



**HYDROGEOLOGICAL ASSESSMENT
SCHEDULE C
CLASS ENVIRONMENTAL ASSESSMENT
FOR PROPOSED WIDENING OF MISSISSAUGA ROAD
FROM FINANCIAL DRIVE TO QUEEN STREET WEST
(LOCATION 1)
BRAMPTON, ONTARIO**

Submitted to:

The Regional Municipality of Peel

c/o Amec Foster Wheeler Environment & Infrastructure,
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Submitted by:

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Amec Foster Wheeler Reference No.: TP115085



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1.0 INTRODUCTION

Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler), was retained by The Regional Municipality of Peel (the Region), to complete a hydrogeological assessment in support of a Schedule C Class Environmental Assessment (EA) study for the widening of Mississauga Road from four-lanes to six-lanes between Financial Drive (south extent) and Queen Street West (north extent) in the City of Brampton, Ontario. The site location is shown in Figure 1. This road widening includes the widening of the bridge spanning the Credit River and some retaining wall installations.

The purpose of this report is to provide a preliminary hydrogeological assessment of the local area and the impacts of the proposed construction on the surrounding private well and septic system users and the local environment. This report summarizes the findings of the geotechnical investigation completed at the site, completed in-situ hydraulic conductivity testing and groundwater level measurements. The report also describes the local environment in the area of the proposed construction.

2.0 SOURCES OF INFORMATION

Information compiled as part of this report include field investigation data and a study completed at the site, both completed by Amec Foster Wheeler, as well as regional-scale mapping products. This work included:

-) Drilling of 50 boreholes drilled to depths between 1.5 m and 14.3 m between 12 June and 22 June 2017 as part of a geotechnical investigation;
-) Installation of 50 mm (2") PVC monitoring wells in two (2) of the boreholes upon the completion of drilling;
-) Collection of groundwater levels at all functional monitoring wells on at least one (1) occasion following the completion of the monitoring well construction; and
-) Conduct hydraulic conductivity testing at the two (2) monitoring wells to assess the degree of permeability that could be encountered during the completion of excavations.

Results of the above field activities are summarized in this report, but are explained in greater detail in the following report completed by Amec Foster Wheeler:

-) DRAFT Geotechnical Investigation and Pavement Design Report, Schedule 'C' Class Environmental Assessment, Proposed Widening of Mississauga Road From Financial Drive to Queen Street West, City of Brampton, Ontario (dated November 2017).

The regional-scale map products reviewed as part of the work completed at this site include the following:

-) Orthophotography, ESRI ArcGIS Online, World Imagery, 2013.
-) Ontario Ministry of Northern Development and Mines, Surficial Geology of Southern Ontario, 2003, Miscellaneous Release - Data 128.
-) Ontario Geological Survey, Bedrock Geology of Ontario, 2011, Miscellaneous Release – Data 126, 1:250,000 scale.
-) Chapman L.J. and Putnam, D.F. 1984 (digitized 2007). Physiography of Southern Ontario: Ontario Geological Survey, Miscellaneous Release – Data 228.

3.0 PROPOSED CONSTRUCTION

The proposed construction is expected to consist of:

-) road widening along Mississauga Road from four (4) lanes to six (6) lanes;
-) bridge widening over the Credit River, which will require the excavation and installation of additional bridge footings; and
-) construction of three (3) retaining walls.

The majority of the work to be completed are not expected to require any major excavations that would be expected to encounter groundwater or require significant dewatering effort. The excavations to complete the installation of the bridge footings are the only ones that may require significant dewatering effort due to potential depth of excavation, the completion of the work in low-lying areas, where the groundwater table may be closer to surface, and the proximity of the Credit River in this area. These excavations will extend below the groundwater table and require dewatering.

4.0 METHODOLOGY

The hydrogeological work completed at this site consisted of the following main tasks. Each task is listed below and discussed in more detail in Sections 6.0 and 7.0:

1. Review of previous geotechnical report and available data in the site area.
2. Collect groundwater levels to establish the depth to the water table.
3. Complete hydraulic conductivity testing to assess the degree of dewatering effort required for the proposed excavations.
4. Complete a private well and septic system survey of properties within 1 km of the Site.
5. Prepare a hydrogeological report summarizing the field data and assessment findings.

Amec Foster Wheeler utilized this information in conducting an impacts assessment of the

proposed construction and dewatering in support of the Class EA.

5.0 PHYSICAL SETTING

The Site is situated within the Credit River watershed in the City of Brampton in Peel Region (Figure 1). The Site is located along Mississauga Road, specifically where the Credit River crosses underneath the Credit River in the community of Huttonville, between Highway 407 (south) and Bovaird Drive (north) and between Heritage Road (west) and Chinguacousy Road (east).

The area that includes the Site generally consists of mixed use at this time, with agricultural land to the west, southwest and northwest of Mississauga Road. To the east, northeast and southeast of Mississauga Road, the area has been developed and consists of single-family residential homes, some of which are still under construction. A golf course (Lionhead Golf and Conference Centre) is located on the east side of Mississauga Road to the south of Queen Street West.

5.1 Topography and Surface Water Features

The Site shows regional topography sloping towards the south (ultimately towards Lake Ontario). Locally, the topography slopes towards the Credit River, which flow from northwest to southeast in the vicinity of the Site, ultimately draining into Lake Ontario at its mouth. The topography and surface water features are shown in Figure 2.

5.2 Physiography and Quaternary Geology

The local physiography (Figure 3) consisted primarily of sand plains, with the southern part of the Site falling within beveled till plains. These are associated with the Peel Plain and South Slope physiographic regions. These physiographic regions both consist predominantly of till soils, with the low slopes and cut by the river valleys of the Greater Toronto Area.

The quaternary geology (Figure 4) across the Site consisted of a combination of glaciolacustrine sand, gravelly sand nearshore and beach deposits, located towards the south, away from the Credit River. In the vicinity of the Credit River, the quaternary geology has been described as silt to silty clay matrix till, associated with the interpreted Halton Till or equivalent.

5.3 Bedrock Geology

The bedrock across the area consists of Georgian Bay Formation shale. For the majority of the work to be completed at the Site associated with the road widening and supporting structures to be constructed, bedrock is not considered to be a hydrogeological factor in this investigation. The only structure that may encounter the bedrock is the excavations for the bridge footings. The bedrock in this area is generally not considered hydraulically productive. The bedrock geology is shown in Figure 5.

5.4 Groundwater Flow

Unconfined groundwater flow generally follows the topography, indicating a regional flow direction towards the south. The local groundwater flow direction, will be towards nearby surface water features, which serve as local groundwater discharge zones, such as the Credit River.

6.0 GEOTECHNICAL INVESTIGATION

The geotechnical investigation was completed by Amec Foster Wheeler for the Site, but presented in a separate report. The geotechnical report, titled “Draft Geotechnical Investigation and Pavement Design Report, Schedule ‘C’ Class Environmental Assessment, Proposed Widening of Mississauga Road from Financial Drive to Queen Street West, City of Brampton, Ontario (Location 1)” was issued on November 20, 2017. The findings of this geotechnical investigation are summarized in the following sections. The geotechnical soils summaries were separated based on the construction to be completed: road widening, bridge construction, and retaining walls, as the locations and investigation requirements and recommendations for each varied.

6.1 Borehole Drilling and Monitoring Well Construction

The geotechnical investigation included the drilling of a total of 48 boreholes along Mississauga Road, which included:

- forty (40) boreholes for pavement widening / underground utilities (BH 1 to BH 42);
- six (6) boreholes for bridge widening (BH B1 to BH B6); and
- two (2) boreholes (BH R1 and BH R2) for Retaining Wall 1.

The boreholes were advanced in the driving lanes, edge of pavement, shoulder of the road, the toe of slope or at top of slope. The depths of the boreholes ranged from about 1.5 m to 14.3 m below the existing grade. The boreholes were advanced using solid-stem continuous-flight augers with truck-mounted and track-mounted power-auger drill rigs, equipped with an automatic hammer, supplied and operated by Drilltech Drilling Ltd. of Newmarket, Ontario. Borehole BH B5 located at the toe of a slope (which was inaccessible to a drill rig) was advanced by using hand-drilling method.

Upon completion of drilling, monitoring wells were installed in two boreholes (BH B3 and BH B4), consisting of 50 mm (2”) PVC for the completion of hydraulic conductivity testing as part of the hydrogeological investigation to assess the subsurface hydrogeological conditions for the bridge footings. The monitoring well screens were installed at depths between 6.1 m and 11.6 m bgs, with one monitoring well screened in the soils (silty clay/clayey silt) and the other screened in the weathered shale.

6.2 Geotechnical Soils – Road Widening

The geotechnical investigation indicated that the soil profile for the Site as they would relate to the road widening, comprised fill soils (sand and gravel, gravelly sand, sand, silty sand, sandy clayey silt, silty clay/clayey silt) below the surficial asphaltic concrete. The fill soils were underlain by natural deposits of sand and gravel, sandy gravel, sand, silty sand / sandy silt, silty sand / sandy silt till, silty clay / clayey silt till and/or weathered shale.

6.3 Geotechnical Soils – Bridge Crossing

The geotechnical investigation indicated that the soil profile for the Site as they would relate to the construction of the bridge crossing, generally consisted of non-cohesive fill (i.e., sand and gravel, sandy gravel, gravelly sand, sand, silty sand), and/or cohesive fill (i.e., silty clay / clayey silt, sandy clayey silt), underlying topsoil or asphaltic concrete. Natural sand and gravel, silty clay / clayey silt till and/or weathered shale were encountered underlying the fill soils in all boreholes.

6.4 Geotechnical Soils – Retaining Wall 1

The geotechnical investigation indicated that the soil profile for the Site as they would relate to the retaining wall, generally consisted of surficial topsoil underlain by fill soils up to a depth of about 2.1 m, overlying loose to compact natural silty sand / sand / silt.

7.0 HYDROGEOLOGY

7.1 Stratigraphy & Hydrostratigraphy

Based on the geotechnical borehole logs, the site appears to be covered by primarily fill material underneath the asphalt. This fill material consisted primarily of silty sand to sand and gravel or gravelly sand. The fill can be thick in places, extending more than 5.5 m bgs.

Below the fill soils, sequences of till or till-like soils were noted near the Credit River in particular, with sand to silty sand to sand and gravel noted in most of the other boreholes along Mississauga Road. None of the boreholes extended fully through these units. Bedrock was generally not confirmed during the geotechnical drilling except in one borehole.

These native sandy soils would be expected to be potential sources of groundwater inflow if excavations are required to be completed into them. While this may not be a requirement as part of the road widening itself, the presence of these materials, if saturated and extensive, could be a factor when considering installing sewer lines below the expanded roadway.

Coarser soils were not noted in the boreholes that were hydraulically tested near the Credit River, so this area, if these soils are the dominant ones to be encountered for the excavations for bridge

footings, suggest that the tighter soils would not be expected to be a significant source of groundwater inflow.

7.2 Groundwater Levels

Groundwater levels were measured both during the geotechnical and hydrogeological investigations. The geotechnical investigation recorded groundwater levels both at the completion of drilling of each borehole (or construction of each monitoring well). The groundwater levels measured during the geotechnical and hydrogeological investigations were as follows:

- Road Widening:
 -) Upon completion of drilling (June 13 to 19, 2017): 2.1 m bgs to 4.4 m bgs (180.5 masl to 201.7 masl) – except for BH 13, which was dry.
 -) September 21 to October 2, 2017: 4.9 m bgs to 5.4 m bgs (179.5 masl to 180.0 masl) – BH 3 only.
- Bridge Crossing:
 -) Upon completion of drilling (June 14 to 19, 2017): 1.8 m bgs to 5.5 m bgs (180.5 masl to 183.2 masl) – except for BH B4 and BH B5, which were dry.
 -) September 21 to October 2, 2017: 4.6 m bgs to 5.4 m bgs (179.5 masl to 180.3 masl) – BH B3 and BH B4 only.
- Retaining Wall 1:
 -) Upon completion of drilling: 6.1 m bgs.

7.3 Hydraulic Conductivity & Dewatering

Hydraulic conductivity testing was completed between September 25 and October 2, 2017 in the two (2) monitoring wells, BH 4 (screened in weathered shale) and BH 3/34 (screened in silty clay/clayey silt). Both tests consisted of rising head single well response tests which consisted of rapidly removing a known volume of water from the monitoring well and measuring the recovery using pressure transducers and manual groundwater levels. The resulting data was analyzed using specialized software to estimate hydraulic conductivity values for the screened intervals by applying the Bouwer-Rice solution. The result for BH 4 was 1.6×10^{-8} m/s, which is a reasonable result for weathered shale. The result for BH 3/34 was 1.7×10^{-9} m/s, which is a reasonable result for a tight clayey silt/silty clay soil. The graphical outputs from the software are included in Appendix A.

If an excavation required dewatering rates of more than 50,000 L/day, an Environmental Activity and Sector Registry (EASR) registration would be required at a minimum. If the dewatering rates exceeded 400,000 L/day, a Permit To Take Water (PTTW) would be required to support the construction. The design for the bridge footings was not complete at the time that this report was

prepared, so site-specific dewatering calculations could not be completed at this time. A dewatering rate was calculated based on an assumed excavation with dimensions of 10 m by 10 m with a groundwater level at ground surface.

Both of the hydraulic conductivity results obtained during this field investigation were very low and would result in relatively low dewatering requirements. Using these hydraulic conductivity test results and the assumed conditions mentioned above, a maximum dewatering inflow rate was calculated of 4,100 L/day (including a 3x multiplier applied to the highest dewatering rate to account for local geologic and hydrogeologic variability across the site). The projected radius of influence would be less than 10 m. These dewatering rate calculations were completed using the Dupuit solution and the radius of influence was calculated using the Sichardt equation (both are shown in the dewatering calculations included in Appendix B and are included in Powers et al. (2007)).

Once the design for the bridge footings has been completed, the dewatering inflow rates would require updating to determine whether an Environmental Activity and Sector Registry (EASR) registration or a Permit To Take Water (PTTW) would be required to support the construction.

No hydraulic conductivity testing was completed away from the bridge crossing location, but additional field investigation to assess the dewatering effort may be required should subsurface infrastructure installations be considered if they are expected to require installation at or below the groundwater table as the soils reported away from the Credit River tended to consist of coarser soils than that encountered in the monitoring wells tested.

7.4 Groundwater Quality & Dewatering Disposal

The field investigation completed by Amec Foster Wheeler did not include groundwater chemistry sampling. As the presence or absence of potential groundwater quality impacts have not been established at this time, the groundwater quality will need to be confirmed to establish disposal options for any water collected during dewatering efforts during construction.

Any water collected during dewatering would need to be tested and potentially treated prior to disposal to confirm the appropriate disposal location and method. Options for disposal would include release to the natural environment (requiring that the discharge meets the Ontario Provincial Water Quality Objectives), local sanitary or storm sewers, if not too far removed from the Site (requiring that the discharge meets the appropriate Peel Region Sewer Use Bylaw criteria), or it could be contained and trucked offsite for treatment.

7.5 Private Wells and Septic Systems

This area of the Region of Peel is on the edge of existing agricultural uses and recently established residential developments. The private well and septic system survey did not identify

the presence of any private wells. A private well and septic system survey was completed between July and September 2017, with a total of approximately 80+ surveys delivered and six (6) completed surveys received (all from the same street). A copy of the survey package that was distributed is included in Appendix C and copies of the surveys received are included in Appendix D.

From the few completed surveys received, the residents along Embleton Drive are municipally serviced for water, but remain on private septic systems. Several of these residences are located close to the existing Mississauga Road, so expansion of this road has the potential to impact these existing septic systems and care will be required not to damage them.

7.6 Surface Water Impacts

The planned construction area extends over the Credit River and the only portion of the construction to be completed that may occur close enough to the river to impact it will be the bridge footings excavations. Measures may be required to isolate the river from the excavations in order to reduce or eliminate the potential for inflow from the river into the excavations which could result in significant dewatering effort.

Additionally, measures should be used during construction to limit the potential for sediment to be flushed from these excavations to wash overland into the river.

7.7 Dewatering-Induced Settlement

Based on the current construction plans, the Site will consist of structures with minimal ground disturbance requirements and minimal to no dewatering requirements, with the possible exceptions of the bridge footings. These would likely be completed in areas near the Credit River and within the river valley, but away from existing structures, such as nearby residences which would be located uphill and outside of the river valley.

Once the final design for the bridge footings have been determined and the dewatering requirements have been established, the potential for dewatering-induced settlement will need to be assessed and mitigated as required.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Based on a review of the available information for the Site and surrounding area and the field investigation completed, Amec Foster Wheeler has made the following conclusions:

-) The available physiographic and quaternary geology mapping, as well as geotechnical borehole logs completed across the Site suggests that the subsurface soils consist of fine-grained, relatively cohesive till or till-like soils in the vicinity of the Credit River, but there

were coarser native soils noted along much of the rest of Mississauga Road. Additionally, groundwater may be perched in the coarser fill soils in some locations.

-) Groundwater level measurements were completed in June 2017 upon completion of drilling as part of the geotechnical investigation and in September and October 2017 as part of the hydrogeological investigation. Groundwater levels were noted to range between 1.8 m bgs and 5.4 m bgs (179.5 masl and 201.7 masl) during the field investigations.
-) Rising head single well response tests completed in monitoring wells installed near the Credit River indicated hydraulic conductivity values of 1.6×10^{-8} m/s (in weathered shale) and 1.7×10^{-9} m/s (tight clayey silt/silty clay soils). These values can be used in assessing dewatering requirements near the Credit River for similar soils or rock.
-) If dewatering inflow rates exceed 50,000 L/day, an EASR registration would be required as a minimum. If dewatering inflow rates exceed 400,000 L/day, a PTTW would be required. Based on an assumed excavation of 10 m by 10 m by 10 m, assuming a groundwater level at ground surface and using the hydraulic conductivity test results obtained during this field investigation, dewatering rates could be expected up to 4,100 L/day (including a safety factor to account for local geologic and hydrogeologic variability). Based on this calculation, neither an EASR nor a PTTW would be required for this construction, primarily due to the low estimated hydraulic conductivity results.
-) Once the design for the bridge footings has been completed, the dewatering inflow rates require updating to confirm whether an EASR or PTTW would be required to support the construction.
-) Due to the proximity of the Credit River to the planned bridge footing locations, measures may be required to isolate the Credit River from the excavation from surface and groundwater interactions, as well as limit the potential for sediment to be flushed from these excavations to wash overland into the river.
-) Should sewer installations be considered along Mississauga Road that could be completed at or below the groundwater table, particularly in locations where coarser soils were reported in the borehole logs, additional hydrogeological characterization will be required to assess the level of dewatering effort required to determine whether an EASR registration or a PTTW will be required to support construction.
-) Once the final design for the bridge footings have been determined and the dewatering requirements have been established, the potential for dewatering-induced settlement will need to be assessed and mitigated as required.
-) The private well and septic survey returned few results with all the surveys received, where the address was indicated, from residents on Embleton Road. All of these residents indicated being supplied with municipal water, but were all on private septic systems. As such, construction completed near these houses as part of the construction will need to take care not to damage the existing septic systems. No private wells were identified during the completion of the well and septic system survey.

-) The local groundwater has not been tested and therefore the local groundwater quality has not been confirmed. The surrounding land use at the time of the preparation of this report is mixed, between suburban/urban residential development and agricultural land use. Prior to the release of any collected groundwater discharge, the water should be held and tested to determine whether it complies with the restrictions associated with the desired discharge point.

The Regional Municipality of Peel
Hydrogeological Assessment
Schedule C Class Environmental Assessment
For Proposed Widening of Mississauga Road
From Financial Drive to Queen Street West, Brampton, Ontario
Amec Foster Wheeler Reference Number: TP115085
December 20, 2017



9.0 CLOSURE

The information and recommendations contained in this report should be used solely for the purpose of hydrogeological investigation of the subject site.

If you should have any questions regarding this submission, please contact Kimberly Gilder at 905-568-2929 or by email kimberly.gilder@amecfw.com, or Martin Shepley at 905-335-2353 or by email martin.shepley@amecfw.com.

The Report Limitations included in Appendix E are an integral part of this report.

Sincerely,
Amec Foster Wheeler Environment & Infrastructure,
a Division of Amec Foster Wheeler Americas Limited

A handwritten signature in black ink that reads "Kim Gilder".

Kimberly Gilder, B.Sc., P.Geo.
Hydrogeologist

A handwritten signature in black ink that reads "MGS".

Martin Shepley, M.Sc., D.Phil., P.Geo.
Associate Hydrogeologist

10.0 REFERENCES

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FIGURES



LEGEND

- Site Location
- Waterbody
- Railway
- Power Transmission Line

NOTES:


LOCATION OF FEATURES ARE APPROXIMATE

This drawing should be read in conjunction with the AMEC Foster Wheeler Environment & Infrastructure Report No. TC160427. Conditions encountered in the field may be different from the interpreted information presented on this figure.

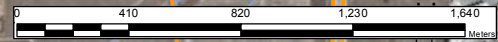
SOURCE: Some data presented in this figure is from the Ontario open dataset: Hillshade (2012); ORN, 2012; Canvec10 (contours).

CLIENT:

Drawn By: LJM	Checked By: KG
Revision: A	Projection: UTM Zone 17N
SCALE: 1:30,926	



HYDROGEOLOGICAL INVESTIGATION Mississauga Road, Brampton, Ontario	
Site Location Plan	
PROJECT N°: TP115085	FIGURE: 1
DATE: December, 2017	
Amec Foster Wheeler Environment & Infrastructure 3450 Harvester Rd, Suite 100., Burlington, Ontario, L7N 3W5 tel: 905-335-2353 www.amecfw.com	



LEGEND

- Site Location
- Waterbody
- Railway
- Power Transmission Line
- Elevation Contour (masl)

NOTES:


LOCATION OF FEATURES ARE APPROXIMATE

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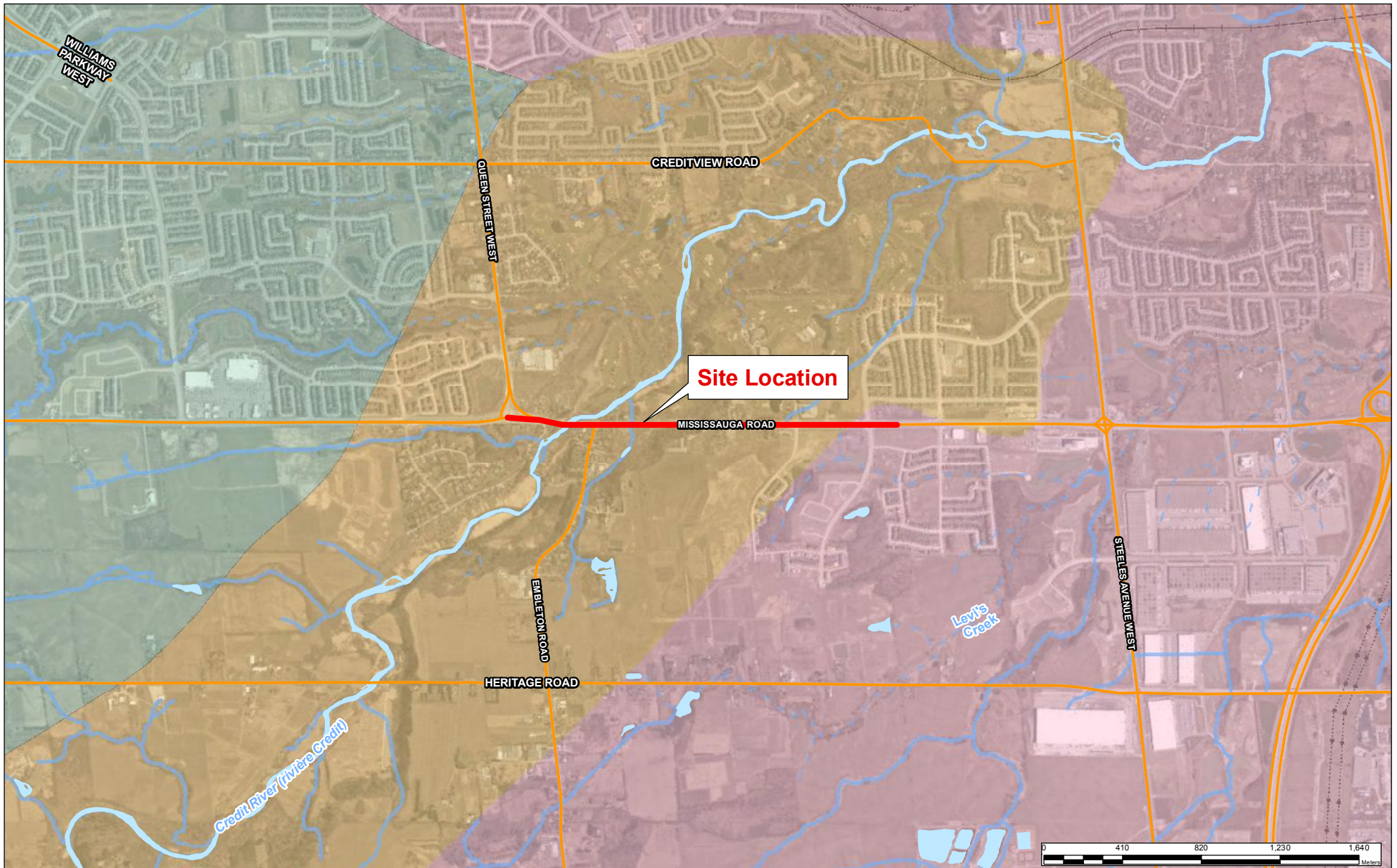
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CLIENT:

Drawn By: LJM	Checked By: KG
Revision: A	Projection: UTM Zone 17N
SCALE: 1:27,661	



HYDROGEOLOGICAL INVESTIGATION	
Mississauga Road, Brampton, Ontario	
Surface Water Features and Topography	
PROJECT N°: TP115085	FIGURE: 2
DATE: December, 2017	
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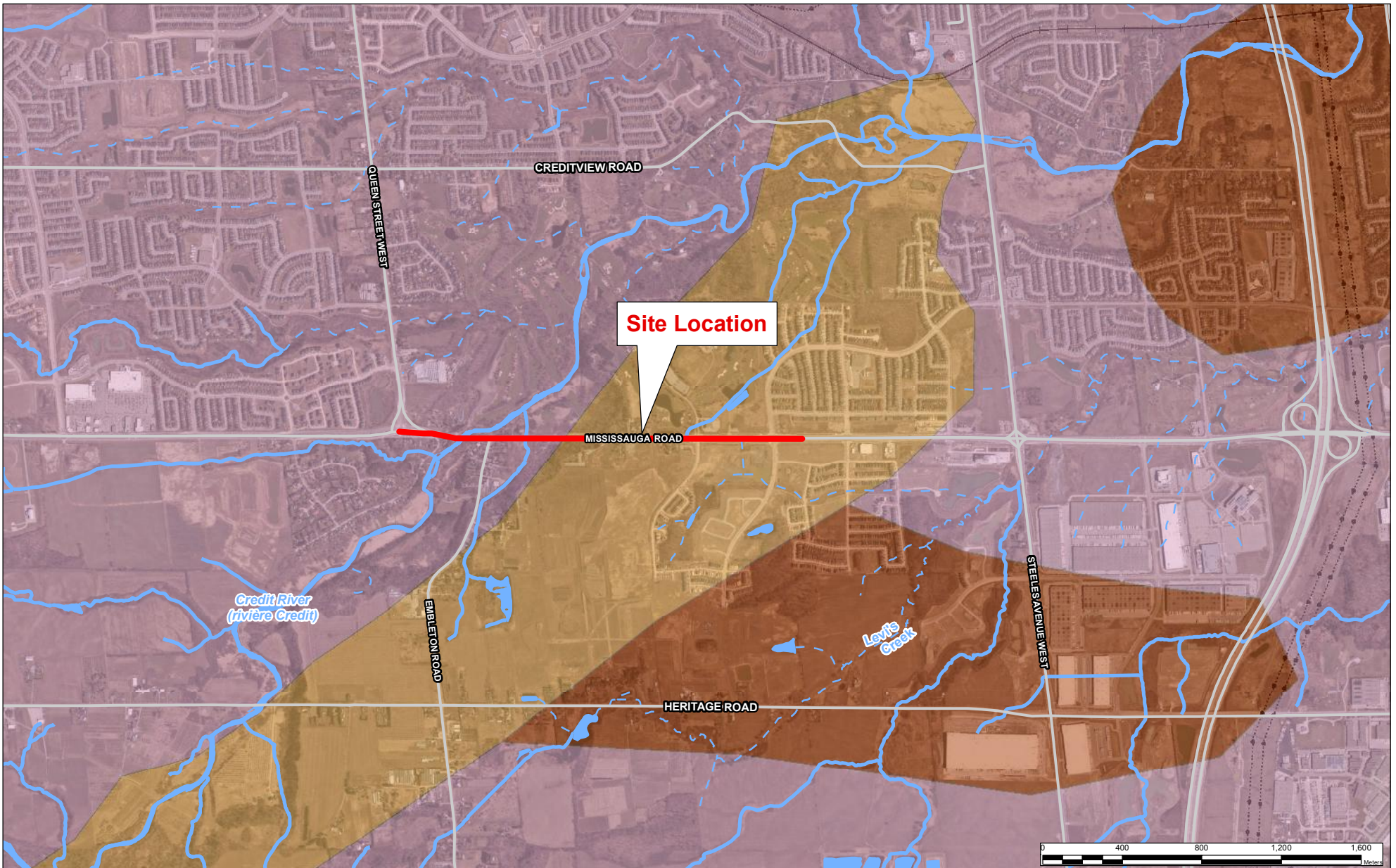


LEGEND	
—	Site Location
—	Waterbody
—	Railway
•	Power Transmission Line
Physiographic Unit & Description.	
 	Bevelled Till Plains
 	16: Sand Plains
 	Till Plains (Drumlinized)
Physiographic Region	
 	Peel Plain
 	South Slope

NOTES:
 LOCATION OF FEATURES ARE APPROXIMATE
 This drawing should be read in conjunction with the AMEC Foster Wheeler Environment & Infrastructure Report No. TC160427. Conditions encountered in the field may be different from the interpreted information presented on this figure.
 SOURCE: Some data presented in this figure is from the Ontario open dataset: Hillshade (2012); ORN, 2012; Canvec10 (contours).

CLIENT:	
Drawn By: LJM	Checked By: KG
Revision: A	Projection: UTM Zone 17N
SCALE: 1:27,661	

HYDROGEOLOGICAL INVESTIGATION	
Mississauga Road, Brampton, Ontario	
Physiography	
PROJECT N°: TP115085	FIGURE: 3
DATE: December, 2017	
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LEGEND	
● Site Location	
◆ Power Transmission Line	
— Railway	
■ Waterbody	
Quaternary Geology	
■ Glaciolacustrine Deposits: silt and clay, minor sand, basin and quiet water deposits	
■ Glaciolacustrine Deposits: sand, gravelly sand and gravel, nearshore and beach deposits	
■ Halton Till: predominantly silt to silty clay matrix, high in matrix carbonate content and clast poor	

NOTES:

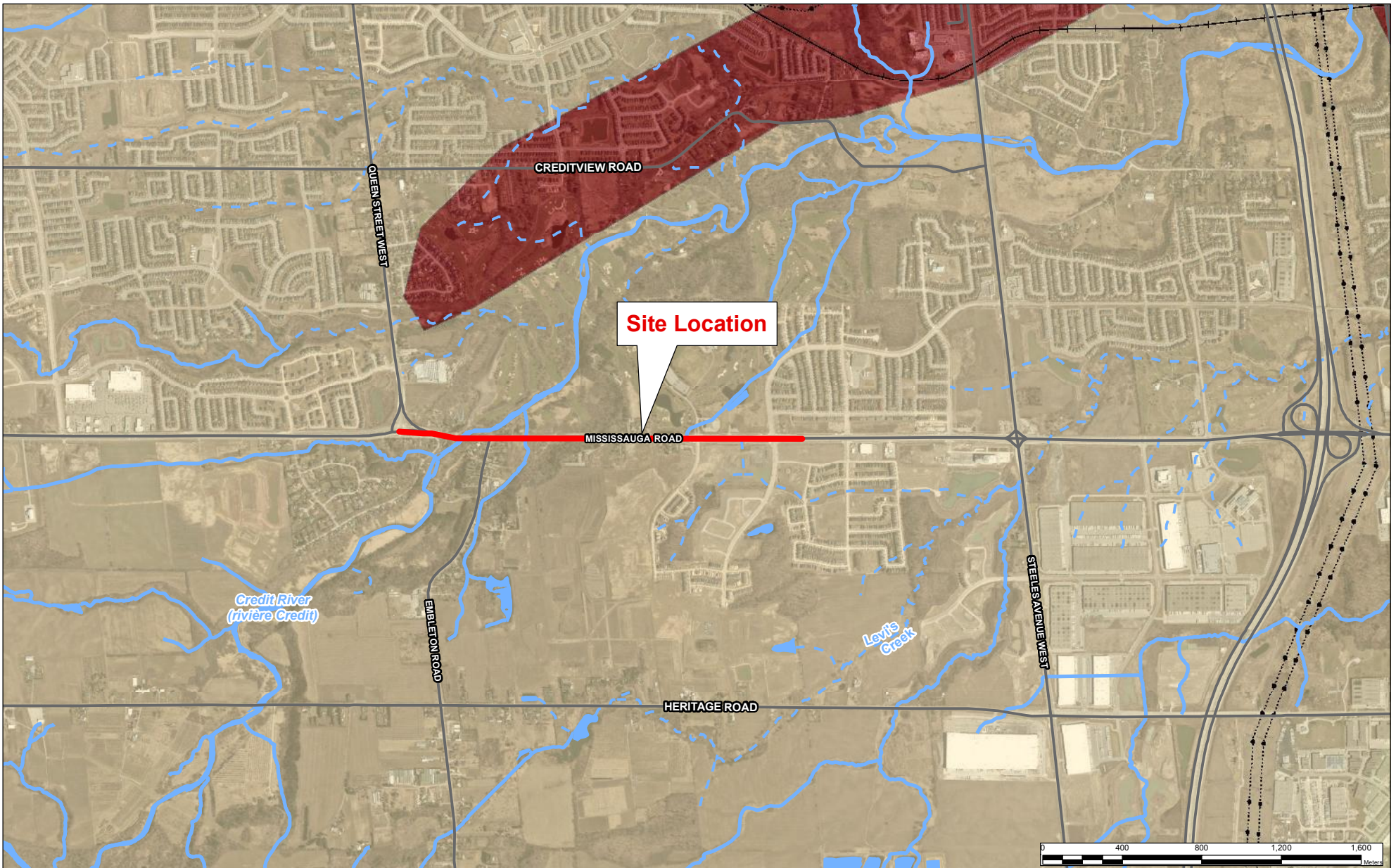
LOCATION OF FEATURES ARE APPROXIMATE

This drawing should be read in conjunction with the AMEC Foster Wheeler Environment & Infrastructure Report No. TC160427. Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: Some data presented in this figure is from the Ontario open dataset: Hillshade (2012); ORN, 2012; Canvec10 (contours).

CLIENT:	
Drawn By: LJM	Checked By: KG
Revision: A	Projection: UTM Zone 17N
SCALE: 1:26,733	

HYDROGEOLOGICAL INVESTIGATION	
Mississauga Road, Brampton, Ontario	
Surficial Geology	
PROJECT N°: TP115085	FIGURE: 4
DATE: December, 2017	
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LEGEND

- Site Location
- Waterbody
- Railway
- Power Transmission Line

Geopoly

- Georgian Bay Formation; Blue Mountain Formation; Billings Formation; Collingwood Member; Eastview Member
- Queenston Formation

NOTES:

LOCATION OF FEATURES ARE APPROXIMATE

This drawing should be read in conjunction with the AMEC Foster Wheeler Environment & Infrastructure Report No. TC160427. Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: Some data presented in this figure is from the Ontario open dataset: Hillshade (2012); ORN, 2012; Canvec10 (contours).

CLIENT:	
Drawn By: LJM	Checked By: KG
Revision: A	Projection: UTM Zone 17N
SCALE: 1:26,733	

HYDROGEOLOGICAL INVESTIGATION	
Mississauga Road, Brampton, Ontario	
Bedrock Geology	
PROJECT N°: TP115085	FIGURE: 5
DATE: December, 2017	
Amec Foster Wheeler Environment & Infrastructure 3450 Harvester Rd, Suite 100., Burlington, Ontario, L7N 3W5 tel: 905-335-2353 www.amecfw.com	

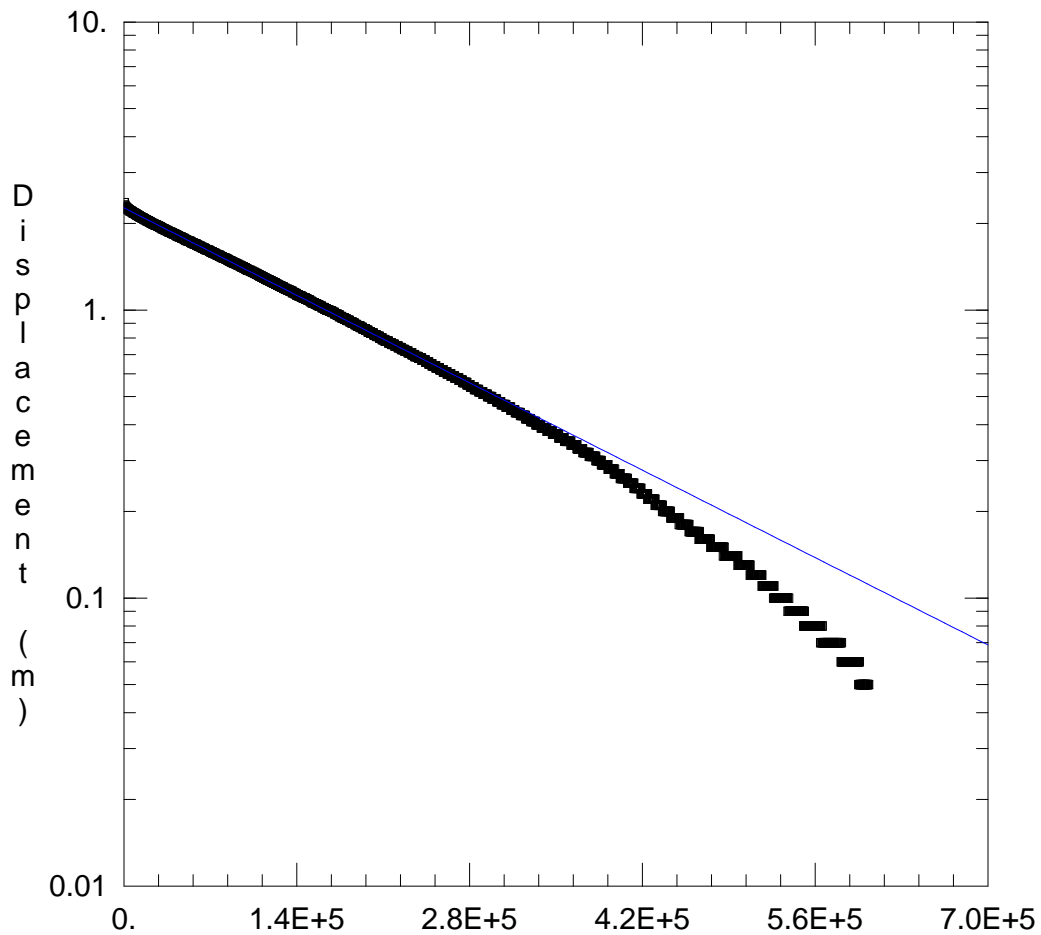


APPENDICES



APPENDIX A

**Hydraulic Conductivity
Test Results**



Time (sec)
WELL TEST ANALYSIS

Data Set: P:\...\BH 3-34 Rising Head Test.aqt
Date: 12/19/17

Time: 16:15:57

PROJECT INFORMATION

Company: The Region of Peel
Client: Amec Foster Wheeler
Project: TP115085
Location: Mississauga Rd
Test Well: BH 35
Test Date: September 25, 2017

AQUIFER DATA

Saturated Thickness: 2.47 m

Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH 3/34)

Initial Displacement: 2.36 m
Total Well Penetration Depth: 2.47 m
Casing Radius: 0.0254 m

Static Water Column Height: 2.47 m
Screen Length: 2.47 m
Well Radius: 0.075 m

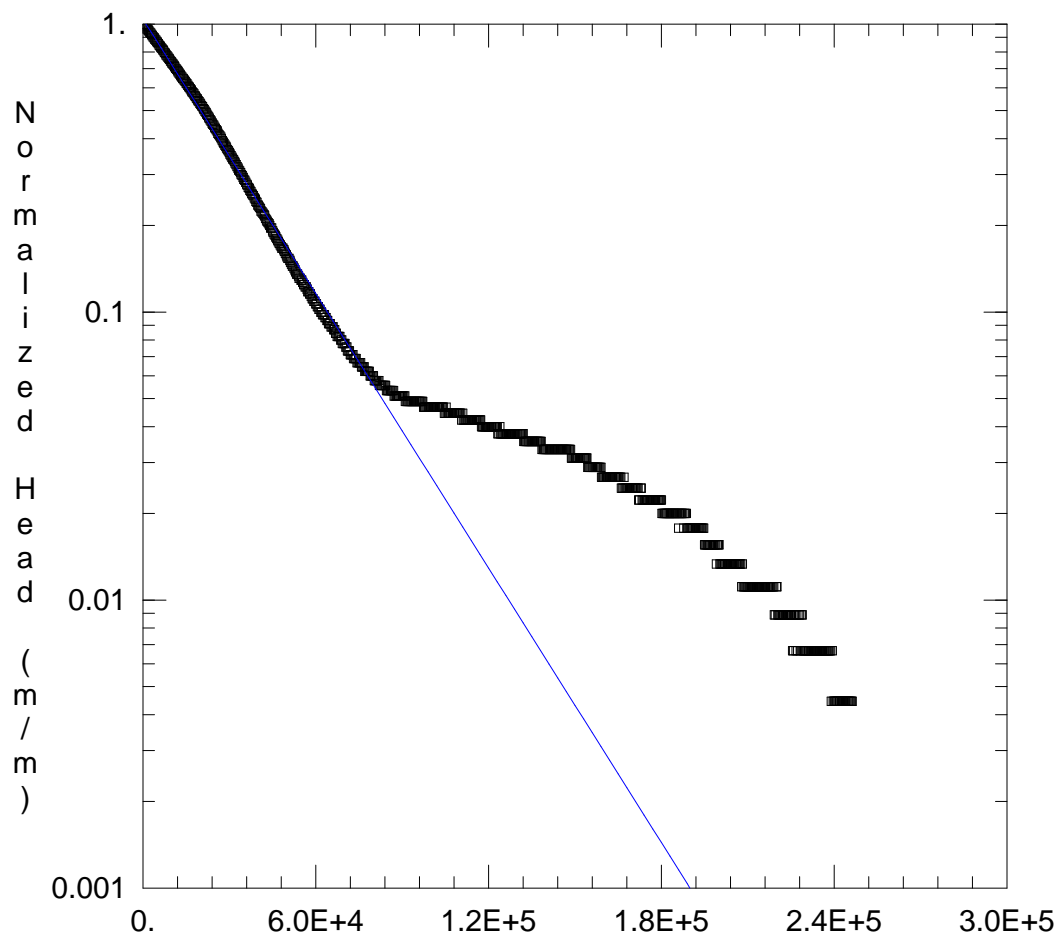
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 1.727E-9 m/sec

y0 = 2.262 m



Time (sec)
WELL TEST ANALYSIS

Data Set: P:\...\BH 4 Rising Head Test.aqt
Date: 12/19/17

Time: 16:06:07

PROJECT INFORMATION

Company: Region of Peel
Client: Amec Foster Wheeler
Project: TP115085
Location: Mississauga Rd
Test Well: MPR1-BTI-04
Test Date: September 25, 2017

AQUIFER DATA

Saturated Thickness: 7.02 m

Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH 4)

Initial Displacement: 4.5 m
Total Well Penetration Depth: 7.02 m
Casing Radius: 0.025 m

Static Water Column Height: 7.02 m
Screen Length: 3. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice


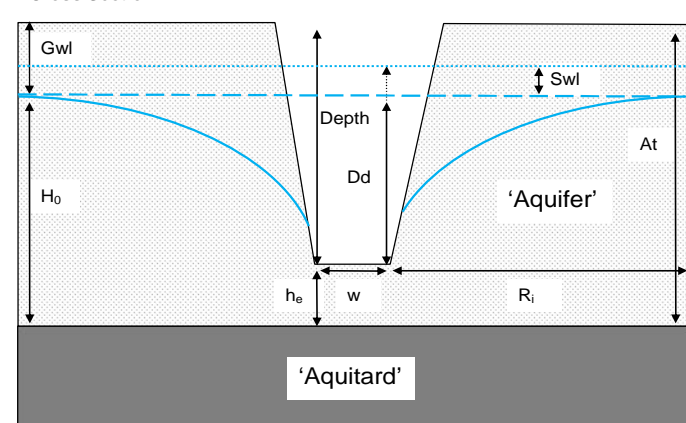
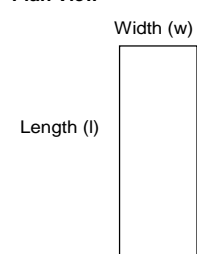
K = 1.63E-8 m/sec

y0 = 4.681 m



APPENDIX B

Dewatering Calculations

Dewatering Rate Estimation - Unconfined Trench																		
Project No.: TP115085 Project Name: Hydrogeological Assessment, Schedule C Class Environmental Assessment for Proposed Mississauga Road Widening Client: Regional Municipality of Peel										 Performed by: KG Checked by: SG								
Location: Mississauga Road from Financial Drive to Queen Street West, Brampton, Ontario Description: Hypothetical Bridge Footing Excavation Dewatering Requirements Date: March 8, 2018																		
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2">EXCAVATION INFO</th> </tr> </thead> <tbody> <tr> <td>Length, l (m)</td> <td>10.0</td> </tr> <tr> <td>Width, w (m)</td> <td>10.0</td> </tr> <tr> <td>Depth (mbgs)</td> <td>10.0</td> </tr> </tbody> </table>											EXCAVATION INFO		Length, l (m)	10.0	Width, w (m)	10.0	Depth (mbgs)	10.0
EXCAVATION INFO																		
Length, l (m)	10.0																	
Width, w (m)	10.0																	
Depth (mbgs)	10.0																	
<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>Cross Section</p>  </div> <div style="text-align: center;"> <p>Plan View</p>  </div> </div> <p style="text-align: center;">Radius of Influence (R₁) calculated with the Sichardt equation $R_1 = 3000(H_0 - h_e)\sqrt{K}$</p> <p style="text-align: center;">Groundwater Inflow (Q) to the excavation calculated with the Dupuit solution combining: 1) radial steady-state for inflow to trench ends; and 2) linear steady-state for inflow to trench sides.</p> $Q = \pi \frac{(H_0^2 - h_e^2)}{\ln\left(\frac{2R_1 + w}{w}\right)} + 2l \frac{(H_0^2 - h_e^2)}{2R_1}$																		
Bh	Gwl Measured Groundwater Level (mbgs)	Swl Estimated Seasonal Fluctuation above Gwl (m)	K Hydraulic Conductivity (m/s)	At 'Aquifer' Thickness (mbgs)	H ₀ Ambient Head above 'Aquitard' (m)	h ₀ Head above 'Aquitard' at Excavation (m)	Dd Drawdown (m)	R ₁ Sichardt Calculation (m)	R ₁ User Defined (m)	Q Groundwater Inflow (m ³ /d)								
BH 4	0.0	0.0	1.6E-08	11.0	11.0	1.0	10.0	3.8		1.4								
BH 3/34	0.0	0.0	1.7E-09	11.0	11.0	1.0	10.0	1.2		0.4								
Maximum										1.4								
K Geometric Mean			5.2E-09	11.00	11.00	1.00	10.00	2.2		0.7								
K Arithmetic Mean			8.9E-09	11.00	11.00	1.00	10.00	2.8		1.0								
Safety Factor		3	Maximum x SF		(K Geometric Mean) x SF		(K Arithmetic Mean) x SF											
Q Groundwater Inflow (m³/d)			4.1		2.2		2.9											
Safety Factor		3	S(Maximum K x SF)		S(K Geometric Mean x SF)		S(K Arithmetic Mean x SF)											
R₁ Radius of Influence, Sichert (m)			6.6		3.8		4.9											
<p>Notes</p> <ol style="list-style-type: none"> mbgs = meters below ground surface The user defined R₁ is used for the calculation of groundwater inflow (Q) if specified Geometric mean calculation is applied only to the hydraulic conductivity (K) - other input parameters for the Dupuit and Sichardt equation use the arithmetic average The calculated groundwater inflows for the arithmetic and geometric mean both use the Sichardt R₁ calculated from the respective mean K If the depth of the excavation is below the base of the 'Aquifer' then the head at the excavation is set at the top of the 'Aquitard' (i.e. h_e = 0) 																		
<p>Comments</p>																		



APPENDIX C

**Private Well and Septic System
Survey Package**

August 23, 2017

TP115085.1.6200



Dear Resident:

**Re: Private Water Well and Septic System Survey,
Municipal Class Environmental Assessment Hydrogeological Investigation,
Widening of Mississauga Road between Financial Drive and Queen Street,
Brampton, Ontario**

Amec Foster Wheeler Environment & Infrastructure (Amec Foster Wheeler) has been retained by the Region of Peel to undertake a private water well and septic system survey in the area surrounding the proposed widening of Mississauga Road between Financial Drive and Queen Street West in Brampton, as seen in the attached figure. The intention of this survey is to identify actively used wells and septic systems that are located in the vicinity of the planned construction.

A short questionnaire is included in this package. The purpose of the questionnaire is to collect basic information including if a well or septic system is located on your property and if it is currently used. If you have an active well and/or septic system and know additional details about it/them, the questionnaire requests additional details including the location, type, age, dimensions, and general condition.

We are also requesting permission to inspect your well and photograph it and your septic bed, if available. There is no well or septic system sampling included as part of this program, however, the results of this survey may be included in future construction surveys, which may include one or more sampling events, so we encourage you to participate in the survey at this time.

A representative of Amec Foster Wheeler will shortly be canvassing door-to-door in order to contact residents to assist in carrying out the survey. If we have missed you during the door-to-door canvassing and you would like to participate in the survey, we ask that you complete the survey provided and return using the prepaid envelope provided. Additionally, the survey can be scanned and emailed to the email address provided below.

Should you have any questions or require additional information regarding this project, please contact Kimberly Gilder of Amec Foster Wheeler at 905-568-2929 extension 4308 or by email at kimberly.gilder@amecfw.com.

**Amec Foster Wheeler Environment & Infrastructure
A Division of Amec Foster Wheeler Americas Limited**

On behalf of the Region of Peel

Yours truly,

A handwritten signature in black ink that reads "Kim Gilder".

Kimberly Gilder, P.Geo.
Hydrogeologist

Private Well and Septic System Survey Form



Home Owner Information

Name: _____ Phone #: _____
Address: _____ Email: _____

Water Use & Well Information (Location sketch to be completed on Page 2)

What is the source of your water: (Please select all that apply)

Well Cistern Other (please specify): _____

Is your well used for drinking: Y / N Do you have a copy of the water well record: Y / N

If you have a well please complete following section to the best of your knowledge.

Is your well: Drilled Dug Date well installed: _____

Well diameter: 4" / 5" / 6" / 36" / other: _____

Depth of well: _____ Water level in well: _____

UTM coordinates for well: _____

Water supply adequate Water quality: Good / Poor

All year: Y / N Colour / _____

Treatment System: Y / N Type: _____ Comments: _____

Septic System Information (continued on Page 2)

Do you have a private septic system:
Yes No (municipally serviced) Don't Know

Do you have a copy of the on-site sewage works approval: Y / N

If you have a septic system please complete following section to the best of your knowledge.

Date of installation (approximate): _____

Who was the installation contractor: _____

Number of people in the household: _____

When was the system last cleaned out: _____

Where is the septic tank/treatment unit and what is its capacity: _____

Private Well and Septic System Survey Form



Septic System Information (continued)

Have there been any maintenance issues with the system: Y / N

Length and number of distribution tiles in the leaching bed:

Is there a pump chamber: Y / N

UTM Coordinates of septic tank:

UTM Coordinates of leaching bed:

Well and/or Septic System Location: (Please Sketch Locations on the property)

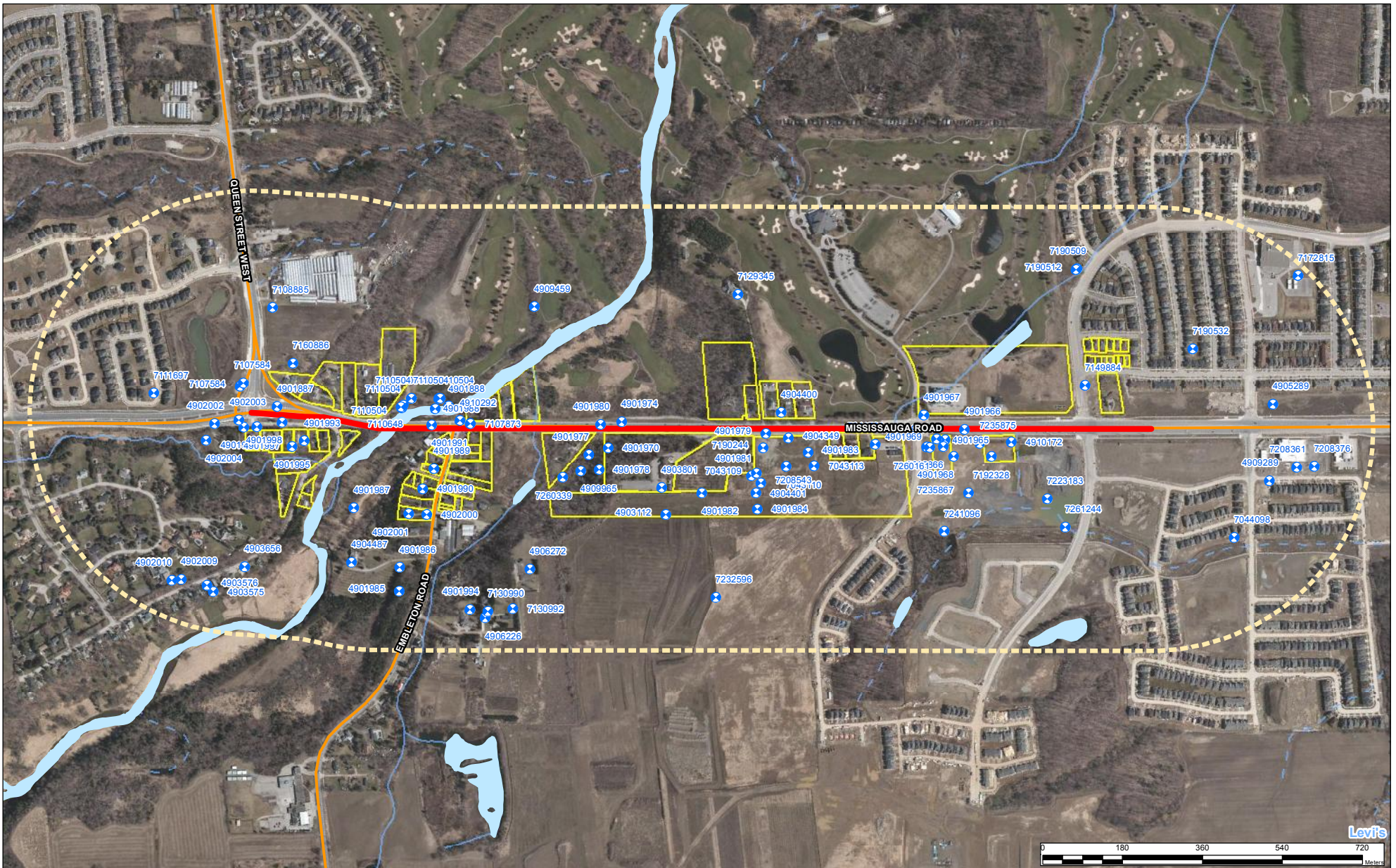
Large empty rectangular area for sketching well and/or septic system locations on the property.

Additional Comments:

Large empty rectangular area for additional comments.

Please return completed survey using prepaid envelope provided or to:

Kimberly Gilder, P.Geo.
Amec Foster Wheeler Environment & Infrastructure
160 Traders' Boulevard East, Suite 110
Mississauga, Ontario L4Z 3K7



LEGEND

- ✕ Water Well Records within 500m from Site Location
- Site Location
- 500m_buffer
- Waterbody
- Properties

NOTES:

LOCATION OF FEATURES ARE APPROXIMATE

This drawing should be read in conjunction with the AMEC Foster Wheeler Environment & Infrastructure Report No. TC160427. Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: Some data presented in this figure is from the Ontario open dataset: Hillshade (2012); ORN, 2012; Canvec10 (contours).

CLIENT:

Drawn By: LJM	Checked By: KG
Revision: A	Projection: UTM Zone 17N
SCALE: 1:11,982	

HYDROGEOLOGICAL INVESTIGATION	
Mississauga Road, Brampton, Ontario	
Water Well Records within 500m from Site Location	
PROJECT N°: TC160427	FIGURE: 1
DATE: July, 2017	
Amec Foster Wheeler Environment & Infrastructure 3450 Harvester Rd, Suite 100., Burlington, Ontario, L7N 3W5 tel: 905-335-2353 www.amecfw.com	



APPENDIX D
Completed Surveys Received

Private Well and Septic System Survey Form



Home Owner Information

Name: **HAROLD & JENNIFER CONNELL**
Address: **2015 OMBLETON RD**

Phone #: **(905) 874-9296**
Email: **jenc_art@hotmail.com**

Water Use & Well Information (Location sketch to be completed on Page 2)

What is the source of your water: (Please select all that apply)

Well Cistern Other (please specify): **MUNICIPAL**

Is your well used for drinking: Y / N Do you have a copy of the water well record: Y / N

If you have a well please complete following section to the best of your knowledge.

Is your well: Drilled Dug Date well installed: **WHO KNOWS - THE HOUSE IS 100 YRS OLD**

Well diameter: 4" / 5" / 6" / 36" / other:

Depth of well: **4' VISIBLE** Water level in well: **LOW**

UTM coordinates for well:

Water supply adequate Water quality: Good / Poor

All year: Y / N

Colour /
OPEN WELL IN BASEMENT
Comments: **UNUSED**

Treatment System: Y / N Type:

Septic System Information (continued on Page 2)

Do you have a private septic system:

Yes No (municipally serviced) Don't Know

Do you have a copy of the on-site sewage works approval: Y / N

If you have a septic system please complete following section to the best of your knowledge.

Date of installation (approximate): **NO IDEA**

Who was the installation contractor: **NO IDEA**

Number of people in the household: **4**

When was the system last cleaned out: **CLEANED OUT YEARLY**

Where is the septic tank/treatment unit and what is its capacity: **NO IDEA**

Private Well and Septic System Survey Form



Septic System Information (continued)

Have there been any maintenance issues with the system: Y / N

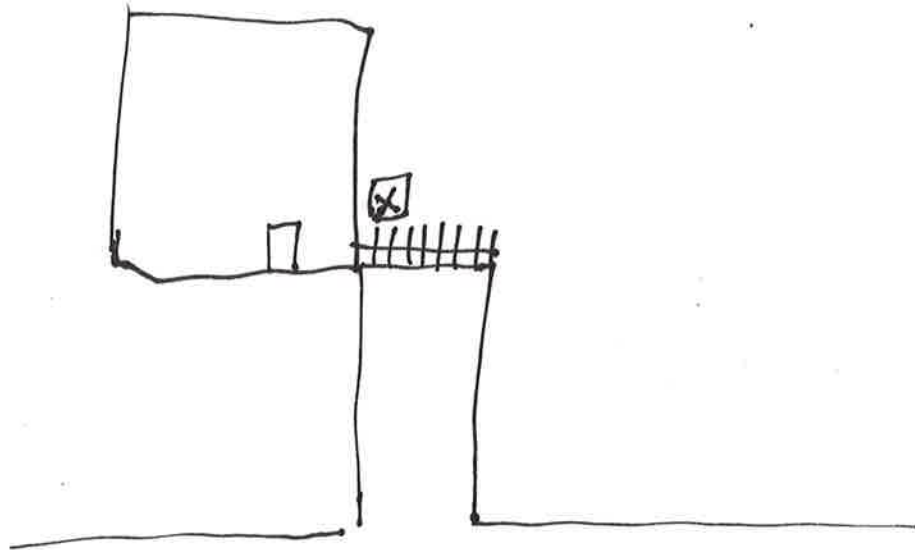
Length and number of distribution tiles in the leaching bed: **NO IDEA**

Is there a pump chamber: Y / N

UTM Coordinates of septic tank: **NO IDEA**

UTM Coordinates of leaching bed: **NO IDEA**

Well and/or Septic System Location: (Please Sketch Locations on the property)



Additional Comments:

Amec Foster Wheeler Environment & Infrastructure

TP115085.1.6200

Please return completed survey using prepaid envelope provided or to:

Kimberly Gilder, P. Geo.
Amec Foster Wheeler Environment & Infrastructure
160 Traders' Boulevard East, Suite 110
Mississauga, Ontario L4Z 3K7

Private Well and Septic System Survey Form



Home Owner Information

Name: PETER + JUDITH McCAWLEY Phone #: 905-457-9627
Address: 2127 EMBLETON RD. Email: PETERMCCAWLEY@HOTMAIL.COM

Water Use & Well Information (Location sketch to be completed on Page 2)

What is the source of your water: (Please select all that apply)

Well Cistern Other (please specify): CITY

Is your well used for drinking: Y N/A Do you have a copy of the water well record: Y N/A

If you have a well please complete following section to the best of your knowledge.

Is your well: Drilled Dug Date well installed:

Well diameter: 4" / 5" / 6" / 36" / other:

Depth of well: Water level in well:

N/A

UTM coordinates for well:

Water supply adequate Water quality: Good / Poor

All year: Y / N Colour /

Treatment System: Y / N Type: Comments:

Septic System Information (continued on Page 2)

Do you have a private septic system:
 Yes No (municipally serviced) Don't Know

Do you have a copy of the on-site sewage works approval: Y N

If you have a septic system please complete following section to the best of your knowledge.

Date of installation (approximate): 1984

Who was the installation contractor: ?

Number of people in the household: 5

When was the system last cleaned out: 2012

Where is the septic tank/treatment unit and what is its capacity: WEST SIDE OF HOUSE
DON'T KNOW CAPACITY

Private Well and Septic System Survey Form



Septic System Information (continued)

Have there been any maintenance issues with the system: Y N

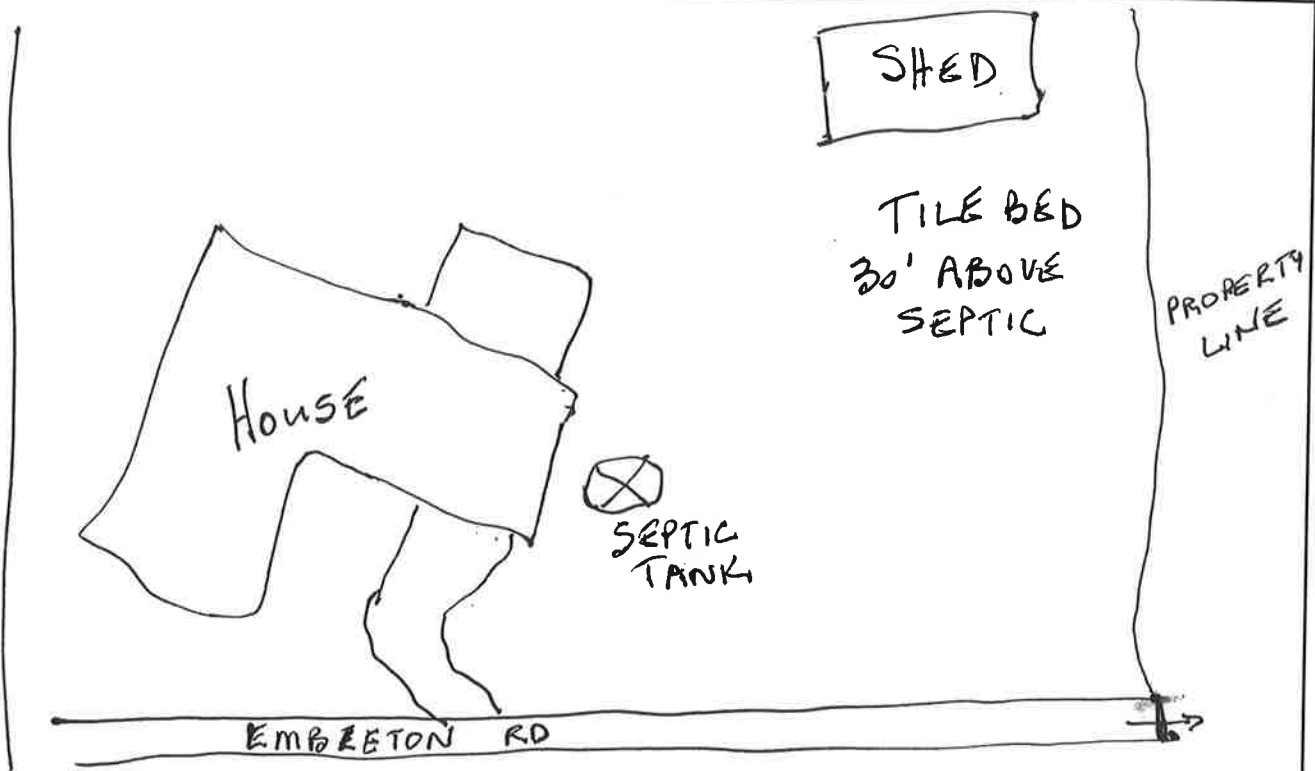
Length and number of distribution tiles in the leaching bed: *DON'T KNOW*

Is there a pump chamber: / N

UTM Coordinates of septic tank:

UTM Coordinates of leaching bed:

Well and/or Septic System Location: (Please Sketch Locations on the property)



Additional Comments:

Amec Foster Wheeler Environment & Infrastructure

TP115085.1.6200

Please return completed survey using prepaid envelope provided or to:

Kimberly Gilder, P. Geo.
Amec Foster Wheeler Environment & Infrastructure
160 Traders' Boulevard East, Suite 110
Mississauga, Ontario L4Z 3K7

Private Well and Septic System Survey Form



Home Owner Information

Name: ATAL PANDEY & BHUVNESHWARI PANDEY
Phone #: ~~416~~ 905 452 0197
Email: ATALPANDEY@HOTMAIL.COM
Address: 2058 EMBLETON RD, BRAMPTON L6X 0C9

Water Use & Well Information (Location sketch to be completed on Page 2)

What is the source of your water: (Please select all that apply)

Well Cistern Other (please specify): MUNICIPAL

Is your well used for drinking: Y / N Do you have a copy of the water well record: Y / N

If you have a well please complete following section to the best of your knowledge.

Is your well: Drilled Dug Date well installed:

Well diameter: 4" / 5" / 6" / 36" / other:

Depth of well: Water level in well:

UTM coordinates for well: NA

Water supply adequate Water quality: Good / Poor

All year: Y / N Colour /

Treatment System: Y / N Type: Comments:

Septic System Information (continued on Page 2)

Do you have a private septic system:
 Yes No (municipally serviced) Don't Know

Do you have a copy of the on-site sewage works approval: Y N

If you have a septic system please complete following section to the best of your knowledge.

Date of installation (approximate): 1986

Who was the installation contractor: Bought home in 2015

Number of people in the household: 2

When was the system last cleaned out: 2015

Where is the septic tank/treatment unit and what is its capacity: Side of the house (West)

Private Well and Septic System Survey Form



Septic System Information (continued)

Have there been any maintenance issues with the system: Y / N

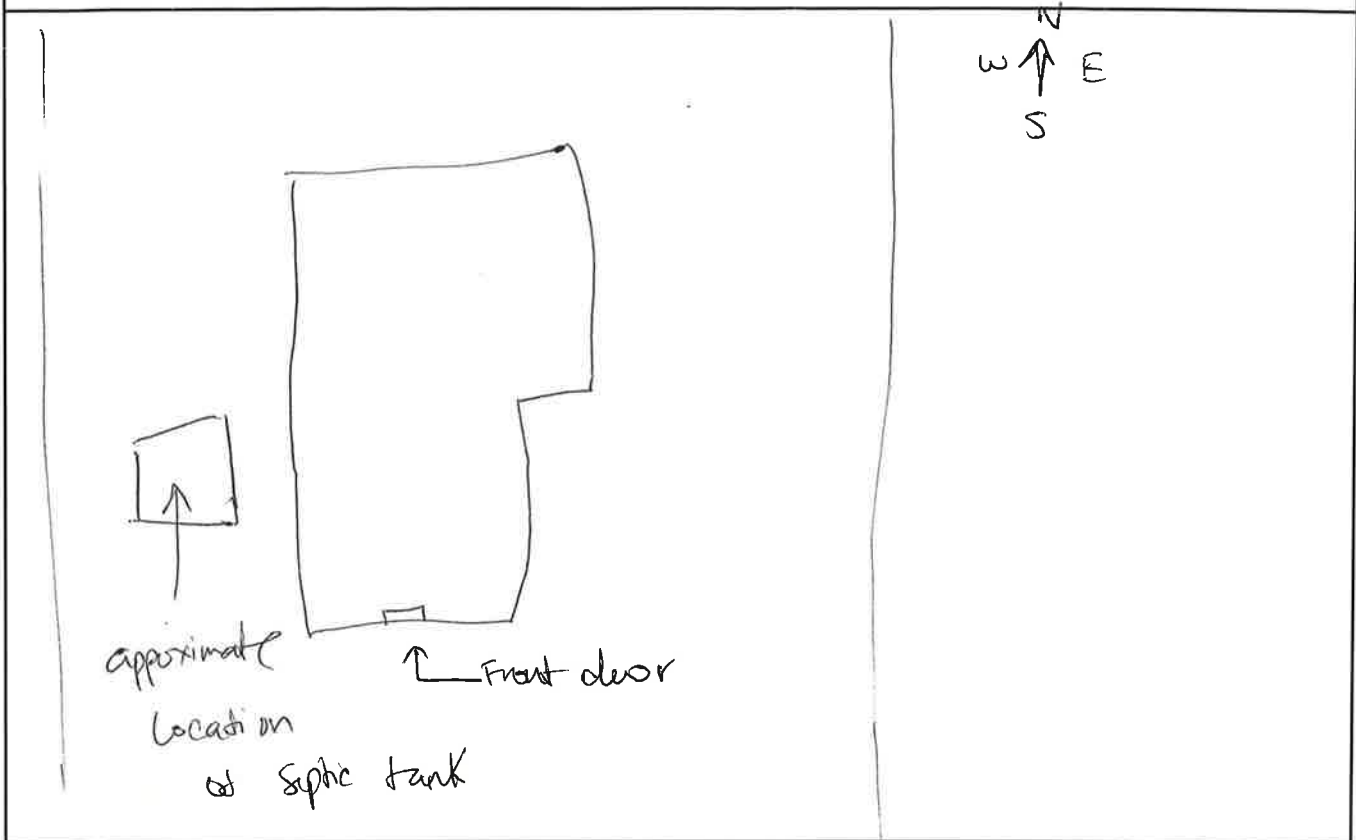
Length and number of distribution tiles in the leaching bed: 3

Is there a pump chamber: Y N

UTM Coordinates of septic tank: N/A

UTM Coordinates of leaching bed: N/A

Well and/or Septic System Location: (Please Sketch Locations on the property)



Additional Comments:

Please return completed survey using prepaid envelope provided or to:

Kimberly Gilder, P. Geo.
Amec Foster Wheeler Environment & Infrastructure
160 Traders' Boulevard East, Suite 110
Mississauga, Ontario L4Z 3K7



APPENDIX E
Report Limitations



**Amec Foster Wheeler Environment & Infrastructure,
a Division of Amec Foster Wheeler Americas Limited**

REPORT LIMITATIONS

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during the construction to confirm that the subsurface conditions across the site do not deviate materially from those encountered in the test holes.

The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, it is recommended that Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited be retained during the final design stage to verify that the design is consistent with Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited's recommendations, and that assumptions made in Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited's analysis are valid.

The comments made in this report relating to potential construction problems and possible methods of construction are intended only for the guidance of the Designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The Contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

The benchmark and elevations mentioned in this report were obtained strictly for use by Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited in the geotechnical report. They should not be used by any other party for any other purpose.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.