.7**
		Clayey Silt Fill	1.1 – 1.5	30	3.0	-	20	-	3.0		
		Sandy Silt Fill	1.5 – 2.2	30	3.0	-	21	-	3.0		
		Sandy Silt Fill	2.2 – 2.9	30	2.0	-	-	11	3.0		
		Sandy Silt Till	2.9 – 6.1	32	4.0	-	-	11	3.3		
		Shale Bedrock	6.1	-	-	400	-	-	-		
OHS-7	OHS-7R	Sand (Fill)	0.1 – 1.6	32	5.0	-	21	-	3.3	2.0	58.7
		Silt and Sand (Fill)	1.6 – 2.0	30	3.0	-	21	-	3.0		
		Silt and Sand (Fill)	2.0 – 2.4	30	2.0	-	-	11	3.0		
		Clayey Silt (Till)	2.4 – 3.1	30	2.0	-	-	10	3.0		
		Silty Sand Till	3.1 – 6.1	30	2.0	-	-	11	3.0		
		Shale Bedrock	6.1	-	-	400	-	-	-		

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# Overhead Signs

Highway 417 Widening –Nicholas Street to O.R. 174

Pole Number	Reference Borehole	Reference Simplified Subsurface Stratigraphy For Design	Depth Below Existing Ground Surface (m)	Foundation Design Parameters							
				$\phi'$ (deg.)	$n_h$ (MN/m <sup>3</sup> )	$c_u$ (kPa)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$K_p$	Groundwater	
										Depth <sup>#</sup> (m)	Elev. (m)
OHS-8	OHS-8L	Sand (Fill)	0.1 – 1.5	32	5.0	-	21	-	3.3	2.9	60.5
		Silty Sand (Till)	1.5 – 2.9	35	8.0	-	21	-	3.7		
		Silty Sand (Till)	2.9 – 3.1	35	6.0	-	-	11	3.7		
		Sand	3.1 – 5.1	35	7.0	-	-	11	3.7		
		Shale Bedrock	5.1	-	-	400	-	-	-		
	OHS-8R	Sand (Fill)	0.1 – 0.8	30	3.0	-	21	-	3.0	3.2	60.5
		Silty Sand (Fill)	0.8 – 1.9	32	5.0	-	21	-	3.3		
		Silty Sand Till	1.9 – 3.2	32	5.0	-	21	-	3.3		
		Silty Sand Till	3.2 – 4.3	32	4.0	-	-	11	3.3		
		Sand	4.3 – 6.1	35	7.0	-	-	11	3.7		
		Shale Bedrock	6.1	-	-	400	-	-	-		
OHS-9	OHS-9L	Sand (Fill)	0.1 – 2.3	32	5.0	-	21	-	3.3	2.4	67.2
		Silty Sand Till	2.3 – 3.7	32	4.0	-	-	11	3.3		
		Shale Bedrock	3.7	-	-	400	-	-	-		
	OHS-9R	Silty Sand (Fill)	0.0 – 1.4	30	3.0	-	21	-	3.0	2.0	67.2**
		Silty Sand	1.4 – 2.0	30	3.0	-	21	-	3.0		
		Silty Sand	2.0 – 2.4	30	2.0	-	-	11	3.0		
		Sandy Silt Till	2.4 – 3.0	32	4.0	-	-	11	3.3		
		Shale Bedrock	3.0	-	-	400	-	-	-		

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Overhead Signs  
Highway 417 Widening –Nicholas Street to O.R. 174

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				$\phi'$ (deg.)	$n_h$ (MN/m <sup>3</sup> )	$c_u$ (kPa)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$K_p$	Groundwater	
										Depth <sup>#</sup> (m)	Elev. (m)
OHS-10	OHS-10L	Sand (Fill)	0.1 – 3.4	32	5.0	-	21	-	3.3	3.5	66.0
		Silty Sand (Fill)	3.4 – 4.7	32	4.0	-	-	11	3.3		
		Sandy Silt Till	4.7 – 6.1	32	4.0	-	-	11	3.3		
		Shale Bedrock	6.1	-	-	400	-	-	-		
	OHS-10R	Silty Sand (Fill)	0.2 – 0.8	30	3.0	-	21	-	3.0	1.8	66.0
		Gravelly Sand (Fill)	0.8 – 1.5	30	3.0	-	21	-	3.0		
		Silty Sand Till	1.5 – 1.8	32	4.0	-	21	-	3.3		
		Silty Sand Till	1.8 – 3.0	32	4.0	-	-	11	3.3		
OHS-11	OHS-11L	Shale Bedrock	3.0	-	-	400	-	-	-	3.8	67.5
		Gravel (Fill)	0.0 – 1.1	32	5.0	-	21	-	3.3		
		Silty Sand (Fill)	1.1 – 2.3	32	5.0	-	21	-	3.3		
		Sand (Fill)	2.3 – 3.1	35	6.0	-	21	-	3.7		
	OHS-11R	Shale Bedrock	3.1	-	-	400	-	-	-	4.2	67.5
		Sand (Fill)	0.1 – 1.5	32	5.0	-	21	-	3.3		
		Clayey Silt (Fill)	1.5 – 3.1	30	3.0	-	20	-	3.0		
		Shale Bedrock	3.1	-	-	400	-	-	-		
OHS-12	OHS-12L	Sand (Fill)	0.1 – 1.7	32	5.0	-	21	-	3.3	4.7	67.6
		Clayey Silt (Fill)	1.7 – 2.4	30	3.0	-	20	-	3.0		
		Sand (Fill)	2.4 – 3.0	32	5.0	-	21	-	3.3		
		Silty Sand Till	3.0 – 4.2	32	4.0	-	21	-	3.3		
	OHS-12R	Shale Bedrock	4.2	-	-	400	-	-	-	4.1	67.6**
		Sand (Fill)	0.1 – 1.5	30	3.0	-	21	-	3.0		
		Gravel (Fill)	1.5 – 2.3	30	3.0	-	21	-	3.0		
		Clayey Silt (Till)	2.3 – 2.7	32	4.0	-	21	-	3.3		
		Shale Bedrock	2.7	-	-	400	-	-	-		

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Overhead Signs  
Highway 417 Widening –Nicholas Street to O.R. 174

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				$\phi'$ (deg.)	$n_h$ (MN/m <sup>3</sup> )	$c_u$ (kPa)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$K_p$	Groundwater	
										Depth <sup>#</sup> (m)	Elev. (m)
OHS-13	OHS-13	Sand (Fill)	0.2 – 1.8	30	3.0	-	21	-	3.0	1.8	65.1
		Sand (Fill)	1.8 – 3.2	30	2.0	-	-	11	3.0		
		Gravelly Sand	3.2 – 4.3	35	7.0	-	-	11	3.7		
		Sand	4.3 – 5.1	35	7.0	-	-	11	3.7		
		Shale Bedrock	5.1	-	-	400	-	-	-		
OHS-14	OHS-14L	Gravelly Sand (Fill)	0.1 – 0.3	30	3.0	-	21	-	3.0	0.3	67.5
		Gravelly Sand (Fill)	0.3 – 2.7	32	4.0	-	-	11	3.3		
		Sand	2.7 – 4.7	30	2.0	-	-	11	3.0		
		Sandy Silt Till	4.7 – 6.2	32	4.0	-	-	11	3.3		
	OHS-14R	Gravelly Sand (Fill)	0.1 – 0.6	32	5.0	-	21	-	3.3	0.7	67.5**
		Silty Sand (Fill)	0.6 – 2.9	30	2.0	-	-	11	3.0		
		Sand	2.9 – 5.5	30	2.0	-	-	11	3.0		
		Sandy Silt Till	5.5 – 6.1	32	4.0	-	-	11	3.3		
OHS-15	OHS-15L	Sand (Fill)	0.1 – 1.2	32	5.0	-	21	-	3.3	6.4	64.0
		Shale (Fill)	1.2 – 6.4	32	5.0	-	21	-	3.3		
		Silty Sand Till	6.4 – 6.7	32	4.0	-	-	11	3.3		
	OHS-15R	Sand (Fill)	0.1 – 0.7	32	5.0	-	21	-	3.3	5.5	63.2
		Shale (Fill)	0.7 – 5.5	32	5.0	-	21	-	3.3		
		Shale (Fill)	5.5 – 6.1	32	4.0	-	-	11	3.3		
		Sandy Silt Till	6.1 – 6.7	32	4.0	-	-	11	3.3		
OHS-16	OHS-16L	Sand (Fill)	0.1 – 0.7	30	3.0	-	21	-	3.0	-	-
		Shale (Fill)	0.7 – 1.7	32	5.0	-	21	-	3.3		
		Clayey Silt (Fill)	1.7 – 2.4	30	2.0	-	20	-	3.0		
		Shale (Fill)	2.4 – 6.7	30	3.0	-	21	-	3.0		
	OHS-16R	Silty Sand (Fill)	0.2 – 1.8	30	3.0	-	21	-	3.0	-	-
		Shale (Fill)	1.8 – 6.7	30	3.0	-	21	-	3.0		

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Pole Number	Reference Borehole	Reference Simplified Subsurface Stratigraphy For Design	Depth Below Existing Ground Surface (m)	Foundation Design Parameters							
				$\phi'$ (deg.)	$n_h$ (MN/m <sup>3</sup> )	$c_u$ (kPa)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$K_p$	Groundwater	
										Depth <sup>#</sup> (m)	Elev. (m)
OHS-17	OHS-17	Silty Clay	0.2 – 1.0	-	-	50	19	-	2.5	1.0	66.3*
		Silty Clay	1.0 – 2.0	-	-	50	-	8	2.5		
		Silty Clay	2.0 – 4.6	-	-	25	-	8	2.5		
		Sandy Silt	4.6 – 6.1	30	2.0	-	-	11	3.0		
		Sand	6.1 – 6.7	32	4.0	-	-	11	3.3		
OHS-18	OHS-18	Sand and Gravel (Fill)	0.0 – 1.1	32	5.0	-	21	-	3.3	1.1	70.2**
		Sand and Gravel (Fill)	1.1 – 1.5	32	4.0	-	-	11	3.3		
		Silty Sand (Fill)	1.5 – 2.1	32	4.0	-	-	11	3.3		
		Clayey Silt	2.1 – 3.0	32	4.0	-	-	11	3.3		
		Shale Bedrock	3.0	-	-	400	-	-	-		

## LEGEND

$\phi'$	=	Angle of Internal Friction (degrees)
$c_u$	=	Undrained Shear Strength (kPa)
$\gamma$	=	Soil Unit Weight (kN/m <sup>3</sup> )
$\gamma'$	=	Submerged Soil Unit Weight (kN/m <sup>3</sup> ) – to be used only for cohesionless soils below the groundwater table
$K_p$	=	Coefficient of Passive Earth Pressure

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**TABLE 2 FOUNDATION DESIGN PARAMETERS  
VARIABLE MESSAGE SIGNS  
HWY 417 WIDENING**

Pole Number	Reference Borehole	Reference Simplified Subsurface Stratigraphy For Design	Depth Below Existing Ground Surface (m)	Foundation Design Parameters							Groundwater	
				$\phi'$ (deg.)	$n_h$ (MN/m <sup>3</sup> )	$c_u$ (kPa)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$K_p$	Depth <sup>#</sup> (m)	Elev. (m)	
VMS-1	VMS-1L	Sand (Fill)	0.3 – 2.4	30	3.0	-	21	-	3.0	7.0	69.0	
		Silty Sand (Fill)	2.4 – 3.0	30	3.0	-	21	-	3.0			
		Clayey Silt (Fill)	3.0 – 4.6	28	1.5	-	20	-	2.8			
		Silty Sand (Till)	4.6	32	5.0	-	21	-	3.3			
	VMS-1R	Sand (Fill)	0.1 – 1.5	30	3.0	-	21	-	3.0	6.7	69.0*	
		Sandy Silt (Fill)	1.5 – 2.4	30	3.0	-	21	-	3.0			
		Silty Sand (Fill)	2.4 – 3.0	30	3.0	-	21	-	3.0			
		Clayey Silt (Fill)	3.0 – 4.6	29	2.5	-	20	-	2.9			
		Gravelly Sand	4.6 – 5.5	32	5.0	-	21	-	3.3			
		Silty Sand (Till)	5.5 – 6.7	32	5.0	-	21	-	3.3			
		Silty Sand (Till)	6.7	32	4.0	-	-	11	3.3			
		VMS-2	VMS-2L	Sand (Fill)	0.1 – 1.0	30	3.0	-	21			-
Sandy Silt Fill	1.0 – 2.2			30	2.0	-	-	11	3.0			
Shale Bedrock	2.2			-	-	400	-	-	-			
VMS-2R	Sand (Fill)		0.0 – 1.1	30	3.0	-	21	-	3.0	2.0	57.5	
	Clayey Silt (Fill)		1.1 – 1.6	30	3.0	-	20	-	3.0			
	Silt (Fill)		1.6 – 2.0	30	3.0	-	20	-	3.0			
	Silt (Fill)	2.0 – 2.3	30	2.0	-	-	10	3.0				
Shale Bedrock	2.3	-	-	400	-	-	-					
VMS-3	VMS-3L	Sand (Fill)	0.1 – 1.0	30	3.0	-	21	-	3.0	3.1	64.0	
		Shale Bedrock	1.0	-	-	400	-	-	-			
	VMS-3R	Sand (Fill)	0.3 – 0.9	30	3.0	-	21	-	3.0	2.9	64.0	
		Shale Bedrock	0.9	-	-	400	-	-	-			

Notes:

1. This table must be read in conjunction with the text of this report.
  2. In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of the caisson within the upper 1.8 m below final grade should be neglected in the foundation design.
- # Depth below existing grade  
\* Groundwater level based on open borehole readings  
\*\* Groundwater level based on piezometer readings

Pole Number	Reference Borehole	Reference Simplified Subsurface Stratigraphy For Design	Depth Below Existing Ground Surface (m)	Foundation Design Parameters							
				$\phi'$ (deg.)	$n_h$ (MN/m <sup>3</sup> )	$c_u$ (kPa)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$K_p$	Groundwater	
										Depth <sup>#</sup> (m)	Elev. (m)
VMS-4	VMS-4L	Sand (Fill)	0.0 – 1.3	30	3.0	-	21	-	3.0	2.0	64.3
		Silty Clay	1.3 – 2.0	-	-	100	19	-	2.5		
		Silty Clay	2.0 – 3.0	-	-	100	-	9	2.5		
		Silty Clay	3.0 – 4.9	-	-	50	-	9	2.5		
		Silty Sand Till	4.9 – 6.1	30	2.0	-	-	11	3.0		
		Gravelly Sand	6.1 – 6.7	32	4.0	-	-	11	3.3		
	VMS-4R	Sand (Fill)	0.0 – 0.9	30	3.0	-	21	-	3.0	1.2	64.3**
		Silty Clay	0.9 – 2.2	-	-	60	-	9	2.5		
		Silty Clay	2.2 – 4.4	-	-	40	-	9	2.5		
		Silty Sand Till	4.4 – 5.5	30	2.0	-	-	11	3.0		
		Sand	5.5 – 6.7	30	2.0	-	-	11	3.0		
VMS-5	VMS-5L	Silty Clay	0.1 – 1.5	-	-	25	-	7	2.5	1.5	68.0**
		Silty Clay	1.5 – 2.5	-	-	20	-	6	2.5		
		Silty Clay	2.5 – 7.0	-	-	20	-	6	2.5		
	VMS-5R	Gravelly Sand (Fill)	0.0 – 0.9	30	3.0	-	21	-	3.0	3.6	68.0
		Silty Clay	0.9 – 3.6	-	-	50	18	-	2.5		
		Silty Clay	3.6 – 7.0	-	-	20	-	6	2.5		

## LEGEND

$\phi'$	=	Angle of Internal Friction (degrees)
$c_u$	=	Undrained Shear Strength (kPa)
$\gamma$	=	Soil Unit Weight (kN/m <sup>3</sup> )
$\gamma'$	=	Submerged Soil Unit Weight (kN/m <sup>3</sup> ) – to be used only for cohesionless soils below the groundwater table
$K_p$	=	Coefficient of Passive Earth Pressure

### Notes:

- This table must be read in conjunction with the text of this report.
  - In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of the caisson within the upper 1.8 m below final grade should be neglected in the foundation design.
- # Depth below existing grade  
\* Groundwater level based on open borehole readings  
\*\* Groundwater level based on piezometer readings

**Appendix A**

**Highway 417: Nicholas Street to Riverside Drive  
(BHs OHS-01L/01R, OHS-02L/02R, OHS-03L/03R, & OHS-04L/04R)  
Record of Borehole Sheets and Laboratory Test Results**

## SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

### 1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

### 2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

### 3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT <sup>(1)</sup> 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer



### 4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

### 5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight		RC Rock Core
			SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$


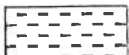



 Water Level  
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

# UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ( $W_L < 30\%$ ).
		CI	Inorganic clays of medium plasticity, silty clays. ( $30\% < W_L < 50\%$ ).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

## EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>	
<b>Fresh (FR)</b>	No visible signs of weathering.		
<b>Fresh Jointed (FJ)</b>	Weathering limited to the surface of major discontinuities.		CLAYSTONE
<b>Slightly Weathered (SW)</b>	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
<b>Moderately Weathered (MW)</b>	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
<b>Highly Weathered (HW)</b>	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
<b>Completely Weathered (CW)</b>	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>		
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	Field Estimation of Hardness*
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m			
Medium bedded	0.2 to 0.6m	Very Strong	100-250	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m			
Very thinly bedded	20 to 60mm	Strong	50-100	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm			
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	Breaks under single blow of geological hammer.

<u>TERMS</u>				
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen			
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.			

# RECORD OF BOREHOLE No OHS-01L

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 167 6 E 369 878 1 ORIGINATED BY RK  
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN  
DATUM Geodetic DATE 2012.03.12 - 2012.03.12 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w <sub>p</sub> w w <sub>L</sub> WATER CONTENT (%)			
61.0														
0.0	TOPSOIL: (150mm)													
0.2	SAND, medium grained Loose Brown Moist		1	SS	8									
60.2														
0.8	(FILL)													
	Gravelly SAND Strong hydrocarbon odour Compact Brown Moist		2	SS	30									
59.5														
1.5	(FILL)													
	Sandy SILT, trace to some clay, some gravel Loose Brown Wet		3	SS	10									
	(FILL)													
			4	SS	7									
58.0														
3.0	Gravelly SAND, some silt, some clay Compact Brown Wet		5	SS	16									
56.9	Auger refusal at 4.1m													
4.1	GRAVEL and COBBLES (up to 170mm)		1	RUN										
			2	RUN										
54.7														
6.3	END OF BOREHOLE AT 6.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar 20/12 4.6 56.4 May 02/12 5.8 55.2													

ONTMT4S 1201A.GPJ 5/16/12

## METRIC

[illegible]

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity



# RECORD OF BOREHOLE No OHS-02L

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 103.0 E 370 116.7 ORIGINATED BY ES  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA  
 DATUM Geodetic DATE 2012.03.21 - 2012.03.21 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			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	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	
61.0												
0.0	ASPHALT: (75mm)											
0.1												
60.6	CONCRETE: (300mm)											
0.4												
60.2	SAND, some gravel, some silt Brown Damp		1	GS								
0.8	(FILL)		1	SS	50/							
					150							
	SAND, fine grained, trace gravel, trace silt Very Dense Light Brown											
59.3	Damp (FILL)		2	SS	79							
1.7												
	Silty SAND, trace clay, trace gravel, occasional shale fragments Very Dense to Dense Brown to Grey Moist (FILL)		3	SS	39							
			4	SS	30							
57.3												
3.7	Silty SAND, some clay, trace gravel Compact Grey Wet (TILL)		5	SS	10							
	Moist		6	SS	20							
54.3												
6.7	END OF BOREHOLE AT 6.7m. WATER LEVEL AT 3.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.4m, CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.											

+ 3, X 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OHS-02R

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 079.5 E 370 138.2 ORIGINATED BY RK  
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA  
DATUM Geodetic DATE 2012.03.13 - 2012.03.13 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
59.7														
0.0	<b>TOPSOIL: (100mm)</b>													
0.1	Gravelly <b>SAND</b> , some silt, trace organics Compact to Very Dense Brown Moist (FILL)		1	SS	10		59							
58.5			2	SS	50/ 150									
1.2	Silty <b>SAND</b> , trace clay, trace gravel Compact Brown Moist (FILL)		3	SS	27		58							5 59 28 8
57.6			4	SS	17		57							
2.1	Silty <b>SAND</b> , some clay, trace to some gravel Compact Grey Wet (TILL)		5	SS	10		56							7 57 24 12
	Poor recovery		6	SS	18		55							
			7	SS	24		54							
53.0														
6.7	END OF BOREHOLE AT 6.7m. WATER LEVEL AT 5.5m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar.21/12 4.0 55.7													

ONTMT4S 1201A.GPJ 4/18/12

# RECORD OF BOREHOLE No OHS-03L

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 142.8 E 370 209.0 ORIGINATED BY RK  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.03.12 - 2012.03.12 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
60.2								20	40	60	80	100		
0.0	TOPSOIL, sandy							UNCONFINED + FIELD VANE						
59.9	Dark Brown		1	SS	13			● QUICK TRIAXIAL x LAB VANE						
0.3	Moist							WATER CONTENT (%)						
59.6	SAND, some gravel, some silt		2	SS	13			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
0.6	Compact Brown Moist (FILL)							W P W W L						
	Sandy SILT, some gravel, trace rootlets		3	SS	36									
	Compact to Loose Brown Moist (FILL) Possible boulder		4	SS	6									
57.2														
3.0	Silty SAND, some clay, trace to some gravel, trace rootlets and wood pieces		5	SS	7									
	Loose to Very Dense Brown Moist (TILL)													
			6	SS	50/ 0.125									
	Easy advancement from 4.9m to 5.5m													
53.9	Sampled from auger at 6.1m		7	SS	50/									
6.3	END OF BOREHOLE AT 6.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.				0.075									
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar.20/12 3.8 56.4 May03/12 3.2 57.0													

ONTMT4S 1201A.GPJ 5/11/12

RECORD OF BOREHOLE No OHS-03R

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 113.3 E 370 213.9 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA  
DATUM Geodetic DATE 2012.03.20 - 2012.03.20 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	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>					
							○ UNCONFINED                      + FIELD VANE ● QUICK TRIAXIAL                      x LAB VANE							
61.1														
0.0	ASPHALT: (75mm)						61							
0.1														
60.8	CONCRETE: (225mm)													
0.3	SAND, some silt and clay, trace gravel Dense Brown Damp to Moist (FILL)		1	GS										
			1	SS	40		60							
			2	SS	38		59							
	Occasional cobbles													
			3	SS	39									
	Compact		4	SS	21		58							
57.1														
4.0	SAND and GRAVEL, some silt Compact Grey Wet						57							
56.1			5	SS	13									
5.0	Silty SAND, trace gravel, trace clay Compact to Very Dense Grey Damp (TILL)						56							
							55							
54.7			6	SS	135/ 200									
54.6	SHALE													
6.5	END OF BOREHOLE AT 6.5m. WATER LEVEL AT 3.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.4m, CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.													








ONTMT4S 1201A GPJ 5/16/12

RECORD OF BOREHOLE No OHS-04L

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 137.5 E 370 444.1 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA  
DATUM Geodetic DATE 2012.03.21 - 2012.03.21 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR   SA   SI   CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED   + FIELD VANE ● QUICK TRIAXIAL   × LAB VANE						
60.8							20   40   60   80   100							
0.0	ASPHALT: (75mm)													
0.1	CONCRETE: (325mm)													
60.4														
0.4	SAND, some silt and clay, trace gravel Dense Brown Damp (FILL)  Occasional shale fragments		1	GS										
			1	SS	51									
			2	SS	34									
			3	SS	40									
57.8														
3.0	SAND, some gravel Compact Brown Damp		4	SS	17									
56.5														
4.3	Silty CLAY, some sand, trace gravel Very Stiff Dark Brown		5	SS	19									0   15   45   40
54.7														
6.1	Silty SAND, trace gravel, shale fragments Very Dense Grey		6	SS	71									
54.1	Damp (TILL)													
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.7m, CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.													

ONTMT4S 1201A.GPJ 5/16/12

# RECORD OF BOREHOLE No OHS-04R

1 OF 1

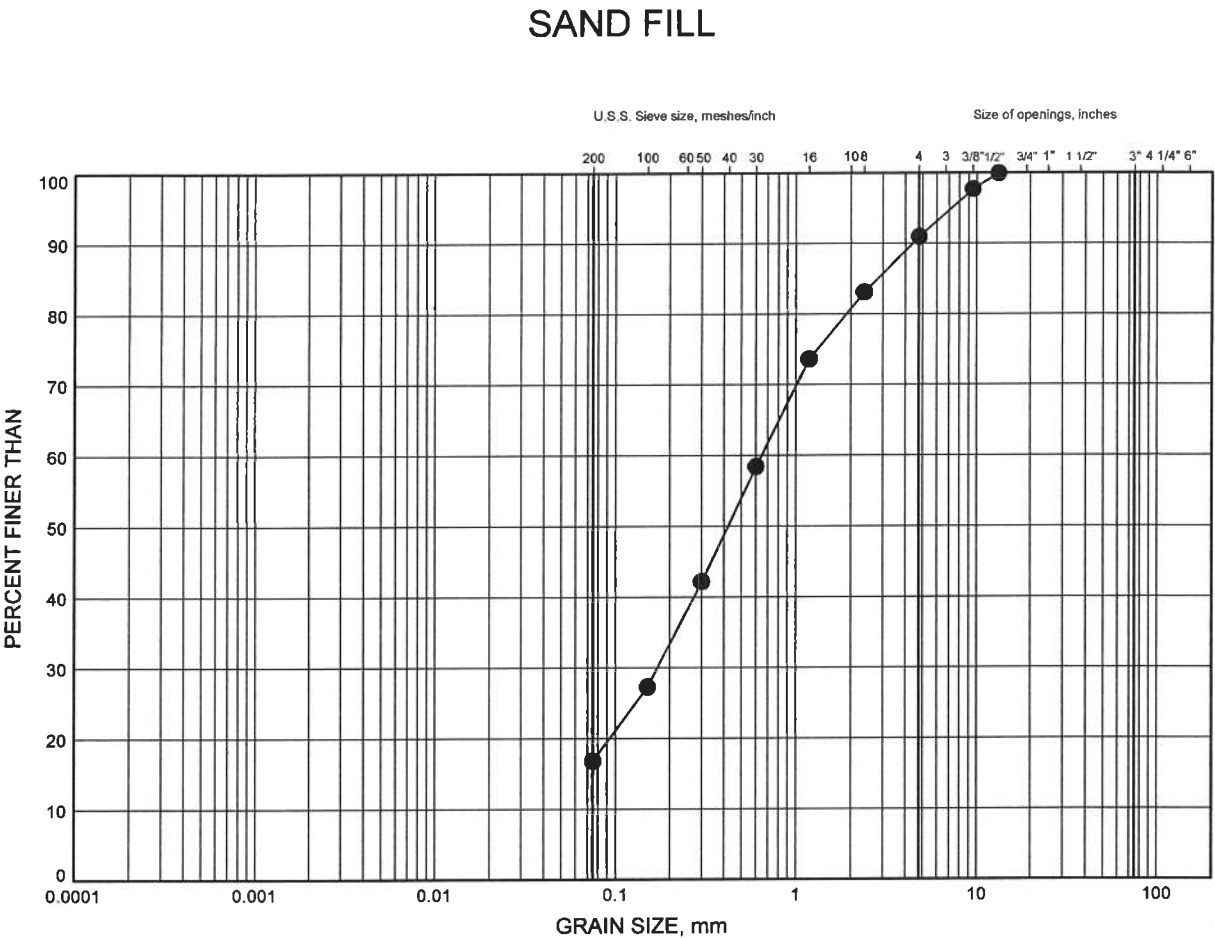
METRIC

W.P. 4091-07-00 LOCATION N 5 031 116.2 E 370 445.6 ORIGINATED BY ES  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN  
 DATUM Geodetic DATE 2012 02 09 - 2012 02 09 CHECKED BY LRB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		WATER CONTENT (%)			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>P</sub> W W <sub>L</sub>	20 40 60			
60.1 0.0 0.1	<b>TOPSOIL:</b> (75mm)  SAND, some silt and clay, trace gravel Compact Brown Damp (FILL)	1	SS	10									
		2	SS	11									
58.0 2.1	Gravelly SAND, some silt, trace clay Compact to Dense Dark Brown Moist (FILL)	3	SS	15								20 53 18 9	
		4	SS	34									
55.5 4.6	Silty SAND, trace gravel, shale fragments Very Dense Grey Damp (TILL)	5	SS	79/ 0.275									
55.1 5.0	SHALE, highly weathered, grey												
54.0 6.1	END OF BOREHOLE AT 6.1m. BOREHOLE DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar.27/12 2.5 57.6	6	SS	50/ 0.050									

Highway 417 Ottawa: Nicholas to Vanier  
GRAIN SIZE DISTRIBUTION

FIGURE A1



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-03R	1.83	59.27

GRAIN SIZE DISTRIBUTION - THURBER 1201A.GPJ 4/18/12

W.P.# 4091-07-00  
Prepared By AN  
Checked By LRB

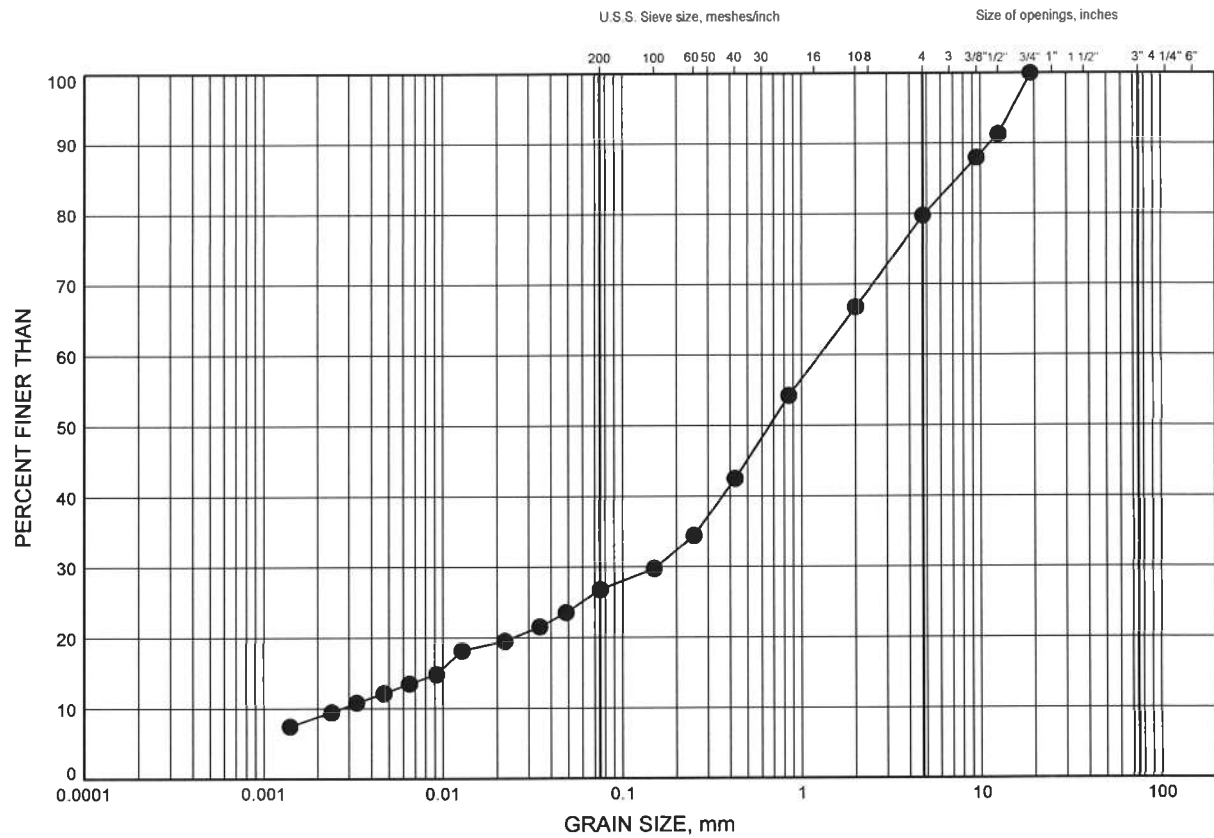


# Highway 417 Ottawa: Nicholas to Vanier

## GRAIN SIZE DISTRIBUTION

FIGURE A2

### GRAVELLY SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-04R	2.59	57.51

Date May 2012  
W.P.# 4091-07-00



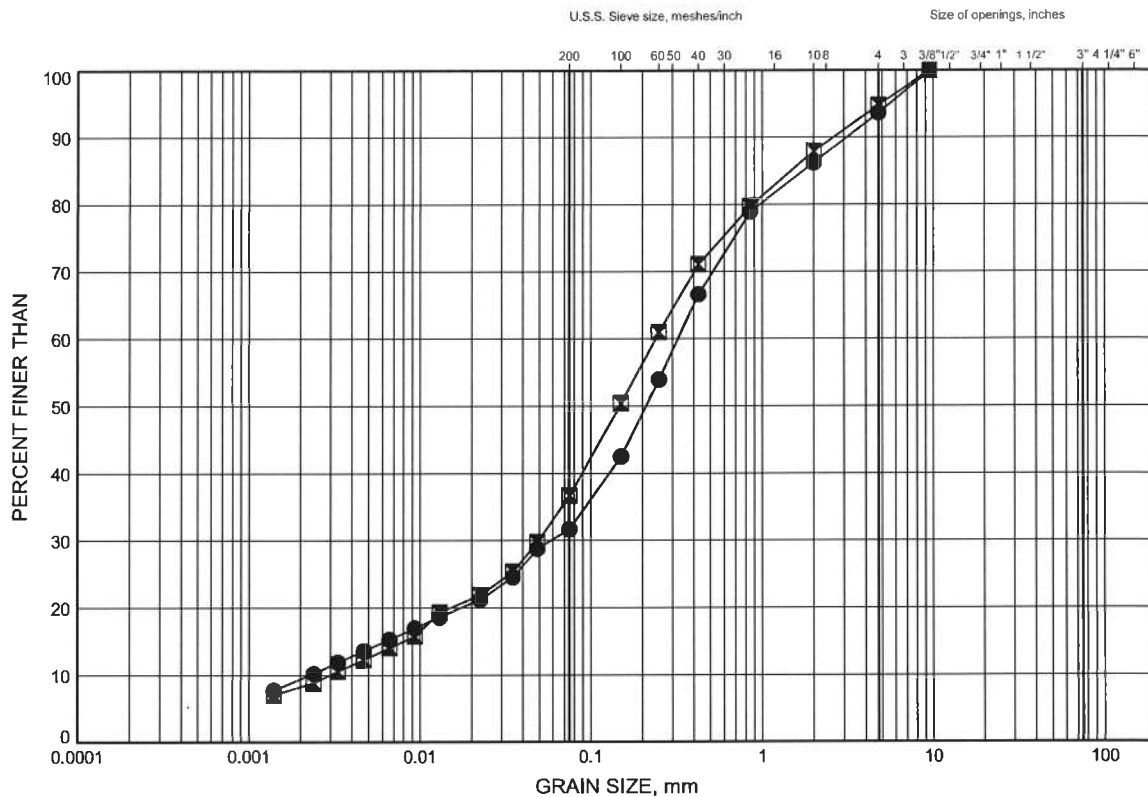
Prep'd MFA  
Chkd. LRB



# Highway 417 Ottawa: Nicholas to Vanier GRAIN SIZE DISTRIBUTION

FIGURE A3

## SILTY SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-02L	3.35	57.65
■	OHS-02R	1.83	57.91

GRAIN SIZE DISTRIBUTION - THURBER 1201A.GPJ 5/10/12

Date May 2012  
W.P.# 4091-07-00

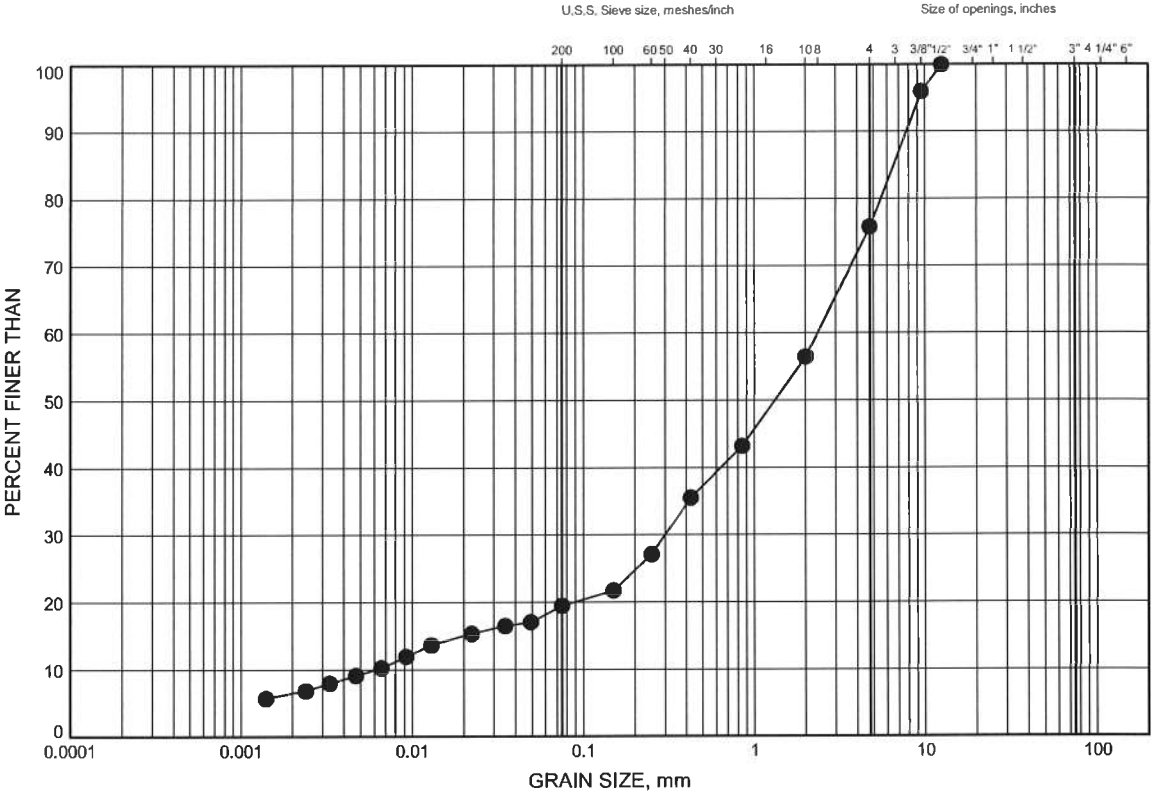


Prep'd AN  
Chkd. LRB

Highway 417 Ottawa: Nicholas to Vanier  
**GRAIN SIZE DISTRIBUTION**

**FIGURE A4**

**GRAVELLY SAND**



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-01R	2.59	57.51

Date May 2012  
W.P.# 4091-07-00

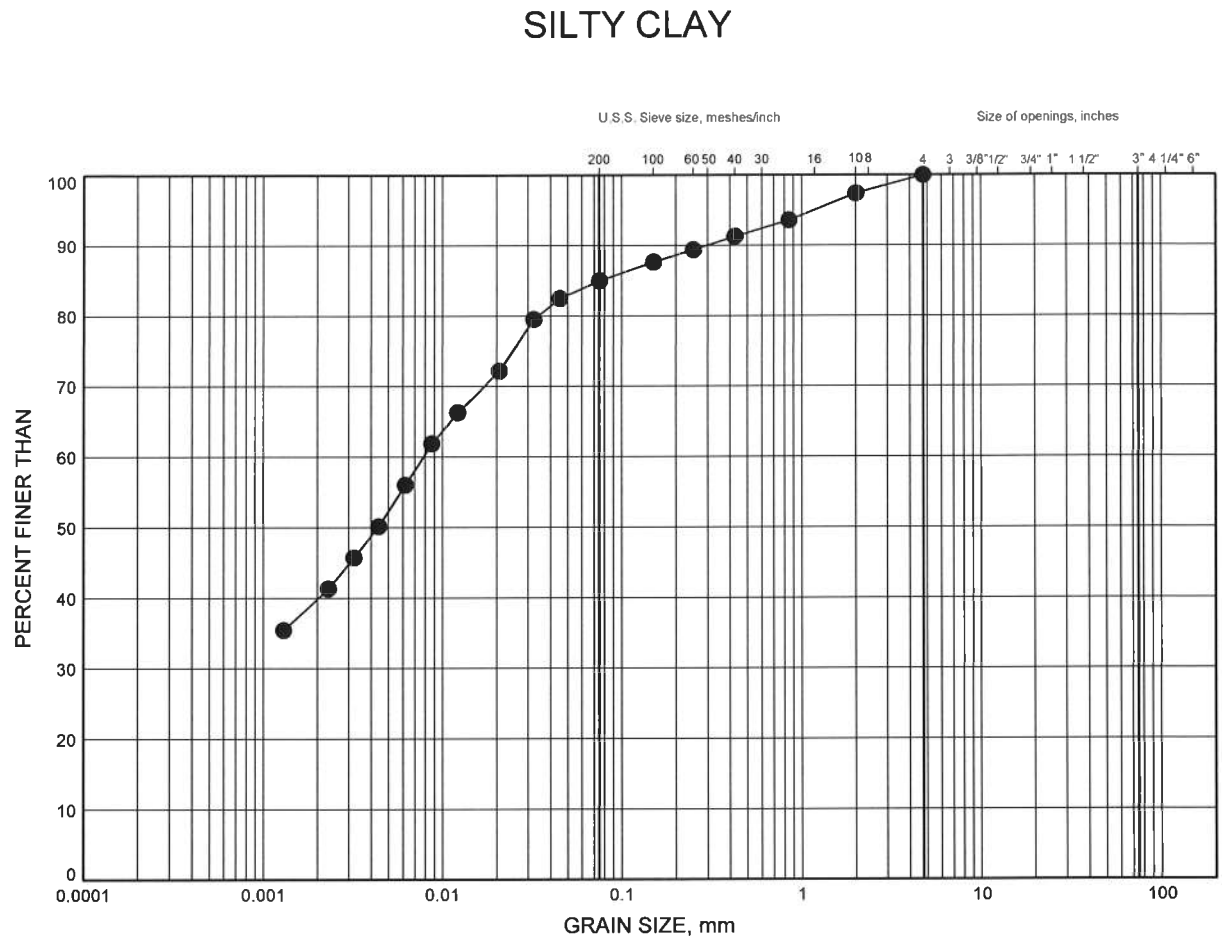


Prep'd AN  
Chkd. LRB

# Highway 417 Ottawa: Nicholas to Vanier

## GRAIN SIZE DISTRIBUTION

FIGURE A5



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-04L	4.88	55.92

Date May 2012  
W.P.# 4091-07-00



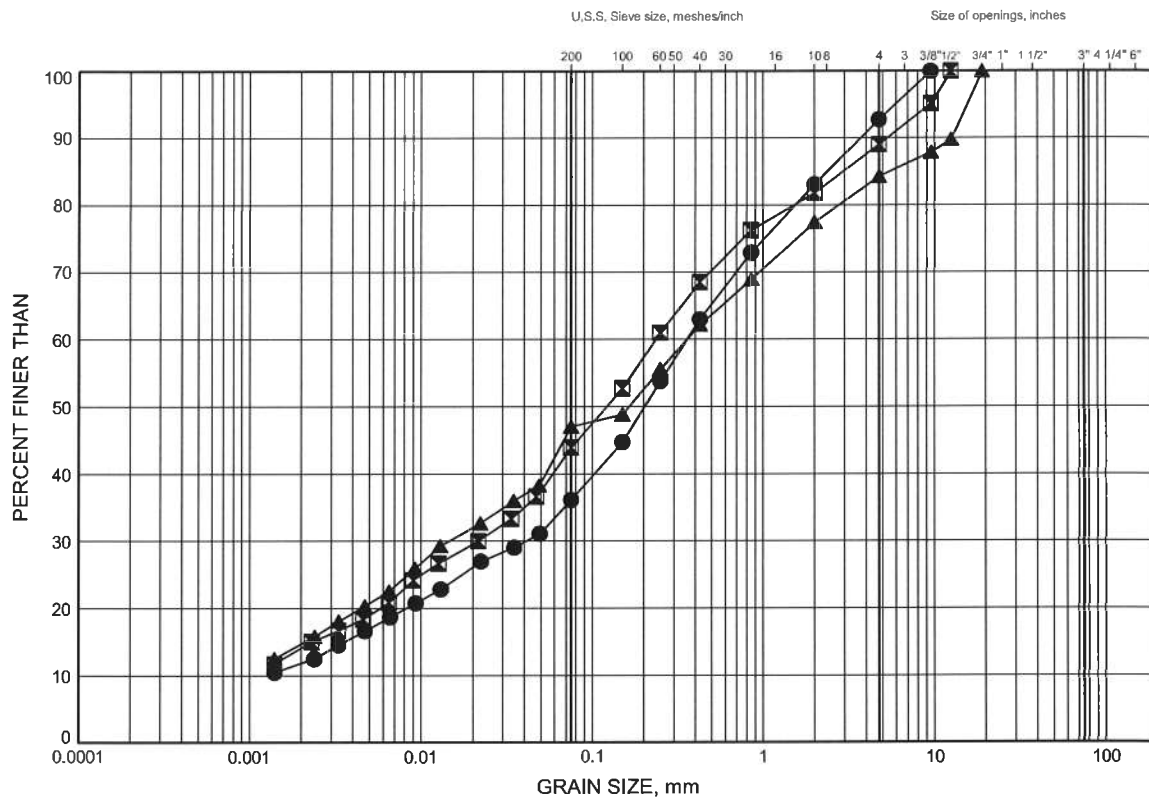
Prep'd MFA  
Chkd. LRB

# Highway 417 Ottawa: Nicholas to Vanier

## GRAIN SIZE DISTRIBUTION

FIGURE A6

### SILTY SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-02R	3.35	56.39
■	OHS-03L	3.35	56.85
▲	OHS-03L	6.25	53.95

GRAIN SIZE DISTRIBUTION - THURBER 1201A.GPJ 5/10/12

Date May 2012  
W.P.# 4091-07-00

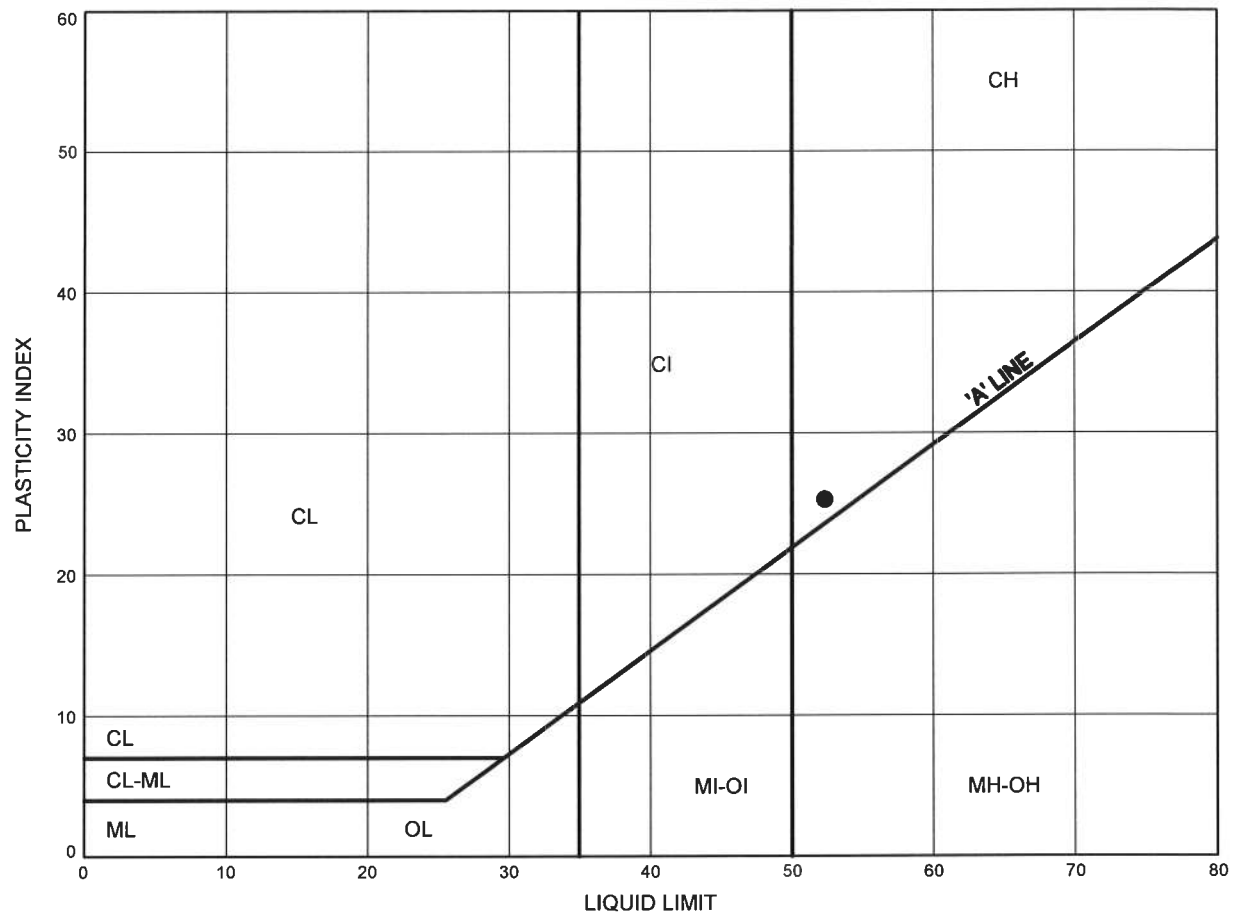


Prep'd AN  
Chkd. LRB

Highway 417 Ottawa: Nicholas to Vanier  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE A7

**SILTY CLAY**



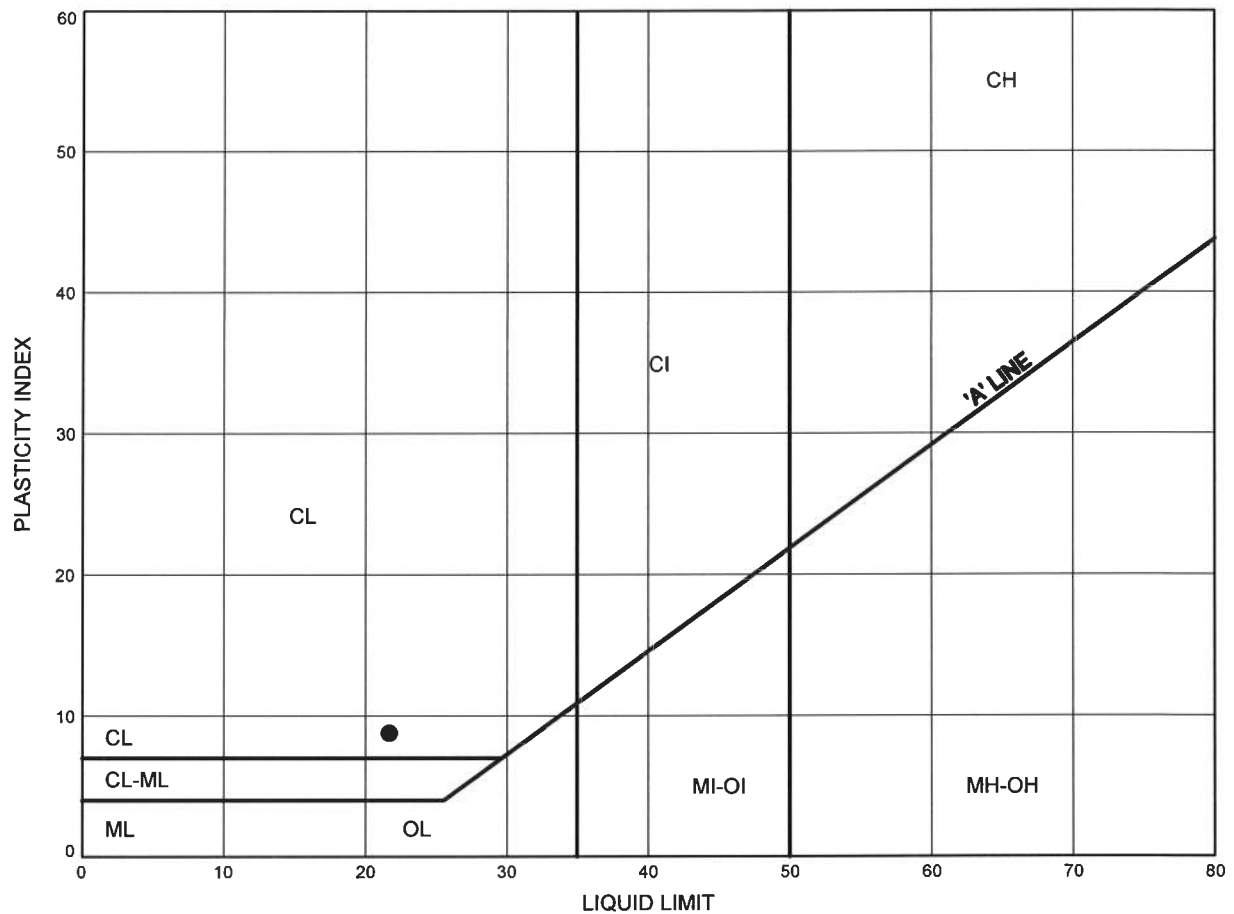
**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-04L	4.88	55.92

Highway 417 Ottawa: Nicholas to Vanier  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE A8

**SILTY SAND TILL**



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-03L	6.25	53.95

## **Appendix B**

### **Highway 417: Riverside Drive to O.R.174 (BHs OHS-05L/05R to OHS-13, VMS-2L/2R & VMS-3L/3R) Record of Borehole Sheets and Laboratory Test Results**

RECORD OF BOREHOLE No OHS-05L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 046.4 E 370 692.6 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers/Casing/NQ Coring COMPILED BY AN  
DATUM Geodetic DATE 2012.02.07 - 2012.02.07 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)						
59.6								20	40	60	80	100						
0.0	ASPHALT: (140mm)																	
0.1	Silty SAND, trace to some gravel Very Dense Dark Brown to Brown Moist (FILL)		1	GS			59											
			1	SS	51													
	Occasional limestone fragments and shale pieces		2	SS	84/ 0.275		58											
57.6																		
2.0	SHALE, moderately to slightly weathered, thinly bedded, grey, limestone interbeds through out  Cored from 2.3m Limestone interbed (25mm thick) at 2.4m, 2.6m, 2.7m, 2.9m, 3.0m, 3.2m, 3.9m, 4.1m  Sub-vertical fractures (25mm to 50mm long) at 3.4m, 4.1m, 5.1m, 5.3m  Limestone interbeds at 4.8m, 5.1m		1	RUN			57											
			2	RUN			56											
			3	RUN			55											
54.3																		
5.3	END OF BOREHOLE AT 5.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.8m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.																	

ONTMT4S 1201B.GPJ 5/11/12



RECORD OF BOREHOLE No OHS-05R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 031.9 E 370 681.0 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN  
DATUM Geodetic DATE 2012.03.27 - 2012.03.27 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED   + FIELD VANE ● QUICK TRIAXIAL   × LAB VANE			WATER CONTENT (%) w <sub>p</sub> w   w <sub>L</sub>					
59.8	ASPHALT: (25mm)  Silty SAND, trace to some gravel, trace clay Compact Brown Damp (FILL)															
59.8			1	GS												
			1	SS	19											12 61 21 6
58.2																
58.6	Sandy SILT, trace gravel Very Dense Grey Damp (TILL)  SHALE, highly to moderately weathered, thinly bedded, horizontally laminated, grey Cored from 1.9m Limestone interbeds at 2.2m, 2.3m and 2.5m Sub-vertical fractures (25mm long) at 2.8m 75mm at 2.4m Core sample jammed in core barrel. Unable to retrieve core Clay seam (25mm thick) at 2.1m, 2.9m, 3.0m: 75mm at 1.8m		2	SS	73/ 0.175									FI		
1.8			1	RUN											3	RUN #1 TCR=100% SCR=97% RQD=85% UCS=8.1MPa (Average)
			2	RUN											5	
			3	RUN											6	
															>5	RUN #2 TCR=100% SCR=100% RQD=0% UCS=9.6MPa (Average)
55.3														>5		
4.5	END OF BOREHOLE AT 4.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m, THEN ASPHALT TO SURFACE.															

ONTMT4S 1201B.GPJ 5/16/12

# RECORD OF BOREHOLE No OHS-06L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 420.0 E 370 907.3 ORIGINATED BY RK/ES  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA  
 DATUM Geodetic DATE 2012.03.14 - 2012.03.22 CHECKED BY LRB

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									WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE						W <sub>p</sub>	W
62.7						20	40	60	80	100	20	40	60					
62.4	TOPSOIL: (50mm)																	
0.3	SAND and GRAVEL Loose Brown Damp (FILL)		1	SS	9						○							
	Silly SAND, some gravel, trace to some clay, occasional shale fragments Compact to Very Dense Brown Damp (FILL)		2	SS	21						○							
			3	SS	41						○				16 41 31 12			
			4	SS	61						○							
59.7																		
3.0	Clayey SILT, some sand, trace gravel, occasional cobbles Very Stiff Brown (FILL)		5	SS	28						○							
58.1																		
4.6	Sandy SILT, trace to some clay, trace gravel Dense Dark Grey Damp (TILL)		6	SS	49						○							
56.6																		
6.1	Clayey SILT, some sand, trace gravel		7	SS	66/						○							
56.3	Hard				175													
56.4	Dark Grey (TILL)																	
6.4	SHALE, weathered, grey																	
	END OF BOREHOLE AT 6.4m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) May02/12 3.0 59.7																	

ONTMT4S 1201B GPJ 5/16/12

# RECORD OF BOREHOLE No OHS-06R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 401 9 E 370 896 1 ORIGINATED BY ES  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.02.10 - 2012.02.10 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
62.9								20 40 60 80 100						
0.0 0.1	TOPSOIL: (75mm)							20 40 60 80 100						
	SAND, some gravel, some silt Compact Brown Moist (FILL)		1	SS	21		62							
61.2														
1.7	Silty SAND, some clay, trace gravel, occasional cobble Compact Dark Brown to Grey Moist (FILL)		2	SS	25		61							5 46 30 19
			3	SS	14		60							
59.8														
3.1	Sandy SILT, trace clay, trace gravel Compact to Very Dense Brown Moist (FILL)		4	SS	16		59							
58.3														
4.6	Silty SAND, some clay, trace gravel Very Dense to Compact Dark Grey Moist (TILL) Occasional shale and limestone fragments		5	SS	50/ 0.100		58							
			6	SS	20		57							1 59 25 15
55.9														
7.0	SAND, trace gravel Very Dense Grey Wet						56							
55.3														
55.9 7.6	SHALE, weathered, grey		7	SS	60/ 0.025									
END OF BOREHOLE AT 7.6m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.														
WATER LEVEL READINGS: DATE      DEPTH (m)      ELEV. (m) Mar.27/ 12      2.0      60.9 May02/12      5.0      57.9														

ONTMT4S 1201B.GPJ 5/11/12

# RECORD OF BOREHOLE No OHS-07L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 391.4 E 371 216.4 ORIGINATED BY RK  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.03.14 - 2012.03.14 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
60.9								20   40   60   80   100		w <sub>p</sub> w   w <sub>L</sub>				
0.0	ASPHALT: (150mm)							○ UNCONFINED   + FIELD VANE						
0.2	Gravelly SAND Brown Moist (FILL)							● QUICK TRIAXIAL   × LAB VANE						
59.8			1	SS	10		60							
1.1	Clayey SILT, some sand, some gravel Stiff Dark Grey (FILL)													
59.4														
1.5	Sandy SILT, some clay Dense to Compact Dark Grey Damp (FILL)		2	SS	38		59							0   30   53   17
			3	SS	13									
58.0														
2.9	Sandy SILT, some clay, trace gravel Compact Dark Grey Damp to Moist (TILL)		4	SS	20		58							
			5	SS	14		56							
54.8			6	SS	50/150		55							
6.1	END OF BOREHOLE AT 6.1m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE   DEPTH (m)   ELEV. (m) Mar.22/12   2.2   58.7													

+<sup>3</sup>, ×<sup>3</sup> Numbers refer to  
Sensitivity 20  
15 10 5  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No OHS-07R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 375.2 E 371 218.8 ORIGINATED BY ES  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.02.16 - 2012.02.16 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR   SA   SI   CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED   + FIELD VANE ● QUICK TRIAXIAL   × LAB VANE	20   40   60   80   100	w <sub>P</sub> w   w <sub>L</sub>				
60.7								20   40   60   80   100		20   40   60				
0.0	ASPHALT: (75mm)													
0.1	SAND, some gravel, some silt, trace clay Dense Brown Damp (FILL)		1	GS			60							
			1	SS	41									
59.1														
1.6	SILT and SAND, some clay, trace gravel Compact Brown Damp (FILL)		2	SS	25		59						3   42   40   15	
58.3														
2.4	Clayey SILT, some sand, trace gravel Stiff Dark Brown (TILL)		3	SS	15		58							
57.6														
3.1	Silty SAND, some clay, trace gravel, occasional cobble Loose Grey Moist to Wet (TILL)		4	SS	4		57						4   54   26   16	
			5	SS	5		56							
							55							
54.6														
54.6	SHALE, highly weathered, grey		6	SS	50									
6.1	END OF BOREHOLE AT 6.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m, THEN ASPHALT TO SURFACE.				0.025									

+ 3, X 3 : Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OHS-08L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 436.6 E 371 623.4 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2012.03.15 - 2012.03.15 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
63.4								20 40 60 80 100						
0.0	ASPHALT: (75mm)							UNCONFINED + FIELD VANE						
0.1	SAND, trace to some gravel, some silt Brown Damp (FILL.) Dense Grey		1	GS				QUICK TRIAXIAL X LAB VANE						
			1	SS	49			WATER CONTENT (%)						
								20 40 60						
61.9														
1.5	Silty SAND, some clay, trace gravel Dense to Very Dense Dark Brown Damp (TILL.)  Occasional cobbles		2	SS	48									
			3	SS	63									
60.3														
3.1	SAND, some silt, trace gravel, occasional cobble Very Dense Dark Brown to Grey Damp  Occasional shale fragments		4	SS	50/ 0.125									
			5	SS	100/ 0.150									
58.3														
5.1	SHALE, highly weathered, grey													
57.3														
6.1	END OF BOREHOLE AT 6.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.8m, CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.		6	SS	100/ 0.025									

+<sup>3</sup>, X<sup>3</sup> Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OHS-08R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 421.1 E 371 625.7 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2012.02.16 - 2012.02.16 CHECKED BY LRB

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 ○ UNCONFINED   + FIELD VANE ● QUICK TRIAXIAL   x LAB VANE		WATER CONTENT (%) w <sub>p</sub> w   w <sub>L</sub>					
63.7							20	40	60	80	100	20	40	60	9   48   30   13
0.0	ASPHALT: (110mm)														
0.1	SAND, trace to some gravel, some silt Brown Damp (FILL)		1	GS											
62.9															
0.8	Silty SAND, some gravel, occasional cobble Very Dense to Dense Dark Brown Damp (FILL)		1	SS	60										
61.8			2	SS	31										
1.9	Silty SAND, some clay, trace gravel Compact Dark Brown Damp (TILL)		3	SS	28										
			4	SS	28										
59.4															
4.3	SAND, trace gravel, occasional cobbles Dense Grey Moist		5	SS	49										
57.6															
56.4	SHALE, weathered, grey		6	SS	100/										
6.2	END OF BOREHOLE AT 6.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.2m, THEN ASPHALT TO SURFACE.				0.125										

+ 3 x 3 Numbers refer to  
Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OHS-09L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 471.6 E 371 134.9 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2012.03.11 - 2012.03.11 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
69.6	ASPHALT: (100mm)													
0.0														
0.1														
	SAND, some gravel, some silt, trace clay Dense to Very Dense Brown Damp (FILL)		1	GS										
			1	SS	32									
			2	SS	60									
67.3														
2.3	Silty SAND, some clay, trace gravel Very Dense to Compact Brown to Grey Moist (TILL)		3	SS	64									
			4	SS	24									
65.9														
3.7	SHALE, highly weathered, grey													
			5	SS	100/									
					0.050									
64														
63.5														
6.1	END OF BOREHOLE AT 6.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.1m, CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.		6	SS	100/									
					0.050									

+<sup>3</sup>, x<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10  
(%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No OHS-09R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 445.0 E 371 138.9 ORIGINATED BY ES  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2012.03.07 - 2012.03.07 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
69.2								20 40 60 80 100					
0.0	TOPSOIL: (50mm)												
	Silty SAND, some gravel, trace to some clay Loose Dark Brown Moist to Wet (FILL)		1	SS	9		69						
67.8							68						
1.4	Silty SAND, trace clay Loose Brown Wet		2	SS	9								0 61 32 7
							67						
66.8													
2.4	Sandy SILT, some gravel, some clay, some shale fragments Dense Dark Brown Moist (TILL)		3	SS	31								
66.2							66						
3.0	SHALE, fresh, dark grey, thinly laminated, occasional limestone interbeds		1	RUN									
			2	RUN									RUN #2 TCR=100% SCR=35% RQD=0%
			3	RUN			65						RUN #3 TCR=100% SCR=61% RQD=15% UCS=15MPa (Average)
			4	RUN			64						RUN #4 TCR=100% SCR=97% RQD=75% UCS=9MPa (Average)
62.9							63						
6.3	END OF BOREHOLE AT 6.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar.22/12 2.0 67.2												

+<sup>3</sup> . X<sup>3</sup> . Numbers refer to  
Sensitivity 20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No OHS-10L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 404.7 E 372 393.9 ORIGINATED BY ES  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA  
 DATUM Geodetic DATE 2012.03.22 - 2012.03.22 CHECKED BY LRB

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								WATER CONTENT (%)		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE									
69.5																		
0.0	ASPHALT: (75mm)																	
0.1	SAND, some gravel, some silt, trace to some clay Compact to Very Dense Brown Damp (FILL)		1	GS														
			1	SS	24													
	Dark Grey		2	SS	77/ 225										20 54 17 9			
	Occasional shale fragments and occasional cobbles		3	SS	50/ 100													
66.1			4	SS	39													
3.4	Silty SAND, some clay, trace gravel, occasional cobbles Dense Dark Grey Damp (FILL)																	
64.8			5	SS	23													
4.7	Sandy SILT, some clay, trace gravel Compact Dark Grey Moist (TILL)																	
63.4			6	SS	100/ 025													
69.4	SHALE, highly weathered, grey																	
6.1	END OF BOREHOLE AT 6.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.0m, CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.																	

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

## METRIC

[illegible]

ONTMT4S 1201B.GPJ 5/11/12

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

RECORD OF BOREHOLE No OHS-11L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 609.2 E 372 954.5 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN  
DATUM Geodetic DATE 2012.03.11 - 2012.03.11 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE				WATER CONTENT (%) w <sub>p</sub> w      w <sub>L</sub>						
71.3								20	40	60	80	100						
71.3	ASPHALT: (50mm)																	
	GRAVEL, some sand Brown Moist (FILL)		1	GS			71							○				
70.2			1	SS	19									○				
1.1	Silty SAND, some clay, trace gravel Dense Dark Brown/Grey (FILL)						70											
			2	SS	38									○				
69.0																		
2.3	SAND, some silt, trace gravel, occasional cobbles Very Dense Brown Damp (FILL)		3	SS	50/ 0.125		69							○				
68.2			4	SS	100/ 0.075									○				
3.1	SHALE, moderately to slightly weathered, thinly bedded, horizontally laminated, grey Limestone interbed at 3.1m Sub-vertical fracture (50mm) at 3.1m Limestone interbeds at 3.7m, 3.8m, 3.9m, 4.2m, 4.4m and 4.5m Broken zone (75mm) at 3.5m and (50mm) at 4.5m		1	RUN			68											
			2	RUN			67											
							66											
	Limestone interbeds at 5.2m, 5.4m, 5.5m, 5.7m, 5.8m, 5.9m, 6.0m, 6.1m		3	RUN														
	Sub-vertical fracture (25mm) at 5.1m																	
65.2																		
6.1	END OF BOREHOLE AT 6.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.2m, CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.																	

1 51 27 21

Run #1  
TCR=100%  
SCR=78%  
RQD=78%  
UCS=29MPa  
(Average)  
Run #2  
TCR=100%  
SCR=95%  
RQD=87%  
UCS=25MPa  
(Average)  
Run #3  
TCR=100%  
SCR=100%  
RQD=97%  
UCS=22MPa  
(Average)

+<sup>3</sup>, ×<sup>3</sup> Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OHS-11R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 585.8 E 372 963.1 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2012.03.14 - 2012.03.14 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
71.7								20	40	60	80	100		
0.0	ASPHALT: (100mm)													
0.1	SAND, some gravel, some silt Compact Brown to Grey Damp to Moist (FILL)		1	GS			71							
			1	SS	23									
70.2														
1.5	Silty CLAY, sandy, trace gravel Hard Grey (FILL)		2	SS	46		70							
			3	SS	25		69							5 24 40 31
68.6			4	SS	100/									
3.1	SHALE, moderately weathered to fresh, thinly bedded, horizontally laminated, grey Limestone interbeds at 3.3m, 3.4m, 3.6m, 3.7m and 4.2m Sub-vertical fractures at: 150mm at 3.5m 75mm at 4.0m		1	RUN	0.075		68							RUN #1 TCR=100% SCR=100% RQD=89% UCS=20MPa (Average)
	Limestone interbeds at 4.3m, 4.4m, 4.5m, 5.3m, 5.4m Vertical fracture (300mm) at 4.8m		2	RUN			67							RUN #2 TCR=100% SCR=100% RQD=100% UCS=21MPa (Average)
	Sub-vertical fracture at 4.9m, 5.0m, 5.1m													
	Limestone interbed at 5.9m, 6.0m, 6.1m, 6.2m and 6.3m		3	RUN			66							RUN #3 TCR=100% SCR=100% RQD=100% UCS=11MPa (Average)
65.3														
6.4	END OF BOREHOLE AT 6.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.9m, CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.													

ONTMT4S 1201B GPJ 5/16/12

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity 20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No OHS-12L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 548.3 E 372 790.5 ORIGINATED BY ES  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.03.13 - 2012.03.13 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <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 LAB VANE				WATER CONTENT (%) w <sub>P</sub> w      w <sub>L</sub>				
72.3							20	40	60	80	100					
0.0	ASPHALT: (100mm)															
0.1	SAND, trace gravel, some silt Brown Damp (FILL)		1	GS												
71.5																
0.8	SAND, fine grained Dense Brown Moist (FILL)		1	SS	35											
70.6																
1.7	Clayey SILT, some sand, trace gravel Stiff Grey (FILL)		2	SS	10											
69.9																
2.4	SAND, fine grained, some silt, trace gravel Compact Brown Moist (FILL)		3	SS	26											
69.3																
3.0	Silty SAND, some clay, trace gravel Compact Dark Brown Damp (TILL)		4	SS	13											2   56   29   13
68.1																
4.2	SHALE, highly weathered, grey		5	SS	100/ 0.125											
66.2																
6.1	END OF BOREHOLE AT 6.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.3m, CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.		6	SS	100/ 0.050											

ONTMT4S 1201B GPJ 5/11/12

# RECORD OF BOREHOLE No OHS-12R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 522.7 E 372 799.5 ORIGINATED BY ES  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2012.02.11 - 2012.02.11 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
71.7								20	40	60	80	100		
0.0	<b>TOPSOIL:</b> (100mm)							20	40	60	80	100		
0.1	<b>SAND</b> , some silt, some gravel Loose Brown Damp (FILL)		1	SS	7		71							
70.2														
1.5	<b>GRAVEL</b> , some sand, trace silt Loose Brown Damp (FILL)		2	SS	8		70							
69.4														
2.3	Clayey <b>SILT</b> , some sand, trace gravel Very Stiff Brown (TILL)		3	SS	18		69							
69.0														
2.7	<b>SHALE</b> , highly to moderately weathered, grey Cored from 3.0m		1	RUN			68						FI	RUN #1 TCR=91% SCR=41% RQD=30% UCS=70MPa (Average)
	Thinly bedded, horizontally laminated Thin limestone interbeds through out Limestone interbed at 3.3m, 3.4m Soft zone (200mm) at 4.0m Sub-vertical fracture (100mm) at 3.4m, 3.6m													RUN #2 TCR=100% SCR=23% RQD=15%
	Vertical fracture (75mm to 100mm) at 4.6m, 5.5m, 5.8m, 6.2m		2	RUN			67							
	Limestone interbed at 5.8m, 6.2m													
			3	RUN			66							RUN #3 TCR=100% SCR=100% RQD=75% UCS=29MPa (Average)
65.4														
6.3	END OF BOREHOLE AT 6.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.													
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar 22/12 4.1 67.6 May 01/12 3.0 68.7													

+ 3, x 3 : Numbers refer to  
Sensitivity 20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No OHS-13

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 780.1 E 373 545.1 ORIGINATED BY ES  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.03.30 - 2012.03.30 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>		
66.9													
0.0	TOPSOIL: (50mm)												
0.2	SAND, some gravel to gravelly, some silt, trace clay Compact Brown Moist (FILL) Trace roots		1	GS									
			1	SS	15		66						
			2	SS	14		65						22 61 14 3
	Wet		3	SS	27		64						
63.7													
3.2	Gravelly SAND, occasional cobble Very Dense Grey Wet		4	SS	59		63						
62.6													
4.3	SAND, coarse grained, trace gravel Dense Grey Wet		5	SS	36		62						
61.8													
5.1	SHALE, highly weathered, grey						61						
60.8													
6.1	END OF BOREHOLE AT 6.1m. WATER LEVEL AT 1.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.5m, THEN CUTTINGS TO SURFACE.		6	SS	50/								
					0.025								

+ 3 . X 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No VMS-2L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 176.0 E 370 722.5 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MFA  
DATUM Geodetic DATE 2012.03.21 - 2012.03.21 CHECKED BY LRB

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									
59.7								20	40	60	80	100					
0.0	ASPHALT: (100mm)																
0.1	SAND, some gravel, some silt Brown Damp (FILL)		1	GS													
58.7																	
1.0	Sandy SILT, some clay, trace gravel Compact to Very Dense Brown to Grey Damp (FILL) Occasional cobble		1	SS	20												
			2	SS	57												
57.5																	
2.2	SHALE, highly weathered, grey Cored from 2.4m  Moderately weathered, thinly bedded, horizontally laminated  Limestone interbeds at 2.46, 2.57, 2.62, 2.74, 2.84, 2.95, 3.22, 3.45, 3.53, 3.56, 3.63, and 3.73m  Sub-vertical fractures at 2.64, 2.84 to 2.92, and 3.02 to 3.07m  Limestone interbeds at 4.04, 4.40, 4.82, 4.85, 4.88, and 5.23m  Highly broken zones at 4.14 to 4.17, and 4.65 to 4.75m  Vertical fracture at 5.36 to 5.49m  Sub-horizontal fracture at 5.36 to 5.49m		3	SS	50/ .125												
			1	RUN													
			2	RUN													
54.2																	
5.5	END OF BOREHOLE AT 5.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.2m, CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.																

+ 3 . X 3 : Numbers refer to  
Sensitivity



20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No VMS-2R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 156.5 E 370 726.4 ORIGINATED BY ES  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2012.02.06 - 2012.02.06 CHECKED BY LRB

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									WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE											
59.5							20	40	60	80	100								
0.0	<b>SAND</b> , some gravel Compact Brown Moist (FILL)		1	GS															
58.4			1	SS	18														
1.1	Clayey <b>SILT</b> , some sand, trace gravel Dark Grey (FILL)																		
57.9																			
1.6	<b>SILT</b> , some sand, some clay, trace gravel Dense Dark Grey Moist (FILL)		2	SS	35														
57.2																			
2.3			3	SS	100/														
					0.100														
	<b>SHALE</b> , highly weathered, thinly bedded, grey, occasional thin limestone interbeds through out																		
	Cored from 3.0m		4	SS	100/														
						0.075													
	Highly broken zone (375mm) at 3.7m		1	RUN															
	Sub-vertical fractures (25mm to 50mm) at 3.5m, 3.6m, 4.5m, 4.7m																		
	Moderately weathered to fresh																		
	Vertical fracture (225mm) at 4.1m																		
	Vertical fractures (50mm) at 4.3m, 4.6m		2	RUN															
53.6																			
5.9	END OF BOREHOLE AT 5.9m. BOREHOLE BACKFILED WITH BENTONITE HOLEPLUG TO 1.1m THEN CUTTINGS TO SURFACE.																		

ONTMT4S 1201B.GPJ 5/11/12

RECORD OF BOREHOLE No VMS-3L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 469 1 E 371 921.8 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN  
DATUM Geodetic DATE 2012.03.15 - 2012.03.15 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
66.9								20	40	60	80	100			
0.0	ASPHALT: (75mm)														
0.1	SAND, some gravel, some silt Dense Brown Damp to Moist (FILL)		1	GS											
65.9			1	SS	50/		66								
1.0	SHALE Cored from 1.1m Moderately weathered, thinly bedded, horizontally laminated, grey  Limestone interbeds at 1.3m, 1.4m, 1.5m, 1.8m, 1.9m, 2.0m, 2.1m, 2.2m, 2.3m, 2.4m Sub-vertical fractures at 1.3m, 1.8m Soft zone at 2.6m and 3.1m Clay seam (50mm) at 2.7m  Limestone interbeds at 3.0m, 3.4m, 3.5m, 3.9m and 4.0m  Sub-vertical fracture (50mm) at 2.8m, 3.0m				0.125								FI	RUN #1 TCR=100% SCR=97% RQD=90% UCS=17MPa (Average)	
			1	RUN			65							>15	
														3	
														>5	
														2	
														2	
							64							>5	RUN #2 TCR=100% SCR=95% RQD=88% UCS=26MPa (Average)
			2	RUN										>5	
														0	
														1	
62.7							63							2	
4.2	END OF BOREHOLE AT 4.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.9m, CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.														

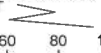








+ 3, x 3 : Numbers refer to 20  
Sensitivity 15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No VMS-3R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 454.9 E 371 918.8 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN  
DATUM Geodetic DATE 2012.02.16 - 2012.02.16 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
							20 40 60 80 100				PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	
							20 40 60 80 100	WATER CONTENT (%)						
							○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
67.1														
0.0	ASPHALT: (100mm)													
0.1														
66.8	CONCRETE: (225mm)		1	GS										
0.3	SAND, trace gravel, some silt Brown Damp (FILL)		1	SS	50/ 0.075									
66.2														
0.9	SHALE, highly weathered, grey Cored from 1.5m		2	SS	50/ 0.025									
	Moderately weathered to fresh, thinly bedded, horizontally laminated Highly broken zone (250mm) at 1.5m		1	RUN										
	Limestone interbeds (25mm to 50mm thick) at 1.8m, 2.2m, 2.4m, 2.5m, 2.9m, 3.2m, 3.3m, 4.0m 125mm at 3.0m													
	Sub-vertical fractures (25mm to 50mm) at 2.3m, 2.6m, 2.7m		2	RUN										
	Limestone interbeds (25mm to 50mm thick) at 4.1m, 4.2m, 4.3m, 4.4m 175mm at 4.5m		3	RUN										
62.3														
4.8	END OF BOREHOLE AT 4.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.2m, THEN ASPHALT TO SURFACE.													

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

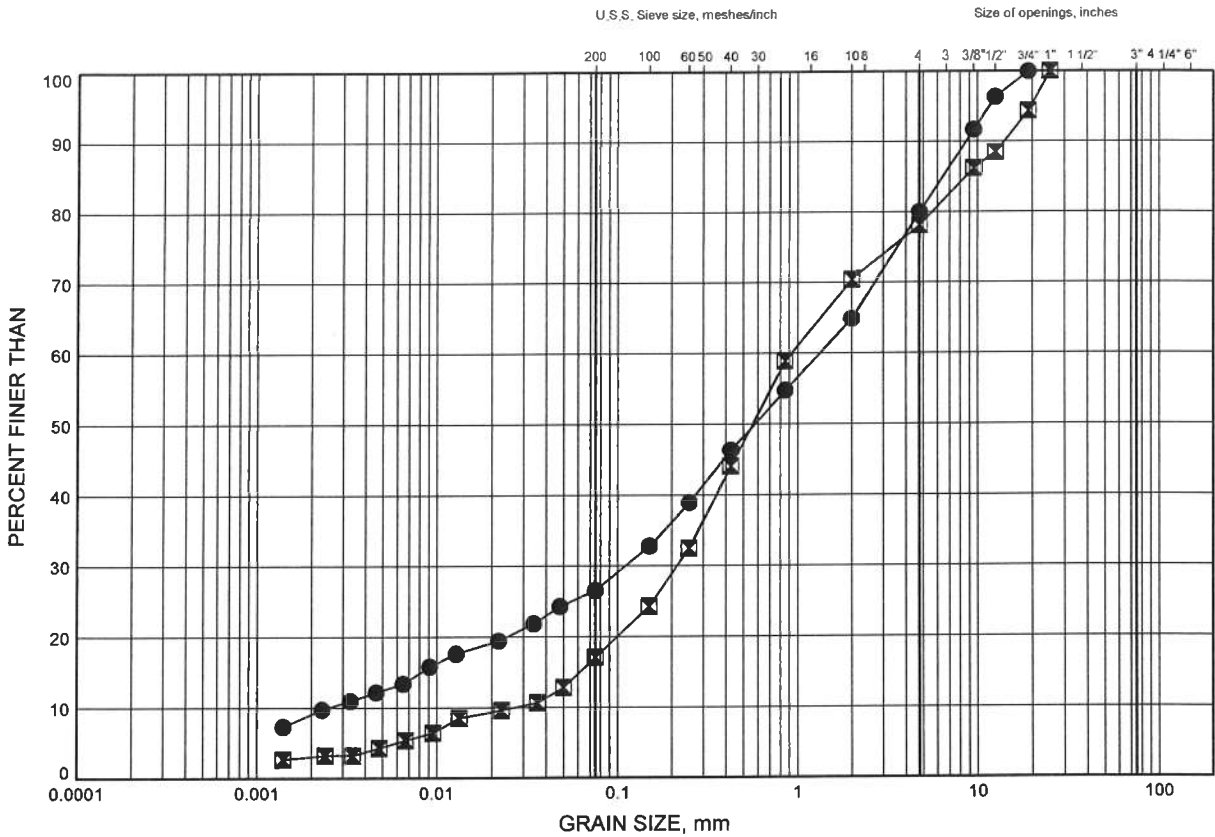
20  
15  
10

(%) STRAIN AT FAILURE

Highway 417 Ottawa: Vanier to OR 174  
GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

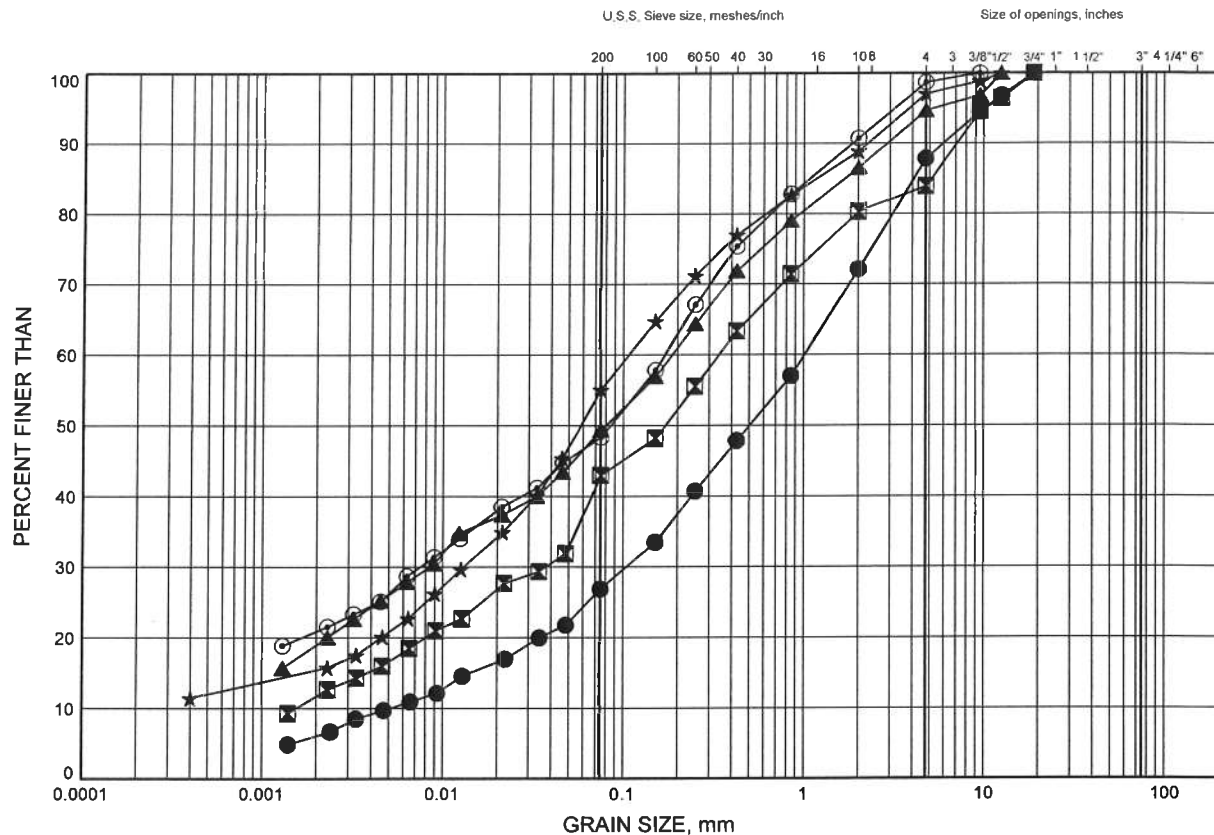
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-10L	1.72	67.78
■	OHS-13	1.83	65.07



# Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE B2

## SILTY SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND			GRAVEL		SIZE

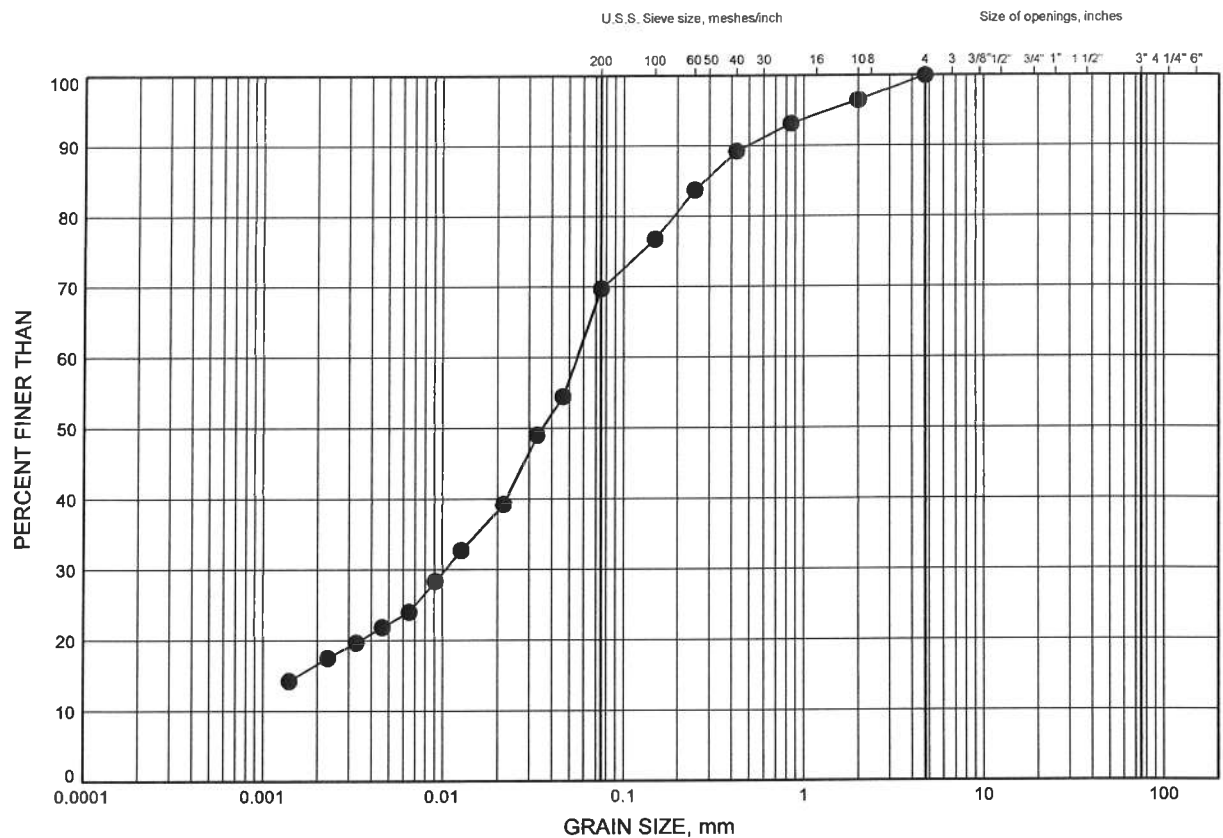
### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-05R	1.07	58.73
⊠	OHS-06L	1.83	60.87
▲	OHS-06R	1.83	61.07
★	OHS-07R	1.83	58.87
⊙	OHS-11L	1.83	69.47

Highway 417 Ottawa: Vanier to OR 174  
**GRAIN SIZE DISTRIBUTION**

FIGURE B3

**SANDY SILT FILL**



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

**LEGEND**

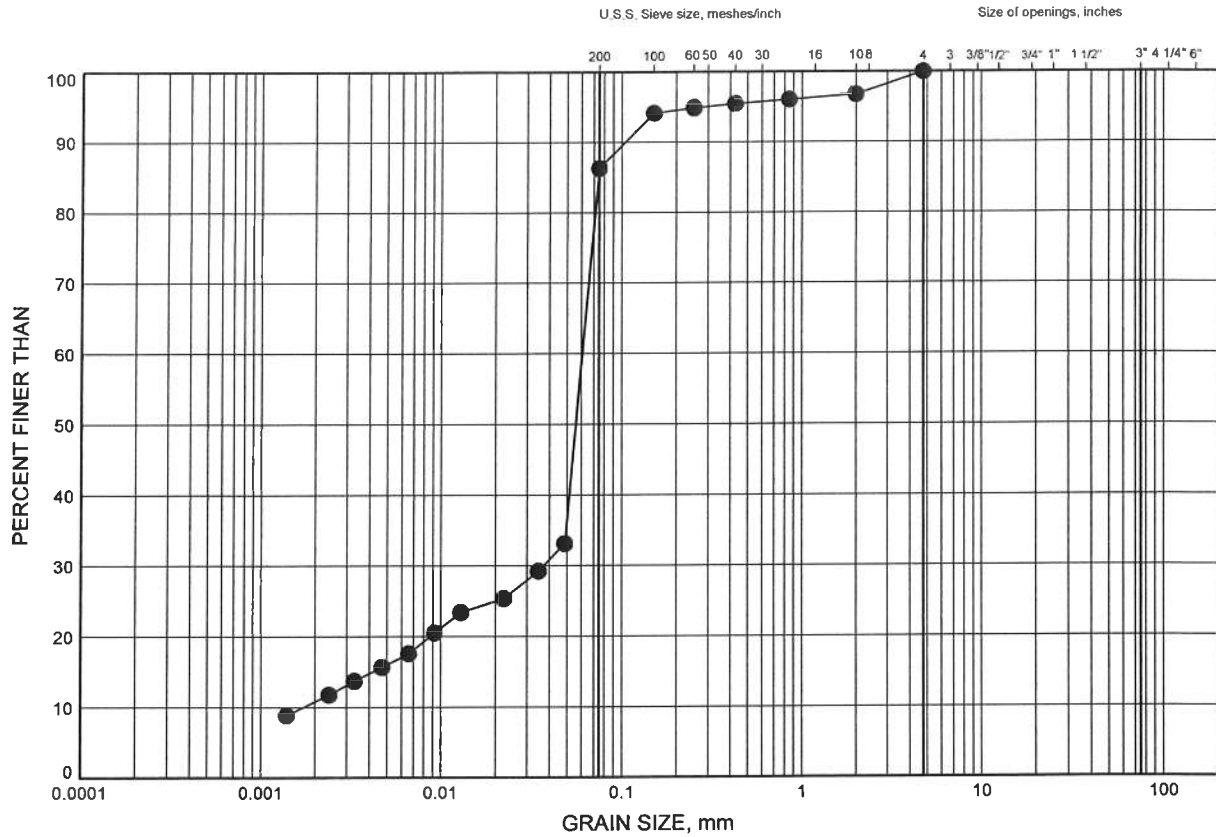
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-07L	1.83	59.07



# Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE B4

## SILT FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

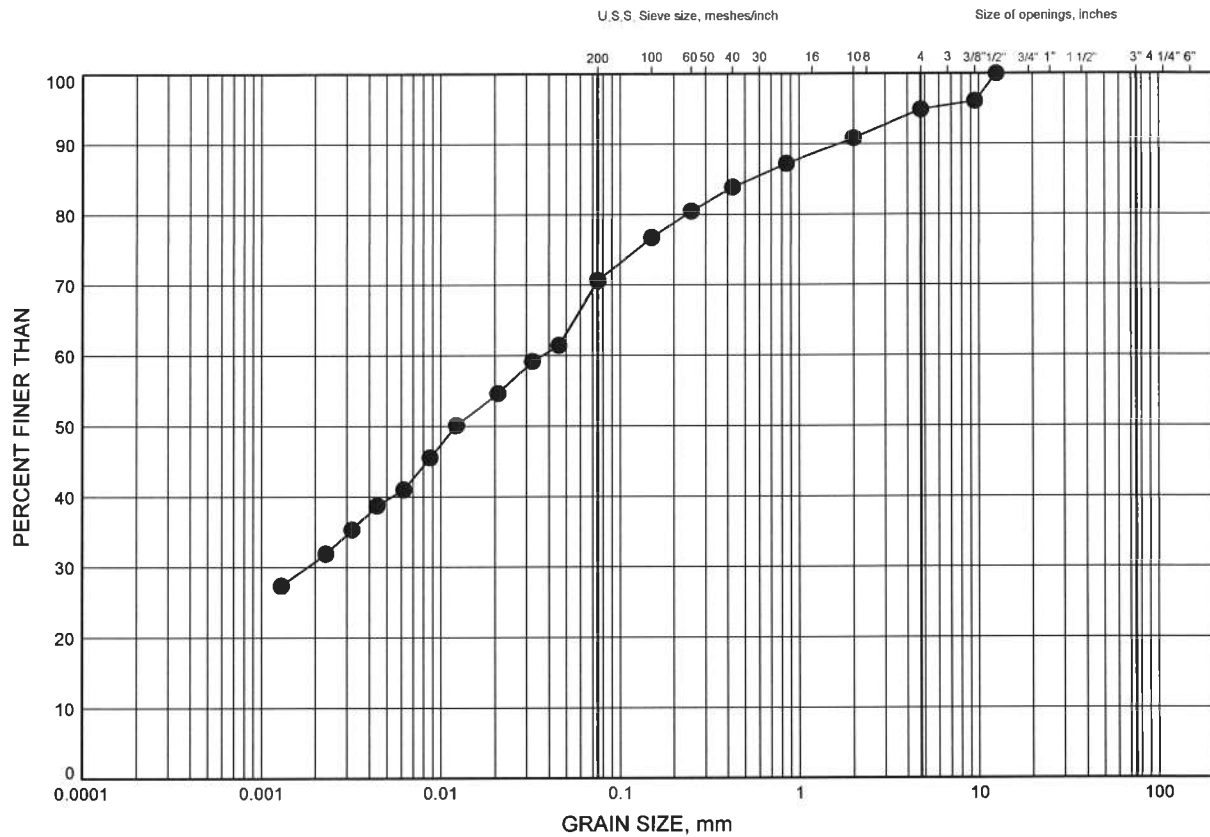
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	VMS-2R	1.83	57.67



Highway 417 Ottawa: Vanier to OR 174  
**GRAIN SIZE DISTRIBUTION**

**FIGURE B5**

**SILTY CLAY FILL**



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

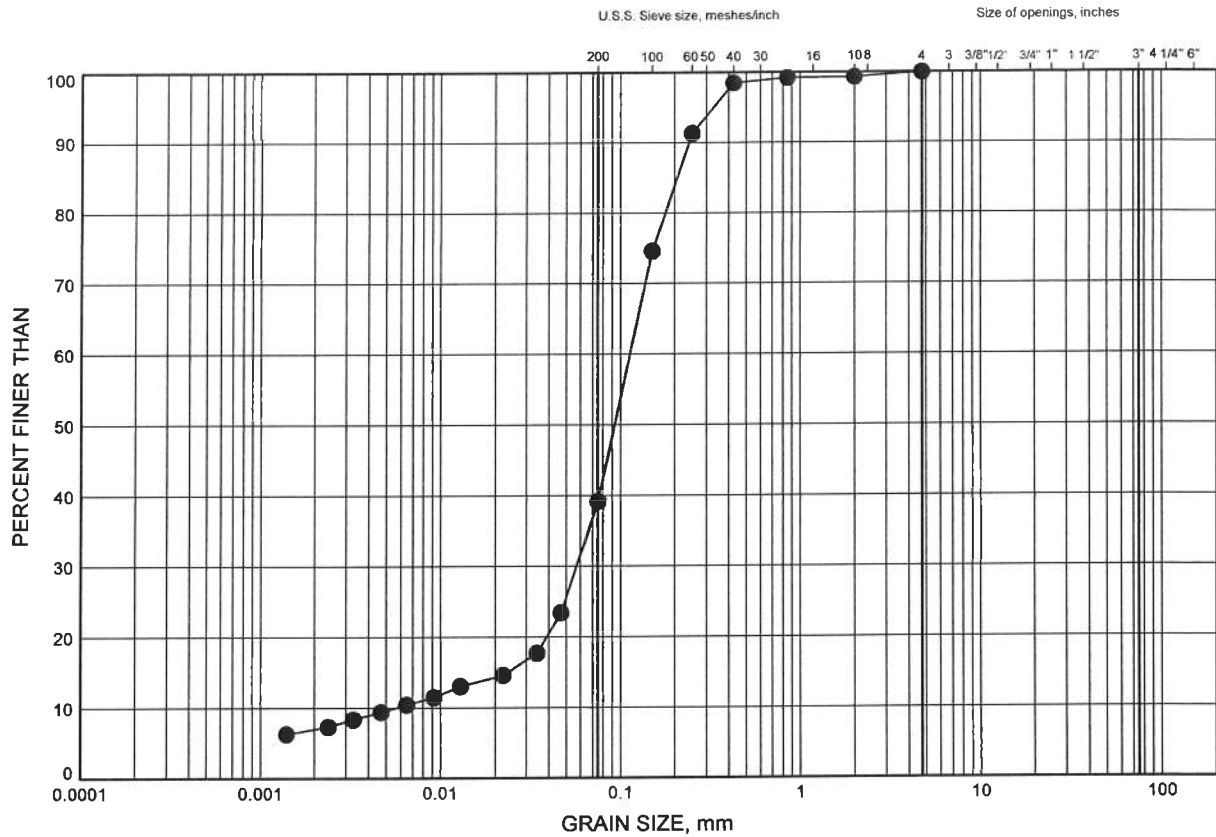
**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-11R	2.59	69.11

# Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE B6

## SILTY SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-09R	1.83	67.37

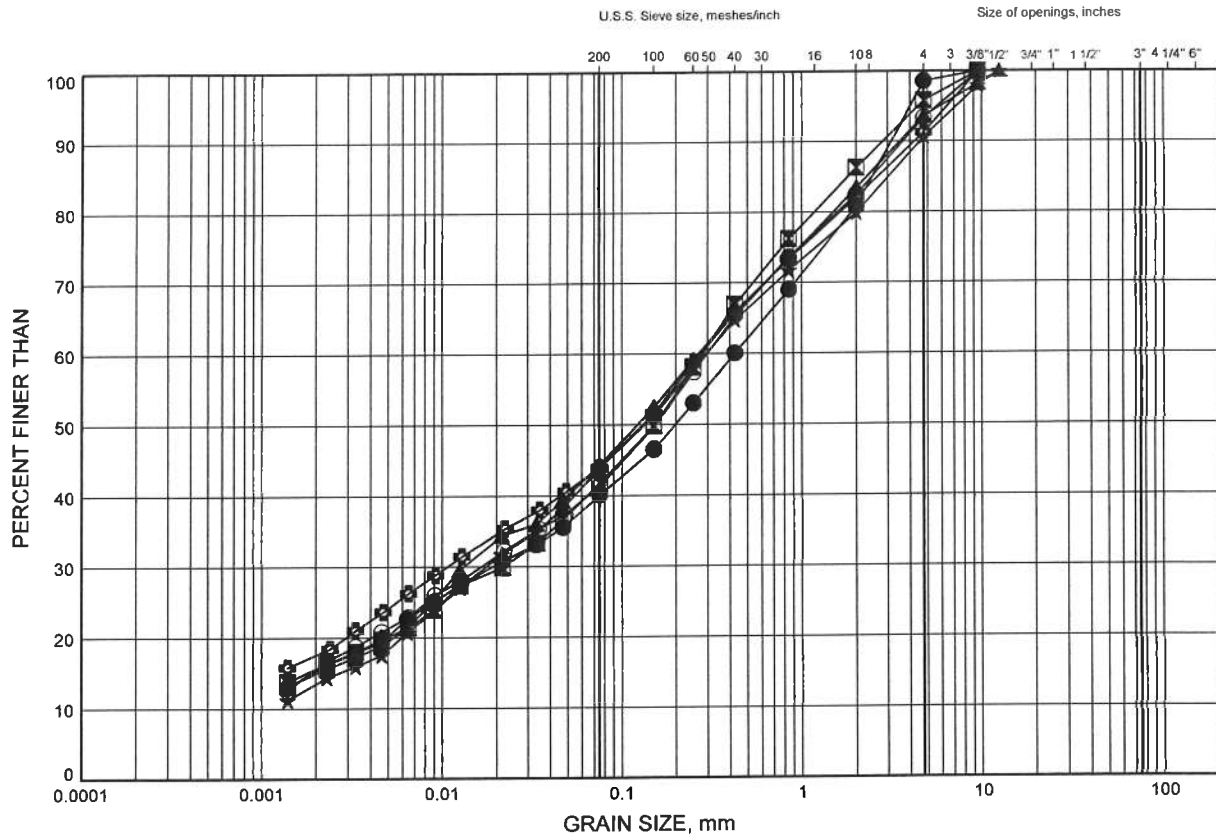


W.P.# 4320-06-00  
Prepared By AN  
Checked By LRB

# Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE B7

## SILTY SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-06R	6.40	56.50
■	OHS-07R	3.35	57.35
▲	OHS-08L	1.83	61.57
★	OHS-08R	2.59	61.11
⊙	OHS-09L	2.59	67.01
⊕	OHS-10R	1.83	65.97

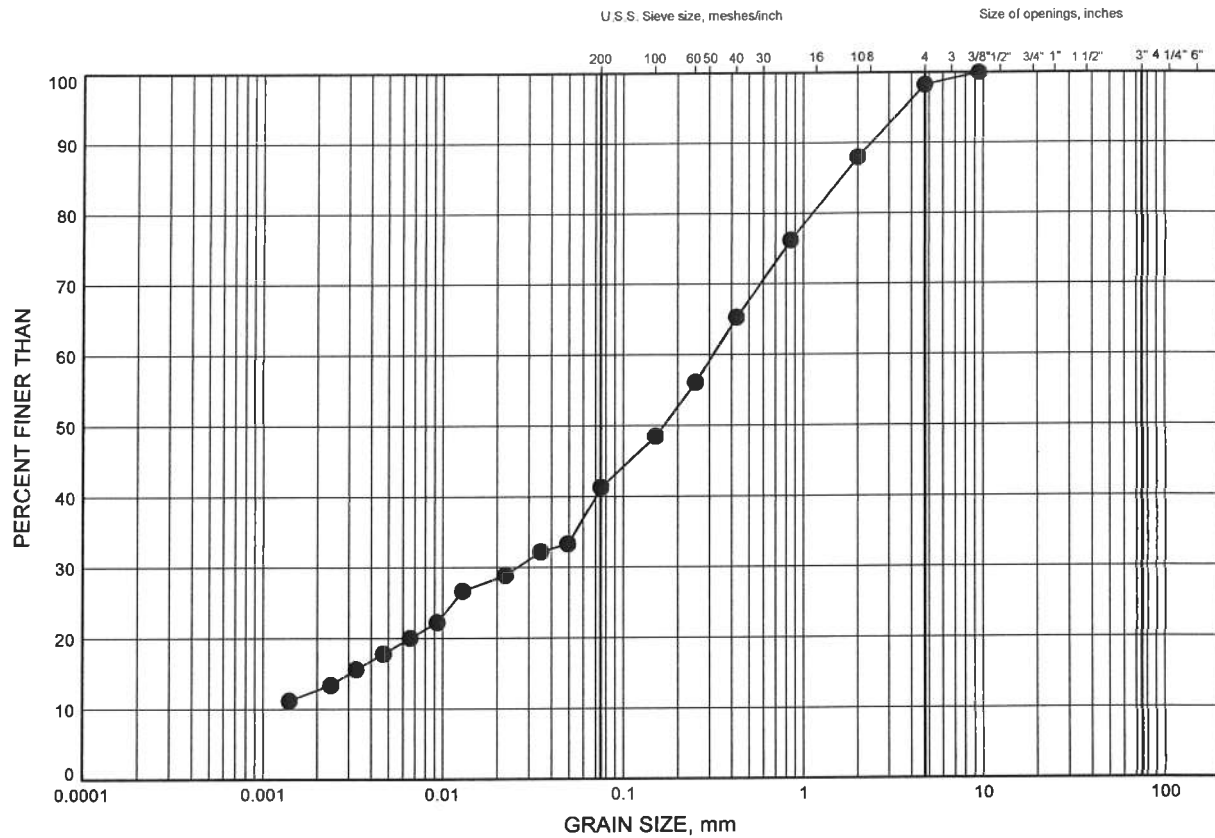


W.P.# 4320-06-00  
Prepared By AN  
Checked By LRB

# Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE B8

## SILTY SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-12L	3.35	68.95

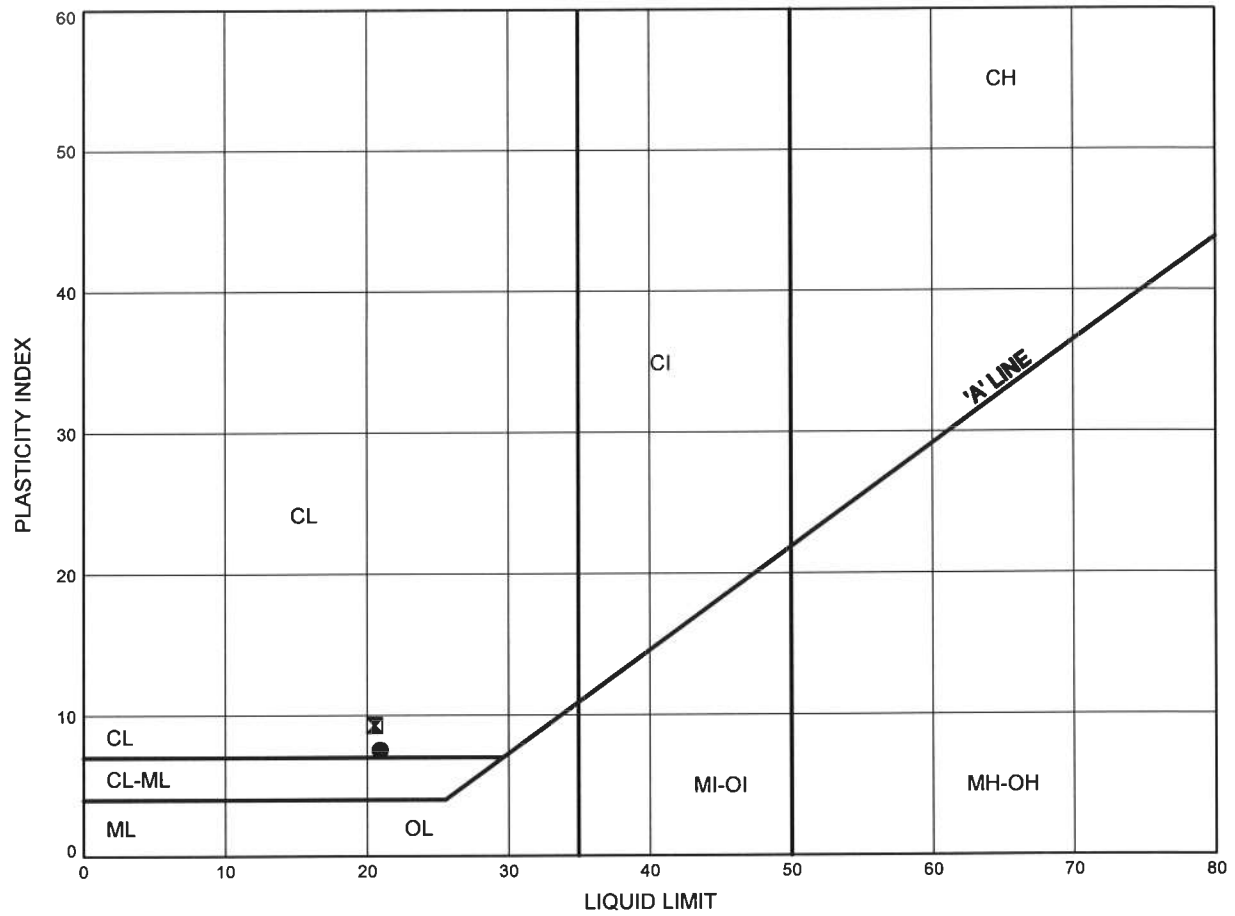


W.P.# 4320-06-00  
Prepared By AN  
Checked By LRB

Highway 417 Ottawa: Vanier to OR 174  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B9

**SILTY SAND FILL**



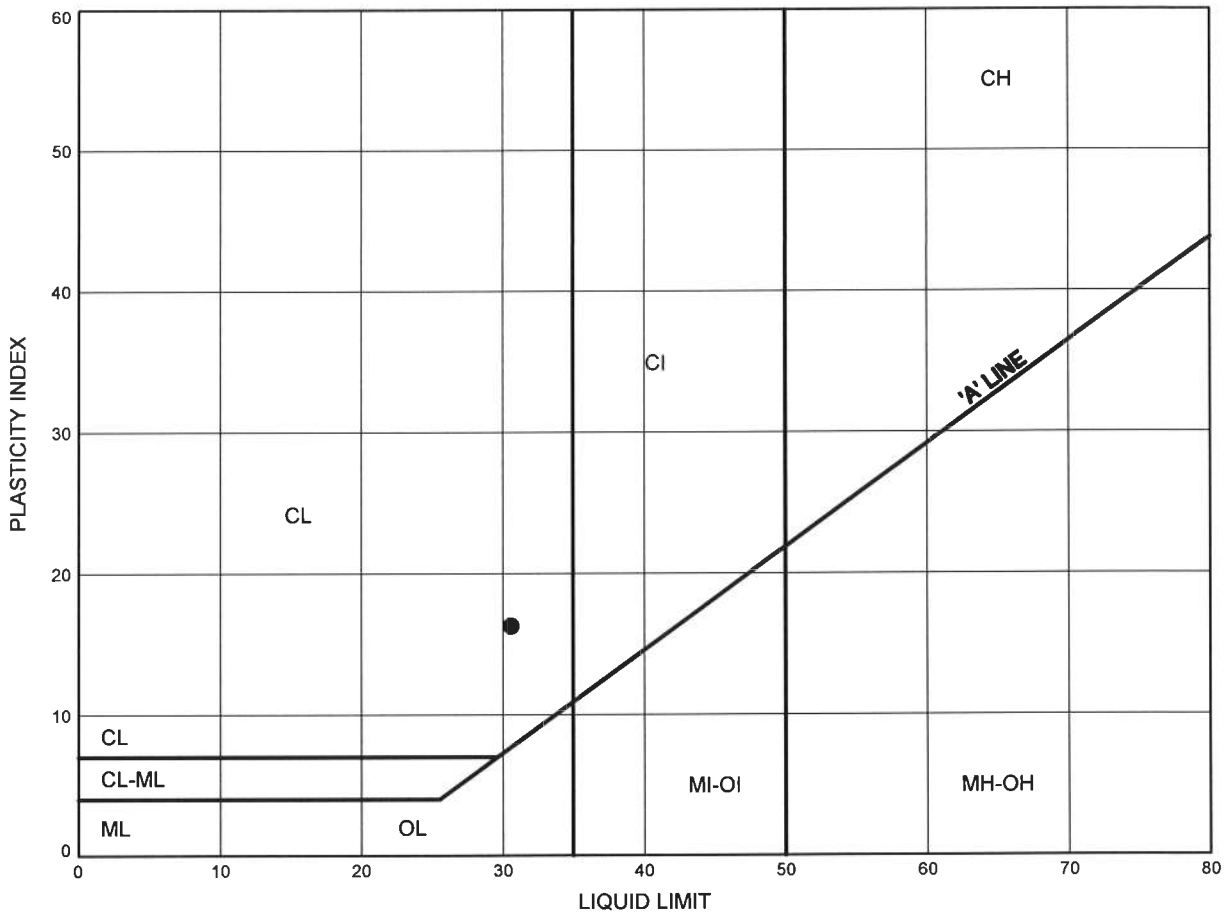
**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-07L	1.83	59.07
⊠	OHS-11L	1.83	69.47

Highway 417 Ottawa: Vanier to OR 174  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B10

**SILTY CLAY FILL**



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-11R	2.59	69.11

Date May 2012  
W.P.# 4320-06-00

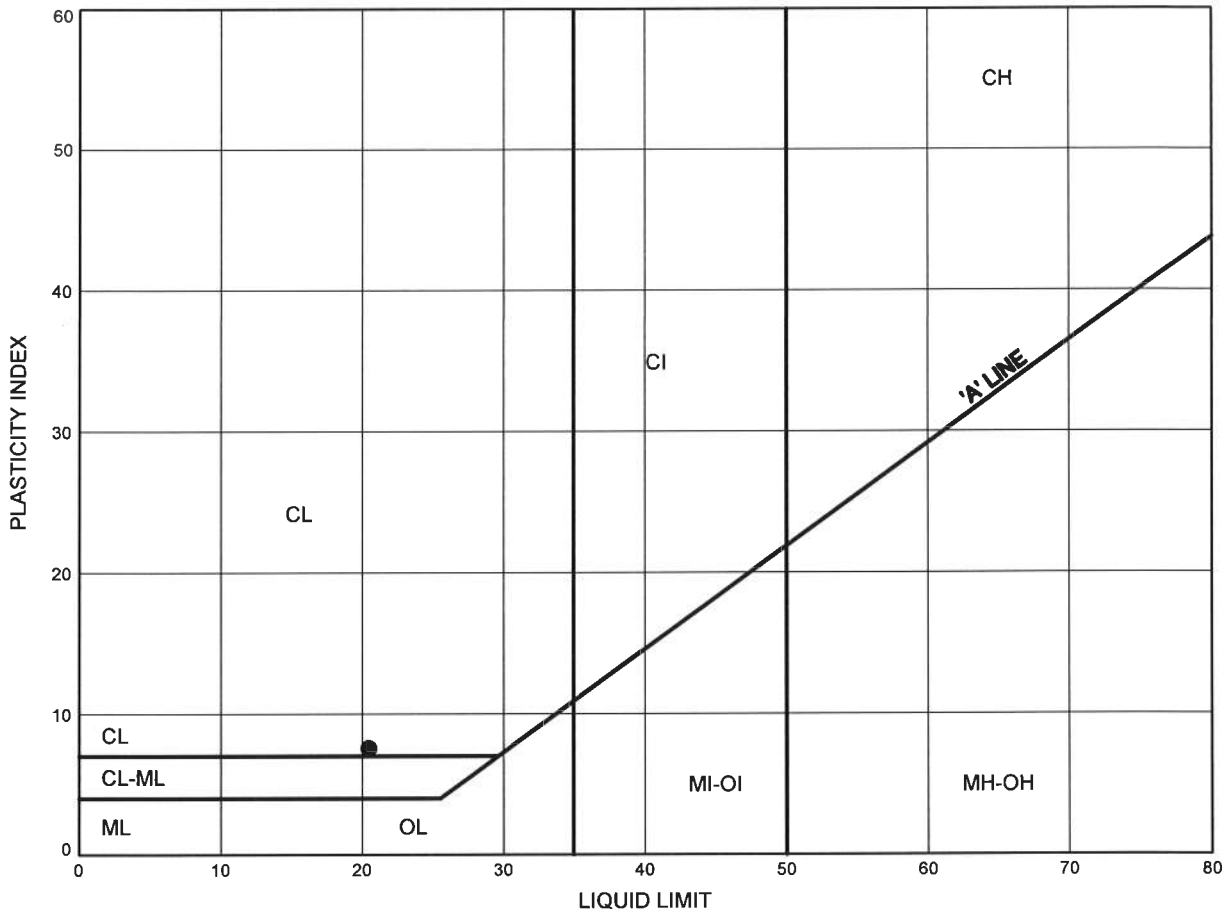


Prep'd MFA  
Chkd. LRB

Highway 417 Ottawa: Vanier to OR 174  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B11

**SILTY SAND TILL**



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-06R	6.40	56.50

Date May 2012  
W.P.# 4320-06-00



Prep'd MFA  
Chkd. MC

## **Appendix C**

### **O.R. 174: Highway 417-O.R.174 Interchange to East of Blair Rd (BHs OHS-14L/14R, OHS-18 & VMS-5L/5R) Record of Borehole Sheets and Laboratory Test Results**



# RECORD OF BOREHOLE No OHS-14L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 992.5 E 373 651.9 ORIGINATED BY RK  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.03.10 - 2012.03.10 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
67.8								20 40 60 80 100						
0.0	TOPSOIL: (100mm)							20 40 60 80 100						
0.1	Gravelly SAND, some silt Loose to Very Dense Brown to Grey Moist (FILL) Augers grinding at 0.6m		1	SS	9		67							
			2	SS	52		66							
	No recovery		3	SS	50/ 0.150									
	No recovery		4	SS	36		65							
65.1														
2.7	SAND, medium grained, trace gravel, trace fines Loose Grey Wet		5	SS	5		64							
63.1							63							
4.7	Sandy SILT, some clay, some gravel Compact Dark Brown to Grey Damp (TILL)		6	SS	28		62							
61.6	Trace shale fragments		7	SS	50/ 0.075									
6.2	END OF BOREHOLE AT 6.2m ON POSSIBLE BEDROCK. BOREHOLE SLOUGHED AND WATER LEVEL AT 2.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG FROM 2.1m TO SURFACE.													

ONTMT4S 1201B.GPJ 5/16/12

+<sup>3</sup> . X<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No OHS-14R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 031 979.3 E 373 669.3 ORIGINATED BY RK  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.03.11 - 2012.03.11 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
68.2								20 40 60 80 100		20 40 60				
0.0	TOPSOIL: (75mm)													
0.1	Gravelly SAND, some silt		1	SS	31		68							
67.6	Dense													
0.6	Brown													
	Moist (FILL)													
	Augers grinding at 0.6m		2	SS	32		67							
	Silty SAND, some gravel, some clay													
	Compact													
	Brown													
	Moist (FILL)		3	SS	12		66						13 48 28 11	
			4	SS	21		65							
65.3														
2.9	SAND, medium grained, trace gravel													
	Loose		5	SS	8		64							
	Brown													
	Wet													
			6	SS	8		63							
62.7														
5.5	Sandy SILT, some clay, some gravel, shale fragments (TILL)													
62.0			7	SS	50									
6.2	END OF BOREHOLE AT 6.2m ON POSSIBLE BEDROCK. WATER LEVEL AT 2.3m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE      DEPTH (m)      ELEV. (m) Mar.29/12      0.7      67.5				0.075									

ONTMT4S 1201B.GPJ 5/16/12

# RECORD OF BOREHOLE No OHS-18

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 032 336.7 E 374 106.2 ORIGINATED BY RK  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.03.10 - 2012.03.10 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
✓ 71.3								20 40 60 80 100					GR SA SI CL
0.0	SAND and GRAVEL, trace silt Compact Brown/Grey Moist to Wet (FILL)		1	SS	21		71						
			2	SS	13		70						
60.8													
1.5	Silty SAND, some clay Compact Orangy Brown Wet (FILL)		3	SS	17								0 61 27 12
69.2													
2.1	Clayey SILT, some sand, some shale fragments Very Stiff Dark Grey		4	SS	50/ 0.125		69						
68.3													
3.0	SHALE, fresh, thinly laminated, horizontal and vertical joints, dark grey		1	RUN			68						RUN #1 TCR=25% SCR=25% RQD=0%
	Rubble zone (150mm) at 3.4m												
	Vertical joint (225mm) at 4.2m		2	RUN			67						RUN #2 TCR=90% SCR=45% RQD=19% UCS=49MPa (Average)

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No VMS-5L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 033 572.4 E 375 693.2 ORIGINATED BY RK  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.03.10 - 2012.03.10 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		WATER CONTENT (%) w <sub>p</sub> w w <sub>L</sub>				
69.5														
0.0														
0.1	TOPSOIL: (75mm)													
	Silly CLAY Soft to Very Soft Light Brown		1	SS	3									
			2	SS	2									
			3	SS	2									
	Grey		4	SS	1									
			5	SS	0									
			6	SS	1									
			7	SS	0									
62.5														
7.0	END OF BOREHOLE AT 7.0m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar.28/12 1.5 68.0													

ONTMT4S 1201B GPJ 5/16/12

+ 3 x 3: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No VMS-5R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 033 551.7 E 375 709.7 ORIGINATED BY RK  
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2012.03.11 - 2012.03.11 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT		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		WATER CONTENT (%) w <sub>p</sub> w w <sub>L</sub>				
71.6 0.0	Gravelly <b>SAND</b> , some silt Compact Brown Frozen (FILL)		1	SS	22									
70.7 0.9	Silty <b>CLAY</b> , trace silt seams Stiff to Firm Light Brown		2	SS	8									
	Grey		3	SS	7									
			4	SS	10									
			5	SS	6									
	Soft to Very Soft		6	SS	2									
			7	SS	1									
64.6 7.0	END OF BOREHOLE AT 7.0m. BOREHOLE BACKFILLED WITH CUTTINGS TO 1.5m, BENTONITE HOLEPLUG TO 0.3m, THEN SAND CUTTINGS TO SURFACE.													

ONTMT4S 1201B.GPJ 5/18/12

+<sup>3</sup> . x<sup>3</sup> : Numbers refer to  
Sensitivity

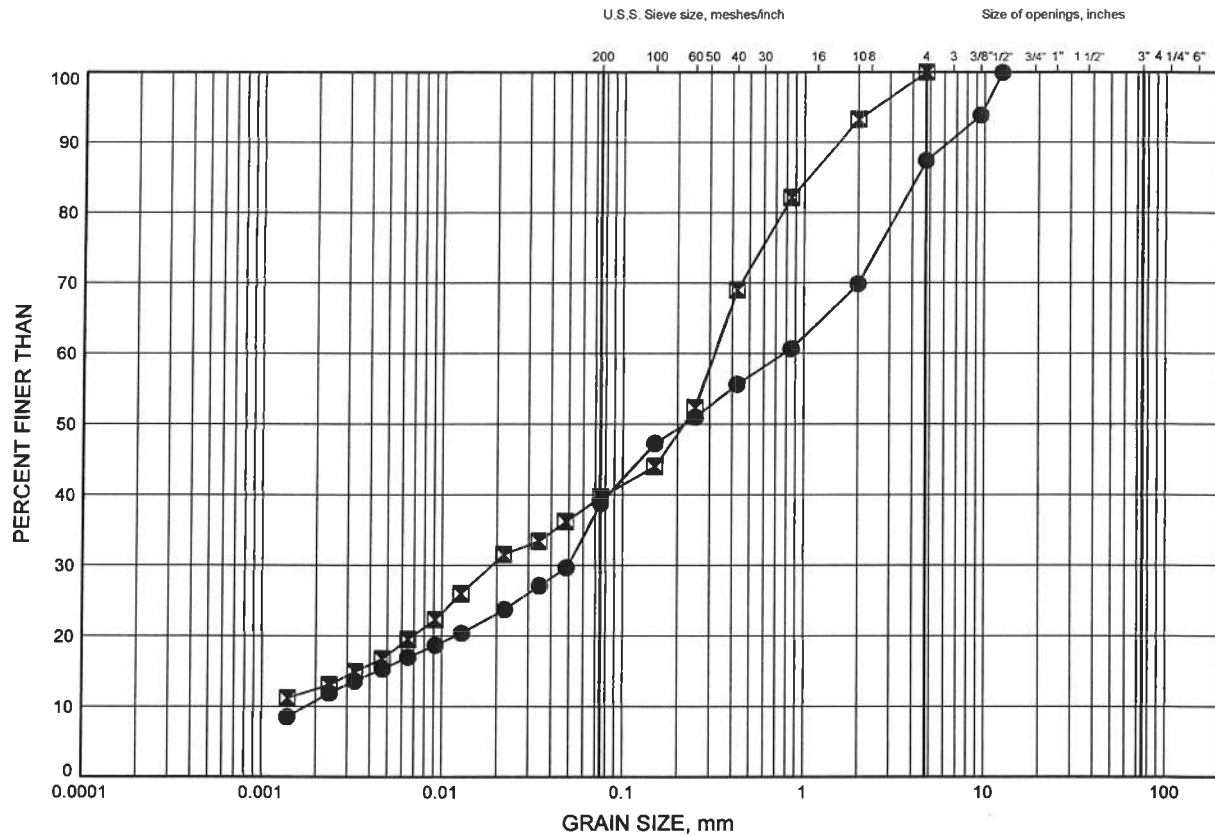
20  
15  
10

(%) STRAIN AT FAILURE

# Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE C1

## SILTY SAND FILL



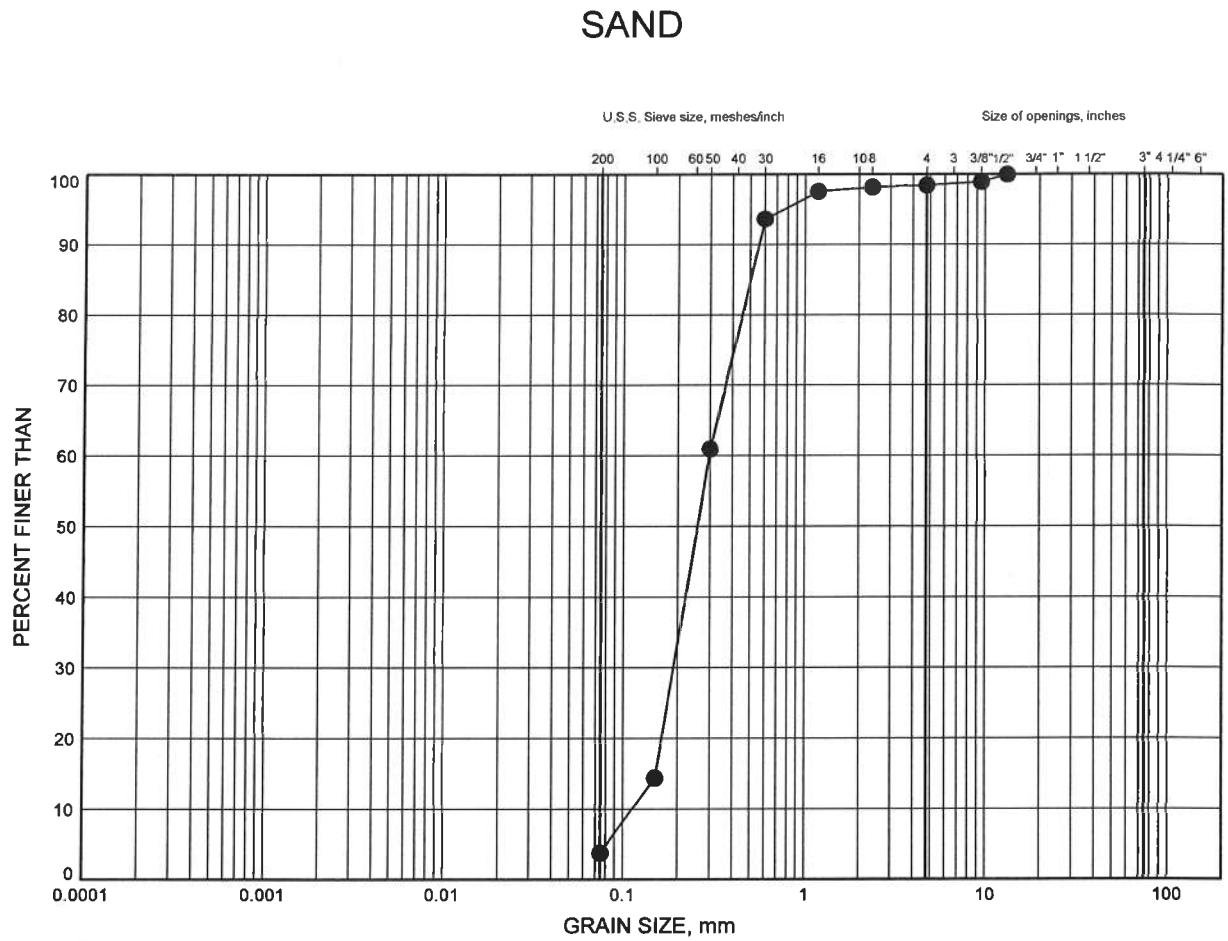
SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-14R	1.83	66.37
◻	OHS-18	1.83	69.47

# Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE C2



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

## LEGEND

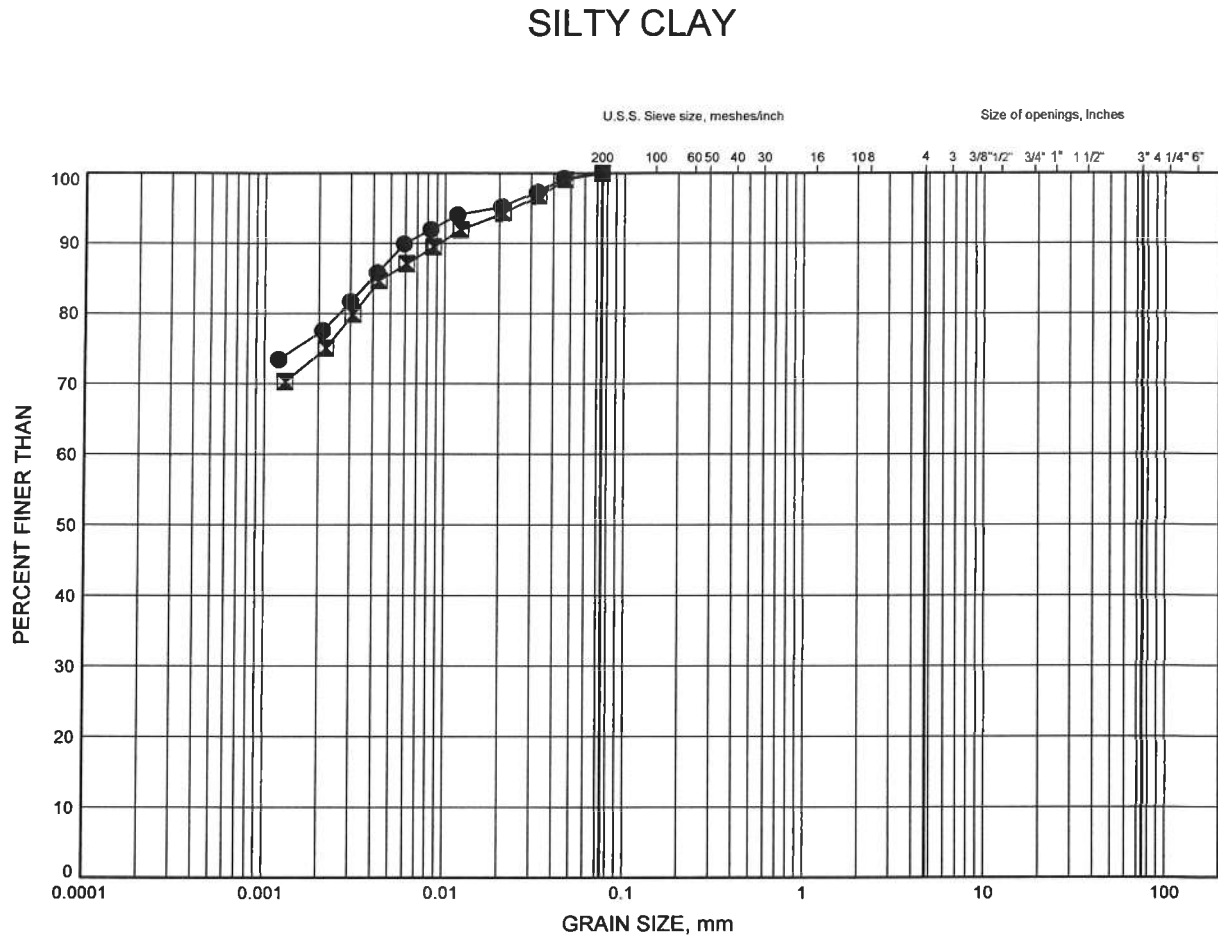
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-14L	3.35	64.45



W.P.# 4320-06-00  
Prepared By AN  
Checked By LRB

# Highway 417 Ottawa: Vanier to OR 174 GRAIN SIZE DISTRIBUTION

FIGURE C3



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	VMS-5L	1.83	67.67
⊠	VMS-5R	2.59	69.01

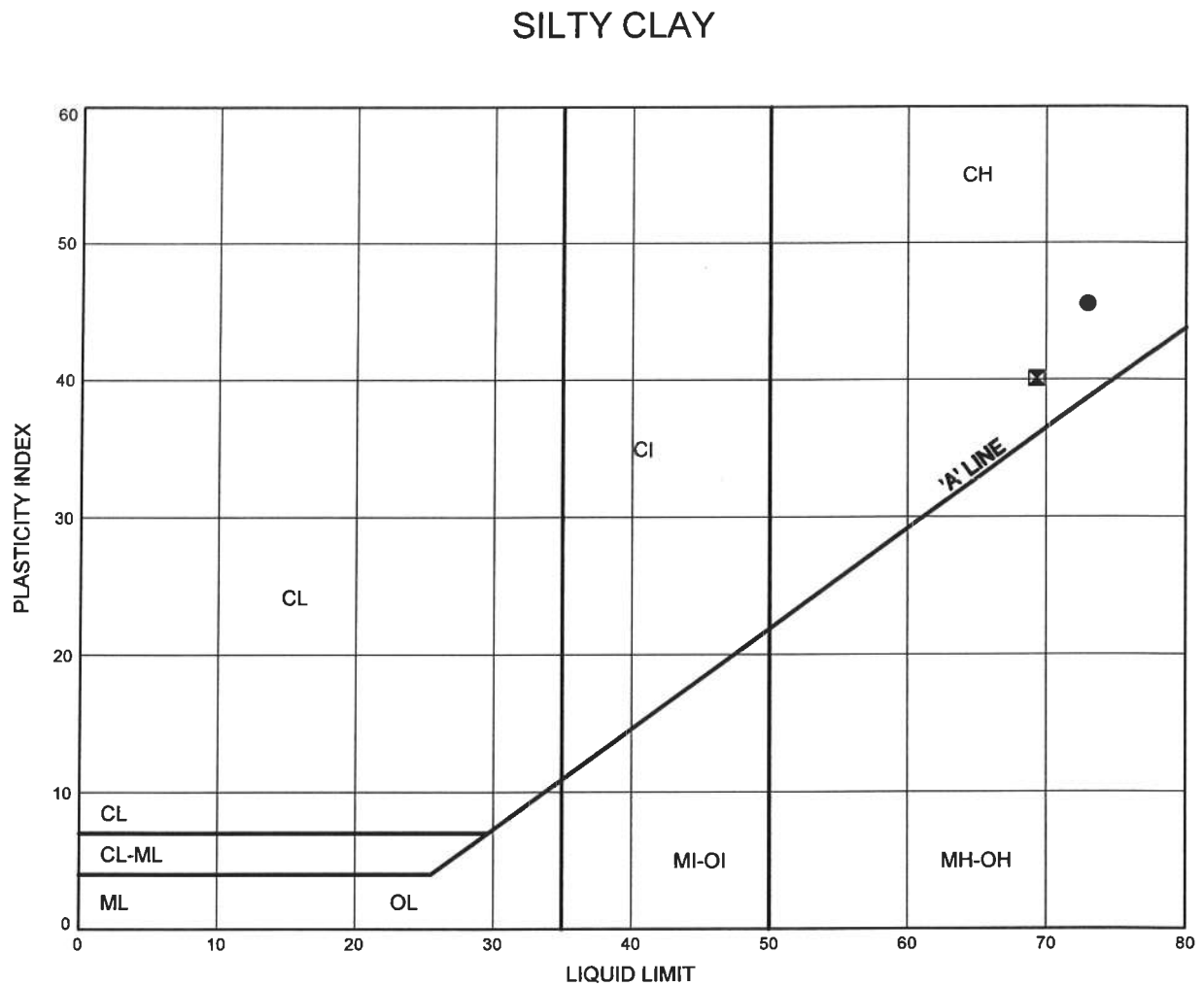


W.P.# .4320-06-00.....  
Prepared By .AN.....  
Checked By .LRB.....



Highway 417 Ottawa: Vanier to OR 174  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C4



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	VMS-5L	1.83	67.67
⊠	VMS-5R	2.59	69.01

**Appendix D**

**Highway 417: Highway 417-O.R.174 Interchange to Walkley Road  
(BHs OHS-15L/15R to OHS-17 & VMS-4L/4R)  
Record of Borehole Sheets and Laboratory Test Results**

RECORD OF BOREHOLE No OHS-15L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 030 731.0 E 374 900.0 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2012 03 08 - 2012 03 08 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
70.4								20 40 60 80 100		w <sub>p</sub>	w	w <sub>L</sub>		
0.0								20 40 60 80 100						
0.1	ASPHALT: (90mm)													
	SAND, some gravel, some silt Brown Damp (FILL)		1	GS			70							
69.2			1	SS	44									
1.2	SHAILE FILL, some silt, trace clay Compact to Dense Grey Damp		2	SS	35		69							
	Occasional cobble or rock slab		3	SS	42		68							
			4	SS	27		67							32 49 14 5
							66							
			5	SS	47		65							
							64							
64.0			6	SS	29	▽								1 44 26 29
6.4	Silty SAND, some clay to clayey, trace gravel													
63.7	Compact Grey Damp (TILL)													
6.7	END OF BOREHOLE AT 6.7m. WATER LEVEL AT 6.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.1m, CUTTINGS TO 0.2m THEN ASPHALT TO SURFACE.													

ONTMT4S 1201B GPJ 5/16/12

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No OHS-15R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 030 715.0 E 374 896.9 ORIGINATED BY ES  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.03.29 - 2012.03.29 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			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		WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
68.7							20 40 60 80 100							
0.0	ASPHALT: (75mm)													
0.1	SAND, some silt, trace gravel Brown Damp (FILL)		1	GS										
68.0														
0.7	SHAILE FILL, some sill, trace clay Dense to Compact Grey Damp		1	SS	35									
			2	SS	39									19 59 18 4
	Occasional cobble or rock slab													
			3	SS	35									
			4	SS	25									
			5	SS	32									
62.6														
6.1	Sandy SILT, some clay, trace gravel, occasional cobble Dense Grey		6	SS	30									
62.0	Damp (TILL)													
6.7	END OF BOREHOLE AT 6.7m. WATER LEVEL AT 5.5m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.1m, CUTTINGS TO 0.15m THEN ASPHALT TO SURFACE.													

+ 3, × 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

## METRIC

[illegible]

+ 3, × 3: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No OHS-16R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 030 471.5 E 375 271.6 ORIGINATED BY RK  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012.03.06 - 2012.03.06 CHECKED BY LRB

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						
73.3														
0.0	TOPSOIL: (150mm)		1	AS										
0.2	Silty SAND, some clay, some gravel, with shale pieces Compact Grey Frozen (FILL)		1	SS	13									
71.5			2	SS	16									
1.8	SHALE FILL, some clay Loose to Dense Brown/Grey Moist to Wet		3	SS	9									
	Occasional cobble or rock slab		4	SS	10									
	Possible boulder or gravel zone		5	SS	32									
			6	SS	49									
66.6	END OF BOREHOLE AT 6.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.													
6.7	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar 01/12 6.1 67.2													

+ 3, × 3 Numbers refer to  
Sensitivity 20  
15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OHS-17

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 030 015.1 E 375 463.3 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2012 03 29 - 2012 03 29 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
67.3								20   40   60   80   100		20   40   60				
0.0	TOPSOIL: (200mm)							○ UNCONFINED   + FIELD VANE ● QUICK TRIAXIAL   × LAB VANE						
0.2	Silty <b>CLAY</b> , trace to some sand Stiff to Soft Brown		1	GS		▽	67				○			
			1	SS	7		66					○		
	Grey		2	SS	9		65					—●—		
			3	SS	4		64					○		
			4	SS	3		63							
							62							
62.7							61				○			
4.6	Sandy <b>SILT</b> , trace clay, trace gravel Compact Grey Wet		5	SS	17		60							
61.2							59							
6.1	<b>SAND</b> , medium to coarse grained, trace gravel Compact Grey Wet		6	SS	26		58							
60.6							57							
6.7	END OF THE BOREHOLE AT 6.7m. WATER LEVEL AT 1.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.7m THEN CUTTINGS TO SURFACE.						56							

ONTMT4S 1201B.GPJ 5/11/12

RECORD OF BOREHOLE No VMS-4L

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 029 661.3 E 375 641.1 ORIGINATED BY ES  
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2012.03.08 - 2012.03.08 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
66.3 0.0	SAND, some gravel to gravelly, some silt Compact Brown to Grey Moist (FILL)		1	GS			66					
65.0 1.3	Silty CLAY, trace sand Very Stiff to Firm Grey		1	SS	23		65					
			2	SS	21		64					
			3	SS	13		63					
			4	SS	7		62					
61.4 4.9	Silty SAND, some clay Loose Dark Brown Moist (TILL)		5	SS	9		61					
60.2 6.1	Gravelly SAND Compact Grey Wet		6	SS	16		60					
59.6 6.7	END OF BOREHOLE AT 6.7m BOREHOLE BACFKILLED WITH BENTONITE HOLEPLUG TO 1.5m THEN CUTTINGS TO SURFACE.											

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No VMS-4R

1 OF 1

METRIC

W.P. 4320-06-00 LOCATION N 5 029 650.2 E 375 623.2 ORIGINATED BY RK  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2012 03.06 - 2012 03.06 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60	w <sub>p</sub> w w <sub>L</sub>	WATER CONTENT (%)	GR SA SI CL		
65.5	TOPSOIL: (50mm)													
64.6	SAND, some gravel, some silt Grey to Brown Frozen (FILL)		1	AS										
0.9	Silty CLAY, trace sand Stiff to Firm Grey		1	SS	9									
			2	SS	9									
			3	SS	5									
			4	SS	6									
61.1	Silty SAND, some clay, trace gravel Loose Dark Brown Wet (TILL)		5	SS	5									
60.0	SAND, coarse grained, some gravel Loose Brown Wet		6	SS	6									
58.8	END OF BOREHOLE AT 6.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.													
6.7	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar.28/12 1.2 64.3													

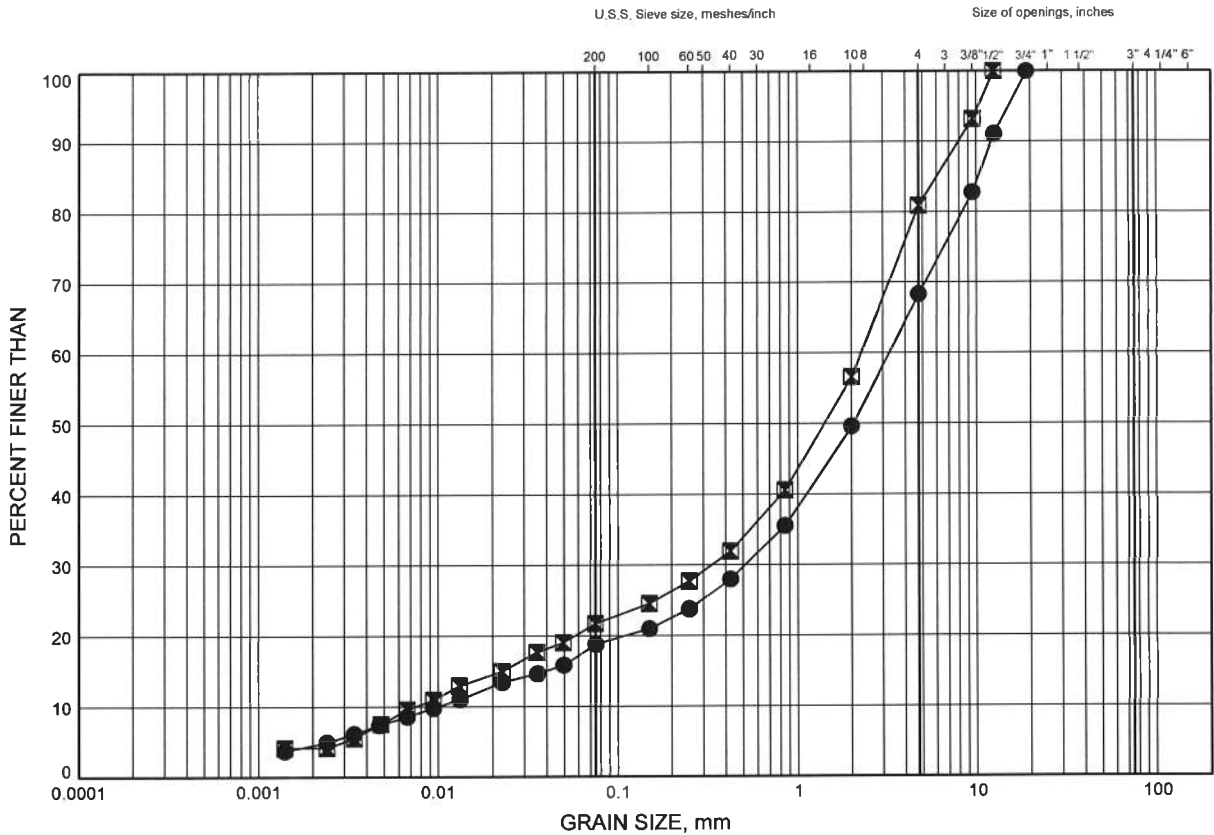
ONTMT4S 1201B GPJ 5/16/12

# Highway 417 Ottawa: Vanier to OR 174

## GRAIN SIZE DISTRIBUTION

FIGURE D1

### SHALE FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-15L	3.38	67.02
■	OHS-15R	1.86	66.84

Date May 2012  
W.P.# 4320-06-00



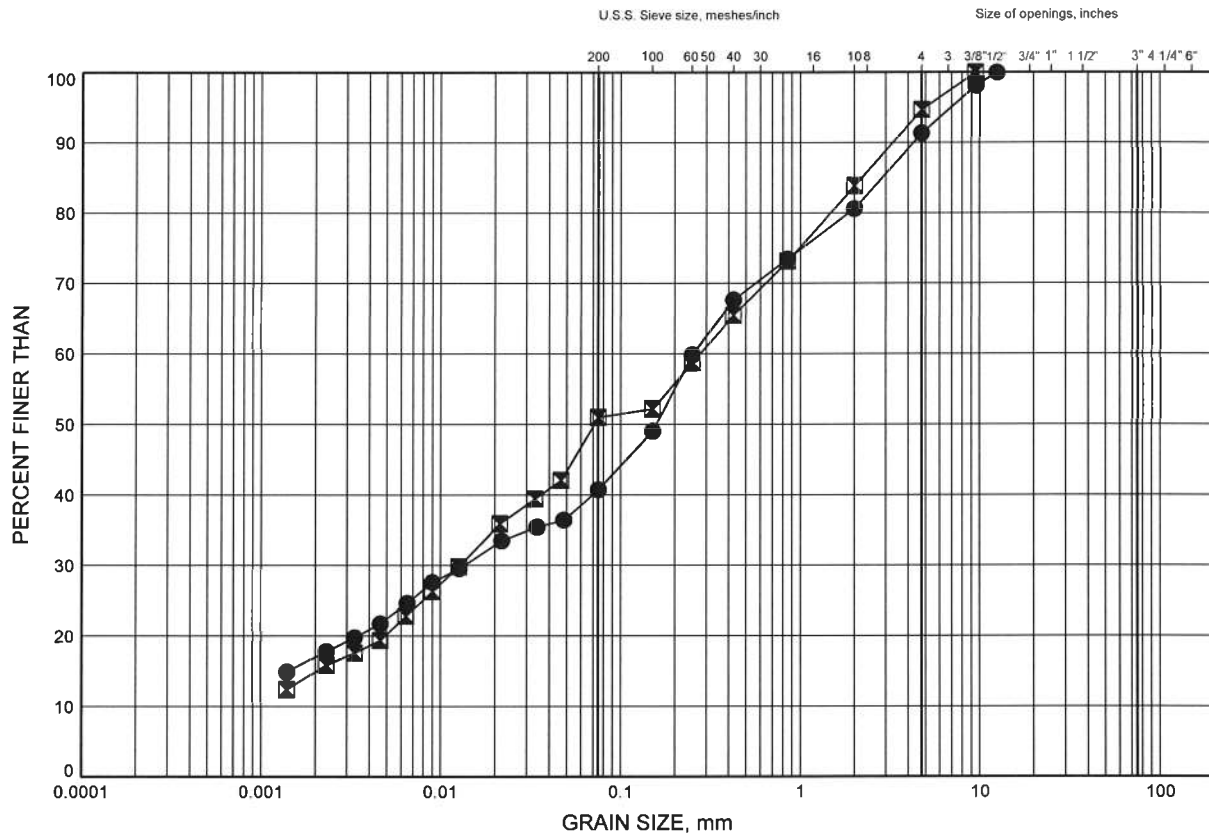
Prep'd MFA  
Chkd. MC

# Highway 417 Ottawa: Vanier to OR 174

## GRAIN SIZE DISTRIBUTION

FIGURE D2

### SHALE FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-16L	4.88	69.92
■	OHS-16R	2.59	70.71

Date May 2012  
W.P.# 4320-06-00

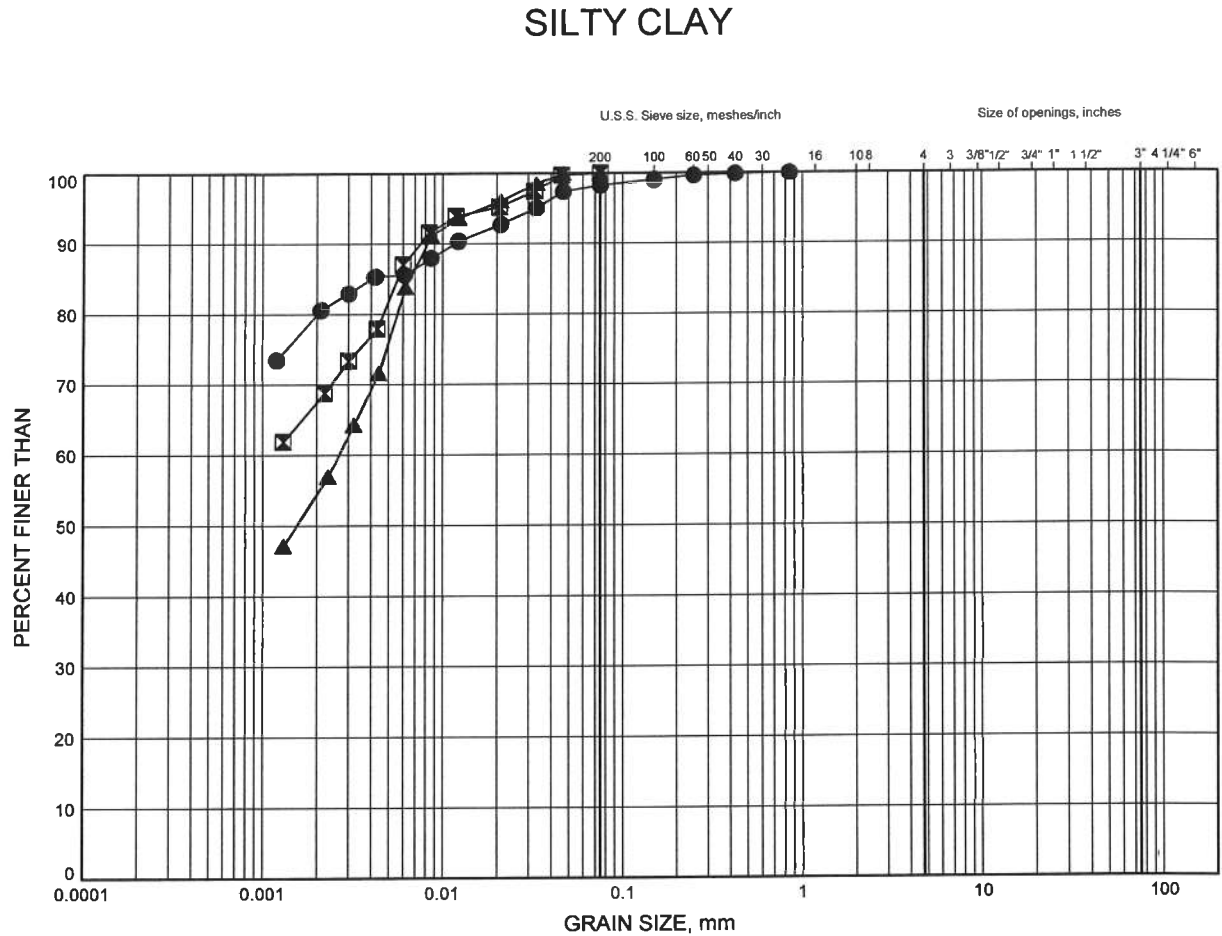


Prep'd MFA  
Chkd. MC

# Highway 417 Ottawa: Vanier to OR 174

## GRAIN SIZE DISTRIBUTION

FIGURE D3



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

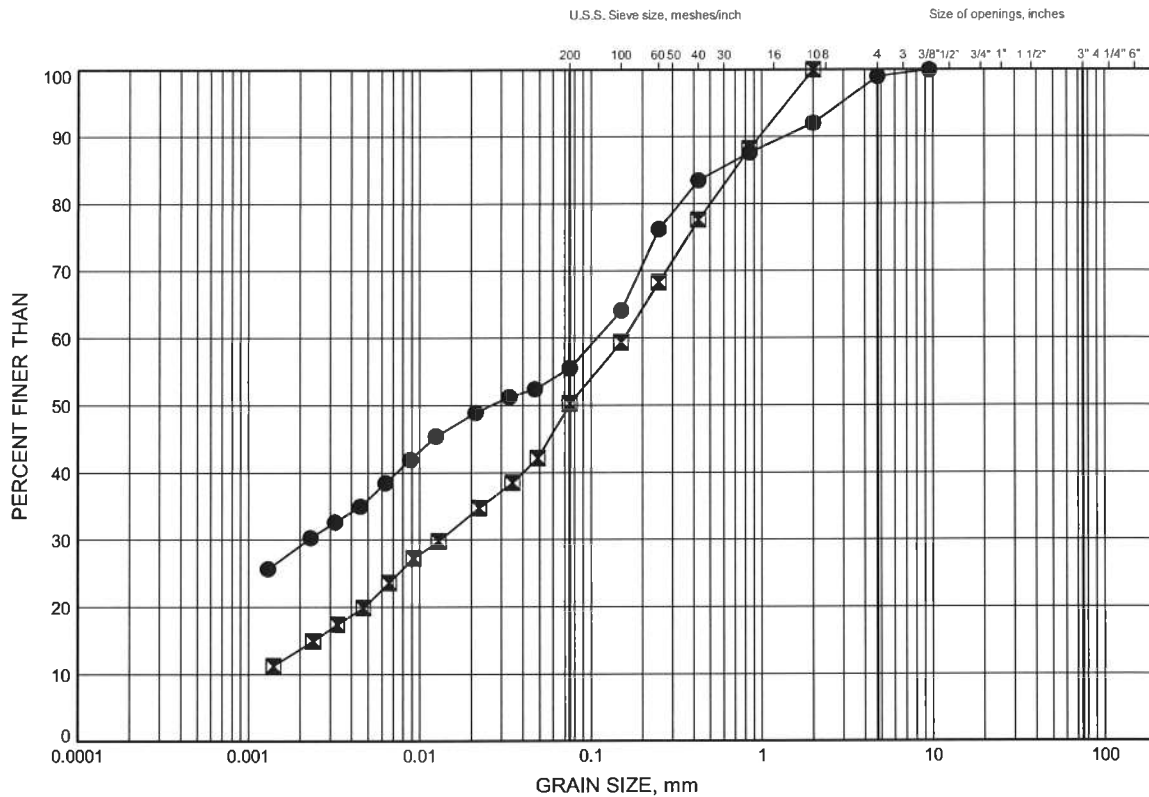
### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-17	1.83	65.47
⊠	VMS-4L	2.59	63.71
▲	VMS-4R	2.59	62.91

Highway 417 Ottawa: Vanier to OR 174  
**GRAIN SIZE DISTRIBUTION**

**FIGURE D4**

**SILTY SAND TILL**



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-15L	6.40	64.00
■	VMS-4R	4.88	60.62

GRAIN SIZE DISTRIBUTION - THURBER 1201B.GPJ 5/11/12

Date May 2012  
W.P.# 4320-06-00

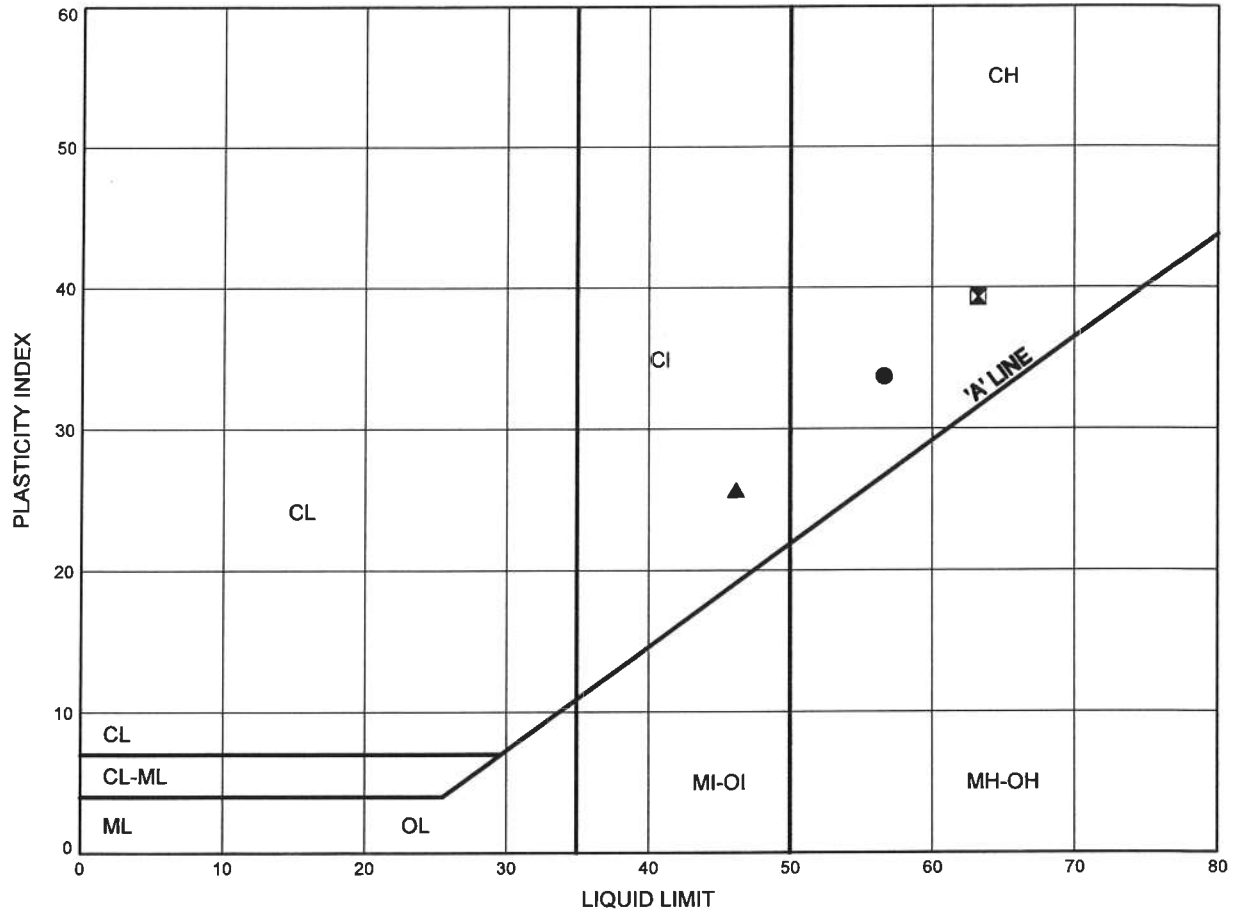


Prep'd AN  
Chkd. LRB

Highway 417 Ottawa: Vanier to OR 174  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE D5

**SILTY CLAY**



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	OHS-17	1.83	65.47
⊠	VMS-4L	2.59	63.71
▲	VMS-4R	2.59	62.91

**Appendix E**

**Highway 417: Parkdale Avenue to Nicholas Street, near Bayswater Avenue  
(BHs VMS-1L/1R)  
Record of Borehole Sheets and Laboratory Test Results**

RECORD OF BOREHOLE No VMS-1L

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 029 423.9 E 366 238.6 ORIGINATED BY GA  
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2012.05.03 - 2012.05.03 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
								20	40	60	80			100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>		
						○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE				WATER CONTENT (%)									
76.0							20	40	60	80	100	20	40	60		GR	SA	SI	CL
0.0	ASPHALT: (100mm)																		
78.7	CONCRETE: (150mm)																		
0.3	SAND, trace to some gravel, some silt Compact Brown Dry (FILL)		1	SS	22														
			2	SS	28														
			3	SS	22														
73.6			4	SS	17														
2.4	Silty SAND, trace gravel Compact Brown Damp (FILL)		5	SS	11														
73.0																			
3.0	Clayey SILT, some sand, trace gravel Stiff Brown (FILL)																		
71.4																			
4.6	Silty SAND, trace to some gravel, trace clay Compact to Dense Brown Dry (TILL)		6	SS	18														
			7	SS	36														
69.3																			
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG FROM 6.7m TO 0.3m, CONCRETE FROM 0.3m TO 0.2m, THEN ASPHALT TO SURFACE.																		

+<sup>3</sup>, ×<sup>3</sup>; Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No VMS-1R

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 029 406.9 E 366 245.3 ORIGINATED BY GA  
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2012.05.04 - 2012.05.04 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa													
75.7								20	40	60	80	100									
0.0	ASPHALT: (100mm)																				
0.1	SAND, trace to some silt, trace gravel Compact to Dense Brown Dry (FILL)		1	SS	24		75														
			2	SS	40																
74.2																					
1.5	Sandy SILT, trace gravel, trace clay Dense Dark Grey Dry (FILL)		3	SS	41		74														
73.3																					
2.4	Silty SAND, trace gravel, trace clay Compact Brown Dry (FILL)		4	SS	29		73											3	65	23	9
72.7																					
3.0	Clayey SILT, some sand, trace gravel, occasional sand seams Stiff Brown (FILL)  Concrete (150mm) and piece of steel at 4.0m		5	SS	15		72														
71.1																					
4.6	Gravelly SAND, trace silt Compact Brown Damp		6	SS	28		71														
70.2																					
5.5	Silty SAND, trace gravel Dense Brown Damp (TILL)						70														
			7	SS	35																
69.0																					
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND WATER LEVEL AT 6.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.3m, CONCRETE TO 0.2m, THEN ASPHALT PATCH TO SURFACE.																				

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

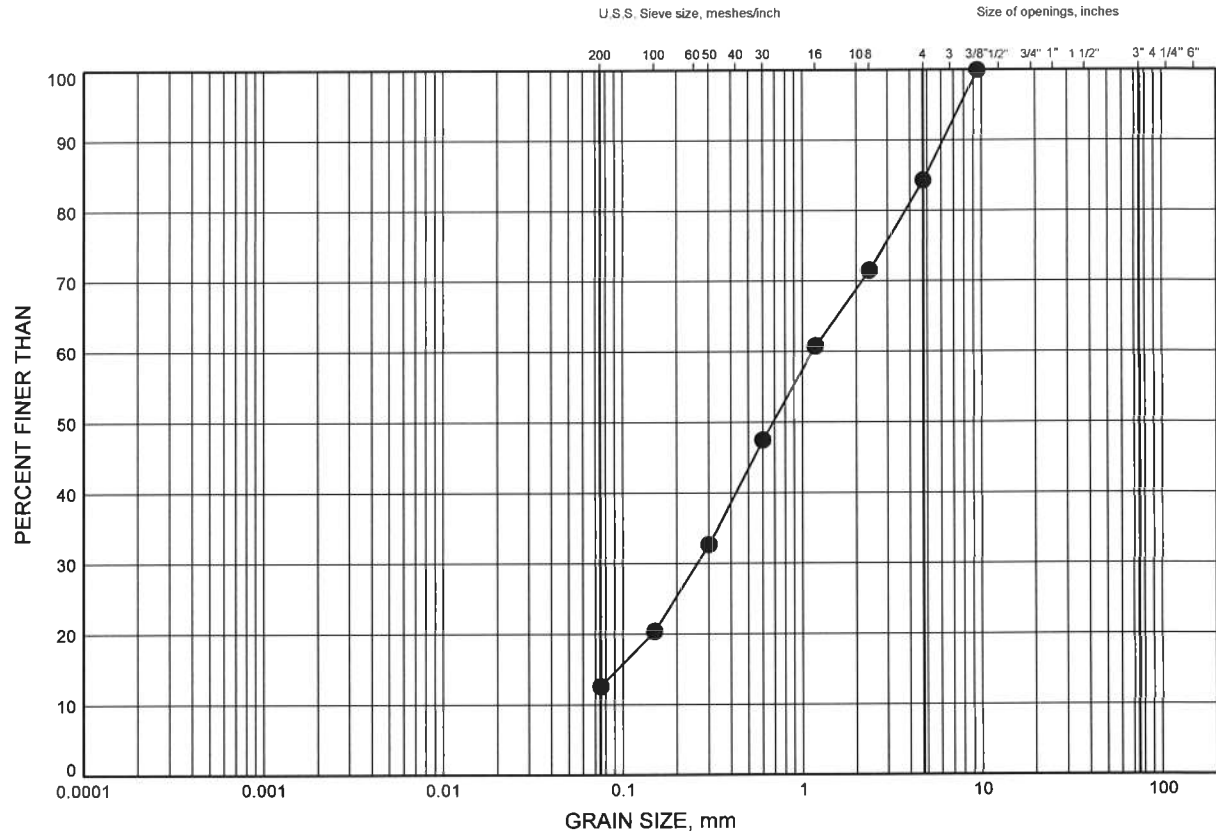
20  
15  
10  
(%) STRAIN AT FAILURE

# Highway 417 Ottawa: Nicholas to Vanier

## GRAIN SIZE DISTRIBUTION

FIGURE E1

### Sand Fill



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	VMS-1L	1.83	74.17

Date May 2012  
W.P.# 4091-07-00



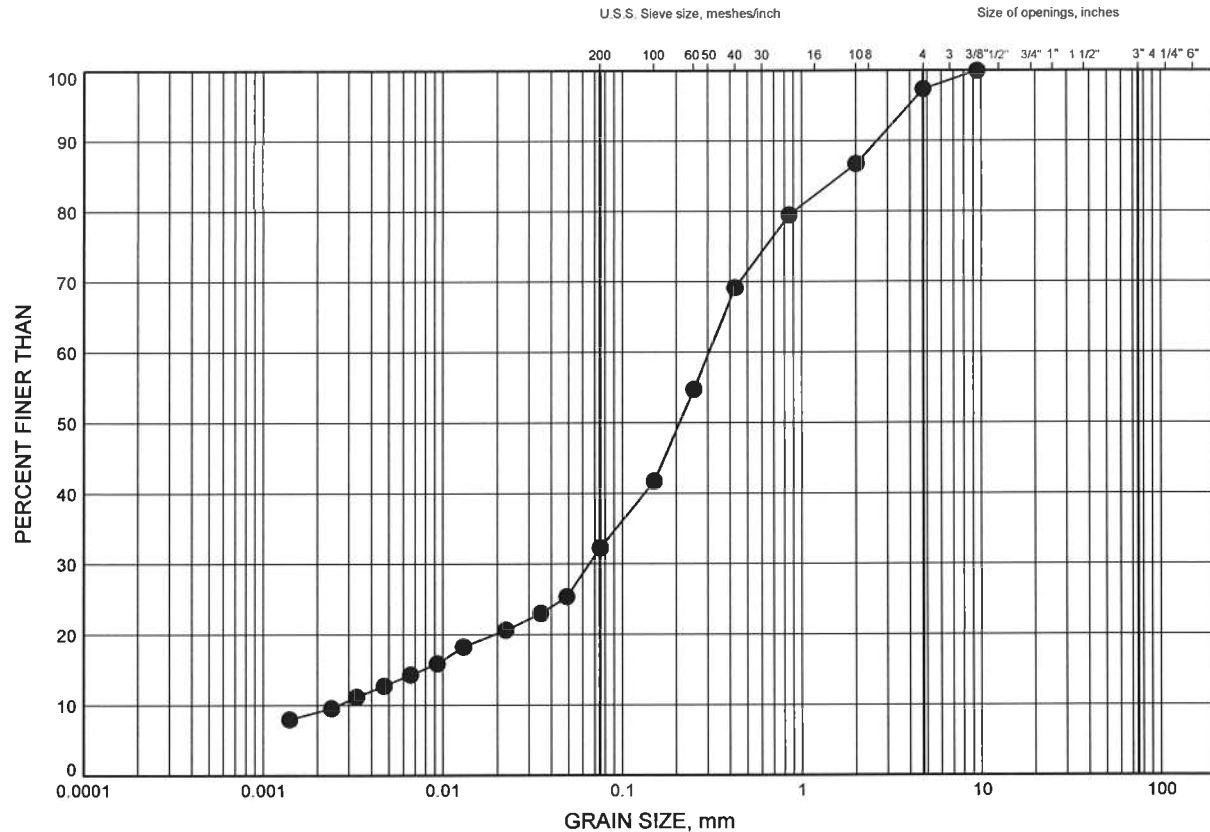
Prep'd MFA  
Chkd. MC

# Highway 417 Ottawa: Nicholas to Vanier

## GRAIN SIZE DISTRIBUTION

FIGURE E2

### Silty Sand Fill



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

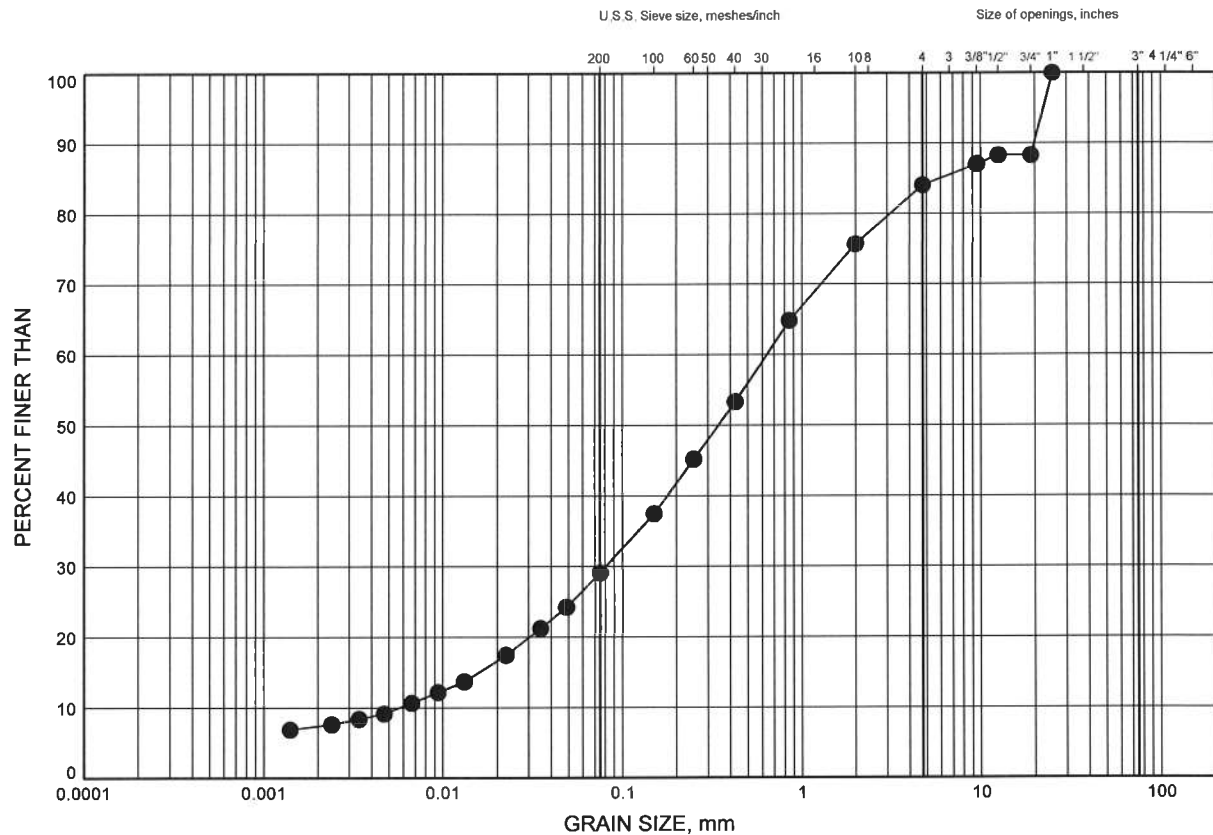
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	VMS-1R	2.59	73.11

# Highway 417 Ottawa: Nicholas to Vanier

## GRAIN SIZE DISTRIBUTION

FIGURE E3

### Silty Sand Till



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	VMS-1L	4.88	71.12

## **Appendix F**

### **List of Selected SPs and OPSS, and Suggested Text for NSSP**

**List of Special Provisions and OPSS Documents Referenced in this Report**

- OPSS 631
- OPSS 902
- OPSS 903

**2. Suggested Text for NSSP on:**

**“Augered Caisson Construction for Overhead Sign (OHS) and Variable Message Sign (VMS) Foundations”**

The Contractor is advised that variable subsurface conditions and bedrock at potentially variable depths/elevations may be encountered at the locations of the OHS and VMS foundations. Soft cohesive deposits and fill consisting of excavated shale bedrock will also be encountered at some locations. For additional information regarding subsurface conditions, the Contractor is referred to the Foundation Investigation Report.

These materials will potentially have an impact on the installation of caissons, such as:

- impeding the advance of the caissons resulting in lower production and faster wear of drilling bits.
- requiring alternate equipment or procedures in cases where obstructions in the fill/till or thick layers of hard limestone in the bedrock are encountered.
- affecting the alignment of the caissons during advancement.
- squeezing of the shaft excavation in the soft cohesive soils.

The Contractor is further advised that non-cohesive soils and high groundwater levels are present on site. Non-cohesive soil is susceptible to disturbance under conditions of unbalanced hydrostatic head.

The Contractor is responsible for constructing the caisson excavation without disturbing the sides or base of the excavation, preventing squeeze, and for cleaning of the socket base. The construction method is the responsibility of the Contractor.

The shale and silty or cohesive soils within the caisson excavation must be protected from softening and deterioration by placement of concrete as soon as practical after completion of the excavation and in no case later than 8 hours after excavation.

## **Appendix G**

### **Drawings titled “Borehole Location Plan”**



GEOGRAPHIC TWP GLOUCESTER

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

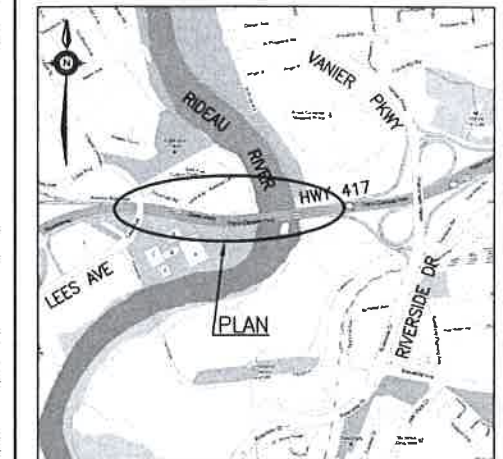
CONT No	
WP No	

HIGHWAY 417 OVERHEAD SIGNS NICHOLAS ST. TO RIVERSIDE DR. BOREHOLE LOCATIONS	
--------------------------------------------------------------------------------------	--

**MRC** **McCORMICK RANKIN**  
A member of  **MMM GROUP**








**THURBER ENGINEERING LTD.**



## KEYPLAN

LEGEND

	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
OHS-01L	61.0	5 031 167.6	369 878.1
OHS-01R	60.1	5 031 145.5	369 875.3
OHS-02L	61.0	5 031 103.0	370 116.7
OHS-02R	59.7	5 031 079.5	370 138.2
OHS-03L	60.2	5 031 142.8	370 209.0
OHS-03R	61.1	5 031 113.3	370 213.9
OHS-04L	60.8	5 031 137.5	370 444.1
OHS-04R	60.1	5 031 116.2	370 445.6

**-NOTES-**

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

**GEOCRES No. 31G5-249**

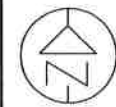
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**METRIC**  
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AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

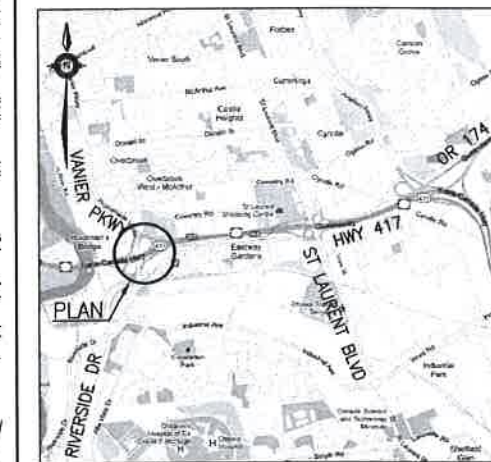
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WP No  
HIGHWAY 417  
OVERHEAD AND VARIABLE MESSAGE SIGNS  
RIVERSIDE DR. TO O.R. 174  
BOREHOLE LOCATIONS



SHEET

**MRC** McCORMICK RANKIN  
A member of MARS GROUP

**THURBER ENGINEERING LTD.**



KEYPLAN

LEGEND

- ◆ Borehole
- ◆ Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level
- HA Head Artesian Water
- P Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
OHS-05L	59.6	5 031 046.4	370 692.6
OHS-05R	59.8	5 031 031.9	370 681.0
OHS-06L	62.7	5 031 420.0	370 907.3
OHS-06R	62.9	5 031 401.9	370 896.1
OHS-07L	60.9	5 031 391.4	371 216.4
OHS-07R	60.7	5 031 375.2	371 218.8
VMS-02L	59.7	5 031 176.0	370 722.5
VMS-02R	59.5	5 031 156.5	370 726.4

-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31G5-249



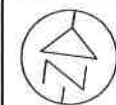
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DRAWN	MFA	CHK PKC	SITE
			LOAD
			DATE JUL, 2012
			STRUCT
			DWG 1



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

CONT No  
WP No

HIGHWAY 417  
OVERHEAD AND VARIABLE MESSAGE SIGNS  
RIVERSIDE DR. TO O.R. 174  
BOREHOLE LOCATIONS



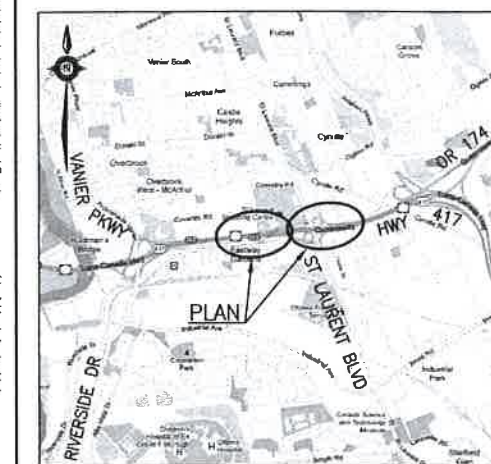
SHEET



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THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

◆	Borehole
◆	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
W	Water Level
HA	Head Artesian Water
P	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

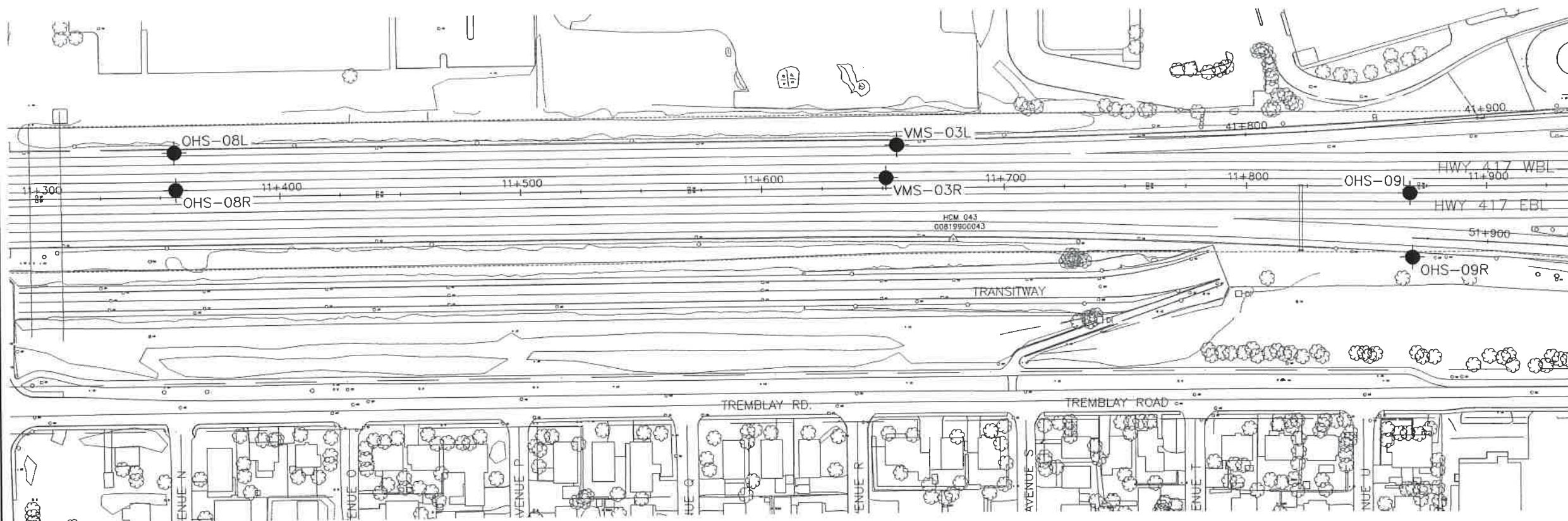
NO	ELEVATION	NORTHING	EASTING
OHS-08L	63.4	5 031 436.6	371 623.4
OHS-08R	63.7	5 031 421.1	371 625.7
OHS-09L	69.6	5 031 471.6	372 134.9
OHS-09R	69.2	5 031 445.0	372 138.9
OHS-10L	69.5	5 031 404.6	372 393.9
OHS-10R	67.8	5 031 385.8	372 383.1
OHS-11L	71.3	5 031 609.2	372 954.5
OHS-11R	71.7	5 031 585.8	372 963.1
OHS-12L	72.3	5 031 548.3	372 790.5
OHS-12R	71.7	5 031 522.7	372 799.5
VMS-03L	66.9	5 031 469.1	371 921.8
VMS-03R	67.1	5 031 454.9	371 918.8

-NOTES-

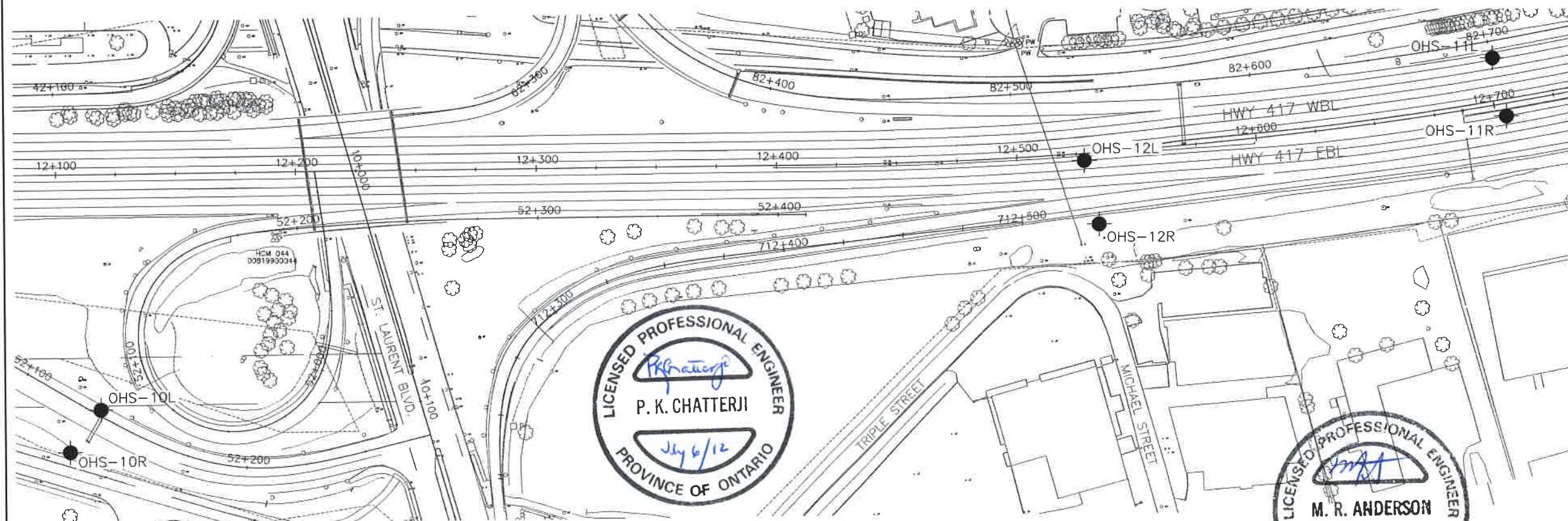
- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRIS No. 31G5-249

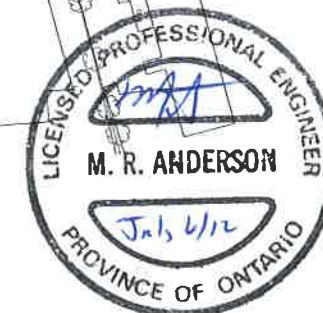
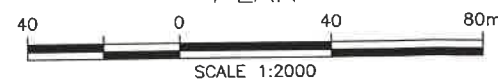
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DESIGN	LRB	CHK MRA	CODE
DRAWN	MFA	CHK PKC	SITE
LOAD	DATE	JUL. 2012	
STRUCT	DWG	2	



PLAN



PLAN





METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN



SHEET

CONT No
WP No

HIGHWAY 417  
OVERHEAD AND VARIABLE MESSAGE SIGNS  
RIVERSIDE DR. TO O.R. 174  
BOREHOLE LOCATIONS



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## KEYPLAN

### LEGEND



	Borehole
--	----------



Borehole and Cone

N

Blows /0.3m (Std Pen Test, 475J/blow)

CONE  
RH

Blows /0.3m (60° Cone, 475J/blow)

PA  
▽

Pressure, Hydraulic  
Water Level

Head Artesian Water

—

Piezometer

90%  
A/R

Rock Quality Designation (RQD)  
Average Refusal

NO	ELEVATION	NORTHING	EASTING
OHS-13	66.9	5 031 780.1	373 545.
OHS-14L	67.8	5 031 992.5	373 651.
OHS-14R	68.2	5 031 979.3	373 669.

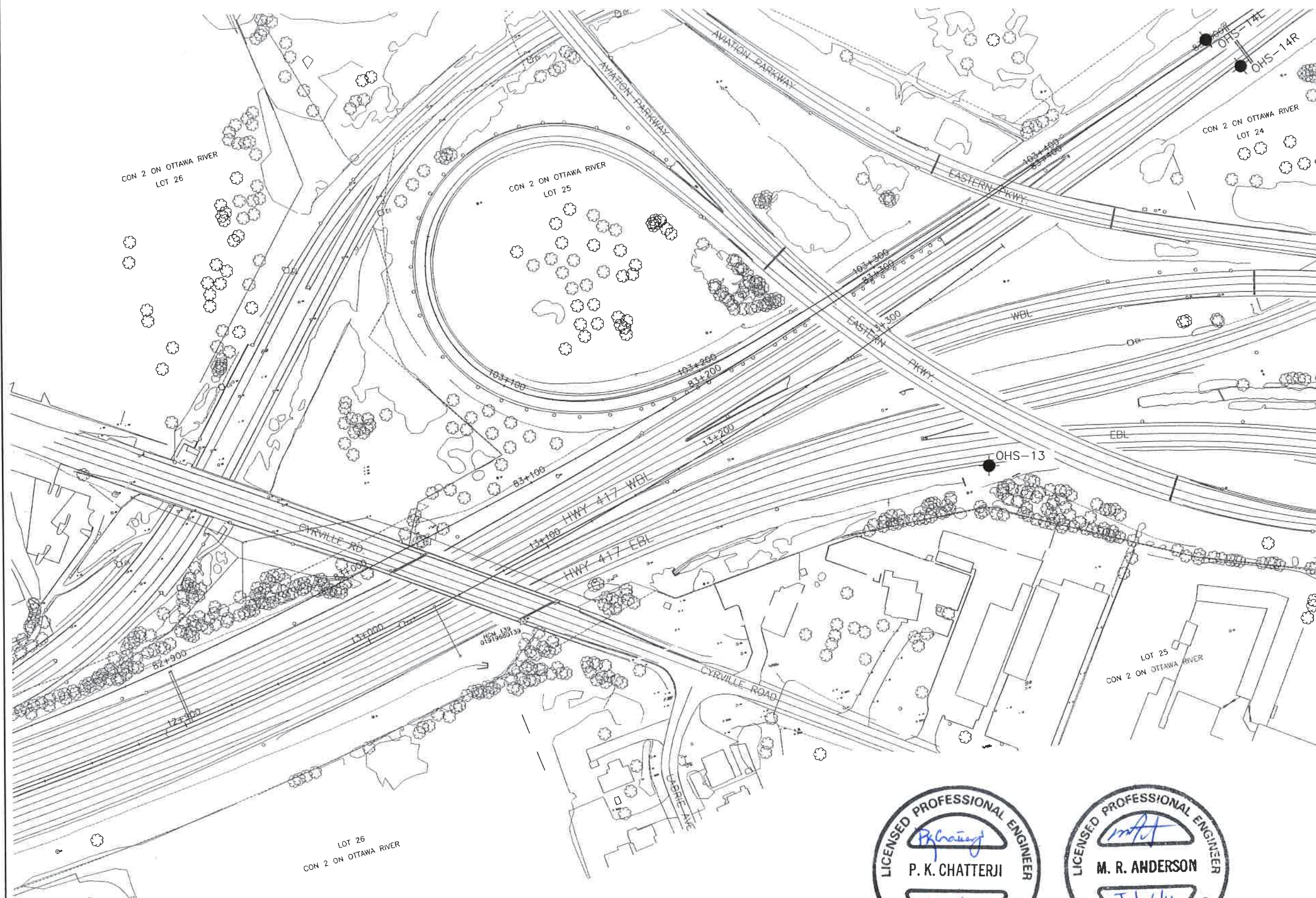
-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

**GEOCRES No. 31G5-249**

[illegible]

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## PLAN



SCALE 1:2000





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

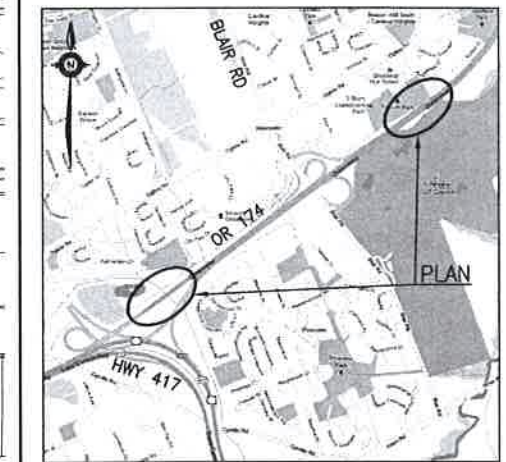
CONT No  
WP No

O.R. 174 OVERHEAD AND VARIABLE MESSAGE SIGNS HWY. 417 TO EAST OF BLAIR RD. BOREHOLE LOCATIONS	
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**MRC** **McCORMICK RANKIN**  
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## KEYPLAN

L E G E N D

	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
OHS-14L	67.8	5 031 992.5	373 651.9
OHS-14R	68.2	5 031 979.3	373 669.3
OHS-18	71.3	5 032 336.7	374 106.2
VMS-05L	69.5	5 033 572.4	375 693.2
VMS-05R	71.6	5 033 551.7	375 709.7

**-NOTES-**

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**GEOCRES No. 31G5-249**

REVISIONS									
	DATE	BY				DESCRIPTION			
DESIGN	LRB	CHK	MRA	CODE		LOAD		DATE	JUL. 2012
DRAWN	MFA	CHK	PKC	SITE		STRUCT	DWG	1	



METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No

WP	No
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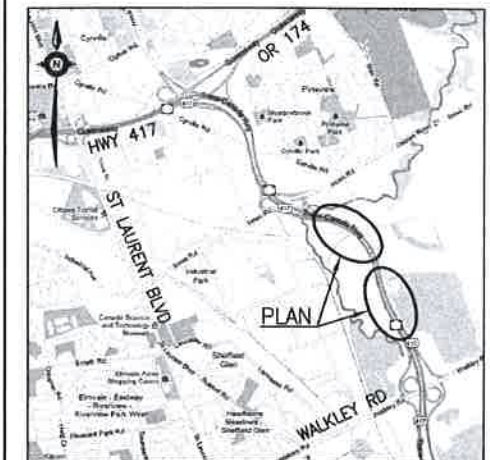
HIGHWAY 417 OVERHEAD AND VARIABLE MESSAGE SIGNS O.R. 174 TO WALKLEY ROAD BOREHOLE LOCATIONS	
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MRC

**McCORMICK RANKIN**  
A member of  **MMM GROUP**








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## KEYPLAN

### LEGEND

- |                                                                                       |                                       |
|---------------------------------------------------------------------------------------|---------------------------------------|
|  | Borehole                              |
|  | Borehole and Cone                     |
| N                                                                                     | Blows /0.3m (Std Pen Test, 475J/blow) |
| CONE                                                                                  | Blows /0.3m (60° Cone, 475J/blow)     |
| PH                                                                                    | Pressure, Hydraulic                   |
|  | Water Level                           |
|  | Head Artesian Water                   |
|  | Piezometer                            |
| 90%                                                                                   | Rock Quality Designation (RQD)        |
| A/R                                                                                   | Auger Refusal                         |

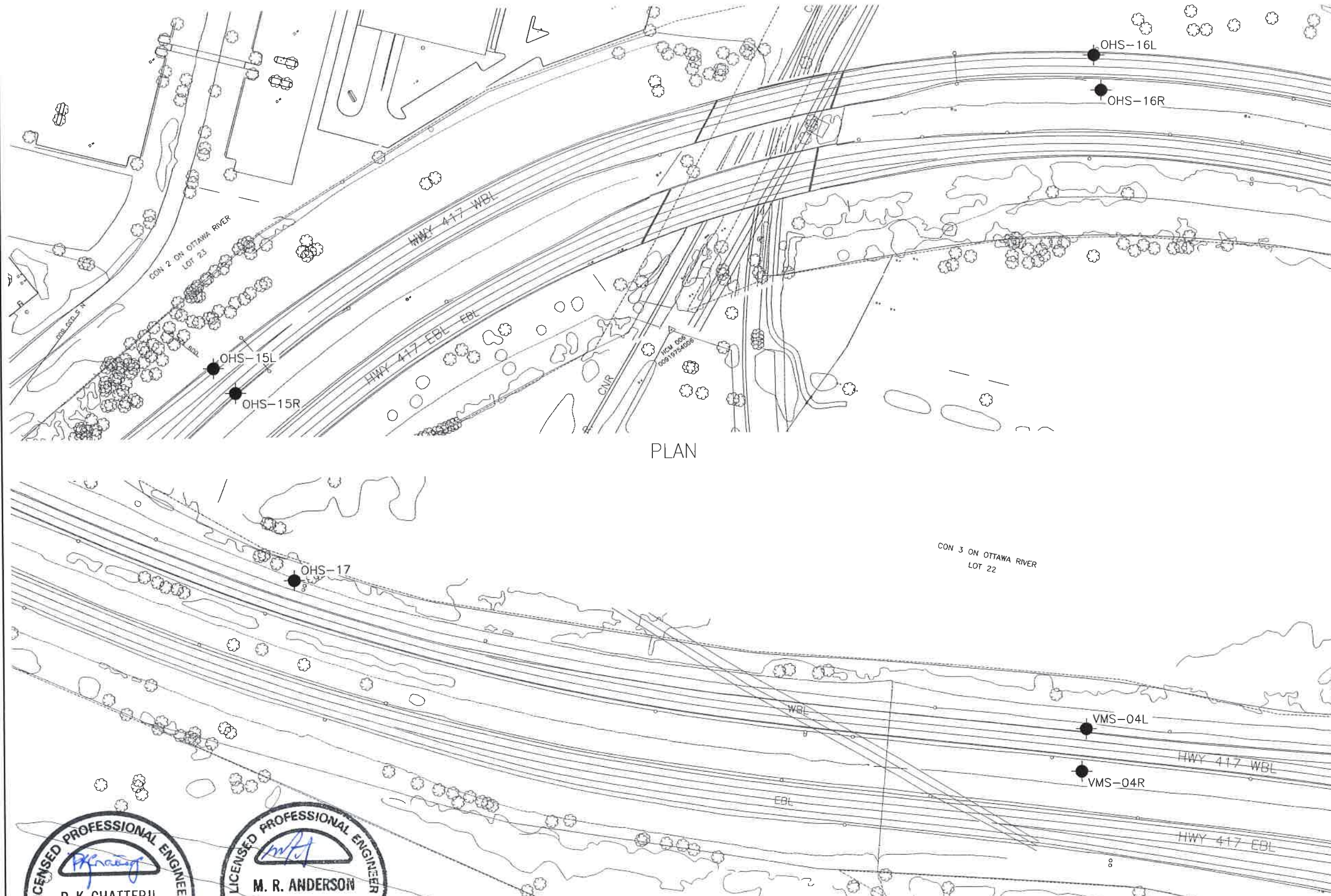
NO	ELEVATION	NORTHING	EASTING
OHS-15L	70.4	5 030 731.0	374 900.0
OHS-15R	68.7	5 030 715.0	374 896.9
OHS-16L	74.8	5 030 485.0	375 283.0
OHS-16R	73.3	5 030 471.5	375 271.6
OHS-17	67.3	5 030 015.1	375 463.3
VMS-04L	66.3	5 029 661.3	375 641.1
VMS-04R	65.5	5 029 650.2	375 623.2

**-NOTES-**

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**GEOCRES No. 31G5-249**

REVISIONS									
	DATE	BY				DESCRIPTION			
DESIGN	LRB	CHK	MRA	CODE		LOAD	DATE	JUL. 2012	
DRAWN	MFA	CHK	PKC	SITE		STRUCT	DWG	1	



## PLAN

CON 3 ON OTTAWA RIVER  
LOT 22

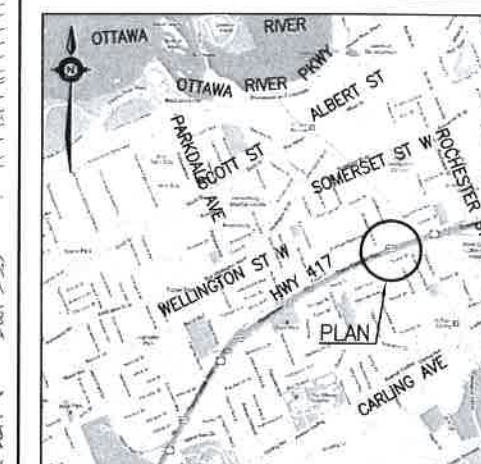
## PLAN

40 0 40 80m

SCALE 1:2000












## KEYPLAN

### LEGEND

	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
VMS-1L	76.0	5 029 423.9	366 238.6
VMS-1R	75.7	5 029 406.9	366 245.3

**-NOTES-**

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**GEOCRES No. 31G5-249**

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## PLAN

