



**FOUNDATION DESKTOP STUDY**  
**HWY 407 EAST EXTENSION – CENTRAL SECTION**  
**W.O. 07 – 20016**

**Prepared for:**  
**Ministry of Transportation Ontario**

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Input Comments by Gartner Lee Limited

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**FOUNDATION DESKTOP STUDY**  
**HWY 407 EAST EXTENSION – CENTRAL SECTION**

**W.O. 07 – 20016**

**INTRODUCTION**

A foundations desktop study has been carried out for the Central Section of the East Extension of Highway 407. Thurber Engineering Ltd. was retained by Totten Sims Hubicki to undertake this study for Ministry of Transportation Ontario (MTO).

The purpose of the study is to assess the potential geotechnical conditions affecting foundation design at the sites of individual structures in this section in advance of site-specific site investigation and field testing. An interpretation of the site geology and geotechnical conditions has been made using existing sources of information. Based on this interpretation, a preliminary assessment has been made of the geotechnical parameters that may be used for structure planning and feasibility studies. A Key Plan showing the individual structure locations is included as Drawing 19-2805-9-2.

While the information presented in this report may be used for planning and feasibility purposes, it is not intended for, nor is it sufficient for preliminary or detail design purposes. Particularly, founding elevations for footings and pile lengths may be revised significantly after site specific investigation has been completed. Therefore, the information presented may be used for the development of an overall budget estimate but must not be used for detailed costing or for bidding purposes.

**SOURCES USED IN THE STUDY**

The main sources of information that have been used in the preparation of the foundations desktop study include the following:

1. Terrain/Drainage Mapping prepared by Gartner Lee Limited (GLL) as part of the Environmental Assessment. The plates prepared from this mapping for the Central Section are included in the report.
2. Comments prepared by GLL on a site-by-site basis, particularly comments regarding the geomorphology of the valleys, groundwater and dewatering. The table of comments supplied by GLL is included in the report.
3. The results of preliminary geotechnical investigations conducted in the past by MTO for planning purposes. The GEOCREs references used include: 30M14-227 and 30M15-85.
4. Gartner Lee Existing conditions report (Gartner Lee Limited, 2006; Natural Environment Revised Draft Existing Conditions Technical Report. Prepared for the Ontario Ministry of Transportation, Central Region. GLL Project # 50613. Submitted August 22, 2006).

**REGIONAL GEOLOGY**

This section of the report has been contributed by Gartner Lee Limited (AECOM) based on Reference 4.

**Physiography**

The analysis area is characterized, from north to south, by three east-west trending physiographic regions: the Oak Ridges Moraine (ORM), the South Slope, and the Iroquois Plain. The ORM is a lateral moraine that forms the northern boundary of the analysis area. The South Slope is a gently rolling till plain, characterized by numerous drumlins oriented upslope. The majority of the Technically Preferred Route (TPR) mainline is located within this region. The Iroquois Plain physiographic region is found extending from the till plain of the South Slope Region down to Lake Ontario. The majority of the East and West Durham Links are located within this region. This area is characterized by gravel beaches that formed along the shore of Glacial Lake Iroquois, while sand was deposited nearshore, grading to silts and clays in the more calm offshore areas.

**Regional Geology and Hydrogeology**

The following description proceeds from the lowermost (oldest) stratigraphic units to the uppermost (youngest) units.

The bedrock is comprised of flat-lying Paleozoic limestones and shales underlying thick overburden sediments throughout the analysis area. Both the limestone of the Lindsay Formation and the blue-grey shale of the Blue Mountain Formation are Upper Ordovician in age. The bedrock in the study area provides a deep aquifer unit, where groundwater flow occurs through bedding plane fractures.

The lowermost sediments were mainly deposited in proglacial lakes and overlie bedrock throughout the analysis area. Because these sediments are not exposed near ground surface, only a brief description of each stratigraphic unit is provided. The Scarborough Formation consists of 30 m of clayey silt, overlain by 20 m of sand aquifer. The Sunnybrook Drift, an aquitard, is a clayey silt diamicton with few stones. The Thorncliffe Formation, comprising laminated clay, silt, and sand, is a major regional aquifer (*Thorncliffe Aquifer*) due to its extent and thickness within the South Slope Region.

The Newmarket Till is a dense, stony, sandy silt diamicton, ranging in thickness from about 5 to 50 m. This unit is exposed at ground surface throughout much of the lower South Slope Physiographic Region. The *Newmarket Till Aquitard* is a major regional aquitard, given its low hydraulic conductivity ( $10^{-9}$  to  $10^{-8}$  m/s) and consistent presence throughout the analysis area. It separates the shallow aquifers from the deep aquifers (*Thorncliffe Aquifer*). Isolated lenses of silt, sand, and gravel are present within the till. Where Newmarket Till is exposed at the surface, the water table is often high because of the poorly drained nature of the soils.

The Oak Ridges Moraine was deposited about 13,300 years ago on the meltwater flood-scoured surface of the Newmarket Till in a deep glacial lake. Numerous “finger-like” protrusions of highly permeable ORM sediments extend southward toward Lake Ontario, but pinch out beneath

the Halton Till. These are occasionally exposed at surface where valleys have incised the Halton Till. The *Oak Ridges Moraine Aquifer* is a major regional aquifer and an important groundwater recharge area. Its sandy and gravelly composition gives it a high permeability and, combined with the hummocky surface topography, facilitates infiltration. Coarse-grained sediments associated with the ORM extend southward, acting as important aquifers for residential use.

The Halton Till ranges in thickness from about 10 to 20 m and has a predominantly clayey silt to silt matrix with isolated lenses of laminated sand, silt, and clay. The *Halton Till Aquitard* has hydraulic conductivities that range from about  $10^{-10}$  to  $10^{-6}$  m/s. On a regional scale, the Halton Till Aquitard acts as a surficial aquitard, inhibiting local groundwater recharge.

The Glacial Lake Iroquois Shoreline Sediments are characterized by gravelly beach sediments along the former shoreline. Nearshore glaciolacustrine deposits of sand and gravel overlie the Newmarket Till and grade to the south into laminated silts and clays. The high permeability of the sandy nearshore deposits of the *Iroquois Plain Shallow Aquifer* provides a pathway for local groundwater discharge. The water table is typically near surface because of the low permeability of the underlying Newmarket Till. Numerous wetlands and lowland stream headwaters coincide with the Iroquois Shoreline. The low permeability silt and clay plains further south inhibit both groundwater recharge and discharge.

### Groundwater Flow

Water table contours and groundwater flow directions subtly reflect the topographic contours in the analysis area, indicating the influence of topography and soil type on the shallow groundwater flow system. Regional groundwater flow in the aquifers within the analysis area is downwards and south-southeast from the ORM towards Lake Ontario. Locally, groundwater flow paths bend into river valleys and isolated topographic depressions. Topographic highs are generally groundwater recharge zones. Groundwater discharge is predominant along the Iroquois shoreline and groundwater flow in the Iroquois Plain Shallow Aquifer is predominantly horizontal due to the Newmarket Till Aquitard below. Regionally, streams that originate from the ORM warm up as they flow over the South Slope till soils due to little moderation by groundwater. Streams that originate on the low permeability till plain of the lower South Slope initially derive most of their water from surface runoff, but receive a significant proportion of their flow from groundwater discharge as they flow across the sandy Iroquois shoreline.

### SITE SPECIFIC ASSESSMENTS

The information gathered for each site is presented in a single sheet that contains:

- A site location plan
- A photograph of the general site area (where these could be readily obtained)
- Reference to existing boreholes available for the site
- A description of the site geology based on terrain mapping
- A simplified stratigraphic log (where a borehole was available)
- Foundation design parameters to be used for planning and feasibility purposes
- Comments on stability and settlement of approach fills
- Comments on dewatering requirements
- A site ranking from a geotechnical perspective and a hydrogeological perspective

Typically, three foundation types have been considered in the desktop study. These are spread footings on engineered fill, spread footings on native soil, or driven steel H-piles (typically HP 310 X 110).

### Site Location Plans

The site location plans on the individual sheets have been cut from the Terrain/Drainage Mapping supplied by GLL. The meanings of symbols can be found in the legend on any of the mapping plates attached to the report.

### Spread Footings on Engineered Fill

At those sites where the use of spread footings on engineered fill is considered feasible, the report provides either a maximum elevation at which the engineered fill pad can be founded or a minimum depth below ground surface. The values have been determined from an existing borehole where one is located at or close to the site. Otherwise they have been assessed from interpreted surface elevations. In all cases they are subject to revision following site investigation.

Spread footings on engineered fill may be designed on the basis of geotechnical resistances of:

900 kPa factored ULS  
350 kPa SLS

The geometry of the engineered fill pad must conform to the requirements set out in Figure 1, following the text. The recommended minimum thickness of engineered fill below the underside of the footing is 2 m.

### Spread Footings on Native Soil

For those sites where the soil conditions are considered to be suitable, recommendations have been provided for the design of spread footings bearing on native soil.

Preliminary values are given for the geotechnical resistances at factored ULS and SLS. The recommendations also include the maximum elevation, or alternatively the minimum depth below existing ground surface, at which the footing may be founded. The values have been determined from an existing borehole where one is located at or close to the site. Otherwise they have been assessed from interpreted surface elevations. In all cases they are subject to revision following site investigation.

### Driven Steel H-Piles

For the purposes of the desktop study, the pile section has been assumed to be HP 310 X 110.

Where the soil conditions appear to be suitable for driven piles, values of the geotechnical resistance have been given at factored ULS and at SLS. An anticipated pile tip elevation and/or pile length has also been provided. The values have been determined from an existing borehole



where one is located at or close to the site. Otherwise they have been assessed from interpreted surface elevations. In all cases they are subject to revision following site investigation.

In the desktop study, no attempt has been made to assess downdrag forces on piles. The requirement to consider downdrag must be assessed during site investigation for the detail design stage.

#### **Valley Slope Stability**

At valley crossings, comments from GLL regarding geomorphological evidence of slope instability has been included in the remarks column, where appropriate. No recommendations have been developed from this information but sites showing evidence of slope slumping should be flagged for close examination during detail design.

#### **Swamps**

No information is available in the wetland complexes and no recommendations have been provided regarding crossing these areas.

#### **MISCELLANEOUS**

The following convention has been used to categorize structures:

Overpass – the main highway passes over the secondary road  
Underpass – the main highway passes under the secondary road  
Overhead – the highway passes over a railway track  
Subway – the highway passes under a railway track  
Ramp Underpass – the main highway passes under a highway ramp  
Ramp Overpass – the main highway passes over a highway ramp

#### **Numbering System**

The following examples illustrate the numbering system that has been developed by the Design Team to describe structure locations:

CM – xx represents a structure on the Mainline in the Central Section

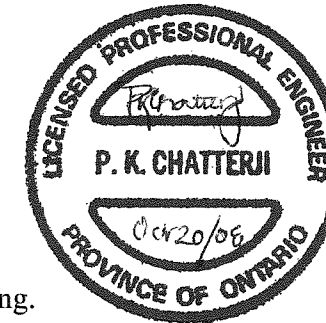
#### **Acknowledgement**

Thurber gratefully acknowledges the contribution made by Gartner Lee Limited (AECOM) in the preparation of this report, in particular the Terrain/Drainage Mapping, description of geology and comments on groundwater and geomorphology.

#### **Report Preparation**

This report was prepared by Mr. Alastair E. Gorman, P.Eng., and was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

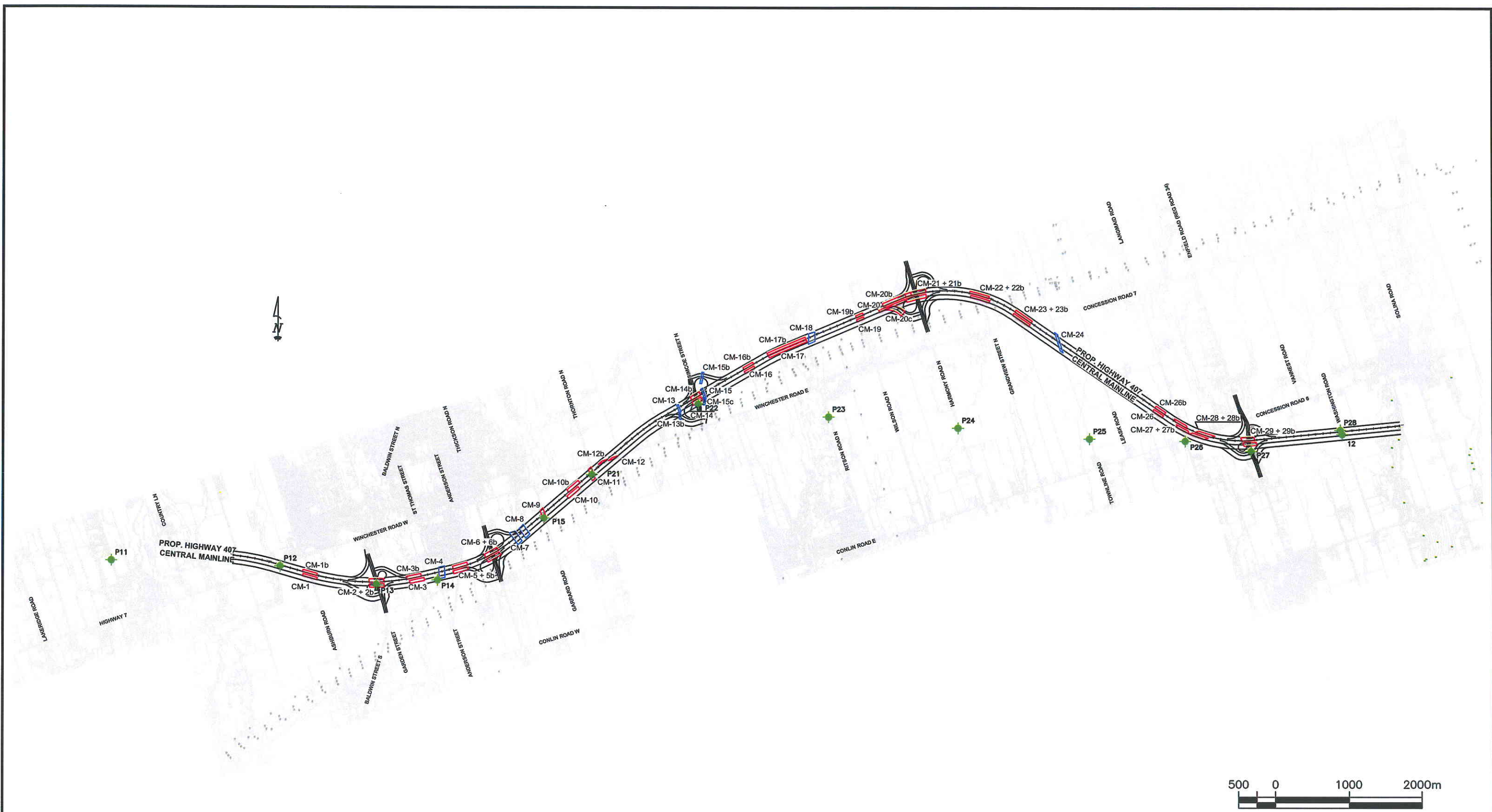
Thurber Engineering Ltd.



P.K. Chatterji, P.Eng.  
Review Principal



Alastair Gorman, P.Eng.  
Senior Foundations Engineer



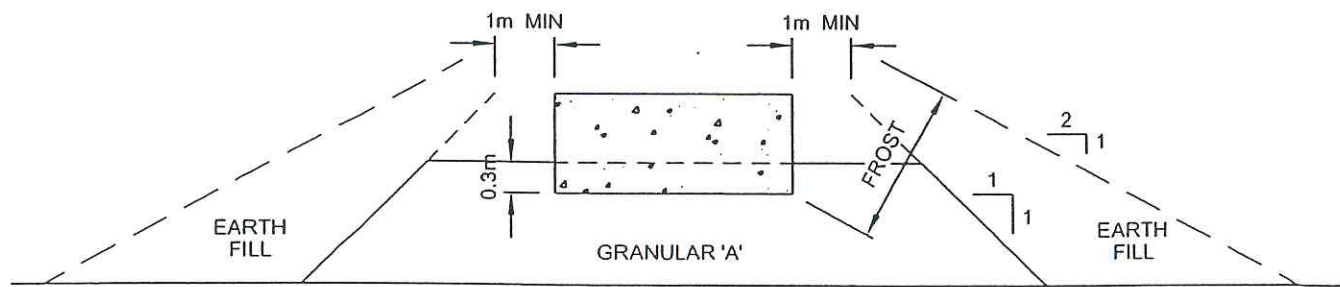
- LEGEND:
- ◆ BOREHOLE LOCATION (PREVIOUS INVESTIGATION)
  - APPROXIMATE STRUCTURE LOCATION
  - APPROXIMATE CULVERT LOCATION

BASE PLAN PROVIDED BY TSH IN OCTOBER, 2007

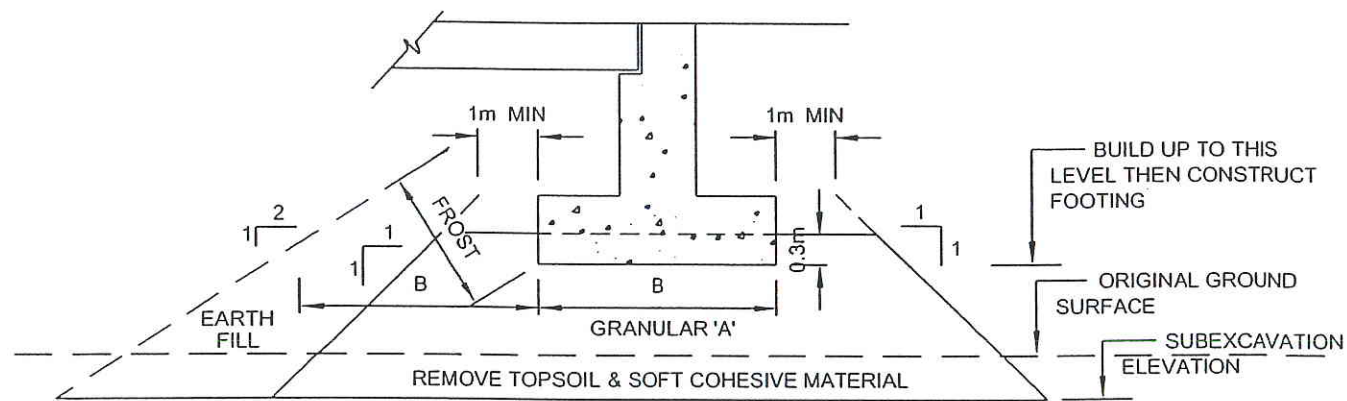
MINISTRY OF TRANSPORTATION ONTARIO	
FOUNDATION DESKTOP STUDY HIGHWAY 407 EAST EXTENSION CENTRAL SECTION KEY PLAN	
19-2805-9	

 <b>THURBER ENGINEERING LTD.</b> GEOTECHNICAL • ENVIRONMENTAL • MATERIALS		
ENGINEER:	DRAWN:	APPROVED:
MEF	MFA	PKC
DATE:	SCALE:	DRAWING No.
OCTOBER 2008	1:50000	19-2805-9-2

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CROSS-SECTION




LONGITUDINAL SECTION

NOT TO SCALE

NOTES:

1. REMOVE TOPSOIL AND SOFT SILTY CLAY SUBSOIL UNDER FOOTPRINT OF COMPACTED GRANULAR 'A'.
2. PLACE GRANULAR 'A' AND EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO O.P.S.S. 501.
3. CONSTRUCT CONCRETE FOOTING.
4. PLACE REMAINDER OF GRANULAR 'A' AND EARTH FILL AS REQUIRED.
5. SOURCE M.T.C. 1982.

ENGINEER	AEG	
DRAWN	SS	
DATE	April , 2004	
APPROVED	PKC	
SCALE	NTS	
ABUTMENT ON COMPACTED FILL SHOWING GRANULAR A CORE		DWG. NO. FIGURE 1

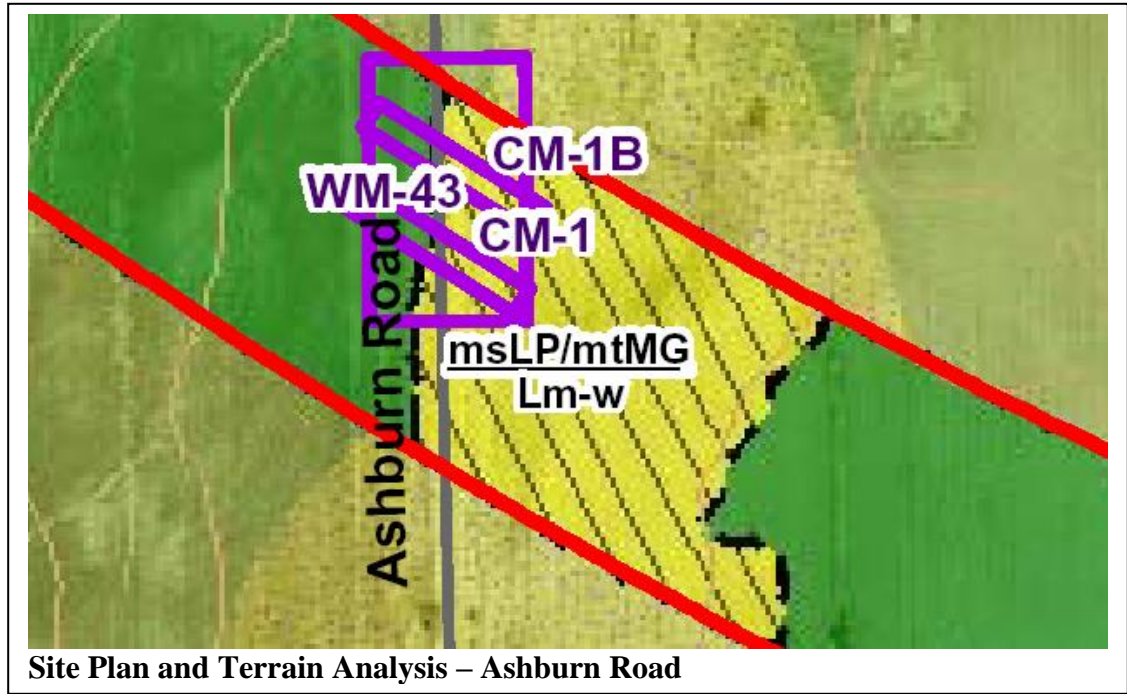


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

Site No:	CM-1 CM-1b
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W.O: 07-20016    Section: Central    Location: Mainline at Ashburn Road    Sta. 11+075

Original Grade: 161.5    Proposed Grade:    Description: Twin structures to carry the Mainline over Ashburn Road



Site Plan and Terrain Analysis – Ashburn Road



Site Photograph – Ashburn Road looking south

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site. BH P12, 30M14-227, lies 500m northwest.</b>	<b>1. Abutments</b>	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.	Unwatering of excavations will be required.
Mapping (West 5) shows that the site lies with a wide area of silt till ground moraine but in the western edge of a local area of silty sand lacustrine plain. The latter soil is interpreted in the mapping as being a shallow deposit overlying the ground moraine.	a. Footings may be founded on Granular A cores at 1.5m below ground surface		
BH P12 encountered:  0.0 – 0.8 Granular fill 0.8 - 3.8 Clayey silt till, very stiff to hard 3.8 – 20.4 Silt and sand till, loose to very dense 20.4– 24.6 EOH Clayey silt till, hard  <b>Groundwater</b>  GWL at Elev. ~159.5 in BH P12.  <b>Estimated overburden thickness – 60m.</b>	b. For closed abutments, footings may be founded on native soil at 2m below ground surface	No global stability or settlement issues are anticipated based on available information.	
	a. Factored resistance at ULS – 450 kPa		
	b. Resistance at SLS – 300 kPa	Stripping of topsoil or other unsuitable soils will be required prior to construction.	
	c. Abutments may also be supported on HP 310X110 piles driven to refusal below El.140.0.		
	a. ULS resistance – 1,600 kN		
	b. SLS resistance – 1,400 kN		
	d. Integral abutments are feasible. Assume 25m piles.		
	<b>2. Piers</b>		
	Piers may be supported using the same foundation options as for abutments.		
	Spread footings on hard native soil are considered to be a suitable foundation option.		
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>Medium</b>

HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-2 CM-2b
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W.O: 07-20016    Section: Central    Location: Mainline at Baldwin Street    Sta. 11+993

Original Grade: 158.8    Proposed Grade:    Description: Twin structures to carry the Mainline over Baldwin Street



Site Photograph – Baldwin Street looking north

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P13, 30M14-227</b>	<b>1. Abutments</b>	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.	No major dewatering requirements are anticipated.
Mapping (West 5) shows that the site is underlain by silt till ground moraine. The relief is low, rolling and imperfectly to poorly drained.	a. Footings may be founded on compacted Granular A cores as per current MTO standard practices below Elev 156.5.	No global stability or settlement issues are anticipated based on available information.	
BH P13 encountered:	b. For closed abutments, footings may be founded on native below Elev 155.0	Stripping of topsoil or other unsuitable soils will be required prior to construction.	
0.0 – 0.5 Granular fill	a. Factored resistance at ULS – 750 kPa		
0.5 – 2.1 Clayey silt fill, clayey silt, gravel, etc, becoming very stiff	b. Resistance at SLS – 500 kPa		
2.1 – 6.1 Silt, sand and gravel, till, dense becoming very dense	c. Abutments may also be supported on HP 310X110 piles driven to refusal below El.152.0.		
6.1– 12.4 EOH Clayey silt trace gravel, cobbles and boulders, till, hard	a. ULS resistance – 1,600 kN		
	b. SLS resistance – 1,400 kN		
	d. Integral abutments are feasible. Assume 15m piles. Predrilling may be required to install the piles.		
	<b>2. Piers</b>		
	Piers may be supported using the same foundation options as for abutments.		
	Spread footings on very dense native soil are considered to be a suitable foundation option.		
<b>Groundwater</b>			
The GWL is anticipated to lie 2 to 3m below ground surface.			
<b>Estimated overburden thickness – 60m.</b>			
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>Low</b>



**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

**W.O:** 07-20016    **Section:** Central    **Location:** Mainline at Lynde Creek    **Sta.** 12+515

<b>Original Grade:</b> ~148	<b>Proposed Grade:</b>	<b>Description:</b> Twin structures to carry Mainline over Lynde Creek
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Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BH at the site. BH P14, 30M14-227, lies 250m east.</b></p> <p>Mapping (West 5) shows that the site is underlain by a 150m wide band of alluvium consisting of silty gravelly sand with peat. The creek meanders within this band of alluvium. The west side of the site is underlain by silty sand glaciolacustrine plain. The surrounding area is silt till ground moraine. The immediate site relief is low plain, poorly to very poorly drained.</p> <p>BH P14 encountered:</p> <p>0.0 – 0.8 Granular fill, loose  0.8 – 1.5 Clayey silt fill,  1.5 – 11.4 Clayey silt, trace sand and gravel, cobbles and boulders, till, hard  11.4 – 20.6 Silty sand with gravel, cobbles and boulders, very dense  20.6 – 23.0 EOH Clayey silt trace sand and gravel, till, hard</p> <p><b><u>Groundwater</u></b></p> <p>GWL recorded approx 2.5m below ground surface.</p> <p><b>Estimated overburden thickness – 55m.</b></p>	<p><b><u>1. Abutments</u></b></p> <p>a. Footings may be founded on compacted Granular A cores as per current MTO standard practices approx 2mbgs.</p> <p>b. For closed abutments, footings may be founded on native below estimated Elev 145.0</p> <p style="padding-left: 40px;">a. Factored resistance at ULS – 600 kPa  b. Resistance at SLS – 400 kPa</p> <p>c. Abutments may also be supported on HP 310X110 piles driven to refusa.</p> <p style="padding-left: 40px;">a. ULS resistance – 1,600 kN  b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 20m piles. Predrilling may be required to install the piles.</p> <p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments.</p> <p>Piles may be the preferred option in the valley.</p>	<p>Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.</p> <p>No global stability or settlement issues are anticipated based on available information.</p> <p>Stripping of topsoil or other unsuitable soils will be required prior to construction. Extensive stripping may be required if the fill is placed on the valley floor.</p>	<p>A requirement for dewatering should be expected in the valley.</p> <p>No major dewatering requirement anticipated on the tablelands.</p> <p>Wide, moderately deep valley with 15-25° steep valleysides, except where meandering channel is undercutting and steepening slope, which has led to localized slumps</p>
		<p style="text-align: center;"><b>Site Ranking</b></p> <p><b>Foundations:                      Medium</b></p> <p><b>Hydrogeology:                    High</b></p>	

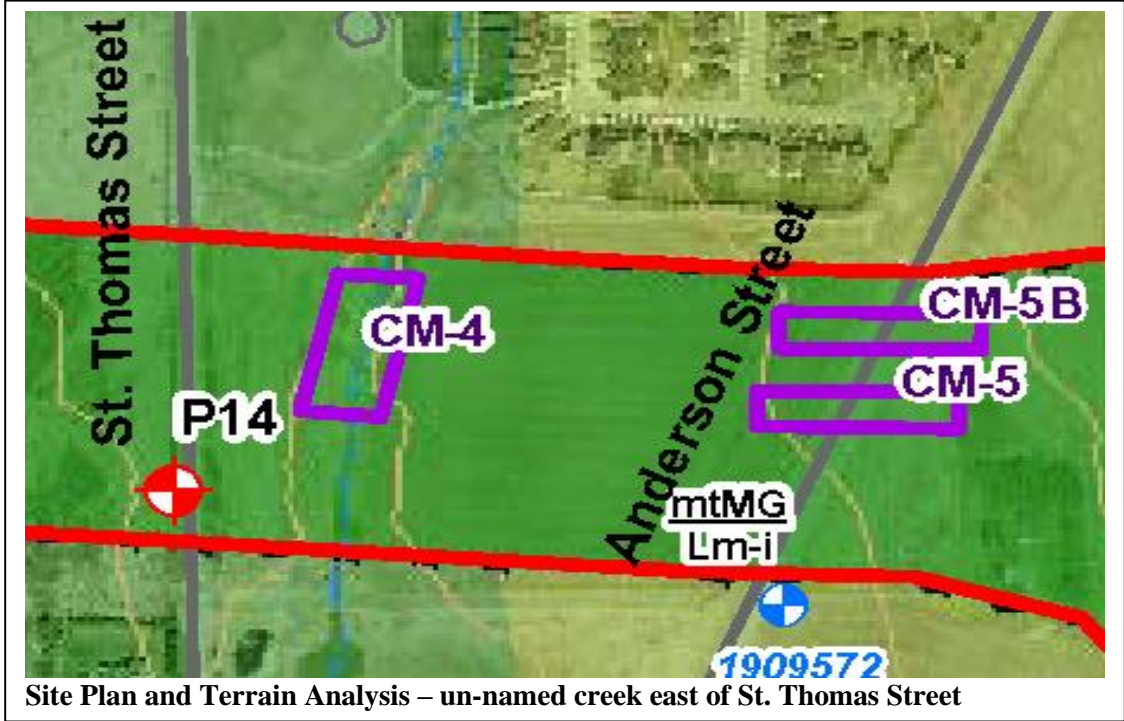


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: CM-4

W.O: 07-20016    Section: Central    Location: Creek east of St. Thomas Street and west of Anderson Street, Whitby    Sta. 12+900

Original Grade:    Proposed Grade:    Description: Mainline crosses creek with no name.



Site Photograph looking southeast across creek valley

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BH at site. BH P14, 30M14-227, lies 300m west.</b></p> <p>Mapping (Central 1) shows that the site is underlain by silt till ground moraine. The relief is low, rolling and imperfectly drained.</p> <p>BH P14 encountered:</p> <p>0.0 – 0.8 Granular fill, loose 0.8 – 1.5 Clayey silt fill, 1.5 – 11.4 Clayey silt, trace sand and gravel, cobbles and boulders, till, hard 11.4 – 20.6 Silty sand with gravel, cobbles and boulders, very dense 20.6 – 23.0 EOH Clayey silt trace sand and gravel, till, hard</p> <p><b><u>Groundwater</u></b></p> <p>GWL recorded approx 2.5m below ground surface at BH P14. GWL to be expected at surface along the creek.</p> <p><b>Estimated overburden thickness – 60m.</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface.</p> <p>Footings may be designed on the basis of</p> <p>a. Factored resistance at ULS – 450 kPa b. Resistance at SLS – 300 kPa</p> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow, channelized valley with no geomorphic evidence of significant valleyside instability.</p> <p>Depending on stream flow and final design, temporary stream diversion may be required.</p> <p>Groundwater control will be required for construction.</p>
		<p><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                      Low</b></p>	



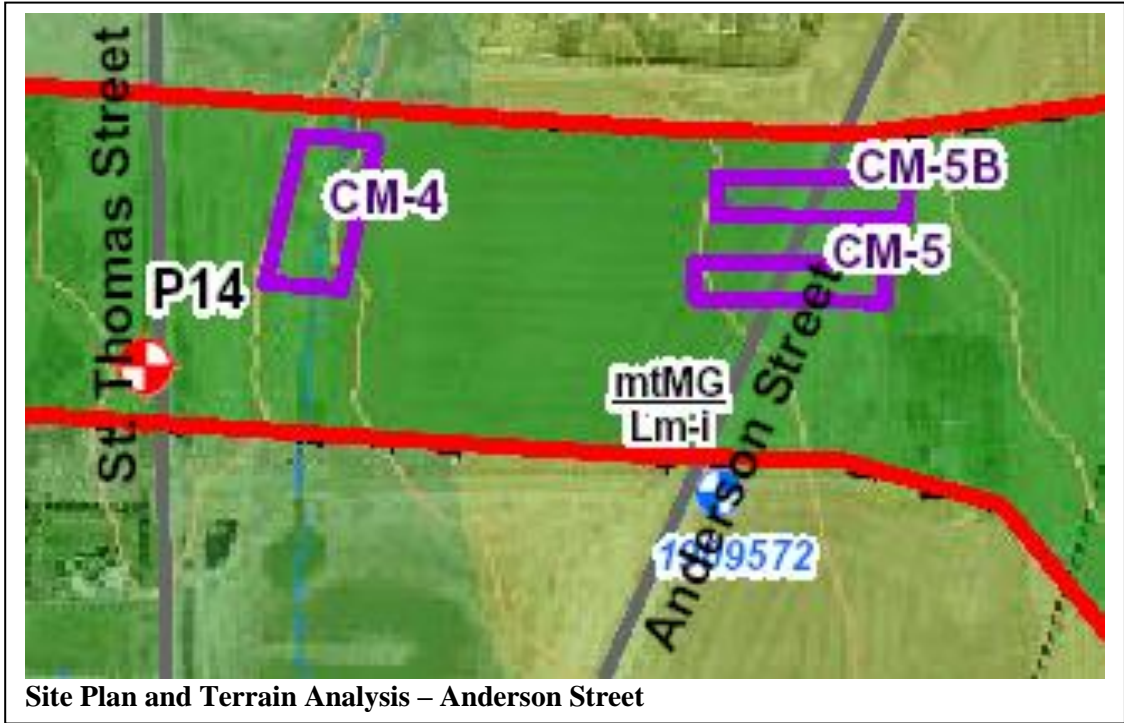
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-5 CM-5b
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W.O: 07-20016    Section: Central    Location: Mainline at Anderson Street    Sta. 13+155

Original Grade: ~160    Proposed Grade:    Description: Twin structures to carry Mainline over Anderson Street



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at site. BH P14, 30M14-227, lies 300m west.</b>	<b>1. Abutments</b>  a. Footings may be founded on compacted Granular A cores as per current MTO standard practices approx 2mbgs.  b. For closed abutments, footings may be founded on native below estimated Elev 155.0 a. Factored resistance at ULS – 450 kPa b. Resistance at SLS – 300 kPa  c. Abutments may also be supported on HP 310X110 piles driven to refusal. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Integral abutments are feasible. Assume 20m piles. Predrilling may be required to install the piles.	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.  No global stability or settlement issues are anticipated based on available information.  Stripping of topsoil or other unsuitable soils will be required prior to construction.	No major dewatering requirements are anticipated.
Mapping (Central 1) shows that the site is underlain by silt till ground moraine. The relief is low, rolling and imperfectly drained.  BH P14 encountered:  0.0 – 0.8 Granular fill, loose 0.8 – 1.5 Clayey silt fill, 1.5 – 11.4 Clayey silt, trace sand and gravel, cobbles and boulders, till, hard 11.4 – 20.6 Silty sand with gravel, cobbles and boulders, very dense 20.6 – 23.0 EOH Clayey silt trace sand and gravel, till, hard  <b>Groundwater</b>  GWL recorded approx 2.5m below ground surface.  <b>Estimated overburden thickness – 60m.</b>	<b>2. Piers</b>  Piers may be supported using the same foundation options as for abutments.  Spread footings on very dense native soil are considered to be a suitable foundation option.	<b>Site Ranking</b>  <b>Foundations:                      Low</b>  <b>Hydrogeology:                    Low</b>	



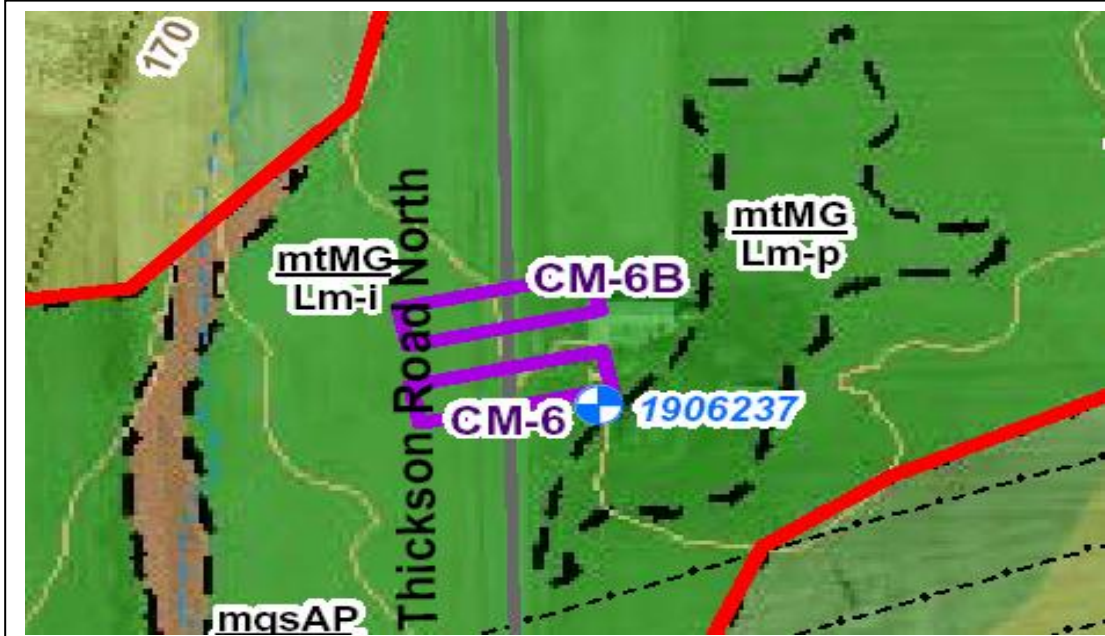
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-6 CM-6b
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W.O: 07-20016    Section: Central    Location: Mainline at Thickson Road    Sta. 13+628

Original Grade: ~170    Proposed Grade:    Description: Twin structures to carry Mainline over Thickson Road



Site Plan and Terrain Analysis – Thickson Road



Site Photograph – Thickson Road facing south

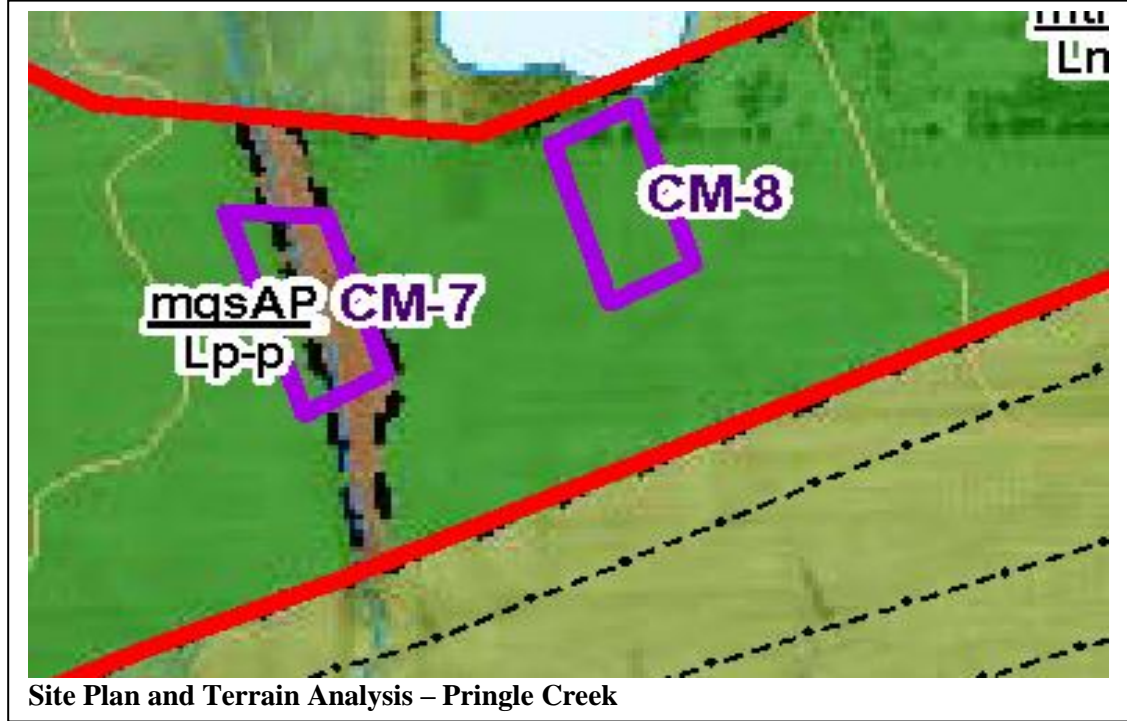
Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes:</b> No BH at the site. BH P14 & P15 (30M14-227, lie 700 to 800m west and east respectively.	<b>1. Abutments</b>  a. Footings may be founded on compacted Granular A cores as per current MTO standard practices approx 1.5mbgs.  b. For closed abutments, footings may be founded on native at estimated 3mbgs a. Factored resistance at ULS – 600 kPa b. Resistance at SLS – 400 kPa  c. Abutments may also be supported on HP 310X110 piles driven to refusal. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Integral abutments are feasible. Assume 20m piles. Predrilling may be required to install the piles.	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.  No global stability or settlement issues are anticipated based on available information.  Stripping of topsoil or other unsuitable soils will be required prior to construction.	No major dewatering requirements are anticipated.
<p>Mapping (Central 1) shows that the site is underlain by silt till ground moraine. The relief is low, rolling, imperfectly to poorly drained. BHs P14 and P15 encountered hard and very dense till soils.</p> <p><b>Groundwater</b></p> <p>GWL should be anticipated to be 2 to 3mbgs.</p> <p><b>Estimated overburden thickness – 60m.</b></p>	<b>2. Piers</b>  Piers may be supported using the same foundation options as for abutments.  Spread footings on hard or very dense native soil are considered to be a suitable foundation option.	<p><b>Site Ranking</b></p> <p><b>Foundations: Medium</b></p> <p><b>Hydrogeology: Low</b></p>	

**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: CM-7

W.O: 07-20016    Section: Central    Location: Pringle Creek    Sta. 14+032

Original Grade:    Proposed Grade:    Description: Mainline crosses Pringle Creek.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site. BH P14 &amp; P15 (30M14-227, lie 1200 to 300m west and east respectively.</b>	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.  Footings may be designed on the basis of a. Factored resistance at ULS – 450 kPa b. Resistance at SLS – 300 kPa  A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.	Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability  Stream is mapped as intermittent. Thus the requirements for stream diversion and groundwater control are judged to be low but to be dependent on the time of year construction is carried out.  Valley alluvium may contain some organic inclusions.
Mapping (Central 1) shows that the site is underlain by silt till ground moraine. The relief is low, rolling, imperfectly to poorly drained. Minor alluvial deposits are mapped along the creek. BHs P14 and P15 encountered hard and very dense till soils.			
<b><u>Groundwater</u></b>			
GWL should be anticipated to be close to ground surface at the creek and 2 to 3mbgs beyond the creek banks.			
<b>Estimated overburden thickness – 60m.</b>			
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>Low</b>



**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	CM-8
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Sta. 14+167

<b>Original Grade:</b>	<b>Proposed Grade:</b>	<b>Description:</b>	Mainline crosses creek with no name.
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### Site Plan and Terrain Analysis – un-named creek



**Site Photograph – looking east towards site of culvert**

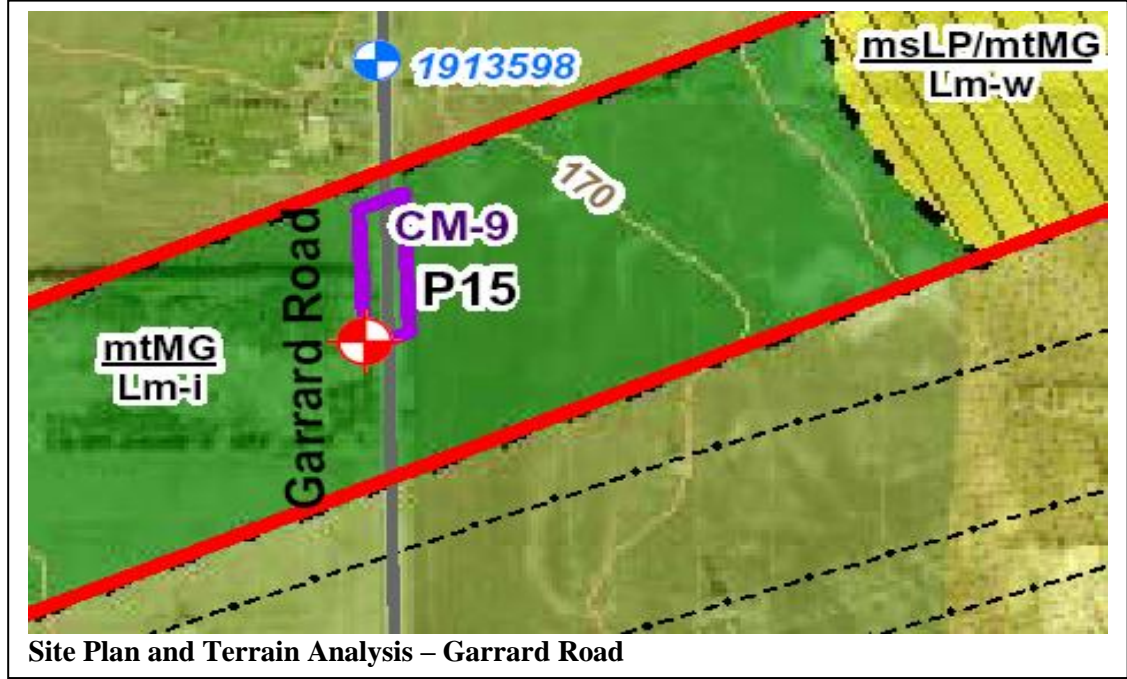
Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BH at the site. P15 (30M14-227, lies 150 to east.</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 1 to 2 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"> <li>a. Factored resistance at ULS – 450 kPa</li> <li>b. Resistance at SLS – 300 kPa</li> </ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow swale with no geomorphic evidence of significant valleside instability</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales</p>
<p>Mapping (Central 1) shows that the site is underlain by silt till ground moraine. The relief is low, rolling, imperfectly to poorly drained. Minor alluvial deposits are mapped along the creek. BH P15 encountered hard and very dense till soils.</p> <p style="text-align: center;"><b><u>Groundwater</u></b></p> <p>GWL should be anticipated to be close to ground surface at the creek and 2 to 3mbgs beyond the creek banks.</p> <p><b>Estimated overburden thickness – 60m.</b></p>		<p style="text-align: center;"><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                      Low</b></p>	

**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: CM-9

W.O: 07-20016    Section: Central    Location: Mainline at Garrard Road    Sta. 14+518

Original Grade: 172.2    Proposed Grade:    Description: Underpass structure to carry Garrard Road over the Mainline



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P15, M14-227</b>	<b>1. Abutments</b>	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.	No major dewatering requirements are anticipated.
Mapping (Central 1) shows that the site is underlain by silt till ground moraine. The relief is low, rolling, imperfectly drained.	a. Footings may be founded on compacted Granular A cores as per current MTO standard practices approx 2mbgs.	No global stability or settlement issues are anticipated based on available information.	
BH P15 encountered:	b. For closed abutments, footings may be founded on native at estimated 3mbgs	Stripping of topsoil or other unsuitable soils will be required prior to construction.	
0.0 – 0.8 Granular fill	a. Factored resistance at ULS – 600 kPa		
0.8 – 8.4 Clayey silt, trace sand and gravel, cobbles and boulders, till, hard	b. Resistance at SLS – 400 kPa		
8.4 –17.0 EOH silt sand and gravel, till, very dense	c. Abutments may also be supported on HP 310X110 piles driven to refusal.		
	a. ULS resistance – 1,600 kN		
	b. SLS resistance – 1,400 kN		
	d. Integral abutments are feasible. Assume 20m piles. Predrilling may be required to install the piles.		
	<b>2. Piers</b>		
	Piers may be supported using the same foundation options as for abutments.		
	Spread footings on hard or very dense native soil are considered to be a suitable foundation option.		
		<b>Site Ranking</b>	
		<b>Foundations: Medium</b>	
		<b>Hydrogeology: Low</b>	



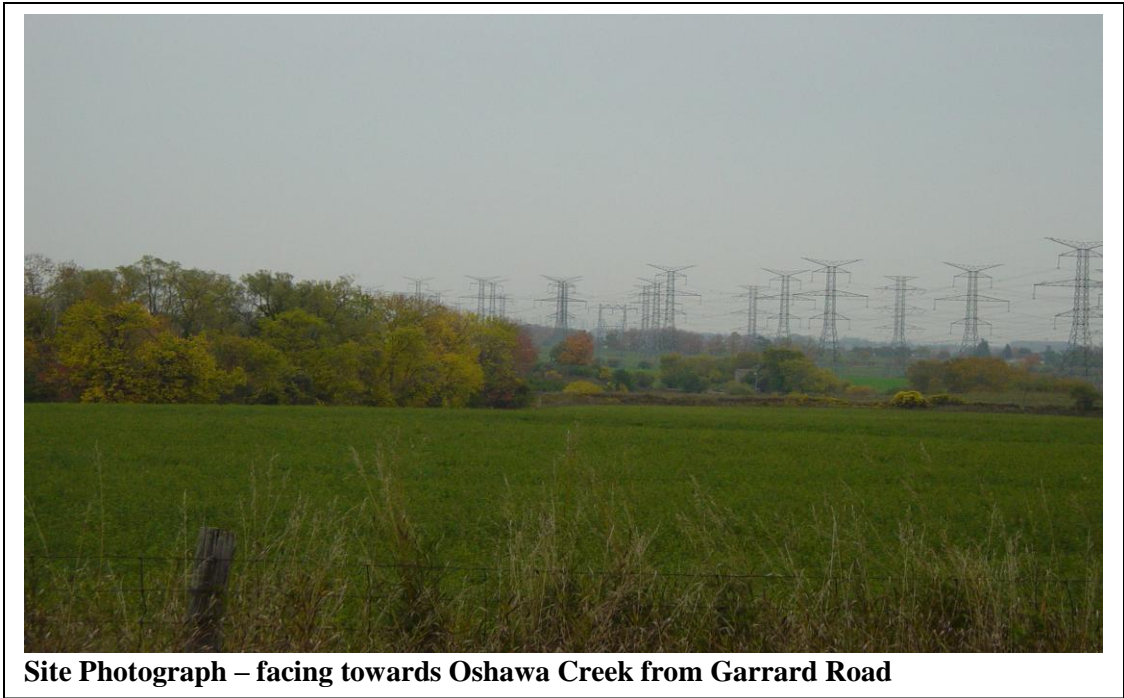
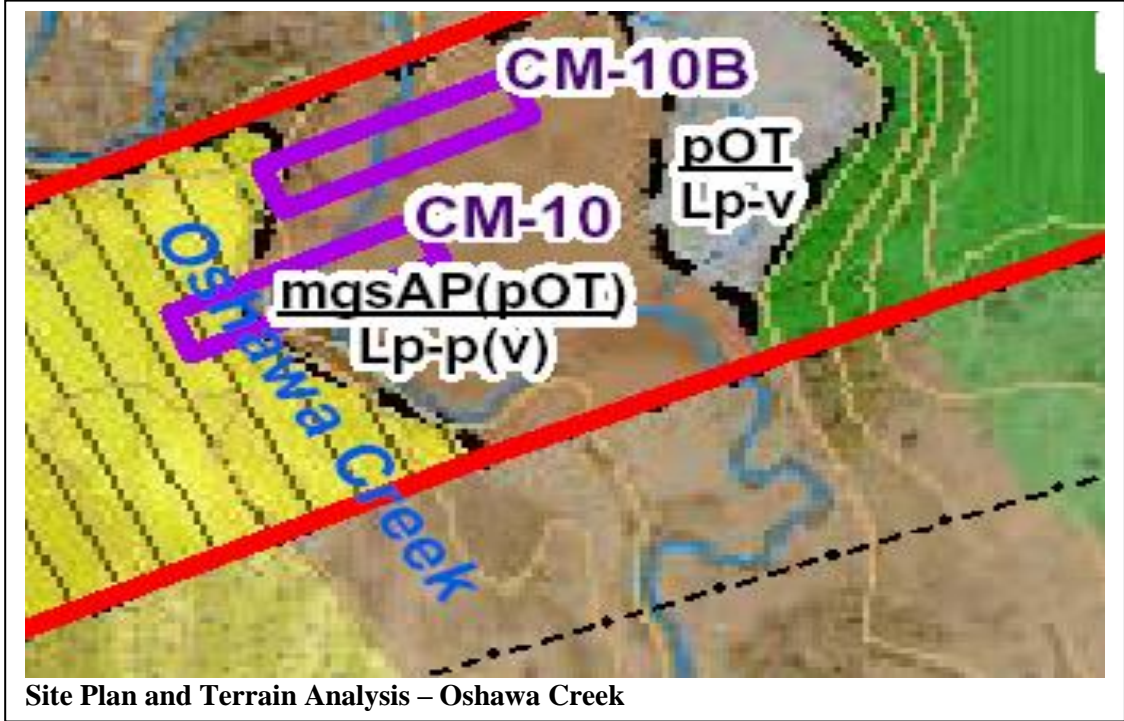
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-10 CM-10b
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W.O: 07-20016    Section: Central    Location: Mainline at Oshawa Creek    Sta. 15+140

Original Grade: ~152    Proposed Grade:    Description: Twin structures to carry Mainline over Oshawa Creek



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site. BH P21, 30M15-85 lies ~250m northeast.</b>	<b>1. Abutments</b>  a. Footings may be founded on compacted Granular A cores as per current MTO standard practices approx 1mbgs.  b. For closed abutments, footings may be founded on native at estimated 3mbgs a. Factored resistance at ULS – 600 kPa b. Resistance at SLS – 400 kPa  c. Abutments may also be supported on HP 310X110 piles driven to refusal. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Integral abutments are feasible. Assume 15m piles. Predrilling may be required to install the piles.	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.  No global stability or settlement issues are anticipated based on available information.  Stripping of topsoil or other unsuitable soils will be required prior to construction. Substantial stripping may be required in the valley.	Dewatering must be anticipated for excavations in the valley bottom.  Wide, deep valley with 30° steep valleysides, except where meandering channel is undercutting and steepening slope, which has lead to localized slumps (bridge abutment locations should take into account potential for continued down-valley migration of meander immediately northwest of proposed footprints); thin soil cover and minor irregularities on east valleyside suggest localized erosion and instability
Mapping (Central 1) shows that the site lies in a 250m wide silty, gravelly sand alluvial plain. The soil at the west end of the structures is a thin deposit of silty sand glaciolacustrine plain, probably underlain by silt till ground moraine. The relief is low plain, poorly to very poorly drained. Peat is mapped at the east side of the alluvial plain.  BH P21 encountered:  0.0 –9.4 EOH Clayey silt some sand, trace gravel, till, hard  <b>Groundwater</b>  GWT was recorded approx. 3mbgs.  <b>Estimated overburden thickness – 35m.</b>	<b>2. Piers</b>  Piers may be supported using the same foundation options as for abutments.  Spread footings on hard native soil may be feasible but piles may be preferred in the valley.	<b>Site Ranking</b>  <b>Foundations: Medium</b>  <b>Hydrogeology: High</b>	



**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: CM-11

W.O: 07-20016    Section: Central    Location: Mainline at Thornton Road    Sta. 15+383

Original Grade: 172.0    Proposed Grade:    Description: Underpass to carry Thornton Road over Mainline



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P21, M15-85.</b>	<b>1. Abutments</b>	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.	No major dewatering requirements are anticipated.
Mapping (Central 1) shows that the site is underlain by silt till ground moraine. The relief is low plain to rolling, imperfectly to poorly drained.	a. Footings may be founded on compacted Granular A cores as per current MTO standard practices approx 2mbgs.	No global stability or settlement issues are anticipated based on available information.	
BH P21 encountered:	b. For closed abutments, footings may be founded on native at estimated 3mbgs	Stripping of topsoil or other unsuitable soils will be required prior to construction.	
0.0 –9.4 EOH Clayey silt some sand, trace gravel, till, hard	a. Factored resistance at ULS – 600 kPa		
	b. Resistance at SLS – 400 kPa		
	c. Abutments may also be supported on HP 310X110 piles driven to refusal.		
	a. ULS resistance – 1,600 kN		
	b. SLS resistance – 1,400 kN		
	d. Integral abutments are feasible. Assume 15m piles. Predrilling may be required to install the piles.		
	<b>2. Piers</b>		
	Piers may be supported using the same foundation options as for abutments.		
	Spread footings on hard native soil are considered to be a viable option.		
		<b>Site Ranking</b>	
		<b>Foundations: Medium</b>	
		<b>Hydrogeology: Medium</b>	

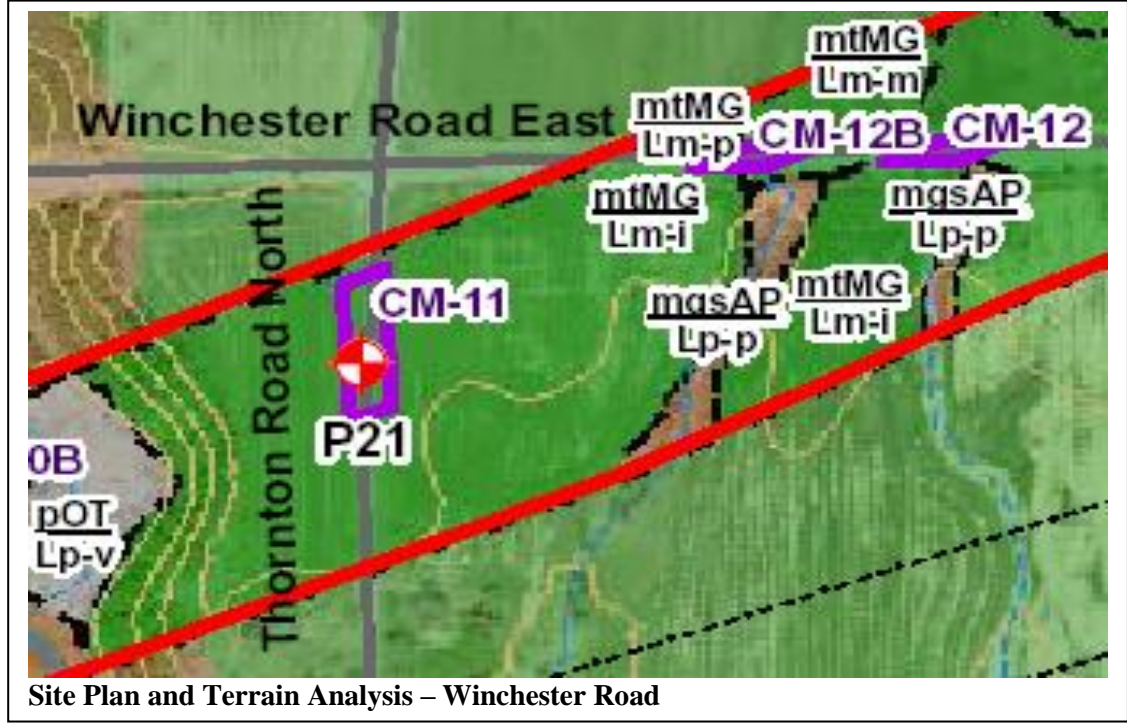


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-12 CM-12b
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W.O: 07-20016    Section: Central    Location: Mainline at Winchester Road    Sta. 15+675

Original Grade: 172.0    Proposed Grade:    Description: Twin structures to carry Mainline over Winchester Road



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site. BH P21, M15-85 lies 320m southeast.</b>	<b>1. Abutments</b>	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.	No major dewatering requirements are anticipated.
Mapping (Central 1) shows that the site is underlain by silt till ground moraine with a minor occurrence of alluvium at the site. The relief is low, rolling, imperfectly to poorly drained.	a. Footings may be founded on compacted Granular A cores as per current MTO standard practices approx 2mbgs.	No global stability or settlement issues are anticipated based on available information.	
BH P21 encountered:	b. For closed abutments, footings may be founded on native at estimated 3mbgs	Stripping of topsoil or other unsuitable soils will be required prior to construction.	
0.0 –9.4 EOH Clayey silt some sand, trace gravel, till, hard	a. Factored resistance at ULS – 600 kPa b. Resistance at SLS – 400 kPa		
<b>Groundwater</b>	c. Abutments may also be supported on HP 310X110 piles driven to refusal.		
GWT was recorded approx. 3mbgs. At BH P21.	a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN		
<b>Estimated overburden thickness – 45m.</b>	d. Integral abutments are feasible. Assume 20m piles. Predrilling may be required to install the piles.		
	<b>2. Piers</b>		
	Piers may be supported using the same foundation options as for abutments.		
	Spread footings on hard native soil are considered to be a viable option.		
		<b>Site Ranking</b>	
		<b>Foundations: Low</b>	
		<b>Hydrogeology: Low</b>	



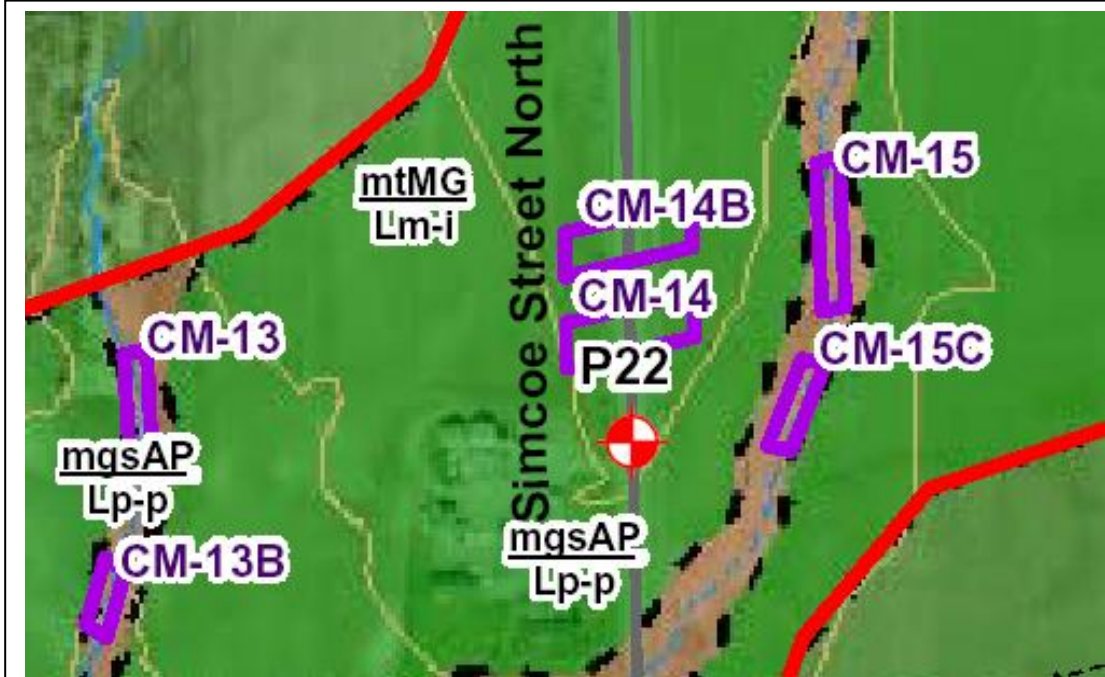
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-13 CM-13B
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W.O: 07-20016    Section: Central    Location: Mainline at Oshawa Creek Tributary    Sta. 16+872

Original Grade: ~175    Proposed Grade:    Description: Twin culverts to carry Mainline over Oshawa Creek Trib.



Site Plan and Terrain Analysis – Oshawa Creek Tributary



Site Photograph – facing east at Oshawa Creek on Winchester Road

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site. BH P22, M15-85 lies 250m southwest.</b>	<b>1. Abutments</b>	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.	Some dewatering and surface water control may be required during construction.
Mapping (Central 2) shows that the site is underlain by a narrow band of alluvium within an area of silt till ground moraine. The relief in the general area is low, rolling, imperfectly drained.  BH P22 encountered:  0.0 – 5.5 Clayey silt, some sand, trace gravel, glacial till. Hard 5.5 – 12.6 EOH Silty sand to sandy silt, trace clay,, trace gravel, till, dense to very dense  <b>Groundwater</b>  GWL encountered approximately 3mbgs in the BH, probably close to the surface at the creek..  <b>Estimated overburden thickness – 50 m.</b>	a. Footings may be founded on compacted Granular A cores as per current MTO standard practices approx 2mbgs.  b. For closed abutments, footings may be founded on native at estimated 3mbgs a. Factored resistance at ULS – 750 kPa b. Resistance at SLS – 500 kPa  c. Abutments may also be supported on HP 310X110 piles driven to refusal below El.148.0. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Integral abutments are feasible. Assume 15m piles. Predrilling may be required to install the piles.	No global stability or settlement issues are anticipated based on available information.  Stripping of topsoil or other unsuitable soils will be required prior to construction.	Narrow, shallow valley with no geomorphic evidence of significant valleside instability
	<b>2. Piers</b>	Piers may be supported using the same foundation options as for abutments.	
Site Ranking			
Foundations:			Low
Hydrogeology:			Medium



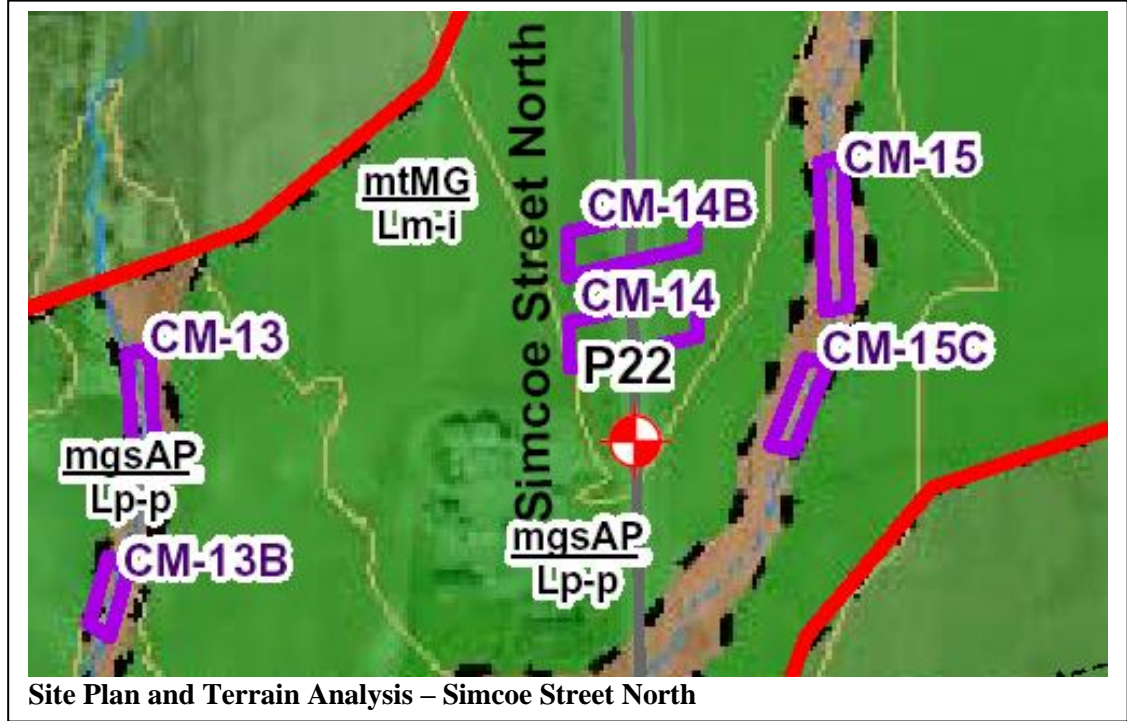
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-14 CM-14b
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W.O: 07-20016    Section: Central    Location: Mainline at Simcoe Street    Sta. 17+144

Original Grade: 184.9    Proposed Grade:    Description: Twin structures to carry the Mainline over Simcoe Street



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P22, 30M15-85</b>	<b>1. Abutments</b>	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.	No major dewatering requirements are anticipated.
Mapping ( Central 2) shows that the site is underlain by silt till glacial moraine. The relief is low, rolling, imperfectly drained.	a. Footings may be founded on compacted Granular A cores as per current MTO standard practices approx 2mbgs.	No global stability or settlement issues are anticipated based on available information.	
BH P22 encountered:	b. For closed abutments, footings may be founded on native at estimated El. 183.0	Stripping of topsoil or other unsuitable soils will be required prior to construction.	
0.0 – 5.5 Clayey silt, some sand, trace gravel, glacial till. Hard	a. Factored resistance at ULS – 600 kPa		
5.5 – 12.6 EOH Silty sand to sandy silt, trace clay,, trace gravel, till, dense to very dense.	b. Resistance at SLS – 400 kPa		
	c. Abutments may also be supported on HP 310X110 piles driven to refusal.		
	a. ULS resistance – 1,600 kN		
	b. SLS resistance – 1,400 kN		
	d. Integral abutments are feasible. Assume 15m piles. Predrilling may be required to install the piles.		
	<b>2. Piers</b>		
	Piers may be supported using the same foundation options as for abutments.		
	Spread footings on hard native soil are considered to be a viable option.		
		<b>Site Ranking</b>	
		<b>Foundations:</b> Low	
		<b>Hydrogeology:</b> Low	



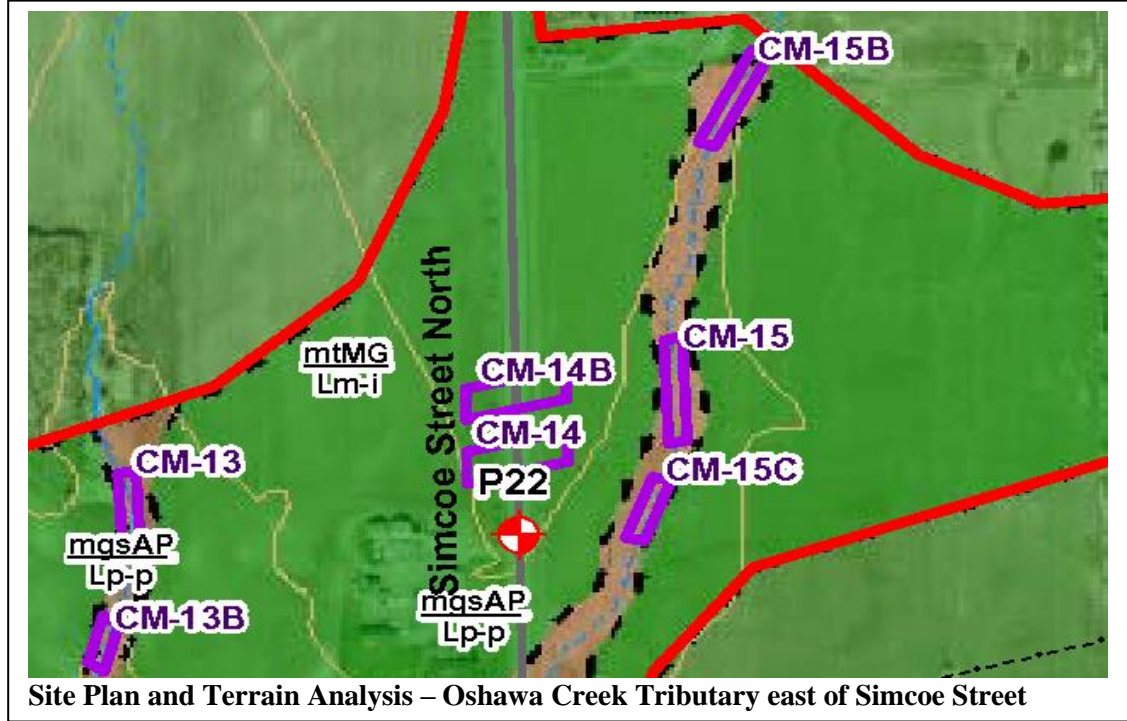
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-15 BM-15b, c
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W.O: 07-20016    Section: Central    Location: Oshawa Creek Tributary east of Simcoe Street    Sta. 17+262

Original Grade:    Proposed Grade:    Description: Mainline and E-N/S Ramp cross creek in three culverts.



Site Photograph – looking east over site

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P22, 30M15-85, lies approx 100m to the west.</b>	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 1 to 2 m below existing ground surface. Footings must bear below organics or recent alluvium.  Footings may be designed on the basis of a. Factored resistance at ULS – 450 kPa b. Resistance at SLS – 300 kPa  A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.	Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.	Narrow, moderately deep valley with no geomorphic evidence of significant valleyside instability  Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys  Stream is mapped as intermittent. Low probability of stream diversion if construction is in dry season. Otherwise stream diversion and groundwater control will be dependent on final design and time of construction.
Mapping ( Central 2) shows that the site is underlain by silt till glacial moraine. The relief is low, rolling, imperfectly drained.			
BH P22 encountered:			
0.0 – 5.5 Clayey silt, some sand, trace gravel, glacial till. Hard			
5.5 – 12.6 EOH Silty sand to sandy silt, trace clay,, trace gravel, till, dense to very dense.			
<b><u>Groundwater</u></b>			
GWL was encountered approximately 3mbgs at BH P22. GWL should be assumed to be at the ground surface at the creek.			
<b>Estimated overburden thickness – 55 m.</b>			
	<b>Site Ranking</b>		
	<b>Foundations:</b>	<b>Low</b>	
	<b>Hydrogeology:</b>	<b>Medium</b>	

**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	CM-16 CM-16b
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**Sta.** 17+980

**Description:** Twin structures to carry Mainline over Oshawa Creek



### Site Photograph

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BH at site.</b></p>	<p><b><u>1. Abutments</u></b></p> <p>a. Footings may be founded on compacted Granular A cores as per current MTO standard practices approx 3mbgs.</p> <p>b. For closed abutments, footings may be founded on native at estimated 3mbgs.</p> <p style="padding-left: 40px;">a. Factored resistance at ULS – 450 kPa</p> <p style="padding-left: 40px;">b. Resistance at SLS – 300 kPa</p> <p>c. Abutments may also be supported on HP 310X110 piles driven to refusal.</p> <p style="padding-left: 40px;">a. ULS resistance – 1,600 kN</p> <p style="padding-left: 40px;">b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 15m piles. Predrilling may be required to install the piles.</p> <p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments. Piles may be the preferred option in the valley.</p>	<p>Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.</p> <p>No global stability or settlement issues are anticipated based on available information.</p> <p>Stripping of topsoil or other unsuitable soils will be required prior to construction.</p>	<p>Some dewatering and surface water control may be required during construction.</p> <p>Narrow, shallow valley with no geomorphic evidence of significant valley-side instability</p>
<p>Mapping (Central 2) shows that the site is underlain by 50m wide silty, gravelly sand alluvial plain within an area of shallow silty sand glaciolacustrine plain. It is anticipated that silt till ground moraine lies at shallow depth.</p> <p style="text-align: center;"><b><u>Groundwater</u></b></p> <p>GWL anticipated to lie close to surface at creek.</p> <p><b>Estimated overburden thickness – 50m.</b></p>		<p style="text-align: center;"><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                    High</b></p>	



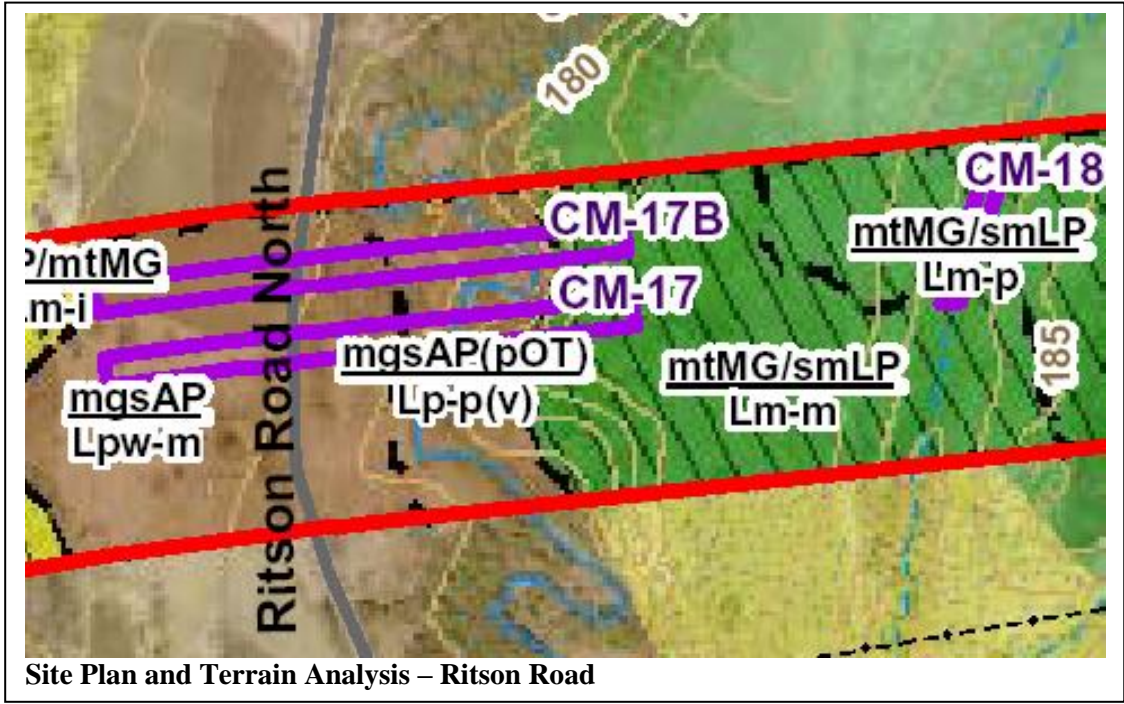
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-17 CM-17b
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W.O: 07-20016    Section: Central    Location: Mainline at Ritson Road Oshawa Creek    Sta. 18+520

Original Grade: ~170 to 190    Proposed Grade:    Description: Twin structures to carry Mainline over Ritson Road and Oshawa Creek



Site Photograph – facing west from Ritson Road

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at site.</b>	<p>In view of the wide valley and alluvial deposits, piled foundations should be assumed at this time.</p> <p>a. Abutments may also be supported on HP 310X110 piles driven to refusal.</p> <p>a. ULS resistance – 1,600 kN</p> <p>b. SLS resistance – 1,400 kN</p> <p>b. Integral abutments are feasible. Assume 20m piles.</p> <p><u><b>2. Piers</b></u></p> <p>Piers may be supported using the same foundation options as for abutments.</p>	<p>On the table lands to the east and west, no serious issues are anticipated for approach fills.</p> <p>In the valley floor, i.e. the alluvial plain, there may be a requirement for extensive stripping and/or preloading.</p>	<p>Some requirement for dewatering is anticipated in the creek valley.</p> <p>Wide, deep valley (old glacial meltwater spillway and early post-glacial river valley) with gentle west valleyside and 35° steep east valleyside, except where meandering channel is undercutting and steepening slope, which has lead to localized slumps; high, eroding cut-banks on east valleyside expose silt till overlying thick silt/sand, which is rilling and slumping</p> <p><b>HIGH PRIORITY SITE FOR PERMISSION TO ENTER.</b></p>
<p>Mapping (Central 2) shows that the site is underlain by a ~250m wide band of silty, gravelly, sand alluvial deposits with some organic soils. To the west, the soil changes to shallow silty sand glaciolacustrine plain. The higher ground to the east is composed of silt till ground moraine. The relief of the alluvial deposits is low plain, moderately to poorly to very poorly drained. The ground to the east is low plain, rolling, moderately well drained.</p> <p><u><b>Groundwater</b></u></p> <p>GWL at the creek is anticipated to be close to the ground surface.</p> <p><b>Estimated overburden thickness – 40m.</b></p>		<p><b>Site Ranking</b></p> <p><b>Foundations: High</b></p> <p><b>Hydrogeology: High</b></p>	

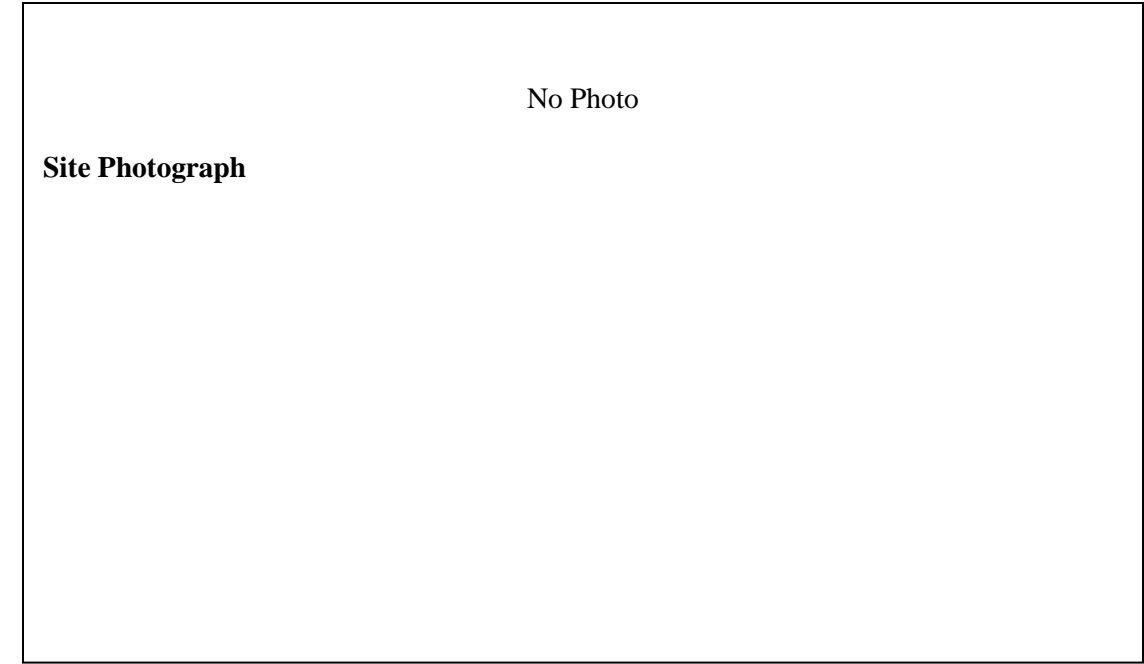
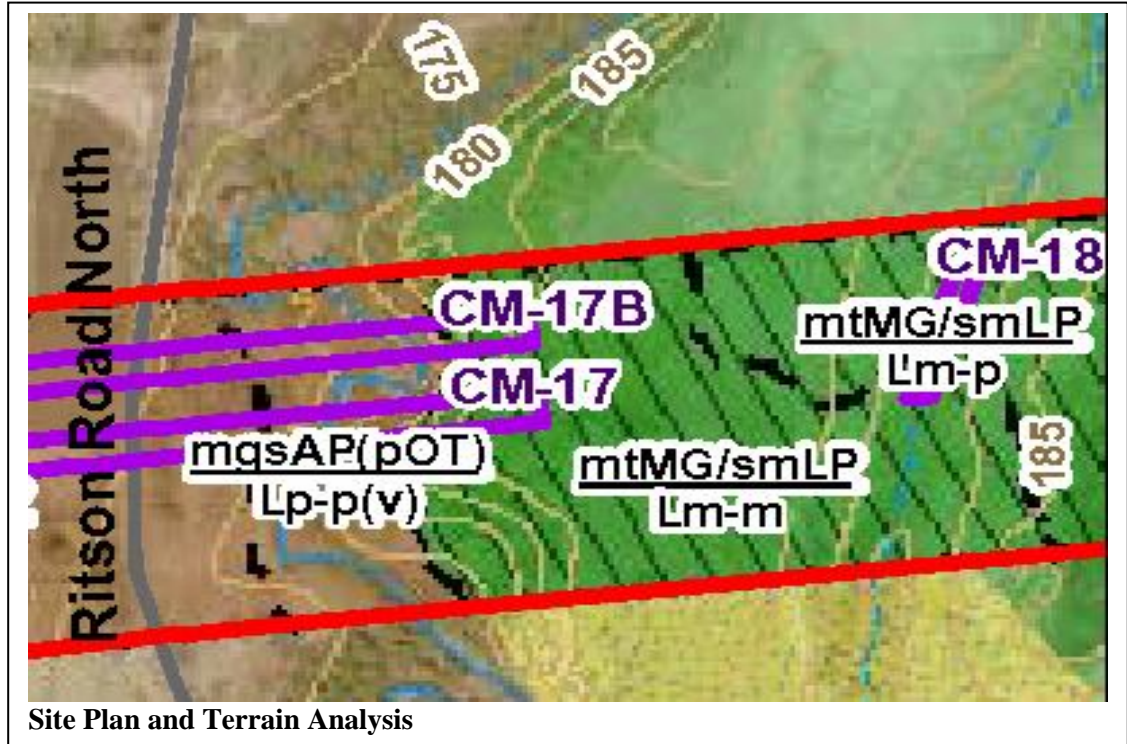


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: CM 18

W.O: 07-20016    Section: Central    Location: Oshawa Creek Tributary between Simcoe Street and Ritson Road    Sta. 18+880

Original Grade:    Proposed Grade:    Description: Mainline crosses creek on culvert.

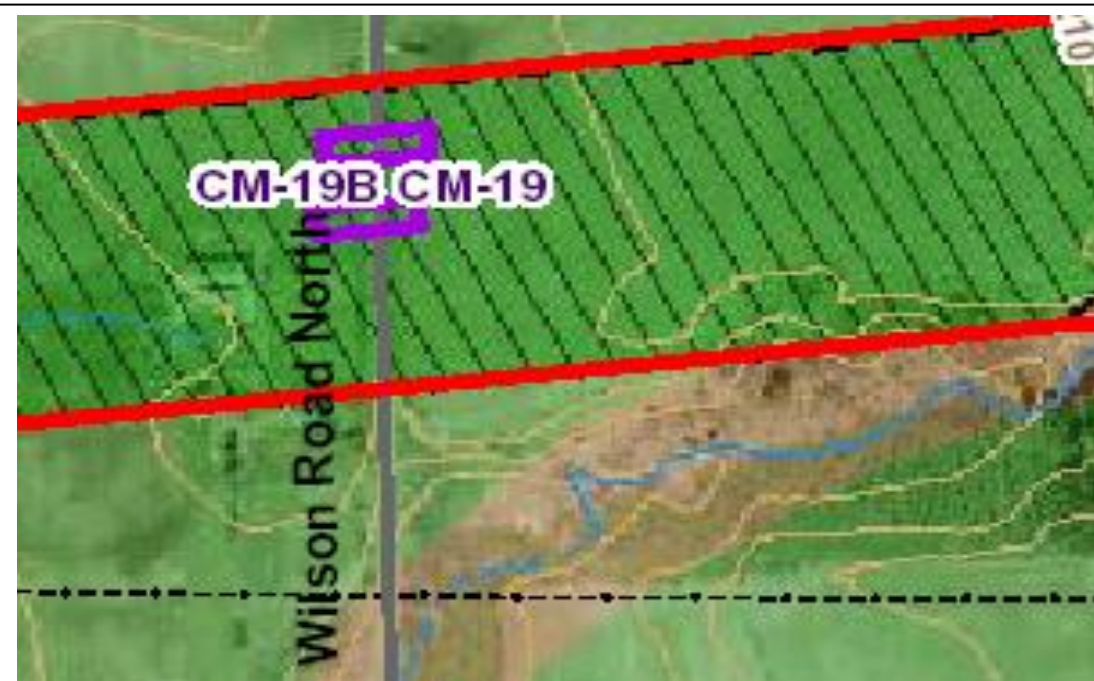


Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BHs near site.</b>  Mapping (Central 2) shows that the site is underlain by shallow silty sand glaciolacustrine plain. The higher ground to the east is composed of silt till ground moraine. The relief of the alluvial deposits is low, rolling, poorly drained.  <b>Groundwater</b>  GWL at the creek is anticipated to be close to the ground surface.  <b>Estimated overburden thickness – 40m.</b>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 1 to 2 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"><li>a. Factored resistance at ULS – 450 kPa</li><li>b. Resistance at SLS – 300 kPa</li></ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow swale with no geomorphic evidence of significant valley-side instability.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales</p> <p>Stream is mapped as intermittent. Low probability of stream diversion if construction is in dry season. Otherwise stream diversion and groundwater control will be dependent on final design and time of construction.</p>
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>Low</b>

**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	CM-19 CM-19b
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<b>Original Grade:</b> ~200	<b>Proposed Grade:</b>	<b>Description:</b> Twin structures to carry Mainline over Wilson Road
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## Site Plan and Terrain Analysis – Wilson Road



**Site Photograph – Wilson Road facing north.**

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site.</b>	<b><u>Based on mapping alone, assume:</u></b>  <b><u>1. Abutments</u></b>  a. Footings may be founded on compacted Granular A cores as per current MTO standard practices approx 2 to 3mbgs.  b. For closed abutments, footings may be founded on native at estimated 3mbgs. a. Factored resistance at ULS – 450 kPa b. Resistance at SLS – 300 kPa  c. Abutments may also be supported on HP 310X110 piles driven to refusal. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Integral abutments are feasible. Assume 20m piles.	Approach fills up to 8 m high may be constructed at side slopes up to 2H:1V using SSM or better.  No global stability or settlement issues are anticipated based on available information.  Stripping of topsoil or other unsuitable soils will be required prior to construction.	No major dewatering requirements are anticipated.
<p>Mapping (Central 3) shows that the site is underlain by shallow sandy silt glaciolacustrine deposits over silt till ground moraine. The relief is low, rolling, poorly drained.</p> <p style="text-align: center;"><b><u>Groundwater</u></b></p> <p>GWL is anticipated to be within 2 to 3mbgs.</p> <p><b>Overburden estimated thickness – 65m.</b></p>		<p style="text-align: center;"><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                      Low</b></p>	

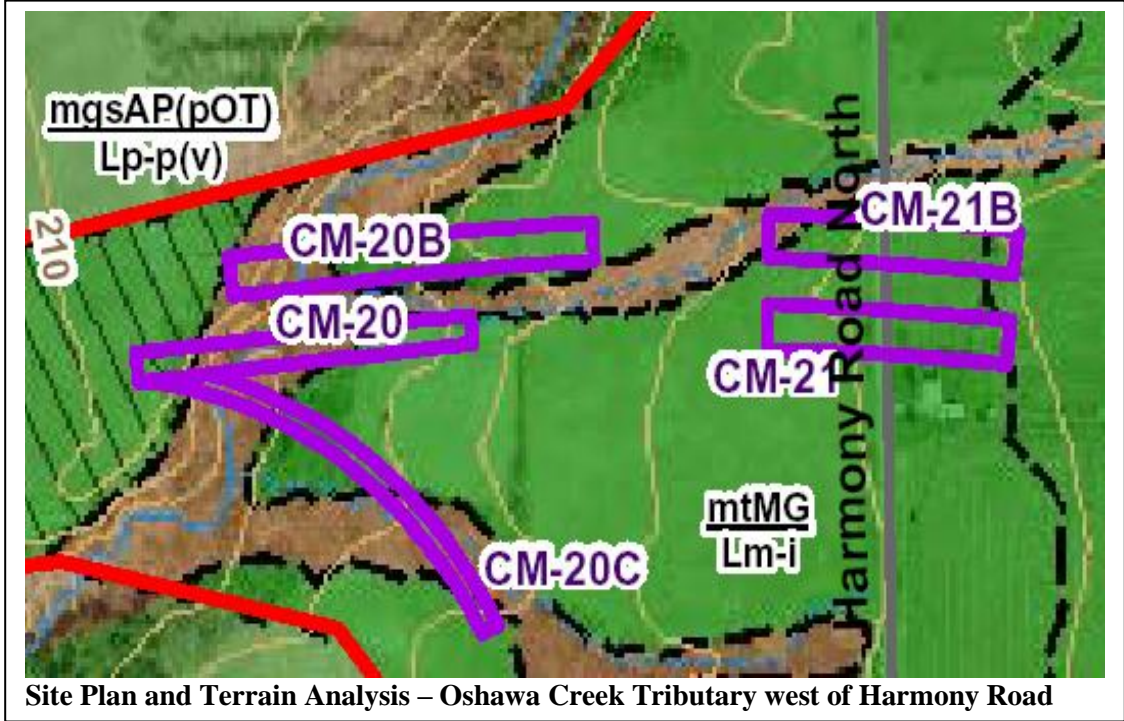


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-20 CM-20b&c
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W.O: 07-20016    Section: Central    Location: Mainline at Oshawa Creek Tributary    Sta. 20+100

Original Grade: ~200    Proposed Grade:    Description: Three structures to carry Mainline and W-S Ramp over Oshawa Creek Tributary and valley west of Harmony Road



Site Photograph – facing west to creek valley from Harmony Road

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site.</b>	<p>In view of the extensive alluvial deposits, piled foundations should be assumed at this time.</p> <p>a. Abutments may also be supported on HP 310X110 piles driven to refusal.</p> <p>    a. ULS resistance – 1,600 kN</p> <p>    b. SLS resistance – 1,400 kN</p> <p>b. Integral abutments are feasible. Assume 20m piles.</p> <p><u><b>2. Piers</b></u></p> <p>Piers may be supported using the same foundation options as for abutments.</p>	<p>On the table lands to the east and west, no serious issues are anticipated for approach fills.</p>	<p>Some requirement for dewatering is anticipated in the creek valley.</p>
<p>Mapping (Central 3) shows that the site is underlain by a complex of alluvium-filled stream channels within a broader area of silt till ground moraine. The relief of the ground moraine is low, rolling, imperfectly drained. The alluvial bands are typically low plain, poorly to very poorly drained.</p> <p><u><b>Groundwater</b></u></p> <p>GWL is anticipated to be close to the ground surface in the valleys.</p> <p><b>Estimated overburden thickness – 70m.</b></p>		<p>In the valley floor, i.e. the alluvial plain, there may be a requirement for extensive stripping and/or preloading.</p>	<p>Narrow, moderately deep valley; meandering channel is undercutting valleyside, which has lead to localized slumps</p>
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Medium</b>
		<b>Hydrogeology:</b>	<b>Low</b>



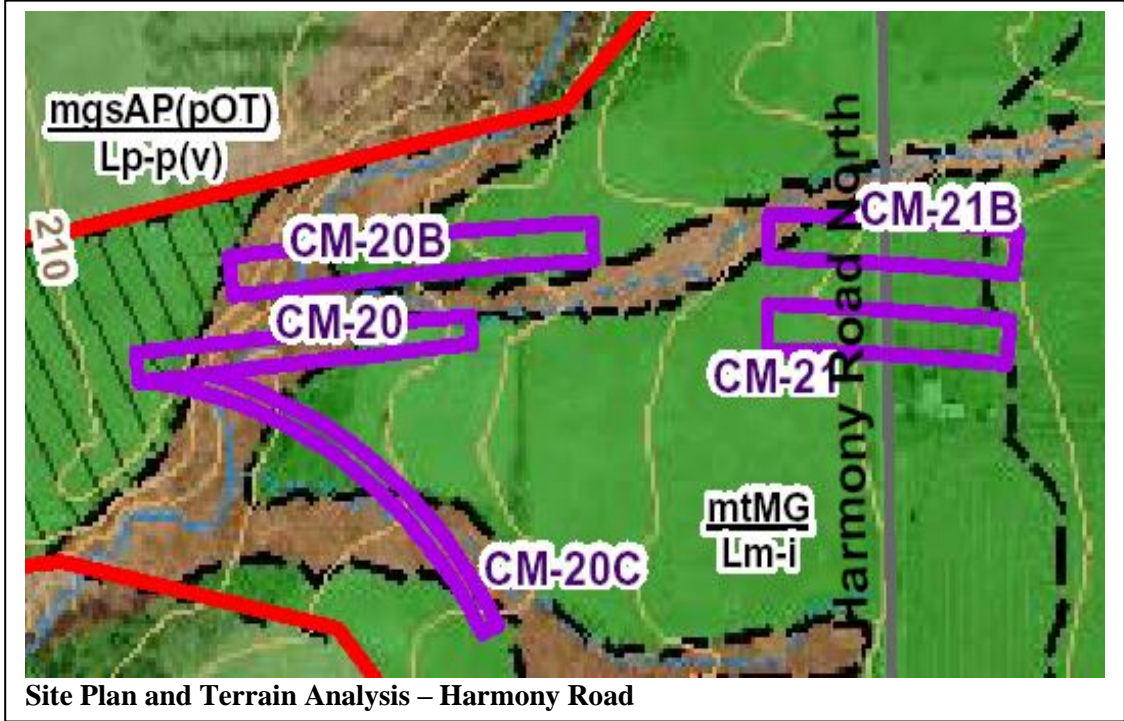
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-21 CM-21b
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W.O: 07-20016    Section: Central    Location: Mainline at Harmony Road    Sta. 20+465

Original Grade: ~220    Proposed Grade:    Description: Twin structures to carry Mainline over Harmony Road



Site Photograph – Harmony Road facing north

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
Boreholes: No BH at the site.	<b><u>1. Abutments</u></b>  a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at assumed 3mbgs.  b. For closed abutments, footings may be founded on native at assumed 3mbgs a. Factored resistance at ULS – 450 kPa b. Resistance at SLS –300 kPa  c. Abutments may also be supported on HP 310X110 piles driven to refusal. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Integral abutments are feasible. Assume 20m piles.  <b><u>2. Piers</u></b>  Piers may be supported using the same foundation options as for abutments.	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.  No global stability or settlement issues are anticipated based on available information.  Stripping of topsoil or other unsuitable soils will be required prior to construction.	No major dewatering requirements are anticipated.
Mapping (Central 3) shows that the site is underlain by silt till ground moraine dissected by narrow bands of alluvium. The relief is low, rolling to kettled, imperfectly to poorly drained.			
<b><u>Groundwater</u></b>  GWL is anticipated within 3mbgs.  <b>Estimated overburden thickness – 85m.</b>			
		<b>Site Ranking</b>  <b>Foundations:                      Medium</b>  <b>Hydrogeology:                    Low</b>	

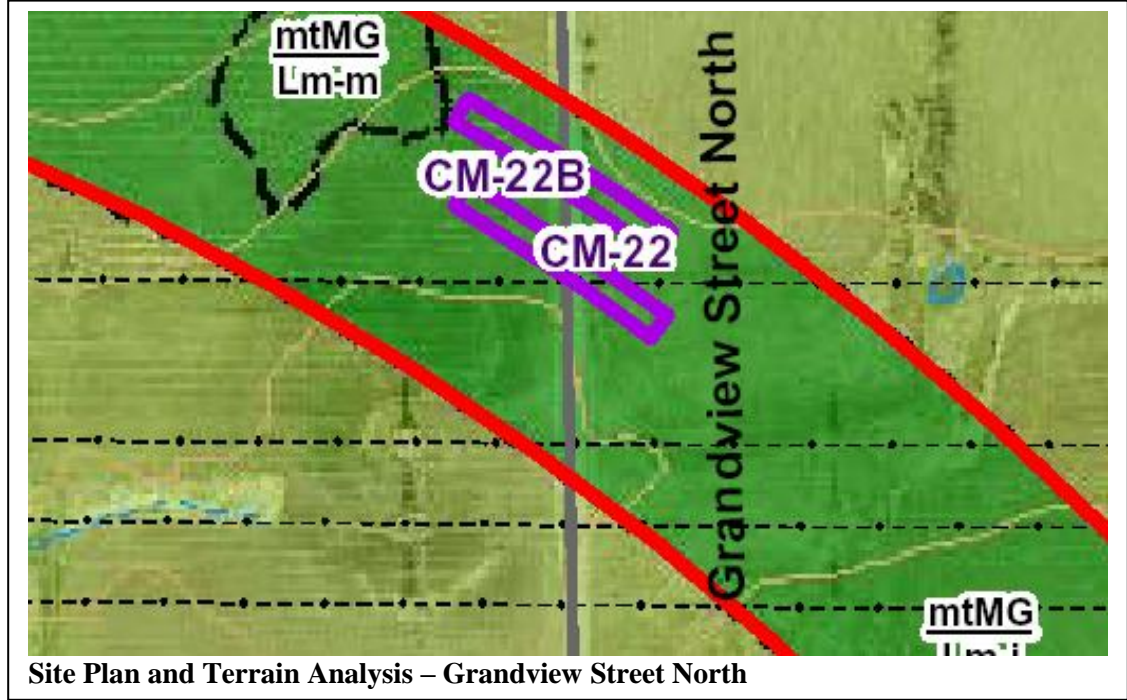


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: CM-22  
CM-22b

W.O: 07-20016    Section: Central    Location: Mainline at Grandview Street North    Sta. 21+349

Original Grade: ~237    Proposed Grade:    Description: Twin structures to carry mainline over Grandview Street North



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site.</b>	<b>1. Abutments</b>	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.	No major dewatering requirements are anticipated.
Mapping (Central 3) shows that the site is underlain by silt till ground moraine. The relief is low, rolling and imperfectly to moderately drained.  <b>Groundwater</b>  GWL anticipated within 3mbgs.  <b>Estimated overburden thickness – 105m.</b>	a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at assumed 3mbgs.	No global stability or settlement issues are anticipated based on available information.	The site lies at the north edge of a major Hydro One transmission corridor.
	b. For closed abutments, footings may be founded on native at assumed 3mbgs a. Factored resistance at ULS – 450 kPa b. Resistance at SLS –300 kPa	Stripping of topsoil or other unsuitable soils will be required prior to construction.	
	c. Abutments may also be supported on HP 310X110 piles driven to refusal below El.148.0. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN		
	d. Integral abutments are feasible. Assume 20m piles.		
	<b>2. Piers</b>		
	Piers may be supported using the same foundation options as for abutments.		
Site Ranking			
Foundations:			Low
Hydrogeology:			Low

**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	CM-23 CM23b
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**W.O:** 07-20016    **Section:** Central    **Location:** Mainline at Winchester Road    **Sta.** 21+964

<b>Original Grade:</b> ~225	<b>Proposed Grade:</b>	<b>Description:</b> Twin structures to carry Mainline over Winchester Road
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## Site Plan and Terrain Analysis – Winchester Road East



### Site Photograph – Winchester Road facing west

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site.</b>	<b><u>1. Abutments</u></b>	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.	No major dewatering requirements are anticipated.
Mapping (Central 3) shows that the site is underlain by silt till ground moraine. The relief is low, rolling and imperfectly drained.	a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at assumed 3mbgs.	No global stability or settlement issues are anticipated based on available information.	The site lies a short distance south of a major Hydro One transmission corridor.
<b><u>Groundwater</u></b>	b. For closed abutments, footings may be founded on native at assumed 3mbgs <ul style="list-style-type: none"> <li>a. Factored resistance at ULS – 450 kPa</li> <li>b. Resistance at SLS –300 kPa</li> </ul>	Stripping of topsoil or other unsuitable soils will be required prior to construction.	
Due to the proximity of a creek the GWL may be close to the surface at the WB structure and slightly lower at the EB structure.	c. Abutments may also be supported on HP 310X110 piles driven to refusal. <ul style="list-style-type: none"> <li>a. ULS resistance – 1,600 kN</li> <li>b. SLS resistance – 1,400 kN</li> </ul>		
<b>Estimated overburden thickness – 105m.</b>	d. Integral abutments are feasible. Assume 20m piles.		
	<b><u>2. Piers</u></b>		
	Piers may be supported using the same foundation options as for abutments.		
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>Low</b>



**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	CM-24
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**W.O:** 07-20016    **Section:** Central    **Location:** Harmony Creek    **Sta.** 22+608

<b>Original Grade:</b>	<b>Proposed Grade:</b>	<b>Description:</b>	Mainline crosses Harmony Creek on culvert
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## Site Plan and Terrain Analysis – Mainline crossing Harmony Creek



**Site Photograph** - Facing south towards CM-24 from Conc. 7 Road

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site.</b>	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 1 to 2 m below existing ground surface. Footings must bear below organics or recent alluvium.  Footings may be designed on the basis of a. Factored resistance at ULS – 450 kPa b. Resistance at SLS – 300 kPa  A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.	Comparatively low approaches across a shallow valley in a silt till ground moraine. No stability or settlement issues are anticipated.	Narrow, shallow, channelized valley with no geomorphic evidence of significant valleyside instability.  Valley bottom sediments likely <1 m deep and dominantly silty gravelly sand alluvium, based on field checks of similar valleys
Mapping (Central 4) shows that the site is underlain by silt till ground moraine. The relief is low, rolling and imperfectly drained.			
<p><b><u>Groundwater</u></b></p> <p>Due to the proximity of a creek the GWL may be close to the surface at the WB structure and slightly lower at the EB structure.</p> <p><b>Estimated overburden thickness – 95m.</b></p>			
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Medium</b>
		<b>Hydrogeology:</b>	<b>Low</b>



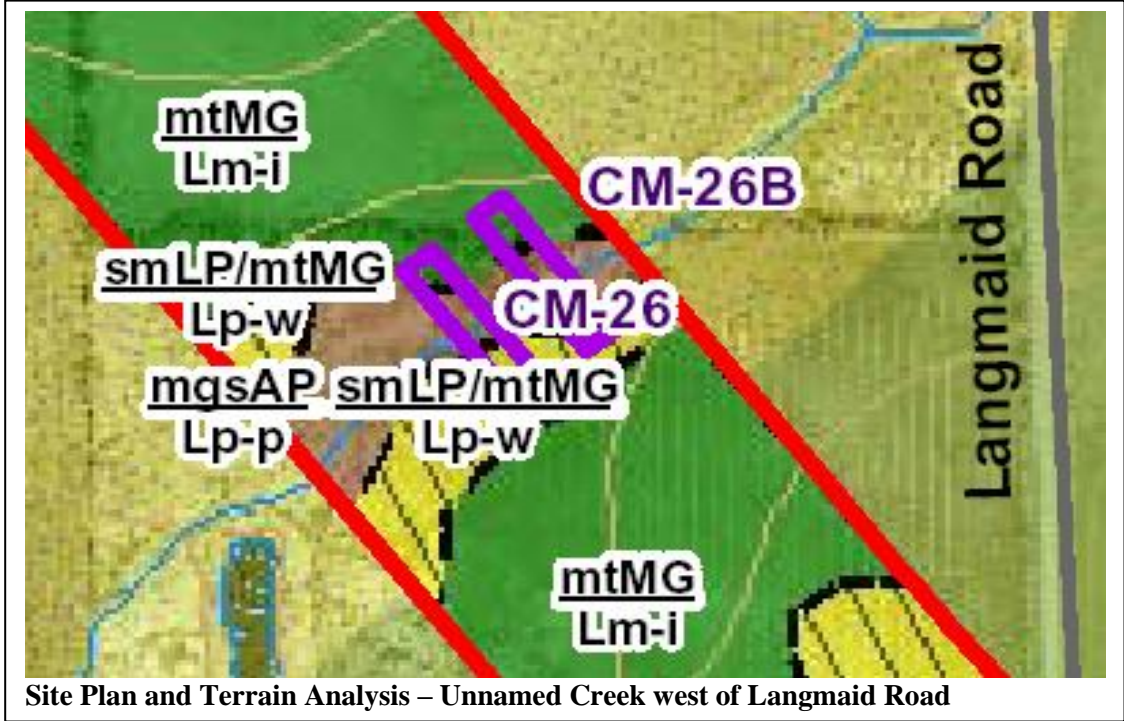
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-26 CM-26b
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W.O: 07-20016    Section: Central    Location: Mainline at unnamed creek.    Sta. 24+261

Original Grade: ~197    Proposed Grade:    Description: Twin structures to carry Mainline over unnamed creek



Site Photograph – facing towards culvert site from Langmaid Road

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site. BH P26, 30M15-85, lies 500m south of the site.</b>	<b>1. Abutments</b>  a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at assumed 3mbgs.  b. For closed abutments, footings may be founded on native at assumed 3mbgs a. Factored resistance at ULS – 450 kPa b. Resistance at SLS –300 kPa  c. Abutments may also be supported on HP 310X110 piles driven to refusal. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Integral abutments are feasible. Assume 15m piles.	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.  No global stability or settlement issues are anticipated based on available information.  Stripping of topsoil or other unsuitable soils will be required prior to construction.	Some dewatering may be required close to the creek.  Narrow, shallow valley with no geomorphic evidence of significant valleside instability
Mapping (Central 5) shows that the site is underlain by a 20 to 50m wide band of recent alluvium with a small area of sandy silt glaciolacustrine soils to the southeast. These soils lie within a wider area of silt till ground moraine. The relief is low plain, poorly drained to well drained.  BH P26 encountered:  0.0 – 9.8 Silty sand to sand silt till, very dense. 9.8 – 16.9 EOH Clayey silt some sand and gravel, till, hard  <b>Groundwater</b>  GWL at the creek is expected to be close to the ground surface. At the borehole, GWL was recoded at approx. 6.5mbgs.  <b>Estimated overburden thickness – 80m</b>	<b>2. Piers</b>  Piers may be supported using the same foundation options as for abutments.	<b>Site Ranking</b>  <b>Foundations:                      Low</b>  <b>Hydrogeology:                    Medium</b>	



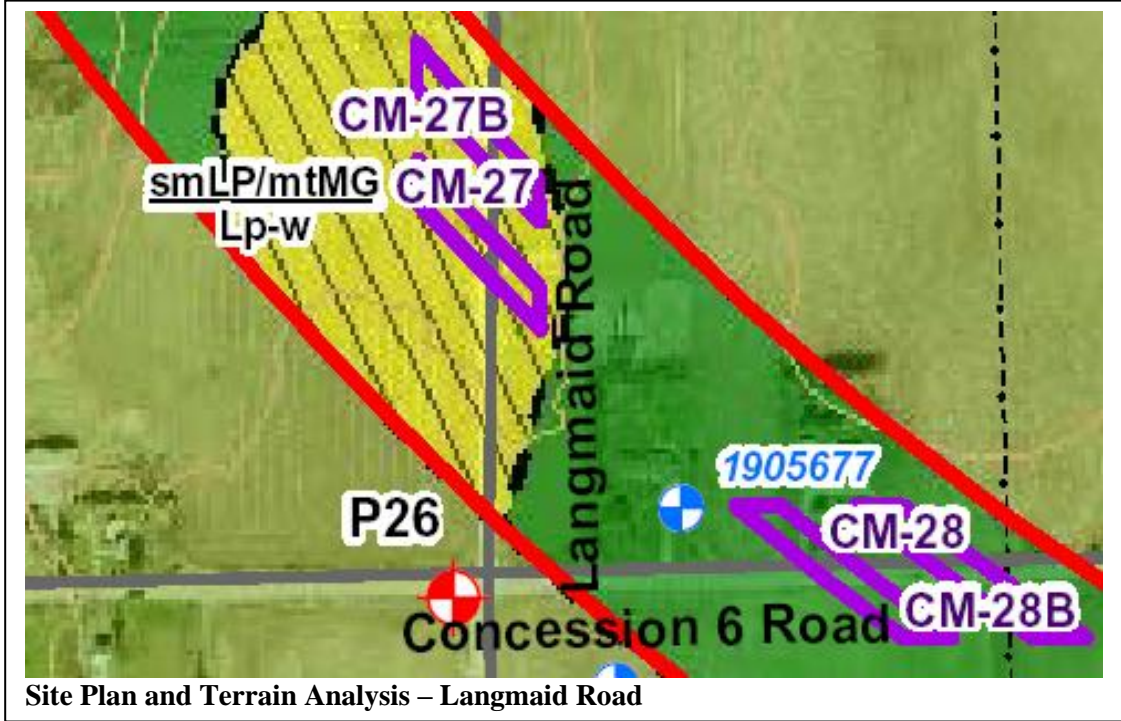
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-27 CM27b
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W.O: 07-20016    Section: Central    Location: Mainline at Langmaid Road    Sta. 24+630

Original Grade: ~209    Proposed Grade:    Description: Twin structures to carry Mainline over Langmaid Road



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site. BH P26, 30M15-85, lies 200m south.</b>	<b>1. Abutments</b>	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.	No major dewatering requirements are anticipated.
Mapping (Central 5) shows that the site lies in sandy silt glaciolacustrine plan. This is probably a shallow deposit overlying silt till ground moraine. The relief is low plain, well drained.	a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at assumed 2mbgs.	No global stability or settlement issues are anticipated based on available information.	
BH P26 encountered:	b. For closed abutments, footings may be founded on native at assumed 2mbgs	Stripping of topsoil or other unsuitable soils will be required prior to construction.	
0.0 – 9.8 Silty sand to sand silt till, very dense.	a. Factored resistance at ULS – 600 kPa		
9.8 – 16.9 EOH Clayey silt some sand and gravel, till, hard	b. Resistance at SLS –400 kPa		
<b>Groundwater</b>	c. Abutments may also be supported on HP 310X110 piles driven to refusal.		
GWL in the BH was recorded at approx. 6.5mbgs.	a. ULS resistance – 1,600 kN		
<b>Estimated overburden thickness – 90m.</b>	b. SLS resistance – 1,400 kN		
	d. Integral abutments are feasible. Assume 15m piles. Predrilling may be required to install the piles.		
	<b>2. Piers</b>		
	Piers may be supported using the same foundation options as for abutments.		
		<b>Site Ranking</b>	
		<b>Foundations: Low</b>	
		<b>Hydrogeology: Medium</b>	

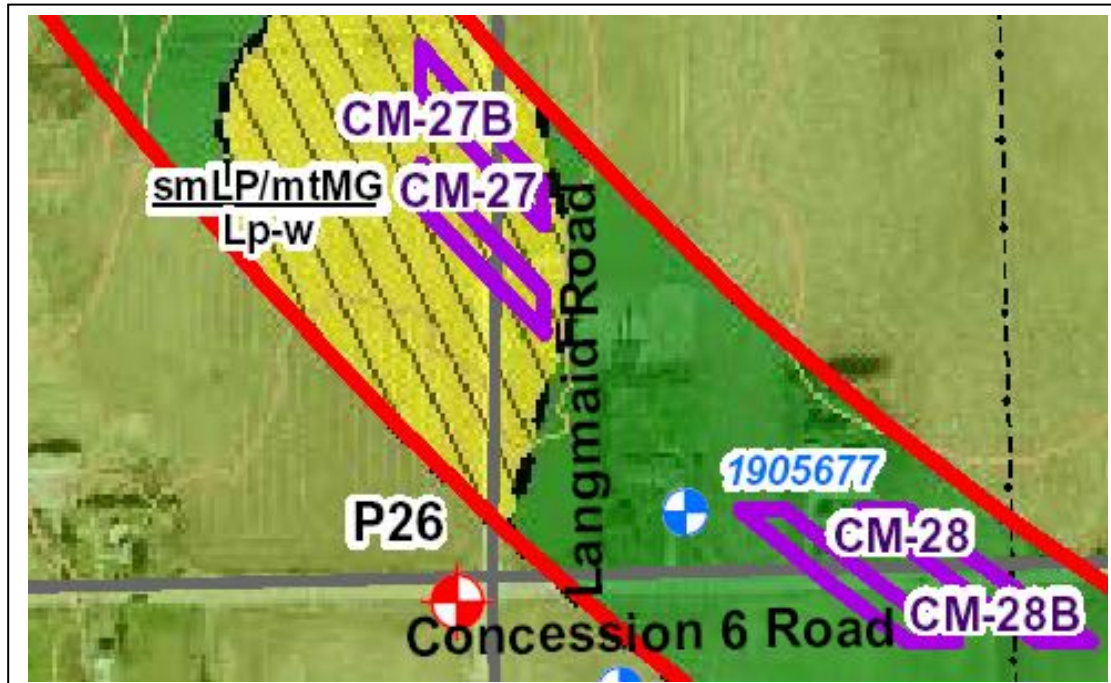


**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	CM-28 CM28b
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**W.O:** 07-20016    **Section:** Central    **Location:** Mainline over Concession 6 Road    **Sta.** 24+929

<b>Original Grade:</b> ~210	<b>Proposed Grade:</b>	<b>Description:</b> Twin structures to carry Mainline over Concession 6 Road
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## Site Plan and Terrain Analysis – Concession 6 Road



**Site Photograph – Concession 6 Road facing east.**

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BH at the site. BH P26, 30M15-85 lies 200m west.</b></p>	<p><b><u>1. Abutments</u></b></p> <p>a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at assumed 2mbgs.</p> <p>b. For closed abutments, footings may be founded on native at assumed 2mbgs</p> <p style="padding-left: 40px;">a. Factored resistance at ULS – 750 kPa</p> <p style="padding-left: 40px;">b. Resistance at SLS –500 kPa</p> <p>c. Abutments may also be supported on HP 310X110 piles driven to refusal below El.148.0.</p> <p style="padding-left: 40px;">a. ULS resistance – 1,600 kN</p> <p style="padding-left: 40px;">b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 15m piles. Predrilling may be required to install the piles.</p> <p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments.</p>	<p>Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.</p> <p>No global stability or settlement issues are anticipated based on available information.</p> <p>Stripping of topsoil or other unsuitable soils will be required prior to construction.</p>	<p>No major dewatering issues are anticipated.</p>
<p>Mapping (Central 5) shows that the site is underlain by silt till ground moraine. The relief is low, rolling, imperfectly drained.</p> <p>BH P26 encountered:</p> <p>0.0 – 9.8 Silty sand to sandy silt till, very dense.</p> <p>9.8 – 16.9 EOH Clayey silt some sand and gravel, till, hard</p> <p><b><u>Groundwater</u></b></p> <p>GWL in the BH was recorded at approx. 6.5mbgs.</p> <p><b>Estimated overburden thickness – 100m.</b></p>		<p style="text-align: center;"><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                    Low</b></p>	



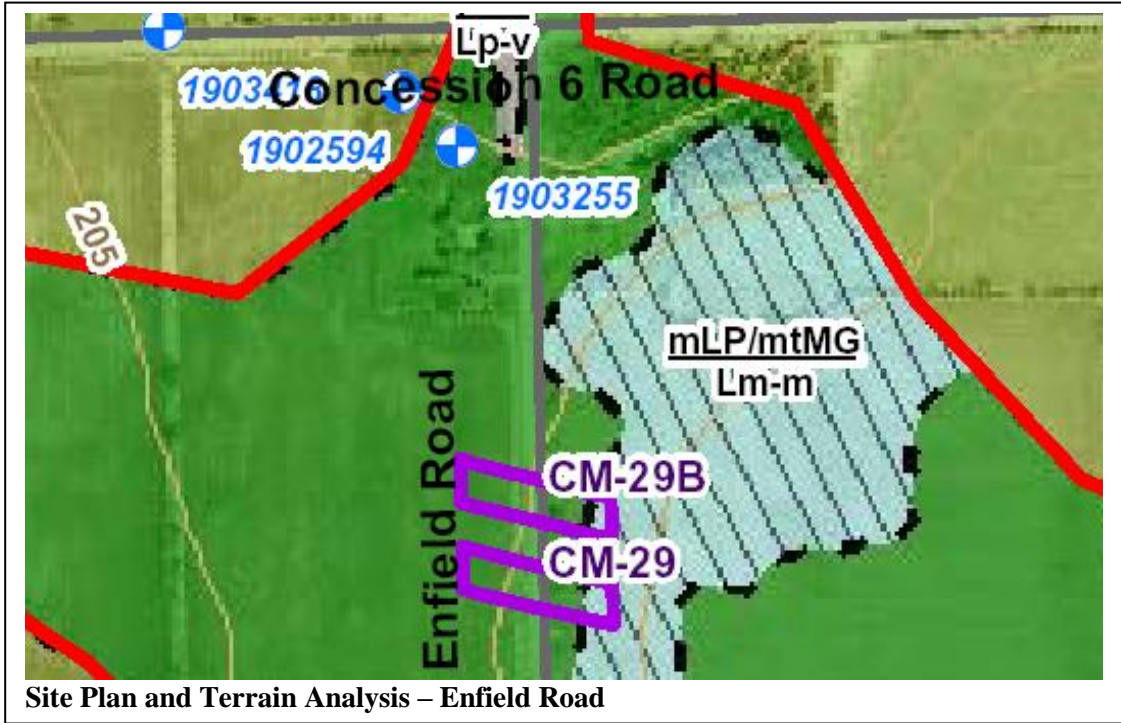
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-29 CM29b
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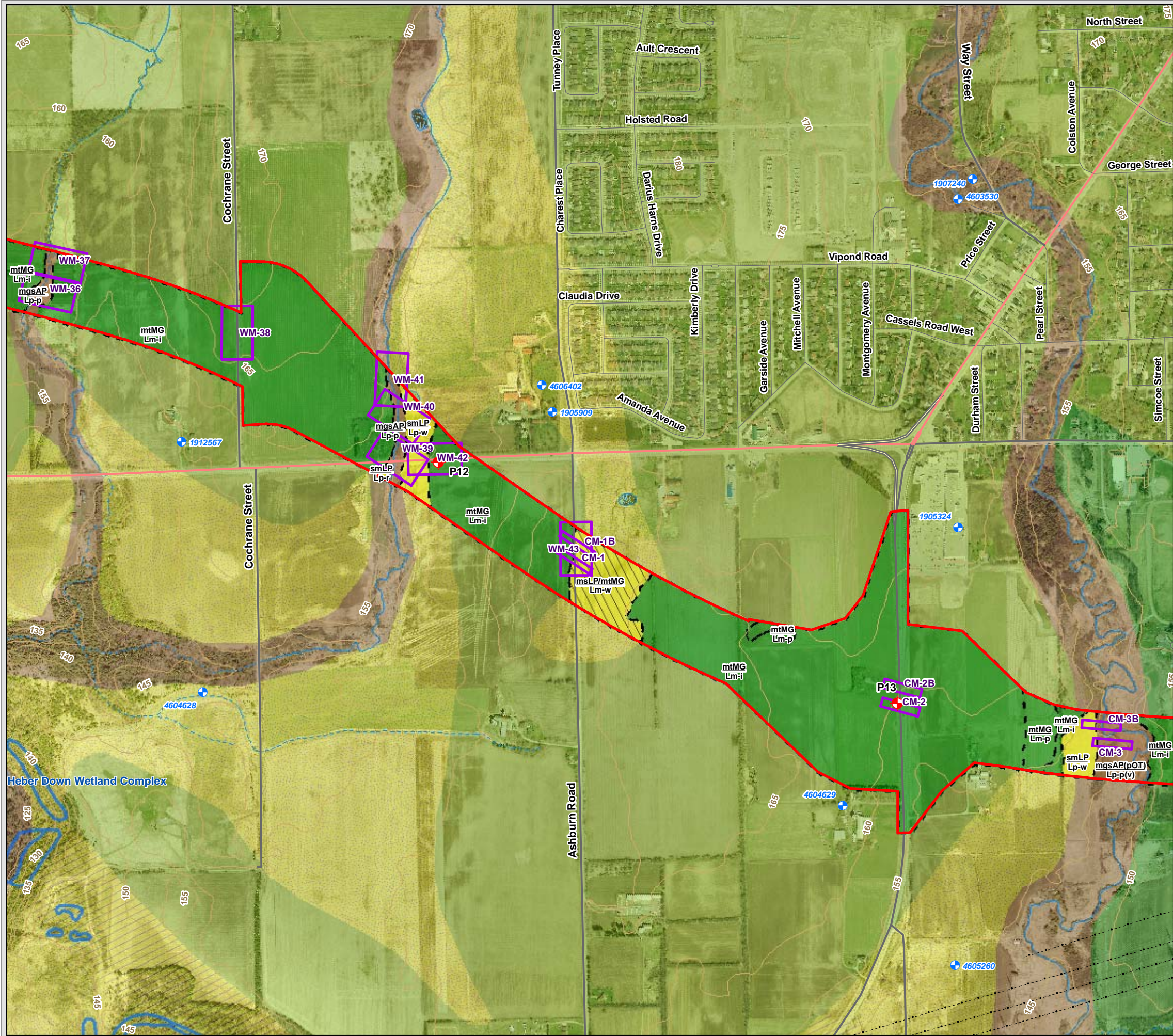
W.O: 07-20016    Section: Central    Location: Mainline at Enfield Road    Sta. 25+588

Original Grade: ~205    Proposed Grade:    Description: Twin structures to carry Mainline over Enfield Road



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site. BH P27, 30M15-85, lies 150m south.</b>  Mapping (Central 5) shows that the site is underlain by silt till ground moraine with the east ends of the structures possibly lying in an area of glaciolacustrine silt.  BH P27 encountered:  0.0 – 9.6 EOH Silty sand to sandy silt, trace clay, trace gravel, till, dense to very dense.  <b>Groundwater</b>  No free groundwater was recorded in the borehole.  <b>Estimated overburden thickness – 95m.</b>	<b>1. Abutments</b>  a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at assumed 2mbgs.  b. For closed abutments, footings may be founded on native at assumed 2mbgs a. Factored resistance at ULS – 600 kPa b. Resistance at SLS –400 kPa  c. Abutments may also be supported on HP 310X110 piles driven to refusal. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Integral abutments are feasible. Assume 15m piles.  <b>2. Piers</b>  Piers may be supported using the same foundation options as for abutments.	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.  No global stability or settlement issues are anticipated based on available information.  Stripping of topsoil or other unsuitable soils will be required prior to construction.	No major dewatering requirements are anticipated.
			<b>Site Ranking</b>  <b>Foundations: Medium</b>  <b>Hydrogeology: Medium</b>





**Legend**

**LANDFORM**

**ORGANIC**

OT Organic terrain

**ALLUVIAL**

AP Alluvial plain

**GLACIOLACUSTRINE**

LB Raised (abandoned) beach form  
LD Glaciolacustrine delta  
LP Glaciolacustrine plain

**GLACIOFLUVIAL**

GD Ice contact delta, esker delta, kame delta, delta moraine  
GE Esker, esker complex, crevasse filling  
GK Kame, kame field, kame terrace, kame moraine  
GO Outwash plain, valley train

**MORAINAL**

ME End moraine  
MG Ground moraine  
MH Hummocky moraine

Underlying material within approx. 3 m of surface

**Components of Terrain/Drainage Code**

Dominant landform  
Material of subordinate landform  
Subordinate landform  
Material  
Local relief of dominant landform  
Topographic variety of dominant landform  
Local relief of subordinate landform  
Topographic variety of subordinate landform  
Surface drainage condition of subordinate landform  
Surface drainage condition of dominant landform

tMG (pOT)  
Lu (Lp) - m(v)

**MATERIAL**

b boulders, bouldery  
c clay, clayey  
g gravel, gravelly  
p peat, muck  
r rubble  
s sand, sandy  
m silt, silty  
t till

**TOPOGRAPHY**

**LOCAL RELIEF**

H Mainly high local relief (>60 m)  
M Mainly moderate local relief (15 - 60 m)  
L Mainly low local relief (<15 m)

**VARIETY**

c channelled  
d dissected, gullied  
j jagged, rugged, cliffed  
k kettled, pitted  
n knobby, hummocky  
p plain  
r ridged  
s sloping  
t terraced  
u undulating  
m rolling  
w washed, reworked

**DRAINAGE**

**SURFACE CONDITION**

x Very rapidly drained  
r Rapidly drained  
w Well drained  
m Moderately well drained  
i Imperfectly drained  
p Poorly drained  
v Very poorly drained  
h Suspected high water table

MOE Water Well  
Existing Geotechnical Borehole  
Contour (5m)  
Freeway  
Highway  
Major Road  
Local Road

Transmission Line  
Railway  
Proposed Structure  
Provincially Significant Wetland  
Locally Significant Wetland  
Technically Recommended Route  
Municipal Division

Notes:

1. Terrain/drainage polygon boundaries and descriptions within Technically Recommended Route based on existing OGS/GSC surficial geology mapping, stereoscopic interpretation of 1:10,000 aerial photographs from 2000, and representative field checks of approximately 25% of the polygons. Existing OGS/GSC surficial geology mapping is displayed outside the Technically Recommended Route for context; its legend is provided separately.

2. Mapping completed by R. McKillop (Gartner Lee Limited), based on the format of the Northern Ontario Engineering Geology Terrain Study (Gartner et al., 1981), with drainage classes assigned according to the British Columbia Field Manual for Describing Terrestrial Ecosystems.

3. No significant colluvial or eolian deposits within Technically Recommended Route, and no attempt made to differentiate tills, given their similarity in shallow hydrogeological and geotechnical characteristics.

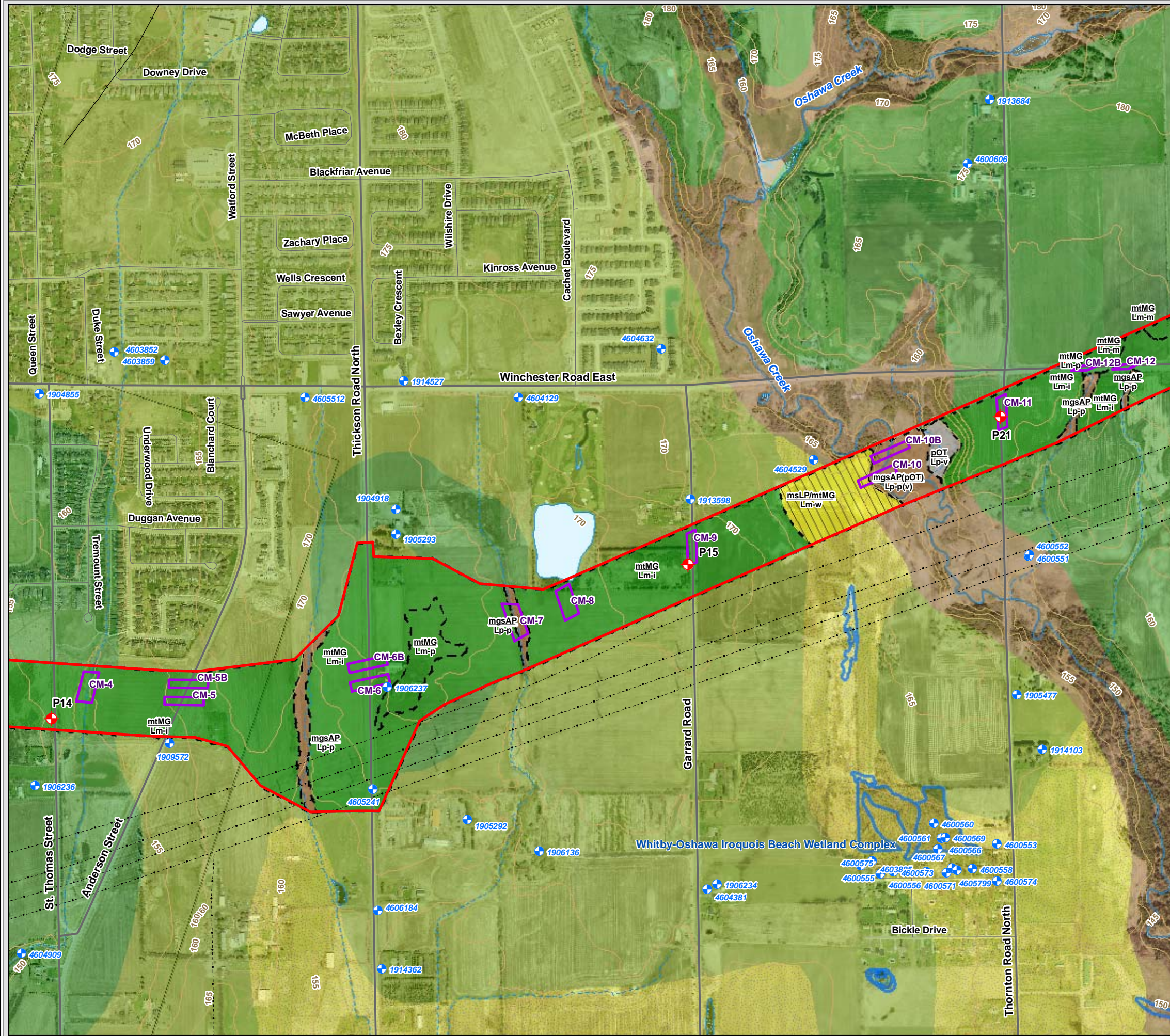
4. A slash (/) is used to indicate near-surface layering of contrasting materials within a dominant or subordinate landform (e.g., sLP/tMG). The material left of the slash (sLP) overlies the material right of the slash (tMG), without specifying any particular depth, but usually the landform material in the numerator is shallow.

5. A landform s composition may be modified by up to three materials, with increasing proportion from left to right. The example cmtMG represents ground moraine (MG) composed of clayey (c) silt (m) till (t).

6. A landform may exhibit up to three topographic varieties, with decreasing prominence from left to right. For example, Lpkd represents a low-relief (L) planar (p) surface with kettles (k), which has been dissected (d).

0 50 100 200 300 400 500  
1:10,000  
UTM Zone 17N, NAD 83





**Legend**

**LANDFORM**

**ORGANIC**

OT Organic terrain

**ALLUVIAL**

AP Alluvial plain

**GLACIOLACUSTRINE**

LB Raised (abandoned) beach form

LD Glaciolacustrine delta

LP Glaciolacustrine plain

**GLACIOFLUVIAL**

GD Ice contact delta, esker delta, kame delta, delta moraine

GE Esker, esker complex, crevasse filling

GK Kame, kame field, kame terrace, kame moraine

GO Outwash plain, valley train

**MORAINAL**

ME End moraine

MG Ground moraine

MH Hummocky moraine

Underlying material within approx. 3 m of surface

**Components of Terrain/Drainage Code**

Dominant landform  
Material of subordinate landform  
Subordinate landform  
Material  
Local relief of dominant landform  
Topographic variety of dominant landform  
Local relief of subordinate landform  
Topographic variety of subordinate landform  
Surface drainage condition of subordinate landform  
Surface drainage condition of dominant landform

tMG (pOT)  
Lu (Lp) - m(v)

**MATERIAL**

b boulders, bouldery

c clay, clayey

g gravel, gravelly

p peat, muck

r rubble

s sand, sandy

m silt, silty

t till

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j jagged, rugged, cliffed

k kettled, pitted

n knobby, hummocky

p plain

r ridged

s sloping

t terraced

u undulating

m rolling

w washed, reworked

**DRAINAGE**

**SURFACE CONDITION**

x Very rapidly drained

r Rapidly drained

w Well drained

m Moderately well drained

i Imperfectly drained

p Poorly drained

v Very poorly drained

h Suspected high water table

MOE Water Well

Existing Geotechnical Borehole

Contour (5m)

Freeway

Highway

Major Road

Local Road

Transmission Line

Railway

Proposed Structure

Provincially Significant Wetland

Locally Significant Wetland

Technically Recommended Route

Municipal Division

**Notes:**

1. Terrain/drainage polygon boundaries and descriptions within Technically Recommended Route based on existing OGS/GSC surficial geology mapping, stereoscopic interpretation of 1:10,000 aerial photographs from 2000, and representative field checks of approximately 25% of the polygons. Existing OGS/GSC surficial geology mapping is displayed outside the Technically Recommended Route for context; its legend is provided separately.

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5. A landform s composition may be modified by up to three materials, with increasing proportion from left to right. The example cmtMG represents ground moraine (MG) composed of clayey (c) silt (m) till (t).

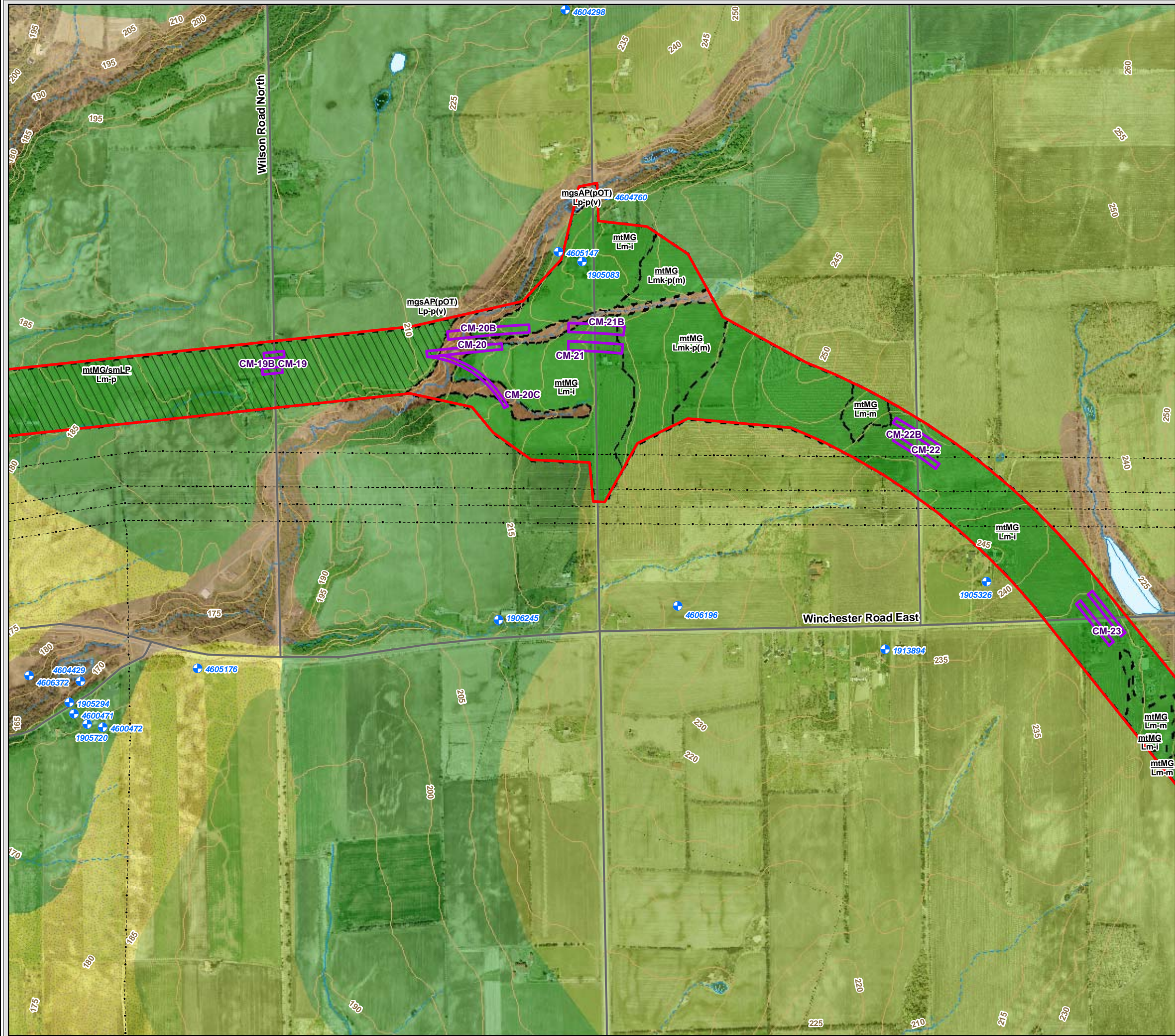
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0 50 100 200 300 400 500  
1:10,000  
UTM Zone 17N, NAD 83









ORGANIC

OT

Organic terrain

ALLUVIAL

AP

Alluvial plain

COARSE

FINE

GLACIOLACUSTRINE

LB

LD

LP

LB

LD

LP

GLACIOFLUVIAL

GD

GE

GK

GO

GD

GE

GK

GO

MORAINAL

ME

MG

MH

ME

MG

MH

Underlying material within approx. 3 m of surface

Dominant landform

Material of subordinate landform

Subordinate landform

Material

tMG (pOT)

Lu (Lp) - m(v)

Local relief of dominant landform

Local relief of subordinate landform

Topographic variety of subordinate landform

Surface drainage condition of subordinate landform

Topographic variety of dominant landform

Local relief of subordinate landform

Topographic variety of subordinate landform

Surface drainage condition of dominant landform

MOE Water Well

Existing Geotechnical Borehole

Contour (5m)

Freeway

Highway

Major Road

Local Road

Transmission Line

Railway

Proposed Structure

Provincially Significant Wetland

Locally Significant Wetland

Technically Recommended Route

Municipal Division

N

W

E

S

Notes:

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0

50

100

200

300

400

500

1:10,000

UTM Zone 17N, NAD 83

407 Environmental Assessment

Technically Recommended Route

Terrain/Drainage Map with

Proposed Structures

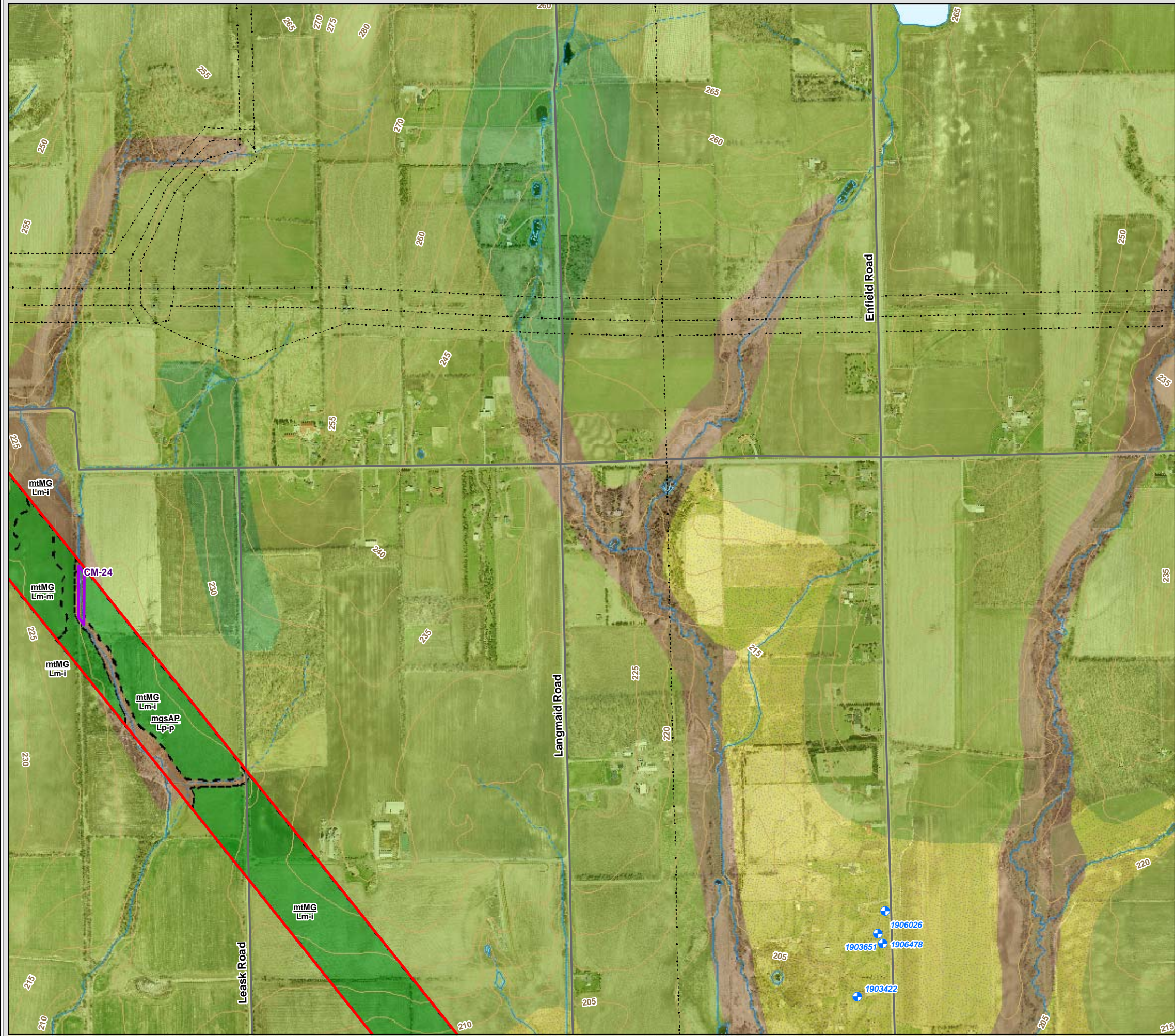
December 2007

Project 50613

Gartner Lee

Central 3





**Legend**

**LANDFORM**

**ORGANIC**

OT Organic terrain

**ALLUVIAL**

AP Alluvial plain

**GLACIOLACUSTRINE**

LB Raised (abandoned) beach form  
LD Glaciolacustrine delta  
LP Glaciolacustrine plain

**GLACIOFLUVIAL**

GD Ice contact delta, esker delta, kame delta, delta moraine  
GE Esker, esker complex, crevasse filling  
GK Kame, kame field, kame terrace, kame moraine  
GO Outwash plain, valley train

**MORAINAL**

ME End moraine  
MG Ground moraine  
MH Hummocky moraine

Underlying material within approx. 3 m of surface

**Components of Terrain/Drainage Code**

Dominant landform — Material of subordinate landform — Subordinate landform

Material — **tMG (pOT)** — Surface drainage condition of subordinate landform

Local relief of dominant landform — **Lu (Lp) - m(v)** — Surface drainage condition of subordinate landform

Topographic variety of dominant landform — Local relief of subordinate landform — Topographic variety of subordinate landform — Surface drainage condition of dominant landform

**MATERIAL**

b boulders, bouldery  
c clay, clayey  
g gravel, gravelly  
p peat, muck  
r rubble  
s sand, sandy  
m silt, silty  
t till

**TOPOGRAPHY**

**LOCAL RELIEF**

H Mainly high local relief (>60 m)  
M Mainly moderate local relief (15 - 60 m)  
L Mainly low local relief (<15 m)

**VARIETY**

c channelled  
d dissected, gullied  
j jagged, rugged, cliffed  
k kettled, pitted  
n knobby, hummocky  
p plain  
r ridged  
s sloping  
t terraced  
u undulating  
m rolling  
w washed, reworked

**DRAINAGE**

**SURFACE CONDITION**

x Very rapidly drained  
r Rapidly drained  
w Well drained  
m Moderately well drained  
i Imperfectly drained  
p Poorly drained  
v Very poorly drained  
h Suspected high water table

MOE Water Well  
Existing Geotechnical Borehole  
Contour (5m)  
Freeway  
Highway  
Major Road  
Local Road

Transmission Line  
Railway  
Proposed Structure  
Provincially Significant Wetland  
Locally Significant Wetland  
Technically Recommended Route  
Municipal Division

Scale: 0 to 500 m  
1:10,000  
UTM Zone 17N, NAD 83

**Notes:**

- Terrain/drainage polygon boundaries and descriptions within Technically Recommended Route based on existing OGS/GSC surficial geology mapping, stereoscopic interpretation of 1:10,000 aerial photographs from 2000, and representative field checks of approximately 25% of the polygons. Existing OGS/GSC surficial geology mapping is displayed outside the Technically Recommended Route for context; its legend is provided separately.
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- No significant colluvial or eolian deposits within Technically Recommended Route, and no attempt made to differentiate tills, given their similarity in shallow hydrogeological and geotechnical characteristics.
- A slash (/) is used to indicate near-surface layering of contrasting materials within a dominant or subordinate landform (e.g., sLP/tMG). The material left of the slash (sLP) overlies the material right of the slash (tMG), without specifying any particular depth, but usually the landform material in the numerator is shallow.
- A landform's composition may be modified by up to three materials, with increasing proportion from left to right. The example cmtMG represents ground moraine (MG) composed of clayey (c) silt (m) till (t).
- A landform may exhibit up to three topographic varieties, with decreasing prominence from left to right. For example, Lpkd represents a low-relief (L) planar (p) surface with kettles (k), which has been dissected (d).

407 Environmental Assessment

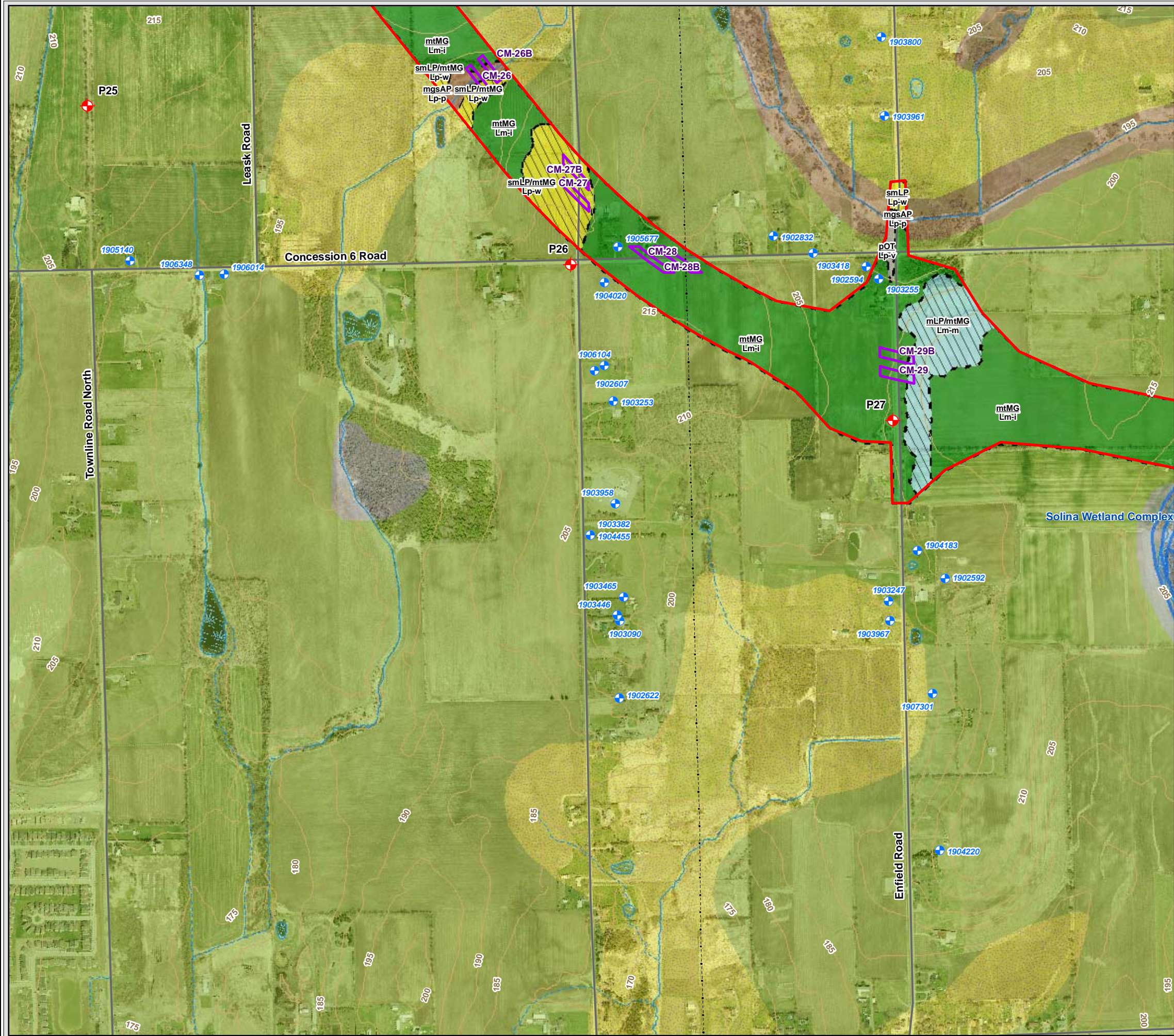
**Technically Recommended Route  
Terrain/Drainage Map with  
Proposed Structures**

December 2007  
Project 50613

**Gartner Lee**

Central 4





ORGANIC

OT

Organic terrain

ALLUVIAL

AP

Alluvial plain

COARSE

FINE

GLACIOLACUSTRINE

LB Raised (abandoned) beach form  
LD Glaciolacustrine delta  
LP Glaciolacustrine plain

GLACIOFLUVIAL

GD Ice contact delta, esker delta, kame delta, delta moraine  
GE Esker, esker complex, crevasse filling  
GK Kame, kame field, kame terrace, kame moraine  
GO Outwash plain, valley train

MORAINAL

ME End moraine  
MG Ground moraine  
MH Hummocky moraine

Underlying material within approx. 3 m of surface

Components of Terrain/Drainage Code

Dominant landform

Material

Local relief of dominant landform

Topographic variety of dominant landform

Material of subordinate landform

Subordinate landform

Surface drainage condition of subordinate landform

Topographic variety of subordinate landform

Local relief of subordinate landform

Surface drainage condition of dominant landform

tMG (pOT)

Lu (Lp) - m(v)

MOE Water Well

Existing Geotechnical Borehole

Contour (5m)

Freeway

Highway

Major Road

Local Road

Transmission Line

Railway

Proposed Structure

Provincially Significant Wetland

Locally Significant Wetland

Technically Recommended Route

Municipal Division

N

E

S

W

Notes:

1. Terrain/drainage polygon boundaries and descriptions within Technically Recommended Route based on existing OGS/GSC surficial geology mapping, stereoscopic interpretation of 1:10,000 aerial photographs from 2000, and representative field checks of approximately 25% of the polygons. Existing OGS/GSC surficial geology mapping is displayed outside the Technically Recommended Route for context; its legend is provided separately.

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3. No significant colluvial or eolian deposits within Technically Recommended Route, and no attempt made to differentiate tills, given their similarity in shallow hydrogeological and geotechnical characteristics.

4. A slash (/) is used to indicate near-surface layering of contrasting materials within a dominant or subordinate landform (e.g., sLP/tMG). The material left of the slash (sLP) overlies the material right of the slash (tMG), without specifying any particular depth, but usually the landform material in the numerator is shallow.

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m

0

50

100

200

300

400

500

1:10,000

UTM Zone 17N, NAD 83

407 Environmental Assessment

Technically Recommended Route

Terrain/Drainage Map with

Proposed Structures

December 2007

Project 50613

Gartner Lee

Central 5



ID	Type	Category	Name	Groundwater Comments	Groundwater Comments	SITE RANKING	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
				SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY				
CM - 1	Bridge	Overpass	Ashburn Road	Surficial silty to clayey till aquitard, overlain by sandy deposits. GWT ~2.75 m in sand, GWT <8 in till.	Potential for dewatering if excavating sandy materials.	Medium				60
CM - 1b	Bridge	Overpass	Ashburn Road	Surficial silty to clayey till aquitard, overlain by sandy deposits. GWT ~2.75 m in sand, GWT <8 in till.	Potential for dewatering if excavating sandy materials.	Medium				60
CM - 2	Bridge	Overpass	Baldwin Street	Surficial silty to clayey till aquitard. Confined aquifer at depth >45mbgs. GWT < 15 mbgs in till.	Nil	Low				60
CM - 2b	Bridge	Overpass	Baldwin Street	Surficial silty to clayey till aquitard. Confined aquifer at depth >45mbgs. GWT < 15 mbgs in till.	Nil	Low				60
CM - 3	Bridge	Overpass	Lynde Creek	Surficial aquifer - alluvial sediments, and lacustrine silty-sand. Water table near surface. Potential for upward gradients - cold water stream.	Potential for dewatering if excavating for foundations	High	Wide, moderately deep valley with 15-25o steep valleysides, except where meandering channel is undercutting and steepening slope, which has lead to localized slumps	Valley bottom sediments >2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material (e.g., a 0.15 m thick organic layer, evidence of previous floodplain elevation, exists approx. 1.5 m below current floodplain)	>100	55
CM - 3b	Bridge	Overpass	Lynde Creek	Surficial aquifer - alluvial sediments, and lacustrine silty-sand. Water table near surface. Potential for upward gradients - cold water stream.	Potential for dewatering if excavating for foundations	High	Wide, moderately deep valley with 15-25o steep valleysides, except where meandering channel is undercutting and steepening slope, which has lead to localized slumps	Valley bottom sediments >2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material (e.g., a 0.15 m thick organic layer, evidence of previous floodplain elevation, exists approx. 1.5 m below current floodplain)	>100	55
CM - 4	Culvert	Overpass	Creek	Surficial silty to clayey till aquitard (at least 11.4 m thick - BHP14) confining gravelly sand aquifer. GWT ~ 2.4 mbgs (BHP14).	Nil	Low	Narrow, shallow, channelized valley with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar valleys	<10	55
CM -5	Bridge	Overpass	Anderson Street	Surficial silty to clayey till aquitard (at least 11.4 m thick - BHP14) confining gravelly sand aquifer. Isolated sand/silt lenses in upper 5-15 m weathered layer of till. GWT ~ 2.4 mbgs (BH P14).	Nil	Low				60
CM - 5b	Bridge	Overpass	Anderson Street	Surficial silty to clayey till aquitard (at least 11.4 m thick - BHP14) confining gravelly sand aquifer. Isolated sand/silt lenses in upper 5-15 m weathered layer of till. GWT ~ 2.4 mbgs (BH P14).	Nil	Low				60
CM - 6	Bridge	Overpass	Thickson Road	Surficial silty to clayey till aquitard confining gravelly sand to silty sand aquifer supplying residential wells. Isolated sand/silt lenses in upper 5-15 m weathered layer. GWT > 13 mbgs. GWT near surface in river valley.	Nil	Low				60
CM - 6b	Bridge	Overpass	Thickson Road	Surficial silty to clayey till aquitard confining gravelly sand to silty sand aquifer supplying residential wells. Isolated sand/silt lenses in upper 5-15 m weathered layer. GWT > 13 mbgs. GWT near surface in river valley.	Nil	Low				60
CM - 7	Culvert	Overpass	Pringle Creek	Surficial poorly drained silty sand alluvial plain with peaty organic materials underlain by silty to clayey till. GWT at surface.	Mapping indicates creek is intermittant. Culvert installation should occur when the stream bed is dry - if not, slight potential for dewatering exists.	Low	Narrow, shallow valley with no geomorphic evidence of significant valleyside instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	10-20	60
CM - 8	Culvert	Overpass	Creek	Surficial silty to clayey till. Isolated sand/silt lenses in upper 5-15 m weathered layer. GWT near surface at stream.	Mapping indicates creek is intermittant. Culvert installation should occur when the stream bed is dry.	Low	Narrow, shallow swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	60
CM - 9	Bridge	Underpass	Garrard Road	Surficial silty to clayey till, at least 17 m thick, GWT ~ 4mbgs (BHP15). Isolated sand/silt lenses in upper 5-15 m weathered layer.	Nil	Low				55



ID	Type	Category	Name	Groundwater Comments	Groundwater Comments	SITE RANKING	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
				SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY				
CM - 10	Bridge	Overpass	Oshawa Creek	Surficial coarse-textured sandy and alluvial deposits in Oshawa Creek. Locally significant organic accumulations. GWT near surface, with high potential for upward gradients in creek valley.	Potential for dewatering if excavating alluvial sediments in valley.	High	Wide, deep valley with 30o steep valleysides, except where meandering channel is undercutting and steepening slope, which has lead to localized slumps (bridge abutment locations should take into account potential for continued down-valley migration of meander immediately northwest of proposed footprints); thin soil cover and minor irregularities on east valleyside suggest localized erosion and instability	Valley bottom sediments >2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material; riparian wetlands likely contain <1 m deep organic material	50-100	35
CM - 10b	Bridge	Overpass	Oshawa Creek	Surficial coarse-textured sandy and alluvial deposits in Oshawa Creek. Locally significant organic accumulations. GWT near surface, with high potential for upward gradients in creek valley.	Potential for dewatering if excavating alluvial sediments in valley.	High	Wide, deep valley with 30o steep valleysides, except where meandering channel is undercutting and steepening slope, which has lead to localized slumps (bridge abutment locations should take into account potential for continued down-valley migration of meander immediately northwest of proposed footprints); thin soil cover and minor irregularities on east valleyside suggest localized erosion and instability	Valley bottom sediments >2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material; riparian wetlands likely contain <1 m deep organic material	50-100	35
CM - 11	Bridge	Underpass	Thornton Road	Surficial silty to clayey till aquitard (at least 9.4 m thick with GWT ~2.8 mbgs - BHP21). Aquitard confines gravelly sand aquifer supplying residential wells. Isolated sand/silt lenses in upper 5-15 m weathered layer. GWT > 3 mbgs.	Nil	Medium				50
CM - 12	Bridge	Overpass	Winchester Road	Surficial silty to clayey till at least 9.4 m thick, GWT ~ 2.8 mbgs - BHP21. Isolated sand/silt lenses in upper 5-15 m weathered layer. GWT near surface at stream.	Nil	Low				45
CM - 12b	Bridge	Overpass	Winchester Road	Surficial silty to clayey till at least 9.4 m thick, GWT ~ 2.8 mbgs - BHP21. Isolated sand/silt lenses in upper 5-15 m weathered layer. GWT near surface at stream.	Nil	Low				45
CM - 13	Culvert	Overpass	Oshawa Creek Tributary	Surficial poorly drained silty sand alluvial plain with peaty organic materials underlain by silty to clayey till. Underlying till more than 20 m thick. GWT near surface.	Potential for dewatering if excavating alluvial sediments in valley.	Medium	Narrow, shallow valley with no geomorphic evidence of significant valleyside instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	50
CM - 13b	Culvert	Overpass	Oshawa Creek Tributary	Surficial poorly drained silty sand alluvial plain with peaty organic materials underlain by silty to clayey till. Underlying till more than 20 m thick. GWT at surface.	Potential for dewatering if excavating alluvial sediments in valley.	Medium	Narrow, shallow valley with no geomorphic evidence of significant valleyside instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	50
CM - 14	Bridge	Overpass	Simcoe Street	Surficial till. Isolated sand/silt lenses in upper 5-15 m weathered layer. BHP22 confirms very dense sandy to silty till to 12.6 mbgs with GWT ~ 3 mbgs.	Nil	Low				55

Site ranking for Hydrogeology: Low/Medium/High risk -in terms of sensitivity of the environment to construction, e.g. High risk - highly sensitive environment.



ID	Type	Category	Name	Groundwater Comments	Groundwater Comments	SITE RANKING	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
				SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY				
CM - 14b	Bridge	Overpass	Simcoe Street	Surficial till. Isolated sand/silt lenses in upper 5-15 m weathered layer. BH P22 confirms sandy to silty till to 12.6 mbgs with GWT ~ 3 mbgs.	Nil	Low				55
CM - 15	Culvert	Overpass	Oshawa Creek Tributary	Surficial poorly drained silty sand alluvial plain with peaty organic materials underlain by very dense sandy to silty till. GWT near surface in river valley. BH P22 penetrated sandy to silty till to 12.6 mbgs with GWT ~ 3 mbgs.	Mapping indicates creek is intermittent. Culvert installation should occur when the stream bed is dry.	Medium	Narrow, moderately deep valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	55
CM - 15b	Culvert	Overpass	Oshawa Creek Tributary	Surficial poorly drained silty sand alluvial plain with peaty organic materials underlain by very dense sandy to silty till. GWT near surface in river valley. BH P22 penetrated sandy to silty till to 12.6 mbgs with GWT ~ 3 mbgs.	Mapping indicates creek is intermittent. Culvert installation should occur when the stream bed is dry.	Medium	Narrow, moderately deep valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	55
CM - 15c	Culvert	Overpass	Oshawa Creek Tributary	Surficial poorly drained silty sand alluvial plain with peaty organic materials underlain by very dense sandy to silty till. GWT near surface in river valley. BH P22 penetrated sandy to silty till to 12.6 mbgs with GWT ~ 3 mbgs.	Mapping indicates creek is intermittent. Culvert installation should occur when the stream bed is dry.	Medium	Narrow, moderately deep valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	55
CM - 16	Bridge	Overpass	Oshawa Creek Tributary	Surficial coarse-textured sandy deposits at the outer edges and alluvial deposits in Oshawa Creek tributary with locally significant organic accumulations, locally highly compressible. GWT near surface in river valley.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	50
CM - 16b	Bridge	Overpass	Oshawa Creek Tributary	Surficial coarse-textured sandy deposits at the outer edges and alluvial deposits in Oshawa Creek tributary with locally significant organic accumulations, locally highly compressible. GWT at surface near river valley.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	50
CM - 17	Bridge	Overpass	Ritson Road and Oshawa Creek Tributary	Surficial moderately to poorly drained silty to gravelly sand alluvial plain with peaty organic materials. GWT near surface.	Potential for dewatering if excavating alluvial sediments in valley. Spring seepage and cattails at toe of steep east valley-side.	High	Wide, deep valley (old glacial meltwater spillway and early post-glacial river valley) with gentle west valley-side and 35o steep east valley-side, except where meandering channel is undercutting and steepening slope, which has led to localized slumps; high, eroding cut-banks on east valley-side expose silt till overlying thick silt/sand, which is rilling and slumping	Modern valley bottom sediments >1.5 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material; early post-glacial alluvial sediments comprising terrace on west side valley dominantly sandy gravel	20-50	40



ID	Type	Category	Name	Groundwater Comments	Groundwater Comments	SITE RANKING	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
				SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY				
CM - 17b	Bridge	Overpass	Ritson Road and Oshawa Creek Tributary	Surficial moderately to poorly drained silty to gravelly sand alluvial plain with peaty organic materials. GWT near surface. Seeps observed at toe of eastern valley wall.	Potential for dewatering if excavating alluvial sediments in valley. Spring seepage and cattails at toe of steep east valleyside.	High	Wide, deep valley (old glacial meltwater spillway and early post-glacial river valley) with gentle west valleyside and 35o steep east valleyside, except where meandering channel is undercutting and steepening slope, which has lead to localized slumps; high, eroding cut-banks on east valleyside expose silt till overlying thick silt/sand, which is rilling and slumping	Modern valley bottom sediments >1.5 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material; early post-glacial alluvial sediments comprising terrace on west side valley dominantly sandy gravel	20-50	40
CM - 18	Culvert	Overpass	Oshawa Creek Tributary	Surficial clayey silt till to sandy silt glaciolacustrine plain with underlying material within 3 m of surface. GWT near surface in creek.	Mapping indicates creek is intermittent. Culvert installation should occur when the stream bed is dry - if not, slight potential for dewatering exists.	Low	Narrow, shallow swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	45
CM -19	Bridge	Overpass	Wilson Road	Surficial silty to clayey till to sandy silt glaciolacustrine plain with underlying materials within 3 m of surface.	Nil	Low				65
CM -19b	Bridge	Overpass	Wilson Road	Surficial silty to clayey till to sandy silt glaciolacustrine plain with underlying materials within 3 m of surface.	Nil	Low				65
CM - 20	Bridge	Overpass	Oshawa Creek Tributary and Valley	Surficial silty sand alluvial plain and organic material underlain by silty to clayey till. GWT near surface in river valley	Mapping indicates creek is intermittent. Culvert installation should occur when the stream bed is dry.	Low	Narrow, moderately deep valley; meandering channel is undercutting valleyside, which has lead to localized slumps	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	20-50	70
CM - 20b	Bridge	Overpass	Oshawa Creek Tributary and Valley	Surficial silty sand alluvial plain and organic material underlain by silty to clayey till. GWT near surface in river valley	Mapping indicates creek is intermittent. Culvert installation should occur when the stream bed is dry.	Low	Narrow, moderately deep valley; meandering channel is undercutting valleyside, which has lead to localized slumps	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	20-50	70
CM - 20c	Bridge	Overpass	Oshawa Creek Tributary and Valley	Surficial silty sand alluvial plain and organic material underlain by silty to clayey till. GWT near surface in river valley	Mapping indicates creek is intermittent. Culvert installation should occur when the stream bed is dry.	Low	Narrow, moderately deep valley; meandering channel is undercutting valleyside, which has lead to localized slumps	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	20-50	70
CM - 21	Bridge	Overpass	Harmony Road	Surficial silty to clayey till.	Potential to encounter perched water table within areas of ablation moraine on east side of Harmony Rd	Low				85
CM - 21b	Bridge	Overpass	Harmony Road	Surficial silty to clayey till. Alluvial soils at west end of study area. GWT near surface in creek.	Potential to encounter perched water table within areas of ablation moraine on east side of Harmony Rd	Low				85
CM - 22	Bridge	Overpass	Grandview Street	Surficial silt till. Till about 12 m thick in the area.	Nil	Low				105
CM - 22b	Bridge	Overpass	Grandview Street	Surficial silt till. Till about 12 m thick in the area.	Nil	Low				105
CM - 23	Bridge	Overpass	Winchester Road	Surficial silt till. Till about 12 m thick in the area.	Nil	Low				105
CM - 23b	Bridge	Overpass	Winchester Road	Surficial silt till. Till about 12 m thick in the area.	Nil	Low				105



ID	Type	Category	Name	Groundwater Comments	Groundwater Comments	SITE RANKING	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
				SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY				
CM - 24	Culvert	Overpass	Harmony Creek	Surficial alluvial sediments underlain by silt till. GWT near surface in river valley	Slight potential for dewatering if excavating alluvial sediments in valley.	Low	Narrow, shallow, channelized valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <1 m deep and dominantly silty gravelly sand alluvium, based on field checks of similar valleys	<10	95
CM - 26	Bridge	Overpass	Creek	Surficial silt till and sandy silt glaciolacustrine plain with silty sand alluvial plain. GWT near surface in river valley	Potential for dewatering if excavating alluvial sediments in valley.	Medium	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	80
CM - 26b	Bridge	Overpass	Creek	Surficial silt till and sandy silt glaciolacustrine plain with silty sand alluvial plain. GWT near surface in river valley	Potential for dewatering if excavating alluvial sediments in valley.	Medium	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	80
CM - 27	Bridge	Overpass	Langmaid Road	Surficial sandy silt glaciolacustrine plain. BHP26 penetrated silty sand to sandy silt (till?) to 9.8 mbgs with GWT ~ 7 mbgs.	Nil	Medium				90
CM - 27b	Bridge	Overpass	Langmaid Road	Surficial sandy silt glaciolacustrine plain. BHP26 penetrated silty sand to sandy silt (till?) to 9.8 mbgs with GWT ~ 7 mbgs.	Nil	Medium				90
CM - 28	Bridge	Overpass	Concession Rd. 6	Surficial silt till. GWT ~ 7 mbgs - BHP26.	Nil	Low				100
CM - 28b	Bridge	Overpass	Concession Rd. 6	Surficial silt till. GWT ~ 7 mbgs - BHP26.	Nil	Low				100
CM - 29	Bridge	Overpass	Enfield Road	Surficial silt till with silt glaciolacustrine plain on east end of study area. BH P27 completed to 9.6 mbgs with no GWT encountered.	Nil	Medium				95
CM - 29b	Bridge	Overpass	Enfield Road	Surficial silt till with silt glaciolacustrine plain on east end of study area. BH P27 completed to 9.6 mbgs with no GWT encountered.	Nil	Medium				95
CM-25?		may not exist	Leask Road?	Surficial silt till.	Nil	Low				100







Jan 11/99

FOUNDATION DESIGN SECTION

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 282-86-01 DIST 6  
HWY 407 STR SITE

Preliminary Design Study for Proposed Hwy. 407  
From Hwy. 48 to Whitby/Oshawa Boundary

foundation  
investigation and  
design report

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 282-86-01 DIST 6  
HWY 407 STR SITE

Preliminary Design Study for Proposed Hwy. 407  
From Hwy. 48 to Whitby/Oshawa Boundary

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FOUNDATION INVESTIGATION REPORT  
For  
Preliminary Design Study For  
Proposed Hwy 407  
From Hwy 48 to Whitby/Oshawa Boundary  
W.P. 282-86-01, District 6, Toronto

## INTRODUCTION

This report summarizes the results of our foundation investigation carried out for the preliminary design study of the proposed Hwy 407 at the above location. This investigation is intended for initial assessment of the feasibility of the proposed alignment from a foundation point of view, with a general coverage of the area by limited number of boreholes. The recommendations given in the report are tentative based on the limited information available and should definitely be reviewed based on supplementary investigations.

Fieldwork was carried out during the period of 93 12 06 to 94 01 12 and is consisted of a total of fifteen (15) sampled boreholes advanced to depths ranging from 10.8 to 27.9 m below ground surface. A desk study carried out before the commencement of the fieldwork has revealed borehole information from existing reports that are relevant to the current design alignment. This information has been extracted and incorporated in this report.

## SITE DESCRIPTION

The area investigated extends from the east end of the Town of Markham through the Town of Pickering to the east boundary of the Town of Whitby. The alignment of the proposed Hwy 407 in this area runs more or less in an east-west direction in the vicinity of Hwy 7. It is located within one km south of the existing Hwy 7 from Hwy 48 to around Sideline 16 in Pickering where it cuts across Hwy 7. From there on, it is located within one km approximately north of Hwy 7. It then runs south and intersects Hwy 7 again just east of Cochrane St. in Whitby. From this point on, it stays within one km south of Hwy 7/Winchester Road through the east end of Whitby. The proposed route is illustrated in Drawing Nos. 2828601-A & B.

The existing ground elevation varies from 180  $\pm$  m at Hwy 48 to 225  $\pm$  m just east of Sideline 24 and dips from there to 140  $\pm$  m at Duffins Creek. The grade elevation then goes up easterly to 200  $\pm$  m just east of Kinsale Road and smooths off gently to 170  $\pm$  m at the east end of Whitby. The topography of the terrain is generally flat to undulating, except at major river or creek locations where relatively deep valleys can be found.

-3-

## Laboratory

The laboratory testing on selected soil samples consisted of the following:

- Atterberg Limit Test
- Grain Size Distribution
- Natural Moisture Content Determination

Laboratory test results are illustrated on Record of Borehole sheets included in the Appendix.

## SUBSURFACE CONDITIONS

Reference should be made to the Record of Borehole sheets contained in the Appendix for subsurface conditions at a particular location. The locations and elevations of the borings are shown on Dwg. Nos. 2828601-A & B.

The predominant soil strata encountered in the boreholes consisted of glacial till with occasional sand layers and silt zones. Silty clay was contacted at two of the boreholes (BH P7 and P8) in the valley with the lowest ground elevations of the area investigated. A surficial layer of granular fill was generally found in all the boreholes as the holes were advanced from existing roads. Bedrock was not encountered at the termination depth of the boreholes.

The glacial till encountered is a heterogeneous mixture of clayey silt, sand and gravel for cohesive tills and a heterogeneous mixture of silt, sand and gravel for non-cohesive tills. Based on the 'N' values of the Standard Penetration test, the glacial till has a hard consistency in the case of a cohesive matrix and a very dense relative density in the case of a non-cohesive matrix. The sand layers or silt zones encountered are also competent with dense to very dense relative density according to the 'N' values obtained. The consistency of silty clay varies widely from hard in BH P8 to soft to stiff in BH P7.

Groundwater level was measured in the open boreholes during the investigation and is given in the Record of Borehole sheet for each borehole. Groundwater levels are subject to seasonal fluctuations and may vary from the values provided in this report.



DISCUSSION AND RECOMMENDATIONS

This report covers the proposed Hwy 407 alignment from Hwy 48 to the Whitby/Oshawa boundary over a distance of about 25 km. The current investigation is intended to collect minimum subsoil information to allow an initial assessment of the feasibility of the proposed route from a foundation point of view. Additional data collected from existing reports are also incorporated.

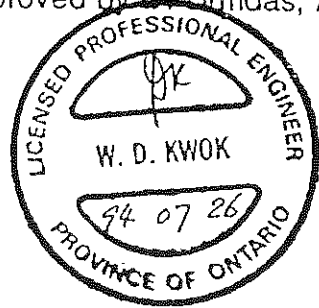
The subsurface conditions at the various structure sites and the corresponding tentative foundation recommendations are summarized in tabular form on the following pages.

*It should be noted that the tentative foundation recommendations provided are for feasibility study or preliminary planning purposes only as they are based on very limited subsurface information. It will be necessary to carry out a detailed investigation at each structure site location when a structure scheme and a profile grade have been decided on.*

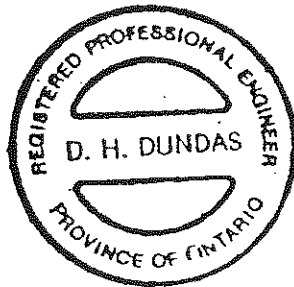
MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of D. Kwok, Project Foundation Engineer. The equipment was owned and operated by Master Soils Investigation Ltd.

The project was carried out by D. Kwok under the supervision of B. Iyer, Senior Foundation Engineer. This report was prepared by D. Kwok, reviewed by P. Payer, Senior Foundation Engineer and approved by D. Dundas, Acting Chief Foundation Engineer.



*[Signature]*  
D. Kwok, P. Eng.  
Project Foundation Engineer



*[Signature]*  
D. Dundas, P. Eng.  
Acting Chief Foundation Engineer

FOUNDATION DATA SHEET

Underpass

Foundation : 183.6 ± m

Area : 1 Struct. No. 01 : Markham Rd Underpass

1 Proposed Hwy 407 Grade Elevation : 175 ± m

	REMARKS
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RECOMMENDATIONS	REMARKS
Spread footings placed within the very stiff glacial till stratum below the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=500kPa Bearing Capacity at SLS Type II=300kPa	
Alternatively, spread footings can be placed on a well compacted Granular 'A' road and designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II=350kPa	
Cuts up to 8 m can be constructed with side slopes of 2H:1V	
Major subsoil deposit is of low permeability and ground water table is close to proposed Hwy 407 grade. It is not a feasible site for infiltration ponds.	



Ground Elevation : C13 178.7m Proposed Hwy 407 Grade Elevation : 178 ± m  
at BH Location C14 178.6m

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<u>Ref. Boreholes</u> (W.P.90-78-00)  BH C13 (WBL)  0-0.3m      Topsoil  0.3-22.9m   V. stiff glacial till  22.9-27.6m V. dense glacial till  BH C13B (EBL)  0-15.7m   Stiff to V. stiff glacial till  Groundwater -  BH C13      168 m BH C13B    not established	1. Spread footings placed within the very stiff glacial till stratum below the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=500kPa Bearing Capacity at SLS Type II=300kPa  2. Alternatively, spread footings can be placed on a well compacted Granular 'A' pad and designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II=350kPa  3. End bearing piles to an elevation of 153±m  4. Fills up to 8 m can be constructed with side slopes of 2H:1V  5. Base groundwater table at 10 ±m below proposed Hwy 407 grade. Subsoil is of low permeability at this depth. The site is not ideal for infiltration ponds.	

## FOUNDATION DATA SHEET

W.P. 282-86-01      Area : 3      Structure No. 4 : 9th Line Underpass

Ground Elevation : 182.4 m  
at BH Location

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<u>Ref Borehole</u> (W.P.90-78-00)  BH C14  0-1.5 m Roadway Fill  1.5-15.7 m Hard glacial till          Groundwater -  Not established	1. Spread footings placed within the hard glacial till stratum below the frost depth (1.2 m) may be designed with  Factored Bearing Capacity at ULS=1000kPa Bearing Capacity at SLS Type II does not control  2. Fills up to 8 m can be constructed with side slopes of 2H:1V  3. Subsoil is generally of low permeability. It is not an ideal site for infiltration ponds.	



# FOUNDATION DATA SHEET

W.P. 282-86-01      Area : 4      Structure No. 5 : N-S Arterial Road Underpass

Ground Elevation : 192.9 m      Proposed Hwy 407 Grade Elevation : 195.6 ± m  
at BH Location

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<u>Ref. Borehole</u> (W.P. 25-69-00)  BH 11  0-13.9 m Hard glacial till          Groundwater -  Not established	1. Spread footings placed within the hard glacial till stratum below the frost depth (1.2 m) may be designed with  Factored Bearing Capacity at ULS=1000kPa Bearing Capacity at SLS Type II does not control  2. Fills up to 8 m can be constructed with side slopes of 2H:1V  3. Subsoil is generally of low permeability. It is not an ideal site for infiltration ponds.	

# FOUNDATION DATA SHEET

W.P. 282-86-01      Area : 5      Struct Nos. 06/07 : 10th Line Overpass  
08/09 : CPR Overhead  
10/11 : Little Rouge River Bridge

Ground Elevation : 193.4 m      Proposed Hwy 407 Grade Elevation : 196.2 ± m  
at BH Location      200.8 ± m  
199.6 ± m

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<u>Ref. Borehole</u> (W.P.282-86-01)  BH P1  0-0.6 m Granular Fill  0.6-10.8 m Hard glacial till          Groundwater -  186.6 m	1. Spread footings placed within the hard glacial till stratum below the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=700 kPa Bearing Capacity at SLS Type II does not govern.  2. Abutment footings may be placed on a well compacted Granular 'A' pad and designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II=350kPa  3. Fills up to 12 m can be constructed at 2H:1V with a 2 m wide mid-height berm  4. Major subsoil deposit is of low permeability and the sites are not recommended for infiltration ponds.	



# FOUNDATION DATA SHEET

W.P. 282-86-01      Area : 6      Struct. No.20 : Regional Road #30 Underpass

Ground Elevation : 205.3 m      Proposed Hwy 407 Grade Elevation : 212 ± m  
at BH Location

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<p>Ref. Borehole (W.P. 282-86-01)</p> <p>BH P2</p> <p>0-0.8m Granular Fill</p> <p>0.8-12.4m V. Stiff to Hard glacial till</p> <p>Groundwater - 195.4 m</p>	<ol style="list-style-type: none"> <li>Spread footings placed within the hard glacial till stratum below the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=700 kPa Bearing Capacity at SLS Type II does not govern</li> <li>Abutment footings may be placed on a well compacted Granular 'A' pad and designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II=350kPa</li> <li>Fills up to 8 m can be constructed at side slopes of 2H:1V.</li> <li>Subsoil is generally of low permeability. It is not an ideal site for infiltration ponds.</li> </ol>	

# FOUNDATION DATA SHEET

W.P. 282-86-01      Area : 7      Struct. Nos. 21/22 : West Duffin Creek Bridge

Ground Elevation : 176.2 m      Proposed Hwy 407 Grade Elevation : 186 ± m  
at BH Location

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<p>Ref. Borehole (W.P. 69-65-02)</p> <p>BH 3</p> <p>0-1m Firm Clayey Silt</p> <p>1-11.1m Dense to V.Dense Sand and Gravel</p> <p>Groundwater - 175.4 m</p>	<ol style="list-style-type: none"> <li>Spread footings placed within dense to very dense sand and gravel material below the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS= Bearing Capacity at SLS Type II=</li> <li>Alternatively, footings can be placed on a well compacted Granular 'A' pad built on the sand and gravel stratum and designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II=350kPa</li> <li>Fills up to 12 m can be constructed at 2H:1V with a 2 m wide mid-height berm.</li> <li>High groundwater table with local artesian conditions. The site is not recommended for infiltration ponds.</li> </ol>	<p>Prior dewatering is required for footing construction on sand and gravel</p> <p>Artesian conditions were found in boreholes south of West Duffin Creek @170 m. Water came up to 300 mm above ground level</p>



# FOUNDATION DATA SHEET

W.P. 282-86-01      Area : 8      Structure No. 23 : North Road Underpass

Ground Elevation : 210.0 m      Proposed Hwy 407 Grade Elevation : 204 ± m  
at BH Location

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<u>Ref. Borehole</u> (W.P.282-86-01)  BH P3  0-0.5m Granular fill  0.5-15.4m Hard glacial till          Groundwater -  dry	1. Spread footings placed within the hard glacial till stratum below El. 209 m and the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=1000kPa Bearing Capacity at SLS Type II does not govern.  2. Cut slopes may be formed at 2H:1V up to 12 m deep with a 2m wide mid-height berm.  3. Subsoil is generally of low permeability and the site is not recommended for infiltration ponds.	

# FOUNDATION DATA SHEET

W.P. 282-86-01      Area : 9      Struct. No. 24 : Sideline 24 Underpass

Ground Elevation : 215.6 m      Proposed Hwy 407 Grade Elevation : 216 ± m

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<u>Ref. Borehole</u> (W.P. 282-86-01)  BH P4  0-1.5m Fill  1.5-10.8m Hard glacial till          Groundwater -  dry	1. Spread footings placed within the hard glacial till stratum below El. 216 m and the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=1000kPa Bearing Capacity at SLS Type II does not govern.  2. Abutment footings may be placed on a well compacted Granular 'A' pad and designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II=350kPa  3. Subsoil is generally of low permeability. The site is not recommended for infiltration ponds.	



Area : 10 Struct. No. 25 : Brock Road Underpass  
No. 26 : Sideline 16 Underpass  
No. 27&28 : Hwy 7 Overpass WBL/EBL

Ground Elevation : 192.4 m	Proposed Hwy 407 Grade Elevation :	189 ± m
at BH Location		179 ± m
		174 ± m

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<u>Ref. Borehole</u> ( W.P. 282-86-01)  BH P5  0-0.9m Granular Fill  0.9-5.3 m Stiff to Hard Till  5.3-9.9m V. Dense Sand/Silt  9.9-10.8m Hard glacial till   Groundwater -  186.1 m	<ol style="list-style-type: none"> <li>1. Spread footings placed within the hard glacial till stratum below the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=700kPa Bearing Capacity at SLS Type II does not govern.</li> <li>2. Alternatively, footings may be placed on a well compacted Granular 'A' pad and designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II =350kPa</li> <li>3. Cuts/Fills up to 10 m may be constructed at 2H:1V with a 2 m wide mid-height berm for fill heights or cut depths over 8 m.</li> <li>4. Groundwater table generally close to proposed Hwy 407 grade. The site is not recommended for infiltration ponds.</li> </ol>	

Area : 11 Structure No. 31 : Sideline 14 Underpass  
Nos.40&41 : Structures @ Sideline 14 I/C

Ground Elevation : 167.1 m      Proposed Hwy 407 Grade Elevation : 164 ± m  
at BH Location

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<p>Ref. Borehole (W.P.282-86-01)</p> <p>BH P6</p> <p>0-3.4 m      Fill</p> <p>3.4-6.9 m   V. Stiff                  to Hard Till</p> <p>6.9-15.7m   Compact                  to Dense                  Silty Sand</p> <p>Groundwater -</p> <p>165.3 m</p>	<ol style="list-style-type: none"> <li>1. Spread footings placed within the glacial till stratum below the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=600kPa Bearing Capacity at SLS Type II=350kPa</li> <li>2. Abutment footings may be placed on a well compacted Granular 'A' pad and designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II=350kPa</li> <li>3. Cut slopes may be formed at 2H:1V with a 2 m berm every 8 m up to a maximum height of 25 m.</li> <li>4. Groundwater table close to proposed Hwy 407 grade. The site is not recommended for infiltration ponds.</li> </ol>	<p>Cuts up to 25±m high may be required west of the structure</p>



## FOUNDATION DATA SHEET

W.P. 282-86-01

Area : 12 Struct. No.32 : Paddock Road Underpass  
Nos.33&34 : East Duffin Creek Bridge  
No.35 : Westney Road Underpass

Ground Elevation : 145.4 m at BH Location  
Proposed Hwy 407 Grade Elevation : 154 ± m  
157 ± m  
153 ± m

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<p>Ref. Borehole (W.P.282-86-01)</p> <p>BH P7</p> <p>0-2.3m Granular Fill</p> <p>2.3-3.5m Peat</p> <p>3.5-5.3m Dense Alluvial Sand</p> <p>5.3-11.4m Soft to Stiff Silty Clay</p> <p>11.4-15.2m Compact Silty Sand</p> <p>15.2-17.5m V. Stiff Silty Clay</p> <p>17.5-18.7m Compact Silty Sand</p> <p>Groundwater - 147.6 m</p>	<p>1. Footings elements can be supported by piles driven to an end bearing stratum below El. 131 m, to be determined by additional investigation.</p> <p>2. All organic material has to be removed prior to placement of fill</p> <p>3. Stability and geometry of fill embankment has to be determined by additional investigation at structure locations.</p> <p>4. Permeable sand layers are intercepted by clay strata of low permeability. The sites are not recommended for infiltration ponds.</p>	<p>Additional investigation is required to determine the pile founding stratum and stability of embankment</p>

## FOUNDATION DATA SHEET

W.P. 282-86-01

Area : 13 Structure 36 : Salem Road Underpass

Ground Elevation : 170.7 m at BH Location  
Proposed Hwy 407 Grade Elevation : 166 ± m

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<p>Ref. Borehole (W.P.282-86-01)</p> <p>BH P8</p> <p>0-0.5m Granular Fill</p> <p>0.5-7.6m V. Stiff to Hard Till</p> <p>7.6-10.7m Dense to V. dense Sand</p> <p>10.7-19.1m Dense to V. dense Silt</p> <p>19.1-27.9m Hard Silty Clay</p> <p>Groundwater - 168.8 m</p>	<p>1. Spread footings placed within the hard glacial till below the frost depth (1.2m) can be designed with Factored Bearing Capacity at ULS=700kPa Bearing Capacity at SLS Type II does not govern.</p> <p>2. Alternatively, footings may be placed on a well compacted Granular 'A' pad and be designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II=350kPa</p> <p>3. Cut slopes may be formed at 2H:1V up to a maximum depth of 8 m.</p> <p>4. Groundwater table close to proposed Hwy 407 grade. Not recommended for infiltration ponds.</p>	



SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<u>Ref Borehole</u> (W.P. 282-86-01)  BH P9  0-0.5m Granular Fill  0.5-1.5m Clayey Silt Fill  1.5-23.3m V. Stiff to Hard Till          Groundwater -  177.7 m	1. Spread footings placed within hard glacial till below the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=1000kPa Bearing Capacity at SLS Type II does not govern  2. Abutment footings may be placed on a well compacted Granular 'A' pad and designed with Factored Bearing Capacity at ULS =900kPa Bearing Capacity at SLS Type II=350kPa  3. Cut slopes may be formed at 2H:1V up to 10 m deep with a 2m wide mid-height berm for cuts deeper than 8 m.  4. Subsoil generally of low permeability. Not an ideal site for infiltration ponds.	Cuts up to 10 m deep may be required between the two structures

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<u>Ref. Borehole</u> (W.P. 282-86-01)  BH P10  0-0.8 m Granular Fill  0.8-7.0m Hard glacial till  7.0-9.1m Very Dense Silty Sand  9.1-12.2m Very Dense glacial till  12.2-15.4m Hard glacial till   Groundwater -  192 m	1. Spread footings placed within hard glacial till below the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=1000kPa Bearing Capacity at SLS Type II does not govern  2. Cut/fill slopes may be formed at 2H:1V up to 8 m maximum.  3. Groundwater table close to proposed Hwy 407 grade. The site is not recommended for infiltration ponds.	



# FOUNDATION DATA SHEET

W.P. 282-86-01 Area : 16 Structure No.51 : Coronation Road Underpass  
Nos.52&53 : West Lynde Creek Bridge  
No.54 : Country Lane Road Underpass

Ground Elevation : 167.2 m Proposed Hwy 407 Grade Elevation : 168 ± m  
at BH Location 161 ± m  
157 ± m

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<u>Ref. Borehole</u> (W.P. 282-86-01)  BH P11  0-0.3m Granular Fill  0.3-1.5m Fill  1.5-21.8m Stiff to Hard glacial till   Groundwater - dry	1. Spread footings placed within hard glacial till below 163 ± m and the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=1000kPa Bearing Capacity at SLS Type II does not govern  2. Alternatively, footings may be placed on a well compacted Granular 'A' pad built over native glacial till material and be designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II=350kPa  3. Cut/fill slopes may be formed at 2H:1V to 10 m maximum with a mid-height berm for slopes more than 8 m high.  4. No aquifer encountered during the investigation. Subsoil generally dry and of low permeability. The site is not recommended for infiltration ponds.	Cuts up to 10 ± m may be required in the vicinity of the structures.

# FOUNDATION DATA SHEET

W.P. 282-86-01 Area : 17 Struct No.55 : Cochrane Street Underpass  
No.56 : Hwy 7 Underpass  
No.57 : Regional Road #41 Underpass

Ground Elevation : 161.5 m Proposed Hwy 407 Grade Elevation : 161 ± m  
at BH Location 164 ± m  
164 ± m

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<u>Ref. Borehole</u> (W.P.282-86-01)  BH P12  0-0.8m Granular Fill  0.8-3.8m Very Stiff to hard till  3.8-20.4m Compact to very dense till  20.4-24.8m Hard till   Groundwater - 159.3 m	1. Spread footings placed within the upper very stiff to hard glacial till stratum below the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=500kPa Bearing Capacity at SLS Type II=300kPa  2. Alternatively, footings may be placed on a well compacted Granular 'A' pad built over native soils and be designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II=350kPa  3. End bearing piles may be founded within the lower hard till stratum at 137.5 ± m.  4. Cut/fill slopes may be formed at 2H:1V up to 8 m maximum.  5. Major aquifer in non-cohesive till with sand layers. The sites may be feasible for construction of infiltration ponds.	



## FOUNDATION DATA SHEET

W.P. 282-86-01 Area : 18 Structure No.58 : Hwy 12 Underpass

Ground Elevation : 158.8 m Proposed Hwy 407 Grade Elevation : 157 ± m

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<p>Ref. Borehole (W.P.282-86-01)</p> <p>BH P13</p> <p>0-0.5m Granular Fill</p> <p>0.5-1.4m Fill</p> <p>1.4-2.1m Very Stiff Till</p> <p>2.1-6.1m Dense to very dense till</p> <p>6.1-12.4m Hard till</p> <p>Groundwater - 157.3 m</p>	<p>1. Spread footings placed within dense to very dense till below the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=700kPa Bearing Capacity at SLS Type II does not govern</p> <p>2. Abutment footings may be placed on a well compacted Granular 'A' pad built over native soils and be designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II=350kPa</p> <p>3. Cut/fill slopes may be formed at 2H:1V up to 8m maximum.</p> <p>4. Groundwater level close to proposed Hwy 407 grade. The site is not recommended for infiltration ponds.</p>	

## FOUNDATION DATA SHEET

W.P. 282-86-01 Area : 19 Struct. Nos. 59 & 60 : Lynde Creek Bridge  
61 : Anderson Road Underpass

Ground Elevation : 156.8 m Proposed Hwy 407 Grade Elevation : 156 ± m  
156 ± m

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<p>Ref. Borehole (W.P.282-86-01)</p> <p>BH P14</p> <p>0-0.8m Granular Fill</p> <p>0.8-1.5m Fill</p> <p>1.5-11.4m Hard till</p> <p>11.4-20.6m Very dense silty sand with gravel</p> <p>20.6-23.0m Hard till</p> <p>Groundwater - 152.6 m</p>	<p>1. Spread footings placed within the hard glacial till below the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=500kPa Bearing Capacity at SLS Type II=300kPa</p> <p>2. Abutment footings may be placed on a well compacted Granular 'A' pad built over native soils and be designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II=350kPa</p> <p>3. Cut/fill slopes may be formed at 2H:1V up to 8 m maximum.</p> <p>4. Aquifer in silty sand stratum some 10 m below proposed Hwy 407 grade. Site No. 61 may be feasible for the construction of infiltration ponds. Site Nos. 59 &amp; 60 are located next to Main Lynde Creek and are therefore environmentally sensitive.</p>	



## FOUNDATION DATA SHEET

W.P. 282-86-01      Area : 20      Struct. No.62 : Thickson Road Underpass  
No.63 : Garrard Road Underpass

Ground Elevation : 172.2 m	Proposed Hwy 407 Grade Elevation :	164 ± m
at BH Location		173 ± m

SUBSURFACE CONDITIONS	RECOMMENDATIONS	REMARKS
<u>Ref. Borehole</u> (W.P.282-86-01)  BH P15  0-0.8m Granular Fill  0.8-8.4m Hard Till  8.4-17.0m Very dense till          Groundwater -  168.2 m	1. Spread footings placed within hard glacial till below the frost depth (1.2 m) may be designed with Factored Bearing Capacity at ULS=650kPa Bearing Capacity at SLS Type II=400kPa  2. Abutment footings may be placed on a well compacted Granular 'A' pad built over native soils and be designed with Factored Bearing Capacity at ULS=900kPa Bearing Capacity at SLS Type II=350kPa  3. Cut/fill slopes may be formed at 2H:1V up to 8 m maximum.  4. Aquifer in non-cohesive till stratum some 10 m below the proposed Hwy 407 grade at Struct. No. 63. Groundwater level is at about 5 m below Hwy 407 grade. The site may be feasible for the construction of infiltration ponds.	

APPENDIX



# EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS  $\bar{N}$ .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON "A" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$c_u$ (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 100mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
$E$	kPa	MODULUS OF LINEAR DEFORMATION
$G$	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$C_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
$H$	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
$U$	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	$e$	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	$n$	1, %	POROSITY	$i_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	$w$	1, %	WATER CONTENT	$D$	mm	GRAIN DIAMETER
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	$h$	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	$q$	m <sup>2</sup> /s	RATE OF DISCHARGE
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	$v$	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	$i$	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	$k$	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	$j$	kn/m <sup>3</sup>	SEEPAGE FORCE
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No C 12 1 OF 1 METRIC																	
W.P. 90-78-00		LOCATION Coods. N 4 857926.8 E 324307.2		ORIGINATED BY BL													
DIST 6 HWY 407		BOREHOLE TYPE H.S. Augers		COMPILED BY BL													
DATUM Geodetic		DATE 79 02 19		CHECKED BY QJ													
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>	WATER CONTENT (%) w	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						
180.8	Ground Surface																
0.0	Sandy Roadway Fill																
179.0	Loose																
1.8			1	SS	5												
			2	SS	24												
			3	SS	74												
	Heterogeneous Mixture of		4	SS	25												
	Clayey Silt, Sand and		5	SS	30												
	Some Gravel		6	SS	30												
	Very Stiff		7	SS	17												
	( Glacial Till )		8	SS	17												
			9	SS	21												
			10	SS	11												
165.1	End of Borehole																



+3, x<sup>5</sup>: Numbers refer to Sensitivity

+3, x5: Numbers refer to Sensitivity



# RECORD OF BOREHOLE No C 14 1 OF 1 METRIC

W.P. 90-78-00 LOCATION Coords. N 4 859210 E 326206.1 ORIGINATED BY BL  
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BL  
 DATUM Geodetic DATE 79 02 22 CHECKED BY CJ

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES		20	40	60	80	100		
182.4	Ground Surface												
0.0	Roadway Fill Material												
180.9													
1.5			1	SS	20								
			2	SS	50								
			3	SS	60								
			4	SS	50								
			5	SS	101								
			6	SS	40								
			7	SS	48								
			8	SS	60								
			9	SS	88								
			10	SS	50								
166.7	End of Borehole												
15.7													

+3, x<sup>5</sup> Numbers refer to  
Sensitivity

20  
15-5 (X) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 11 1 OF 1 METRIC

W.P. 25-69-00 LOCATION Coords. N 4 859667.2 E 327461.9 ORIGINATED BY J.J.  
 DIST 6 HWY EMF BOREHOLE TYPE H.S. Auger COMPILED BY J.J.  
 DATUM Geodetic DATE 78 08 16 CHECKED BY O.J.

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES		20	40	60	80	100		
192.9	Ground Surface												
0.0													
			1	SS	30								
			2	SS	60								
			3	SS	130								
			4	SS	85								
			5	SS	70								
			6	SS	108								
			7	SS	60								
			8	SS	60								
			9	SS	90								
179.0	End of Borehole												
13.9													

+3, x<sup>5</sup> Numbers refer to  
Sensitivity

20  
15-5 (X) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No P1														1 OF 1		METRIC	
W.P. 282-86-01		LOCATION N 4 859623.2 E 328166.1				ORIGINATED BY DK											
DIST 6 HWY 407		BOREHOLE TYPE S.S. Auger, Cone Test				COMPILED BY DK											
DATUM Geodetic		DATE 94 01 12				CHECKED BY BR											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80						100
193.4	Ground Surface																
0.0	Granular Fill																
0.8																	
	Very Stiff		1	SS	28												
	Hard		2	SS	80												
	Heterogeneous Mixture of Clayey Silt, Trace Gravel																
	Occasional Sand Layers, Cobbles and Boulders																
	Brown																
	Grey																
	( Glacial Till )																
182.6																	
10.8	End of Borehole																
	• Unstabilized water level measured upon completion of drilling on 94 01 12																

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

RECORD OF BOREHOLE No P2														1 OF 1		METRIC	
W.P. 282-86-01		LOCATION N 4 860936.6 E 329984.7				ORIGINATED BY DK											
DIST 6 HWY 407		BOREHOLE TYPE S.S. Auger, Cone Test				COMPILED BY DK											
DATUM Geodetic		DATE 94 01 11 - 94 01 12				CHECKED BY BR											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80						100
205.3	Ground Surface																
204.3	Granular Fill																
0.8																	
	Very Stiff		1	SS	21												
	Hard																
	Heterogeneous Mixture of Clayey Silt, Trace Sand		2	SS	100												
	Trace Gravel																
	Occasional																
	Cobbles and Boulders																
	( Glacial Till )																
	Silty Sand with Gravel Very Dense																
192.9																	
12.4	End of Borehole																
	• Unstabilized water level measured upon completion of drilling on 94 01 12																

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



RECORD OF BOREHOLE No 3															1 OF 1		METRIC				
W.P. 69-65-02			LOCATION Sta. 37+87, 16 ft. lt. (Imperial units)										ORIGINATED BY VK								
DIST 6 HWY 7			BOREHOLE TYPE NX casing and washboring										COMPILED BY VK								
DATUM Geodetic			DATE 68 05 16										CHECKED BY MD								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES																
176.2	Ground Surface																				
0.0	Clayey Silt with Sand and a trace of Organic matter Grey, Firm		1	TW	-																3.29% Organic Content
175.1			2	SS	25																27 55 15 3
1.1			3	SS	44																51 43 (6)
	Sandy Gravel to		4	SS	84																
	Gravelly Sand with a		5	SS	157																
	Trace of Silt and Clay		6	SS	77																22 55 17 8
	Grey		7	SS	93																
	Compact to Very Dense		8	SS	154																
			9	SS	100																
			10	SS	100																
165.1																					
11.1	End of Borehole																				

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

RECORD OF BOREHOLE No P3															1 OF 1		METRIC				
W.P. 282-66-01			LOCATION N 4 862074.3 E 331845.5										ORIGINATED BY OK								
DIST 6 HWY 407			BOREHOLE TYPE S.S. Auger, Cone Test										COMPILED BY OK								
DATUM Geodetic			DATE 94 01 10 - 94 01 11										CHECKED BY BI								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES																
210.0	Ground Surface																				
0.0	50mm Asphalt over Granular Fill																				
0.5			1	SS	27																
			2	SS	30																
			3	SS	120																
			4	SS	100																
			5	SS	103																
			6	SS	100																
			7	SS	101																
			8	SS	100																
			9	SS	100																
			10	SS	100																
194.6																					
15.4	End of Borehole																				
	Borehole dry upon completion of drilling on 94 01 11																				

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

+3, x<sup>5</sup>: Numbers refer to Sensitivity

+  $\sigma_x \times \sigma_y$ : Numbers refer to Sensitivity



RECORD OF BOREHOLE No P6															1 OF 1		METRIC												
W.P. 282-86-01			LOCATION N 4 865235.6 E 337903.4			ORIGINATED BY DK																							
DIST 6 HWY 407			BOREHOLE TYPE H.S. Auger, Cone Test			COMPILED BY DK																							
DATUM Geodetic			DATE 94 01 05 - 94 01 07			CHECKED BY BI																							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES																								
167.1	Ground Surface																												
0.0	Clayey Silt, Trace Gravel Some Organic Inclusions Brown and Grey, Firm ( Fill )		1	SS	6																								
163.7			2	SS	17																								
3.4	Heterogeneous Mixture of Clayey Silt, Trace Gravel Some Sand layers, Grey Very Stiff to Hard ( Glacial Till )		3	SS	33																								
160.2			4	SS	30																								
5.9			5	SS	17																								
			6	SS	23																								
	Silty Sand		7	SS	34																								
	Trace Gravel		8	SS	20																								
	Grey, Compact to Dense		9	SS	37																								
151.4			10	SS	68																								
15.7	End of Borehole																												
	• Unstabilized water level measured upon completion of drilling on 94 01 07																												

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (X) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No P7															1 OF 1		METRIC												
W.P. 282-86-01			LOCATION N 4 865854.8 E 338570.2			ORIGINATED BY DK																							
DIST 6 HWY 407			BOREHOLE TYPE H.S. Auger, Cone Test			COMPILED BY DK																							
DATUM Geodetic			DATE 94 01 05			CHECKED BY BI																							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES																								
145.4	Ground Surface																												
0.0	Silty Sand, Trace Gravel Brown and Grey, Compact ( Fill )		1	SS	27																								
143.1			2	SS	8																								
2.3	Organics with Wood Fibres Black, Loose ( Peat )		3	SS	32																								
141.9			4	SS	4																								
3.5	Sand with Gravel, Trace Silt Grey, Dense ( Alluvial Deposit )		5	SS	6																								
140.1			6	SS	11																								
5.3	Silty Clay		7	SS	15																								
	Some silt zones		8	SS	4**																								
	Grey		9	SS	3**																								
	Soft to Stiff		10	SS	24																								
134.0			11	SS	17																								
11.4	Silty Sand		12	SS	8**																								
	Grey																												
	Compact																												
130.2																													
15.2	Silty Clay																												
	Grey, Very Stiff																												
127.8																													
17.5	Silty Sand, Grey, Compact																												
126.7	Occasional Silt Zones																												
18.7	End of Borehole																												
	• Unstabilized water level taken upon completion of drilling on 94 01 05																												
	** Unrepresentative blowcounts due to possible disturbance caused by unbalanced hydrostatic heads																												

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (X) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No P8 1 OF 1 METRIC

W.P. 282-86-01 LOCATION N 4 866905.5 E 340849.2 ORIGINATED BY DK  
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY DT  
DATUM Geodetic DATE 93 12 21 - 93 12 24 CHECKED BY BI

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES	20	40	60	80	100	W <sub>p</sub>	W <sub>L</sub>	W <sub>U</sub>	7
170.7	Ground Surface													
0.0	Granular Fill													
0.5	Very Stiff		1	SS	17									
	Hard		2	SS	31									
	Heterogeneous Mixture of Clay Silt, Trace Sand		3	SS	51									
	Trace Gravel, Occasional Cobbles and Boulders		4	SS	100									
	Brown				25cm									
	Grey		5	SS	45									
	( Glacial Till )													
	Some Sand Layers													
163.1			6	SS	100									
					23cm									
163.1			7	SS	33									
7.6	Silty Sand													
	Dense to Very Dense		8	SS	74									
	Brown and Grey													
160.0			9	SS	46									
10.7	Silt													
	Trace Clay, Some Sand		10	SS	91									
	Grey													
	Dense to Very Dense		11	SS	100									
					18cm									
	Silty Sand layer		12	SS	40									
	Becoming more Clayey		13	SS	100									
					23cm									
151.6			14	SS	100									
19.1			15	SS	76									
	Silty Clay													
	Grey, Hard		16	SS	48									
	( Lacustrine )													
			18	SS	70									
142.8			19	SS	58									
27.9	End of Borehole													
	• 93 12 24													

+3, x5: Numbers refer to  
Sensitivity 20  
15-5 (X) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No P9 1 OF 1 METRIC

W.P. 282-86-01 LOCATION N 4 867137.7 E 341645.3 ORIGINATED BY DK  
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY DT  
DATUM Geodetic DATE 93 12 20 - 93 12 21 CHECKED BY BI

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES	20	40	60	80	100	W <sub>p</sub>	W <sub>L</sub>	W <sub>U</sub>	7
181.1	Ground Surface													
0.0	Granular Fill													
0.5	Clayey Silt, Trace Gravel and Organics, Greenish Grey, Soft ( Fill )		1	SS	4									
179.6			2	SS	21									
1.5	Very Stiff													
	Hard		3	SS	88									
			4	SS	100									
					20cm									
	Heterogeneous Mixture of		5	SS	79									
	Clayey Silt, Trace Gravel		6	SS	65									
	Occasional Cobbles and		7	SS	64									
	Boulders, Grey		8	SS	66									
	( Glacial Till )		9	SS	43									
	Occasional Sand Layers		10	SS	61									
			11	SS	72									
			12	SS	100									
					28cm									
			13	SS	114									
					20cm									
			14	SS	122									
					25cm									
157.8			15	SS	120									
23.3	End of Borehole													
	• Unstabilized water table measured upon completion of drilling on 93 12 21													

+3, x5: Numbers refer to  
Sensitivity 20  
15-5 (X) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No P10															1 OF 1		METRIC	
W.P. 282-86-01			LOCATION N 4 867555.7 E 343258.4			ORIGINATED BY DK												
DIST 6 HWY 407			BOREHOLE TYPE H.S. Auger, Cone Test			COMPILED BY DT												
DATUM Geodetic			DATE 93 12 17 - 93 12 20			CHECKED BY BI												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20	40	60						80	100	WATER CONTENT (%)
191.4	Ground Surface																	
0.0 190.6	Granular Fill																	
0.8	Heterogeneous Mixture of Clayey Silt, Trace Gravel Occasional Sand Seams, Cobbles and Boulders, Hard ( Glacial Till )		1	SS	33													
			2	SS	82													
			3	SS	110													
			4	SS	110													
			5	SS	59													
184.4			6	SS	120													
7.0	Silty Sand with Gravel Grey, Very Dense		7	SS	100													
182.3			8	SS	100													
9.1	Heterogeneous Mixture of Silt, Sand and Gravel Occasional Sand Layers Grey, Very Dense ( Glacial Till )		9	SS	100													
179.2			10	SS	106													
12.2	Heterogeneous Mixture of Clayey Silt, Trace Gravel Occasional Sand Layers, Cobbles and Boulders Grey, Hard ( Glacial Till )		11	SS	138													
176.0			12	SS	170													
15.4	End of Borehole																	
+ 93 12 20																		

+ 3, x 5: Numbers refer to  
Sensitivity

20  
15-5 (x) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No P11															1 OF 1		METRIC	
W.P. 282-86-01			LOCATION N 4 867746.0 E 344497.0			ORIGINATED BY DK												
DIST 6 HWY 407			BOREHOLE TYPE H.S. Auger, Cone Test			COMPILED BY DT												
DATUM Geodetic			DATE 93 12 15 - 93 12 16			CHECKED BY BI												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20	40	60						80	100	WATER CONTENT (%)
167.2	Ground Surface																	
0.0 166.7	Asphalt and Granular Fill																	
0.3	Clayey Silt with Organic Inclusions, Firm, Brown ( Fill )		1	SS	6													
1.5			2	SS	14													
			3	SS	25													
			4	SS	52													
			5	SS	100													
			6	SS	100													
			7	SS	100													
			8	SS	110													
			9	SS	110													
			10	SS	115													
			11	SS	120													
			12	SS	110													
			13	SS	100													
			14	SS	115													
145.4																		
21.8	End of Borehole																	
+ 93 12 16																		

+ 3, x 5: Numbers refer to  
Sensitivity

20  
15-5 (x) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No P12 1 OF 1 METRIC

W.P. 282-86-01 LOCATION N 4 867570.7 E 346795.7 ORIGINATED BY DK  
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY DT  
DATUM Geodetic DATE 93 12 14 - 93 12 15 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
161.5	Ground Surface															
160.9	Granular Fill															
0.8	Heterogeneous Mixture of Clayey Silt, Trace Sand and Gravel	Brown	1	SS	26		180									
	Very Stiff to Hard	Grey	2	SS	33											
	( Glacial Till )		3	SS	21											
157.7			4	SS	25											
3.8			5	SS	36											
	Silty Sand		6	SS	5**											
	Grey		7	SS	6**											
	Loose		8	SS	24											
	Heterogeneous Mixture of Silt, Sand and Gravel		9	SS	120											
	Occasional Cobbles and Boulders				/23cm											
	Grey, Compact to Very Dense		10	SS	52											
	( Glacial Till )		11	SS	80											
	Trace Clay		12	SS	40											
			13	SS	54											
	Trace Clay		14	SS	113											
			15	SS	42											
	Some Sand Layers		16	SS	115											
					/23cm											
141.1			17	SS	120											
20.4	Heterogeneous Mixture of Clayey Silt, Trace Gravel															
	Occasional Cobbles and Boulders															
	Grey, Hard															
	( Glacial Till )															
136.9																
24.8	End of Borehole															
	* Unstabilized water level measured upon completion of drilling on 93 12 15															
	** Unrepresentative blowcounts due to possible disturbance caused by unbalanced hydraulic heads															

+3, x5: Numbers refer to  
Sensitivity

20

15-5 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No P13 1 OF 1 METRIC

W.P. 282-86-01 LOCATION N 4 867422.8 E 348100.7 ORIGINATED BY DK  
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY DT  
DATUM Geodetic DATE 93 12 13 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
158.8	Ground Surface															
0.0	Granular Fill															
0.5	Clayey Silt, Trace Sand, with Organic Inclusions ( Fill )		1	SS	9		158									
157.4	Heterogeneous Mixture of Clayey Silt, Gravel, Brown, Very Stiff		2	SS	20											
1.4			3	SS	37											
2.1	Brown, Dense Grey, Very Dense		4	SS	123											
	Heterogeneous Mixture of Silt, Sand and Gravel, Occasional Cobbles and Boulders		5	SS	120											
	( Glacial Till )		6	SS	103											
152.7			7	SS	112											
6.1	Heterogeneous Mixture of Clayey Silt, Trace Gravel		8	SS	120											
	Occasional Sand layers, Cobbles and Boulders, Grey, Hard		9	SS	120											
	( Glacial Till )		10	SS	120											
146.4			11	SS	120											
12.4	End of Borehole															
	* Unstabilized water level measured upon completion of drilling on 93 12 13															

+3, x5: Numbers refer to  
Sensitivity

20

15-5 (%) STRAIN AT FAILURE

10



# RECORD OF BOREHOLE No P14 1 OF 1 METRIC

W.P. 282-86-01 LOCATION N 4 867482.6 E 348937.8 ORIGINATED BY OK  
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, Cone Test, BW Casing COMPILED BY DT  
DATUM Geodetic DATE 93 12 06 - 93 12 10 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	10 20 30	WATER CONTENT (%)	7		
156.8	Ground Surface												
0.0	Granular Fill												
0.8	Clayey Silt, Trace Gravel Brown, Firm		1	SS	6								
1.5	Heterogeneous Mixture of Clayey Silt Trace Sand and Gravel		2	SS	30								
	Silt and Sand Occasional Cobbles and Boulders		3	SS	33								
	Grey, Dense		4	SS	39								
	Occasional Sand layers and Silt zones		5	SS	30								
	Brown, Hard ( Glacial Till )		6	SS	72								
	Grey		7	SS	100								
			8	SS	65								
145.4			9	SS	100								
11.4	Silty Sand with Gravel Occasional Cobbles and Boulders		10	SS	58								
	Grey, Very Dense		11	WS	-								
			12	SS	100								
			13	SS	113								
			14	WS	-								
136.2			15	SS	160								
20.6	Heterogeneous Mixture of Clayey Silt, Trace Sand & Gravel Grey, Hard ( Glacial Till )		16	SS	150								
133.8			17	SS	150								
23.0	End of Borehole												
	Unstabilized water level measured 1.5 hours after completion of drilling on 93 12 10												

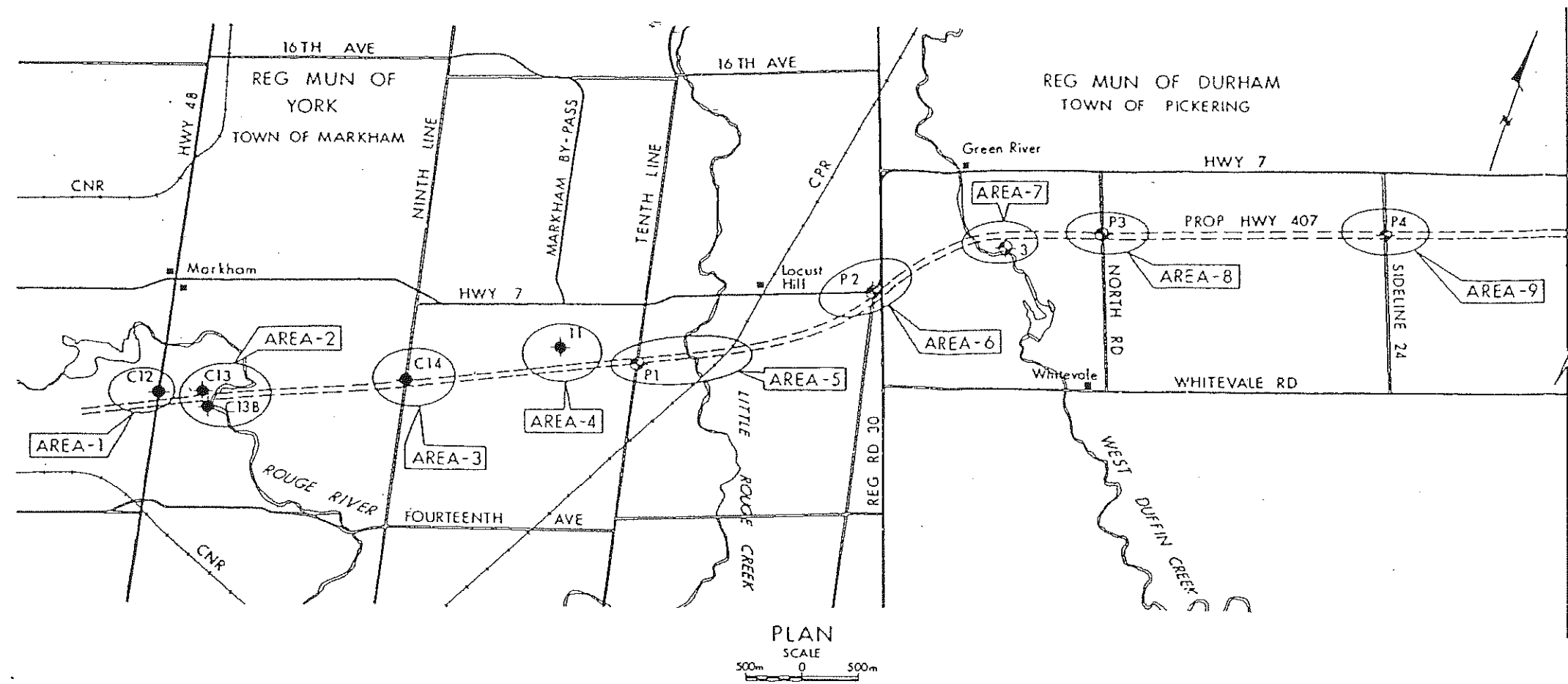
3, 5: Numbers refer to  
Sensitivity 20  
15-5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No P15 1 OF 1 METRIC

W.P. 282-86-01 LOCATION N 4 868335.2 E 350382.7 ORIGINATED BY OK  
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY DT  
DATUM Geodetic DATE 93 12 06 - 93 12 07 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	10 20 30	WATER CONTENT (%)	7		
172.2	Ground Surface												
0.0	Granular Fill												
0.8	Heterogeneous Mixture of Clayey Silt, Trace Sand & Gravel Occasional Sand layers, Cobbles and Boulders, Hard		1	SS	31								
			2	SS	38								
			3	SS	37								
			4	SS	48								
	Brown Grey		5	SS	40								
			6	SS	89								
			7	SS	70								
163.8			8	SS	71								
8.4	Heterogeneous Mixture of Silt, Sand and Gravel Occasional Cobbles and Boulders Grey, Very Dense		9	SS	58								
	Occasional Sandy and Gravelly layers		10	SS	50								
			11	SS	100								
			12	SS	110								
			13	SS	100								
155.2			14	SS	100								
17.0	End of Borehole												
	Unstabilized water level measured 5 hours after completion of drilling on 93 12 07												

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

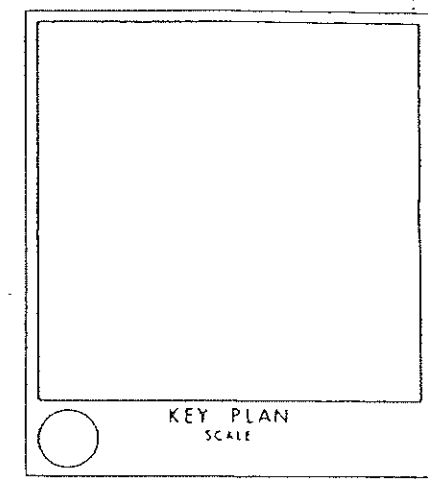


**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
IN KILOMETRES - METRES.

CONT No  
WP No 282-86-01

PROP HWY 407  
From  
HWY 48 TO WHITBY OSHAWA BOUNDARY  
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND			
●	Bore Hole		
⊕	Dynamic Cone Penetration Test (Cone)		
⊗	Bore Hole & Cone		
N	Blows/0.3m (Std Pen Test, 475 J/blow)		
CONE	Blows/0.3m (60' Cone, 475 J/blow)		
W.L.	W.L. at time of investigation 1968 05 1978 08, 1979 02, 1994 01		
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
P1	193.4	4 859 623.2	328 166.1
P2	205.3	4 860 936.6	329 984.7
P3	210.0	4 862 074.3	331 845.5
P4	215.6	4 862 825.5	334 219.0
C12	180.8	4 857 926.8	324 307.2
C13	178.7	4 858 121.9	324 633.3
C13B	178.6	4 858 048.7	324 727.8
C14	182.4	4 859 210.0	326 206.1
11	192.9	4 859 667.2	327 461.9
3	176.2		

AREA	BOREHOLE No	STRUCT REF No	DESCRIPTION
1	C12 [WP 90-78-00]	1	MARKHAM ROAD UNDERPASS
2	C13 C13B [WP 90-78-00]	2 3	ROUGE RIVER BRIDGE WBL ROUGE RIVER BRIDGE EBL
3	C14 [WP 90-78-00]	4	9TH LINE UNDERPASS
4	11 [WP 25-69-00]	5	N-S ARTERIAL ROAD UNDERPASS
5	P1	6 7 8 9 10 11	10TH LINE OVERPASS WBL 10TH LINE OVERPASS EBL CPR OVERHEAD WBL CPR OVERHEAD EBL LITTLE ROUGE RIVER BRIDGE WBL LITTLE ROUGE RIVER BRIDGE EBL
6	P2	20	REGIONAL ROAD 30 UNDERPASS
7	3 [WP 69-65-02]	21 22	WEST DUFFIN CREEK BRIDGE WBL WEST DUFFIN CREEK BRIDGE EBL
8	P3	23	NORTH ROAD UNDERPASS
9	P4	24	SIDELINE 24 UNDERPASS

NOTE  
For Soil details refer to  
Record of Borehole Sheets

NOTE  
The boundaries between soil strata have been established  
only at Bore Hole locations. Between Bore Holes the  
boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically included in accordance with the conditions of Section GC 2.01 of OPS Gen Con.

DATE	BY	DESCRIPTION

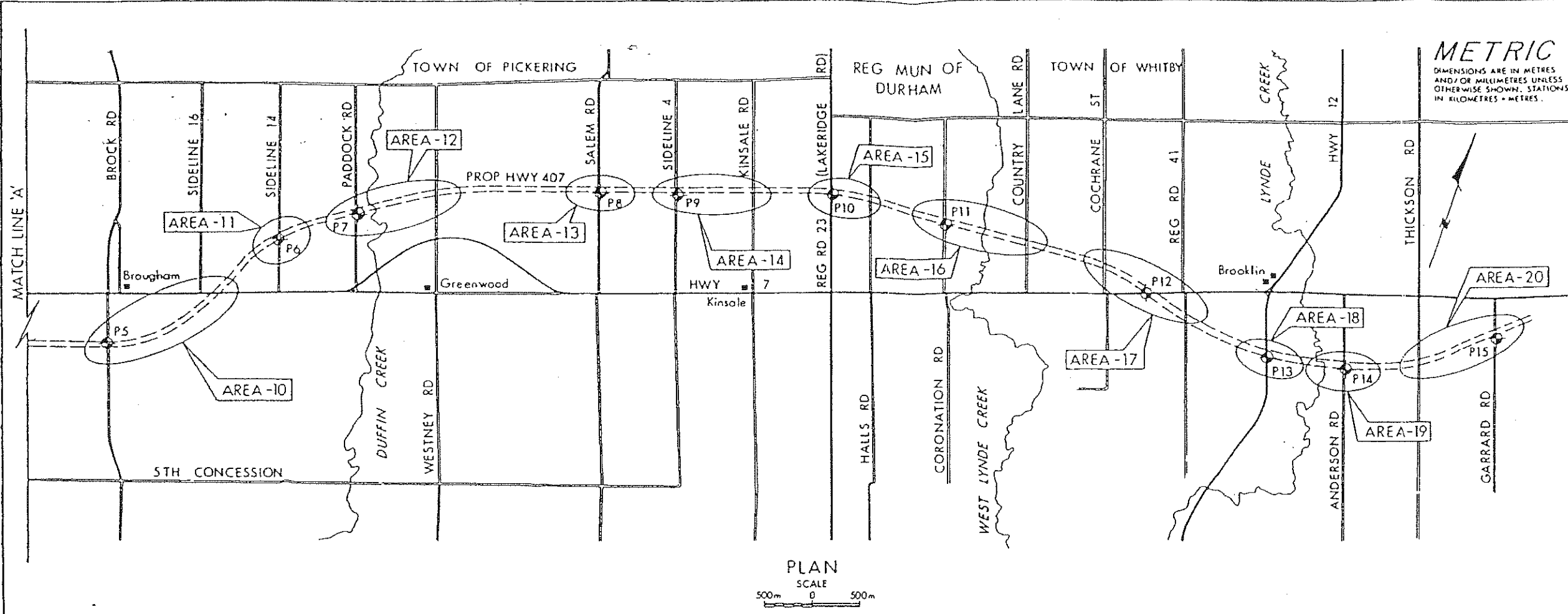
Geos No 30M14-277

HWY No 407	DIST 6
SUBMD DK [CHECKED]	DATE 1994 02 18
DRAWN DT [CHECKED AS]	10WG 2828601-





MINISTRY OF TRANSPORTATION, DURHAM, P.A.D.-107-1810



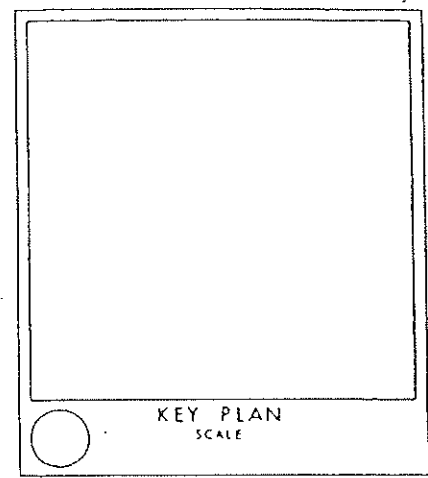
PLAN  
SCALE  
500m 0 500m

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

CONT No  
WP No 282-86-01

PROP HWY 407  
From  
HWY 48 TO WHITBY OSHAWA BOUNDARY  
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



- LEGEND**
- Bore Hole
  - ⊕ Dynamic Cone Penetration Test (Cone)
  - ⊙ Bore Hole & Cone
  - N Blows/0.3m (Std Pen Test, 475 J/blow)
  - CONE Blows/0.3m (60° Cone, 475 J/blow)
  - Wt at time of investigation  
1993 12 & 1994 01

NOTE  
For Soil details refer to  
Record of Borehole Sheets

AREA	BOREHOLE No	STRUCT REF No	DESCRIPTION
10	P5	25	BROCK ROAD UNDERPASS
		26	SIDELINE 16 UNDERPASS
		27	HWY 7 OVERPASS WBL
		28	HWY 7 OVERPASS EBL
		29 & 30	HWY 407/HWY 7 INTERCHANGE
11	P6	31 40 & 41	SIDELINE 14 UNDERPASS STRUCTURES AT SIDELINE 14 INTERCHANGE
12	P7	32	PADDOCK ROAD UNDERPASS
		33	EAST DUFFIN CREEK BRIDGE WBL
		34	EAST DUFFIN CREEK BRIDGE EBL
		35	WESTNEY ROAD UNDERPASS
13	P8	36	SALEM ROAD UNDERPASS
14	P9	37 38	SIDELINE 4 UNDERPASS KINSALE ROAD UNDERPASS
15	P10	39 50	REGIONAL ROAD 23 UNDERPASS HALLS ROAD UNDERPASS

AREA	BOREHOLE No	STRUCT REF No	DESCRIPTION
16	P11	51	CORONATION ROAD UNDERPASS
		52	WEST LYNDE CREEK WBL
		53	WEST LYNDE CREEK EBL
		54	COUNTRY LANE ROAD UNDERPASS
17	P12	55 56 57	COCHRANE STREET UNDERPASS HWY 7 UNDERPASS REGIONAL ROAD 41 UNDERPASS
18	P13	58	HWY 12 UNDERPASS
19	P14	59 60 61	LYNDE CREEK BRIDGE WBL LYNDE CREEK BRIDGE EBL ANDERSON ROAD UNDERPASS
20	P15	62 63	THICKSON ROAD UNDERPASS GARRARD ROAD UNDERPASS

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
P5	192.4	4 863 709.4	336 527.6
P6	167.1	4 865 235.6	337 903.4
P7	145.4	4 865 854.8	338 570.2
P8	170.7	4 866 905.5	340 849.2
P9	181.1	4 867 137.7	341 645.3
P10	191.4	4 867 555.7	343 258.4
P11	167.2	4 867 746.0	344 497.0
P12	161.5	4 867 670.7	346 795.7
P13	158.8	4 867 422.8	348 100.7
P14	156.8	4 867 482.6	348 937.8
P15	172.2	4 868 335.2	350 382.7

**NOTE**  
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 201 of OPS Gen Con



REV	DATE	BY	DESCRIPTION
1	1994 02 18	W.D. SWOK	Site
2	1994 02 18	W.D. SWOK	Dist

Geocres No 30M14-227

HWY No 407

SUBM'D OK [ ] CHECKED [ ] DATE 1994 02 18 SITE

DRAWN DT [ ] CHECKED [ ] DATE 1994 02 18 SITE

DWG 282 86 01

11/99

## FOUNDATION DESIGN SECTION

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 326-88-01 DIST 6  
HWY 407 STR SITE -

Feasibility Study for Hwy 407  
From Whitby/Oshawa Boundary to Hwy 35/115

foundation  
investigation and  
design report

1.2

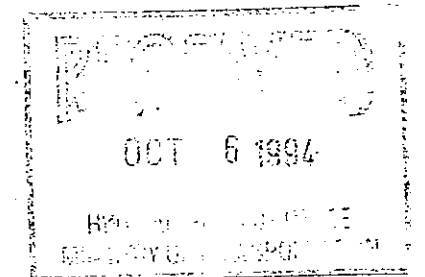
ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 326-88-01 DIST 6  
HWY 407 STR SITE -

Feasibility Study for Hwy 407  
From Whitby/Oshawa Boundary to Hwy 35/115

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FOUNDATION INVESTIGATION REPORT  
For  
Feasibility Study For Hwy 407  
From Whitby/Oshawa Boundary to Hwy 35/115  
W.P. 326-88-01, Central Region

---

2

## INTRODUCTION

This report summarizes the results of a foundation investigation for the preliminary design study of the proposed Hwy 407 from Whitby/Oshawa boundary easterly to Hwy 35/115 in the City of Oshawa and Newcastle, Region of Durham. The investigation was carried out at the request of Central Region Structural Section.

Several routes were proposed for Hwy 407 between Whitby/Oshawa boundary and Hwy 35/115. All proposed routes were within the City of Oshawa and Town of Newcastle, except for one northerly route which extended into the Township of Manvers. However, the technically preferred route, where this foundation investigation took place, was the most southerly one, within the City of Oshawa and Town of Newcastle in the Region of Durham. The proposed technically preferred route originates at the intersection of Winchester Road and Whitby/Oshawa boundary. From that point it runs in a southeast direction, intersects Conlin Road just east of Oshawa and Newcastle boundary and then runs more or less parallel to Concession Road 6 in a zigzag manner towards the east, until it intersects Regional Road No. 42. The proposed route then runs in a northeast direction and connects to Hwy 35/115 intersection. The details of the proposed technically preferred route and structures are illustrated on Drawing No. 3268801-A.

This Foundation investigation was intended for initial assessment of the feasibility of the proposed alignment from a foundation point of view, with a general coverage of the area by limited number of boreholes.

Before initiating the Foundation investigation, a Preliminary Geotechnical Conditions report by Geocon Inc., dated July 10, 1990 was reviewed by this office (Geocon Report T11547/53425, Highway 407 Route Planning and Environmental Assessment Study, Hwy 48 to Hwy 35-115).

## SITE DESCRIPTION

The site for the proposed Hwy 407 from Whitby/Oshawa boundary to Hwy 35/115 is located within the City of Oshawa and Town of Newcastle in the Region of Durham. Residential properties are primarily located along the major streets which the proposed highway would cross.

The existing ground elevation varies from 166.3m (BH P23) to 345.0m (east of BH P41, near Hwy 35/115 intersection). The proposed route is about 30.5 kilometre long (from station 9+500 to station 40+000). Between stations 31+000 and 40+000 the ground slopes down sharply from east to west at about 2.4 per cent slope (elevation drops from 345.0m to 163m). Further west of station 31+000 the ground surface is undulating, the slope ranges from 0.3 per cent to 2 per cent and the ground elevation varies from 155m and 225m.

Physiographically, the area is located in a region referred to as the "South Slope and Iroquois Plain" (Reference: Chapman and Putnam "The Physiography of Southern Ontario; 3rd Edition, 1984). This is the low land bordering Lake Ontario which was inundated in the Pleistocene time by Lake Iroquois. Subsoils in these areas generally are characterized by a mosaic of till plains, drumlins and areas of Glaciolacustrine deposits of silt, sand and clayey silt.

## INVESTIGATION PROCEDURES

The field work for the investigation was carried out between 94 05 25 and 94 05 30. The investigation consisted of twenty one (21) sampled boreholes (BH P21 through P41). In general, at least one borehole was put down at each proposed major interchange. The boreholes were advanced to depths of 9.3 (BH P29) to 16.9 (BH P26) <sup>meters</sup>.

The boreholes were advanced with three track mounted machines equipped with continuous flight augers. Conventional solid and hollow stem augers were used. The sampling program consisted of split spoon samples collected in the overburden. Soil samples were retrieved by split spoon sampler in accordance with Standard Penetration Test (ASTM D1586).

Standard Penetration 'N' values were recorded for assessment of the strength of the materials encountered. All subsoil samples were identified in the field and returned to the laboratory for further visual examination and testing. Groundwater levels were measured in each borehole and all boreholes were backfilled upon completion of the field work.

Surveying required to ascertain borehole locations and elevations was carried out by the Central Region Surveys and Plans Section.

### SUBSURFACE CONDITIONS

The record of Borehole sheets in the Appendix illustrate the subsurface conditions at the borehole locations. The location and elevation of the boreholes are shown on Drawing No. 3268801-A.

Since the investigation was spread over a large area of 30.5 kilometre (station 9+500 to 40+000), individual borehole logs should be referred to for information on soil conditions at any structure location. However, the predominant soil strata encountered at the site consisted of glacial till (made up primarily of silty clay to clayey silt and silt to silty sand). The surficial deposit at the site was generally a glacial till.

The Standard Penetration test in cohesive glacial till recorded 'N' values from 8 blows to more than 100 blows. Based on the 'N' values, the cohesive glacial till has a stiff to hard consistency. In non-cohesive glacial till the 'N' value ranged from 9 to more than 100 blows indicating the material to be loose to very dense.

### GROUNDWATER CONDITIONS

Individual boreholes should be referred to for groundwater elevation at any proposed structure locations. Groundwater level was recorded in all boreholes except for Boreholes P27, P28, P39, and P41 where either the boreholes remained dry or water level couldn't be measured due to borehole collapse. The groundwater table stabilized at depths ranging from 0.7m (BH P24) to 9.1m (BH P34) below ground surface. The groundwater elevation ranged from 157.7m (BH P23) to 252.6m (BH P40). Groundwater levels are subject to seasonal fluctuations and may vary from the values provided in this report.

## DISCUSSION AND RECOMMENDATIONS

### General

This report contains recommendations pertaining to the structure foundations, approach embankments, cuts and hydrogeological aspects for various structures for the proposed Hwy 407 from Whitby/Oshawa boundary easterly to Hwy 35/115 in the City of Oshawa and Newcastle, Region of Durham. The recommendations given in the report are tentative based on the limited information available and should definitely be reviewed based on supplementary investigations. The site location is shown on Drawing No. 3268801-A.

Total 66 bridge structures (Structure 3 through 68) are proposed along the proposed Hwy 407 from Whitby/Oshawa boundary easterly to Hwy 35/115 in the City of Oshawa and Newcastle, Region of Durham. This includes 22 watercourse structure sites (W), 28 grade separated structure sites (GS) and 16 interchange structure sites (I).

In general, the geotechnical conditions within the proposed route corridors are favourable. There are no foundation concerns that would require realignment of the proposed Hwy 407 route from Whitby/Oshawa boundary easterly to Hwy 35/115. Subsurface conditions over the site are uniform and competent for structure foundation and embankment loadings. The glacial till is expected to provide adequate bearing for most structures and may be able to sustain low to medium loads on shallow spread footings. However, deep foundations such as caissons and piles may be required to transfer heavier loads to greater depths and to more competent bearing material. Our comments from the feasibility, design and construction of the various structures are given on the Foundation Data Sheets included in the Appendix. Twenty one data sheets (Area 21 through 41) are provided for the 66 structures; the area locations are also shown on Drawing No. 3268801-A. An explanation of information provided on the data sheet is outlined below:

1. The structure number (i.e. 03, 04, 05 etc.) are the numbers assigned to the structures for the purpose of the feasibility study. The area number such as 21, 22, 23, etc is based on the borehole numbers P21, P22, P23, etc drilled in those areas. The actual location is shown on Drawing No. 3268801-A
2. The original ground elevation is based on the survey results of the borehole locations along the proposed Hwy 407 from Whitby/Oshawa boundary easterly to Hwy 35/115 in the City of Oshawa and Newcastle, Region of Durham.



3. The grades of roadway given is based on the proposed grades of proposed Hwy 407 at the respective sites, obtained from a profile of the Technically Preferred Route supplied to us (no reference no).
4. Subsurface conditions are described very briefly and are based on generally one borehole per area.

5. Structure Foundations

The recommendations are for pier and abutment foundations. The options for structure foundations are given in preferential order based on geotechnical/economical considerations. Further elaboration of structure recommendations made on the data sheets are given below:

Compacted Granular 'A' Core (Engineered Fill) - This option is generally for abutments where subsurface conditions are competent. The minimum requirements of a compacted granular 'A' core are shown on Figure No. 1 (attached). Furthermore, the footing for this scheme could be designed using the following parameters:

Factored Bearing Capacity at U.L.S. = 900 kPa  
 Bearing Capacity at S.L.S. Type II = 350 kPa

Spread Footings: This option is given for abutments and piers where subsurface conditions are competent. The highest elevation and corresponding maximum design load is given. It is to be noted the spread footing should be provided with a minimum of 1.2m of earth cover for frost protection purposes. In addition, where the spread footing is to be founded on a cohesive deposit, subject to softening upon exposure to construction or weather conditions, it would be necessary to protect the base of the footing excavation from softening by placing a working slab of lean concrete immediately upon completion of the footing excavation. Also, where the footing is located in a non cohesive deposit and the water table is at or above the footing founding level, it will be necessary to prevent the base of the footing from "boiling" due to an unbalanced excess hydrostatic head. In this case a dewatering scheme would be required.

End-Bearing Piles: This founding scheme is recommended for the abutments and piers where appropriate. The recommendation gives the estimated pile tip elevation. Generally, the end-bearing piles can be designed for the factored axial capacity at U.L.S. and the axial capacity at S.L.S. Type II which is dependent on the pile section chosen. The following design parameters are recommended for the pile foundation:

Pile Type	Factored Axial Capacity at U.L.S. (kN)	Axial Capacity at S.L.S. Type II (kN)
310X79	1150	900
310X110	1600	1150

It is generally assumed that steel 'H' piles will be used. Pile driving would be controlled by the Hiley Formula unless it is being driven to the bedrock surface or in clayey subsoil.

6. Approaches

The recommendation for fill slopes, cut slopes and berm requirements, are based on the proposed preliminary grades assuming fills are constructed of acceptable earth borrow according to current MTO Specifications. Any changes in profile grade would require a reassessment of these recommendations. Also, discussed under this heading is special treatment, i.e. benching, slope protection, etc., that is anticipated at this location. No excessive settlements of embankments at the proposed fill heights are anticipated at this stage.

7. Other Considerations

The granular 'A' or 'B' backfill should be in accordance with Special Provision. The following properties will be used for the calculation of lateral pressure:

Granular 'A'	$\gamma = 22.8 \text{ kN/m}^3$ , $\phi = 35^\circ$ , $K_o = 0.43$ , $K_a = 0.27$
Granular 'B'	$\gamma = 21.2 \text{ kN/m}^3$ , $\phi = 30^\circ$ , $K_o = 0.50$ , $K_a = 0.33$
Native Soil	$\gamma = 20.0 \text{ kN/m}^3$ , $\phi = 26^\circ$ , $K_o = 0.56$ , $K_a = 0.39$

If the structure is to be designed as a rigid frame then the coefficient of earth pressure at rest ( $K_0$ ) will be used.

All foundation elements should have a minimum of 1.2m earth cover for frost protection. The concrete for the footings should be placed 'in the dry'. Consequently a dewatering scheme will be required if the concrete is poured below the prevailing water level

#### 8. Remarks

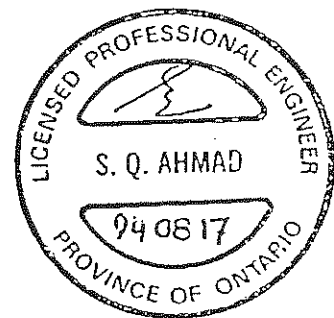
In this column comments are made about any construction difficulties, dewatering and hydrogeological concerns at any given site.

#### MISCELLANEOUS

The tentative foundation recommendations outlined in this report are for feasibility study or preliminary planning purposes only as they are based on very limited subsurface information. It will be necessary to carry out a detailed foundation investigation at each of the structure sites when the design details and geometries are finalized and approved. In some areas, groundwater studies and special in-situ field testing may be warranted.

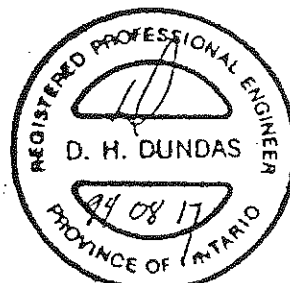
The field work for this investigation was carried out under the supervision of Todd Barlow, Lori O'Malley and Tanya Cross Engineering students, using equipment owned and operated by Master Soil Investigation and Atcost Soil Drilling.

The report was prepared by K.S.Q. Ahmad, P. Eng. Foundation Engineer and reviewed and approved by D. Dundas, P. Eng. Acting Chief Foundation Engineer.



*K.S.Q. Ahmad*

K.S.Q. Ahmad, P. Eng.  
Foundation Engineer



*D. Dundas*

D.H. Dundas, P. Eng.  
Chief Foundation Engineer (Acting)

## APPENDIX



# FOUNDATION DATA SHEETS

## FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 21 STRUCTURE Nos. 03-04-05-06 LOCATION Oshaw Creek Bridges, Thornton Road Overpasses

ORIGINAL GROUND ELEV. 172.0 m PROPOSED HWY 407 GRADE ELEV. 173.0 m, 177.0 m

Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> <u>P 21</u> 0.0 - 9.4 m Clayey Silt Hard (Glacial Till)	1.) For pier and abutments, spread footings placed within hard glacial till below elevation 171.0 m and below a frost depth of 1.2 m may be designed for: - Factored Bearing Capacity at U.L.S. = 500 kPa - Bearing Capacity at S.L.S. Type II = 300 kPa 2.) For foundations at higher elevations, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa 3.) Higher Bearing Capacities can be utilized at a lower depth below elevation 166.0 m.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated. 2.) No major dewatering problems are anticipated. 3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.
<u>Groundwater Elevation</u> 169.2 m			

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 22 STRUCTURE Nos. 07 LOCATION Simcoe Road Underpass  
ORIGINAL GROUND ELEV. 184.9 m PROPOSED HWY 407 GRADE ELEV. 182.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 22 0.0 - 5.5 m Clayey Silt Hard (Glacial Till)  5.5 - 12.6 m Silty Sand to Sandy Silt Dense to V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  181.8 m	1.) For abutments and piers, spread footings placed within hard glacial till below elevation 182.0 m and below a frost depth of 1.2 m may be designed for: <ul style="list-style-type: none"><li>- Factored Bearing Capacity at U.L.S. = 600 kPa</li><li>- Bearing Capacity at S.L.S. Type II = 400 kPa</li></ul> 2.) Higher Bearing Capacities can be utilized at a lower depth below elevation 176.0 m.	Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 23 STRUCTURE Nos. 08, 09, 10, 11 LOCATION Oshawa Creek Bridges, Ritson Road Overpasses  
ORIGINAL GROUND ELEV. 166.3 m PROPOSED HWY 407 GRADE ELEV. 177.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 23 0.0 - 5.5 m Silty Clay to Clayey Silt V. Stiff to Hard (Glacial Till)  5.5 - 9.6 m Silty Sand to Sandy Silt Dense to V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  157.7 m	1.) For pier and abutment foundations, spread footings can be placed on a well compacted granular 'A' pad designed for: <ul style="list-style-type: none"><li>- Factored Bearing Capacity at U.L.S. = 900 kPa</li><li>- Bearing Capacity at S.L.S. Type II = 350 kPa</li></ul> 2.) Piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.



FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 24 STRUCTURE Nos. 12,13,14 LOCATION Wilson Road, Harmony Road, Grandview Road Underpasses  
ORIGINAL GROUND ELEV. 203.2 m PROPOSED HWY 407 GRADE ELEV. 183.0 m, 200.0 m, 196.0 m, Respectively  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 24 0.0 - 9.6 m Clayey Silt Hard (Glacial Till)  <u>Groundwater Elevation</u>  202.5 m	1.) For pier and abutment foundations, spread footings placed within hard glacial till below elevation 200.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 800 kPa - Bearing Capacity at S.L.S. Type II = Not Governed	Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 25 STRUCTURE Nos. 15 LOCATION West Townline Road Underpass  
ORIGINAL GROUND ELEV. 212.3 m PROPOSED HWY 407 GRADE ELEV. 202.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 25 0.0 - 13.8 m Sandy Silt to Silt V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  211.9 m	1.) For abutment and pier foundations, spread footings placed within V. Dense glacial till below elevation 202.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 1000 kPa - Bearing Capacity at S.L.S. Type II = Not Governed	Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) Dewatering will be required for excavation below water table. Dewatering may be limited to oversize excavation.  3.) This is not a suitable site for an infiltration pond. Due to possible high water table after construction.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 26 STRUCTURE Nos. 16,17 LOCATION Conlin Road, Langmaid Road Underpasses  
ORIGINAL GROUND ELEV. 210.6 m PROPOSED HWY 407 GRADE ELEV. 198.0 m, 202.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 26 0.0 - 9.8 m Silty Sand to Sandy Silt V. Dense (Glacial Till)  9.8 - 16.9 m Clayey Silt Hard (Glacial Till)  <u>Groundwater Elevation</u> 203.6 m	1.) For abutment and pier foundations, spread footings placed within V. Dense or Hard glacial till below elevation 202.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 1000 kPa - Bearing Capacity at S.L.S. Type II = Not Governed	Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 27 STRUCTURE Nos. 18,19 LOCATION Regional Road 34 Overpasses  
ORIGINAL GROUND ELEV. 205.4 m PROPOSED HWY 407 GRADE ELEV. 213.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 27 0.0 - 9.6 m Silty Sand to Sandy Silt Dense to V. Dense (Glacial Till)  <u>Groundwater Elevation</u> Dry	1.) For pier foundations, spread footings placed within Dense to V. Dense glacial till below elevation 204.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 500 kPa - Bearing Capacity at S.L.S. Type II = 300 kPa  2.) For abutment foundations, spread footings can be placed on a well compacted granular 'A' pad designed for:  - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  3.) Higher bearing capacities can be utilized at a lower depth below elevation 202.0 m.  4.) Piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This may be a potential site for an infiltration pond, but should be verified by further investigation.



FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 28 STRUCTURE Nos. 20, 21 LOCATION Farewell Creek Bridge, Solina Road Underpass  
ORIGINAL GROUND ELEV. 211.1 m PROPOSED HWY 407 GRADE ELEV. 190.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 28 0.0 - 12.4 m Silty Sand to Sandy Silt V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  Hole Collapsed	1.) For pier and abutment, spread footings placed within V. Dense glacial till below elevation 190.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 1000 kPa - Bearing Capacity at S.L.S. Type II = Not Governed	Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 29 STRUCTURE Nos. 22, 23, 24 LOCATION Solina Road Underpass, Rundle Road Overpasses  
ORIGINAL GROUND ELEV. 188.5 m PROPOSED HWY 407 GRADE ELEV. 187.0 m, 184.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 29 0.0 - 4.9 m Silty Sand V. Dense  4.9 - 9.3 m Clayey Silt Hard (Glacial Till)  <u>Groundwater Elevation</u>  184.9 m	1.) For Abutment and pier, spread footings placed within V. Dense Silty Sand or Hard glacial till below elevation 187.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 1000 kPa - Bearing Capacity at S.L.S. Type II = Not Applicable  2.) Piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.  Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 30 STRUCTURE Nos. 25 LOCATION Holt Road Underpass  
ORIGINAL GROUND ELEV. 192.6 m PROPOSED HWY 407 GRADE ELEV. 182.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 30 0.0 - 12.3 m Silty Sand to Sandy Silt V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  186.5 m	1.) For abutment and pier, spread footings placed within V. Dense glacial till below elevation 182.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 1000 kPa - Bearing Capacity at S.L.S. Type II = Not Governed	Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 31 STRUCTURE Nos. 26, 27, 28, 29 LOCATION Bowmanville Creek Bridges, Old Scugog Road Overpass  
ORIGINAL GROUND ELEV. 174.4 m PROPOSED HWY 407 GRADE ELEV. 180.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 31 0.0 - 9.8 m Silty Clay to Clayey Silt V. Stiff to Hard (Glacial Till)  <u>Groundwater Elevation</u>  173.9 m	1.) For abutment and pier foundations, spread footings can be placed on a well compacted granular 'A' pad designed for:  - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  2.) Higher bearing capacities can be utilized at a lower depth below elevation 170.0 m.  3.) Piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.



FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 32 STRUCTURE Nos. 30, 31, 32, 33, 34, 35, 36, 37 LOCATION Regional Road 57, Cedar Park Road and Creek Structures  
ORIGINAL GROUND ELEV. 172.9 m PROPOSED HWY 407 GRADE ELEV. 182.0 m, 184.0 m, 187.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 32 0.0 - 9.6 m Silty Clay Firm to Hard  <u>Groundwater Elevation</u>  168.5 m	1.) For abutment and pier foundations, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  3.) For higher bearing capacities this structure can be supported on deep foundations. If deep foundations are considered, further investigation will be required.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 33 STRUCTURE Nos. 38, 39, 40, 41 LOCATION Middle Road and Creek East of Middle Road Structures  
ORIGINAL GROUND ELEV. 178.2 m PROPOSED HWY 407 GRADE ELEV. 187.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 33 0.0 - 2.4 m Silty Sand Loose  2.4 - 9.8 m Silty Clay to Clayey Silt V. Stiff to Hard (Glacial Till)  <u>Groundwater Elevation</u>  177.9 m	1.) For abutment and pier foundations, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  2.) For higher bearing capacity, piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability and the water table is high.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 34 STRUCTURE Nos. 42 LOCATION Regional Road 14 Underpass  
ORIGINAL GROUND ELEV. 188.4 m PROPOSED HWY 407 GRADE ELEV. 186.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 34 0.0 - 4.0 m Clayey Silt V. Stiff to Hard (Glacial Till)  4.0 - 7.0 m Silty Sand to Sandy Silt V. Dense (Glacial Till)  7.0 - 12.6 m Silty Clay to Clayey Silt V. Stiff to Hard (Glacial Till)  <u>Groundwater Elevation</u>  179.3 m	1.) For pier foundations, spread footings placed within V. Stiff to Hard glacial till below elevation 186.0 m and below frost depth of 1.2 m may be designed for: - Factored Bearing Capacity at U.L.S. = 650 kPa - Bearing Capacity at S.L.S. Type II = 400 kPa  2.) For abutment foundation, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  3.) Piles and caissons are also feasible, but should be selected on a cost comparison basis.	Cuts up to 6 m deep will be stable at 2 H : 1 V side slopes. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 35 STRUCTURE Nos. 43, 44, 45, 46, 47, 48 LOCATION Clemens Road, Mackie Creek and Bethesda Road Structures  
ORIGINAL GROUND ELEV. 184.4 m PROPOSED HWY 407 GRADE ELEV. 185.0 m, 189.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 35 0.0 - 9.8 m Silty Sand to Sandy Silt V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  182.0 m	1.) For pier foundations, spread footings placed within V. Dense glacial till below elevation 183.0 m and below frost depth of 1.2 m may be designed for: - Factored Bearing Capacity at U.L.S. = 750 kPa - Bearing Capacity at S.L.S. Type II = 500 kPa  2.) For abutment foundations, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  3.) For higher bearing capacities, piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.



FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 36 STRUCTURE Nos. 49, 50, 51, 52, 53 LOCATION Acres Road, Cole Road and Soper Creek Structures  
ORIGINAL GROUND ELEV. 171.9 m PROPOSED HWY 407 GRADE ELEV. 188.0 m, 180.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 36 0.0 - 9.6 m Silty Sand Compact to V. Dense (Glacial Till)  Groundwater Elevation 166.2 m	1.) For abutment and pier foundations, spread footings can be placed on a well compacted granular 'A' pad designed for:  - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  2.) Piles and caissons are also feasible, but should be selected on a cost comparison basis. If this option is selected, further investigation would be required.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This may be a potential site for an infiltration pond. Further investigation will be required to prove this site to be suitable for an infiltration pond.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 37 STRUCTURE Nos. 54, 55 LOCATION Darlington Town Line Road and Brown Road Structures  
ORIGINAL GROUND ELEV. 191.0 m PROPOSED HWY 407 GRADE ELEV. 187.0 m, 197.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 37 0.0 - 7.0 m Silty Sand to Sandy Silt V. Dense  7.0 - 10.8 m Clayey Silt Hard (Glacial Till)  Groundwater Elevation 184.0 m	1.) For pier and abutment foundations, spread footings placed within V. Dense glacial till below elevation 187.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 1000 kPa - Bearing Capacity at S.L.S. Type II = 500 kPa  2.) For pier and abutment foundations at higher elevations, spread footings can be placed on a well compacted granular 'A' pad designed for:  - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  3.) For Higher bearing capacities, piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.  Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This may be a potential site for an infiltration pond. The permeability of the soil is low to medium. Further study will be required to determine if the site is suitable for an infiltration pond.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 38 STRUCTURE Nos. 56, 57, 58, 59, 60, 61 LOCATION Mosport Road, Wilmot Creek and Leskard Road Structures  
ORIGINAL GROUND ELEV. 202.3 m PROPOSED HWY 407 GRADE ELEV. 204.0 m, 209.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 38 0.0 - 9.5 m Silty Sand Compact to V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  195.1 m	1.) For pier foundations, spread footings placed within Compact to V. Dense glacial till below elevation 201.0 m and below frost depth of 1.2 m may be designed for: - Factored Bearing Capacity at U.L.S. = 500 kPa - Bearing Capacity at S.L.S. Type II = 300 kPa  2.) For pier and abutment foundations, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  3.) For higher bearing capacities, piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This may be a potential site for an infiltration pond. Further investigation would be required to confirm this.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 39 STRUCTURE Nos. 62 LOCATION Best Road Structures  
ORIGINAL GROUND ELEV. 244.4 m PROPOSED HWY 407 GRADE ELEV. 238.5 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 32 0.0 - 12.3 m Silty Sand to Sandy Silt Compact to V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  Not Established	1.) For pier and abutment foundations, spread footings placed within Dense to V. Dense glacial till below elevation 238.0 m and below frost depth of 1.2 m may be designed for: - Factored Bearing Capacity at U.L.S. = 650 kPa - Bearing Capacity at S.L.S. Type II = 400 kPa  2.) Higher bearing capacities can be utilized at a lower depth below elevation 237.0 m.  3.) Piles and caissons are also feasible, but should be selected on a cost comparison basis.	Cuts up to 6 m deep will be stable at 2 H : 1 V side slopes. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) May be a candidate site for an infiltration pond. Further investigation will be required to prove this.



RECORD OF BOREHOLE No P21															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords.: N 4 868 931.8 E 351 038.5			ORIGINATED BY LO												
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem / Hollow Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 30			CHECKED BY KA												
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	20	40	60	80						100	20
172.0	Ground Surface																	
0.0	Clayey Silt Some Sand, Trace Gravel Hard (Glacial Till)		1	SS	31													
	Sandy Silt		2	SS	31													
			3	SS	41													
			4	SS	57													
			5	SS	104													
162.5			6	SS	120													
9.4	End of Borehole																	

+3, x<sup>5</sup>: Numbers refer to 20  
15-5 (X) STRAIN AT FAILURE

RECORD OF BOREHOLE No P23															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords.: N 4 869 724.6 E 354 258.5			ORIGINATED BY LO												
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 27			CHECKED BY KA												
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	20	40	60	80						100	20
166.3	Ground Surface																	
0.0																		
	Silty Clay to Clayey Silt Some Sand, Trace Gravel V. Stiff to Hard (Glacial Till)		1	SS	16													
			2	SS	52													
			3	SS	27													
160.8																		
5.5	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Dense to V. Dense (Glacial Till)		4	SS	76													
			5	SS	46													
156.7			6	SS	53													
9.8	End of Borehole																	

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

RECORD OF BOREHOLE No P22															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords.: N 4 869 896.0, E 352 482.8			ORIGINATED BY LO												
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem / Hollow Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 26			CHECKED BY KA												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W <sub>L</sub>	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20	40	60	80						100	20
184.9	Ground Surface																	
0.0	Clayey Silt Some Sand, Trace Gravel Hard (Glacial Till)		1	SS	74													
			2	SS	100													
179.4			3	SS	39													
5.5	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Dense to V. Dense (Glacial Till)		4	SS	41													
			5	SS	108													
172.3			6	SS	100													
12.6	End of Borehole		7	SS	101													

+3, 5 Numbers refer to 20  
15-6.5 (x) STRAIN AT FAILURE

RECORD OF BOREHOLE No P24															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords.: N 4 869 574.1, E 356 028.6			ORIGINATED BY LO												
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 27			CHECKED BY KA												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W <sub>L</sub>	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20	40	60	80						100	20
203.2	Ground Surface																	
0.0	Clayey Silt Some Sand, Trace Gravel Hard (Glacial Till)		1	SS	44													
			2	SS	78													
			3	SS	120													
			4	SS	85													
			5	SS	104													
193.6			6	SS	105													
9.8	End of Borehole																	

+3, 5 Numbers refer to 20  
15-6.5 (x) STRAIN AT FAILURE



RECORD OF BOREHOLE No P25															1 OF 1		METRIC												
W.P. 326-88-01			LOCATION Coords.: N 4 869 427.6, 357 821.1			ORIGINATED BY LO																							
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO																							
DATUM Geodetic			DATE 1994 05 25			CHECKED BY KA																							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20	40	60	80	100	20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>	7	GR	SA	SI	CL				
213.2	Ground Surface																												
0.0																													
	Sandy Silt to Silt Trace Clay, Trace Gravel V. Dense (Glacial Till)		1	SS	58																								
			2	SS	150	/8cm																							
			3	SS	150	/8cm																							
			4	SS	150	/18cm																							
			5	SS	111																								
199.3			6	SS	150	/10cm																							
13.8	End of Borehole																												

+3, x 5 Numbers refer to 20  
15-0-5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No P26															1 OF 1		METRIC												
W.P. 326-88-01			LOCATION Coords.: N 4 869 399.7, E 359 124.9			ORIGINATED BY LO																							
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO																							
DATUM Geodetic			DATE 1994 05 25			CHECKED BY KA																							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20	40	60	80	100	20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>	7	GR	SA	SI	CL				
210.8	Ground Surface																												
0.0																													
	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel V. Dense (Glacial Till)		1	SS	135																								
			2	SS	150																								
			3	SS	138																								
			4	SS	150	/15cm																							
200.8			5	SS	150	/18cm																							
9.6			6	SS	150	/18cm																							
	Clayey Silt Some Sand, Some Gravel Hard (Glacial Till)		7	SS	138																								
			8	SS	150	/15cm																							
			9	SS	150	/15cm																							
193.6																													
16.9	End of Borehole																												

+3, x 5 Numbers refer to 20  
15-0-5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No P27															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords.: N 4 869 259.2, E 360 032.5			ORIGINATED BY LO												
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem / Hollow Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 30			CHECKED BY KA												
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 (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	SHEAR STRENGTH kPa										
							20 40 60 80 100 • UNCONFINED + FIELD VANE • QUICK TRIAXIAL * LAB VANE 20 40 60 80 100											
205.4	Ground Surface																	
0.0	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Dense to V. Dense (Glacial Till)		1	SS	33													
			2	SS	105													
			3	SS	150	/27cm												
			4	SS	89													
			5	SS	70													
195.8			6	SS	116													
9.6	End of Borehole																	

RECORD OF BOREHOLE No P28															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords.: N 4 869 551.5, E 361 241.7			ORIGINATED BY IC												
DIST 6 HWY 407			BOREHOLE TYPE Hollow Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 25			CHECKED BY KA												
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 (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	SHEAR STRENGTH kPa										
							20 40 60 80 100 • UNCONFINED + FIELD VANE • QUICK TRIAXIAL * LAB VANE 20 40 60 80 100											
211.1	Ground Surface																	
0.0	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel V. Dense (Glacial Till)		1	SS	107													
			2	SS	96	/15cm												
			3	SS	150	/20cm												
			4	SS	120													
			5	SS	130	/18cm												
198.7			5	SS	130	/18cm												
12.4	End of Borehole																	
	Unable to Measure Ground Water Due to the Hole Collapsing																	



RECORD OF BOREHOLE No P29															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords: N 4 869 697.3, E 362 491.2			ORIGINATED BY IC												
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 26			CHECKED BY KA												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES	20	40	60						80	100	SHEAR STRENGTH kPa
188.5	Ground Surface																	
0.0	Silty Sand Trace of Clay, Trace of Gravel V. Dense		1	SS	185													
183.6																		
4.9	Clayey Silt Some Sand, Trace Gravel Hard (Glacial Till)		2	SS	189													
			3	SS	140													
179.2			4	SS	128													
9.3	End of Borehole																	

±3 x 5: Numbers refer to 20  
15-25 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No P30															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords: N 4 870 650.8, E 363 911.5			ORIGINATED BY IC												
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 26			CHECKED BY KA												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES	20	40	60						80	100	SHEAR STRENGTH kPa
192.8	Ground Surface																	
0.0																		
			1	SS	120	/15cm												
			2	SS	120													
	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Pockets of Gravelly Sand V. Dense (Glacial Till)																	
			3	SS	90	/15cm												
			4	SS	160	/15cm												
180.3			5	SS	152	/15cm												
12.3	End of Borehole																	

±3 x 5: Numbers refer to 20  
15-25 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No P31															1 OF 1		METRIC	
W.P. 326-88-01		LOCATION Coords.: N 4 871 079.4 E 364 649.2				ORIGINATED BY TC												
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem				COMPILED BY LO												
DATUM Geodetic		DATE 1994 05 27				CHECKED BY KA												
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
						20 40 60 80 100					10 20 30							
						• UNCONFINED + FIELD VANE												
						• QUICK TRIAXIAL * LAB VANE												
						20 40 60 80 100												
174.4	Ground Surface																	
0.0																		
	Silty Clay to Clayey Silt Some Sand, Trace Gravel V. Stiff to Hard (Glacial Till)		1	SS	25													
			2	SS	42													
			3	SS	55													
			4	SS	55													
	Locustrine		5	SS	128													
164.8			6	SS	122													
9.6	End of Borehole																	

RECORD OF BOREHOLE No P32															1 OF 1		METRIC	
W.P. 326-88-01		LOCATION Coords.: N 4 871 347.3 E 365 431.0				ORIGINATED BY TC												
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem				COMPILED BY LO												
DATUM Geodetic		DATE 1994 05 30				CHECKED BY KA												
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
						20 40 60 80 100					10 20 30							
						• UNCONFINED + FIELD VANE												
						• QUICK TRIAXIAL * LAB VANE												
						20 40 60 80 100												
172.9	Ground Surface																	
0.0																		
	Silty Clay Trace of Sand, Trace of Gravel		1	SS	19													
			2	SS	43													
			3	SS	13													
	Stiff to Hard		4	SS	6													
	Firm		5	SS	5													
			6	SS	8													
163.3																		
9.6	End of Borehole																	



RECORD OF BOREHOLE No P33															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION			Coords.: N 4 871 673.1, E 367 022.7			ORIGINATED BY IC & VB									
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem						COMPILED BY LO									
DATUM Geodetic			DATE 1994 05 27						CHECKED BY KA									
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)	
178.2	Ground Surface																	
0.0	Silty Sand Trace of Clay, With Some Gravel (Glacial Till)		1	SS	9													
175.8																		
2.4			2	SS	47													
	Silty Clay to Clayey Silt Some Sand, Trace Gravel V. Stiff to Hard (Glacial Till)		3	SS	37													
			4	SS	23													
			5	SS	36													
168.6			6	SS	21													
9.8	End of Borehole																	

RECORD OF BOREHOLE No P34															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION			Coords.: N 4 871 786.0, E 367 844.0			ORIGINATED BY TG									
DIST 6 HWY 407			BOREHOLE TYPE Hollow Stem						COMPILED BY LO									
DATUM Geodetic			DATE 1994 05 30						CHECKED BY KA									
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)	
188.4	Ground Surface																	
0.0	Clayey Silt Some Sand, Trace of Gravel V. Stiff to Hard (Glacial Till)		1	SS	19													
			2	SS	41													
184.4																		
4.0	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel V. Dense (Glacial Till)		3	SS	55													
			4	SS	90													
181.4																		
7.0	Silty Clay to Clayey Silt Some Sand, Trace of Gravel V. Stiff to Hard (Glacial Till)		5	SS	38													
			6	SS	29													
			7	SS	42													
175.8			8	SS	164													
12.6	End of Borehole																	

RECORD OF BOREHOLE No P35															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords.: N 4 872 244.1, E 369 422.3			ORIGINATED BY TB												
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 25			CHECKED BY KA												
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										
184.4	Ground Surface						20	40	60	80	100							
0.0	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel V. Dense (Glacial Till)		1	SS	66													
			2	SS	77													
			3	SS	81													
			4	SS	83													
			5	SS	152													
174.8			6	SS	125													
9.6	End of Borehole																	

+3, x5: Numbers refer to 20  
15-5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No P36															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords.: N 4 873 130.2, E 370 875.9			ORIGINATED BY TB												
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 25			CHECKED BY KA												
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										
171.9	Ground Surface						20	40	60	80	100							
0.0	Silty Sand Trace of Clay, Trace of Gravel Compact to V. Dense (Glacial Till)		1	SS	18													
			2	SS	48													
			3	SS	63													
			4	SS	63													
			5	SS	26													
162.3			6	SS	20													
9.6	End of Borehole																	

+3, x5: Numbers refer to 20  
15-5 (%) STRAIN AT FAILURE



w. r. H. z. m. k. m. s. t. s. f. a. c. t. s. 20

+3, x 5: Numbers refer to  $\frac{20}{15-0.5}$  (X) STRAIN AT FAILURE

RECORD OF BOREHOLE No P39																			
1 OF 1										METRIC									
W.P. 326-88-01					LOCATION Coords.: N 4 875 662.9 E 374 279.7					ORIGINATED BY TB									
DIST 6 HWY 407					BOREHOLE TYPE Solid Stem					COMPILED BY LO									
DATUM Geodetic					DATE 1994 05 30					CHECKED BY KA									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)							
								20	40	60	80	100							
								20	40	60	80	100							
244.4	Ground Surface																		
0.0																			
	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Occasional Layers of Gravelly Sand Compact to V. Dense (Glacial Till)		1	SS	18														
			2	SS	37														
			3	SS	120														
			4	SS	99														
	Sandy Gravel		5	SS	120														
232.0			6	SS	123														
12.3	End of Borehole																		
	Ground Water Not Established																		

RECORD OF BOREHOLE No P40																			
1 OF 1										METRIC									
W.P. 326-88-01					LOCATION Coords.: N 4 876 521.2 E 374 481.4					ORIGINATED BY TB									
DIST 6 HWY 407					BOREHOLE TYPE Solid Stem					COMPILED BY LO									
DATUM Geodetic					DATE 1994 05 26					CHECKED BY KA									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)							
								20	40	60	80	100							
								20	40	60	80	100							
255.9	Ground Surface																		
0.0																			
	Clayey Silt Some Sand, Traces of Gravel Silt (Glacial Till)		1	SS	11														
			2	SS	8														
252.0			3	SS	49														
4.0			4	SS	94														
	Silt to Silty Sand V. Dense		5	SS	25														
			6	SS	57														
246.3																			
9.6	End of Borehole																		



RECORD OF BOREHOLE No P41 1 OF 1 METRIC																	
W.P. 326-88-01		LOCATION Coords: N 4 878 682.4, E 374 562.7					ORIGINATED BY TB										
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem					COMPILED BY LO										
DATUM Geodetic		DATE 1994 05 30					CHECKED BY KA										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa									
								20	40	60	80	100					
319.0	Ground Surface																
0.0	Silty Clay to Clayey Silt Some Sand, Traces of Gravel V. Silt to Hard		1	SS	26												
			2	SS	17												
	Silty Sand		3	SS	24												
313.6			4	SS	49												
5.5	Silt to Silty Sand V. Dense		5	SS	46												
			6	SS	144												
309.4																	
9.8	End of Borehole																
	• Ground Water Not Established																

+3, x5: Numbers refer to 20  
15-5 (%) STRAIN AT FAILURE

## EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS  $\bar{N}$ .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON "A" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$c_u$ (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

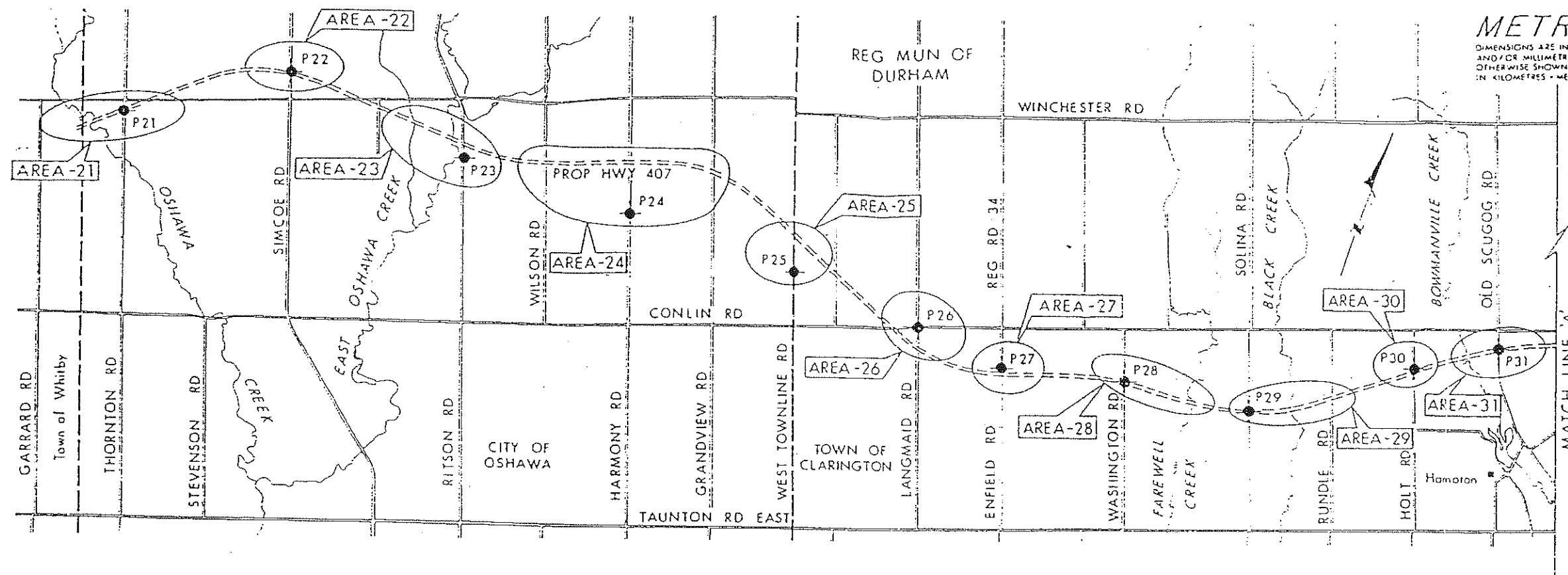
SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING			MECHANICAL PROPERTIES OF SOIL		
S S	SPLIT SPOON	T P	THINWALL PISTON	$m_v$	$kPa^{-1}$ COEFFICIENT OF VOLUME CHANGE
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE	$C_c$	1 COMPRESSION INDEX
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE	$C_s$	1 SWELLING INDEX
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY	$C_a$	1 RATE OF SECONDARY CONSOLIDATION
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY	$c_v$	$m^2/s$ COEFFICIENT OF CONSOLIDATION
T W	THINWALL OPEN	F S	FOIL SAMPLE	H	m DRAINAGE PATH
STRESS AND STRAIN			$T_v$	1	TIME FACTOR
$u_w$	kPa		U	%	DEGREE OF CONSOLIDATION
$l_u$	1		$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma$	kPa		$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\sigma'$	kPa		$T_f$	kPa	SHEAR STRENGTH
$\tau$	kPa		$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\sigma_1, \sigma_2, \sigma_3$	kPa		$\phi'$	°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$\epsilon$	%		$c_u$	kPa	APPARENT COHESION INTERCEPT
$\epsilon_1, \epsilon_2, \epsilon_3$	%		$\phi_u$	°	APPARENT ANGLE OF INTERNAL FRICTION
E	kPa		$\tau_r$	kPa	RESIDUAL SHEAR STRENGTH
G	kPa		$\tau_f$	kPa	REMOULDED SHEAR STRENGTH
$\mu$	1		$S_l$	1	SENSITIVITY = $\frac{c_u}{\tau_f}$

## PHYSICAL PROPERTIES OF SOIL

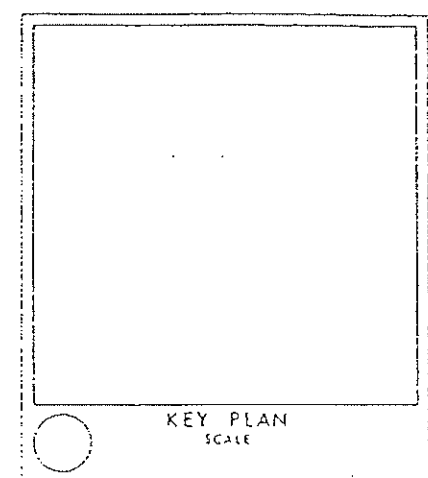
$\rho_s$	$kg/m^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$kN/m^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	$kg/m^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$kN/m^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$kg/m^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$kN/m^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$kg/m^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$m^3/s$	RATE OF DISCHARGE
$\gamma_d$	$kN/m^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	$kg/m^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	$kN/m^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$kg/m^3$	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$kN/m^2$	SEEPAGE FORCE
$\gamma'$	$kN/m^3$	UNIT WEIGHT OF SUBMERGED SOIL						



PLAN  
SCALE  
500m 0 500m

NOTE  
For Soil Details Refer to  
Record of Borehole Sheets

CONT No  
WP No 326-88-01  
FEASIBILITY STUDY FOR HWY 407  
FROM WHITBY/OSHAWA BOUNDARY  
TO HWY 35/115  
BORE HOLE LOCATIONS & SOIL STRATA



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blow/0.3m (Std Pen Test, 475 lb/blow)
- CONE Blow/0.3m (60° Cone, 475 lb/blow)
- WL at time of investigation 1994 Q3

AREA	BOREHOLE No	STRUCT REF No	DESCRIPTION
21	P21	3	OSHAWA CREEK BRIDGE WBL (W)
		4	OSHAWA CREEK BRIDGE EBL (W)
		5	THORNTON RD OVERPASS WBL (I)
		6	THORNTON RD OVERPASS EBL (I)
22	P22	7	SIMCOE RD UNDERPASS (I)
23	P23	8	EAST OSHAWA CREEK BRIDGE WBL (W)
		9	EAST OSHAWA CREEK BRIDGE EBL (W)
		10	RITSON RD OVERPASS - ALT A (GS)
		11	RITSON RD OVERPASS - ALT A (GS)
24	P24	12	WILSON RD UNDERPASS - ALT A (GS)
		13	HARMONY RD UNDERPASS - ALT A (I)
		14	GRANDVIEW RD UNDERPASS - ALT A (GS)
25	P25	15	WEST TOWNLINE RD UNDERPASS - ALT A (I)
26	P26	16	CONLIN RD UNDERPASS - ALT A (GS)
		17	LANGMAID RD UNDERPASS - ALT A (GS)

LEGEND

- W - WATERCOURSE STRUCTURE SITES
- GS - GRADE SEPARATED STRUCTURE SITES
- I - INTERCHANGE STRUCTURE SITES

AREA	BOREHOLE No	STRUCT REF No	DESCRIPTION
27	P27	18	REGIONAL RD 34 OVERPASS WBL - ALT A (I)
		19	REGIONAL RD 34 OVERPASS EBL - ALT A (I)
28	P28	20	FAREWELL CREEK BRIDGE WBL (W)
		21	FAREWELL CREEK BRIDGE EBL (W)
29	P29	22	SOLINA RD UNDERPASS (GS)
		23	RUNDLE RD OVERPASS WBL (I)
		24	RUNDLE RD OVERPASS EBL (I)
30	P30	25	HOLT RD UNDERPASS (GS)
31	P31	26	BOWMANVILLE CREEK BRIDGE WBL (W)
		27	BOWMANVILLE CREEK BRIDGE EBL (W)
		28	OLD SCUGOG RD OVERPASS WBL (GS)
		29	OLD SCUGOG RD OVERPASS EBL (GS)

No	ELEVATION	CO-ORDINATES NORTH	EAST
P21	172.0	4 268 931.8	351 035.5
P22	184.9	4 809 896.0	352 432.8
P23	166.5	4 869 724.0	354 153.5
P24	203.2	4 869 571.1	356 028.0
P25	213.2	4 869 427.6	357 821.1
P26	210.6	4 869 399.7	359 124.3
P27	205.4	4 869 259.2	360 032.5
P28	211.1	4 869 551.5	361 241.7
P29	188.5	4 869 297.3	362 491.2
P30	192.6	4 870 650.8	363 911.5
P31	174.4	4 871 079.4	364 649.2

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically included in accordance with the conditions of Section GC 2.01 of GPS Gen Cons.

DATE	BY	DESCRIPTION
1994 08 08	1994 08 08	1994 08 08

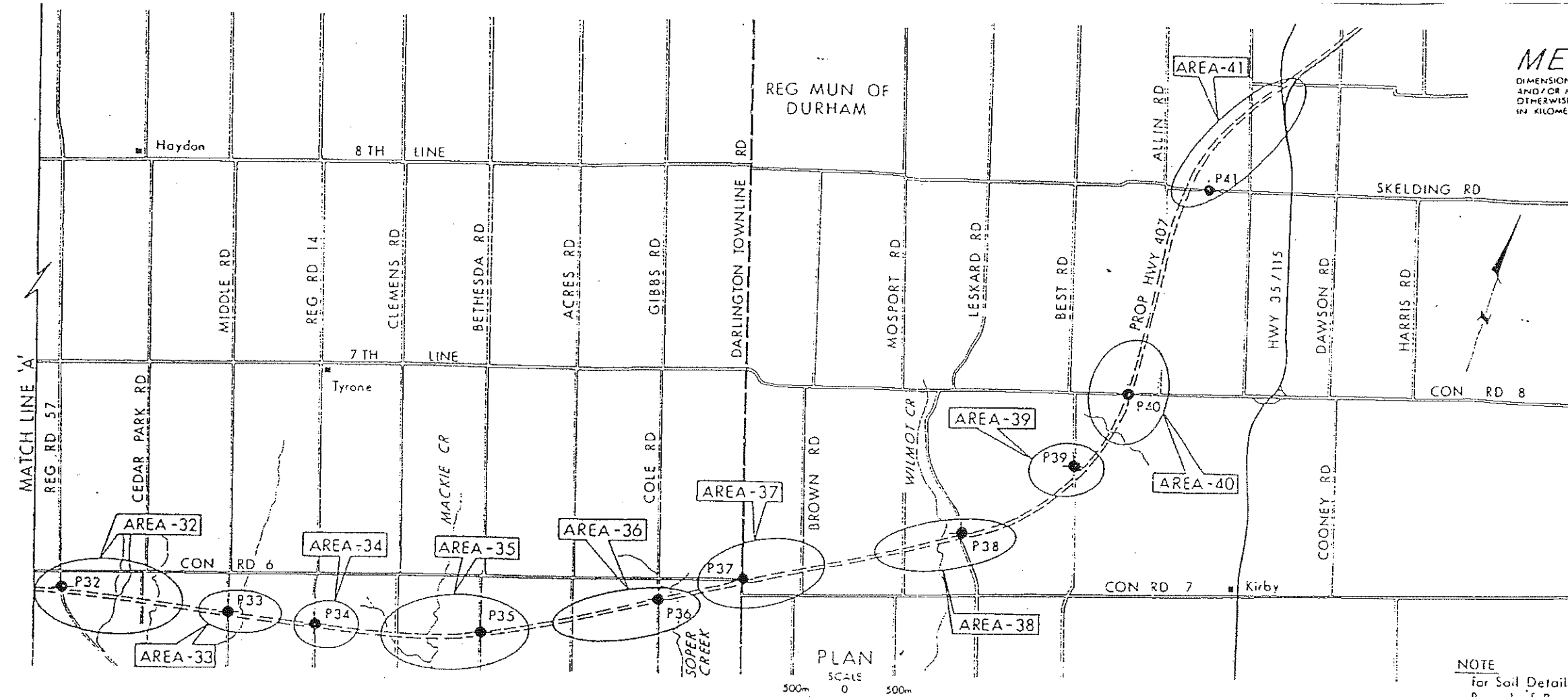
Geocres No 30M15-35

HWY No 407 DIST 0

SUBWD 4A CHECKED DATE 1994 08 08 SITE

DRAWN DT CHECKED DATE 1994 08 08 DWG 3268801-2





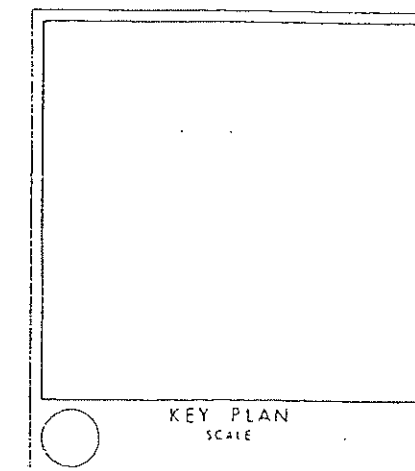
**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
IN KILOMETRES - METRES.

CONT No  
WP No 326-88-01

FEASIBILITY STUDY FOR HWY 407  
FROM WHITBY/OSHAWA BOUNDARY  
TO HWY 15/115  
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND				
•	Bore Hole			
⊕	Dynamic Cone Penetration Test (Cone)			
⊗	Bore Hole & Cone			
N	Blows/0.3m (Sra Pen Test, 475 J/blow)			
CONE	Blows/0.3m (60° Cone, 475 J/blow)			
±	WL at time of investigation 1994 GS			

NOTE  
For Soil Details Refer to  
Record of Borehole Sheets

AREA	BOREHOLE No	STRUCT REF No	DESCRIPTION
32	P32	30	REGIONAL RD 57 OVERPASS WBL (I)
		31	REGIONAL RD 57 OVERPASS EBL (I)
		32	CREEK EAST OF REG RD 57 BRIDGE WBL (W)
		33	CREEK EAST OF REG RD 57 BRIDGE EBL (W)
		34	CEDAR PARK RD OVERPASS WBL (GS)
		35	CEDAR PARK RD OVERPASS EBL (GS)
		36	CREEK EAST OF CEDAR PARK RD BRIDGE WBL (W)
33	P33	37	CREEK EAST OF CEDAR PARK RD BRIDGE EBL (W)
		38	MIDDLE RD OVERPASS WBL (GS)
		39	MIDDLE RD OVERPASS EBL (GS)
		40	CREEK EAST OF MIDDLE RD BRIDGE WBL (W)
34	P34	41	CREEK EAST OF MIDDLE RD BRIDGE EBL (W)
		42	REGIONAL RD 14 UNDERPASS (I)
35	P35	43	CLEMENS RD OVERPASS WBL (GS)
		44	CLEMENS RD OVERPASS EBL (GS)
		45	MACKIE CREEK BRIDGE WBL (W)
		46	MACKIE CREEK BRIDGE EBL (W)
		47	BETHESDA RD OVERPASS WBL (I)
		48	BETHESDA RD OVERPASS EBL (I)

**LEGEND**

W - WATERCOURSE STRUCTURE SITES  
GS - GRADE SEPARATED STRUCTURE SITES  
I - INTERCHANGE STRUCTURE SITES

AREA	BOREHOLE No	STRUCT REF No	DESCRIPTION
36	P36	49	ACRES RD UNDERPASS (GS)
		50	COLE RD OVERPASS WBL (GS)
		51	COLE RD OVERPASS EBL (GS)
		52	SOPER CREEK BRIDGE WBL (W)
37	P37	53	SOPER CREEK BRIDGE EBL (W)
		54	DARLINGTON TOWNLINE RD U'PASS (I)
		55	BROWN RD UNDERPASS (GS)
38	P38	56	MOSPORT RD OVERPASS WBL (GS)
		57	MOSPORT RD OVERPASS EBL (GS)
		58	WILMOT CREEK BRIDGE WBL (W)
		59	WILMOT CREEK BRIDGE EBL (W)
		60	LESKARD RD OVERPASS WBL (GS)
		61	LESKARD RD OVERPASS EBL (GS)
39	P39	62	BEST RD UNDERPASS (GS)
40	P40	63	CREEK EAST OF BEST RD BRIDGE WBL (W)
		64	CREEK EAST OF BEST RD BRIDGE EBL (W)
		65	CON RD 8 OVERPASS WBL (GS)
41	P41	66	CON RD 8 OVERPASS EBL (GS)
		67	SKELDING RD UNDERPASS (GS)
		68	HWY 35/115 UNDERPASS (I)

No	ELEVATION	CO-ORDINATES NORTH	EAST
P32	172.9	4 871 147.3	3 65 431.0
P33	178.2	4 871 673.1	3 67 022.7
P34	188.4	4 871 780.0	3 67 824.0
P35	184.4	4 872 244.1	3 69 422.3
P36	171.9	4 873 130.2	3 70 875.9
P37	191.0	4 873 565.4	3 71 610.1
P38	202.3	4 874 706.1	3 73 460.3
P39	244.4	4 875 662.9	3 74 279.7
P40	255.9	4 876 521.2	3 74 481.4
P41	319.0	4 878 682.4	3 74 562.7

**NOTE**  
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DATE	BY	DESCRIPTION
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Geocres No 30M15-35

HWY No 407	10/15/94	10/15/94
SUBMIT K.A. [CHECKED]	DATE 1994 08 08	SITE
DRAWN BY [CHECKED]	DATE 1994 08 08	DWG 326 88 01

REF No NTS Maps 30M/15b & 30M/15g

