Region of Peel

Mississauga Road Improvements from North of Bovaird Drive West to Mayfield Road Municipal Class Environmental Assessment Environmental Study Report

VOLUME 2 – Appendices C to H

April 2013

AECOM

Appendix C

Background Reports

- C.1 Stage 1 and 2 Archaeological Assessments
- C.2 Built Heritage and Cultural Landscape Assessment
- C.3 Ecological Investigations and Impact Assessment
- C.4 Meander Belt Study
- C.5 Stormwater Management
- C.6 Noise Impact Study
- C.7 Air Quality Assessment
- C.8 Geotechnical/Hydrogeological Report

AECOM

C.1 Stage 1 and 2 Archaeological Assessments

Stage 1 Archaeological Assessment

Alloa Reservoir, Pumping Station, and Feedermain
Class Environmental Assessment,
City of Brampton, Region of Peel, Ontario

Submitted to:

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Archaeological License P243
MCL CIF #P243-008-2007

May 2007

ARCHAEOLOGICAL SERVICES INC.
ENVIRONMENTAL ASSESSMENTS

PROJECT PERSONNEL

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Stage 1 Archaeological Assessment

Alloa Reservoir, Pumping Station, and Feedermain Class Environmental Assessment, City of Brampton, Region of Peel, Ontario

1.0 INTRODUCTION

Archaeological Services Inc. (ASI) was contracted by Earth Tech Canada Inc., St. Catherines, to conduct a Stage 1 archaeological assessment for the Alloa Reservoir, Pumping Station, and Feedermain Class Environmental Assessment, City of Brampton, Region of Peel, Ontario (Figure 1). The project consists of the proposed construction of a 35 ML reservoir and pumping station in the vicinity of Mayfield Road and Creditview Road, and a 1200 mm diameter feedermain from the intersection of Mississauga Road and Bovaird Drive to the proposed Alloa Reservoir. Six different sites have been proposed for the new reservoir and pumping station, some which overlap. Three different routes have also been proposed for the new feedermain.

The assessment was conducted under the project direction of Mr. Robert Pihl, ASI, under an archaeological license (P243) issued to Dr. Carla Parslow. All fieldwork was conducted by Mr. Pihl, pursuant to the *Ontario Heritage Act* (2005).

Permission to access the study area and to carry out the activities necessary for the completion of the Stage 1 assessment was granted to ASI by Earth Tech Canada Inc. on January 17, 2007. This report presents the results of the Stage 1 background research and field review and makes several recommendations.

2.0 STAGE 1 BACKGROUND RESEARCH

The Stage 1 archaeological assessment of the EA study area was conducted in accordance with the Ontario Ministry of Culture's archaeological assessment technical guidelines (2006). A Stage 1 archaeological assessment involves research to describe the known and potential archaeological resources within a study area. Such an assessment incorporates a review of previous archaeological research, physiography, and land use history for the property. Background research was completed to identify any archaeological sites in the study area and to assess its archaeological site potential.

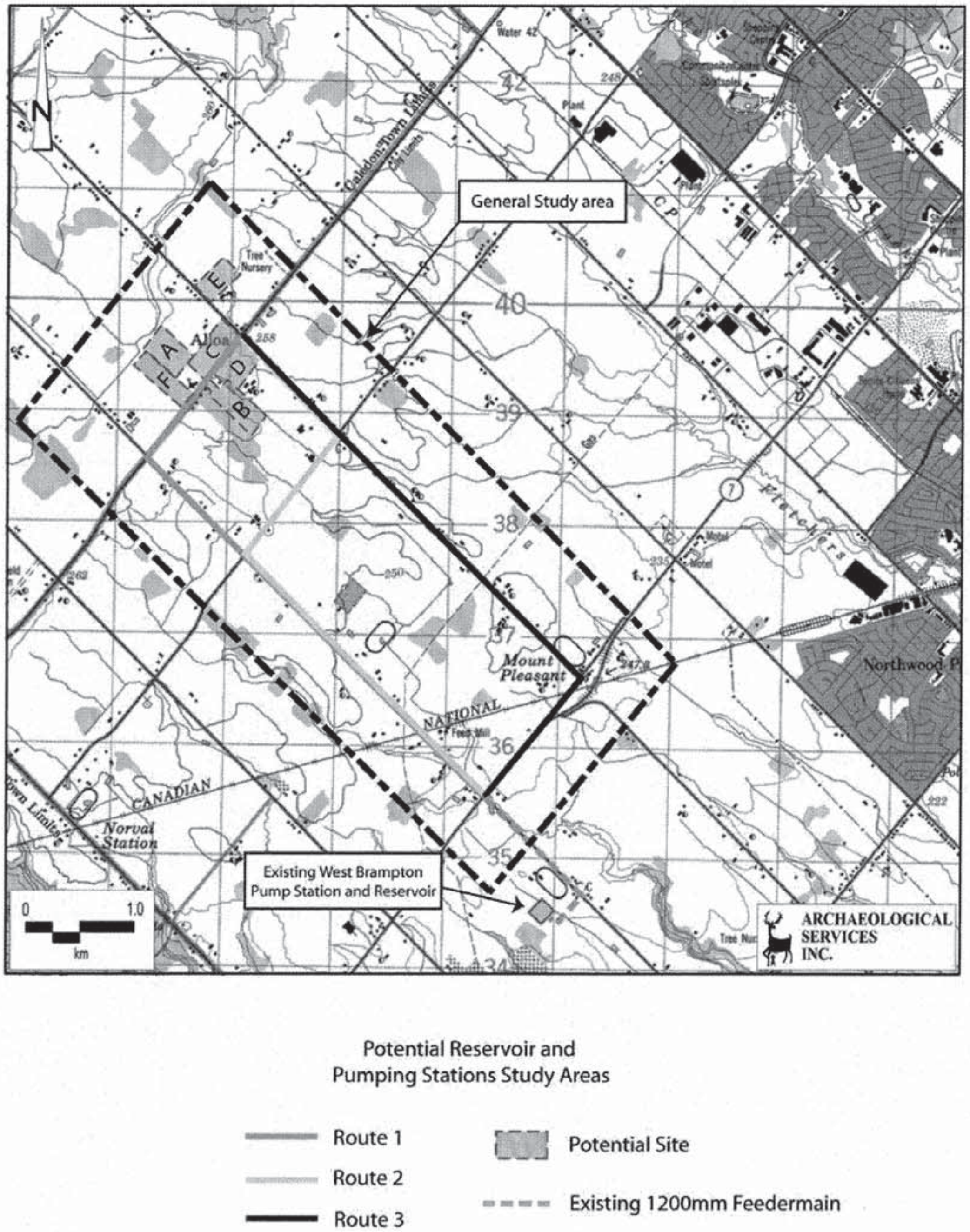

Figure 1: Location of the study area (NTS map Brampton, 30 M/12)

2.1 Previous Archaeological Research

In order that an inventory of archaeological resources could be compiled for the study area, three sources of information were consulted: registered archaeological site records kept by the Ontario Ministry of Culture; published and unpublished documentary sources; and the files of ASI.

In Ontario, information concerning archaeological sites is stored in the Ontario Archaeological Sites Database (OASD) maintained by the Ontario Ministry of Culture. This database contains archaeological sites registered according to the Borden system. Under the Borden system, Canada has been divided into grid blocks based on latitude and longitude. A Borden Block is approximately 13 kilometres east to west, and approximately 18.5 kilometres north to south. Each Borden Block is referenced by a four-letter designator, and sites within a block are numbered sequentially as they are found. The study area under review is located in Borden Blocks *AjGw, AkGw, and AkGx.*

According to the OASD, 10 archaeological sites have been previously registered within the immediate vicinity of the study area or within approximately two kilometres of its limits.

Table 1: Registered Sites in Vicinity of Study Area

Borden No.	Name	Temporal/ Cultural Affiliation	Site Type	Researcher
AjGw-18	Fraser	Archaic	Campsite	D. Spittal, 1977
AjGw-355	1-1	Euro-Canadian	Homestead	C. Dodd, 2003
AkGw-153	N/A	Pre-Contact	Findspot	K. Slocki, 2001
AkGw-68	Samual McClure	Euro-Canadian	Homestead	D. Poulton, 1993
AkGx-20	Creditview 1	Pre-Contact	Scatter	J. Bursey, 1998
AkGx-21	Creditview 2	Plaeo-Indian, Late	Findspot	J. Bursey, 1998
AkGx-22	Creditview 3	Early Archaic (Netting/Kirk)	Findspot	J. Bursey 1998
AkGx-37	N/A	Early Archaic	Findspot	R. Williamson, 1997
AkGx-42	Alloa	Middle Archaic, Late Archaic	Campsite	M. Cooper, 2001; B. Welsh, 2003
AkGx-47	N/A	Late Archaic	Findspot	M. Henry,2005

In 2005, ASI conducted a Stage 2 archaeological assessment of the proposed West Brampton Reservoir, Pumping Station and Transmission Main, City of Brampton, which is illustrated in pink in Figure 1 (ASI 2005). Three prehistoric findspots, none of which were culturally diagnostic, were identified, one of which has been registered with the Ministry of Culture (Findspot P2, AjGw-383). No further archaeological assessment was recommended for the study area which was considered clear of additional concern. A report is now on file at the Ministry of Culture, Toronto.

2.2 Physiography and Assessment of Pre-contact Archaeological Potential

The study area is situated within the South Slope physiographic region of southern Ontario which forms the south slope of the Oak Ridges moraine and also includes the strip of land south of the Peel plain (Putnam and Chapman 1984). The study area is located in that region between the Oak Ridges moraine and the Peel plain which, in this area, is characterized by a surface of ground moraine of limited relief. The clay loam soils (Soil Survey 1953) and gently sloping terrain are drained by tributaries of Fletchers and Etobicoke Creek which is located east of the study area and is itself a tributary of the Credit River tributary to the west of the study area.

Water is arguably the single most important resource necessary for any extended human occupation or settlement and proximity to water can be regarded as the primary indicator of archaeological site potential. Accordingly, distance from water is one of the most commonly used variables for predictive modeling of archaeological site location.

The Ministry of Culture's draft *Standards and Guidelines for Consulting Archaeologists* (2006: Unit 1c 5 – 7, 10) stipulates that undisturbed land within 300 metres of a primary water source (lakeshore, river, large creek, etc.), and undisturbed land within 200 metres of a secondary water source (stream, spring, marsh, swamp, etc.), as well as undisturbed land within 300 metres of an ancient water source (as indicated by remnant beaches, shorecliffs, terraces, abandoned river channel features, etc.), are considered to have archaeological potential.

Based on the presence of the Fletchers Creek tributaries, the study area may be characterized as having potential for the presence of archaeological sites.

2.3 Assessment of Historic Site Potential

The 1877 *Historical Atlas of Peel County, Ontario* was reviewed to determine the potential for the presence of nineteenth century archaeological remains within the study area. The study area is located within parts of Lot 10 to 18, Concession III to IV in the former Township of Chinguacousy, County of Peel (Figure 2).

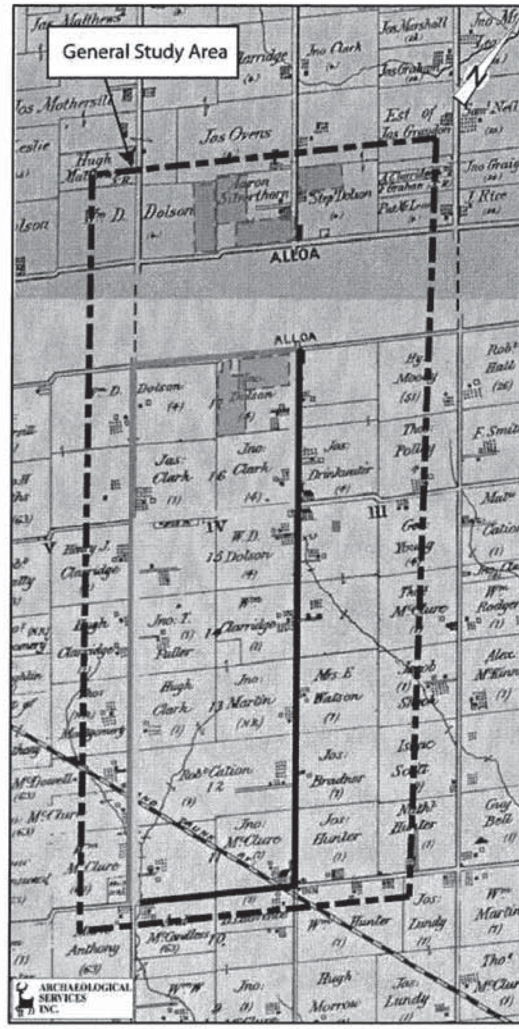

Figure 2: Study area highlighted on a map of Chingacousy Township in the 1877 *Historical Atlas of Peel County, Ontario.*

According to the atlas, a number of property owners and historical features are illustrated within or adjacent to the study area. Table 2 presents a list of such features and owners/residents located within or adjacent to each individual proposed feedermain routes and the location of the proposed stations. It should be noted, however, that not all features of interest were mapped systematically in the Ontario series of historical atlases, given that they were financed by subscription, and subscribers were given preference with regard to the level of detail provided on the maps. Moreover, not every feature of interest would have been within the scope of the 1877 atlas.

Table 2: Property Owner(s)/Resident(s) and Historical Feature(s) Illustrated Within or Adjacent to the Study Area

Con.#	Lot#	Owner(s)/Resident(s)	Feature(s)	Proposed Routes/Sites
III	10	Wm. Hunter	Inn	Route 3
	11	Jos. Hunter (west)	Blacksmiths shop and residence	Route 3
	12	Jos. Bradnor (west)	Residence	Route 3
	13	Mrs. E. Watson (west)	Residence with orchard	Route 3
	14	W.D. Dolson (west)	---	Route 3
	15	W.D. Dolson (west)	School house; Spring	Route 3
	16	Jas. Drinkwater (west)	Church; Residence with orchard	Routes 2 and 3
	17	Jno. Dolson (NW) Jas. Drinkwater (SW)	Residence with orchard; Residence ---	Routes 2 and 3 Routes 2 and 3
	18	Steph. Dolson	Residence	Routes 1, 2, 3; Sites E
IV	10	Andw. McCandless (west) D. Lawrence (east)	Residence with orchard Barn	Routes 1, 2 and 3 Routes 1, 2 and 3
	11	Robt. Cation	---	Routes 1, 2 and 3
	13	Hugh Clark (west) Jno. Martin (east)	Residence, barn and orchard Residence, barn and orchard	Routes 1 and 2 Route 3
	14	Jno. T. Fuller (west) Wm. Clarridge (east)	--- Residence with orchard	Route 1 and 2 Route 3
	15	Jas. Clark (west) W.D. Dolson (east) W.G.B. (NW)	--- Cemetery; orchard Residence	Routes 1 and 2 Routes 2 and 3 Route 2
	16	Jas. Clark (west) Jno. Clark (east)	Residence with orchard Residence with orchard; Residence	Routes 1 and 2 Routes 2 and 3
	17	Wm. D. Dolson (west) Jno. Dolson	Residence Orchard	Route 1, Site F Routes 1, 2, 3; Sites B, D
	18	Wm. D. Dolson (west) Aaron Silverthorn	--- Residence with orchard	Route 1 Routes 1, 2, 3; Sites A, C
V	10	Mark Anthony (east)	Orchard	Routes 1, 2, and 3
	11	Wm. McClure (east) Mrs. B. (SE)	Residence with orchard Orchard	Routes 1 and 2 Routes 1 and 2
	12	Jno. McClure (south) D. McDowell (north)	Residence, barn and orchard ---	Routes 1 and 2 Routes 1 and 2
	13	Thos. Montgomery (east)	---	Routes 1 and 2
	14	Hugh Clarridge (east)	Two residences with orchards	Routes 1 and 2
	15	Henry J. Clarridge (east)	Residence with orchard	Routes 1 and 2
	16	Wm. D. Dolson (east)	---	Routes 1 and 2
	17	Wm. D. Dolson (east)	Residence and barn	Route 1
	18	Wm. D. Dolson (east)	---	Route 1

For the Euro-Canadian period, the majority of early nineteenth century farmsteads (i.e., those which are arguably the most potentially significant resources and whose locations are rarely recorded on nineteenth century maps) are likely to be captured by the basic proximity to the water model outlined in Section 2.2, since these occupations were subject to similar environmental constraints. An added factor however is the development of the network of concession roads and railroads through the course of the nineteenth century. These transportation routes frequently influenced the siting of farmsteads and businesses. Accordingly, undisturbed lands within 100 metres of an early settlement road, such as present Mississauga Road, Creditview Road, Highway 7, Wanless Drive and Mayfield Road, or within 100 metres of an early railroad, such as present the Canadian National Rail, are also considered to have potential for the presence of Euro-Canadian archaeological sites.

Therefore, depending on the degree of previous land disturbance, it may be concluded that there is potential for the recovery for historic cultural material within the Alloa Reservoir and Pumping Station and Feedermain study area.

3.0 FIELD ASSESSMENT

A field review of the study area was carried out by Mr. Robert Pihl (P057), ASI, on March 28, 2007 in order to confirm the assessment of archaeological site potential and to determine the degree to which development and landscape alteration may have affected that potential. Weather conditions during the field assessment were cool with clear skies. Field observations and photographs have been compiled on a map of the study area (Figure 3; Plates 1 to 40). The study area includes three feedermain route alternatives and six potential reservoir and pumping stations.

All feedermain routes originate at the intersection of Bovaird Drive (formerly Highway 7), and Mississauga Road. Routes 1 and 2 run up Mississauga Road and diverge at Wanless Drive. Route 1 heads north to Mayfield Road, then heads east to the intersection of Creditview Road. Route 2 heads north to Wanless Drive then east to Creditview Road, it then runs north on Creditview to Mayfield Drive. Route 3 runs east on Bovaird Drive to Creditview Road and then heads north to the Mayfield Road. intersection.

Route 1 runs north on Mississauga Road, within the existing ROW (Plates 1, 4, 6-11, 13-17). Mississauga Road shows disturbance on both sides of the road due to road widening and sewer trunk installation. A small creek flows under the road just south of Mayfield Road (Plate 15). Mayfield Road is also disturbed within the ROW, with rolling agricultural fields adjacent to the road (Plates 18-19). It is not anticipated that feedermain installation activities will occur outside the disturbed ROW on Mississauga Road or Mayfield Road.

Route 2 also runs within the existing ROW of Mississauga Road. This route diverges from Route 1 at Wanless Drive, where the ROW is disturbed and agricultural fields lie adjacent to the road (Plates 20-24). A creek runs under the Wanless Drive half-way between Mississauga Road and Creditview Road, flowing through low-lying wetlands (Plate 22). Running north on Creditview, the ROW is disturbed and agricultural fields lie adjacent to the road (Plates 29-32). A small creek crosses under the road, south of Mayfield Road (Plate 33). It is not anticipated that feedermain installation activities will occur outside the disturbed ROW on Mississauga Road, Wanless Drive, or Creditview Road.

Route 3 runs east on Bovaird Drive in the ROW (Plates 2-3, 5). Bovaird Drive shows disturbance on both sides of the road due to road widening and sewer trunk installation. The route then runs north on Creditview Road to Mayfield Road, where the ROW is disturbed (Plates 25-28). Agricultural fields are adjacent to the road. It is not anticipated that feedermain installation activities will occur outside the disturbed ROW on Bovaird Drive, Creditview Road, or Mayfield Road.

All six potential reservoir and pumping station sites are located near the Mayfield Road and Creditview Road intersection (Plates 34-40). The potential sites are situated on gently rolling agricultural land. Due to the relatively undisturbed nature of this land and presence of nearby drainages, archaeological potential is determined to be present for all six sites.

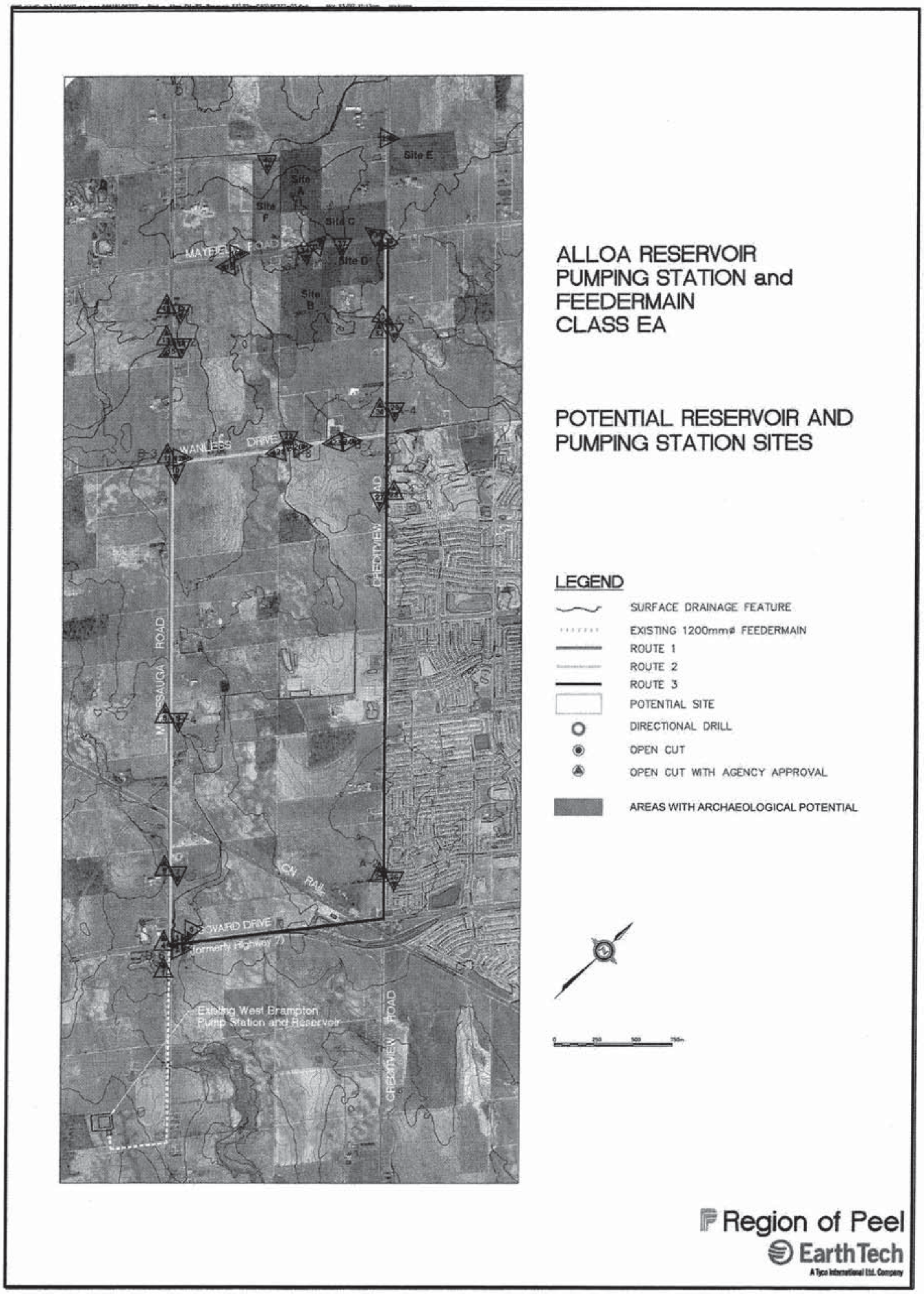

Figure 3: Alloa Reservoir, Pumping Station and Feedermain Class EA – Results of Stage 1 Archaeological Assessment

4.0 SUMMARY AND RECOMMENDATIONS

The Stage 1 archaeological assessment of the Alloa Reservoir Pumping Station and Feedermain Class Environmental Assessment, City of Brampton, Region of Peel, Ontario revealed that 10 archaeological sites have previously been registered within approximately two kilometres of the study area. Additionally, a review of the general physiography and local nineteenth century land use within the study area suggested that it exhibits archaeological site potential.

All three potential feedermain routes are within existing road ROWs. The field review conducted by Mr. Rob Pihl, ASI, confirmed that disturbance due to road widening, ditches, and existing sewer installation extends to the right-of-way limit. These three routes, therefore, have no archaeological potential.

All potential reservoir and pumping station sites are in agricultural lands. These lands are reasonably undisturbed with associated drainages and therefore have archaeological potential.

In light of these results, the following recommendations are made:

1. No additional archaeological assessment is recommended for the three Feedermain routes (Figure 3) and they are considered clear of any further archaeological concern;

2. Should the proposed construction of the Alloa Reservoir and Pumping Station encroach onto previously undisturbed lands determined to have archaeological site potential (see Figure 3; green areas), a Stage 2 archaeological assessment should be conducted in accordance with the Ministry of Culture's *Standards and Guidelines for Consultant Archaeologists* (2006 final draft). This work is required prior to any land disturbing activities in order to identify any archaeological remains that may be present

The above recommendations are subject to Ministry of Culture approval, and it is an offence to alter any archaeological site without Ministry of Culture concurrence. No grading or other activities that may result in the destruction or disturbance of an archaeological site are permitted until notice of Ministry of Culture approval has been received.

The following conditions also apply:

- Should deeply buried archaeological remains be found during construction activities, the Heritage Operations Unit of the Ontario Ministry of Culture should be notified immediately.

- In the event that human remains are encountered during construction, the proponent should immediately contact both the Ministry of Culture, and the Registrar or Deputy Registrar of the Cemeteries Regulation Unit of the Ministry of Government Services, Consumer Protection Branch at (416) 326-8404 or toll-free at 1-800-889-9768.

The documentation related to the archaeological assessment of this project will be curated by archaeological Services Inc. until such a time that arrangements for their ultimate transfer to Her Majesty the Queen in right of Ontario, or other public institution, can be made to the satisfaction of the project owner, the Ontario Ministry of Culture, and any other legitimate interest groups.

5.0 REFERENCES CITED

Archaeological Services Inc. (ASI)

2005 Stage 2 Archaeological Assessment, West Brampton Reservoir, Pumping Station and Transmission Main, City of Brampton, Regional Municipality of Peel, Ontario. On file at the Ministry of Culture, Toronto.

Chapman, L.J. and D.F. Putnam

1984 *The Physiography of Southern Ontario*. Second Edition. Toronto: University of Toronto Press.

Historical Atlas of Peel County, Ontario.

1877 Toronto: Walker and Miles.

Ministry of Culture

1997 Conserving a Future for our Past: Archaeology, Land Use Planning & Development in Ontario. Toronto: Cultural Programs Branch, Archaeology & Heritage Planning Unit.

2006 *Standards and Guidelines for Consultant Archaeologists* (final draft). Toronto: Cultural Programs Branch, Archaeology and Planning Unit

Soil Survey Map

1953 *Soil Map of Peel Coiunty, Ontario, Soil Survey Report* No. 18. Ottawa.

6.0 PHOTOGRAPHS

Plate 1: View northwest along west side of Mississauga Road.

Plate 2: View northeast along south side of Bovaird Street.

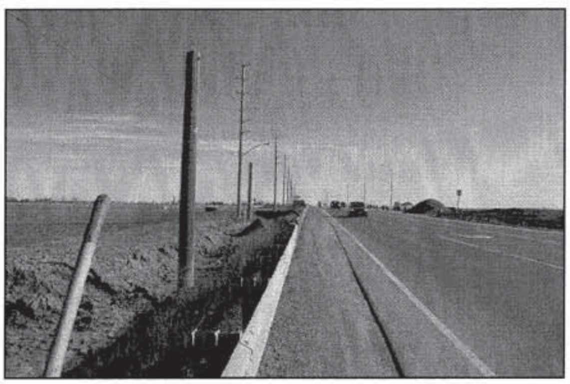

Plate 3: View to the northwest along the north side of Bovaird Drive at disturbed ROW due to widening of the intersection.

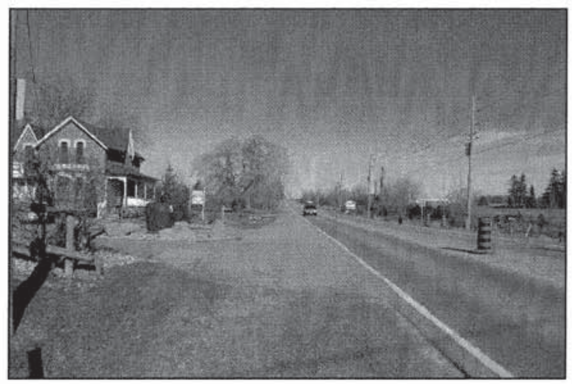

Plate 4: View to the northwest along west side of Mississauga Road at distribued ROW where additional shafts of sewer installations are to occur

Plate 5: View along illustrating disturbance where additional sewer shafts are being installed.

Plate 6: View northwest along Mississauga Road. (west side) along disturbed ROW

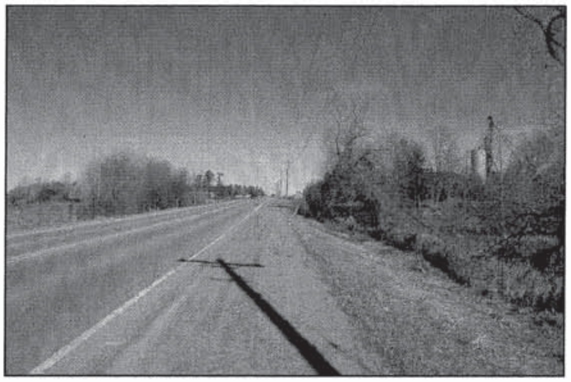

Plate 7: View northwest along Mississauga Road (east side).

Plate 8: View northwest along Mississauga Road. (east side).

Plate 9: View southeast along Mississauga Road (west side).

Plate 10: View southeast along Mississauga Road (east side).

Plate 11: View northwest along Mississauga Road (west side).

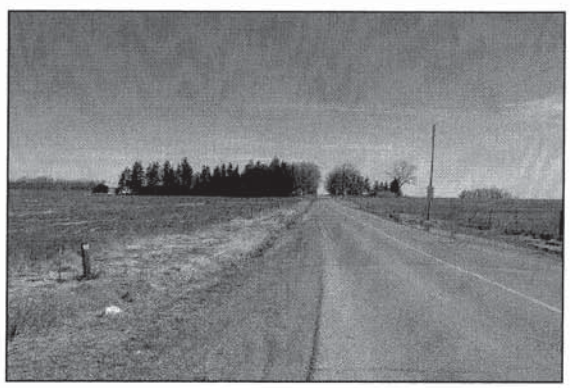

Plate 12: View northeast along Mississauga Road (north side).

Plate 13: View southeast along Mississauga Road (west side)

Plate 14: View southeast along Mississauga Road (east side).

Plate 15: View of a small creek within a field south of Mississauga Road.

Plate 16: View northwest along Mississauga Road (west side).

Plate 17: View southeast along Mississauga Road (east side).

Plate 18: View southwest along Mayfield Road (south side).

Plate 19: View northeast along Mayfield Road.(north side).

Plate 20: View to the southwest (south side) of Wanless Drive.

Plate 21: View to the southwest (south side) of Wanless Drive.

Plate 22: View to the southeast of Wanless Drive showing ploughed agricultural lands except where wetlands associated with a small creek.

Plate 23: View southwest (south side) of Wanless Drive.

Plate 24: View northeast (south side) of Wanless Drive.

Plate 25: View to the northwest along Creditview Road (west side).

Plate 26: View to the southeast along Creditview Road (east side).

Plate 27: View southeast along Creditview Road (west side).

Plate 28: View northwest along Creditview Road (east side).

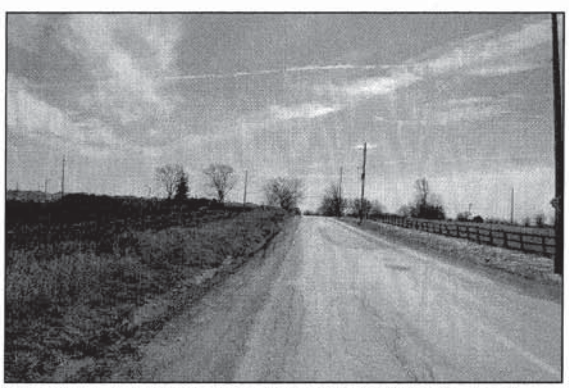

Plate 29: View southeast along Creditview Road (east side).

Plate 30: View northwest along Creditview Road (west side).

Plate 31: View to the southeast (east side) along Creditview Road.

Plate 32: View to the northwest (west side) along Creditview Road.

Plate 33: View to the east along Creditview Road showing a creek , ploughed agricultural field. Note new fence along ROW.

Plate 34: View to the southeast off Mayfield Road across from hay field at potential site B.

Plate 35: View to the north off Mayfield Road looking across agricultural field that will need ploughing at potential site C.

Plate 36: View to the west off Mayfield Road looking across agricultural field that will need ploughing at potential site C.

Plate 37: View southeast off Mayfield Road looking across ploughed agricultural field at potential site D

Plate 38: View to the south off Mayfield Road looking across agricultural field that will need ploughing at potential site D.

Plate 39: View to the northeast looking across agricultural field that will need ploughing at potential site E.

Plate 40: View to the northwest looking across agricultural field that will need ploughing at potential site F.

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Stage 1 and 2 Archaeological Assessments Mississauga Road 1200 mm Sanitary Sewer, 1200 mm Feedermain and 600 mm Watermain Parts of Lots 10–14, Concession 4–5 W.H.S. Geographic Township of Chinguacousy City of Brampton Regional Municipality of Peel, Ontario

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Project #P007-368 and #P007-391
PIF #P007-368-2011 and #P007-391-2012

12/07/2012

Original Report

EXECUTIVE SUMMARY

Under a contract awarded by GENVIAR in September 2011, Archaeological Research Associates Ltd. carried out Stage 1 and 2 archaeological assessments of lands with the potential to be impacted by the proposed Mississauga Road 1200 mm Sanitary Sewer and 600 mm Watermain project in the City of Brampton, Regional Municipality of Peel, Ontario. Although not part of this project, the proposed Mississauga Road 1200 mm Feedermain will share the same tunnel and tunnel shaft staging areas as of the 1200 mm Sanitary Sewer. All of these three pipes will be constructed as part of one construction contract and approximately within the same timeframe. This report documents the background research and fieldwork involved in these assessments, and presents conclusions and recommendations pertaining to archaeological concerns within the project lands. The assessment was completed as a component of a Municipal Class Environmental Assessment study, in compliance with the *Environmental Assessment Act*.

The background research component of the Stage 1 assessment determined that several of the properties within the study area were previously assessed between 2006 and 2010. The majority of these surveyed lands were not recommended for further assessment, but one property contains the Euro-Canadian Primont H1 site, which was recommended for a Stage 3 site-specific assessment. Although the subject study area traverses the extent of Primont H1, project impacts in this area will occur approximately 27 m below the ground surface in the shared tunnel for the Mississauga Road 1200 mm Sanitary Sewer and 1200 mm Feedermain. In August 2008, Archaeological Research Associates Ltd. also conducted a Stage 1 assessment for the proposed widening of Mississauga Road, which included lands within the current project limits. Since this report has been accepted into the Provincial Register of Reports, the results of the archaeological potential modelling are reproduced in the present study.

The Stage 1 assessment of the previously un-assessed portions of the study area was conducted in October 2011 and June 2012 under licence #P007, PIF #P007-368-2011. The Stage 1 assessment identified several local features of archaeological potential, including an unnamed tributary of the Credit River, Bovaird Drive West, Mississauga Road, the Canadian National Railway, and two registered archaeological sites. On-site documentation, however, identified several disturbed areas within the study area. Accordingly, in its current state, the study area comprises a mixture of areas of archaeological potential and no archaeological potential. The previously un-assessed areas of archaeological potential clearly warranted a Stage 2 assessment.

The Stage 2 assessment of the previously un-assessed lands (i.e. those not subjected to past Stage 2, 3 and/or 4 assessments) was carried out in June 2012 under licence #P007, PIF #P007-391-2012. Legal permission to enter and conduct all necessary fieldwork activities on project lands was granted by the property owners. This assessment, completed under optimal conditions, did not result in the discovery of any archaeological materials.

Based on these findings, Archaeological Research Associates Ltd. recommends that the Primont H1 site be subjected to a Stage 3 site-specific assessment if any future developments are planned in the area that could result in disturbances to the site. Since the shared tunnel for the Mississauga Road 1200 mm Sanitary Sewer and 1200 Feedermain will pass approximately 27 m

below the site, Archaeological Research Associates Ltd. does not recommend that it be assessed prior to construction.

Given that the project limits traverse the extent of Primont H1, however, unintentional project impacts are a concern. In accordance with the direction set out in Section 7.8.5 of the *Standards and Guidelines for Consultant Archaeologists* (MTC 2011:140–141), Archaeological Research Associates Ltd. recommends that 1) all traffic be prohibited within the site or within a 20 m protective buffer around the site, 2) that the 20 m protective buffer be marked by a temporary barrier within the project lands, and 3) that all construction activities within 70 m of the site be monitored by a licenced archaeologist to ensure that impacts do not occur. A reduced buffer is acceptable where it is interrupted by a permanently disturbed cultural form (e.g., Mississauga Road, the CN Railway) (MTC 2011:68). A *Letter of Review and Acceptance into the Provincial Register of Reports* is requested, as provided for in Section 65.1 of the *Ontario Heritage Act*.

TABLE OF CONTENTS

LIST OF IMAGES

LIST OF MAPS

LIST OF TABLES

LIST OF APPENDICES

GLOSSARY OF ABBREVIATIONS

ARA – Archaeological Research Associates Ltd.
CHVI – Cultural Heritage Value or Interest
MTC – (Former) Ministry of Tourism and Culture
MTCS – Ministry of Tourism, Culture and Sport
PIF – Project Information Form
ROW – Right-of-Way
W.H.S. – West of Hurontario Street

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Project Manager: C.E. Gohm (MTCS Licence #R187)
Field Director: P. Hoskins (MTCS Licence #R415)
Assistant Field Director: L. Akida
Field Cartographer (GPS): P. Hoskins
Additional Field Crewmembers: R. Hughes, C. Shipley, T. Taylor, M. Triggs, C. Wilson
Technical Photographer: P. Hoskins
Historical Researcher: C.J. Gohm, M.A.
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1.0 PROJECT CONTEXT

1.1 Development Context

Under a contract awarded by GENVIAR in September 2011, ARA carried out Stage 1 and 2 archaeological assessments of lands with the potential to be impacted by the proposed Mississauga Road 1200 mm Sanitary Sewer and 600 mm Watermain project in the City of Brampton, Regional Municipality of Peel, Ontario. Although not part of this project, the proposed Mississauga Road 1200 mm Feedermain will share the same tunnel and tunnel shaft staging areas as of the 1200 mm Sanitary Sewer. All of these three pipes will be constructed as part of one construction contract and approximately within the same timeframe (see Appendix A –Appendix G). This report documents the background research and fieldwork involved in these assessments, and presents conclusions and recommendations pertaining to archaeological concerns within the project lands. The assessment was completed as a component of a Municipal Class Environmental Assessment study, in compliance with the *Environmental Assessment Act*.

The study area consists of two irregularly-shaped parcels of land (6.69 ha in total) extending along Mississauga Road for approximately 1.9 km from just southeast of Bovaird Drive West to just northwest of the proposed alignment of Sandalwood Parkway West (see Map 1–Map 2). These parcels encompass the proposed alignments of the 1200 mm Sanitary Sewer, 1200 mm Feedermain and the 600 mm Watermain. In legal terms, the study area falls on parts of Lots 10–14, Concession 4–5 W.H.S. and the historically-surveyed road allowance for Mississauga Road in the Geographic Township of Chinguacousy.

The background research component of the Stage 1 assessment determined that several of the properties within the study area were previously assessed between 2006 and 2010 (see Section 1.3.2). The majority of these surveyed lands were not recommended for further assessment, but one property contains the Euro-Canadian Primont H1 site, which was recommended for a Stage 3 site-specific assessment. Although the subject study area traverses the extent of Primont H1, project impacts in this area will occur approximately 27 m below the ground surface in the shared tunnel for the Mississauga Road 1200 mm Sanitary Sewer and 1200 mm Feedermain. In August 2008, ARA also conducted a Stage 1 assessment for the proposed widening of Mississauga Road, which included lands within the current project limits. Since this report has been accepted into the Provincial Register of Reports, the results of the archaeological potential modelling are reproduced in the present study.

The Stage 1 assessment of the previously un-assessed portions of the study area was conducted in October 2011 and June 2012 under licence #P007, PIF #P007-368-2011. The Stage 2 assessment of the previously un-assessed lands was carried out in June 2012 under licence #P007, PIF #P007-391-2012. Legal permission to enter and conduct all necessary fieldwork activities on project lands was granted by the property owners. In compliance with the objectives set out in Section 1.0 and Section 2.0 of the *Standards and Guidelines for Consultant Archaeologists* (MTC 2011:13–41), these investigations were carried out in order to:

- Provide information concerning the study area's geography, history and current land condition;

- Determine the presence of known archaeological sites in the study area;
- Evaluate in detail the study area's archaeological potential;
- Empirically document all archaeological resources on the properties;
- Determine whether the properties contains resources requiring further assessment; and
- Recommend appropriate Stage 3 assessment strategies for identified archaeological sites.

The assessments were conducted in accordance with the provisions of the *Ontario Heritage Act*, R.S.O. 1990, c. O.18. All notes, photographs and records pertaining to the project are currently housed in ARA's processing facility located at 154 Otonabee Drive, Kitchener. Subsequent long-term storage will occur at ARA's head office located at 97 Gatewood Road, Kitchener.

The MTCS is asked to review the results and recommendations presented in this report and provide their endorsement through a *Letter of Review and Acceptance into the Provincial Register of Reports.*

1.2 Historical Context

After a century of archaeological work in southern Ontario, scholarly understanding of the historic usage of lands in the City of Brampton has become very well-developed. What follows is a detailed summary of the archaeological cultures that have settled in the vicinity of the study area over the past 11,000 years; from the earliest Palaeo-Indian hunters to the most recent Euro-Canadian farmers.

1.2.1 Pre-Contact

1.2.1.1 Palaeo-Indian Period

The first documented evidence of occupation in southern Ontario dates to around 9000 BC, after the retreat of the Wisconsinan glaciers and the formation of Lake Algonquin, Early Lake Erie and Early Lake Ontario (Jarrow and Warner 1990; Jackson et al. 2000:416–419). At that time small Palaeo-Indian bands moved into the region, leading mobile lives based on the communal hunting of large game and the collection of plant-based food resources (Ellis and Deller 1990:38; MCL 1997:34). Current understanding suggests that Palaeo-Indian peoples ranged over very wide territories in order to live sustainably in a post-glacial environment with low biotic productivity. This environment changed considerably during this period, developing from a sub-arctic spruce forest to a boreal forest dominated by pine (Ellis and Deller 1990:52–54, 60).

An Early Palaeo-Indian period (ca. 9000–8400 BC) and a Late Palaeo-Indian period (ca. 8400–7800 BC) are discernable amongst the lithic spear and dart points. Early points are characterized by grooves or 'flutes' near the base while the later examples lack such fluting. All types would have been used to hunt caribou and other 'big game'. Archaeological sites from both time-periods typically served as small campsites or 'way-stations' (occasionally with hearths or fire-pits), where tool manufacture/maintenance and hide processing would have taken place. For the most part, these sites tend to be small (less than 200 sq. m) and ephemeral (Ellis and Deller 1990:51–52, 60–62). Many parts of the Palaeo-Indian lifeway remain unknown.

1.2.1.2 Archaic Period

Beginning in the early 8th millennium BC, the biotic productivity of the environment began to increase as the climate warmed and southern Ontario was colonized by deciduous forests. This caused the fauna of the area to change as well, and ancient peoples developed new forms of tools and alternate hunting practices to better exploit both animal and plant-based food sources. These new archaeological cultures are referred to as 'Archaic'. Thousands of years of gradual change in stone tool styles allows for the recognition of Early (7800–6000 BC), Middle (6000–3000 BC) and Late Archaic periods (3000–900 BC) (MCL 1997:34).

The Early and Middle Archaic periods are characterized by substantial increases in the number of archaeological sites and a growing diversity amongst stone tool types and exploited raw materials. Notable changes in Archaic assemblages include a shift to notched or stemmed projectile points, a growing prominence of net-sinkers (notched pebbles) and an increased reliance on artifacts like bone fish hooks and harpoons. In addition to these smaller items, archaeologists also begin to find evidence of more massive wood working tools such as ground stone axes and chisels (Ellis et al. 1990:65–67).

Towards the end of the Middle Archaic (ca. 3500 BC), the archaeological evidence suggests that populations were 1) increasing in size, 2) paying more attention to ritual activities, 3) engaging in long distance exchange (e.g. in items such as copper) and 4) becoming less mobile (Ellis et al. 1990:93; MCL 1997:34). Late Archaic peoples typically made use of shoreline/riverine sites located in rich environmental zones during the spring, summer and early fall, and moved further inland to deer hunting and fruit-gathering sites during late fall and winter (Ellis et al. 1990:114).

During the Late Archaic these developments continued, and new types of projectile points appear along with the first true cemeteries. Excavations of burials from this time-frame indicate that human remains were often cremated and interred with numerous grave goods, including items such as projectile points, stone tools, red ochre, materials for fire-making kits, copper beads, bracelets, beaver incisors, and bear maxilla masks (Ellis et al. 1990:115–117). Interestingly, these true cemeteries may have been established in an attempt to solidify territorial claims, linking a given band or collection of bands to a specific geographic location.

From the tools unearthed at Archaic period sites it is clear that these people had an encyclopaedic understanding of the environment that they inhabited. The number and density of the sites that have been found suggest that the environment was exploited in a successful and sustainable way over a considerable period of time. The success of Archaic lifeways is attested to by clear evidence of steady population increases over time. Eventually, these increases set the stage for the final period of Pre-Contact occupation—the Woodland Period (Ellis et al. 1990:120).

1.2.1.3 Early and Middle Woodland Periods

The beginning of the Woodland period is primarily distinguished from the earlier Archaic by the widespread appearance of pottery. Although this difference stands out prominently amongst the archaeological remains, it is widely believed that hunting and gathering remained the primary subsistence strategy throughout the Early Woodland period (900–400 BC) and well into the Middle Woodland period (400 BC–AD 600). In addition to adopting ceramics, communities also grew in size during this period and participated in developed and widespread trade relations (Spence et al. 1990; MCL 1997:34).

The first peoples to adopt ceramics in the vicinity of the study area are associated with the Meadowood archaeological culture. This culture is characterized by distinctive Meadowood preforms, side-notched Meadowood points and Vinette 1 ceramics (thick and crude handmade pottery with cord-marked decoration). Meadowood peoples are believed to have been organized in bands of roughly 35 people, and some of the best documented sites are fall camps geared towards the hunting of deer and the gathering of nuts (Spence et al. 1990:128–137).

Ceramic traditions continued to develop during the subsequent Middle Woodland period, and three distinct archaeological cultures emerged in southern Ontario: 'Point Peninsula' north and northeast of Lake Ontario, 'Couture' near Lake St. Clair and 'Saugeen' in the rest of southwestern Ontario (see Map 3). These cultures all shared a similar method of decorating pottery, using either dentate or pseudo-scallop shell stamp impressions, but they differed in terms of preferred vessel shape, zones of decoration and surface finish (Spence et al. 1990:142–43).

The local Saugeen complex, which appears to have extended from Lake Huron to as far east as the Humber River, is characterized by stamped pottery, distinctive projectile points, cobble spall scrapers and a lifeway geared towards the exploitation of seasonally-available resources such as game, nuts and fish (Spence et al. 1990:147–156). Although relatively distant from the study area, the Donaldson site along the Saugeen River may be representative of a typical Saugeen settlement; it was occupied in the spring by multiple bands that came to exploit spawning fish and bury members who had died elsewhere during the year (Finlayson 1977:563–578). The archaeological remains from this site include post-holes, hearth pits, garbage-dumps (middens), cemeteries and even a few identifiable rectangular structures (Finlayson 1977:234–514).

During the Middle to Late Woodland transition (AD 600–900), the first rudimentary evidence of maize (corn) horticulture appears in southern Ontario. Based on the available archaeological evidence, which comes primarily from the vicinity of the Grand and Credit Rivers, this pivotal development was not particularly widespread (Fox 1990:171, Figure 6.1). The adoption of maize horticulture instead appears to be linked to the emergence of the Princess Point complex, whose material remains include decorated ceramics (combining cord roughening, impressed lines and punctuate designs), triangular projectile points, T-based drills, steatite and ceramic pipes, and ground stone chisels and adzes (Fox 1990:174-188).

The Grand Banks site near Cayuga is one of the best known Princess Point sites, and a calibrated radiocarbon date of AD 406–586 indicates that it was home to the first maize horticulturalists in northeastern North America (Warrick 2000:427). Generally, Princess Point sites consist of what are called 'incipient' longhouses, circular or square houses and even rudimentary palisades. Excavated evidence suggests that a typical village would have contained upwards of five contemporary houses at any one time, serving a population of roughly 75 people for perhaps 40–50 years. The evidence also indicates that many of these villages were reoccupied repeatedly over the centuries (Warrick 2000:429–434).

Intriguingly, approximately half of the documented Princess Point sites in Ontario have been discovered along the Grand River, but examples have also been found in the vicinity of the Credit and Humber Rivers (see Map 4). The Maracle camp site along the Credit River is a prime example of one such site (Fox 1990:175, Figure 6.1). The distinctive artifacts and horticultural practices of Princess Point peoples have led to the suggestion that they were the ancestors of the later Iroquoian-speaking populations of southern Ontario (Warrick 2000:427).

1.2.1.4 Late Woodland Period

In the Late Woodland period (ca. AD 900–1600), the practice of maize horticulture spread beyond the western end of Lake Ontario, allowing for population increases which in turn led to larger settlement sizes, higher settlement density and increased social complexity among the peoples involved. These developments are believed to be linked to the spread of Iroquoian-speaking populations in the area; ancestors of the historically-documented Huron, Neutral and Haudenosaunee Nations. Other parts of southern Ontario, including the Georgian Bay littoral, the Bruce Peninsula and the vicinity of Lake St. Clair, were inhabited by Algonkian-speaking peoples, who were much less agriculturally-oriented. Late Woodland archaeological remains from the greater vicinity of the study area show three major stages of cultural development prior to European contact: 'Early Iroquoian', 'Middle Iroquoian' and 'Late Iroquoian' (Dodd et al. 1990; Lennox and Fitzgerald 1990; Williamson 1990).

Early Iroquoians (AD 900–1300) lived in small villages (ca. 0.4 ha) of between 75 and 200 people, and each settlement consisted of four or five longhouses up to 15 m in length. The houses contained central hearths and pits for storing maize (which made up 20–30% of their diet), and the people produced distinctive pottery with decorative incised rims (Warrick 2000:434–438). The best documented Early Iroquoian culture in the local area is the Glen Meyer complex, which is characterized by well-made and thin-walled pottery, ceramic pipes, gaming discs, and a variety of stone, bone, shell and copper artifacts (Williamson 1990:295–304).

Over the next century (AD 1300–1400), Middle Iroquoian culture became dominant in southwestern Ontario, and distinct 'Uren' and 'Middleport' stages of development have been identified. Both houses and villages dramatically increased in size during this time: longhouses grew to as much as 33 m in length, settlements expanded to 1.2 ha in size and village populations swelled to as many as 600 people. Middle Iroquoian villages were also better planned, suggesting emerging clan organization, and most seem to have been occupied for perhaps 30 years prior to abandonment (Dodd et al. 1990:356–359; Warrick 2000:439–446).

During the Late Iroquoian period (AD 1400–1600), the phase just prior to widespread European contact, it becomes possible to differentiate between the archaeologically-represented groups that would become the Huron and the Neutral Nations. The study area itself lies within the territorial boundaries of the Pre-Contact Neutral Nation, documented in lands as far west as Chatham and as far east as New York State.

The Neutral Nation is well represented archaeologically: typical artifacts include ceramic vessels and pipes, lithic chipped stone tools, ground stone tools, worked bone, antler and teeth, and exotic goods obtained through trade with other Aboriginal (and later European) groups (Lennox and Fitzgerald 1990:411–437). The population growth so characteristic of earlier Middleport times appears to have slowed considerably during the Late Iroquoian period, and the Pre-Contact Neutral population likely stabilized at around 20,000 by the early 16^{th} century (Warrick 2000:446).

Pre-Contact Neutral villages were much larger than Middleport villages, with average sizes in the neighbourhood of 1.7 ha. Exceptional examples of these could reach 5 ha in size, containing longhouses over 100 m in length and housing 2,500 individuals. This seemingly rapid settlement growth is thought to have been linked to Middleport 'baby boomers' starting their own families and needing additional living space (Warrick 2000:446–449).

It has been suggested that the size of these villages, along with the necessary croplands to sustain them, may have had some enduring impacts on the landscapes that surrounded them. In particular, there has been a correlation postulated between Pre-Contact era corn fields and modern stands of white pine (Janusas 1987:69–70, Figure 7). Aside from these villages, the Pre-Contact Neutral also made use of hamlets, agricultural field cabins, specialized camps (e.g. fishing camps) and cemeteries (MCL 1997:35; Warrick 2000:449).

For the most part, Pre-Contact Neutral archaeological sites occur in isolated clusters defined by some sort of geographic region, usually within a watershed or another well-defined topographic feature (see Map 5). It is believed that these clusters represent distinct tribal units, which may have been organized as a larger confederacy akin to the historic Five Nations Iroquois (Lennox and Fitzgerald 1990:410). Nineteen main clusters of villages have been identified, the closest local manifestation of which was known simply as the 'Milton Cluster'. The principal sites associated with this cluster date to the late 16^{th} and early 17^{th} centuries, making it one of the latest manifestations of Neutral lifeways prior to the invasion of the Five Nations (Lennox and Fitzgerald 1990:Table 13.1).

The end of the Late Woodland period can be conveniently linked to the arrival and spread of European fur traders in southern Ontario, and a terminus of AD 1600 effectively serves to demarcate some substantial changes in Aboriginal material culture. Prior to the establishment of the fur trade, items of European manufacture are extremely rare on Pre-Contact Neutral sites, save for small quantities of reused metal scrap. With the onset of the fur trade ca. AD 1580, European trade goods appear in ever-increasing numbers, and glass beads, copper kettles, iron axes and iron knifes have all been found during excavations (Lennox and Fitzgerald 1990:425–432).

1.2.2 Early Contact

1.2.2.1 European Explorers

The first European to venture into what would become southern Ontario was Étienne Brûlé, who was sent by Samuel de Champlain in the summer of 1610 to accomplish three goals: 1) to consolidate an emerging friendship between the French and the First Nations, 2) to learn their languages, and 3) to better understand their unfamiliar customs. Other Europeans would subsequently be sent by the French to train as interpreters. These men became *coureurs de bois*, "living Indian-style ... on the margins of French society" (Gervais 2004:182). Such 'woodsmen' played an essential role in all later communications with the First Nations.

Champlain himself made two trips to Ontario: in 1613, he journeyed up the Ottawa River searching for the North Sea, and in 1615/1616, he travelled up the Mattawa River and descended to Lake Nipissing and Lake Huron to explore Huronia (Gervais 2004:182–185). He learned about many First Nations groups during his travels, including prominent Iroquoian-speaking peoples such as the Wendat (Huron), Petun (Tobacco) and '*la nation neutre*' (the Neutrals), and a variety of Algonkian-speaking Anishinabeg bands. Champlain's map of *Nouvelle France* from 1632 encapsulates his accumulated knowledge of the area (see Map 6). Although the distribution of the Great Lakes is clearly an abstraction, prolific Neutral village sites can be seen 'west' of *Lac St. Louis* (Lake Ontario).

1.2.2.2 Trading Contacts and Conflict

The first half of the 17th century saw a marked increase in trading contacts between the First Nations and European colonists, especially in southern Ontario. Archaeologically, these burgeoning relations are clearly manifested in the widespread appearance of items of European manufacture by AD 1630, including artifacts such as red and turquoise glass beads, scissors, drinking glasses, keys, coins, firearms, ladles and medallions. During this time, many artifacts such as projectile points and scrapers began to be manufactured from brass, copper and iron scrap, and some European-made implements completely replaced more traditional tools (Lennox and Fitzgerald 1990:432–437).

Nicholas Sanson's *Le Canada, ou Nouvelle France* (1656) provides an excellent representation of southern Ontario at this time of heightened contact. Here the lands of the Neutral Nation are clearly labelled with the French rendering of their Huron name, '*Attawandaron*' (see Map 7). Unfortunately, this increased contact had the disastrous consequence of introducing European diseases into First Nations communities. These progressed from localized outbreaks to much more widespread epidemics (MCL 1997:35; Warrick 2000:457). Archaeological evidence of disease-related population reduction appears in the form of reduced longhouse sizes, the growth of multi-ossuary cemeteries and the loss of traditional craft knowledge and production skills (Lennox and Fitzgerald 1990:432–433).

1.2.2.3 Five Nations Invasion

The importance of European trading contacts eventually led to increasing factionalism and tension between the First Nations, and different groups began to vie for control of the lucrative fur trade (itself a subject of competition between the French and British). In what would become Ontario, the Huron, the Petun, and their Anishinabeg trading partners allied themselves with the French. In what would become New York, the League of the Haudenosaunee (the Five Nations Iroquois at that time) allied themselves with the British. The latter alliance may have stemmed from Champlain's involvement in Anishinabeg and Huron attacks against Iroquoian strongholds in 1609 and 1615, which engendered enmity against the French (Lajeunesse 1960:xxix). Interposed between the belligerents, the members of the Neutral Nation refused to become involved in the conflict.

Numerous military engagements occurred between the two opposing groups during the first half of the 17th century, as competition over territories rich in fur-bearing animals increased. These tensions boiled over in the middle of the 17th century, leading to full-scale regional warfare (MNCFN 2010:5). In a situation likely exacerbated by epidemics brought by the Europeans and the decimation of their population, a party of roughly 1,000 Mohawk and Seneca warriors set upon Huronia in March 1649. The Iroquois desired to remove the Huron Nation altogether, as they were a significant obstacle to controlling the northern fur trade (Hunt 1940:91–92).

The Huron met their defeat in towns such as Saint Ignace and Saint Louis, and Sainte-Marie was abandoned and burned in the spring of 1649. Those that were not killed were either adopted in the Five Nations as captives or dispersed to neighbouring regions and groups (Ramsden 1990:384). The Petun shared a similar fate, and the remnants of the affected groups formed new communities outside of the disputed area, settling in Quebec (modern-day Wendake), in the area of Michilimackinac and near Lake St. Clair (where they were known as the Wyandot).

Anishinabeg populations from southern Ontario, including the Ojibway, Odawa, and Pottawatomi, fled westward to escape the Iroquois (Schmalz 1977:2). The Neutral were targeted in 1650 and 1651, and the Iroquois took multiple frontier villages (one with over 1,600 men) and numerous captives (Coyne 1895:18). The advance of the Iroquois led to demise of the Neutral Nation as a distinct cultural entity (Lennox and Fitzgerald 1990:456).

For the next four decades, southern Ontario remained an underpopulated wilderness (Coyne 1895:20). This rich hunting ground was exploited by the Haudenosaunee to secure furs for trade with the Dutch and the English, and settlements were established along the north shore of Lake Ontario at places like Teiaiagon on the Humber River and Ganatswekwyagon on the Rouge River (Williamson 2008:51). The Haudenosaunee are also known to have traded with the northern Anishinabeg during the second half of the 17th century (Smith 1987:19).

Due to their mutually violent history, the Haudenosaunee did not permit French explorers and missionaries to travel directly into southern Ontario for much of the 17th century. Instead, they had to journey up the Ottawa River to Lake Nipissing and then paddle down the French River into Georgian Bay (Lajeunesse 1960:xxix). New France was consequently slow to develop in southern Ontario, at least until the fall of several Iroquoian strongholds in 1666 and the opening of the St. Lawrence and Lake Ontario route to the interior (Lajeunesse 1960:xxxii).

In 1669, the Haudenosaunee allowed an expedition of 21 men to pass through their territory. This expedition, which included François Dollier de Casson (a Sulpician priest) and René Bréhant de Galinée, managed to reach and explore the Grand River, which they named *le Rapide* after the swiftness of its current. These men descended the Grand to reach Lake Erie, and they wintered at the future site of Port Dover (Coyne 1895:21). Galinée's map is one of the earliest documented representations of the interior of southwestern Ontario (see Map 8). In it, he notes the locations of several former Neutral villages at the western end of Lake Ontario, likely consisting of abandoned ruins.

1.2.2.4 Anishinabeg Influx

The fortunes of the Five Nations began to change in the 1690s, as disease and casualties from battles with the French took a toll on the formerly-robust group (Smith 1987:19). On July 19, 1701, the Haudenosaunee ceded lands in southern Ontario to King William III with the provision that they could still hunt freely in their former territory (Coyne 1895:28). However, this agreement appears to have lacked any sort of binding formality.

According to the traditions of the Algonkian-speaking Anishinabeg, Ojibway, Odawa and Potawatomi bands began to mount an organized counter-offensive against the Iroquois in the late 17th century (MNCFN 2010:5). Around the turn of the 18th century, the Anishinabeg of the Great Lakes expanded into Haudenosaunee lands, and attempted to trade directly with the French and the English (Smith 1987:19). This led to a series of battles between the opposing groups, in which the Anishinabeg were more successful (Coyne 1895:28).

Haudenosaunee populations subsequently withdrew into New York State, and Anishinabeg bands established themselves in southern Ontario. Many of these bands were mistakenly grouped together by the immigrating Europeans under the generalized designations of 'Chippewa/ Ojibway' and 'Mississauga'. 'Mississauga', for example, quickly became a term applied to many Algonkian-speaking groups around Lake Erie and Lake Ontario (Smith 1987:19), despite the fact that the Mississaugas were but one part of the larger Ojibway Nation (MNCFN 2010:3).

The Anishinabeg are known to have taken advantage of the competition between the English and French over the fur trade, and they were consequently well-supplied with European goods. The Mississaugas, for example, traded primarily with the French and received "everything from buttons, shirts, ribbons to combs, knives, looking glasses, and axes" (Smith 1987:22). The British, on the other hand, were well-rooted in New York State and enjoyed mutually beneficial relations with the Haudenosaunee.

As part of this influx, many members of the Algonkian-speaking Ojibway, Potawatomi and Odawa First Nations came back to Lake Huron littoral. Collectively, these people came to be known as the Chippewas of Saugeen Ojibway Territory (also Saugeen Ojibway Nation). These Algonkian-speakers established themselves in the Bruce Peninsula, all of Bruce and Grey Counties, and parts of Huron, Dufferin, Wellington, and Simcoe Counties (Schmalz 1977:233).

Throughout the 1700s and into the 1800s, Anishinabeg populations hunted, fished, gardened and camped along the rivers, floodplains and forests of southern Ontario (Warrick 2005:2). However, their 'footprint' was exceedingly light, and associated archaeological sites are both rare and difficult to detect. Historical records often play a pivotal role in reconstructing Anishinabeg lifeways during the timeframe, as the first European colonists often wrote about the locations of Aboriginal camps and hunting grounds.

Historical maps from the 18th century likewise shed valuable light on the contemporary cultural landscape. H. Popple's *A Map of the British Empire in America* (1733), for example, does not show any prominent settlements in the vicinity of the study area, which is a result of the ephemeral environmental impact of the mobile Ojibway (see Map 9). Interestingly, this map also depicts a long river named '*Tanaovate*', which is widely held to represent the Humber River.

1.2.2.5 Relations and Ambitions

The late 17th and early 18th centuries bore witness to the continued growth and spread of the fur trade across all of what would become the Province of Ontario. The French, for example, established and maintained trading posts along the Upper Great Lakes, offering enticements to attract fur traders from the First Nations. Even further north, Britain's Hudson Bay Company dominated the fur trade. Violence was common between the two parties, and peace was only achieved with the Treaty of Utrecht in 1713 (Ray 2012). Developments such as these resulted in an ever-increasing level of contact between European traders and local Aboriginal communities.

As the number of European men living in Ontario increased, so too did the frequency of their relations with Aboriginal women. Male employees and former employees of French and British companies began to establish families with these women, a process which resulted in the ethnogenesis of a distinct Aboriginal people: the Métis. Comprised of the descendants of those born from such relations (and subsequent intermarriage), the Métis emerged as a distinct Aboriginal people during the 1700s (MNO 2011).

Métis settlements developed along freighting waterways and watersheds, and were tightly linked to the spread and growth of the fur trade. These settlements were part of larger regional communities, connected by "the highly mobile lifestyle of the Métis, the fur trade network, seasonal rounds, extensive kinship connections and a shared collective history and identity" (MNO 2011).

In 1754, hostilities over trade and the territorial ambitions of the French and the British led to the Seven Years' War (often called the French and Indian War in North America), in which many Anishinabeg bands fought on behalf of the French. After the French surrender in 1760, these bands adapted their trading relationships accordingly, and formed a new alliance with the British (Smith 1987:22). In addition to cementing British control over the Province of Quebec, the Crown's victory over the French also proved pivotal in catalyzing the Euro-Canadian settlement process. The resulting population influx caused the demographics of many areas to change considerably.

R. Sayer and J. Bennett's *General Map of the Middle British Colonies in America* (1776) provides an excellent view of the ethnic landscape of southern Ontario prior to the widespread arrival of European settlers. This map clearly depicts the Grand and Humber Rivers, the territory of the Mississaugas, and the virtually untouched lands of southern Ontario (see Map 10).

1.2.3 The Euro-Canadian Era

1.2.3.1 British Colonialism

With the establishment of absolute British control came a new era of land acquisition and organized settlement. In the *Royal Proclamation* of 1763, which followed the Treaty of Paris, the British government recognized the title of the First Nations to the land they occupied. In essence, the 'right of soil' had to be purchased by the Crown prior to European settlement (Lajeunesse 1960:cix). Numerous treaties and land surrenders were accordingly arranged by the Crown, and great swaths of territory were acquired from the Ojibway and other First Nations.

These first purchases established a pattern "for the subsequent extinction of Indian title" (Gentilcore and Head 1984:78).

The first land purchases in Ontario took place along the shores of Lake Ontario and Lake Erie, as well as in the immediate 'back country'. Such acquisitions began in August 1764, when a strip of land along the Niagara River was surrendered by Six Nations, Chippewa and Mississauga chiefs (NRC 2010a). Although many similar territories were purchased by the Crown in subsequent years, it was only with the conclusion of the American Revolutionary War (1775–1783) that the British began to feel a pressing need for additional land. In the aftermath of the conflict, waves of United Empire Loyalists came to settle in the Province of Quebec, driving the Crown to seek out property for those who had been displaced. This influx had the devastating side effect of sparking the slow death of the fur trade, which was a primary source of income for many First Nations groups.

By the mid-1780s, the British recognized the need to 1) secure a military communication route from Lake Ontario to Lake Huron other than the vulnerable passage through Niagara, Lake Erie and Lake St. Clair; 2) acquire additional land for the United Empire Loyalists; and 3) modify the administrative structure of the Province of Quebec to accommodate future growth. The first two concerns were addressed through the negotiation of numerous 'land surrenders' with Anishinabeg groups north and west of Lake Ontario, and the third concern was mitigated by the establishment of the first administrative districts in the Province of Quebec.

On July 24, 1788, Sir Guy Carleton, Baron of Dorchester and Governor-General of British North America, divided the Province of Quebec into the administrative districts of Hesse, Nassau, Mecklenburg and Lunenburg (Archives of Ontario 2009). The vicinity of the study area fell within the district of Nassau at this time, which consisted of a massive tract of land extending due north from the head of Bay of Quinte in the east and the tip of Long Point on Lake Erie in the west. According to early historians, "this division was purely conventional and nominal, as the country was sparsely inhabited … the necessity for minute and accurate boundary lines had not become pressing" (Mulvany et al. 1885:13).

Further change came in December 1791, when the Parliament of Great Britain's *Constitutional Act* created the Provinces of Upper Canada and Lower Canada from the former Province of Quebec. Colonel John Graves Simcoe was appointed as Lieutenant-Governor of Upper Canada, and he became responsible for governing the new province, directing its settlement and establishing a constitutional government modelled after that of Britain (Coyne 1895:33).

Simcoe initiated several schemes to populate and protect the newly-created province, employing a settlement strategy that relied on the creation of shoreline communities with effective transportation links between them. These communities, inevitably, would be composed of lands obtained from the First Nations, and many more purchases were subsequently arranged. In July 1792, Simcoe divided the province into 19 counties consisting of previously-settled lands, new lands open for settlement and lands not yet acquired by the Crown. These new counties stretched from Essex in the west to Glengarry in the east. Three months later, in October 1792, an Act of Parliament was passed whereby the four districts established by Lord Dorchester were renamed as the Western, Home, Midland and Eastern Districts (Archives of Ontario 2009).

The vicinity of the study area nominally fell within the Home District and York County at this time, the latter of which consisted of a west and east riding. Although designated as part of the west riding, this area technically remained in the hands of Mississaugas. D.W. Smyth's *A Map of the Province of Upper Canada* map from 1800 clearly shows the extent of their lands, as well the townships that had already been established to the east and west of the study area (see Map 11). The Mississaugas' ownership of the lands along the western end of Lake Ontario was not to last, however, particularly given the exponential growth of York (the seat of government). In 1805, Lieutenant-Governor Peter Hunter decided that it was time to arrange for the surrender of the Mississauga Tract. Hunter saw this time as ideal for the commencement of negotiations, as Joseph Brant was no longer the land agent for the Mississaugas (NRC 2010a).

These dealings culminated with what is known as the First Purchase of the Mississauga Tract. The First Purchase (Treaty 13A, or the Mississauga Purchase) involved a meeting between representatives of the British Crown and the Mississaugas on August 2, 1805 near the mouth of the Credit River. Roughly 74,000 acres of land were acquired, save for a 1 mile strip on either side of the river which became the Credit Reserve. This tract was surveyed in 1806 (the 'Old Survey'), and became part of the Township of Toronto (see Map 12).

The crown negotiated the Second Purchase with the Mississaugas on October 28, 1818, and over 600,000 acres were acquired by the Crown (Treaty 19). This area became known as the 'New Survey', and was divided into the Townships of Toronto, Chinguacousy, Caledon, Albion and Toronto Gore. On February 28, 1820, the signing of Treaties 22 and 23 resulted in the surrender of the majority of the Credit Reserve lands set aside in 1805. In 1847, the Mississaugas relocated and settled on the New Credit Reserve at Hagersville near Branford (Heritage Mississauga 2009).

1.2.3.2 Peel County

Shortly after the creation of Upper Canada, the original arrangement of the Province's districts and counties was deemed inadequate. As population levels soared, smaller administrative bodies became desirable in Upper Canada, resulting in the division of the largest units into more 'manageable' component parts. In 1816, the territory of the expansive Home District was reduced with the incorporation of the Gore District, and the southwestern parts of York County were redefined as Wentworth and Halton Counties. The study area remained part of York County during this period of change (see Map 13).

After the abolishment of the district system in 1849, many of the counties within southern Ontario would be reconfigured once again. In 1851, Ontario and Peel Counties were created from the eastern and western parts of York County, respectively (Archives of Ontario 2009). At that time, the vicinity of the study area fell under the jurisdiction of the new Peel County (see Map 14). Peel County functioned as an upper-tier municipality throughout the remainder of the Euro-Canadian era, up until the incorporation of the Regional Municipality of Peel in 1973.

Historic Peel County consisted of the Townships of Caledon, Albion, Chinguacousy, Toronto and Toronto Gore. This county occupied an area of roughly 300,160 acres along the northwestern shore of Lake Ontario, stretching northwards to Dufferin and Simcoe Counties, westwards to Wellington and Halton Counties, and eastwards to York County (home of the provincial capital, York/Toronto).

Peel County was surveyed on two different occasions, the first (the 'Old Survey') after the First Purchase and the second (the 'New Survey') after the Second Purchase (Heritage Mississauga 2009). For the majority of the county, concession lines ran from Lake Ontario at right angles and were crossed from east to west by side roads, creating parallelograms consisting primarily of 100 acre parcels. The Township of Toronto, the southernmost and first to be surveyed and settled, was organized along slightly different lines, as the layout was complicated by the presence of the Mississauga Reserve.

As the first township surveyed in the Peel County, the Township of Toronto was the most populous of its neighbours, and the most extensively cleared. In 1821, the township had a population of 803, and 2,924 acres had been cleared for agricultural purposes. These numbers dwarfed those of neighbouring townships: Chinguacousy and Toronto Gore had only 412 people and 230 acres cleared, Albion had 110 people and 62 acres cleared, and Caledon had 100 people with no record of the amount of cleared land (Walker & Miles 1877:84). By 1941, over 90% of the land in Peel County was occupied farmland (274,225 acres), with the remainder consisting of roads, bogs and marshes (Hoffman and Richards 1953:10).

Population growth in Peel County was initially rapid, increasing from 12,993 in 1841, to 24,816 in 1851 and 27,240 in 1861. A drop in population occurred in the following years, as only 26,011 people were documented in the 1871 census (Walker & Miles 1877:84). This decline continued until 1901, when the population reached a level of 21,475. This trend was eventually reversed, and in 1941 the population reached 31,539, 70% of which were rural dwellers (Hoffman and Richards 1953:10).

The original settlers in Peel County had to deal with an extensive wilderness, but the numerous waterways provided power for early mills, and eventually a road pattern emerged that was augmented by the arrival of the rail lines. The earliest arrivals included settlers from New Brunswick, the States and parts of Upper Canada, who settled in the Township of Toronto ca. 1810. Later arrivals (after the Second Purchase) consisted largely of Irish from New York. Chinguacousy was settled mainly by United Empire Loyalists, while other townships were populated by Europeans from overseas (Walker & Miles 1877:84–85). By the mid-19th century, 52.6% of Peel County residents were of British background, 23.9% were Irish descendants and 14% were of a Scottish origin (Hoffman and Richards 1953:10). These settlers were successful agriculturalists for the most part, and the earliest log cabins and lean-tos were quickly replaced by brick homes and large barns.

The administrative heart of historic Peel County was located in Brampton, and other key centres included Port Credit (a marketing centre on Lake Ontario), Streetsville (which had a well-known grist mill) and Bolton (on the Humber River). Other small villages and communities were located at Cooksville, Malton, Churchville, Meadowvale, Caledon and Alton (Walker & Miles 1877:4-5). The principal road in the county was Dundas Street, which passed through the Township of Toronto from northeast to southwest and was gravelled by 1836. Hurontario Street was another major roadway, running the length of the county just east of the study area. On the whole, all of the roads in Peel County were of good quality and were open for travel by the mid-19th century. The Grand Trunk Railway and the Toronto Grey & Bruce Railway ran through the county was well, which contributed to its settlement and prosperity (Walker & Miles 1877:85).

1.2.3.3 Township of Chinguacousy

In historic times, the Township of Chinguacousy was bordered on the northeast by the Townships of Albion and Toronto Gore, on the south by the Township of Toronto, on the west by the Townships of Esquesing and Erin, and on the north by the Township of Caledon. According to W.H. Smith, Chinguacousy was one of the best-settled townships in the Home District, featuring excellent land, many good farms and abundant hardwood (1846:32). It was relatively well-watered by the Credit River and Etobicoke Creek, which traversed the western and east-central parts of the township, respectively (see Map 15–Map 16).

The Township of Chinguacousy was initially settled at the same time as the New Survey in 1818. This survey divided the area into western and eastern halves on either side of Hurontario Street, and the concessions were numbered to the east and west of the thoroughfare (e.g. Concession 1 W.H.S. and Concession 1 E.H.S.). The majority of the township's first settlers were from New Brunswick, the United States and parts of Upper Canada. Many were the children of United Empire Loyalists who settled in Niagara after the end of the war (Walker & Miles 1877:90). By 1821, the combined population of the Townships of Chinguacousy and Toronto Gore was 412, and only 230 acres were under cultivation (Walker & Miles 1877:84).

Over the following decades, however, the Township of Chinguacousy developed substantially. By 1841, the population of the township had grown to 3,721. By 1846, the population reached 3,965, and a total of 22,266 acres were under cultivation. At that time there were seven saw mills and one grist mill in the township (Smith 1846:32). Only five years later, in 1851, the population soared to 7,469 (Walker & Miles 1877:84). By the late 19th century, the area was characterized by excellent farms, and the township was "noted for its beautiful and substantial farm residences and commodious barns … the farms also are generally in the highest state of cultivation, while the grounds in front of the residences are for the most part tastefully arranged" (Walker & Miles 1877:90).

The principal settlement in the township was Brampton, which was incorporated as a village in 1852 and became a town in 1873. This settlement began with the founding of a tavern by William Buffy, and later Judge Scott added a small store, a pot ashery, a distillery and a mill. In 1834, John Elliott laid out the lots in the village, and the settlement was formally named 'Brampton'. It soon became a central settlement in the township, and many new businesses moved to the area. Brampton served as a major market for the region's agricultural products, and developed even further when a Grand Trunk Railway station was opened. By 1877, the Town of Brampton had a population of 2,551 (Walker & Miles 1877:87).

Cheltenham was another substantial settlement in the township, but unlike the central Town of Brampton, this community developed along the banks of the Credit River in the northwestern part of the township. This area was first settled in 1820 when Charles Haynes, a millwright who emigrated from England in 1816, arrived in the area. In 1827, Haynes built a grist mill which served the early settlers of the township. Later, Haynes built the larger Cheltenham Mill, and the settlement's first store followed in 1842. The first tavern was built in 1845. By 1877, this village had a population of approximately 350 (Walker & Miles 1877:90).

Other important communities developed at Salmonville, Victoria, Campbell's Cross, Kilmanagh, Sand Hill, Mayfield, Edmonton, Alloa, Norval Station, Westervelt's Corners, Woodhill, Springbrook and Huttonville (see Map 15–Map 16). Huttonville, located only 3.1 km southeast of the study area, was home to the prosperous mills of J.P. Hutton. The original mills at Huttonville were founded by Mr. Brown in 1848, but J.P. Hutton purchased his business in 1855 and made many improvements. After the purchase, the mills began cutting from 10,000–20,000 feet of lumber per day. By 1877, Huttonville had a population of roughly 150 (Walker & Miles 1877:90–91).

1.2.3.4 The Study Area

As discussed in Section 1.1, the study area falls on parts of Lots 10–14, Concession 4–5 W.H.S. and the historically-surveyed road allowance for Mississauga Road in the Geographic Township of Chinguacousy. These lots and concessions were laid out in the early 19th century, and the vicinity of the study area was relatively well-settled for the majority of the Euro-Canadian period.

In an attempt to reconstruct the historic land use of the study area, ARA examined two historical maps that documented past residents, structures (e.g. homes, businesses and public buildings) and features during the late 19th century. These maps, published in Walker & Miles' *Historical Atlas of Peel County* (1877), were of the most detailed scale available (40 chains to 1 inch). A georeferenced and merged version of these historical maps, showing the location of the study area, appears in Map 17 (McGill University 2001).

Based on the depictions from Walker & Miles' *Historical Atlas of Peel County* (1877), the study area was well-settled by the late 19th century. The names and associated biographical details of the historic residents of Lots 10–14, Concession 4–5 W.H.S. are summarized in Table 1.

Table 1: Euro-Canadian Residents in the Township of Chinguacousy, according to Walker & Miles' *Historical Atlas of Peel County* from 1877 (McGill University 2001)

Lot	Concession	Property Owner	Size of Property (acres)	Post Office	Visible Features/Structures
10	4 W.H.S.	Andrew McCandless	75	Norval	Farmstead and orchard northeast of study area
11	4 W.H.S.	William McClure	190 (total)	Norval	Farmstead and orchard northeast of study area
12	4 W.H.S.	Robert Cation	200	Brampton	No features/structures depicted in the vicinity of the study area, save for the Grand Trunk Railway
13	4 W.H.S.	Hugh Clark	100	Brampton	Farmstead and orchard northeast of study area

Lot	Concession	Property Owner	Size of Property (acres)	Post Office	Visible Features/Structures
14	4 W.H.S.	John T. Fuller	100	Brampton	Farmstead and orchard north of study area
10	5 W.H.S.	Mark Anthony	100	Norval	Farmstead and orchard southwest of study area
11	5 W.H.S.	William McClure	190 (total)	Norval	Farmstead and orchard west of study area
		Mrs. B.	N/A	N/A	Orchard southeast of study area
12	5 W.H.S.	Jonathan McClure	100	Norval	Orchard within study area, farmstead to southwest
		D. McDowell	100	Norval	Driveway within study area, farmstead and orchard to the southwest
13	5 W.H.S.	Thomas Montgomery	100	N/A	Farmstead and orchards southwest of study area
14	5 W.H.S.	Hugh Clarridge	100	Brampton	Farmstead and orchard northwest of study area

1.2.3.5 Summary of Past and Present Land Use

During Pre-Contact and Early Contact times, the vicinity of the study area would have comprised a mixture of deciduous trees and open areas. It seems clear that the First Nations managed the landscape to some degree, but the extent of such management is unknown. During the early 19th century, Euro-Canadian settlers arrived in the area and began to clear the forests for agricultural purposes. Over the course of the Euro-Canadian era, the study area would have comprised a mixture of agricultural lands and the historically-surveyed road allowance for Mississauga Road. Presently, the study area comprises parts of agricultural fields, residential driveways, lawns, the CN Railway, and Mississauga Road.

1.2.3.6 Additional Background Information

In the course of the past archaeological assessment conducted for the project (or other projects in the immediate vicinity), additional research concerning the settlement history and land use of the study area was carried out. In accordance with the requirements set out in Section 7.5.7 of the *Standards and Guidelines for Consultant Archaeologists* (MTC 2011:125), the title, author and PIF number of the related work appears below:

- Title: *Archaeological Assessment (Stages 1 & 2), Mattamy Homes – McClure Property, Lot 10 and 11, Concession 4, Geo. Twp. Of Chinguacousy, Peel County, Ontario*. Author: Archaeologix Inc. PIF #P084-127-2007 (Archaeologix Inc. 2007).
- Title: *Stage 1&2 Archaeological Assessment of 10473 Mississauga Road, Wanless Developments Inc., Part of Lot 13, Concession 4 W.H.S., City of Brampton, Regional Municipality of Peel, Ontario*. Author: The Archaeologists Inc. PIF #P052-133-2006 (TAI 2008a).

- Title: *Stage 1&2 Archaeological Assessment of 10571 Mississauga Road, Walness [sic] Developments Inc., Part of Lot 13, Concession 4 W.H.S., City of Brampton, Regional Municipality of Peel, Ontario*. Author: The Archaeologists Inc. PIF #P052-135-2006 (TAI 2008b)
- Title: *Stage 1 Archaeological Assessment, Mississauga Road, Extending 1.9 km North of Bovaird Drive, City of Brampton, Regional Municipality of Peel, Ontario.* Revised July 2011. Author: Archaeological Research Associates Ltd. PIF #P007-176-2008 (ARA 2008).
- Title: *Report on the 2009 Stage 1-2 Archaeological Assessment of 10124 Mississauga Road, Part of Lot 11, Concession 5 W.H.S., City of Brampton, Regional Municipality of Peel*. Author: AMICK Consultants Ltd. PIF #P058-512-2009 (AMICK 2010).
- Title: *Stage 1–2 Archaeological Assessment (AA) of: Proposed Development in Part of the West Half of Lot 13, Concession 4 West of Hurontario Street, City of Brampton, Regional Municipality of Peel, Ontario*. Revised March 2010. Author: Archaeoworks Inc. PIF #P029-693-2009 (Archaeoworks Inc. 2010a)
- Title: *Stage 1–2 Archaeological Assessment (AA) of: Proposed Development in Part of the West Half of Lot 14, Concession 4 West of Hurontario Street, City of Brampton, Regional Municipality of Peel, Ontario*. Revised March 2010. Author: Archaeoworks Inc. PIF #P029-694-2009 (Archaeoworks Inc. 2010b)
- Title: *Stage 1–2 Archaeological Assessment (AA) of: Proposed Development within Part of the North Half of Lot 12, Concession 5 West of Hurontario Street, City of Brampton, Regional Municipality of Peel, Ontario*. Revised March 2010. Author: Archaeoworks Inc. PIF #P058-512-2009 (Archaeoworks Inc. 2010c)
- Title: *Stages 1 and 2 Archaeological Assessment, Mattamy Homes Sharf Property, West Half of Lot 12, Concession 4 W.H.S., Geographic Township of Chinguacousy now City of Brampton, Regional Municipality of Peel, Ontario*. Author: Golder Associates Ltd. PIF #P243-058-2010 (Golder 2010a).
- Title: *Stage 3 Archaeological Assessment, Mattamy Homes Sharf Property, West Half of Lot 12, Concession 4 W.H.S., Geographic Township of Chinguacousy now City of Brampton, Regional Municipality of Peel, Ontario*. Author: Golder Associates Ltd. PIF Unavailable (Golder 2010b).
- Title: *Stage 4 Archaeological Assessment, Mattamy Homes Sharf Property, Location 2 (AkGx-71), West Half of Lot 12, Concession 4 W.H.S., Geographic Township of Chinguacousy now City of Brampton, Regional Municipality of Peel, Ontario*. Author: Golder Associates Ltd. PIF #P243-071-2010 (Golder 2010c).

The additional information included in these reports was considered during the formulation of fieldwork strategies and recommendations pertaining to archaeological concerns within the study area (see Section 2.0–Section 3.0).

1.3 Archaeological Context

1.3.1 Summary of Registered Archaeological Sites

An archival search was conducted using the MTCS's Ontario Archaeological Sites Database in order to determine the presence of any registered archaeological resources which might be located within a 1 km radius of the study area (MTCS 2011). A total of 17 previously-identified sites were found within these limits. The excavation results from these sites are summarized in Table 2.

Table 2: Registered Archaeological Sites within 1 km of the Study Area

Borden No.	Site Name	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
AkGx-71	Location 2	*N/A*	*N/A*	*N/A*	*The MTCS has not yet entered this data into the OASD*
AkGx-77	Primont H1	*N/A*	*N/A*	*N/A*	*The MTCS has not yet entered this data into the OASD*
AjGw-355	1-1	2003	Euro-Canadian	Homestead	Artifact scatter (400 sq. m); 1840s–1870s
AjGw-383	Findspot P2	2005	Undetermined Pre-Contact	Findspot	No further work recommended
AkGw-323	-	2007–2008	Euro-Canadian	Residential	Scatter of 165 artifacts (60 x 40 m)
AkGw-274	Helport 2	2004	Undetermined Pre-Contact	Lithic Scatters	Locus A - 16 artifacts (20 x 10 m); Locus B – 5 artifacts (30 x 20 m)
AkGw-275	Helport 3	2004	Middle Archaic	Findspot	1 Stanley/Neville projectile point; no further work recommended
AkGw-276	Helport 4	2004	Early Woodland (Meadowood)	Findspot	1 Meadowood projectile point
AjGw-372	Bluegrass	2005	Early Archaic	Camp	2 scatters of 675 artifacts (10 x 11 m and 10 x 10 m)
AkGw-153	-	2001	Undetermined Pre-Contact	Findspot	1 projectile point fragment
AkGw-69	Samual McClure	1993	Euro-Canadian	Homestead	Scatter of 173 artifacts (35 x 30 m)
AkGx-20	Creditview 1	1998	Undetermined Pre-Contact	Lithic Scatter	46 flakes
AkGx-21	Creditview 2	1998	Late Palaeo-Indian	Findspot	1 possible Hi-Lo biface and 5 flakes
AkGx-22	Creditview 3	1998	Early Archaic	Findspot	1 Kirk corner-notched or Nettling point
AkGx-9	Dixon	1993	Undetermined Pre-Contact	Findspot	1 scraper
AjGw-373	Helport 1	2004	Palaeo-Indian?	Lithic Scatter	Scatter of 9 artifacts (20 x 15 m)
AkGx-37	-	1997	Early Archaic	Findspot	1 Nettling projectile point

Of these 17 archaeological sites, only two are located in close proximity to the study area. These include AkGx-71 (Location 2) and AkGx-77 (Primont H1). AkGx-71 was identified during the assessment of the west half of Lot 12, Concession 4 W.H.S. in April 2010, and AkGx-77 was found during the assessment of the north half of Lot 12, Concession 5 W.H.S. (see Section 1.3.2). Both of these sites are traversed by the proposed alignments for the Mississauga Road 1200 mm Sanitary Sewer, 1200 m Feedermain and 600 mm Watermain, although impacts to the Primont H1 site will occur approximately 27 m below the ground surface in a shared tunnel (see Appendix D).

Nearly all of the other 15 registered archaeological sites are located east and southeast of the study area in lands previously or currently under consideration for development in the City of Brampton. Only one site (AkGx-9) is located west of the study area. The abundance of both Pre-Contact and Euro-Canadian sites within 1 km of the project lands demonstrates the desirability of this locality for early settlement and resource exploitation.

1.3.2 Previous Archaeological Work

As mentioned in Section 1.1, several of the properties with the potential to be impacted by the proposed Mississauga Road 1200 mm Sanitary Sewer, 1200 mm Feedermain and 600 mm Watermain project were previously assessed between 2006 and 2010 (see Map 18–Map 20). These assessments were carried out for a variety of proposed residential and infrastructural developments in this part of the City of Brampton. In accordance with the requirements set out in Section 7.5.8 of the *Standards and Guidelines for Consultant Archaeologists* (MTC 2011:125), descriptions of these past assessments and their associated recommendations are summarized below.

In November 2006, The Archaeologists Inc. conducted Stage 1 and 2 archaeological assessments on a 20.25 ha property located on the southwest part of Lot 13, Concession 4 W.H.S. (TAI 2008a). The work, conducted under licence #P052, PIF #P052-133-2006, did not result in the identification of any archaeological materials. The Archaeologists Inc. recommended that no further assessment be required within their study area, and the former MTC accepted this report into the Provincial Register of Reports (J. Laventhall, pers. comm.). This study area overlaps with parts of the proposed alignments in the northwestern part of the current project lands.

The Archaeologists Inc. also conducted Stage 1 and 2 archaeological assessments on the south-central part of Lot 13, Concession 4 W.H.S. in November 2006 (TAI 2008b). This property was only 10.1 ha in size, and the assessments were carried out under licence #P052, PIF #P052-135-2006. This work did not result in the identification of any archaeological materials, and The Archaeologists Inc. recommended that no further assessment be required within their study area. The former MTC accepted this report into the Provincial Register of Reports (J. Laventhall, pers. comm.). This study area overlaps with parts of the proposed alignments in the northwestern part of the current project lands.

In June 2007, Archaeologix Inc. conducted Stage 1 and 2 archaeological assessments on a 70.9 ha development property located on parts of Lots 10 and 11, Concession 4 W.H.S. (Archaeologix Inc. 2007). The assessments of these lands, carried out under licence #P084, PIF #P084-127-2007, resulted in the discovery of three Euro-Canadian findspots

(Location 1/AkGw-322, Location 2/AkGw-323 and Location 3/AkGw-324). All of these findspots were recommended for further archaeological assessment (Archaeologix Inc. 2007:14). Following Stage 3 site-specific excavations, the sites were found to have no further CHVI and were not recommended for Stage 4 assessment (R. von Bitter, pers. comm.). Archaeologix Inc.'s study area overlaps with parts of the proposed alignments in the southeastern part of the current project lands. The nearest site (Location 3) lies roughly 30 m beyond the study area.

In August 2008, ARA conducted a Stage 1 archaeological assessment of lands with the potential to be impacted by the proposed widening of Mississauga Road (ARA 2008). This assessment, conducted under licence #P007, PIF #P007-176-2008, identified numerous areas of no archaeological potential within the study area. Based on these findings, ARA recommended that a Stage 2 assessment be conducted on all lands with archaeological potential to be affected by the proposed widening (ARA 2008:14). In a letter of *Review and Acceptance into the Provincial Register of Reports* dated November 1, 2011, the former MTC concurred with this recommendation. Since this report has been accepted into the Provincial Register of Reports, the results of the archaeological potential modelling are reproduced in the present study.

The southeast part of Lot 13, Concession 4 W.H.S. was assessed by Archaeoworks Inc. in October 2009 (Archaeoworks Inc. 2010a). The Stage 1 and 2 assessments of this 10.1 ha property, conducted under licence #P029, PIF #P029-693-2009, did not result in the identification of any archaeological sites. Archaeoworks Inc. recommended that no further assessment be required within their study area, and the former MTC accepted this report into the Provincial Register of Reports (J. Laventhall, pers. comm.). This study area overlaps with parts of the proposed alignments in the northwestern part of the current project lands.

Archaeoworks Inc. also conducted Stage 1 and 2 assessments on a 10.1 ha property located on the southeast part of Lot 14, Concession 4 W.H.S. (Archaeoworks Inc. 2010b). This work, conducted in November 2009 under licence #P029, PIF #P029-694-2009, did not result in the identification of any archaeological materials. Archaeoworks Inc. recommended that no further assessment be required within their study area, and the former MTC accepted this report into the Provincial Register of Reports (J. Laventhall, pers. comm.). This study area overlaps with parts of the proposed alignments at the northwestern terminus of the current project lands.

The northern part of Lot 11, Concession 5 W.H.S. was subjected to Stage 1 and 2 archaeological assessments in November 2009. These assessments were conducted under AMICK Consulting Ltd. under licence #P058, PIF #P058-512-2009, and encompassed an area of 35.41 ha (AMICK 2010). This work did not result in the identification of any archaeological materials of CHVI (some modern materials were found), and AMICK Consultants Ltd. recommended that no further assessment be required within their study area (AMICK 2010:12). In a letter of *Review and Acceptance into the Provincial Register of Reports* dated February 23, 2012, the MTCS concurred with this recommendation. This study area overlaps with parts of the proposed alignments in the southeastern part of the current project lands.

In April 2010, Golder Associates Ltd. conducted Stage 1 and 2 archaeological assessments on a 15.8 ha property located on the west half of Lot 12, Concession 4 W.H.S. (Golder 2010a). The assessments, conducted under licence #P243, PIF #P243-058-2010, resulted in the discovery of two Pre-Contact findspots (Locations 1 and 3) and one Euro-Canadian artifact scatter from the mid- to late 19th century (Location 2/AkGx-71). Although Locations 1 and 3 were not recommended for further work, Location 2 was significant enough to warrant a Stage 3 assessment (Golder 2010a:16). The former MTC concurred with Golder Associates Ltd.'s recommendations and accepted the Stage 1 and 2 report into the Provincial Register of Reports (J. Laventhall, pers. comm.). This study area overlaps with parts of the proposed alignments in the central part of the current project lands, north of the CN Railway. Part of the study area traverses the extent of Location 2 (see Supplementary Documentation Map 2).

The Stage 3 assessment of Location 2/AkGx-71, also conducted by Golder Associates Ltd., resulted in the discovery of numerous 19th century ceramics and structural remains. Based on the fact that Location 2/AkGx-71 was of further CHVI, it was recommended for a Stage 4 archaeological investigation (Golder 2010b:17). The Stage 4 assessment of this site, conducted under PIF #P243-071-2010, was completed in July 2010. Golder Associates Ltd. recommended that the site be considered completely mitigated and that no additional assessment be required (Golder 2010c:18). The former MTC concurred with these recommendations and accepted the Stage 4 report into the Provincial Register of Reports (J. Laventhall, pers. comm.).

In September 2010, Archaeoworks Inc. conducted Stage 1 and 2 archaeological assessments on a 25 ha property within part of the northern half of Lot 12, Concession 5 W.H.S. (Archaeoworks Inc. 2010c). This survey, conducted under licence #P334, PIF #P334-006-1010, resulted in the discovery of one Euro-Canadian artifact scatter (Primont H1/AkGx-77). This site was found to be of further CHVI, and Archaeoworks Inc. recommended that it be subjected to a Stage 3 assessment. No further assessment was recommended for the remainder of the property (Archaeoworks Inc. 2010c:11). In a letter of *Review and Acceptance into the Provincial Register of Reports* dated February 29, 2012, the MTCS concurred with this recommendation. Part of the study area traverses the extent of Primont H1 (see Supplementary Documentation Map 2).

1.3.3 Natural Environment of the Study Area

Environmental factors played a substantial role in shaping ancient land-use and site selection processes, particularly in small Pre-Contact societies with non-complex, subsistence-oriented economies. Euro-Canadian settlers also gravitated towards favourable environments, particularly those with agriculturally-suitable soils and a moderate climate. In order to fully comprehend the archaeological context of the study area, the following five features of the local natural environment must be considered: 1) forests; 2) drainage systems; 3) climatic conditions; 4) physiography; and 5) soil types.

The study area is located within the deciduous forest, an ecological zone described as having the most diverse forest life in Ontario. The region is characterized by a wide range of tree and shrub species, including eastern white pine, red pine, eastern hemlock, white cedar, yellow birch, sugar and red maple, basswood, red oak, black walnut, butternut, tulip, magnolia, black gum, and many types of oaks and hickories. A number of rare species of mammals, birds, plants and insects reside in the deciduous forest, including sassafras and tulip trees, southern flying squirrels, and red-bellied woodpeckers. Today, over 90% of Ontario's population lives in this small region (MNR 2012).

Relatively little of the original forest cover remains standing today, however, as early Euro-Canadian agriculturalists conducted large-scale clearing operations to prepare the land for cultivation—only scattered woodlots remain in areas that are otherwise too poor for agriculture (MNR 2012). In Pre-Contact times, however, these dense forests would have been particularly bountiful. It is believed that the First Nations of the Great Lakes region exploited close to 500 plant species for food, beverages, food flavourings, medicines, smoking, building materials, fibres, dyes and basketry (Mason 1981:59–60). Furthermore, this diverse vegetation would have served as both home and food for a wide range of game animals, including white tailed deer, turkey, passenger pigeon, cottontail rabbit, elk, muskrat and beaver (Mason 1981:60).

The subject lands are located within the Credit River watershed at the northwestern end of Lake Ontario, an area with includes nearly 1,500 km of streams and creeks including Black Creek, Silver Creek, Shaw's Creek, Fletcher's Creek, Caledon Creek and the East and West Credit Rivers (CVCF 2012). The southern part of the study area is traversed by an unnamed tributary of the Credit River, which flows from northwest to southeast towards Huttonville and Eldorado Park. The Credit River is located 2.2 km southwest of the intersection of Bovaird Drive West and Mississauga Road.

The local climatic region is that of the South Slopes, which lies southwest of the Simcoe and Kawartha Lakes region and is characterized by considerable regional variation. For the vicinity of the study area, average daily temperatures are -6.7 °C in January and 20 °C in July. The frost-free period typically lasts between 133 and 147 days, and the growing season is generally between 192 and 200 days long. The mean annual precipitation level for the area is 800 mm, with 348 mm falling between May and October (Hoffman and Richards 1953:19–22). On the whole, this climate is well suited for the common grain and forage crops grown during the Euro-Canadian period.

Physiographically, the study area lies in the region known as the South Slope, which includes lands along the southern slope of the Oak Ridges Moraine and a strip of land south of the Peel Plain (including the Trafalgar Moraine). In the western part of the South Slope, from Vaughan to Halton Hills, the surface of the land is morainic (i.e. consisting of an accumulation of boulders, stones, or other debris deposited by a glacier). Specifically, this area is characterized by ground moraine of limited relief (Chapman and Putnam 1984:172–173). These physiographic elements have accumulated over red shale bedrock belonging to the Upper Ordovician Queenston formation (Davidson 1989:42).

The study area consists of two primary soil types: Chinguacousy clay loam in the northwest and Oneida clay loam in the southeast. Both of these soils belong to the Grey-Brown Podzolic group and consist of heavy-textured shale and limestone till. Chinguacousy clay loam is characterized by imperfect drainage qualities with few stones and a smooth, gently sloping topography. Oneida clay loam, on the other hand, has good drainage qualities with few stones and a smooth, moderately sloping topography (Hoffman and Richards 1953:Soil Map).

In summary, the vicinity of the study area possesses a number of environmental characteristics which would have made it attractive to both Pre-Contact and Euro-Canadian populations. The rich deciduous forest and the nearby waterway would have attracted a wide variety of game animals, and consequently, early hunters. The relatively well-drained soils would have been ideal for the maize horticulture of Middle to Late Woodland peoples and the mixed agriculture practiced by later Euro-Canadian populations. Finally, the proximity of the study area to the Credit River would also have influenced its settlement and land-use history. Such major waterways functioned as principal transportation routes in both Pre- and Post-Contact times.

1.3.4 Archaeological Fieldwork and Property Conditions

The Stage 2 property assessment was carried out on June 4, 2012 under MTCS licence #P007, PIF #P007-391-2012. This assessment encompassed all previously un-assessed lands that could be impacted by the project, and involved the on-site documentation of all areas of no archaeological potential. Legal permission to enter and conduct all necessary fieldwork activities on project lands was granted by the property owners.

Key personnel involved during the assessments were P. Racher, Project Director; C.E. Gohm, Project Manager; P. Hoskins, Field Director; L. Akida, Assistant Field Director; P. Hoskins, Field Cartographer (GPS); and five additional crewmembers. As discussed in Section 1.2.3.5, the study area currently comprises parts of agricultural fields, residential driveways, lawns, the CN Railway, and Mississauga Road. The required minimum weather and lighting conditions set forth in Section 2.1 of the *Standards and Guidelines for Consultant Archaeologists* (MTC 2011:29) were met during the assessment. Specifically, the field conditions were excellent, with overcast skies, seasonal temperatures, excellent visibility, dry soils for screening, and well-weathered soils in the ploughed lands.

No unusual physical features were encountered during the Stage 2 assessment that affected fieldwork strategy decisions or the identification of artifacts or cultural features (e.g. dense root mats, boulders, rubble, etc.).

2.0 STAGE 1 BACKGROUND STUDY

2.1 Summary

The Stage 1 assessment of the previously un-assessed portions of the subject lands, conducted under MTCS licence #P007, PIF #P007-368-2011, was accomplished through an examination of the archaeology, history, geography and current land condition of the vicinity of the study area. This background study was carried out using archival sources (e.g. historical publications and records) and current academic and archaeological publications (e.g. archaeological studies and reports). It also included the analysis of modern topographic maps (at a 1:50,000 scale), recent satellite imagery, and historical maps/atlases of the most detailed scale available (e.g. 40 chains to 1 inch).

With occupation beginning in the Palaeo-Indian period approximately 11,000 years ago, the greater vicinity of the study area comprises a complex chronology of Pre-Contact and Euro-Canadian histories (see Section 1.2). Evidence of Archaic period, Woodland period and Early Contact period remains are well-attested in the City of Brampton, and Euro-Canadian archaeological sites dating to pre-1900 and post-1900 contexts are likewise common. The abundance of registered archaeological sites in the immediate vicinity of the study area demonstrates the attractiveness of the region for early settlement (see Section 1.3.1).

The natural environment of the study area would have been attractive to both Pre-Contact and Euro-Canadian populations as a result of proximity to an unnamed tributary of the Credit River. The relatively well-drained soils and diverse vegetation of the greater vicinity of the study area would also have encouraged settlement throughout Ontario's lengthy history. Euro-Canadian populations would have been particularly drawn to Mississauga Road and Bovaird Drive West, both of which were surveyed in the first half of the 19th century (see Section 2.3).

In summary, the Stage 1 background study included an up-to-date listing of sites from the MTCS's archaeological sites database (in a 1 km radius around the study area), the consideration of previous archaeological field work in the area (in a 50 m radius around the study area), the analysis of topographic maps and historic settlement maps (at the most detailed scale available), and the study of aerial photographs/satellite imagery. In this manner, the standards for background research set out in Section 1.1 of the *Standards and Guidelines for Consultant Archaeologists* (MTC 2011:14–15) were met.

2.2 Field Methods (Property Inspection)

A Stage 1 property inspection was not conducted for this background study. Instead, all on-site documentation was carried out over the course of the Stage 2 property survey, in keeping with Standards 2a–b in Section 2.1 of the *Standards and Guidelines for Consultant Archaeologists* (MTC 2011:28). As mentioned in Section 1.3.4, legal permission to enter and conduct all necessary fieldwork activities on project lands was granted by the property owners. The results of ARA's archaeological potential modelling are discussed below.

2.3 Analysis and Conclusions

In addition to the relevant historical sources and the results of past excavations and surveys (see Section 1.2–Section 1.3), the archaeological potential of a property can be assessed using its soils, hydrology and landforms as considerations. What follows is an in-depth analysis of the archaeological potential of the previously un-assessed portions of the study area, which incorporates the results of the on-site documentation conducted in June 2012.

Throughout southern Ontario, scholars have noted a strong association between site locations and waterways. Young, Horne, Varley, Racher and Clish, for example, state that "either the number of streams and/or stream order is <u>always</u> a significant factor in the positive prediction of site presence" (1995:23). They further note that certain types of landforms, such as moraines, seem to have been favoured by different groups throughout prehistory (Young et al. 1995:33). According to Janusas (1988:1), "the location of early settlements tended to be dominated by the proximity to reliable and potable water resources." Site potential modeling studies (Peters 1986; Pihl 1986) have found that most prehistoric archaeological sites are located within 300 m of either extant water sources or former bodies of water, such as post-glacial lakes.

While many of these studies do not go into detail as to the basis for this pattern, Young, Horne, Varley, Racher and Clish (1995) suggest that the presence of streams would have been a significant attractor for a host of plant, game and fish species, encouraging localized human exploitation and settlement. Additionally, lands in close proximity to streams and other water courses were highly valued for the access they provided to transportation and communication routes. Primary water sources (e.g. lakes, rivers, streams and creeks) and secondary water sources (e.g. intermittent streams and creeks, springs, marshes and swamps) are therefore of pivotal importance for identifying archaeological potential (MTC 2011:17).

Section 1.3.1 of the *Standards and Guidelines for Consultant Archaeologists* emphasizes the following six features/characteristics as being additional indicators of positive potential for Pre-Contact archaeological materials: 1) features associated with extinct water sources (glacial lake shorelines, relic river channels, shorelines of drained lakes, etc.); 2) the presence of pockets of well-drained soils (for habitation and agriculture); 3) elevated topography (e.g. drumlins, eskers, moraines, knolls, etc.); 4) distinctive landforms that may have been utilized as spiritual sites (waterfalls, rocky outcrops, caverns, promontories, etc.); 5) proximity to valued raw materials (quartz, ochre, copper, chert outcrops, medicinal flora, etc.); and 6) accessibility of plant and animal food sources (spawning areas, migratory routes, prairie lands, etc.) (MTC 2011:17–18).

Conversely, it must be understood that non-habitational sites (e.g. burials, lithic quarries, kill sites, etc.) may be located anywhere. Potential modeling appears to break down when it comes to these idiosyncratic sites, many of which have more significance than their habitational counterparts due to their relative rarity. The Stage 1 archaeological assessment practices outlined in Section 1.4.1 of the *Standards and Guidelines for Consultant Archaeologist* ensure that these important sites are not missed in Ontario, as no area can be exempted from further archaeological work unless it has been subjected to a Stage 1 property inspection or Stage 2 on-site documentation (MTC 2011:20–21).

With the development of integrated 'complex' economies in the Euro-Canadian era, settlement tended to become less dependent upon local resource procurement/production and more tied to wider economic networks. As such, proximity to transportation routes (roads, canals, etc.) became the most significant predictor of site location, especially for Euro-Canadian populations. In the early Euro-Canadian era (pre-1850), when transport by water was the norm, sites tended to be situated along major rivers and creeks—the 'highways' of their day. With the opening of the interior of the Province of Ontario to settlement after about 1850, sites tended to be more commonly located along historically-surveyed roads. Section 1.3.1 of the *Standards and Guidelines for Consultant Archaeologists* recognizes trails, passes, roads, railways and portage routes as examples of such early historical transportation routes (MTC 2011:18).

In addition to transportation routes, Section 1.3.1 of the *Standards and Guidelines for Consultant Archaeologists* emphasizes three other indicators of positive potential for Euro-Canadian archaeological materials: 1) areas of early settlement (military outposts, pioneer homesteads or cabins, early wharfs or dock complexes, pioneer churches, early cemeteries, etc.); 2) properties listed on a municipal register, designated under the *Ontario Heritage Act* or otherwise categorized as a federal, provincial or municipal historic landmark/site; and 3) properties identified with possible archaeological sites, historical events, activities or occupations, as identified by local histories or informants (MTC 2011:18).

Based on the location, drainage and topography of the subject lands and the application of land-use modelling, it seems clear that the previously un-assessed portions of the study area, in their pristine states, would have clear potential for Pre-Contact and Euro-Canadian archaeological sites. Indicators of archaeological potential include an unnamed tributary waterway of the Credit River (a primary water source), Bovaird Drive West and Mississauga Road (both historically-surveyed roadways), and the Canadian National Railway (the historic Grand Trunk Railway). The presence of two registered archaeological sites (Location 2; AkGx-71 and Primont H1; AkGx-77) within the project limits also contributes to the archaeological potential of the study area. As mentioned in Section 1.3.2, Location 2 has been fully mitigated.

On-site documentation and modern satellite imagery, however, demonstrate that this archaeological potential has been negatively affected by modern land use. Section 2.1 of the *Standards and Guidelines for Consultant Archaeologists* states that only those areas that are permanently wet, consist of exposed bedrock, have steep slopes greater than 20°, or have been subjected to deep land alterations that have severely damaged the integrity of archaeological resources can be considered exempt from requiring archaeological assessment (MTC 2011:28).

Areas of no archaeological potential were identified along privately-owned paved driveways, within the Mississauga Road and CN Railway ROWs, and in other lands affected by past infrastructural developments (e.g. paved roadways, embankments and drainage ditches). These areas of no archaeological potential are shown in Map 21–Map 23 (see Image 1–Image 9). The areas of no archaeological potential identified under PIF #P007-176-2008 for the proposed widening of Mississauga Road (ARA 2008) are reproduced on these maps, in accordance with the requirements set out in Section 7.8.1 of the *Standards and Guidelines for Consultant Archaeologists* (MTC 2011:135).

Based on the results of this evaluation, those portions of the study area not previously subjected to Stage 2, 3 and/or 4 assessments comprise a mixture of areas of archaeological potential and areas of no archaeological potential.

2.4 Recommendations

The results of the Stage 1 archaeological assessment indicated that the previously un-assessed portions of the study area, in their pristine state, would have clear potential for Pre-Contact and Euro-Canadian archaeological sites. On-site documentation, however, identified numerous areas of no archaeological potential. In their current condition, therefore, the previously un-assessed lands consist of a mixture of areas of archaeological potential and areas of no archaeological potential. As previously reported to the MTCS, several areas of archaeological potential were also identified under licence #P007, PIF #P007-176-2008 for the proposed widening of Mississauga Road (ARA 2008). All areas of archaeological potential within the study area warranted further assessment.

3.0 STAGE 2 PROPERTY ASSESSMENT

3.1 Field Methods

Given that the previously un-assessed areas of archaeological potential within the study area consisted of actively or recently cultivated fields and lands where ploughing was not possible or viable, it was necessary to utilize both the pedestrian survey and test pit survey methods to complete the Stage 2 property assessment.

In the actively or recently cultivated parts of the study area, the archaeological assessment was carried out using the pedestrian survey method. Section 2.1.1 of the *Standards and Guidelines for Consultant Archaeologists* provides clear requirements for the condition of such lands prior to the commencement of fieldwork: all fields must be recently ploughed; all soils must be well-weathered; and at least 80% of the ploughed ground surface must be visible (MTC 2011:30). These conditions were met during the pedestrian survey component of the Stage 2 assessment (see Image 10).

Following the standard strategy for pedestrian survey outlined in Section 2.1.1 *Standards and Guidelines for Consultant Archaeologists*, ARA crewmembers traversed the study area along parallel transects established at a maximum interval of 5 m, yielding at least 20 survey transects per hectare (see Image 11–Image 12). If archaeological materials were encountered in the course of the pedestrian survey, the transect interval would be closed to 1 m and a close inspection of the ground would be conducted for 20 m in all directions. All diagnostic artifacts and a representative sample of non-diagnostic artifacts would then be collected for analysis. All remaining artifacts would be left *in situ* until a proper Stage 3 Controlled Surface Pickup could be carried out.

In those parts of the study area that physically could not be ploughed or where ploughing was not viable, the assessment was conducted using the test pit survey method (sometimes referred to as shovel-testing). In this method, ARA crewmembers hand-excavated small regular test pits with a minimum diameter of 30 cm at prescribed intervals within the study area. Section 2.1.2 *Standards and Guidelines for Consultant Archaeologists* stipulates that lands within 300 m of any feature of archaeological potential be examined at 5 m intervals, and any lands more than 300 m from such features be examined at 10 m intervals (MTC 2011:31–32). Given the presence of multiple indicators of archaeological potential in the vicinity of the study area (e.g. a primary water source and two historically-surveyed roadways), a 5 m interval was adopted for the property assessment (see Image 13–Image 14).

In accordance with Section 2.1.2 of the *Standards and Guidelines for Consultant Archaeologists*, each test pit was excavated into the first 5 cm of subsoil (MTC 2011:32). The resultant pits were then examined for stratigraphy, cultural features and/or evidence of fill (see Image 16–Image 17). The soil from each test pit was screened through 6 mm mesh and examined for archaeological materials (see Image 18). If archaeological materials were encountered over the course of the test pitting survey, each Positive Test Pit would be documented and all artifacts would be collected according to their associated test pit. All test pits were backfilled upon completion, as per the property owners' instruction (MTC 2011:32).

Artifacts that may indicate the presence of significant cultural deposits include bone, charcoal, lithics (stone tools and refuse generated by their production and use), ceramics, glass and metal. Archaeological features such as pits, foundations and other non-portable remains may also be detected during a Stage 2 property assessment. All archaeological materials with potential CHVI are documented, whether associated with Pre-Contact Aboriginal groups or Post-Contact First Nations, Métis and Euro-Canadian populations. Artifact locations are recorded on topographic maps, in field notes and on a GPS handheld unit. Specifically, ARA utilized a WAAS-enabled Garmin eTrex Legend with a +/- 2 m accuracy (using the UTM17 NAD83 coordinate system).

Multiple areas affected by previous deep land alterations (i.e. disturbances) were identified in the course of the test pit survey. In accordance with Section 2.1.8 of the *Standards and Guidelines for Consultant Archaeologists* (MTC 2011:38), a combination of property inspection and test pitting was used to confirm these disturbances.

All previously un-assessed areas of archaeological potential within the study area were surveyed according to these methods (see Map 21–Map 23). In fulfillment of the requirements set out in Section 7.8 of the *Standards and Guidelines for Consultant Archaeologists* (MTC 2011:137), the field methods utilized during the Stage 2 assessment can be summarized as follows:

- Area of Stage 2 Assessment: 100% (3.10 ha)
- Property assessed by pedestrian survey at a maximum interval of 5 m: 53.30% (1.65 ha)
- Property assessed by test pit survey at a maximum interval of 5 m: 27.65% (0.86 ha)
- Property not assessed because of areas of no archaeological potential: 19.05% (0.59 ha)
- Property assessed where standard survey intervals could not be maintained: 0.0% (0.0 ha)

3.2 Record of Finds

The Stage 2 property assessment of the study area did not result in the identification of any archaeological materials. As part of the assessment, all field data were removed from the study area with permission from the property owners. The photographs, mapping materials and field notes relating to the assessment were safely transported to ARA's facility located at 154 Otonabee Drive, Kitchener, Ontario for processing and storage (see Table 3).

Table 3: Inventory of Documentation Generated in the Field

Field Documents	Total	Nature	Location
Photographs	68	Digital	On server at 154 Otonabee Drive, Kitchener; Folder P007-391-2012
Field Notes	4	Digital and hard copy	Filed and on server at 154 Otonabee Drive, Kitchener; P007-391-2012
Field Maps	5	Digital and hard copy	Filed and on server at 154 Otonabee Drive, Kitchener; P007-391-2012

3.3 Analysis and Conclusions

No archaeological sites were identified within the study area.

3.4 Recommendations

Based on the results of the property assessment, the previously un-assessed portions of the study area appear to be devoid of any significant archaeological remains. As discussed in Section 1.3.2, however, the previously-identified Primont H1 site is traversed by the subject study area. Since the shared tunnel for the Mississauga Road 1200 mm Sanitary Sewer and 1200 Feedermain will pass approximately 27 m below this site, ARA does not recommend that it be assessed prior to construction. Archaeological monitoring is recommended to ensure that project impacts do not occur (see Section 4.0). ARA also recommends that the Primont H1 site be subjected to a Stage 3 site-specific assessment if any future developments are planned in the area that could result in disturbances to the site.

4.0 SYNTHESIS OF CONCLUSIONS AND RECOMMENDATIONS

The Stage 1 and 2 archaeological assessments of the study area were completed in June 2012. The background research component of the Stage 1 assessment determined that several of the properties within the study area were previously assessed between 2006 and 2010. The majority of these surveyed lands were not recommended for further assessment, but one property contains the Euro-Canadian Primont H1 site, which was recommended for a Stage 3 site-specific assessment. Although the subject study area traverses the extent of Primont H1, project impacts in this area will occur approximately 27 m below the ground surface in the shared tunnel for the Mississauga Road 1200 mm Sanitary Sewer and 1200 mm Feedermain (see Appendix D). In August 2008, ARA also conducted a Stage 1 assessment for the proposed widening of Mississauga Road, which included lands within the current project limits. Since this report has been accepted into the Provincial Register of Reports, the results of the archaeological potential modelling were reproduced in this study.

The Stage 1 assessment identified several local features of archaeological potential, including an unnamed tributary of the Credit River, Bovaird Drive West, Mississauga Road, the CN Railway, and two registered archaeological sites. On-site documentation, however, identified several disturbed areas within the study area. Accordingly, in its current state, the study area comprised a mixture of areas of archaeological potential and no archaeological potential. The previously un-assessed areas of archaeological potential clearly warranted a Stage 2 assessment. The Stage 2 assessment of the previously un-assessed lands, completed under optimal conditions, did not result in the discovery of any archaeological materials.

Based on these findings, ARA recommends that the Primont H1 site be subjected to a Stage 3 site-specific assessment if any future developments are planned in the area that could result in disturbances to the site. Since the shared tunnel for the Mississauga Road 1200 mm Sanitary Sewer and 1200 Feedermain will pass approximately 27 m below the site, ARA does not recommend that it be assessed prior to construction.

Given that the project limits traverse the extent of Primont H1, however, unintentional project impacts are a concern. In accordance with the direction set out in Section 7.8.5 of the *Standards and Guidelines for Consultant Archaeologists* (MTC 2011:140–141), ARA recommends that 1) all traffic be prohibited within the site or within a 20 m protective buffer around the site, 2) that the 20 m protective buffer be marked by a temporary barrier within the project lands, and 3) that all construction activities within 70 m of the site be monitored by a licenced archaeologist to ensure that impacts do not occur (see Supplementary Map 3). A reduced buffer is acceptable where it is interrupted by a permanently disturbed cultural form (e.g., Mississauga Road, the CN Railway) (MTC 2011:68). A *Letter of Review and Acceptance into the Provincial Register of Reports* is requested, as provided for in Section 65.1 of the *Ontario Heritage Act*.

5.0 ADVICE ON COMPLIANCE WITH LEGISLATION

Section 7.5.9 of the *Standards and Guidelines for Consultant Archaeologists* requires that the following information be provided for the benefit of the proponent and approval authority in the land use planning and development process (MTC 2011:126–127):

- This report is submitted to the Minister of Tourism, Culture and Sport as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c 0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological fieldwork and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Ministry of Tourism, Culture and Sport, a letter will be issued by the ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.
- It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological fieldwork on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest, and the report has been filed in the Ontario Public Register of Archaeology Reports referred to in Section 65.1 of the *Ontario Heritage Act*.
- Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48 (1) of the *Ontario Heritage Act*.
- Archaeological sites recommended for further archaeological fieldwork or protection remain subject to Section 48 (1) of the *Ontario Heritage Act* and may not be altered, or have artifacts removed from them, except by a person holding an archaeological licence.
- The *Cemeteries Act*, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33 (when proclaimed in force) require that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services.

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7.0 IMAGES

Image 1: Area of No Archaeological Potential – Disturbed Lands
(Google Maps 2012; Facing Southwest)

Image 2: Area of No Archaeological Potential – Disturbed Lands
(Google Maps 2012; Facing Northeast)

Image 3: Area of No Archaeological Potential – Disturbed Lands
(Google Maps 2012; Facing Northwest)

Image 4: Area of No Archaeological Potential – Disturbed Lands and CN Railway
(Google Maps 2011; Facing West)

Image 5: Area of No Archaeological Potential – Disturbed Lands
(Photo Taken June 4, 2012; Facing East)

Image 6: Area of No Archaeological Potential – Disturbed Lands
(Photo Taken June 4, 2012; Facing East)

Image 7: Area of No Archaeological Potential – Disturbed Lands
(Google Maps 2012; Facing West)

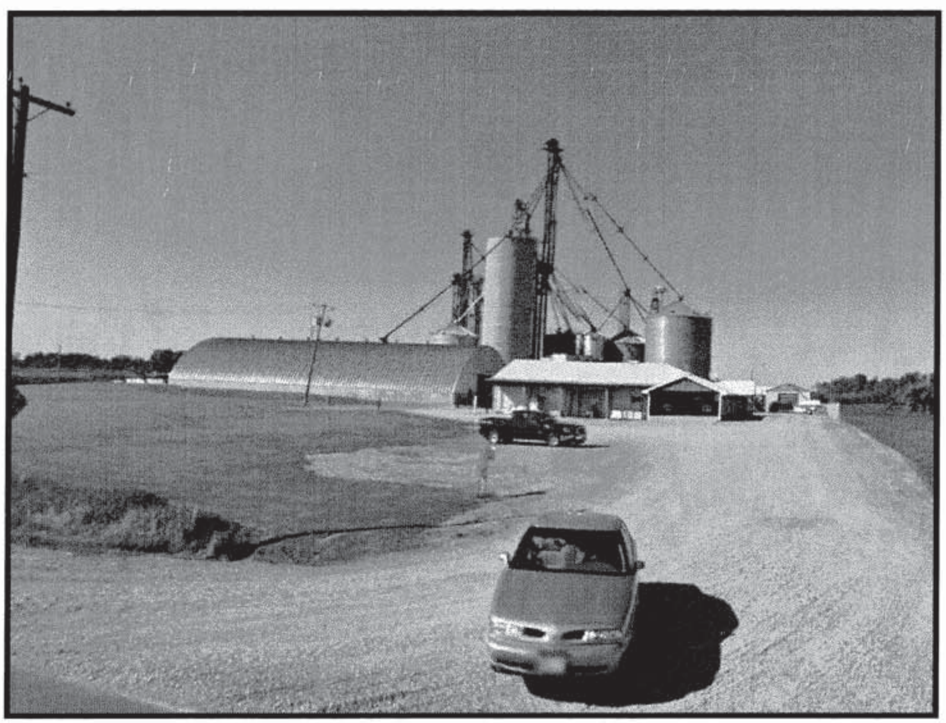


Image 8: Area of No Archaeological Potential – Disturbed Lands
(Google Maps 2012; Facing Northeast)

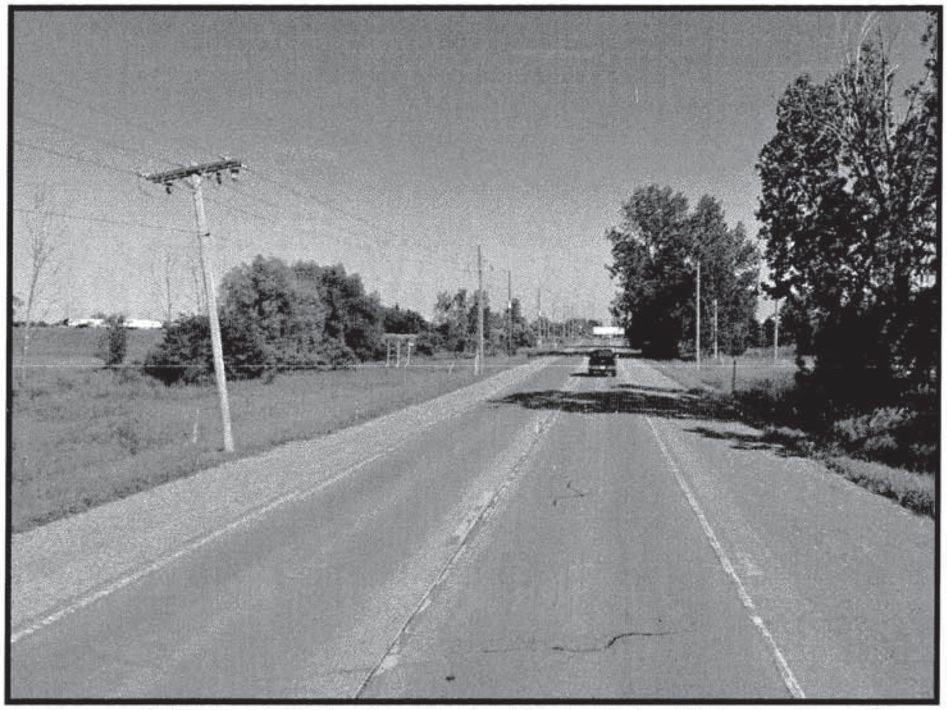


Image 9: Area of No Archaeological Potential – Disturbed Lands
(Google Maps 2012; Facing Southeast)

Image 10: View of Field Conditions
(Photo Taken on June 4, 2012; Facing Southeast)

Image 11: View of Crewmembers Conducting Pedestrian Survey at a Maximum Interval of 5 m
(Photo Taken on June 4, 2012; Facing Northwest)

Image 12: View of Crewmembers Conducting Pedestrian Survey at a Maximum Interval of 5 m
(Photo Taken on June 4, 2012; Facing Northwest)

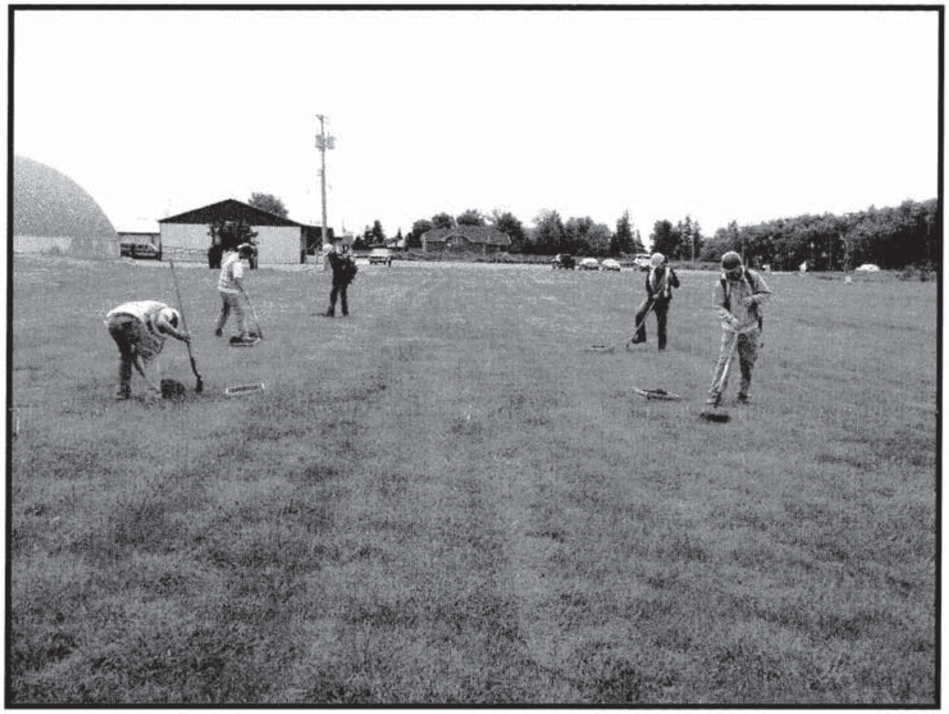


Image 13: View of Crewmember Test Pitting at a Maximum Interval of 5 m
(Photo Taken on June 4, 2012; Facing Southeast)

Image 14: View of Crewmember Test Pitting at a Maximum Interval of 5 m
(Photo Taken on June 4, 2012; Facing West)

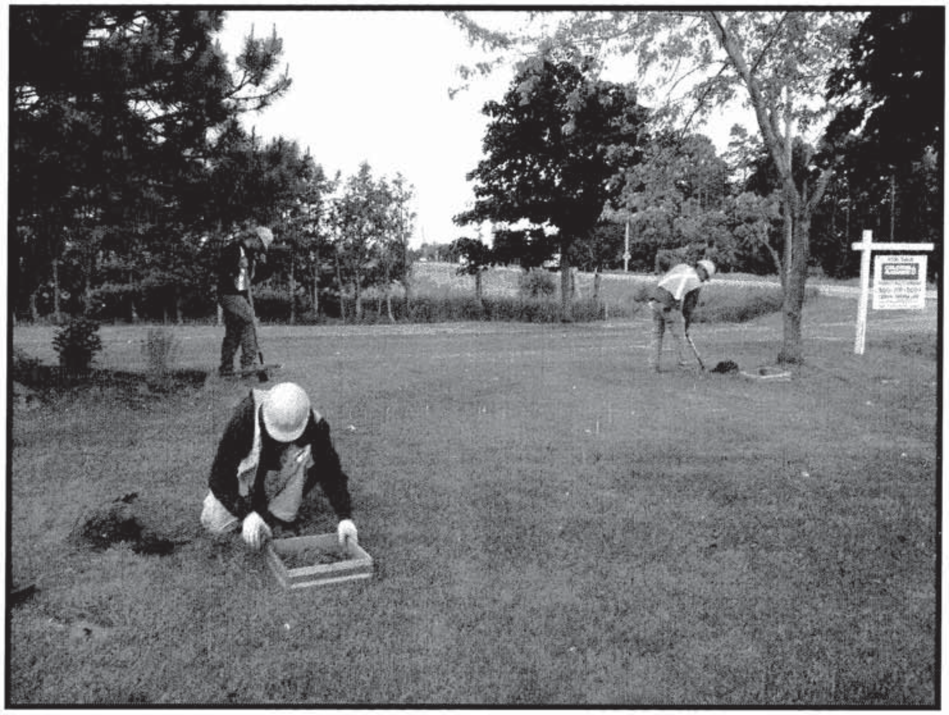


Image 15: View of Crewmember Test Pitting at a Maximum Interval of 5 m
(Photo Taken on June 4, 2012; Facing Northeast)

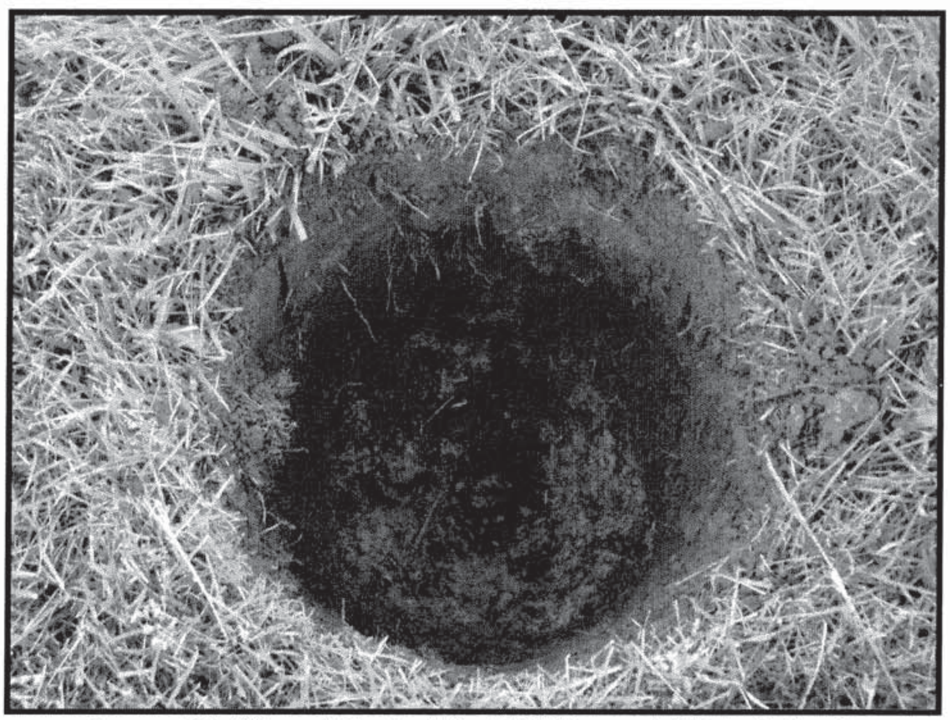


Image 16: View of Typical Test Pit Excavated into Subsoil
(Photo Taken on June 4, 2012)

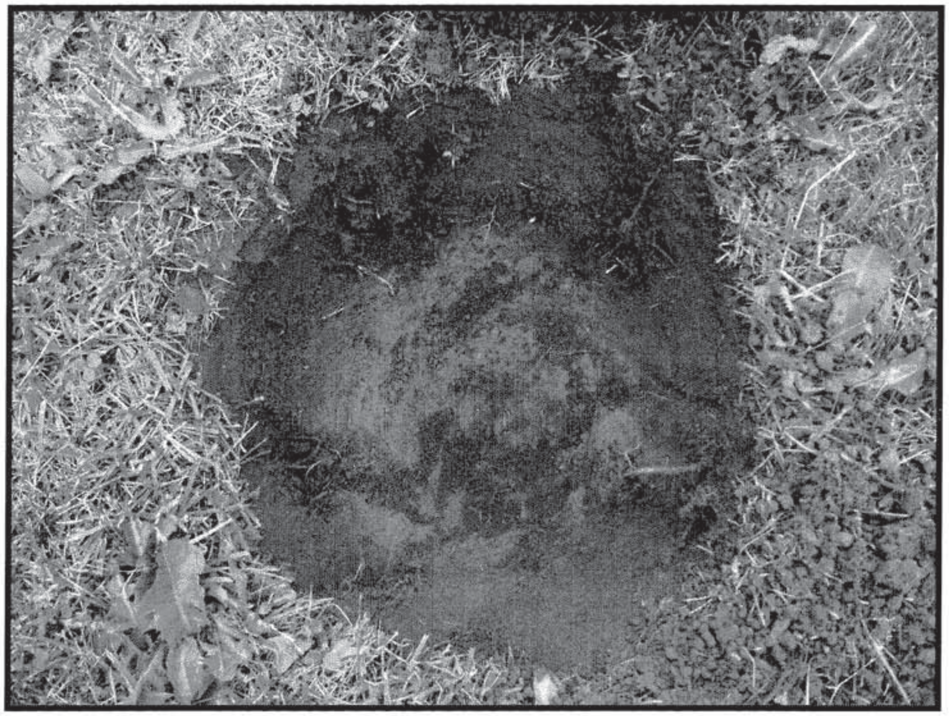
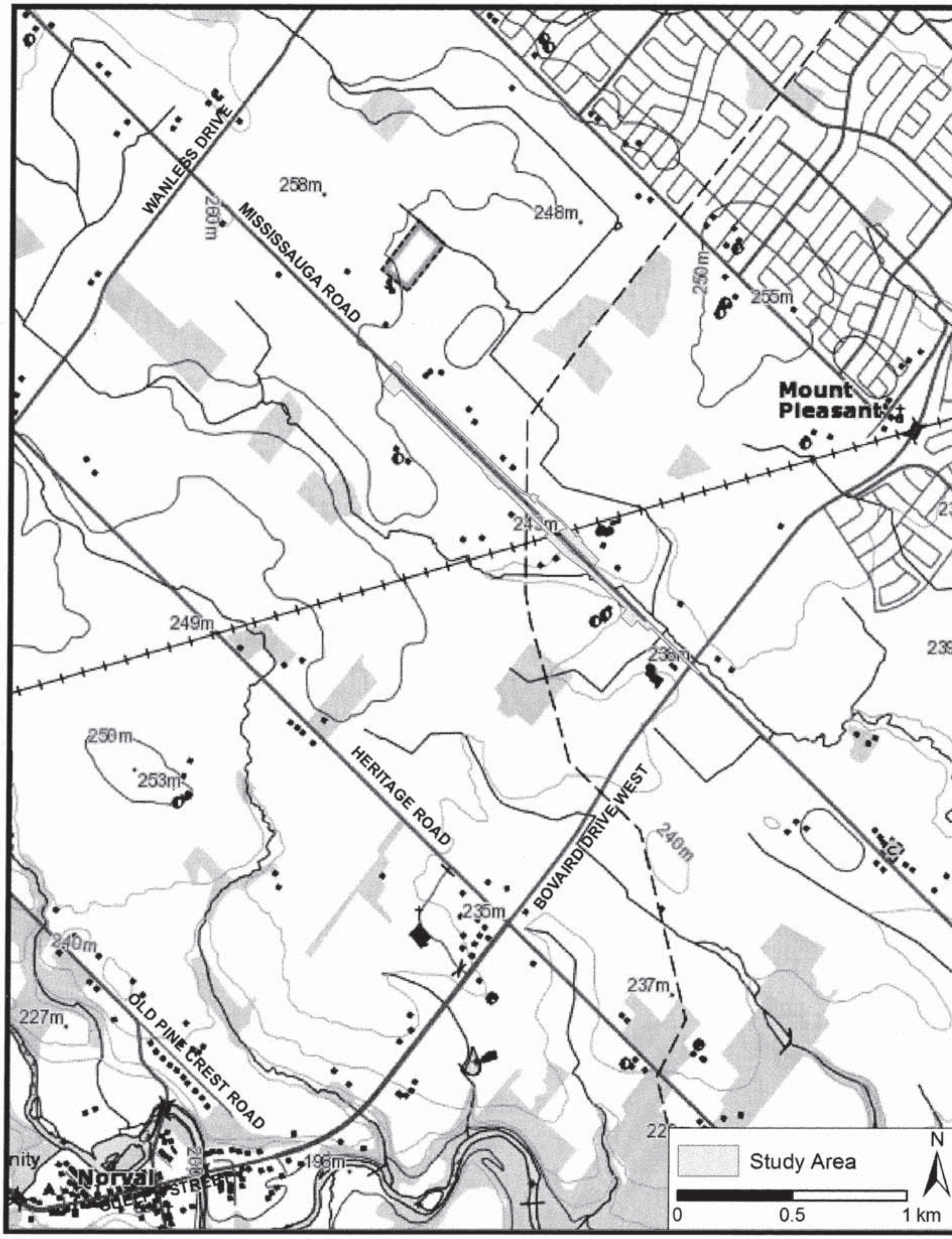


Image 17: View of Typical Test Pit Excavated into Subsoil
(Photo Taken on June 4, 2012)

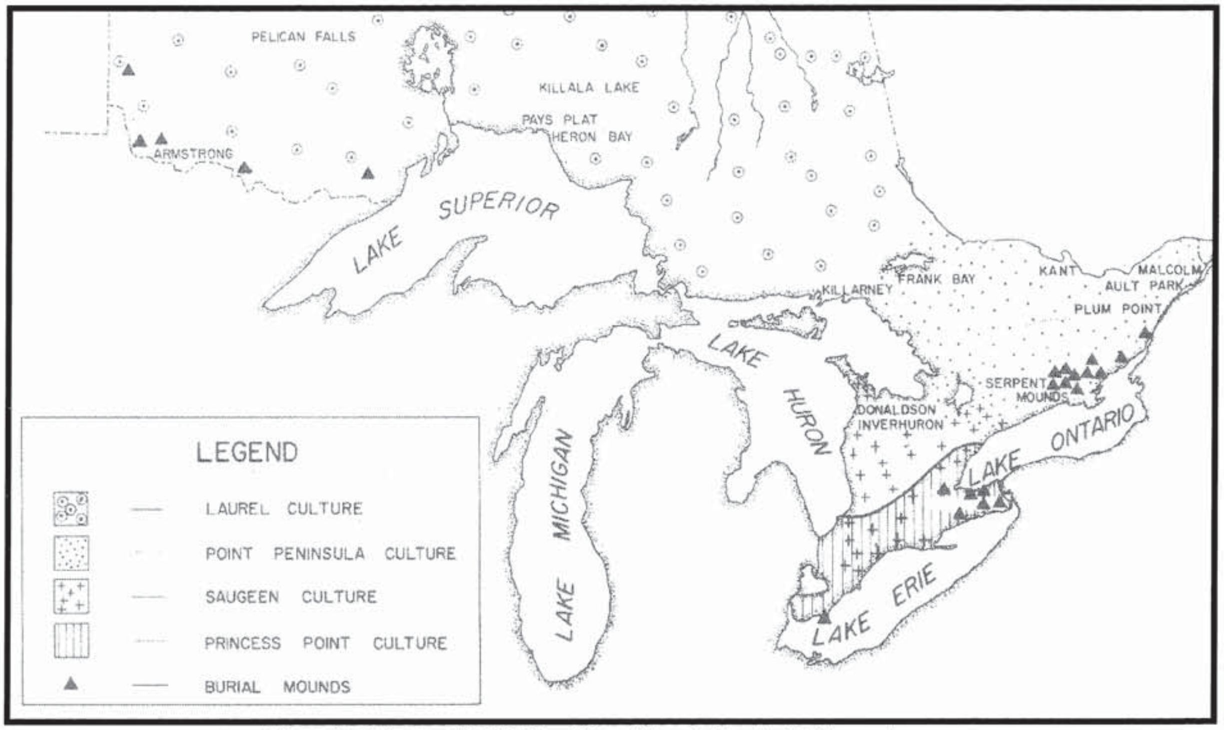
Image 18: View of Crewmember Screening Soil through 6 mm Mesh
(Photo Taken June 4, 2012; Facing Southeast)

8.0 MAPS

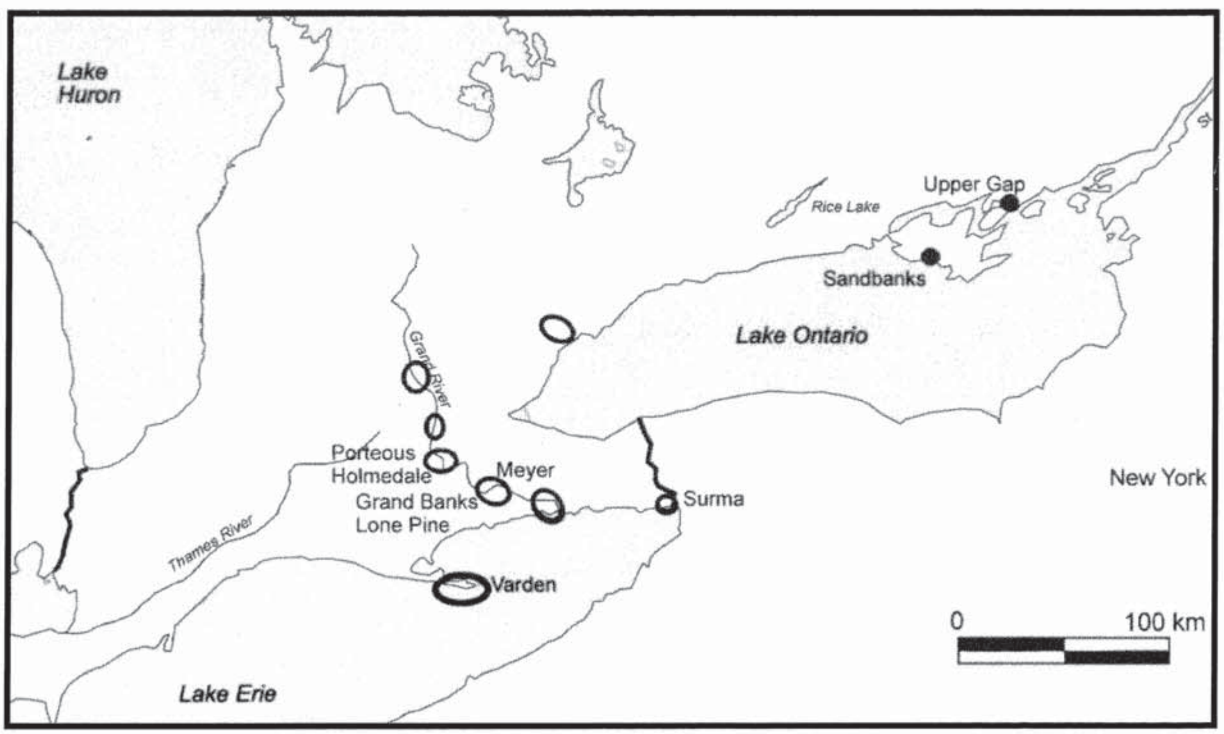
Map 1: Location of the Study Area in the Province of Ontario
(NRC 2004)



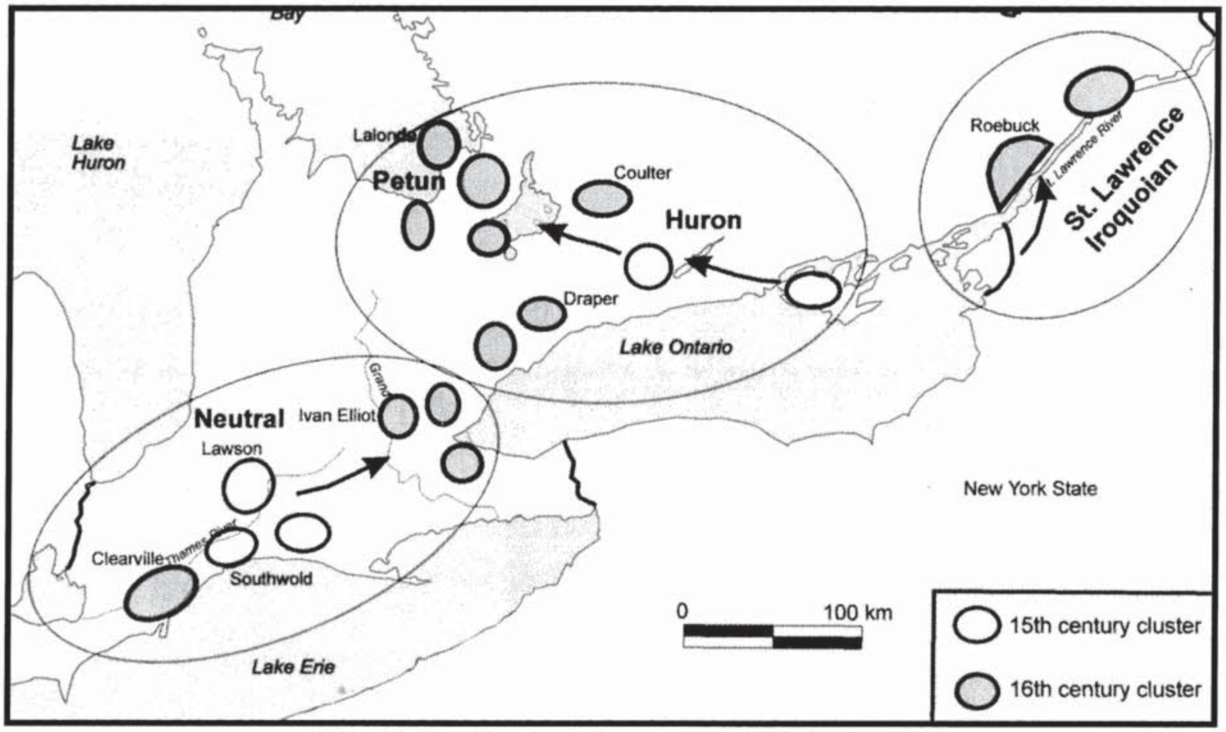
Map 2: General View of the Study Area in the City of Brampton
(NRC 2010b)



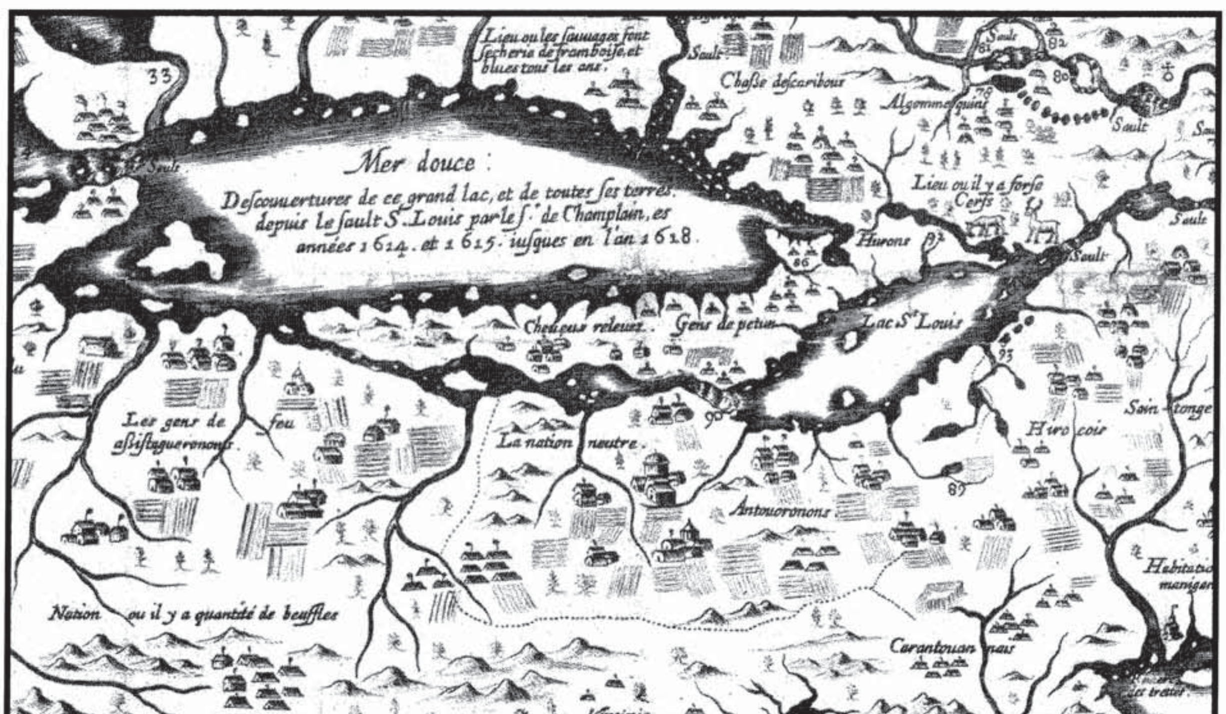
Map 3: Map of Middle Woodland Period Complexes
(Wright 1972:Map 4)



Map 4: Princess Point Site Clusters in Southern Ontario
(Warrick 2000:Figure 3)

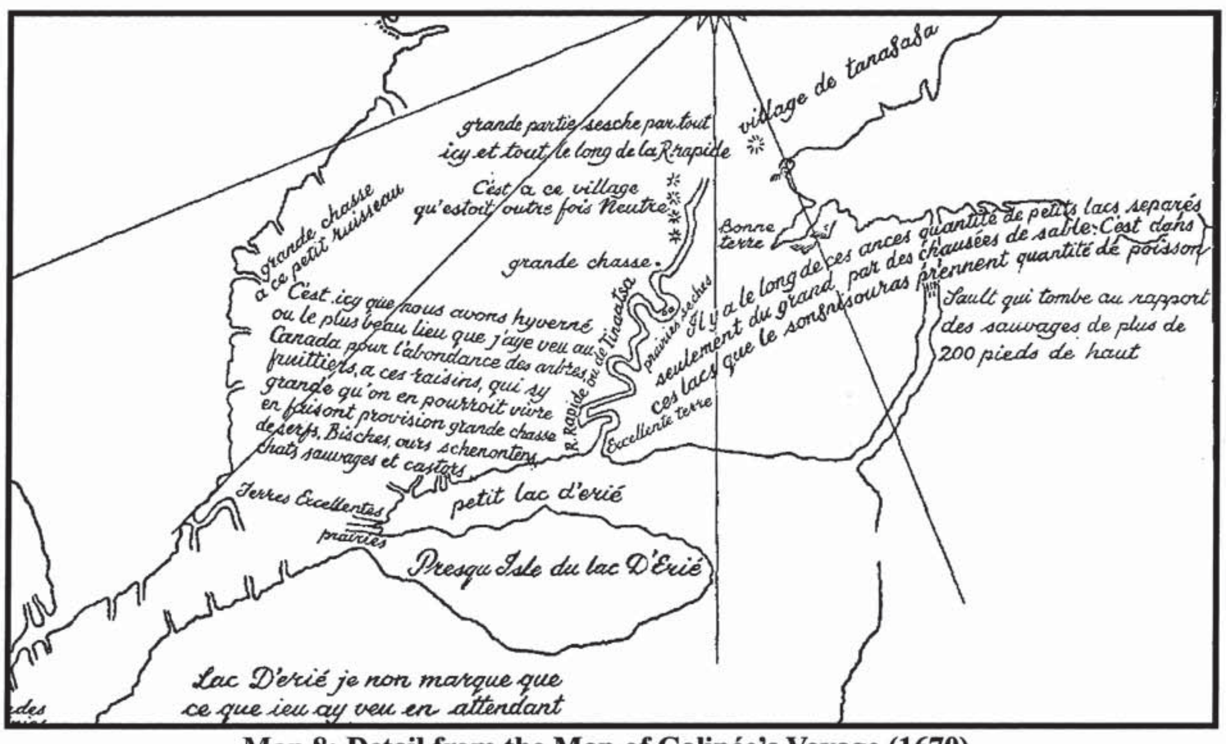


Map 5: Pre-Contact Iroquoian Site Clusters
(Warrick 2000:Figure 10)



Map 6: Detail from S. de Champlain's *Carte de la Nouvelle France* (1632)
(Gentilcore and Head 1984:Map 1.2)

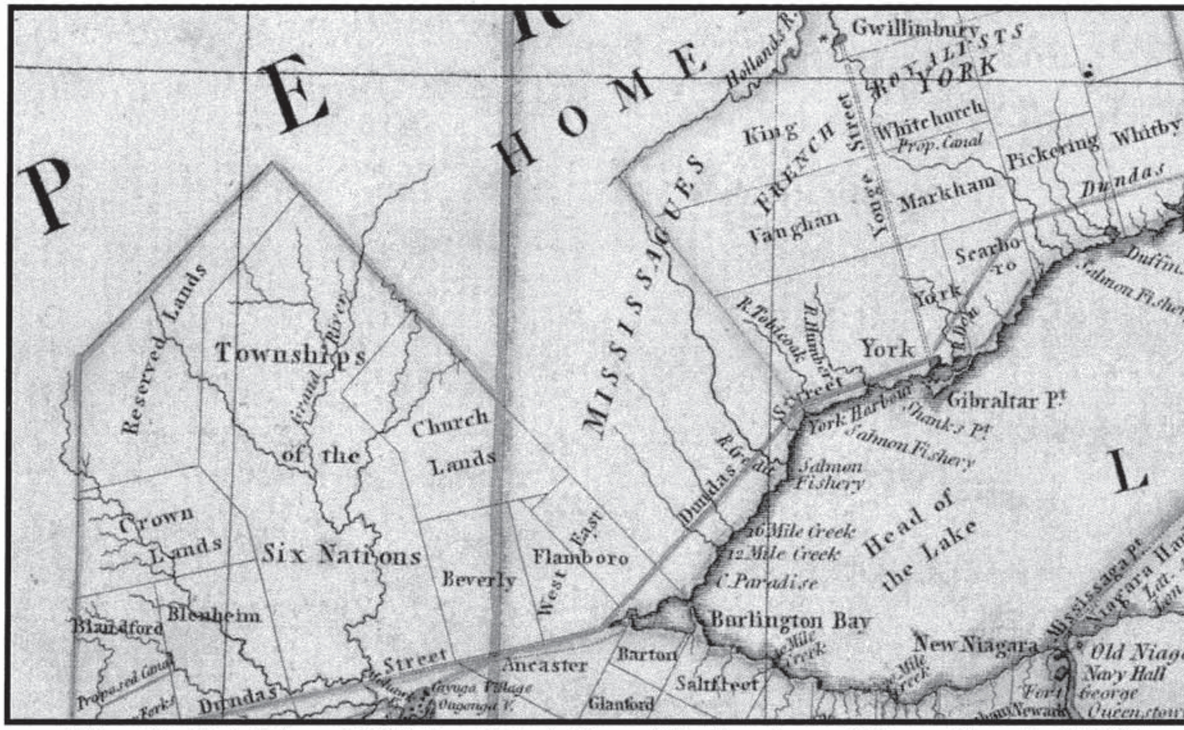
Map 7: Detail from N. Sanson's *Le Canada, ou Nouvelle France* (1656)
(Gentilcore and Head 1984:Map 1.10)



Map 8: Detail from the Map of Galinée's Voyage (1670)
(Lajeunesse 1960:Map 2)

Map 9: Detail from H. Popple's *A Map of the British Empire in America* (1733)
(Cartography Associates 2009)

Map 10: Detail from R. Sayer and J. Bennett's *General Map of the Middle British Colonies in America* (1776)
(Cartography Associates 2009)

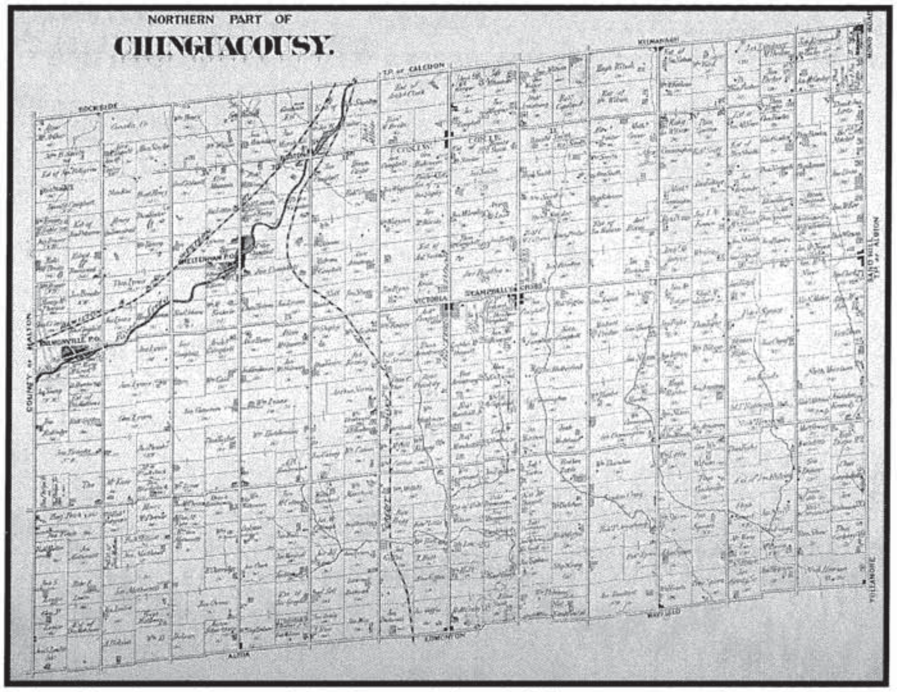


Map 11: Detail from D.W. Smyth's *A Map of the Province of Upper Canada* (1800)
(Cartography Associates 2009)

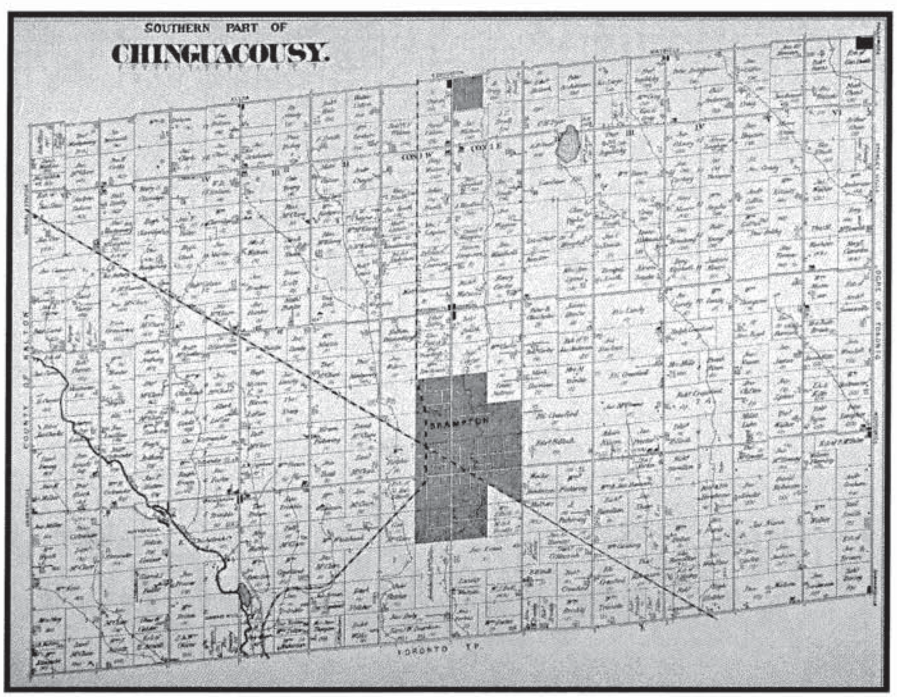
Map 12: Detail from J. Purdy's *A Map of Cabotia* (1814)
(Cartography Associates 2009)

Map 13: Detail from J. Arrowsmith's *Upper Canada* (1837)
(Cartography Associates 2009)

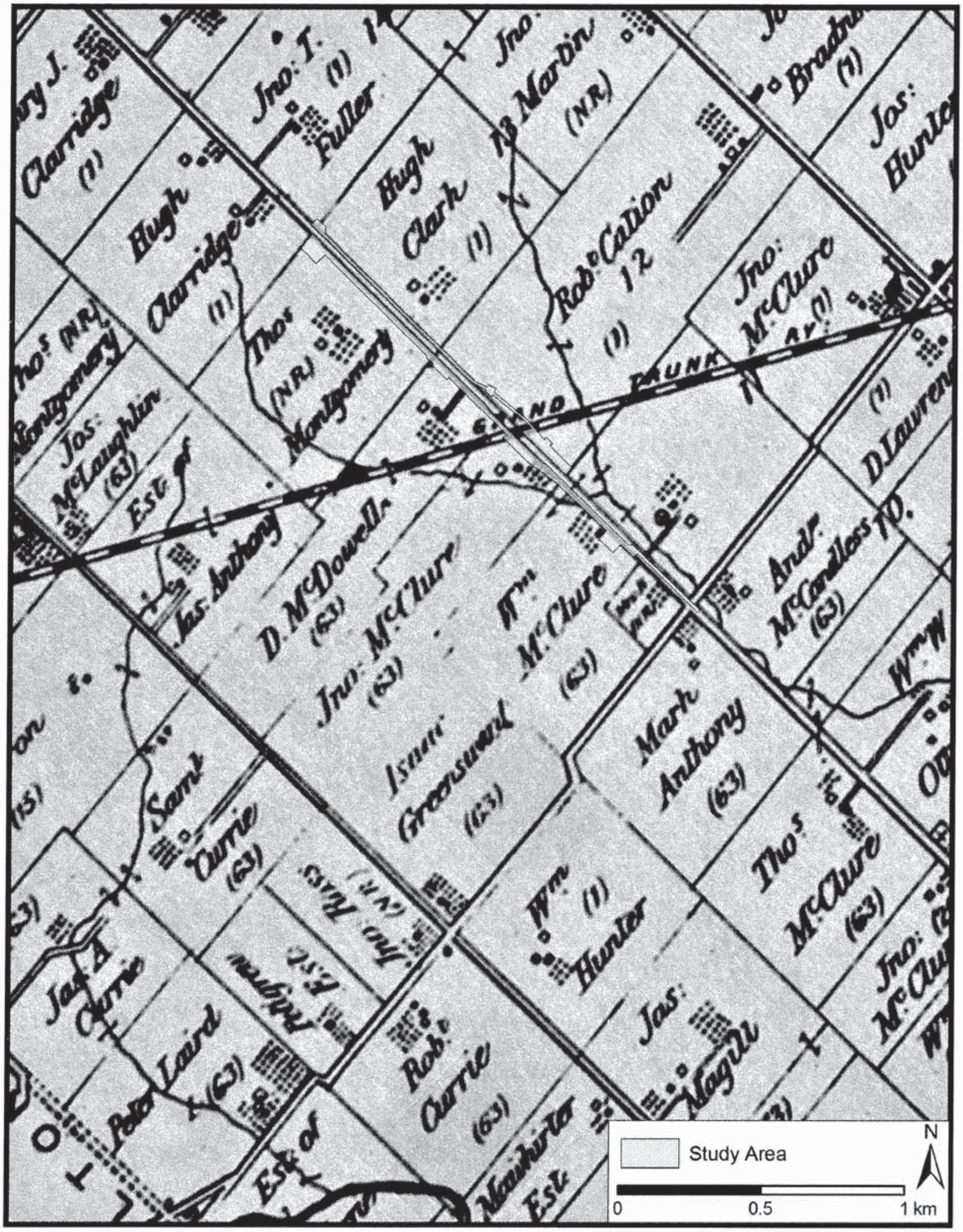
Map 14: Detail from G.W. Colton's *Canada West* (1856)
(Cartography Associates 2009)



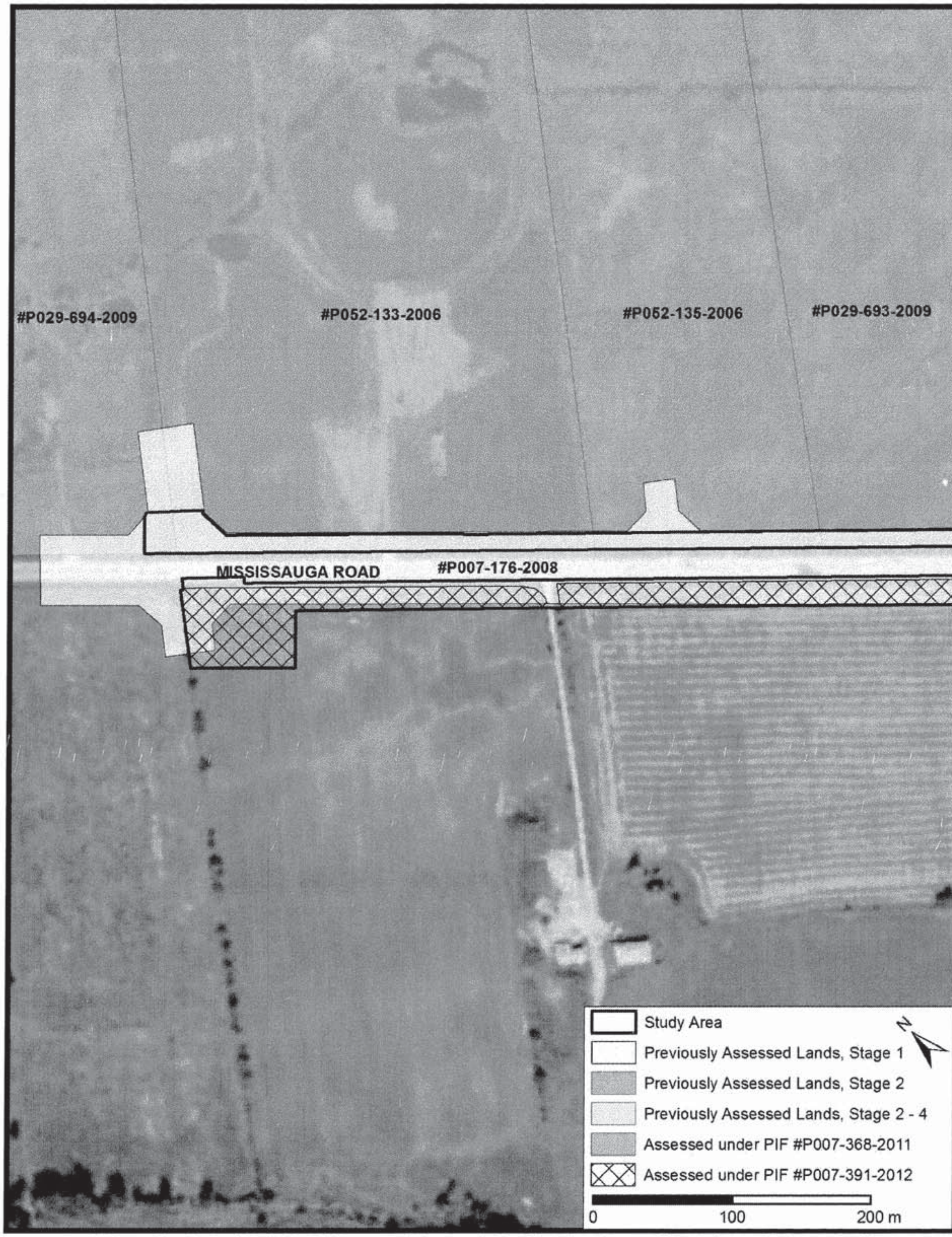
Map 15: The Northern Part of the Township of Chinguacousy from Walker & Miles' *Historical Atlas of Peel County* (1877)
(McGill University 2001)



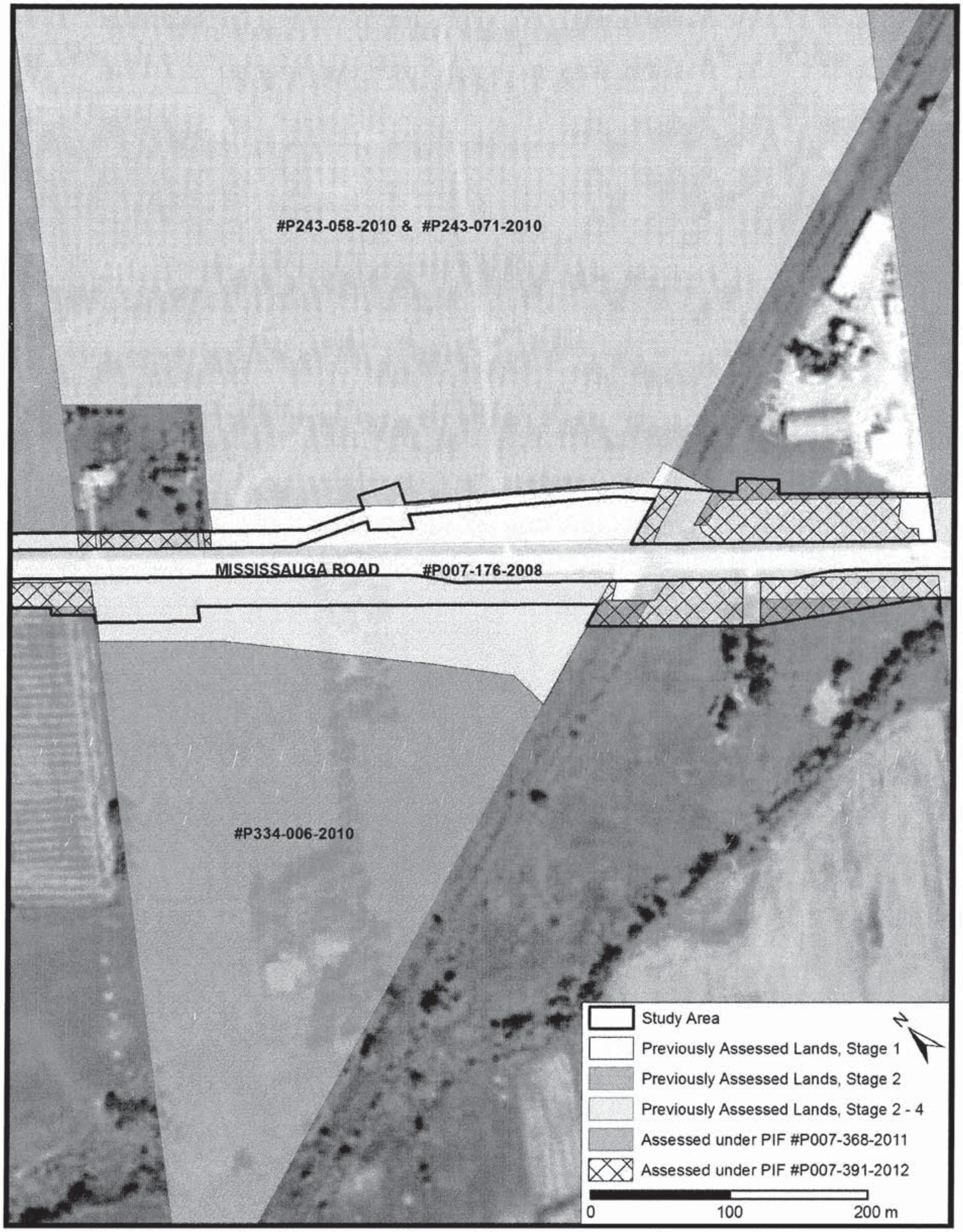
Map 16: The Southern Part of the Township of Chinguacousy from Walker & Miles' *Historical Atlas of Peel County* (1877)
(McGill University 2001)



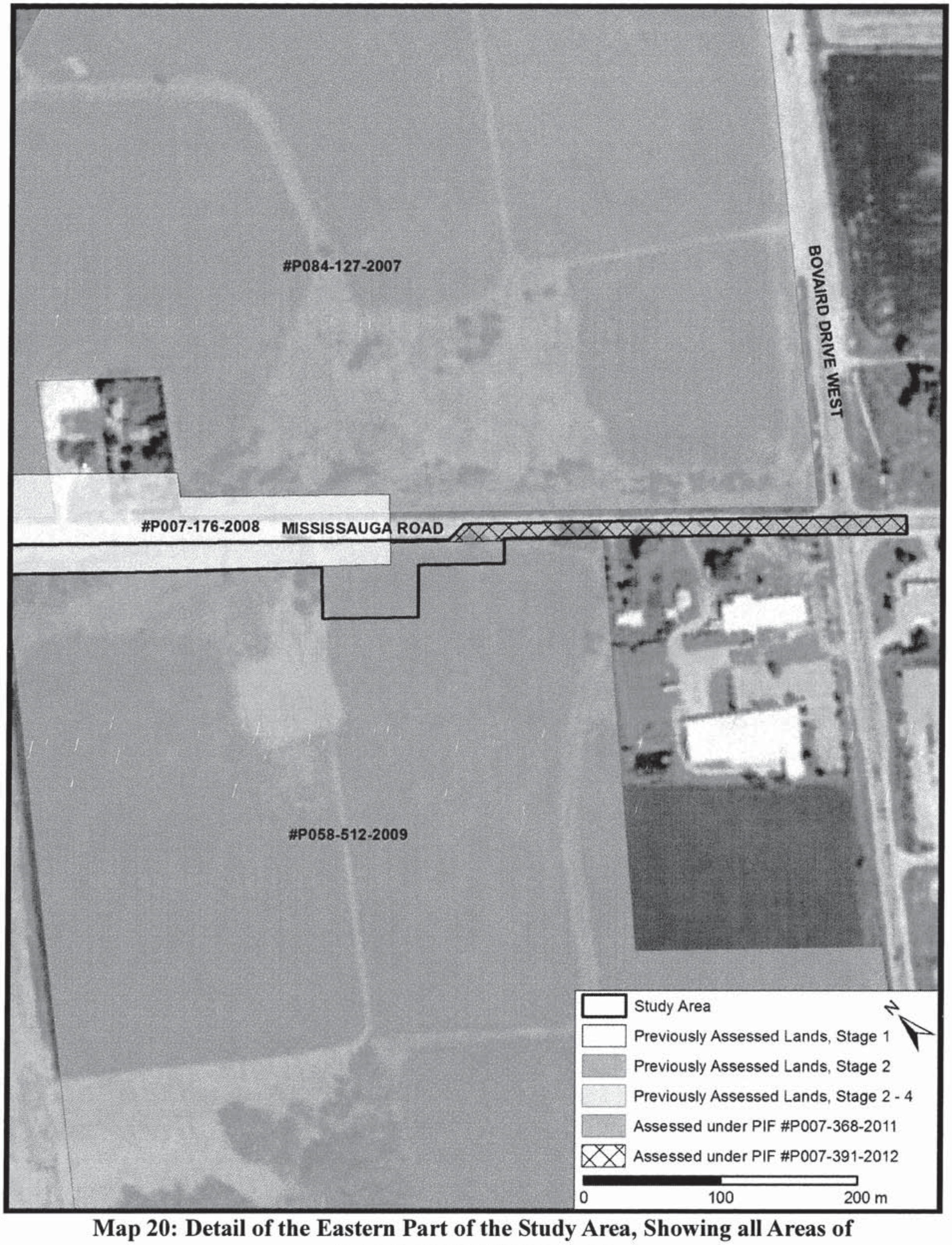
Map 17: Detail of the Southern Part of the Township of Chinguacousy from Walker & Miles' *Historical Atlas of Peel County* (1877), Showing the Study Area
(McGill University 2001)



Map 18: Detail of the Western Part of the Study Area, Showing all Areas of Archaeological Assessment
(Google Earth 2012)

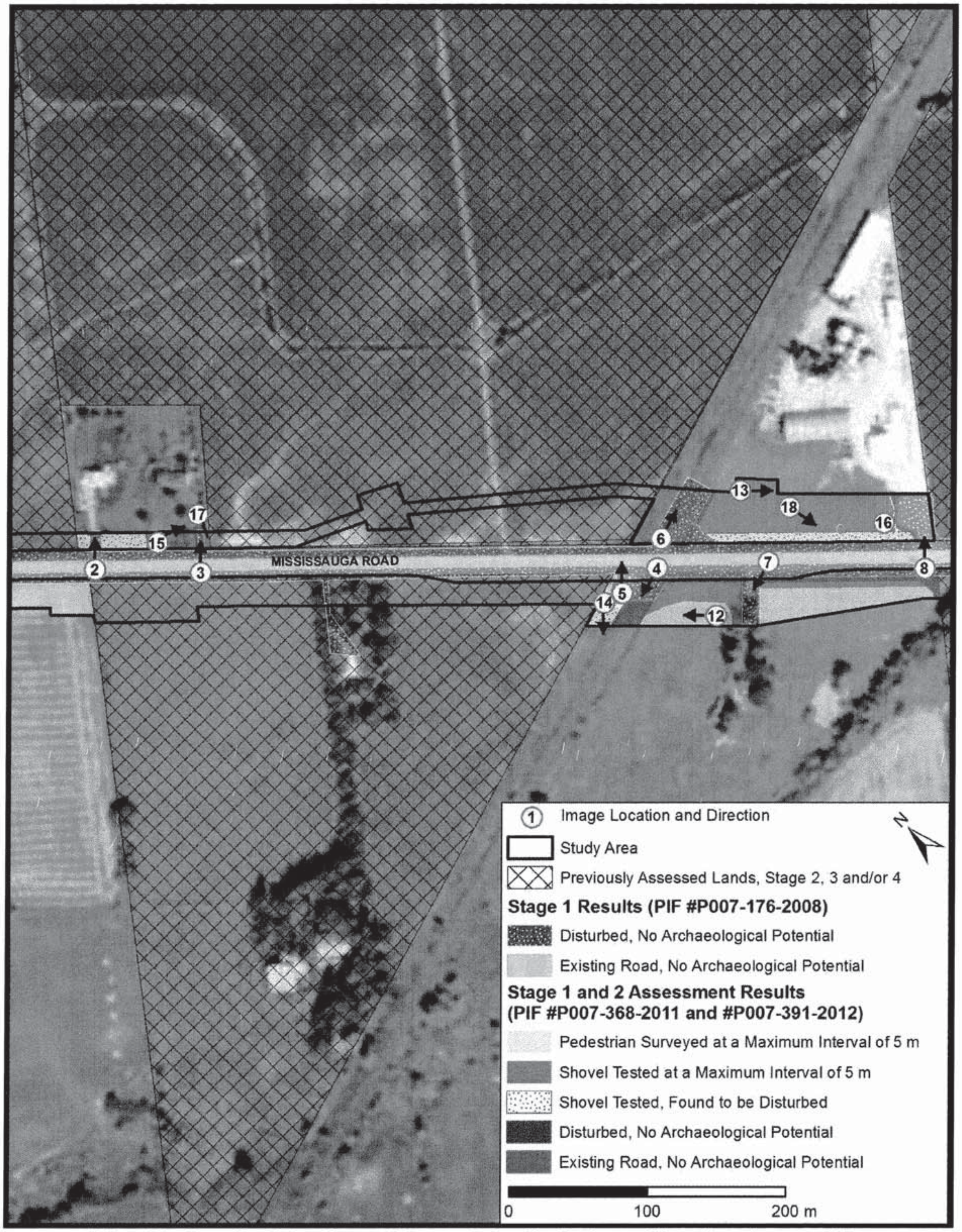


Map 19: Detail of the Central Part of the Study Area, Showing all Areas of Archaeological Assessment
(Google Earth 2012)

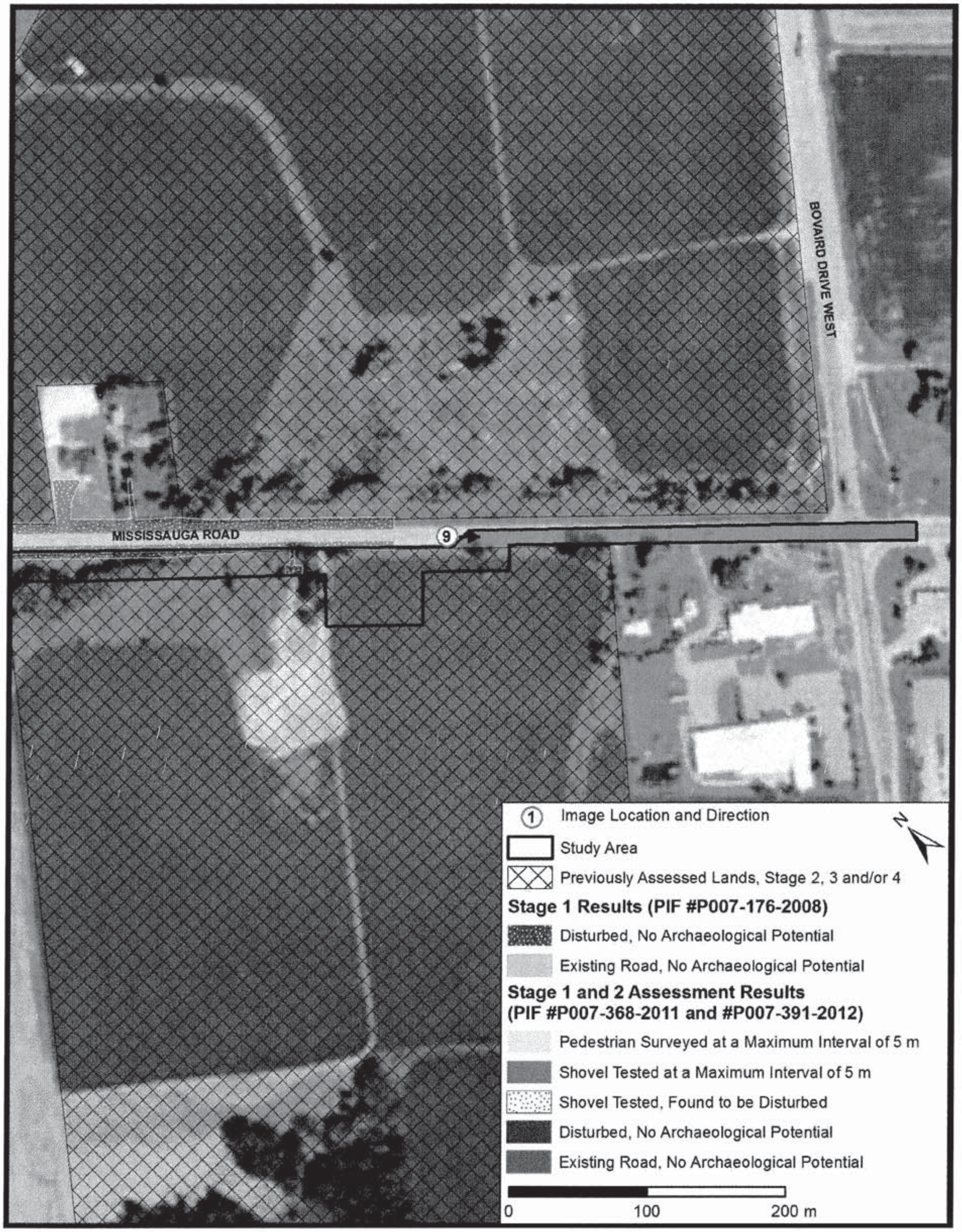


Map 20: Detail of the Eastern Part of the Study Area, Showing all Areas of Archaeological Assessment
(Google Earth 2012)

Map 21: Detail of the Western Part of the Study Area, Showing Areas of No Archaeological Potential and Stage 2 Field Methods
(Google Earth 2012)



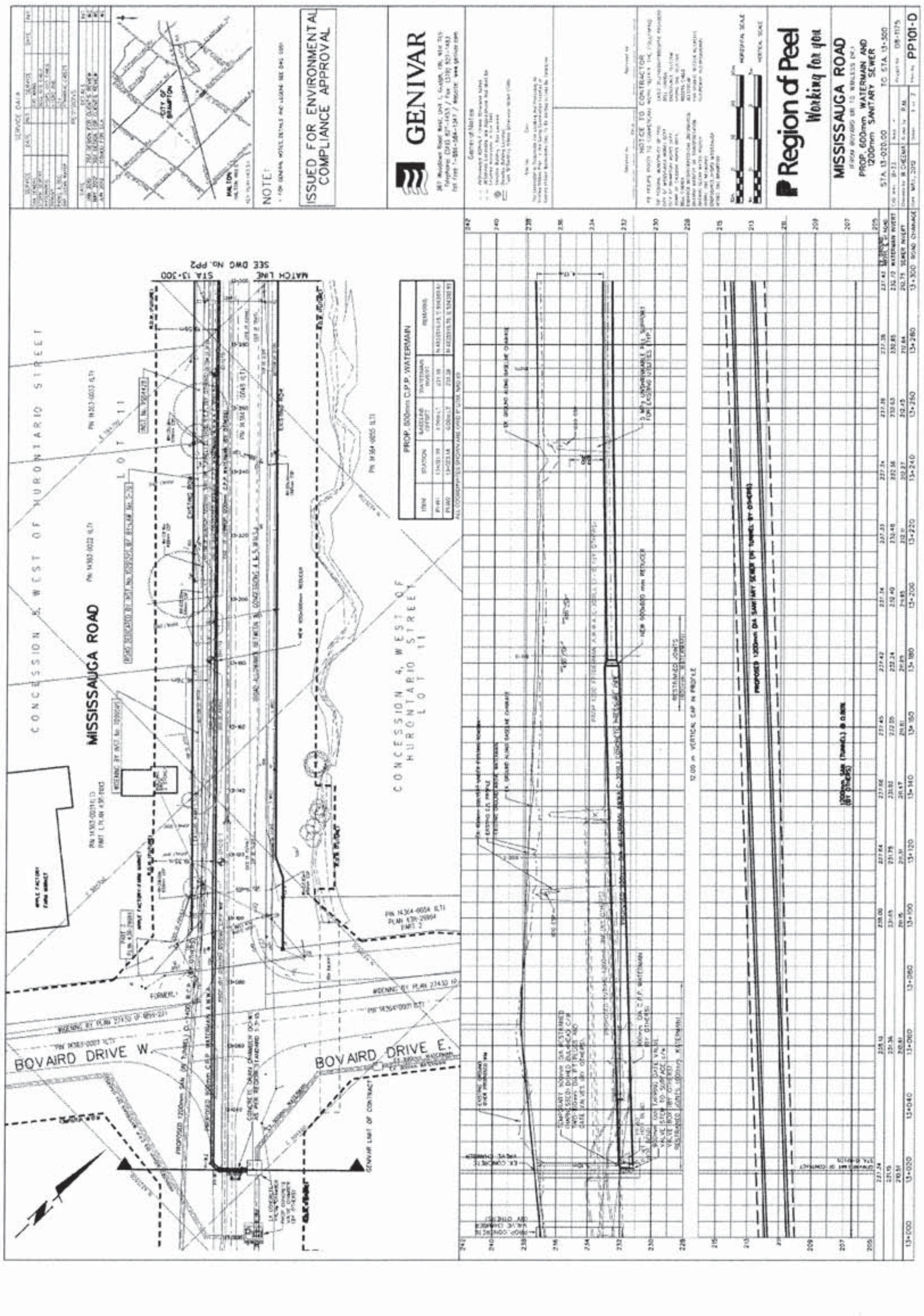
Map 22: Detail of the Central Part of the Study Area, Showing Areas of No Archaeological Potential and Stage 2 Field Methods
(Google Earth 2012)



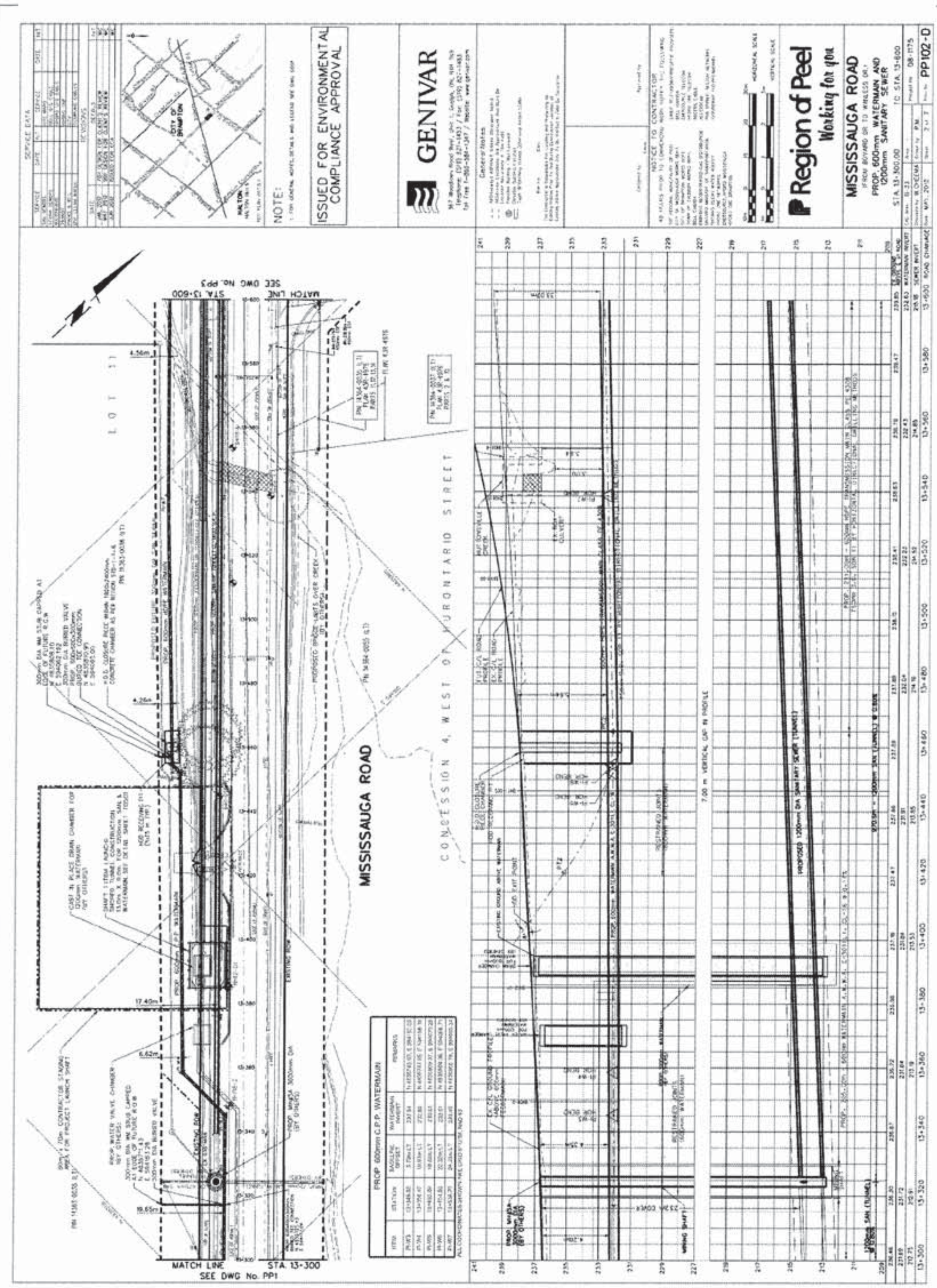
Map 23: Detail of the Eastern Part of the Study Area, Showing Areas of No Archaeological Potential and Stage 2 Field Methods
(Google Earth 2012)

APPENDICES

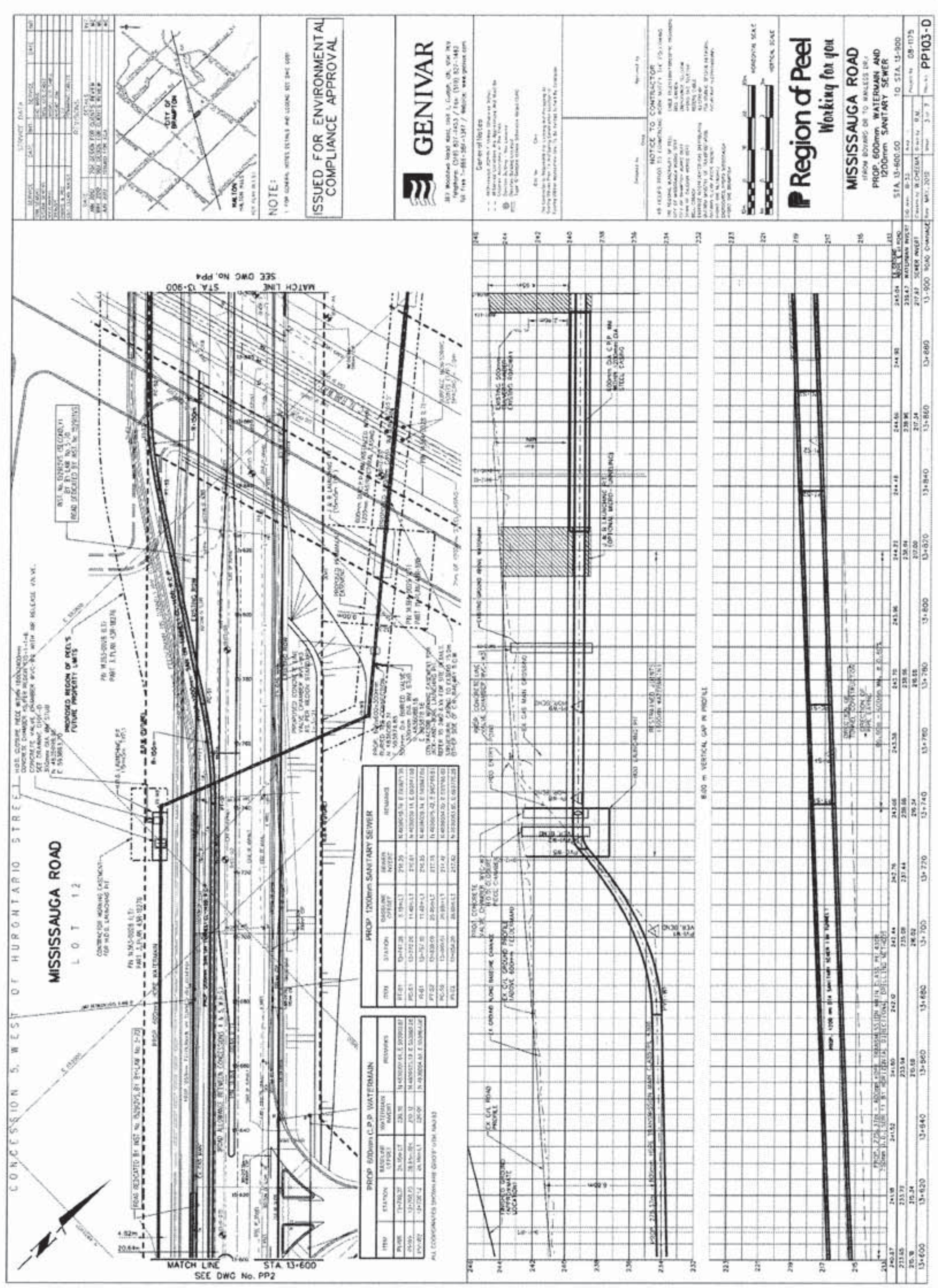
Appendix A: Mapping for the Mississauga Road 1200 mm Sanitary Sewer, 1200 mm Feedermain and 600 mm Watermain, Map 1 of 7
(Provided by GENIVAR)



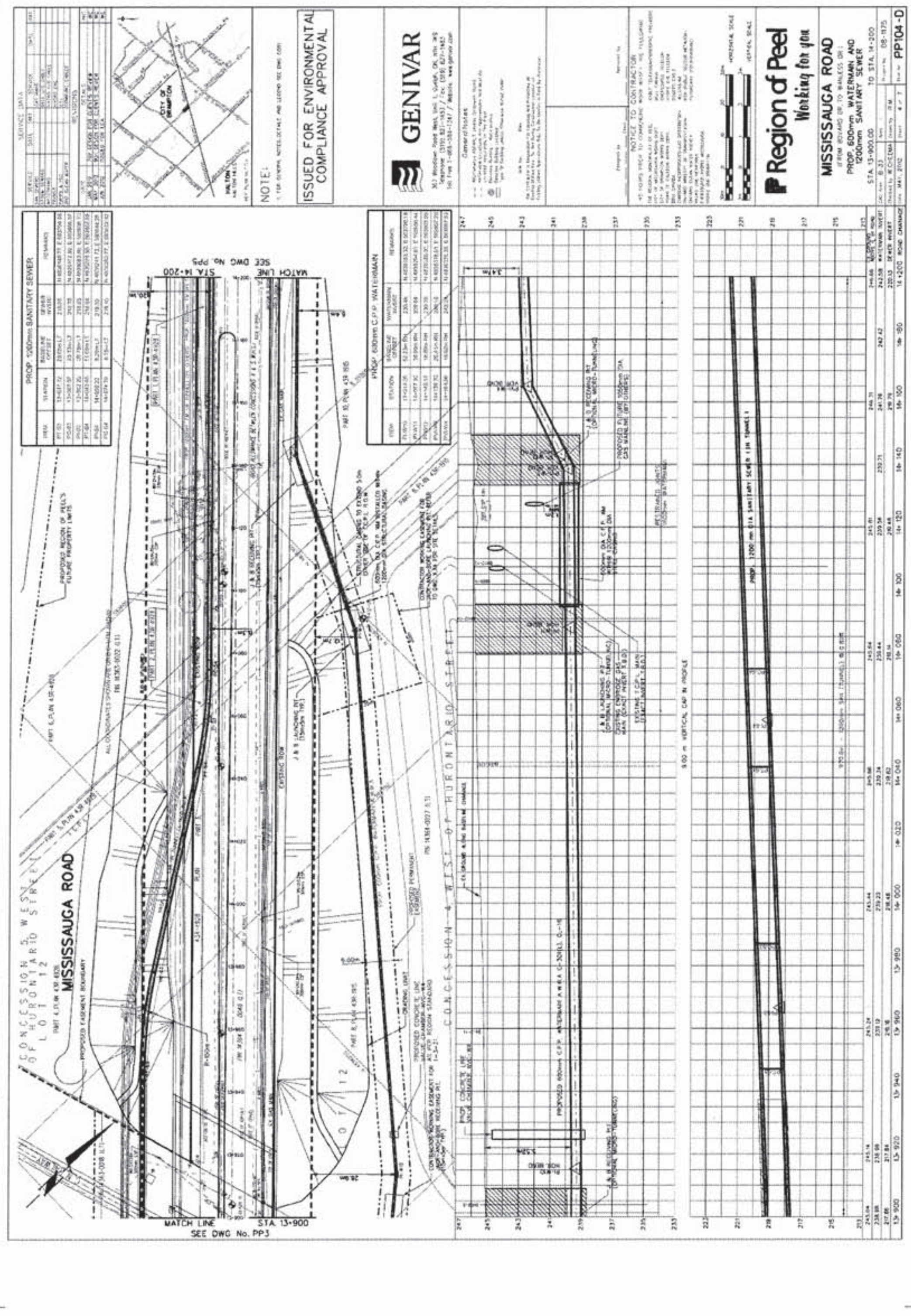
Appendix B: Mapping for the Mississauga Road 1200 mm Sanitary Sewer, 1200 mm Feedermain and 600 mm Watermain, Map 2 of 7 (Provided by GENIVAR)



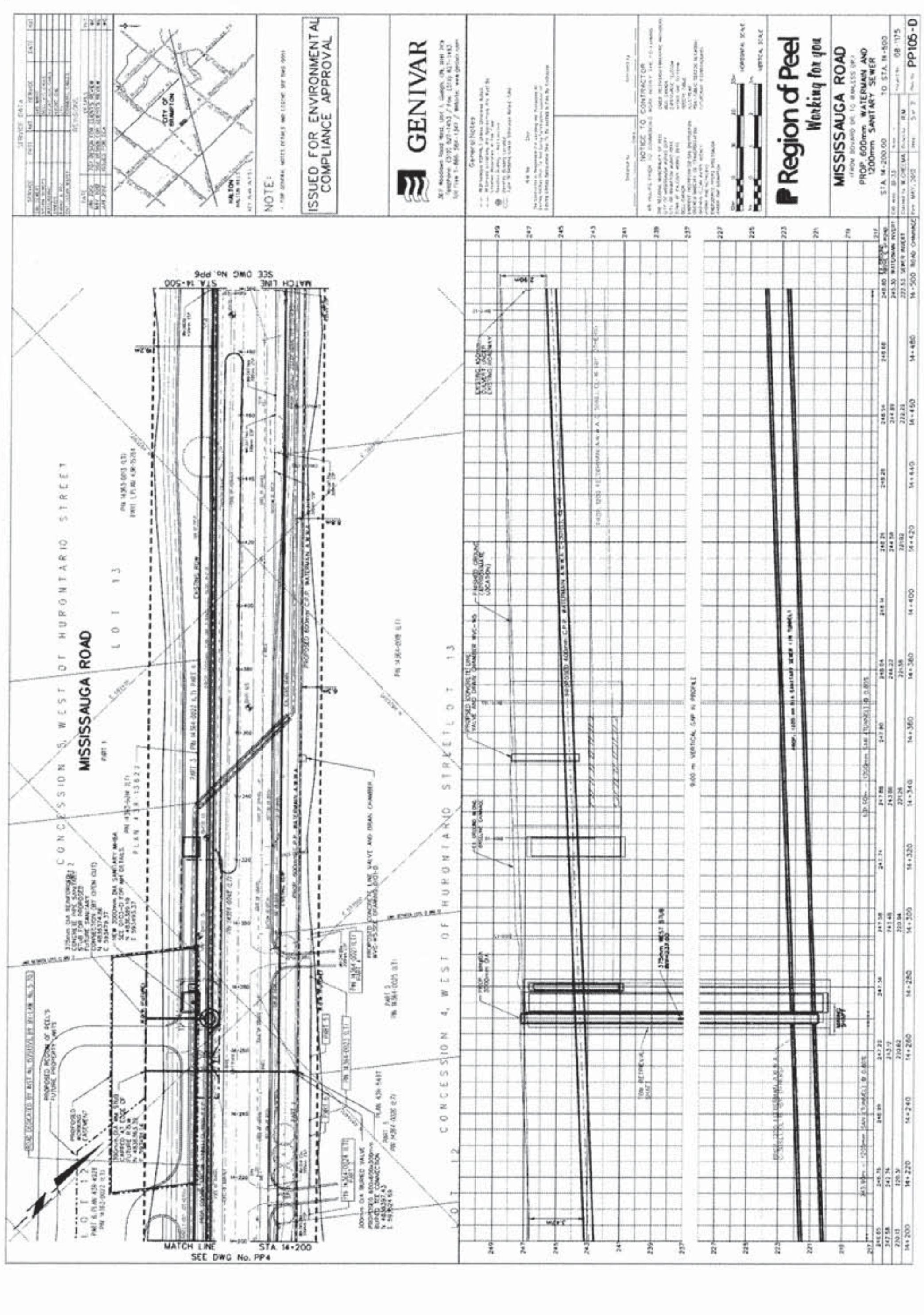
Appendix C: Mapping for the Mississauga Road 1200 mm Sanitary Sewer, 1200 mm Feedermain and 600 mm Watermain, Map 3 of 7 (Provided by GENIVAR)



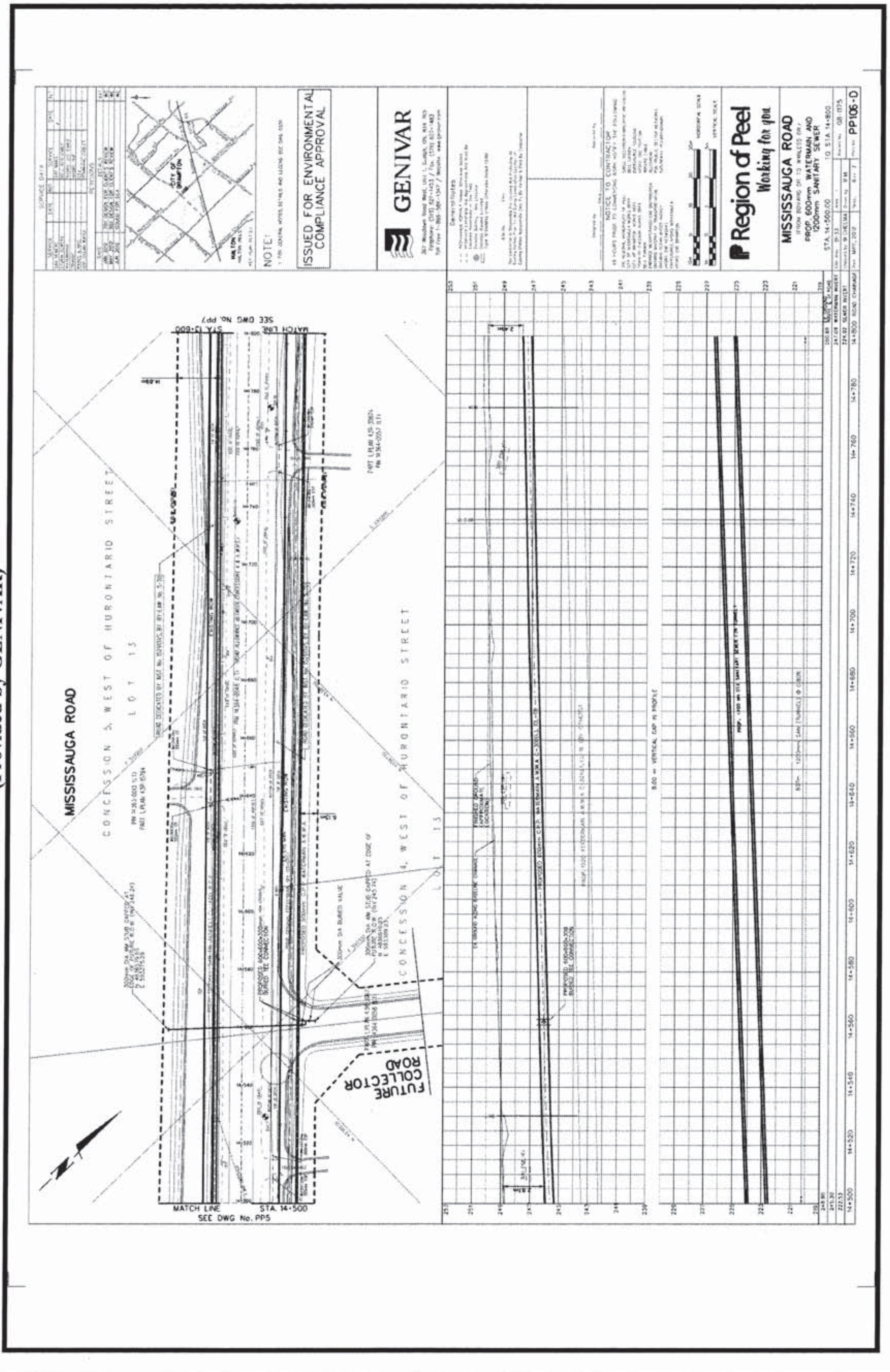
Appendix D: Mapping for the Mississauga Road 1200 mm Sanitary Sewer, 1200 mm Feedermain and 600 mm Watermain, Map 4 of 7
(Provided by GENIVAR)



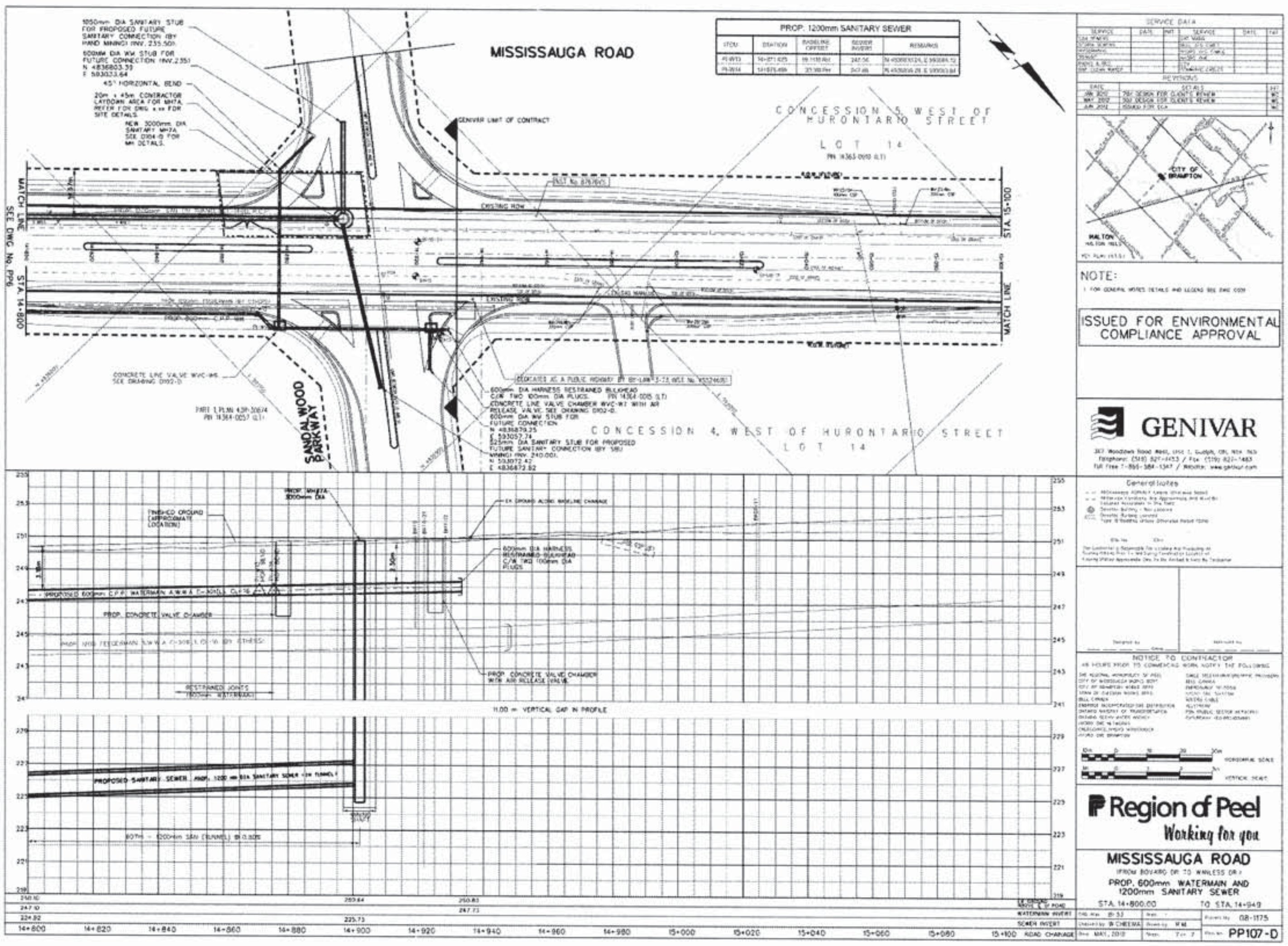
Appendix E: Mapping for the Mississauga Road 1200 mm Sanitary Sewer, 1200 mm Feedermain and 600 mm Watermain, Map 5 of 7
(Provided by GENIVAR)



Appendix F: Mapping for the Mississauga Road 1200 mm Sanitary Sewer, 1200 mm Feedermain and 600 mm Watermain, Map 6 of 7
(Provided by GENIVAR)



Appendix G: Mapping for the Mississauga Road 1200 mm Sanitary Sewer, 1200 mm Feedermain and 600 mm Watermain, Map 7 of 7
(Provided by GENIVAR)



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12 July, 2012

Archaeology Administrative Coordinator
Ministry of Tourism, Culture and Sport
Programs and Services Branch
401 Bay Street, Suite 1700
Toronto, ON M7A 0A7
Tel: (416) 212-8002

Dear Archaeology Administrative Coordinator:

RE: Submission of original report entitled **"Stage 1 and 2 Archaeological Assessments, Mississauga Road 1200 mm Sanitary Sewer, 1200 mm Feedermain and 600 mm Watermain, Parts of Lots 10–14, Concession 4–5 W.H.S., Geographic Township of Chinguacousy, City of Brampton, Regional Municipality of Peel, Ontario."**

Please find enclosed one copy of the above-mentioned report, one copy of supplementary documentation, one copy of the development map set, one copy of an expedited review request and a digital copy of each on CD. These assessments were completed under MTCS licence #P007, PIF #P007-368-2011 and PIF #P007-391-2012 and were carried out under contract to GENIVAR Inc. as a component of a Municipal Class Environmental Assessment study, in compliance with the *Environmental Assessment Act*.

The contact information for the proponent and the approval authority is as follows:

Designated Proponent Contact:
Waqar Cheema, P.Eng; M.Eng; PMP
Sr. Civil Engineer – Project Manager
GENIVAR Inc.
1-367 Woodlawn Rd. West
Guelph, Ontario N1H 7K9
Tel: (519) 827-1453 ext. 258
Waqar.Cheema@genivar.com

Approval Authority:
Grace Krasowski, P. Eng.
Project Manager, Capital Works
Peel Region Public Works
10 Peel Centre Drive, Suite A and B
Brampton, ON L6T 4B9
Tel: (905) 791-7800 ext.7820
Grace.Krasowski@peelregion.ca

I the undersigned hereby declare that, to the best of my knowledge, the information in this report and submitted in support of this report is complete and accurate in every way, and I am aware of the penalties against providing false information under section 69 of the *Ontario Heritage Act*. Should you have any questions or concerns, please do not hesitate to contact me at your earliest convenience.

Best regards,

Paul J. Racher, M.A., CAHP, MTCS Licence #P007
Vice-President, Operations
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Ministry of Tourism, Culture and Sport

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Ontario

August 9, 2012

Mr. Paul Racher
Archaeological Research Associates Ltd.
154 Otonabee Drive
Kitchener
Ontario N2C 1L7

RE: Entry into the Ontario Public Register of Archaeological Reports: Archaeological Assessment Report Entitled, *"Stage 1 and 2 Archaeological Assessments Mississauga Road 1200 mm Sanitary Sewer, 1200 mm Feedermain and 600 mm Watermain, Parts of Lots 10-14, Concession 4-5 W.H.S., Geographic Township of Chinguacousy, City of Brampton, Regional Municipality of Peel, Ontario,"* Dated July 12, 2012, Received by MTC Toronto Office on July 13, 2012, MTCS Project Information Form Number P007-368-2011 and P007-391-2011 , MTCS RIMS Number 21WT059

Dear Mr. Racher:

This office has reviewed the above-mentioned report, which has been submitted to this Ministry as a condition of licensing in accordance with Part VI of the Ontario Heritage Act, R.S.O. 1990, c 0.18. This review has been carried out in order to determine whether the licensed professional consultant archaeologist has met the terms and conditions of their licence, that the licensee assessed the property and documented archaeological resources using a process that accords with the 2011 *Standards and Guidelines for Consultant Archaeologists* set by the Ministry, and that the archaeological fieldwork and report recommendations are consistent with the conservation, protection and preservation of the cultural heritage of Ontario.

The report recommends the following:

> The Stage 1 and 2 archaeological assessments of the study area were completed in June 2012. The background research component of the Stage 1 assessment determined that several of the properties within the study area were previously assessed between 2006 and 2010. The majority of these surveyed lands were not recommended for further assessment, but one property contains the Euro-Canadian Primont H1 site, which was recommended for a Stage 3 site-

specific assessment. Although the subject study area traverses the extent of Primont H1, project impacts in this area will occur approximately 27 m below the ground surface in the shared tunnel for the Mississauga Road 1200 mm Sanitary Sewer and 1200 mm Feedermain (see Appendix D). In August 2008, ARA also conducted a Stage 1 assessment for the proposed widening of Mississauga Road, which included lands within the current project limits. Since this report has been accepted into the Provincial Register of Reports, the results of the archaeological potential modelling were reproduced in this study.

The Stage 1 assessment identified several local features of archaeological potential, including an unnamed tributary of the Credit River, Bovaird Drive West, Mississauga Road, the CN Railway, and two registered archaeological sites. On-site documentation, however, identified several disturbed areas within the study area. Accordingly, in its current state, the study area comprised a mixture of areas of archaeological potential and no archaeological potential. The previously un-assessed areas of archaeological potential clearly warranted a Stage 2 assessment. The Stage 2 assessment of the previously un-assessed lands, completed under optimal conditions, did not result in the discovery of any archaeological materials.

Based on these findings, ARA recommends that the Primont H1 site be subjected to a Stage 3 site-specific assessment if any future developments are planned in the area that could result in disturbances to the site. Since the shared tunnel for the Mississauga Road 1200 mm Sanitary Sewer and 1200 Feedermain will pass approximately 27 m below the site, ARA does not recommend that it be assessed prior to construction.

Given that the project limits traverse the extent of Primont H1, however, unintentional project impacts are a concern. In accordance with the direction set out in Section 7.8.5 of the *Standards and Guidelines for Consultant Archaeologists* (MTC 2011:140–141), ARA recommends that 1) all traffic be prohibited within the site or within a 20 m protective buffer around the site, 2) that the 20 m protective buffer be marked by a temporary barrier within the project lands, and 3) that all construction activities within 70 m of the site be monitored by a licenced archaeologist to ensure that impacts do not occur (see Supplementary Map 3). A reduced buffer is acceptable where it is interrupted by a permanently disturbed cultural form (e.g., Mississauga Road, the CN Railway) (MTC 2011:68).

Based on the information contained in the report, the ministry is satisfied that the fieldwork and reporting for the archaeological assessment is consistent with the ministry's 2011 *Standards and Guidelines for Consultant Archaeologists* and the terms and conditions for archaeological licences.This report will be entered into the Ontario Public Register of Archaeological Reports. Please note that the ministry makes no representation or warranty as to the completeness, accuracy or quality of reports in the register.

Should you require any further information regarding this matter, please feel free to contact me.

Sincerely,

Andrea K. Williams

Andrea K. Williams
A/ Archaeology Review Officer

cc. Archaeology Licensing Officer
Waqar Cheema, GENIVAR Inc.
Grace Krasowski, Peel Region Public Works

In no way will the Ministry be liable for any harm, damages, costs, expenses, losses, claims or actions that may result: (a) if the Report(s) or its recommendations are discovered to be inaccurate, incomplete, misleading or fraudulent; or (b) from the issuance of this letter. Further measures may need to be taken in the event that additional artifacts or archaeological sites are identified or the Report(s) is otherwise found to be inaccurate, incomplete, misleading or fraudulent.

C.2 Built Heritage and Cultural Landscape Assessment

Built Heritage and Cultural Landscape Assessment

Alloa Reservoir Pumping Station and Feedermain Class Environmental Assessment, City of Brampton, Region of Peel, Ontario

Submitted to:

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ASI File 06EA-202
May 2007

ARCHAEOLOGICAL SERVICES INC.
ENVIRONMENTAL ASSESSMENTS

PROJECT PERSONNEL

Project Director:	Robert M. Pihl, M.A., C.A.P.H.C. Partner and Senior Archaeologist Manager, Environmental Assessments
Project Manager:	Mary L. MacDonald, M.A., C.A.P.H.C. Built Heritage, Cultural Landscape and Planning
Field Reviewer:	Peter Carruthers, M.A., C.A.P.H.C. Senior Associate
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Report Reviewer:	Peter Carruthers

TABLE OF CONTENTS

Built Heritage and Cultural Landscape Assessment

Alloa Reservoir Pumping Station and Feedermain Class Environmental Assessment, City of Brampton, Region of Peel, Ontario

1.0 INTRODUCTION

Archaeological Services Inc. (ASI) was contracted by Earth Tech Canada Inc., St. Catherines, to conduct a Built Heritage and Cultural Landscape assessment for the Alloa Reservoir Pumping Station and Feedermain Class Environmental Assessment, City of Brampton, Region of Peel, Ontario (Figure 1). The project consists of the proposed construction of a 35-ML reservoir and pumping station in the vicinity of Mayfield Road and Creditview Road and a 1200 mm diameter feedermain from the intersection of Mississauga Road and Bovaird Drive to the proposed Alloa Reservoir. Six different sites have been proposed for the new reservoir and pumping station, some which overlap. Three different routes have also been proposed for the new feedermain.

The assessment was conducted under the project direction of Mr. Robert Pihl, ASI. The field review and heritage assessment was conducted by Mr. Peter Carruthers, M.A., CAPHC, in accordance with the Ontario Heritage Act (2005) and Ministry guidelines. The purpose of this report is to present the Built Heritage and Cultural Landscape inventory for the study area and to assess the impact of proposed activities on above ground cultural heritage resources.

2.0 BUILT HERITAGE AND CULTURAL LANDSCAPE ASSESSMENT CONTEXT

2.1 Approach and Methodology

This cultural heritage assessment considers cultural heritage resources in the context of improvements to specified areas, pursuant to the *Environmental Assessment Act*. This assessment addresses above ground cultural heritage resources over 50 years old.

The proposed improvements to the Alloa Reservoir Pumping Station and Feedermain have the potential to affect cultural heritage resources in a variety of ways. These include the loss or displacement of resources through removal or demolition and the disruption of resources by introducing physical, visual, audible or atmospheric elements that are not in keeping with the resources and/or their setting.

For the purposes of this assessment, the term cultural heritage resources was used to describe both cultural landscapes and built heritage features. A cultural landscape is perceived as a collection of individual built heritage features and other related features that together form farm complexes, roadscapes and nucleated settlements. Built heritage features are typically individual buildings or structures that may be associated with a variety of human activities, such as historical settlement and patterns of architectural development.

The analysis throughout the study process addresses cultural heritage resources under various pieces of legislation and their supporting guidelines. Under the *Environmental Assessment Act* environment is defined in Subsection 1(c) to include:

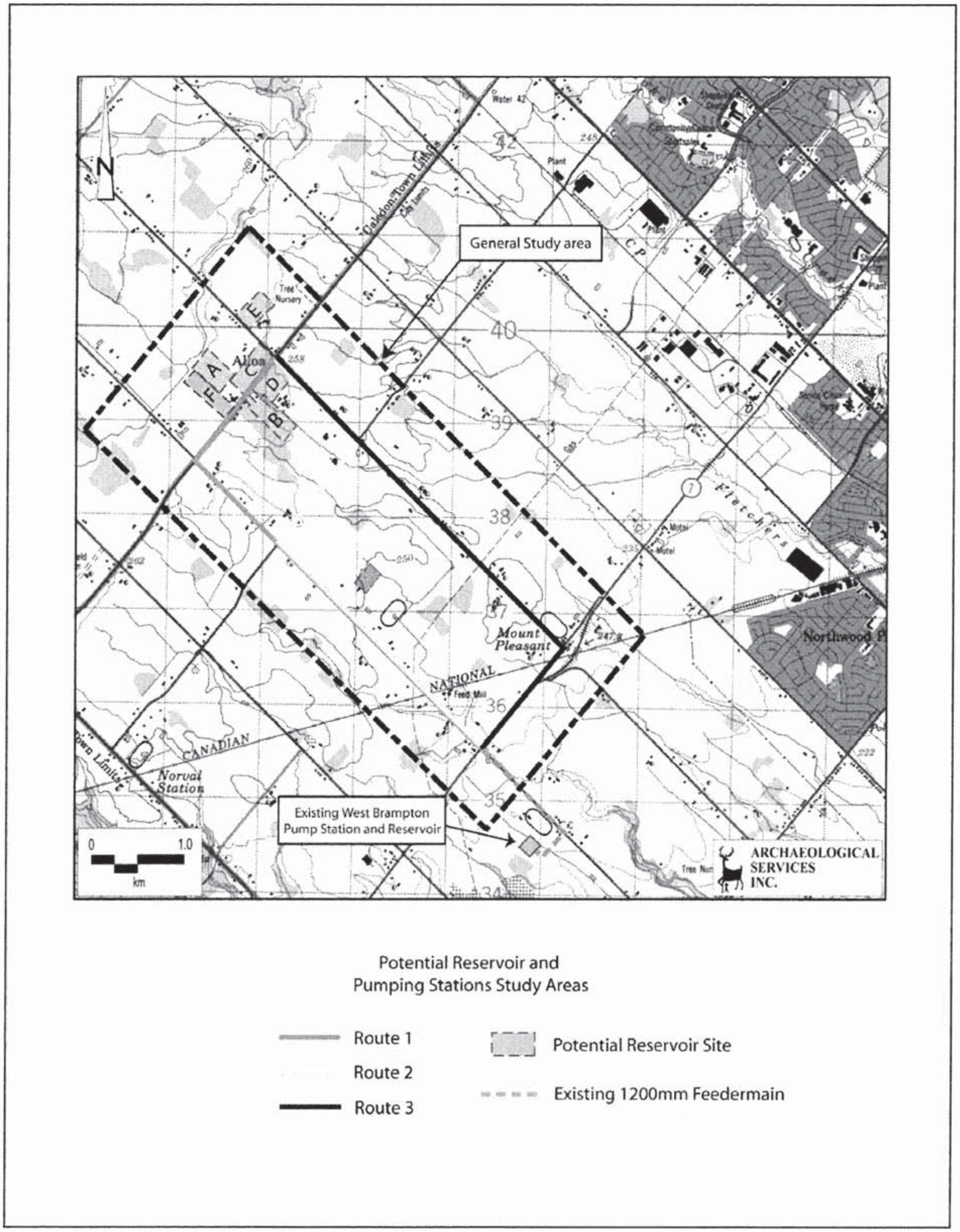


Figure 1: Location of the study area (NTS map Brampton, 30 M/12)

- cultural conditions that influence the life of man or a community, and;
- any building, structure, machine, or other device or thing made by man.

The Ministry of Culture is charged under Section 2 of the *Ontario Heritage Act* with the responsibility to determine policies, priorities and programs for the conservation, protection and preservation of the heritage of Ontario and has published two guidelines to assist in assessing cultural heritage resources as part of an environmental assessment: *Guideline for Preparing the Cultural Heritage Resource Component of Environmental Assessments* (1992), and *Guidelines on the Man-Made Heritage Component of Environmental Assessments* (1980). Accordingly, both guidelines have been utilized in this assessment process.

The *Guidelines on the Man-Made Heritage Component of Environmental Assessments* states the following:

> When speaking of man-made heritage we are concerned with the works of man and the effects of his activities in the environment rather than with movable human artifacts or those environments that are natural and completely undisturbed by man.

In addition, environment may be interpreted to include the combination and interrelationships of human artifacts with all other aspects of the physical environment, as well as with the social, economic and cultural conditions that influence the life of the people and communities in Ontario. The *Guidelines on the Man-Made Heritage Component of Environmental Assessments* distinguish between two basic ways of visually experiencing this heritage in the environment, namely as cultural landscapes and as cultural features.

Within this document, cultural landscapes are defined as the following:

> The use and physical appearance of the land as we see it now is a result of man's activities over time in modifying pristine landscapes for his own purposes. A cultural landscape is perceived as a collection of individual man-made features into a whole. Urban cultural landscapes are sometimes given special names such as townscapes or streetscapes that describe various scales of perception from the general scene to the particular view. Cultural landscapes in the countryside are viewed in or adjacent to natural undisturbed landscapes, or waterscapes, and include such landuses as agriculture, mining, forestry, recreation, and transportation. Like urban cultural landscapes, they too may be perceived at various scales: as a large area of homogeneous character; or as an intermediate sized area of homogeneous character or a collection of settings such as a group of farms; or as a discrete example of specific landscape character such as a single farm, or an individual village or hamlet.

A cultural feature is defined as the following:

> …an individual part of a cultural landscape that may be focused upon as part of a broader scene, or viewed independently. The term refers to any man-made or modified object in or on the land or underwater, such as buildings of various types, street furniture, engineering works, plantings and landscaping, archaeological sites, or a collection of such objects seen as a group because of close physical or social relationships.

Additionally, the *Planning Act* and related Provincial Policy Statement make a number of provisions relating to heritage conservation. One of the general purposes of the *Planning Act* is to integrate matters of provincial interest in provincial and municipal planning decisions. In order to inform all those involved in planning activities of the scope of these matters of provincial interest, Section 2 of the *Planning Act* provides an extensive listing. These matters of provincial interest shall be regarded when certain authorities, including the council of a municipality, carry out their responsibilities under the *Act*. One of these provincial interests is directly concerned with:

> 2(d) the conservation of features of significant architectural, cultural, historical, archaeological or scientific interest;…

In Part IV of the Policy Statement it is mandated that:

> These policies are to be applied in dealing with planning matters. Official Plans will integrate all applicable provincial policies and apply appropriate land use designations and policies. Since the policies focus on end results, the official plan is the most important vehicle for the implementation of the Policy Statement.

Those policies of particular relevance for the conservation of heritage features are contained in Section 2- Resources, wherein Subsection 2.5- Cultural Heritage and Archaeological Resources, makes the following provisions:

> 2.5.1 Significant built heritage resources and cultural heritage landscapes will be conserved.

A number of definitions that have specific meanings for use in a policy context accompany the policy statement. These definitions include built heritage resources and cultural heritage landscapes.

Built heritage resources mean one or more buildings, structures, monuments, installations, or remains associated with architectural, cultural, social, political, economic, or military history, and identified as being important to a community.

Cultural heritage landscapes mean a defined geographical area of heritage significance that has been modified by human activities. Such an area is valued by a community, and is of significance to the understanding of the history of a people or place.

In addition, the term "significant" is also more generally defined. It is assigned a specific meaning according to the subject matter or policy context, such as wetlands or ecologically important areas. As cultural heritage landscapes and built heritage resources may be considered another matter, the following definition of significant applies:

> …in regard to other matters, important in terms of amount, content, representation or effect.

Accordingly, the foregoing guidelines and relevant policy statement were used to guide the scope and methodology of the cultural heritage analysis for the assessment of the proposed pumping station and feedermain construction in the study area.

2.2 Data Collection

For the purposes of the cultural heritage assessment of the proposed pumping station and feedermain construction, all potentially affected cultural heritage resources within the study area were subject to inventory. A short form name was applied to each resource type (e.g. barn, residence), and the locations were plotted on area maps. Building interiors were not subject to survey. Historical research was also conducted for the purposes of identifying broad agents or themes of historical change in the area, while historic mapping was consulted to reveal cultural landscape development in the area. The results of historical research are contained in Section 3.0.

Built heritage features and cultural landscapes were inventoried according to a consistent typology of units based upon Ministry of Culture guidelines and past experience (see Table 1).

The following definitions of typical cultural landscapes units were used:

Farm complex: comprise two or more buildings, one of which must be a farmhouse or barn, and may include a tree-lined drive, tree windbreaks, fences, domestic gardens and small orchards.

Roadscapes: generally two lanes in width with absence of shoulders or narrow shoulders only, ditches, tree lines, bridges, culverts and other associated features.

Waterscapes: waterway features that contribute to the overall character of the cultural heritage landscape, usually in relation to their influence on historic development and settlement patterns.

Railscapes: active or inactive railway lines or railway rights-of-way and associated features.

Historical settlements: groupings of two or more structures with a commonly applied name.

Cemeteries: land used for burial of human remains.

Results of the field survey are contained in Section 3.0, while Sections 4.0 and 5.0 contain conclusions and recommendations with respect to all identified heritage resources to be applied during the preliminary design of the Alloa Reservoir Pumping Station and Feedermain improvements.

3.0 BUILT HERITAGE AND CULTURAL LANDSCAPE ASSESSMENT

3.1 Introduction

Following a brief historical overview of the study area, which is located within parts of Lot 10 to 18, Concession III to V the former Township of Chingacousy, County of Peel (Figure 2), this section provides a preliminary inventory of above ground cultural heritage resources that may be affected by the proposed improvements to the Alloa Reservoir Pumping Station and Feedermain

3.2 Historical Land Use Summary

In 1788, the County of Peel was part of the extensive district known as the "Nassau District". Later called the "Home District", its administrative centre was located in Newark, now called Niagara. After the province of Quebec was divided into Upper and Lower Canada in 1792, the Province was separated into nineteen counties, and by 1852, the entire institution of districts was abolished and the late Home Districts were represented by the Counties of York, Ontario and Peel. Shortly after, the County of Ontario became a separate county, and the question of separation became popular in Peel. A vote for independence was taken in 1866, and in 1867 the village of Brampton was chosen as the capital of the new county.

The Township of Chingacousy is the largest township in the county and was first settled around 1818. The majority of the first settlers were from New Brunswick, the United States and parts of Upper Canada. In 1821, the Township of Chingacousy had a population of 412. By 1841, it boasted had a population of 3,721 and ten years later, that number doubled to 7,469. The population, however, decreased to 6,897 in 1861 and to 6,129 in 1871. Chingacousy was described as a first-class agricultural township, and was known for its beautiful and substantial farmsteads.

The historic community of Alloa, which is non-existent today, is located at the northern end of the general study area, at the intersection of Creditview Road and Mayfield Road. The crossroads was originally called Throughtons Corners after the Throughton family who were early settlers in the area (Caledon Heritage Committee 2006). Alloa appears on Tremaine's 1859 map at the corner of 3rd Line West and 17 Sideroad. A post office was established in 1863 which was located in a house beside the church. In the south corner of the intersection was located a hotel and a slaughterhouse. According to the Caledon Heritage Committee, the cornerstone from the original church is in the basement of the new building.

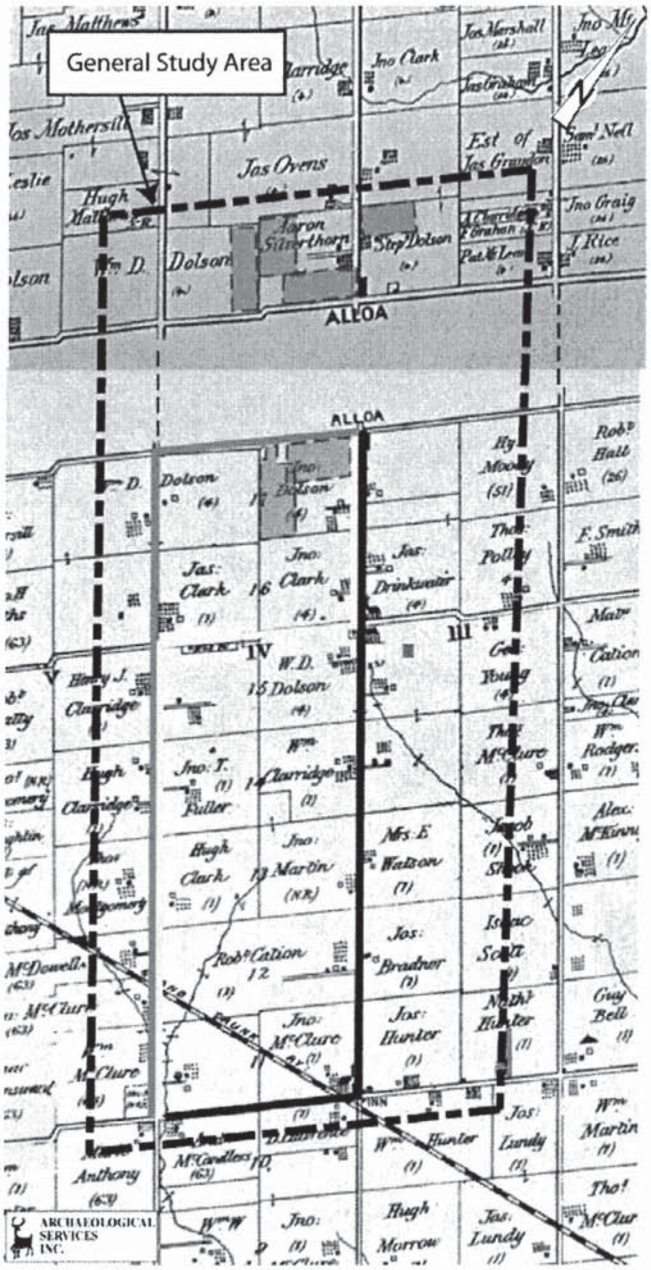


Figure 2: Study area highlighted on a map of Chingacousy Township in the 1877 *Historical Atlas of Peel County, Ontario.*

3.3 Existing Conditions

In order to create a list of heritage properties within or adjacent to the study area, the Ontario Heritage Properties Database was consulted and the City of Brampton's and the Town of Caledon's Heritage Resource Officers were contacted. A field review was then conducted by Mr. Peter Carruthers in May 2007, in order to identify those built heritage features and cultural landscape units within the study area. The field reviews revealed twenty-two (22) built heritage features and nineteen (19) cultural landscape units.

The study area, which remains largely agricultural with the exception of the east side of Creditview Road, comprises a portion of five (5) historic roads that, for the most part, follow the township surveys established in the 19th century. These roadscapes include Mississauga Road (CLU 14) and Creditview Road (CLU 17), which are intersected by Mayfield Road (CLU 16), Wanless Drive (CLU 15) and Bovaird Drive/Highway 7 (CLU 18). All roadscapes, although of historical interest for their associations with transportation and township surveys, have been modified in varying degrees to accommodate the increased demands of vehicular traffic over the past century. While they are of heritage interest as early roadscapes, they are of no greater significance beyond this fact and should not hinder any preferred infrastructure proposals.

The study area also contains nineteen (19) residences, six (6) of which are individual 19th century homes (BHF 2, BHF 6, BHF 11, BHF 13, BHF 15, BHF 19), and eleven (11) of which are part of larger farm complexes or other cultural landscape (BHF 4/CLU 3, BHF 5/CLU 4, BHF 7/CLU 11, BHF 9/CLU 12, BHF 10/CLU 8, BHF 12/CLU 10, BHF 14/CLU 7, BHF 16/CLU 5, BHF 17/CLU 6, BHF 20/CLU 2, and BHF 21/CLU 9). The field review determined that most of these features were set well back from the right-of-ways. The field review, however, failed in relocating two of the farmhouses listed as heritage properties by the City of Brampton (BHF 1 and BHF 8).

The remaining heritage features include two churches (BHF 3 and BHF 18), a driveshed (BHF 19), which with one of the churches (BHF 18) form CLU 13, and one railscape (CLU 19). Originally the Grand Trunk Railway in the 19th century, the railroad is now owned and operated by CN.

The James Clark House (BHF 12) has been designated under part IV of the *Ontario Heritage Act.*

Table 1 lists all of the features of heritage interest and Figure 3 shows their general locations.

4.0 CONCLUSIONS

Historic research revealed that the study area has origins in nineteenth-century survey and settlement in Chingacousy Township. A review of provincial and municipal sources followed by a field survey revealed a large number of heritage resources within the study area.

These include

- Twenty-two (22) built heritage features, one of which is designated under part IV of the *Ontario Heritage Act*
- Nineteen (19) cultural landscape units.

Table 2 lists the sum total of identified heritage features for each of the three potential routes and six potential sites.

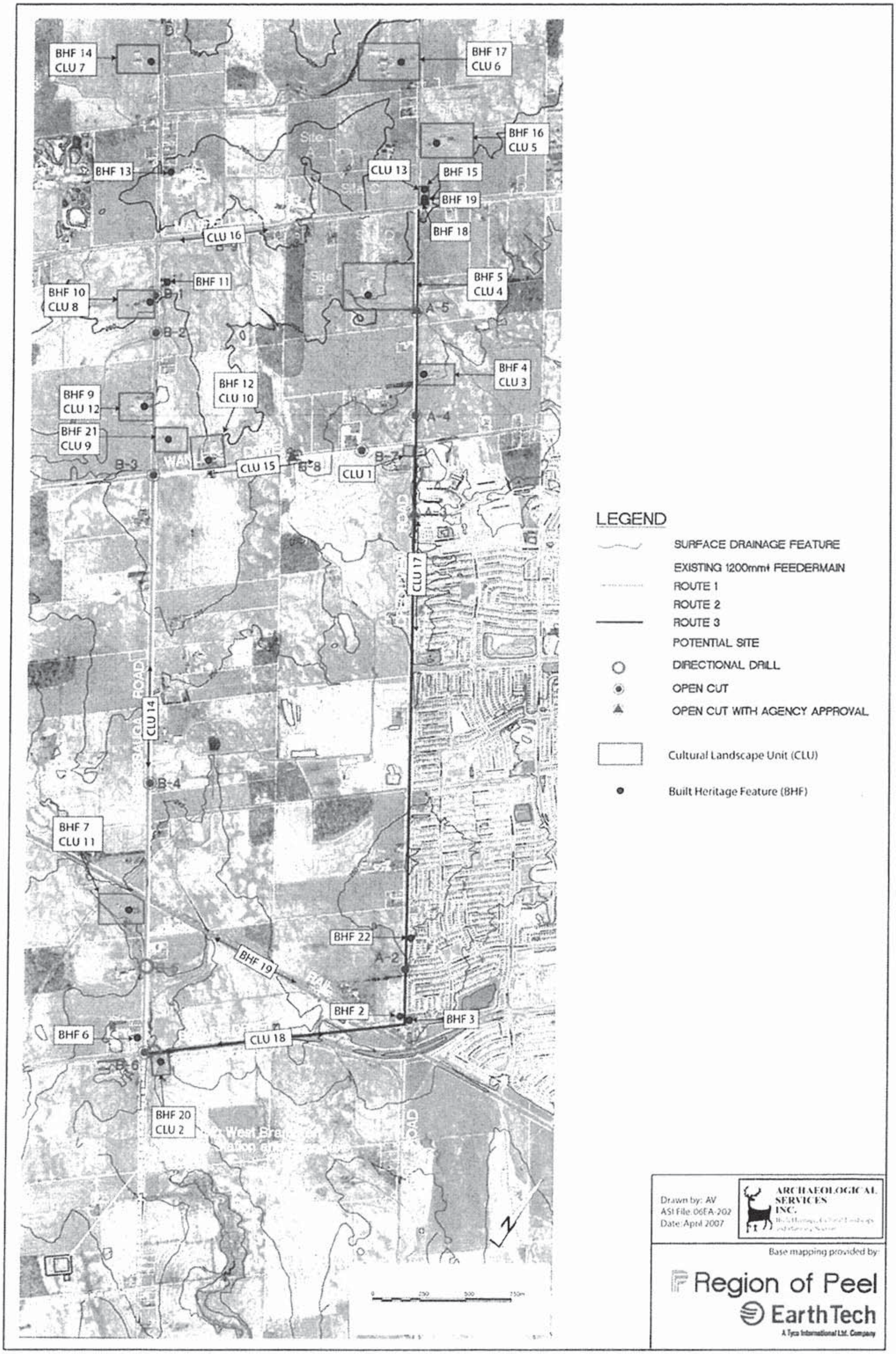


Figure 3: Built Heritage Features (BHF) and Cultural Landscape Units (CLU) located within the Alloa Reservoir Pumping Station and Feedermain Study Area

TABLE 1: Built Heritage Features (BHF) and Cultural Landscape Units (CLU) Located within the Alloa Reservoir Pumping Station and Feedermain Study Area

Feature	Location	Feature Type	Age	Comments	Routes/Sites
BHF 1	10054 Creditview Rd	Farmhouse	Pre-1878	Listed with City; not located	
BHF 2	10055 Creditview Rd	Farmhouse or Inn	Pre-1878	Listed	Route 3
BHF 3	10060 Creditview Rd	Church	1904	Listed	Route 3
BHF 4	11285 Creditview Rd	Farmhouse	Pre-1878	Listed; part of CLU 3	Routes 2, 3
BHF 5	11630 Creditview Rd	Farmhouse	Pre-1900	Listed; part of CLU 4	Routes 2, 3, Sites B, D
BHF 6	10020 Mississauga Rd	Farmhouse	Pre-1900	Listed	Routes 1, 2
BHF 7	10244 Mississauga Rd	Farm	Pre-1878	Listed; part of CLU 11	Routes 1, 2
BHF 8	10473 Mississauga Rd	Farm	Pre-1878	Listed with City; not located	
BHF 9	11248 Mississauga Rd	Farmhouse	Pre-1900	Listed;part CLU 12	Route 1
BHF 10	11722 Mississauga Rd	Farmhouse	Late 19th C.	Listed; part of CLU 8	Route 1
BHF 11	11827 Mississauga Rd	Farm	Pre-1878	Listed	Route 1
BHF 12	1930 Wanless Dr	House	Pre-1878	Designated; part of CLU 10	Route 2
BHF 13	12111 Mississauga Rd	Farmhouse	Late 19th C.	Listed	
BHF 14	12300 Mississauga Rd	Farmhouse	Late 19th C.	Listed; part of CLU 7	
BHF 15	12017 Creditview Rd	Residence	Late 19th – early 20th C.	Listed;	Site C
BHF 16	12101 Creditview Rd	Farmhouse and barn	Late 19th C.	Listed; part of CLU 5	Sites E
BHF 17	12240 Creditview Rd	Farmhouse and barn	Late 19th C.	Listed; part of CLU 6	
BHF 18	1500 Mayfield Rd	Church	1926	Listed; part of CLU 13	Routes 1, 2, 3; Sites C, D
BHF 19	1500 Mayfiedl Rd	Driveshed	mid-19th C.	Listed; part of CLU 13	Routes 1, 2, 3; Sites C, D
BHF 20	1985 Bovaird Drive	Residence	Pre-1878	part of CLU 2	Route 3
BHF 21	11157 Mississauga Rd	Farmhouse		part of CLU 9	Route 1
BHF 22	Unknown Creditview Rd	Farmhouse	Pre-1900		Route 3
CLU 1	South corner of Wanless and Creditview	Cemetery	Pre-1878	Listed	Routes 2, 3
CLU 2	1985 Bovaird Drive	Treeline/Windbreak		incl. BHF 20	Route 3
CLU 3	11285 Creditview Rd	Farm Complex	Pre-1878	incl. BHF 4	Routes 2, 3
CLU 4	11630 Creditview Rd	Farm Complex	Pre-1900	incl. BHF 5	Routes 2, 3; Sites B, D
CLU 5	12101 Creditview Rd	Farm Complex	Late 19th C.	incl. BHF 16	Site E
CLU 6	12240 Creditview Rd	Farm Complex	Late 19th C	incl. BHF 17	
CLU 7	12300 Mississauga Rd	Farm Complex	Late 19th C.	incl. BHF 14	
CLU 8	11722 Mississauga Rd	Farm Complex	Late 19th C	incl. BHF 10	Route 1
CLU 9	11157 Mississauga Rd	Farm Complex		incl. BHF 21	Route 1
CLU 10	1930 Wanless Drive	Farm Complex	Pre-1878	incl. BHF 12	Route 2
CLU 11	10244 Mississauga Rd	Farm Complex	Pre-1878	incl. BHF 7	Route 2
CLU 12	11248 Mississauga Rd	Farm Complex	Pre-1900	incl. BHF 9	Routes 1, 2

TABLE 1: Built Heritage Features (BHF) and Cultural Landscape Units (CLU) Located within the Alloa Reservoir Pumping Station and Feedermain Study Area (continued)					
Feature	**Location**	**Feature Type**	**Age**	**Comments**	**Routes/Sites**
CLU 13	1500 Mayfield Rd	Church property		incl. BHF 18, 19	Routes 1, 2, 3 Sites C, D
CLU 14	Mississauga Road	Roadscape			Routes 1, 2
CLU 15	Wanless Drive	Roadscape			Routes 1, 2, 3
CLU 16	Mayfield Road	Roadscape			Routes 1, 2 ,3; Sites B,C,D,F
CLU 17	Creditview Road	Roadscape			Routes 1, 2, 3; Sites C,D,E
CLU 18	Bovaird Drive/Hwy 7	Roadscape			Routes 1, 2, 3
CLU 19	CN Rail	Railscape			Routes 1, 2

Table 2: Number of Heritage Features Potentially Affected by each Proposed Route/Site		
Proposed Route/Site	**# of BHFs**	**# of CLUs**
Route 1	8	10
Route 2	7*	13
Route 3	8	9
Site A	0	0
Site B	1	2
Site C	3	3
Site D	3	4
Site E	1	2
Site F	0	1

*includes BHF 12, which is designated under part IV of the *Ontario Heritage Act.*

There are a high number of potentially affected heritage features for each of the three routes. The one feature which has been designated under part IV of the *Ontario Heritage Act* is located along Route 2. Proposed Site A would not affect any heritage features and Site F would only potentially affect Mayfield Road, which was already determined to be of no greater significance beyond having heritage interest as a historic roadscape.

5.0 RECOMMENDATIONS

Construction of reservoir pumping stations and feedermains may have a variety of impacts upon built heritage and cultural landscapes. These include the loss or displacement of resources through removal or demolition and the disruption of resources by introducing physical, visual, audible or atmospheric elements that are not in keeping with the resources and/or their setting. The following recommendations should be considered during the proposed work within the Alloa Reservoir Pumping Station and Feedermain study area.

1. Any proposed alterations within the study area should be planned in a manner that avoids any identified, above ground, cultural heritage resource. Where any identified, above ground, cultural heritage resource is to be affected by loss or displacement further research should be undertaken

to identify both the specific heritage significance of the affected cultural heritage resource and appropriate mitigation measures required to avoid or minimize impact.

2. Where features are to be disrupted by introducing physical, visual, audible or atmospheric elements that are not in keeping with the resources and/or their setting, suitable measures such as landscaping, buffering or other forms of mitigation should be adopted. In this regard provincial guidelines should be consulted for advice. Where possible, existing trees and plantings should be retained.

6.0 REFERENCES CITED

Caledon Heritage Committee
2006 Non-Existing Hamlets of Caledon Today, Caledon Public Library. http://www.caledon.library.on.ca/index.php?option=com_content&task=view&id=102

Ministry of Culture
1981 *Guidelines on the Man-Made Heritage Component Environmental Assessments.*

Ministry of Transportation
2002 *Environmental Reference for Highway Design*

Walker & Miles
1877 *Historical Atlas of Peel County, Ontario*. Toronto.

APPENDIX A

Alloa Reservoir Pumping Station and Feedermain
Inventory of Built Heritage Features (BHF) and Cultural Landscape Units (CLU)

Built Heritage Feature:	BHF 2
Address:	10055 Creditview Road
Feature Type:	Farmhouse or Inn
Construction Period:	Pre-1900
Construction Material:	Brick on stone foundation
Description:	Two storey structure with a hipped and metal roof. There are decorated bargeboards and soffit brackets. There is a side porch and a rear addition.
Architecture Type:	Vernacular
Integrity:	Altered
Condition:	Deteriorating but habitable
Historical Associations:	Associated with the crossroad community of Mount Pleasant.
Other Comments:	Has a small vertical plank barn on the property.

Built Heritage Feature: BHF 3
Address: 10060 Creditview Road

Feature Type: Church

Construction Period: 1904

Construction Material: Brick on stone foundation

Description: Modern brick addition to the rear.

Architecture Type: 20th Century Gothic Romanesque

Integrity: Good

Condition: Good

Historical Associations:

Other Comments: No church yard.
Built as Mount Pleasant Presbyterian Church in 1904 and became United Church in 1925.

Built Heritage Feature:	BHF 4
Address:	11285 Creditview Road
Feature Type:	Farmhouse
Construction Period:	Pre-1878
Construction Material:	Brick on stone foundation
Description:	Two storey five bay structure with a metal roof and no gables.
Architecture Type:	Georgian
Integrity:	Good
Condition:	Good
Historical Associations:	Township settlement; agricultural settlement
Other Comments:	Part of CLU 3 (Drinkwater farm complex)

Built Heritage Feature:	BHF 5
Address:	11630 Creditview Road
Feature Type:	Farmhouse
Construction Period:	Pre-1878
Construction Material:	Brick on stone foundation
Description:	Two storey L-shaped structure with a peak and asphalt roof. The house has two fronts (on the east and north sides). A front porch has been added and the windows are not original.
Architecture Type:	Vernacular
Integrity:	Good
Condition:	Good
Historical Associations:	Township settlement; agricultural settlement
Other Comments:	Part of CLU 4 (farm complex).

Built Heritage Feature: BHF 6
Address: 10020 Mississauga Road

Feature Type: Farmhouse

Construction Period: 1870's

Construction Material: Brick on stone and brick foundation

Description: Two storey structure with a peak gabled, asphalt roof. A rear garage has been added to the house. The house has an angled bay window on the south side and a veranda.

Architecture Type: Vernacular Victorian

Integrity: Altered

Condition: Good

Historical Associations: Township settlement, agricultural settlement

Other Comments: Is now a Real Estate Office.

Built Heritage Feature:	BHF 7
Address:	10244 Mississauga Road
Feature Type:	Farmhouse
Construction Period:	Pre-1878
Construction Material:	Brick on stone/rubble foundation
Description:	One and one-half storey structure with a central gable and asphalt roof. The addition on the rear of the house is covered in board and batten cladding. There is a front porch.
Architecture Type:	Gothic Revival
Integrity:	Good
Condition:	Moderate, needs repair
Historical Associations:	Township settlement; agricultural settlement
Other Comments:	Part of CLU 11 (J.N.O. McClure farm complex). The roof is rotting and leaking.


Built Heritage Feature:	BHF 9
Address:	10248 Mississauga Road
Feature Type:	Farmhouse
Construction Period:	Pre-1900
Construction Material:	Brick on unknown foundation
Description:	Two storey structure with cross gabled asphalt roof. The house has an original summer kitchen and a modern addition.
Architecture Type:	Late Victorian
Integrity:	Main house is good, but the addition on the front affects the overally integrity.
Condition:	Good
Historical Associations:	Township settlement, agricultural settlement
Other Comments:	Part of CLU 12 (farm complex).

Built Heritage Feature:	BHF 10
Address:	1722 Mississauga Road
Feature Type:	Farmhouse
Construction Period:	Pre-1900
Construction Material:	Brick on stone foundation
Description:	Two and one-half storey structure with a hipped roof
Architecture Type:	Classic Edwardian with Italianate features
Integrity:	Good
Condition:	Moderate
Historical Associations:	Township settlement; agricultural settlement
Other Comments:	Part of CLU 8 (farm complex). There are mature trees on the property.

Built Heritage Feature:	BHF 11
Address:	11827 Mississauga Road
Feature Type:	Farmhouse
Construction Period:	Pre-1878
Construction Material:	Brick on stone foundation
Description:	One and one-half storey structure with a low pitched peek roof with a front gable. There is a front porch and a side addition.
Architecture Type:	Vernacular
Integrity:	Moderate due to alterations
Condition:	Poor
Historical Associations:	Township settlement, agricultural settlement
Other Comments:	Once part of the Dolson farm

Built Heritage Feature:	BHF 12
Address:	1930 Wanless Drive
Feature Type:	Farmhouse
Construction Period:	Pre-1878
Construction Material:	Brick on stone foundation
Description:	Two storey house with hipped roof, with angled bay projection on the front and an enclosed porch.
Architecture Type:	Vernacular
Integrity:	Good, but altered
Condition:	Good
Historical Associations:	Township settlement; agricultural settlement
Other Comments:	Part of CLU 10 (James Clark farm complex). This house is designated under Part IV of the *Ontario Heritage Act.*

Built Heritage Feature:	BHF 13
Address:	12111 Mississauga Road
Feature Type:	Farmhouse
Construction Period:	Late 19th century
Construction Material:	Brick on stone foundation
Description:	Two storey structure with a steeply pitched gabled roof with asphalt shingles. There are buff brick voussoirs over the windows and a front/side porch. There is a rear addition to the house.
Architecture Type:	Gothic Revival
Integrity:	Moderate
Condition:	Good
Historical Associations:	Township settlement; agricultural settlement
Other Comments:	Is now an office.

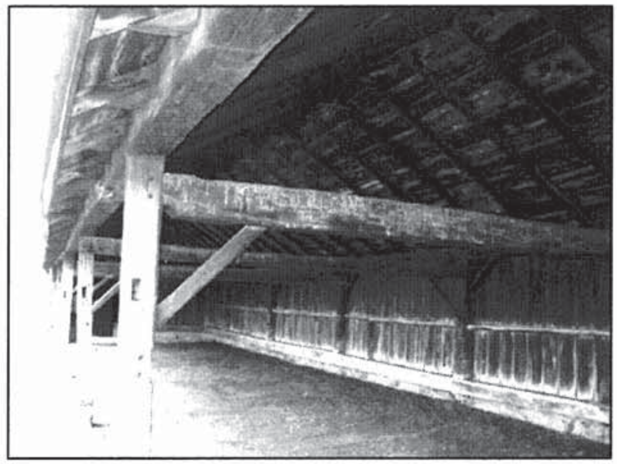
Built Heritage Feature:	BHF 14
Address:	12300 Mississauga Road
Feature Type:	Farmhouse
Construction Period:	Late 19th century
Construction Material:	Brick on stone foundation
Description:	One and one-half storey structure with a multiple gable and asphalt roof. There is a modern closed in front porch
Architecture Type:	High Victorian Gothic Revival
Integrity:	Good
Condition:	Good
Historical Associations:	Township settlement; agricultural settlement
Other Comments:	Part of CLU 7(farm complex).

Built Heritage Feature:	BHF 15
Address:	12017 Creditview Road
Feature Type:	Residence
Construction Period:	Late 19th-early 20th century
Construction Material:	Frame walling on concrete foundation
Description:	Two storey structure with an L-shaped asphalt roof. The house is clad in wooden clapboard siding. There is a front porch.
Architecture Type:	Late Victorian Vernacular
Integrity:	Good, some alterations
Condition:	Good
Historical Associations:	Township settlement
Other Comments:	There is a shed or summer kitchen at the back of the house. Possibly part of CLU 15 and associated with the Church (Church Manse?).

Built Heritage Feature:	BHF 16
Address:	12101 Creditview Road
Feature Type:	Farmhouse
Construction Period:	Pre-1878
Construction Material:	Brick on stone foundation
Description:	Two storey structure with peaked asphalt roof. The brick is polychrome. There is a new chimney and enclosed porch.
Architecture Type:	High Victorian Vernacular
Integrity:	Good
Condition:	Good
Historical Associations:	Township settlement; agricultural settlement
Other Comments:	Part of CLU 5 (farm complex).

Built Heritage Feature:	BHF 17
Address:	12240 Creditview Road
Feature Type:	Farmhouse
Construction Period:	Late 19th Century
Construction Material:	Brick on stone foundation
Description:	Three storey structure with hipped asphalt roof.
Architecture Type:	Late Italianate
Integrity:	Good
Condition:	Good
Historical Associations:	Township settlement; agricultural settlement
Other Comments:	Part of CLU 6 (McClure family farm complex).

Built Heritage Feature:	BHF 18
Address:	1500 Mayfield Road
Feature Type:	Church
Construction Period:	1926
Construction Material:	Brick on concrete foundation
Description:	Peaked roof with asphalt shingles
Architecture Type:	20th Century Gothic
Integrity:	Good
Condition:	Good
Historical Associations:	Township settlement;
Other Comments:	Driveshed (BHF 19) found behind the church. Structure replaced an earlier one. Part of CLU 13.

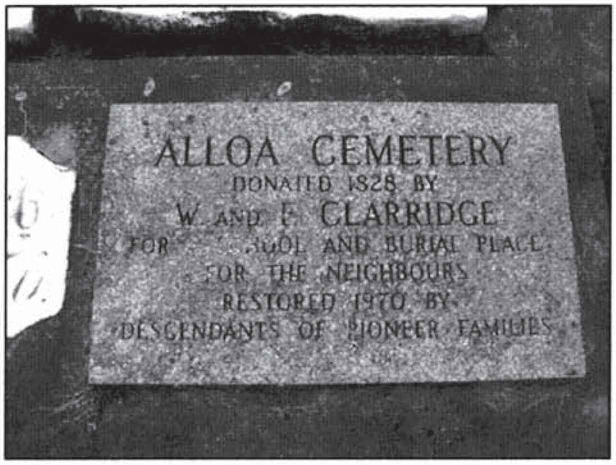


Built Heritage Feature:	BHF 19
Address:	1500 Mayfield Road
Feature Type:	Driveshed
Construction Period:	mid 19th-century
Construction Material:	Concrete foundation
Description:	Vertical plank shed with aluminum roof
Architecture Type:	Post and beam
Integrity:	Good
Condition:	Good
Historical Associations:	
Other Comments:	Located in the back of the church (BHF 18). Part of CLU 13.

Built Heritage Feature:	BHF 20
Address:	1985 Bovaird Drive
Feature Type:	Farmhouse
Construction Period:	Pre-1878
Construction Material:	Frame construction on stone foundation.
Description:	One and one-half storey structure with gable and asphalt roof. There is a rear summer kitchen/wood shed. The exterior cladding has been removed down to the strapping.
Architecture Type:	
Integrity:	Good
Condition:	poor
Historical Associations:	Township settlement; agricultural settlement
Other Comments:	Part of CLU 2 Located just east of the tributary of the Credit which joins just east of Huttonville.

Built Heritage Feature:	BHF 21
Address:	11157 Mississauga Road
Feature Type:	Farmhouse
Construction Period:	Mid-19th century
Construction Material:	Frame and stucco
Description:	One and one-half storey structure with a centre gable and asphalt roof. There is an enclosed front porch. The house is covered in stucco.
Architecture Type:	Vernacular
Integrity:	much altered
Condition:	Moderate
Historical Associations:	Township settlement; agricultural settlement
Other Comments:	Part of CLU 9 (farm complex).

Built Heritage Feature:	BHF 22
Address:	Unknown Creditview address
Feature Type:	Farmhouse
Construction Period:	Pre-1900
Construction Material:	Stone walling on stone foundation
Description:	One and one-half storey salt box structure with a peaked roof with wood shingles. There is a 20th century frame addition to the rear.
Architecture Type:	Salt-box
Integrity:	Good
Condition:	Moderate
Historical Associations:	Township settlement; agricultural settlement
Other Comments:	Surrounded by a modern subdivision.

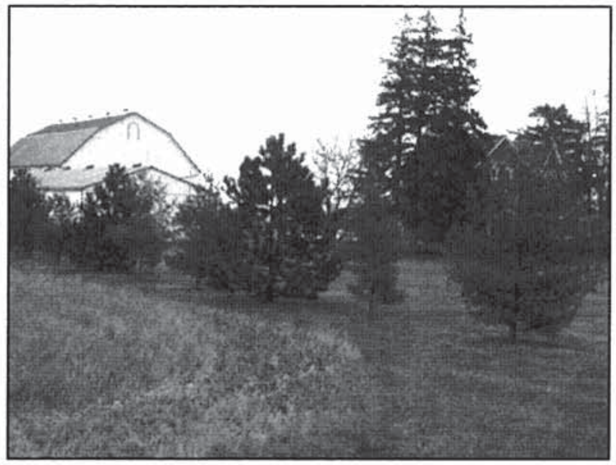


Cultural Landscape Unit:	CLU 1
Location:	Wanless Drive and Creditview Road (southwest corner)
Landscape Feature Type:	Cemetery
Integrity:	Altered
Associated BHFs:	
Historical Associations:	Township settlement
Other Comments:	Established in 1828 and appears on the 1877 atlas map. Stones have been relocated and distributed along the south and west boundaries of the cemetery, which was restored by descendants in 1970.

Cultural Landscape Unit:	CLU 2
Location:	1985 Bovaird Drive
Landscape Feature Type:	Treeline/Windbreak
Integrity:	Good
Associated BHFs:	BHF 20 (located behind treeline)
Historical Associations:	Township settlement
Other Comments:	Note the Credit River tributary valley to the right.

Cultural Landscape Unit:	CLU 3
Location:	11285 Creditview Road
Landscape Feature Type:	Farm Complex
Integrity:	Good
Associated BHFs:	BHF 4
Historical Associations:	Township settlement, agricultural settlement
Other Comments:	In addition to the farmhouse (BHF 4), comprises a silo, a drive shed and a barn. Listed as the Drinkwater farmstead.

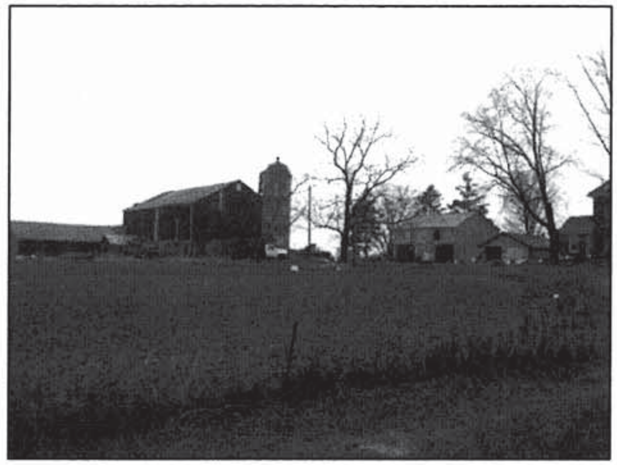
Cultural Landscape Unit:	CLU 4
Location:	11630 Creditview Road
Landscape Feature Type:	Farm complex
Integrity:	Good
Associated BHFs:	BHF 5
Historical Associations:	Township settlement, agricultural settlement
Other Comments:	In addition to the farmhouse (BHF 5), comprises a garage, a silo, a barn, a drive shed, old foundations and a woodlot.



Cultural Landscape Unit:	CLU 5
Location:	12101 Creditview Road
Landscape Feature Type:	Farm complex
Integrity:	Good
Associated BHFs:	BHF 16
Historical Associations:	Township settlement, agricultural settlement
Other Comments:	In addition to the farmhouse (BHF 16), comprises a barn and sheds.

Cultural Landscape Unit:	CLU 6
Location:	12240 Creditview Road
Landscape Feature Type:	Farm complex
Integrity:	Good
Associated BHFs:	BHF 17
Historical Associations:	Township settlement, agricultural settlement
Other Comments:	In addition to the farmhouse (BHF 17), comprises a silo, a barn, and various sheds and ancillary buildings. Owned and operated by the McClure family (historic family in the area).

Cultural Landscape Unit:	CLU 7
Location:	12300 Mississauga Road
Landscape Feature Type:	Farm Complex
Integrity:	Good
Associated BHFs:	BHF 14
Historical Associations:	Township settlement, agricultural settlement
Other Comments:	In addition to the farmhouse (BHF 14), comprises a barn, a machine shed and various other out buildings. Beachmore Farms.



Cultural Landscape Unit:	CLU 8
Location:	11722 Mississauga Road
Landscape Feature Type:	Farm Complex
Integrity:	Good
Associated BHFs:	BHF 10
Historical Associations:	Township settlement, agricultural settlement
Other Comments:	In addition to the farmhouse (BHF 10), comprises a barn, a garage, a drive shed and other out buildings. There are mature trees on the property.

Cultural Landscape Unit:	CLU 9
Location:	11157 Mississauga Road
Landscape Feature Type:	Farm Complex
Integrity:	Good
Associated BHFs:	BHF 21
Historical Associations:	Township settlement, agricultural settlement
Other Comments:	In addition to the farmhouse (BHF 21), comprises a garage and a barn.

Cultural Landscape Unit:	CLU 10
Location:	1930 Wanless Drive
Landscape Feature Type:	Farm complex
Integrity:	Good
Associated BHFs:	BHF 12
Historical Associations:	Township settlement, agricultural settlement
Other Comments:	In addition to the farmhouse (BHF 12), comprises a drive shed, barns and several other out buildings.

Cultural Landscape Unit:	CLU 11
Location:	10244 Mississauga Road
Landscape Feature Type:	Farm Complex
Integrity:	Good
Associated BHFs:	BHF 7
Historical Associations:	Township settlement, agricultural settlement
Other Comments:	In addition to the farmhouse (BHF 7), comprises a garage and a barn.

Cultural Landscape Unit:	CLU 12
Location:	11248 Mississauga Road
Landscape Feature Type:	Farm Complex
Integrity:	Good
Associated BHFs:	BHF 9
Historical Associations:	Township settlement, agricultural settlement
Other Comments:	In addition to the farmhouse (BHF 9), comprises a barn, an old drive shed, a garage, fencing and a treeline/windbreak.

Cultural Landscape Unit:	CLU 13
Location:	1500 Mayfield Road
Landscape Feature Type:	Church, driveshed
Integrity:	Good
Associated BHFs:	BHF 18 and 19
Historical Associations:	Township settlement,
Other Comments:	Possibly includes BHF 15 (residence), which could have served as a church manse.

Cultural Landscape Unit:	CLU 14
Location:	Mississauga Road
Landscape Feature Type:	Roadscape
Integrity:	Altered
Historical Associations:	Township settlement, transportation
Other Comments:	Consists of a two lane paved road with wide gravel shoulders and grassy ditches. A hydro line parallels the west side of the road.

Cultural Landscape Unit: CLU 15
Location: Wanless Drive

Landscape Feature Type: Roadscape

Integrity: Altered

Historical Associations: Township settlement, transportation

Other Comments: Consists of a two lane paved road with narrow gravel shoulders and wide grassy ditches.

Cultural Landscape Unit: CLU 16
Location: Mayfield Road

Landscape Feature Type: Roadscape

Integrity: Altered

Historical Associations: Township settlement, transportation

Other Comments: Consists of a two lane paved road with wide gravel shoulders and grassy ditches. A hydro line parallels the north side of the road.

Cultural Landscape Unit:	CLU 17
Location:	Creditview Road
Landscape Feature Type:	Roadscape
Integrity:	Altered
Historical Associations:	Township settlement, transportation
Other Comments:	Consists of a two lane paved road with narrow gravel shoulders and grassy ditches. A hydro line parallels the west side of the road.

Cultural Landscape Unit:	CLU 18
Location:	Bovaird Road/Highway 7
Landscape Feature Type:	Roadscape
Integrity:	Altered
Historical Associations:	Township settlement, transportation
Other Comments:	Consists of a multi-laned paved road (with turning lanes) with guardrails along some stretches. A hydro line parallels the north side of the road.

AECOM

C.3 Ecological Investigations and Impact Assessment

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Memorandum

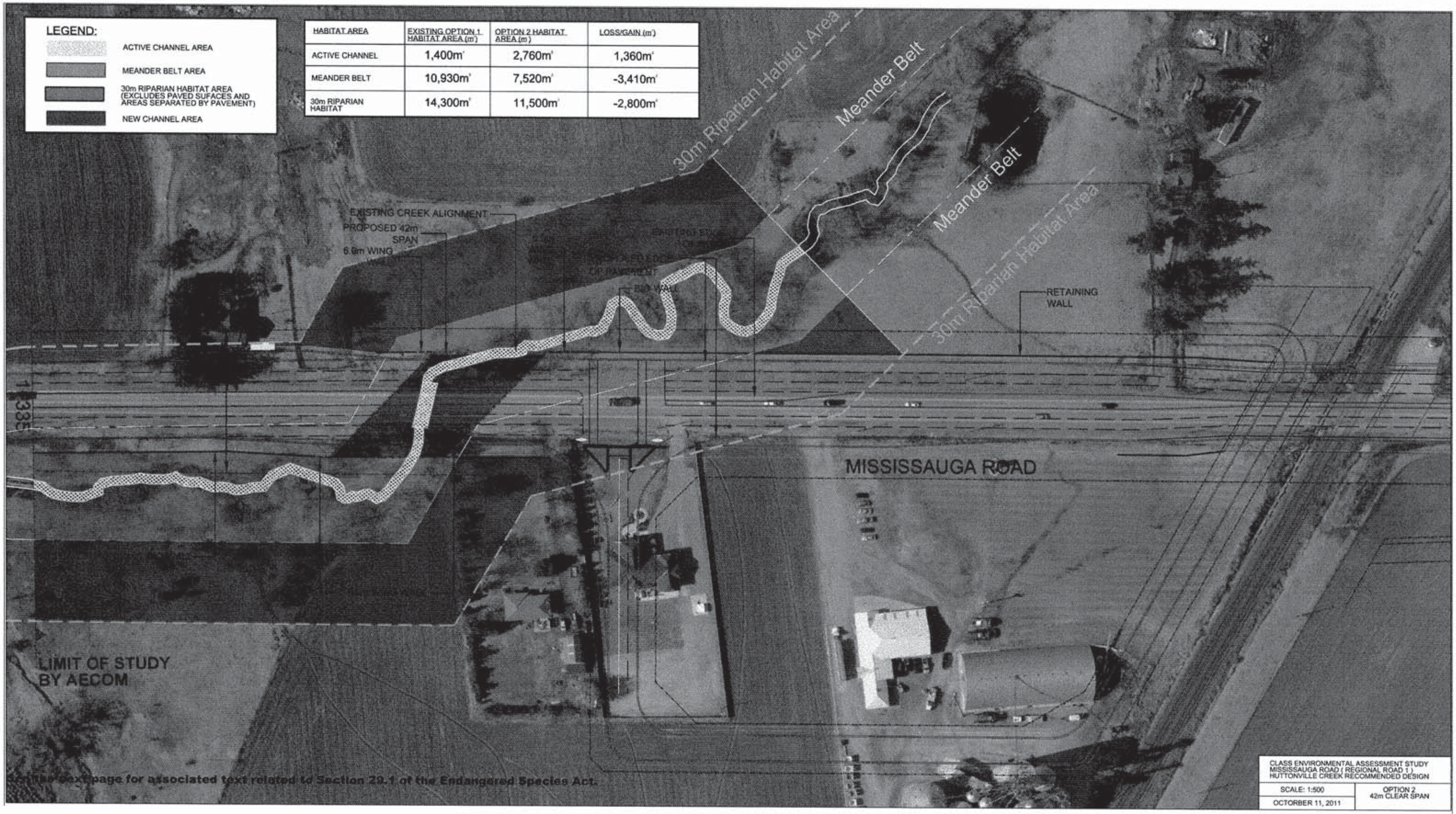
To	File	Page	1
CC	Jillian deMan		
Subject	Update to Natural Environment Assessment, September 30, 2008		
From	Nicola Lower		
Date	March, 23 2011	Project Number	60116610

The memo dated September 30 2008 outlines the Natural Environmental Conditions observed during site visits in August 2008. Terrestrial and Aquatic existing conditions were documented along Mississauga Road north of Bovaird Drive to Mayfield Road in the City of Brampton, Ontario.

The memo also outlines an assessment of impact. Redside Dace occur in Huttonville Creek and at the time of the memo in 2008, Redside Dace was listed as 'Endangered' by COSEWIC (Committee on the Status of Endangered Wildlife in Canada).

However, since February 18, 2009 the Redside Dace has been listed as Endangered under Ontario's Endangered Species Act (ESA, 2007). Section 9 of the ESA prohibits harmful actions such as killing, harming, harassment, possession, buying and selling of any of these species. Section 10 of the ESA prohibits the damage or destruction of the habitat of all endangered species, including the Redside Dace.

As such, the evaluation of Phase 3 design concepts including the Huttonville Creek crossing will be evaluated considering MNR guidelines and legislation concerning the protection of Redside Dace. This includes the draft Recovery Strategy for Redside Dace.



HABITAT AREA	EXISTING OPTION 1 HABITAT AREA (m²)	OPTION 2 HABITAT AREA (m²)	LOSS/GAIN (m²)
ACTIVE CHANNEL	1,400m²	2,760m²	1,360m²
MEANDER BELT	10,930m²	7,520m²	-3,410m²
30m RIPARIAN HABITAT	14,300m²	11,500m²	-2,800m²

next page for associated text related to Section 29.1 of the Endangered Species Act.

Section 29.1 of the Endangered Species Act

29.1 For the purpose of clause (a) of the definition of "habitat" in subsection 2 (1) of the Act, the following areas are prescribed as the habitat of redside dace:

1. Within the cities of Hamilton and Toronto, the counties of Bruce, Grey, Huron, Simcoe and Wellington, the regional municipalities of Durham, Halton, Peel and York, the Townships of St. Joseph, Jocelyn and Hilton, and the Village of Hilton Beach,

i. any part of a stream or other watercourse that is being used by a redside dace,

ii. any part of a stream or other watercourse that was used by a redside dace at any time during the previous 20 years and that provides suitable conditions for a redside dace to carry out its life processes,

iii. the area encompassing the meander belt width of an area described in subparagraph i or ii,

iv. the vegetated area or agricultural lands that are within 30 metres of an area described in subparagraph iii, and

v. a stream, permanent or intermittent headwater drainage feature, groundwater discharge area or wetland that augments or maintains the baseflow, coarse sediment supply or surface water quality of a part of a stream or other watercourse described in subparagraph i or ii, provided the part of the stream or watercourse has an average bankfull width of 7.5 metres or less.

M E M O

Date:	September 30, 2009	Project No. 105163
To:	File	c: Gary Epp
From:	Jillian deMan/David Praskey	
Subject:	**Mississauga Road Improvements from North of Bovaird Drive to Mayfield Road: Natural Environmental Assessment**	

The following outlines the results from the natural environmental investigations completed for the Class Environmental Assessment (Class EA) study along Mississauga Road from 300 metres north of Bovaird Drive to Mayfield Road in the City of Brampton, Ontario. Investigations were completed on August 21st, 2008 and consisted of both aquatic and terrestrial assessments. The intent of these investigations were to i) identify the natural features potentially affected by the proposed road improvements including widening to an ultimate 6 lane cross section, ii) determine the significance of those features observed, iii) provide input for a preliminary impact assessment, and iv) determine mitigation measures for those features which require protection.

1.0 METHODS

Assessments were completed within a 20-30 metres proximity to the road and were focused on the terrestrial and aquatic environments.

Terrestrial Methods – methods used to describe the terrestrial environment included a combination of Rapid Assessment Ecological Land Classification (ELC) delineation following those guidelines outlined by Ministry of Natural Resources (Lee et al, 1998) for the description of vegetation communities over 0.5 ha in size, documentation of individual tree/shrub surveys of trees which occurred within proximity to the proposed right-of-way and a comprehensive floral species list. Information collected for each tree included; species, diameter at breast height (DBH), health and location.

Aquatic Methods – methods used to describe the aquatic environment comprised of a background information review of data and mapping from the Credit Valley Conservation Authority and Ministry of Natural Resources, field investigations at every watercourse crossing which included habitat assessments with observations pertaining to channel morphology (i.e. channelized or natural), fish presence/absence and water conveyance status (i.e. permanent, intermittent, seasonal).

2.0 FINDINGS

The following presents the findings from the terrestrial and aquatic environmental assessments.

2.1 Aquatic Findings

Field investigations on August 21st, 2008 revealed a total of seven water crossings. One crossing (Huttonville Creek) contains fish habitat. A summary of the main observations and measurements taken during habitat investigations is documented in Table 1-1.

Table 1-1: Aquatic Habitat Results

Site	Average Wetted Width (m)/Average Water Depth (m)	Riffle/Pool Definition (poor, moderate, good, excellent)	Substrate Description	Woody Debris Availability (poor, moderate, good, excellent)	Average In-Stream Cover – all types (%)	Average Terrestrial Canopy Cover (%)	Potential Fish Habitat
Crossing-1 (C1) Surface water conveyance system in channelized ditch	0.5/0.10	poor	Gravel with some silt and detritus	poor	0-25	0-US 0-DS	Not Fish Habitat
Crossing-2 (C2) Surface water conveyance system in agricultural field	0.5/.10	poor	Sandy silty gravel with some detritus	poor	0-25	0-US 0-DS	Not Fish Habitat
Crossing-3 (C3) Surface water conveyance system in soybean field. Conveys to tributary of Huttonville Creek	0.5-1/0.10	poor	Sandy silt with some gravel	poor	0-25	0-US 0-DS	Not Fish Habitat
Crossing-4 (C4) Surface water conveyance system north of Wanless Road through soybean field	0.5-1/0.10	poor	Silty gravel with sand	poor	0-25	0-US 0-DS	Not Fish Habitat
Crossing-5 (C5) Surface water conveyance system, Warmwater sport fish/bait fish	0.5-3/0.50	moderate	Gravely sand with some silt and rubble	moderate	25-75	25-75 US 25-75 DS	Fish Habitat
Crossing-6 (C6) CVC Regulated Watercourse crossing	0-0.5/0-0.10	poor	grass	none	0	0	Not Fish Habitat

Attachment 'A', Maps 1a through 1f present the location of each of these crossings.

Attachment 'B', Representative Photographs presents photos of each crossing location.

Based on the above table, the overall aquatic habitat availability is poor. There is fish habitat at one of the crossings at Huttonville Creek, which has the best quality fish habitat in the study area and is currently undergoing rehabilitation efforts by the Credit Valley Conservation Authority, Lawrence Avenue Group Ltd, Credit River Anglers Association, Department of Fisheries and Oceans and the Ministry of Natural Resources. Field investigations revealed typical riffle/pool sequencing with evidence of dramatic water level variation (i.e. bare banks and trapped debris) over 1 metre above current water levels. Blacknose dace were common in reconnaissance level fish sampling using a dip net. Other species captured include creek chub and brook stickleback as well as other possible unidentified cyprinid species. In Credit Valley's Subwatershed Study completed in January 2004, additional species sampled in the reach upstream included white sucker, fathead minnows and Redside dace, an Endangered species.

2.2 Terrestrial Findings

Along the alternative alignments, the major terrestrial feature consists of active agricultural corn/soya fields. No major woodland or wetlands, greater than 2ha, are within 20-30 metres of the road allowance. Vegetation communities associated with the riparian zone of all the watercourses/ water conveyance channels were present. Dominant species consist of emergent grasses such as reed canary grass and cattails. Riparian vegetation associated with water conveyance systems either consisted of a very small patch at the culverts or were only constrained to the channels themselves (i.e. Crossing 4). Riparian vegetation associated with Huttonville Creek consists of poplar, willow and ash trees with hawthorn, dogwood shrubs and emergent grasses. Table 1-2 below summarizes these findings.

Table 1-2 Summary of Condition of Terrestrial Vegetation

Tree/ Stand / Community #	Condition	Tree Species/ Community	Diameter at breast height/ Size	Dripline	Health
T1	- contains one silver maple tree with Tartarian honeysuckle shrubs. A cattail community occurs to the north.	Silver Maple (*Acer saccharum*) MAS 2-1: Cattail Mineral Shallow Marsh Type.	~ 55 centimetres Less than 0.5 ha in size	4 metres	Fair to poor: 40% dead branches Good
T2	- a stand of planted trees surround a residential property including three silver maple, tamarack, and Norway spruce.	Silver maple	~65 centimetres	4 metres	Good: occurs about 4.5 metres from road
		Silver maple	40 centimetres	5 metres	Fair: branches have been pruned to avoid power lines. Approximately 40% of its branches are dead
		Sugar maple with three trunks	40, 20 and 20 centimetres	4 metres	Fair to good: branches have been pruned to avoid power lines.
		Tamarack (*Larix larcina*)	n/a	n/a	Dead.
		Norway Spruce (*Picea abies*)	20 centimetres	n/a	Poor: top has been pruned.
T3	- a stand of planted trees surround a residential property including eleven Norway Spruce, two Scot's pine, four silver maple, one ash and lilac shrubs.	Norway Spruce stand	20 centimetre average	n/a	Fair to poor
		Scot's Pine	20 centimetre average	n/a	Good
		Silver maple stand	20 to 40 centimetres	n/a	Good
		Ash	10 centimetres	n/a	Good
		Lilac and cherry clump	n/a	n/a	Good
T4	A clump of trees comprised of white ash, staghorn sumac, Manitoba maple and white elm. Meadow species include knapweed, reed canary grass, common burdock, ragweed, Canadian goldenrod, smooth brome grass.				
T5	One Cottonwood along south side of Creek Crossing No. 3 with smooth brome grass underneath.	Cottonwood (*Populous deltoides*)	75 centimetres	5 metre	Good
T6	Planted ornamental trees along either side of a driveway for property # 11473 within 10 metres to the road.	Crimson King Maple (*Acer platanoides*)	Less than 10 centimetres	n/a	Good
		Crimson King Maple	Less than 10 centimetres	n/a	Good
		Blue spruce (*Picea pungens*)	Less than 10 centimetres	n/a	Good
T7	Planted trees in front of property	Weeping willow	10 centimetres	n/a	Good
		Spruce	10 centimetres	n/a	Good

Tree/ Stand / Community #	Condition	Tree Species/ Community	Diameter at breast height/ Size	Dripline	Health
	#11413 within 20 metres of the road.	Catalpa	10 centimetres	n/a	Good
		Scot's Pine	10 centimetres	n/a	Good
		Sugar Maple	10 centimetres	n/a	Good
		Sugar Maple	20 centimetres	n/a	Good
T8	Planted trees in front of property #11248.	Seven Norway spruce	n/a	n/a	Good
		Horse chestnut (*Aesculus hippocastanum*)	30 centimetres	n/a	Good. Branches occur near hydro wires
		Weeping willow (*Salix alba var. vitellina*)	70 centimetres		Good. Occurs 10 metres from the road
		Black maple (*Acer nigrum*)	n/a	n/a	Poor. 60% dead branches. By driveway and within 5 metres of road
T9	Individual cottonwood.	Cottonwood (*Populous deltoides*)	70 centimetres	n/a	Good. Within 5 metres of road.
T10	Trees within property # 11157 within 20 metres of road.	Scot's Pine (*Pinus sylvestris*)	10 centimetres	n/a	Good
		Manitoba maple (*Acer negundo*)	15 centimetres	n/a	Good
T11	Trees within/near property #10934.	Bur oak (*Quercus macrocarpa*)	65 centimetres	5 metres	Fair to good. Branches are pruned to avoid hydro wires
		willow (*Salix sp.*)	10 centimetres	n/a	Good
		Black walnut (*Juglans nigra*)	30 centimetres	2 metres	Poor. Infested by tent catepillars. Branches severely pruned. Also has 80% dead branches
		Black walnut	40 centimetres	3 metres	Good
		Cedar (*Thuja occidentalis*)	Less than 10 centimetres	n/a	Good
		Black walnut	35 centimetres	n/a	Good
		Norway spruce	30 centimetres	n/a	Good
		Eight individual Black walnut	20 to 50 centimetre average	n/a	Good
		Black maple	20 centimetres	n/a	Good
T12	Trees that have been planted in rows (like a nursery) and contain silver maple, Norway spruce and cedar species with some juniper, spruce and locust in front of the house (property # 10816) Silver maple (*Acer saccharinum*)				
T13	Hedgerow of Norway spruce occurs 15 metres from road.				
T14	Individual tree within 5 metres of road.	Cottonwood (*Populous deltoides*) with three trunks	20 centimetres		Fair to good. Has 20% dead branches
T15	A stand of trees located within property #10675.	Eleven Norway maple (*Acer platanoides*)	15 centimetres on average	n/a	Four in Good condition, 3 in poor condition, four are almost dead
		Blue spruce	Less than 10 centimetres	n/a	Good
		Norway maple	n/a	n/a	Good
T16	A strip of cedar shrubs with Norway spruce, weeping willow, black walnut and smooth brome grass.				
T17	Individual tree with common buckthorn shrubs (*Rhamnus cathartica*).	Bur oak (*Quercus macrocarpa*)	30 centimetres	n/a	Good to fair. Leaves exhibit premature drying
T18	Planted trees within property #10571.	Seven Scot's pine within 10 metres of road	n/a	n/a	All in good condition
		One Norway spruce	15 centimetres	n/a	Good.
T19	Two individual trees.	Cottonwood (*Populous deltoides*)	Less than 10 centimetres	n/a	Fair

Tree/ Stand / Community #	Condition	Tree Species/ Community	Diameter at breast height/ Size	Dripline	Health
		Cottonwood	n/a	n/a	Nearly dead
T20	Individual tree.	Cottonwood	65 centimetres	n/a	Good.
T21	Two trees planted within property # 10391.	Norway maple	20 centimetres	n/a	Fair. Contains 20% dead branches
		Trembling aspen (*Populous tremuloides*)	15 centimetres	n/a	Good.
	Four trees planted within property # 10375.	Three Crimson king (*Acer platanoides*)	Less than 10 centimetres average	n/a	1 Poor with 50% dead branches. 2 are in good condition
		One silver maple	Less than 10 centimetres	n/a	Good
T22	Hedgerow of Scot's pine and Manitoba maple at property #10344.				
T23	Two trees within 10 metres of road.	Weeping willow (*Salix alba var. vitellina*)	1 metre	n/a	Good
		Silver maple	n/a	n/a	Good
T24	Trees amongst a property with a house that's boarded up.	Nine green ash (*Fraxinus pennsylvanicai*)	10 to 15 centimetres average	n/a	Good
		Five Norway spruce	40 to 60 centimetres	n/a	Good
T25	Riparian community along Huttonville Creek.	This riparian community has trees along the banks of Huttonville Creek and shrubs/herbaceous plants extending beyond. This community functions as cover for the creek, helping to provide an overall cooler thermal regime for resident fish species. **Trees include:** willow hybrids, cottonwood, silver maple, Manitoba maple, and sage green willow. **Shrubs include:** red osier dogwood, cedar, white pine, mock cucumber, wild grape, Virginia creeper, common buckthorn, sandbar willow and elderberry. **Groundcover includes:** jewelweed, reed canary grass, teasel, broad-leaved cattail, common burdock, common dandelion, New England aster, smooth brome grass, common milkweed, spotted joe pyeweed, Canada goldenrod, blue vervain, stining nettle, purple loosestrife, watercress, deadly nightshade, cow vetch, western dock and lady's thumb.			

Attachment 'A', Maps 1a through 1f present the location of each of these terrestrial units.

3.0 Assessment of Significance

The features found within the study area have been assessed using provincial and federal rankings systems outlined by Ontario Ministry of Natural Resources and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The following provides a summary of the identified significant features found within the study area described in section 2.0. Below lists the significant features as identified at the federal, provincial, regional, and local municipal levels of jurisdiction.

3.1 Federally Recognized Features & Species

The following federally recognized species were found within the subject property:

- Redside dace "Endangered" COSEWIC

3.2 Provincially Recognized Features & Species

No provincially significant features were observed within the study area.

3.3 Regionally Recognized Features & Species

The following regionally/locally recognized features and species were found:

- Wetland communities surrounding Huttonville Creek are identified on Schedule 'D' of City of Brampton's Official Plan as "Other Wetland".

4.0 IMPACT ASSESSMENT

The primary issue of importance for the subject lands, with regard to environmental management and impact assessment, is the protection of the functions of Huttonville Creek and its riparian communities. Consequently, the planning and management of areas adjacent to the creek will be important to the overall avoidance of environmental impacts.

There are two key stages in the improvements, particularly widening of Mississauga Road during which potential environmental effects may occur: 1) *construction stage* and, 2) *post-construction stage*. The majority of short-term impacts will be related to the construction stage of the proposed road widening. Generally, these will be temporary in nature and are preventable through proper construction practices and site inspection. Long-term impacts are considered as those related to the general roads maintenance.

4.1 Existing Impacts

It is recognized that within Southern Ontario there are few, if any, natural areas that have not been disturbed by some human activity in the past. Therefore, in order to assess the potential impacts of a proposed development it is necessary to consider the historical and the existing impacts that are present within the site prior to the initiation of development-related work. Historical/existing impacts should be documented in order to determine, following land development, whether impacts are a result of the development or a result of previous activities or events on the site. Some historical/existing impacts provide an opportunity for the implementation of restoration initiatives as part of the environmental management for the proposed development.

Existing impacts have been noted for areas within the study area lands:

- *Loss of woody vegetation through past agricultural use*
- *Sedimentation via overland flow from surrounding agricultural communities, and*
- *High percentage of invasive plants such as reed canary grass species within majority of wetland communities along water conveyance channels*

4.2 Potential Short-term Construction-Related Impacts

The potential short-term environmental effects associated with the proposed widening of Mississauga Road relate primarily to construction activities. Potential construction related impacts that are of particular relevance to the development include:

1. **Soil disturbance/sedimentation to Huttonville Creek -** The grading and disturbance of soils within the site introduce the potential for erosion and deposition of soils and silt within the wetland and aquatic communities.

2. **Potential disturbance to Huttonville Creek** – Through the proposed widening of Mississauga Road, the culvert for Huttonville Creek at Crossing No. 6 and 7 will have to be replaced and

lengthened. This will create a HADD and therefore will require the preparation of a letter of intent to the Department of Fisheries and Oceans.

3. **Disturbance of street trees** – Through the proposed widening of Mississauga Road, various street trees will be affected and will have to be removed due to their proximity to the existing road.

4.3 Potential Long-term Environmental Impacts

The potential long-term environmental effects associated with the proposed development relate to the future management of the Mississauga Road. The impacts of these features are described below.

1. **Increased potential contamination to Huttonville Creek – T**here is a potential for contaminated (i.e. salt) water to be washed into Huttonville Creek during rain events.

2. **Decreased infiltration – T**he proposed widening of Mississauga Road will increase the amount of impervious surfaces, thereby decreasing the amount of infiltration into the wetland communities along Huttonville Creek.

5.0 RECOMMENDATIONS

The following provides recommendations for future improvements along Mississauga Road.

Recommendation 1 – Protection of Huttonville Creek and its surrounding wetland communities. Those wetland communities encroached upon should be replaced at a 1:1 ratio within suitable areas along Huttonville Creek. At detailed design stage, appropriate areas should be delineated with an appropriate planting plan in consultation with the Credit Valley Conservation Authority.

Recommendation 2 – Provision of a Letter of Intent for the disturbance to Huttonville Creek and Redside dace habitat through the replacement and lengthening of the existing culvert. This should be completed at detailed design and with consultation with Department of Fisheries and Oceans.

Recommendation 3 – Provision of a Tree Preservation/Replacement plan for individual trees along the existing road. Trees will be affected by the proposed road widening. During detailed design, information on individual trees should be confirmed and surveyed. Those trees lost should be replaced at a 1:1 ratio. This should be completed in consultation with the City of Brampton's forester.

Recommendation 4 – Provision of Sediment Control Measures for all watercourses and water conveyance systems to ensure sedimentation does not occur. Sediment control should measures should entail sediment fencing along the entire stretch of road that is being widened; heavy duty fencing (OPSD 219.130) should be installed for works in the vicinity of Huttonville Creek, sediment fencing following OPSD 219.190 should be installed for the remainder of the study area. Straw bales should be installed within all water conveyance systems and road side ditches following OPSD 219.120.

Attachment 'A' – Maps

Mississauga Road Widening Class Environmental Assessment

NATURAL ENVIRONMENTAL FEATURES

MAP 1A

Legend

- limits of terrestrial units

T# - terrestrial unit no.*

C# - watercourse crossing no.*

* Refer to report for descriptions

EARTH TECH | AECOM

N

Mississauga Road Widening Class Environmental Assessment

NATURAL ENVIRONMENTAL FEATURES

MAP 1B

Legend

- conveyance channel
- watercourse
- limits of terrestrial units
- T# - terrestrial unit no.*
- C# - watercourse crossing no.*

* Refer to report for descriptions

EARTH TECH | AECOM

N

Mississauga Road Widening Class Environmental Assessment

NATURAL ENVIRONMENTAL FEATURES

MAP 1C

Legend

- conveyance channel
- watercourse
- limits of terrestrial units
T# - terrestrial unit no.*
C# - watercourse crossing no.*

* Refer to report for descriptions

EARTH TECH | AECOM

N

Mississauga Road Widening Class Environmental Assessment

NATURAL ENVIRONMENTAL FEATURES

MAP 1D

Legend

- conveyance channel
- watercourse
- limits of terrestrial units
- T# - terrestrial unit no.*
- C# - watercourse crossing no.*

* Refer to report for descriptions

EARTH TECH | AECOM

N

Mississauga Road Widening Class Environmental Assessment

NATURAL ENVIRONMENTAL FEATURES

MAP 1E

Legend

- conveyance channel
- watercourse
- limits of terrestrial units
- T# - terrestrial unit no.*
- C# - watercourse crossing no.*

* Refer to report for descriptions

EARTH TECH | AECOM

N

Mississauga Road Widening Class Environmental Assessment

NATURAL ENVIRONMENTAL FEATURES

MAP 1F

Legend

- conveyance channel
- watercourse
- limits of terrestrial units
- T# - terrestrial unit no.*
- C# - watercourse crossing no.*

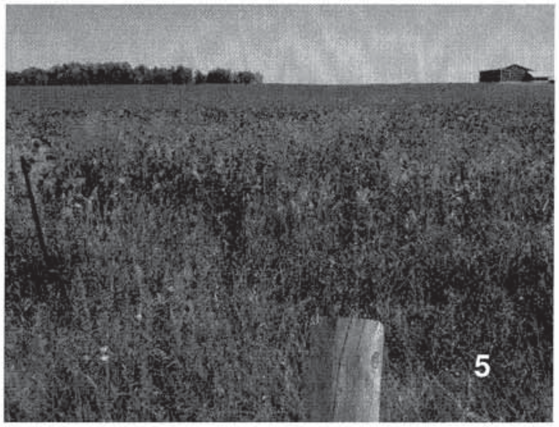
* Refer to report for descriptions

EARTH TECH | AECOM

N

Attachment 'B' – Representative Photographs

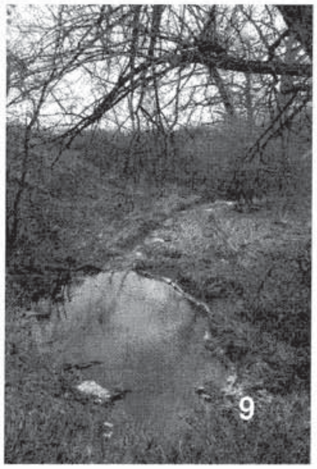
Representative Photographs

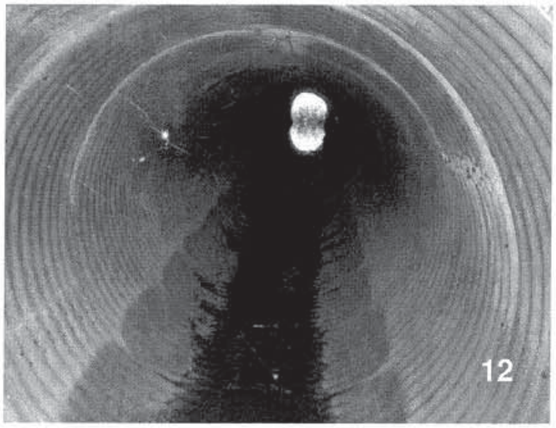


Photograph 1) east side of surface water conveyance system in channelized ditch – crossing1, 2) west side of surface water conveyance system in channelized ditch - crossing 1, 3) east side of surface water conveyance system in agricultural field – crossing 2, 4) west side of surface water conveyance system in agricultural field – crossing 2, 5) east side of surface water conveyance system in soybean field – crossing 3, 6) west side of surface water conveyance system in soybean field – crossing 3.

Representative Photographs

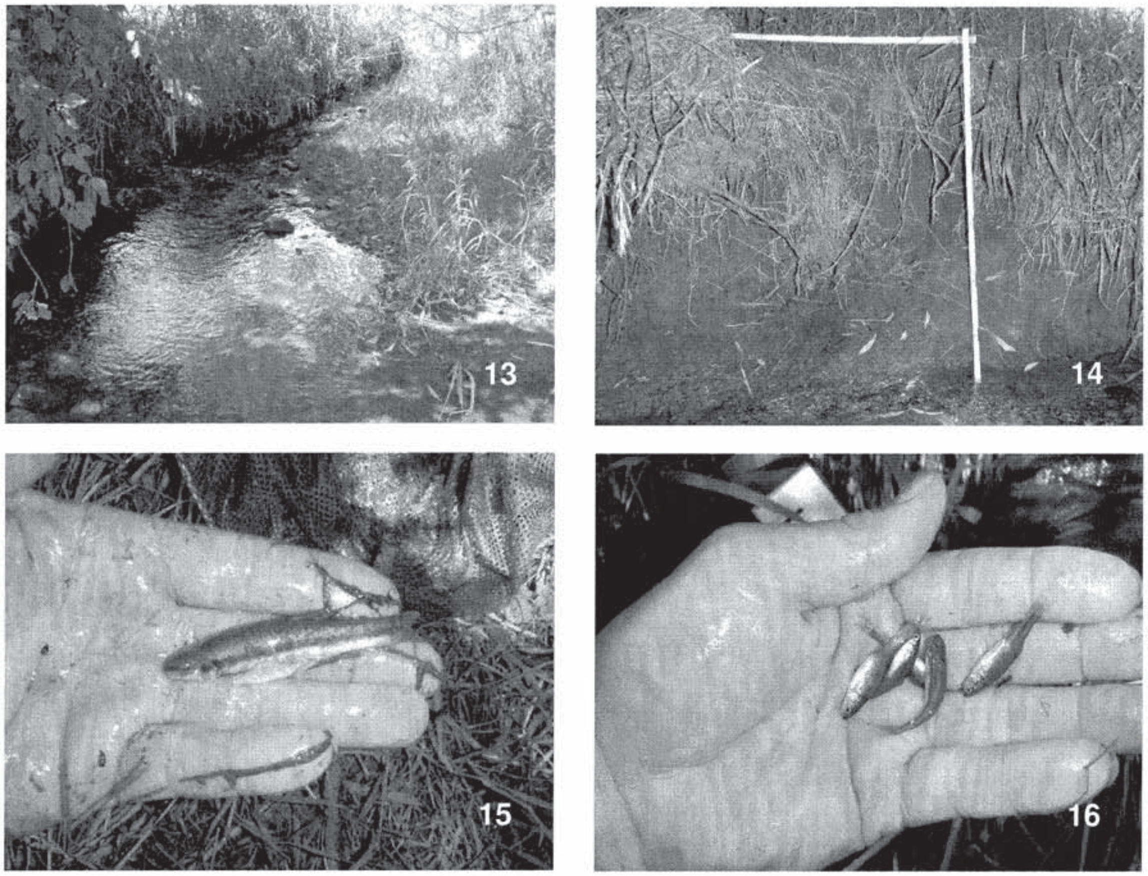




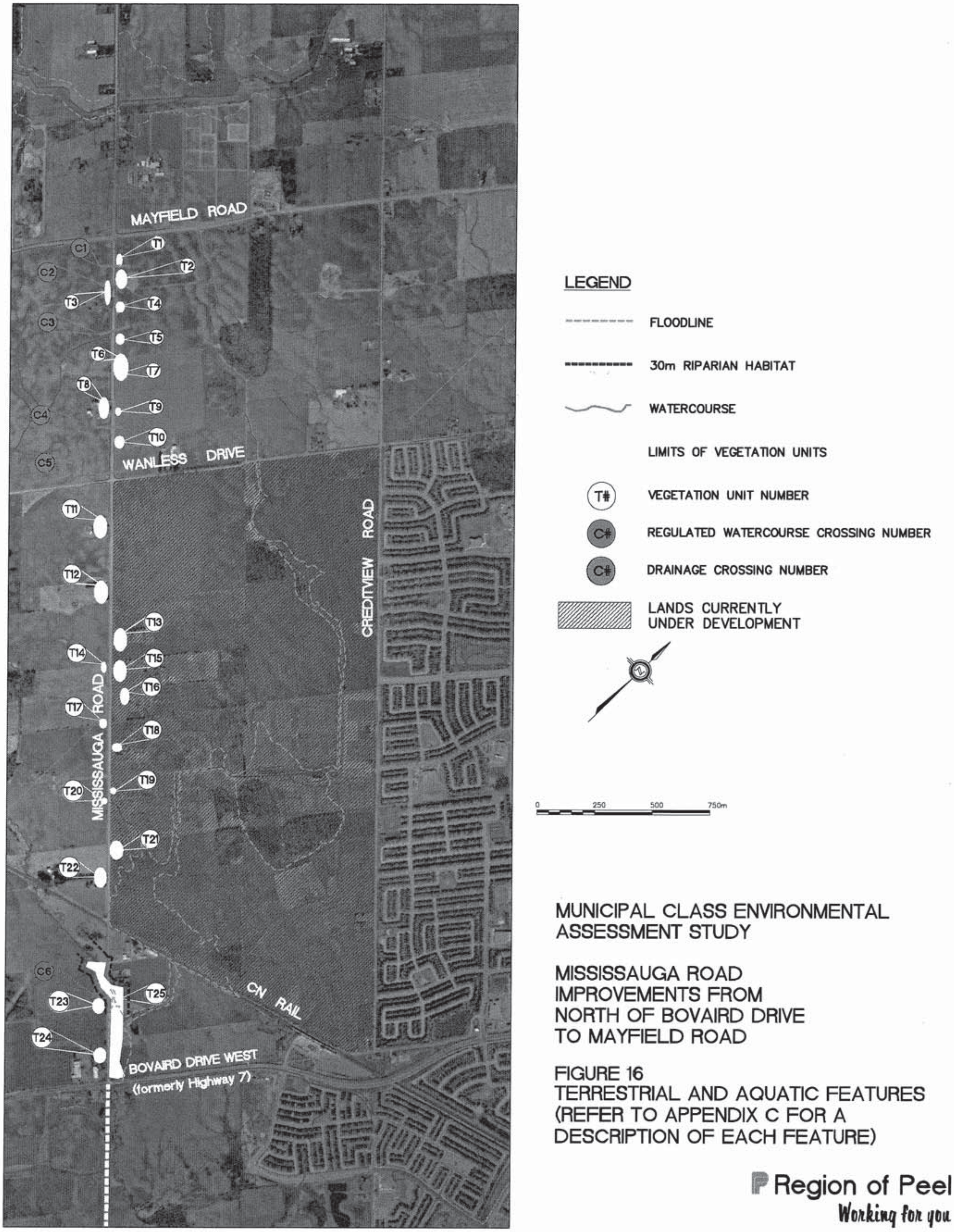



Photograph 7) east side of surface water conveyance system through soybean field – crossing 4, 8) west side of surface water conveyance system through soybean field – crossing 4, 9) east side of Huttonville Creek – crossing 5, 10) west side of Huttonville Creek – crossing 5, 11) east side of surface water conveyance flowing through CSP – crossing 6, 12) west side of surface water conveyance flowing through CSP – crossing 6.

Representative Photographs



Photograph 13) typical riffle/pool sequencing, 14) evidence of dramatic water level variation, 15) blacknose dace, 16) unidentified cyprinid species.



MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT STUDY

MISSISSAUGA ROAD IMPROVEMENTS FROM NORTH OF BOVAIRD DRIVE TO MAYFIELD ROAD

FIGURE 16
TERRESTRIAL AND AQUATIC FEATURES (REFER TO APPENDIX C FOR A DESCRIPTION OF EACH FEATURE)

Region of Peel
Working for you

AECOM

C.4 Meander Belt Study

AECOM
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Markham, ON, Canada L3R 5Z6
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905 477 8400 tel
905 477 1456 fax

Memorandum

To	Ralph Ehlers	Page	1
CC	Javier Mena-Diep and Brian Richert		
Subject	Meander Belt Assessment of Huttonville Creek at Mississauga Road		
From	Robin McKillop, M.Sc., P.Geo. (Fluvial Geomorphologist)		
Date	May 10, 2010	Project Number	60116610

1. Introduction

Mississauga Road is proposed to be widened between Bovaird Drive and Mayfield Road, in Brampton, in association with the Region of Peel's overall plan for transportation improvements. Huttonville Creek flows eastward beneath Mississauga Road through a concrete box culvert (C3, Figure 1), before bending sharply southward to parallel the east side Mississauga Road and flow through a recently installed concrete box culvert beneath Bovaird Drive (C1, Figure 1). This memorandum has been prepared to characterize the local fluvial geomorphology of Huttonville Creek, identify its trends and rates in lateral and down-valley erosion, and establish its meander belt boundaries. Based on the results of this assessment, recommendations are provided for the size and orientation of the proposed replacement crossing structure beneath Mississauga Road and the position and treatment of the eastern edge of Mississauga Road.

Following provision of a summary of the methodology used in this study, this memorandum describes the physical setting, surrounding land use and morphology of Huttonville Creek, provides its 100-year erosion rate and meander belt width, and discusses the implications of the observations and predictions for road widening and crossing structure design.

2. Methods

Aerial photographs, topographic maps and surficial geology maps were reviewed to gain an initial understanding of Huttonville Creek and its shallow valley. The meander belt width assessment completed by Trow Associates Inc. (2006) for the reach of Huttonville Creek immediately downstream of Bovaird Drive was also consulted. Two reaches were defined for the purposes of channel description and the meander belt and erosion analyses (Figure 1). Although the valley characteristics, channel gradients and bed and bank compositions are similar in both reaches, a significant, albeit unnamed, tributary (hereinafter referred to as "Tributary A") enters Huttonville Creek near the middle of the overall study reach. A reach break was defined at this confluence, given the dependence of channel morphology and the rates of erosion and deposition on peak flows.

Legend
Historical Channel Configuration
2004
1982
1961
Meander Belt
Reach Break
Regional Floodline
Culvert
Flow Direction
M3 - Meander #3 (used for erosion rate estimation; see Table 1)
Note: No oxbows or meander scars were observed within either studied reach.
Subject Area
Basemapping from Ontario Ministry of Natural Resources Orthophotography: 2004
0 17.5 35 70 105 140
m
1:3,500
UTM Zone 17N, NAD 83
This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent.
Region of Peel
Mississauga Road Class EA from Bovaird Drive to Mayfield Road
Huttonville Creek Meander Belt
December 2010
Project 60116610
AECOM
Figure 1
CN Railway
Huttonville Creek
Reach 2
Reach 1
Tributary A
Mississauga Rd
Bovaird Dr W
M1
M2
M3
M4
M5
M6
M7
M8
C1
C2
C3
594000

Field reconnaissance was completed along each reach on April 29, 2010 to determine the average bankfull width and depth, the composition of the mostly gentle valleysides, the locations of confinement by valleysides and the degree of channel-floodplain connectivity. Erosion sites and constraints on meander propagation were documented and photographed.

Aerial photograph stereopairs from 1961 and 1982 (Appendix A), and orthophotography from 2004, provided the basis for comparing historical channel configurations (Figure 1). Both sets of historical aerial photographs were studied stereoscopically (i.e., in 3D), because stereoscopic analysis enables subtle topographic and alluvial features that are not visible in orthophotography and, in some cases even difficult to identify in the field, to be detected. After the aerial photographs were scanned at high-resolution and rectified in ArcGIS (based on multiple control points), the centrelines of the historical channel configurations were digitized and overlaid onto 2004 orthophotograph basemapping (Figure 1). Short breaks in the mapped channel centrelines exist upstream of Mississauga Road, where a dense tree canopy obscured the channel from view.

All measurements associated with the determination of the 100-year erosion rate were made directly on-screen, at a large scale, to ensure precision and consistency. It should be noted, however, that apparent irregularities in channel movement represent an approximate measure of the uncertainty associated with the available measurement technique – in this case, around ±3 m.

The lateral and down-valley distances between the apices of meander bends from different years, ideally situated along the edge of the meander belt, were measured at representative meander bends within each reach (Figure 1). Four meander bends were measured within Reach 1 (i.e., meanders M1 to M4). Within Reach 2, two meander bends downstream (i.e., M5 and M6) and two bends upstream (i.e., M7 and M8) of the Mississauga Road crossing were measured, in accordance with the *Urban Road Stream Crossings Guideline* (Toronto and Region Conservation Authority (TRCA) et al., 2006). Each meander erosion rate was estimated by dividing the meander migration distance by the associated time interval. The 100-year meander migration distance was estimated by multiplying the average meander erosion rates by 100 years.

Determination of the meander belt width along each reach followed the *Belt Width Delineation Procedures* prepared for TRCA (Parish Geomorphic, 2004). The method was based on the protocol that accounts for a change in hydrologic regime (flow duration and frequency), given the inevitable change in surrounding land use from agricultural to suburban residential and industrial. The preliminary meander belt was established by drawing parallel lines tangential to the outermost meander bends along each sub-reach axis, including any oxbows. The maximum distance between these boundary lines defined the preliminary meander belt width, to which the average bankfull width, ascertained during field reconnaissance, was added. To account for the likelihood that the existing meander belt may not represent a quasi-equilibrium form, a factor of safety is generally required. The existing meander belt was multiplied by 1.05 and, to this product, the estimated 100-year migration distance was added. The total represents the final meander belt width (Figure 1).

3. Physical Setting

3.1 Physiography

Huttonville Creek flows in a southeasterly direction from its headwaters near Mayfield Drive to its confluence with Silver Creek, a major tributary of Credit River, in the town of Huttonville. Its watershed is entirely within the South Slope physiographic region (Chapman and Putnam, 1984), which is characterized by its gently rolling plain composed predominantly of Halton Till, a dense, clayey silt diamicton deposited beneath a lobe of the Laurentide Ice Sheet during the last glaciation. Both study reaches are within a broad, poorly defined valley that is incised shallowly into the surrounding till plain. Thin alluvial deposits of silt, sand and gravel form a level floodplain within the valleybottom, but till, which is relatively resistant to erosion due to its cohesiveness and density, is exposed discontinuously along the channel bed and its lower banks. Tributary A, which is comparable in drainage area to upper Huttonville Creek, enters the east side of Huttonville Creek about half way between Bovaird Drive and the culvert beneath Mississauga Road.

3.2 Land Use

Agriculture is still the predominant land use within the Huttonville Creek watershed, although residential development is beginning to occupy portions of the watershed downstream of the study reaches. It is undoubtedly only a matter of time before agricultural land use in the upper Huttonville Creek watershed is at least partly replaced by more urban land uses.

Relatively few changes in land use in the immediate vicinity of the two study reaches have occurred in the last half century. Farm fields still extend to within just a few metres of either bank of Huttonville Creek. A localized narrowing of the channel between rip-rapped banks, just downstream of the confluence with Tributary A, provides likely evidence of an old farm crossing. A small pond that was excavated prior to 1961 within the floodplain on the north side of the creek, near the upstream end of Reach 2, still exists. The CN railway crossing of Huttonville Creek about 0.7 km upstream of Mississauga Road has also been present since prior to 1961. A small plaza in the northwestern corner of the intersection between Mississauga Road and Bovaird Drive has recently replaced the previous small development.

Notwithstanding the relatively few changes that have occurred during the past several decades, the channel appears to have been realigned in the first half of the 20^{th} century to accommodate agricultural practices or the original construction of Mississauga Road. This realignment predates the earliest available aerial photography of the region from 1944 (Trow Associates Inc., 2006). There is no evidence of the original (natural) channel configuration upstream of Bovaird Drive, and all channel adjustments now occur between the gentle eastern valleyside and the eastern limit of Mississauga Road.

Riparian vegetation consists mostly of meadow species and grasses, although the density and continuity of riparian shrubs and deciduous and coniferous trees have gradually increased since 1961, particularly along Reach 2 (Figure 1).

4. Geomorphic Description of Huttonville Creek

4.1 Overview

Huttonville Creek is a 4th order stream with a drainage area of approximately 4.5 km^2 where it crosses Bovaird Drive. It exhibits an unconfined, sinuous to irregularly meandering pattern, except where it impinges on a locally defined valleyside immediately downstream of its crossing of Mississauga Road (M6, Figure 1). The floodplain is continuous and flat, with no evidence of historical channel configurations (e.g., oxbows).

4.2 Reach 1

Reach 1 extends from Bovaird Drive upstream to the confluence with Tributary A (Figure 1). Along this reach, Huttonville Creek has a roughly trapezoidal cross-section with an average bankfull width of approximately 3.5 m, although there is considerable evidence of channel widening at some locations. The average bankfull depth is approximately 0.6 m, and there is no entrenchment, so floodwaters are able to spread and attenuate across the floodplain during storms. The observation of 'trash lines' wrapped around the upstream sides of woody riparian vegetation is indeed evidence of recent overbank flooding. The channel exhibits well-defined pool-riffle bed morphology. It has relatively short (<3 m), till-derived cobble riffles and relatively long (5-10 m), gravelly pools embedded with fine sand and silt (Photo 1).

Photo 1. Pool-riffle morphology along Reach 1

The outer banks of meanders are severely undercut in places, which has led to localized slumping and the formation of vegetated "islands" within the channel (Photo 2). The observed widening likely reflects the erosion-resistant till substrate and a gradual increase to a more rapidly responding hydrologic regime. No obvious cases exist of meander adjustment through chute or neck cut-off (e.g., oxbows); evidence of progressive bank erosion, however, is widespread.

Photo 2. Fragments of slumped banks at M3 indicative of channel widening

A narrow strip of riparian shrubs and deciduous and coniferous trees has grown along the banks within the past few decades through natural colonization and deliberate planting. A nearby sign erected alongside Huttonville Creek confirms the collaborative efforts of Credit Valley Conservation (CVC) and neighbouring landowners to help stabilize the channel and improve aquatic habitat. Although there is currently little to no in-stream large woody debris in this reach, the root systems of a number of trees growing along the banks have been exposed through gradual undercutting (Photo 3). Thus, in-stream woody debris will likely have a greater influence on local channel morphology in the future.

A small corrugated steel pipe (CSP) culvert (C2) drains water from the west side of Mississauga Road into the east roadside ditch, which ultimately enters Huttonville Creek just upstream of Bovaird Drive, at M1 (Figure 1). The ditch is poorly defined and filled in its lower end with cattails and, at the time of survey, stagnant water. Neither the ditch nor Huttonville Creek itself exhibits any significant erosion in the vicinity of the culvert beneath Bovaird Drive (C1).

The localized narrowing and rip-rap lining of the channel at the abandoned farm crossing is located near the upstream end of Reach 1 (Photo 4).

Photo 3. Downstream view toward M4, showing exposed tree roots from undercutting

Photo 4. Channel narrowing and rip-rapped banks at old farm crossing

4.3 Reach 2

Reach 2 extends from the confluence with Tributary A upstream past the existing crossing of Mississauga Road to the excavated pond on the north side of the creek (Figure 1). Along this reach, Huttonville Creek has similar average bankfull dimensions to those observed along Reach 1 – a width and depth of approximately 3.5 m and 0.5 m, respectively – but with considerably greater variability. The greater variability is attributed to the influence of in-stream woody debris on channel morphology. Unlike along Reach 1, a significant portion of Reach 2 is bordered by mature trees. Where trees have fallen into the channel, either through undercutting or windthrow, the channel has become anomalously wide, locally up to 6 m (Photo 5). In open, grassy areas, however, the channel is as narrow as 2 m. Pool-riffle bed morphology is also more poorly developed, likely due to the irregular disturbance of woody debris on sediment transport and bed form. Riffles are composed of subangular to rounded cobbles, and pools typically contain a veneer of fine sand and silt.

Photo 5. In-stream large woody debris and anomalously wide channel

Bank erosion is concentrated along the outer banks of meanders, although it is less pronounced than along Reach 1. No obvious cases of meander adjustment through chute or neck cut-off were observed; most channel movement appears to have been the result of progressive bank erosion.

The perpendicular orientation of the existing culvert beneath Mississauga Road (C3) has directed outflow toward the toe of a moderately steep, 4 m-high valleyside – the only well-defined valleyside along either reach. As a result, bank erosion is gradually steepening the slope, exposing tree roots and threatening to undermine an old wooden fence (Photo 6).

Photo 6. Eroding valleyside and collapsing old wooden fence at M6

At the inlet of C3, the channel is forced through a sharp bend, as its trajectory approaching the culvert is nearly perpendicular to the orientation of the culvert. Nonetheless, there is no significant erosion along the outer bank (Photo 7). Several comparatively large meanders, the amplitudes of which define the meander belt boundaries, exist approximately 75 m upstream of the existing inlet of C3. Although their positions have changed slightly over time, the locally shallow channel depth limits the amount of bed and bank erosion and allows even moderate floods to spill across the floodplain and attenuate energy.

As along Reach 1, there is evidence of recent plantings across the floodplain of Huttonville Creek, which help to stabilize the soil and enlarge the narrow tree canopy that already exists.

5. 100-Year Erosion and Meander Belt Assessment

The lateral and down-valley erosion rates of the outermost meanders along Reach 1 and the meanders upstream and downstream of Mississauga Road along Reach 2 are summarized in Table 1. The average 100-year lateral and down-valley migration distances for Reach 1 are 6 m and 14 m, respectively; the corresponding distances for Reach 2 are 3 m and 14 m, respectively. These erosion rates are consistent with typical 100-year toe erosion rates reported for narrow sand/silt-banked watercourses in the Ontario Ministry of Natural Resources (2003) *Natural Hazards Training Manual* (i.e., 8 to 15 m). The rates also encompass the single value of 8.9 m that was derived for the reach immediately downstream of Bovaird Drive (Trow Associates Inc., 2006). In both reaches, nearly all measured meanders exhibit significantly higher down-valley bank erosion rates than lateral bank erosion rates. In other words, meander migration appears to be occurring primarily through down-valley translation rather than through lateral extension. Field observations of severely undercut banks along the downstream arm of meanders, as opposed to at the apices of the meanders, corroborate this finding.

Photo 7. Inlet of existing culvert (C3) beneath Mississauga Road

In accordance with the *Belt Width Delineation Procedures* (Parish Geomorphic, 2004), separate meander belts were established for each reach (Table 2 and Figure 1). Given the absence of any oxbows or meander scars, the belt width is based on the position of the apices of the outermost meanders within each reach. The existing belts in Reach 1 and Reach 2 are approximately 16 m and 35 m wide, respectively, including the bankfull channel width. A factor of safety must be added to each existing meander belt to account for the possibility that the channel may be in quasi-equilibrium and may respond to future changes in hydrologic regime by widening its belt. Therefore, each existing belt was multiplied by 1.05 and, to this product, the respective 100-year erosion distance was added. The final meander belts for Reach 1 and Reach 2 are 22 m and 39 m, respectively (Table 2), which indicates that the meander belt, as depicted by the dashed red lines in Figure 1, actually narrows in a downstream direction.

Table 1. Meander Erosion Rates and Distances (1961 – 2004)

Reach	Meander #	Lateral Erosion			Down-Valley Erosion		
		Shift (m)	Rate (m/yr)	100-Yr Distance (m)	Shift (m)	Rate (m/yr)	100-Yr Distance (m)
1	1	3.5	0.08	8	0.0	0.00	0
	2	4.0	0.09	9	6.0	0.14	14
	3	0.0	0.00	0	9.0	0.21	21
	4	3.0	0.07	7	9.0	0.21	21
	Average:	**2.6**	**0.06**	**6**	**6.0**	**0.14**	**14**
2	5	0.0	0.00	0	7.0	0.16	16
	6	0.0	0.00	0	6.0	0.14	14
	7	6.0	0.14	14	0.0	0.00	0
	8	0.0	0.00	0	11.0	0.26	26
	Average:	**1.5**	**0.03**	**3**	**6.0**	**0.14**	**14**

Notes: Meander # = meander bend at which measurements completed (see Figure 1 for location).
A 0.0 m value represents no lateral or down-valley erosion.

This narrowing of the meander belt from a reach with a smaller drainage area (and lower discharge) to one with a larger drainage area (and higher discharge) may seem contrary to what is typically expected. However, based on Annable's (1996) development of morphological relationships for streams in southern Ontario, the correlation between meander belt and bankfull discharge is very weak (r^2 of 0.52, his Table 6). An explanation for the down-valley narrowing is that the more continuous and mature riparian vegetation along Reach 2 has limited the amount of lateral channel movement over the long-term. Also, the channel is notably shallower in places, which allows flood energy to dissipate across the floodplain.

It is also important to note that the meander belt in the segment of Reach 2 east of Mississauga Road is significantly wider than the existing corridor occupied by the channel. Over time, though, the meander amplitudes may increase in a consistent manner to M7 and M8, upstream of Mississauga Road (Figure 1).

Table 2. Meander Belt Widths

Reach	Preliminary Belt Width (m)	Bankfull Channel Width (m)	Existing Belt Width (m)	100-Yr Lateral Erosion Distance (m)	Final Meander Belt*
1	12	3.5	16	6	**22**
2	31	3.5	35	3	**39**

*Note: * Includes factor of safety*

6. Implications for the Mississauga Road Widening and Replacement Crossing Structure

The findings of this meander belt and erosion assessment have important implications for both the proposed widening of Mississauga Road, particularly with regard to the eastern edge, and the proposed replacement crossing structure through which Huttonville Creek will flow beneath Mississauga Road. Each issue is addressed separately, below.

6.1 Mississauga Road Widening

The western meander belt boundary along Reach 1 is approximately 7 m from the existing toe of the road fill embankment. Even at its closest, the existing channel bank is still 13.8 m from the embankment (as measured in the field). Accordingly, the existing road embankment should not be at risk of erosion from meander migration alongside Reach 1. This finding could prove important if any road or utility modifications need to be accommodated in the northeastern corner of the intersection between Mississauga Road and Bovaird Drive.

The western meander belt boundary along Reach 2 falls mid-slope along the existing road fill embankment. Therefore, according to the procedures followed in this assessment, the existing embankment may be at a slight risk of erosion from meander migration in the long-term. That being said, the lateral erosion rate is only 0.03 m/yr, so it should take more than 400 years for the existing channel to meet the existing embankment. Any widening alongside Reach 2 would best be restricted to the west side of Mississauga Road, if feasible, to avoid encroaching further into the corridor that may, in the future, be occupied by the channel. Armouring the toe of the embankment is not likely necessary, considering the substantial separation distance of the channel and the relatively slow rate of lateral adjustment.

6.2 Huttonville Creek Crossing of Mississauga Road

The existing concrete box culvert through which Huttonville Creek flows beneath Mississauga Road is approximately 4 m wide. This width sufficiently accommodates the natural (average) bankfull width of the channel, but it does not provide the opportunity for any channel movement over time. A 39 m wide structure would be required to span the full meander belt at this location, but such a structure is likely cost-prohibitive and, as indicated below, unnecessary to avoid impacts to fluvial processes or the structure itself, during its expected lifespan.

The meanders upstream of Mississauga Road have amplitudes as large as 35 m (that is why the *existing* belt width in Reach 2 is 35 m (Table 2)), but they are situated approximately 75 m upstream, beyond a straight channel segment. Even at a down-valley migration rate of 0.14 m/yr (Table 1), these meanders would take more than 500 years to reach the existing culvert. The amplitudes of the meanders a short distance downstream of the crossing are no more than approximately 9 m. A span that accommodates meanders of this amplitude would also likely accommodate 100 years of channel adjustment, based on conservatively adding the 100-year lateral erosion distance (i.e., 3 m) to *both* sides of the existing channel (3.5 m), to give a width of 9.5 m. Even this width is relatively conservative, because the erosion rates are based on measurements obtained from the apices of meanders – the locations of greatest concentration of erosive forces – not relatively straight channel segments such as that upstream of Mississauga Road. Indeed, the nearly perfect coincidence of the historical channel centrelines along this straight segment indicates channel movement since 1961 has been negligible.

In conclusion, the replacement crossing structure should be designed with a clear span of at least 9.5 m to accommodate fluvial processes, including channel migration, within its expected lifespan. Although not critical, and also dependent on hydraulic constraints, consideration should be given to re-orienting the culvert to be more in-line with the channel. This would smooth out the existing jog in the channel, reduce the potential for outer bank erosion at the forced sharp bend into the inlet, and slow bank erosion at the toe of the valleyside immediately downstream.

7. Conclusions

This memorandum provides the results and implications of the meander belt and erosion assessment of Huttonville Creek for the proposed widening of Mississauga Road and the proposed replacement crossing structure beneath it. It provides the basis for CVC to evaluate the suitability of the proposed transportation improvements from a fluvial geomorphological perspective.

Huttonville Creek exhibits a sinuous to irregularly meandering pattern within a mostly unconfined, shallow valley setting on both sides of Mississauga Road. Channel adjustment occurs through progressive bank erosion, as opposed to meander cut-off, predominantly through down-valley meander migration. The meander belt narrows downstream from Reach 2 (39 m) to Reach 1 (22 m), likely due to the stabilizing influence of woody riparian vegetation along Reach 2.

The existing east road fill embankment of Mississauga Road is outside the meander belt alongside Reach 1, but at the margin of the meander belt alongside lower Reach 2. According to estimated bank erosion rates, it may be more than 400 years before the channel encroaches along the eastern road edge. Nonetheless, to be conservative, widening would best be restricted to the western side of the existing road alongside Reach 2.

The existing culvert through which Huttonville Creek flows beneath Mississauga Road is approximately 4 m wide. A replacement crossing structure with an open span of at least 9.5 m is required to accommodate fluvial processes, including channel migration, within the expected lifespan of the structure.

8. References

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Belt Width Delineation Procedures, submitted to Toronto and Region Conservation Authority on September 27, 2001 (Revised January 30, 2004).

Toronto and Region Conservation Authority, Fisheries and Oceans Canada, Parish Geomorphic and Dougan & Associates, 2006:
Urban Road Stream Crossings Guideline, Draft for Discussion, August 2006.

Trow Associates Inc., 2006:
Meander Belt Width Assessment – Huttonville Creek, submitted to Region of Peel on April 10, 2006.

Appendix A

Historical Aerial Photographs

May 10, 1961 (Fragment of Aerial Photograph 6473-32-191):

April 23, 1982 (Fragment of Aerial Photograph 82027-24-9):

AECOM

C.5 Stormwater Management

AECOM

Region of Peel

Stormwater Management Report

Mississauga Road Widening
Municipal Class EA

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Date:

September, 2012

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Revision #	Revised By	Date	Issue / Revision Description
1	BRR	Dec 2010	Updated for Huttonville Creek culvert assessment
2	BRR	Dec 2011	Updated for recommended SWM strategy
3(b)	BRR	Feb 2012	Updated text – addressing Peel concerns
4	BRR	Sept 2012	Revised report for finalized preferred alternatives

AECOM Signatures

Report Prepared By:

Brian Richert, P.Eng.

Table of Contents

List of Figures

List of Tables

Appendices

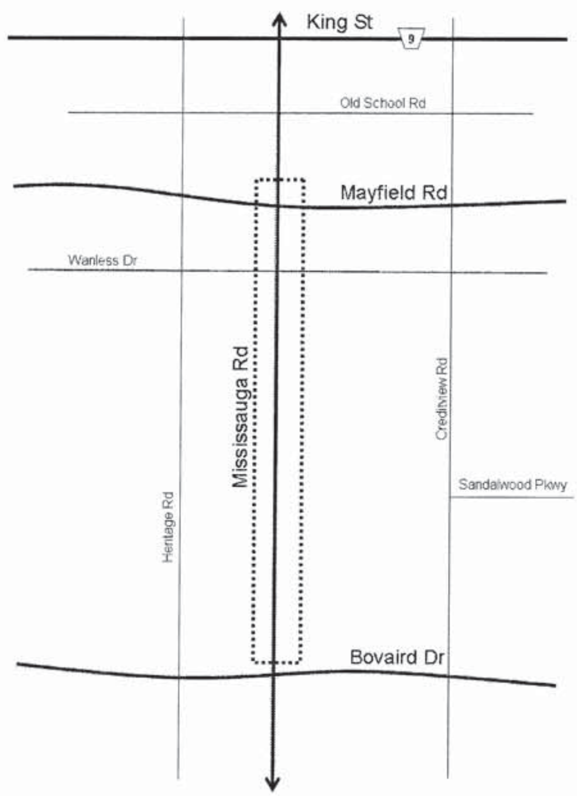
1. Introduction

The Region of Peel retained AECOM to undertake a Municipal Class EA for the widening of a portion of Mississauga Road. Various road widening alternatives are being assessed as part of the EA. This report reviews the stormwater management alternatives for a widened road, and provides input into the overall evaluation of the road widening alternatives prepared for the EA. A proposed SWM alternative is developed that addresses stormwater management objectives for a widened roadway.

1.1 Study Area

The study area is shown in Figure 1, consisting of the Mississauga Road Road corridor from just upstream of Bovaird Drive northward to Mayfield Road.

Figure 1. Study Area

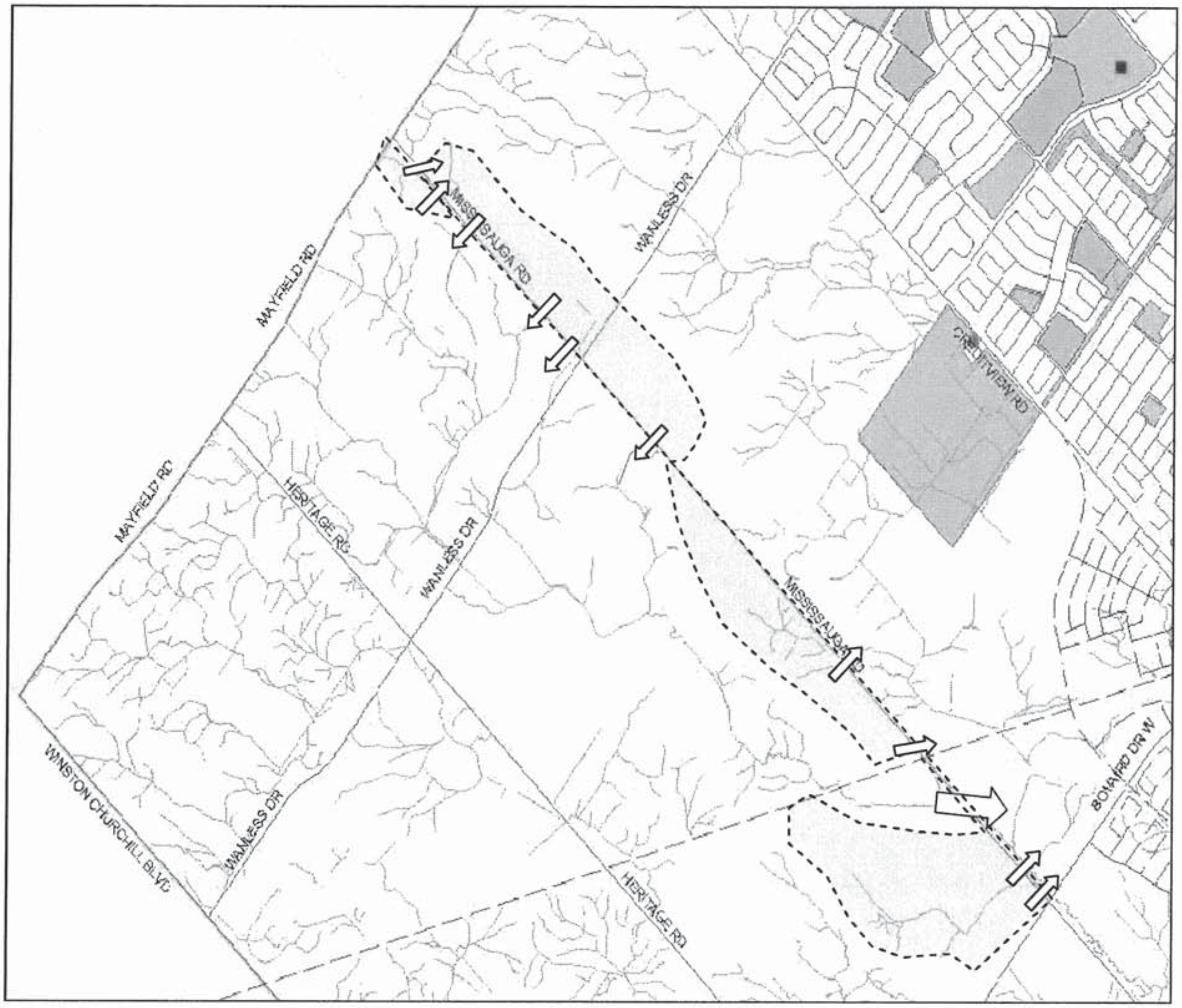


1.2 Existing Storm Drainage

Mississauga Road is within the Huttonville Creek Watershed. The local existing drainage is provided in Figure 2, which shows existing watercourses and tributaries draining to the west branch of Huttonville Creek. The Figure shows that northern half of the study area generally drains across Mississauga Road from east to west, and the southern half generally crosses from west to east.

With the exception of the Huttonville Creek crossing, all of the culvert crossings are located within the tributary headwaters, and have very little external upstream catchment area.

Figure 2. Existing Drainage in Watershed

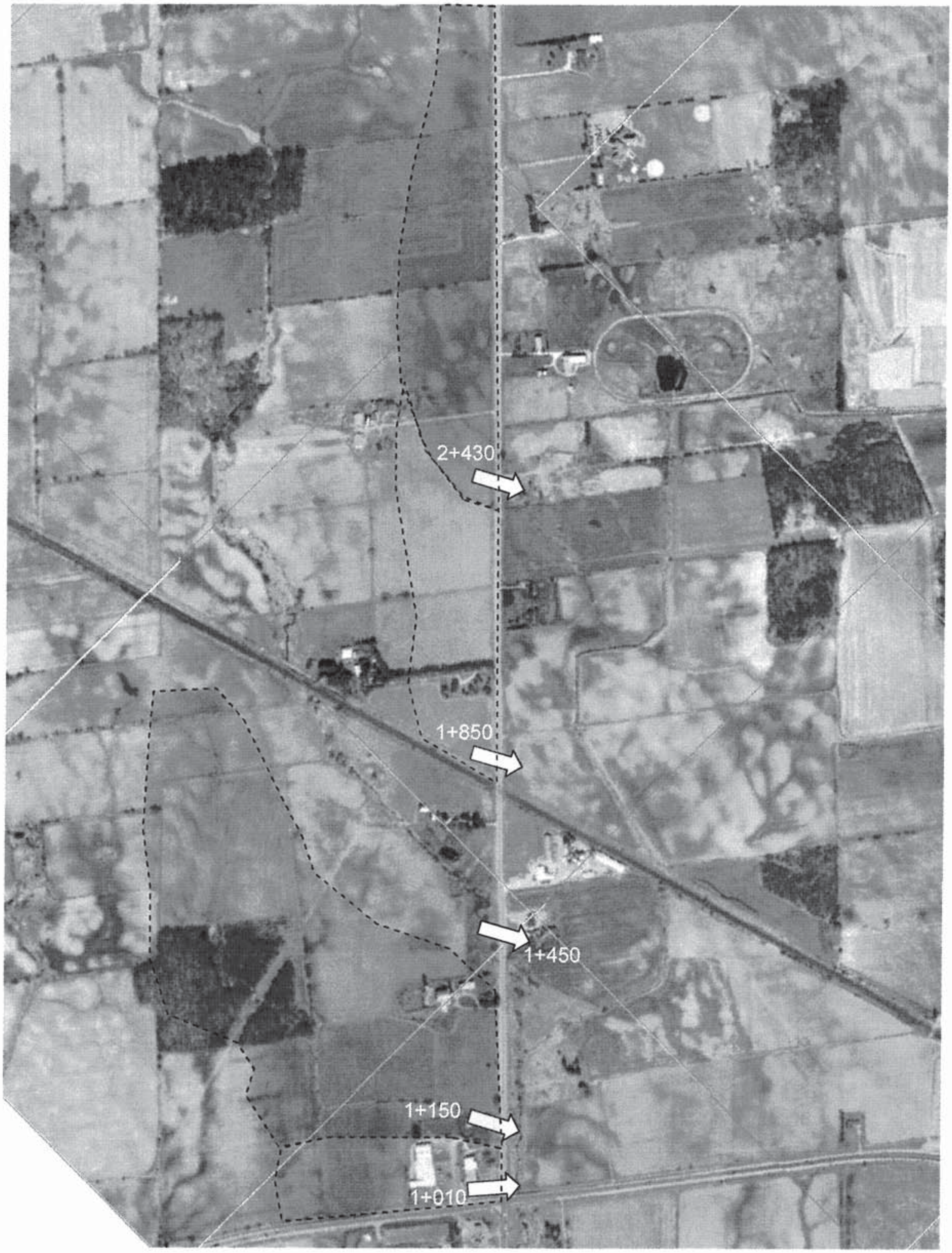


The existing drainage system in the study area road corridor consists of roadside ditches directing road drainage to culvert crossing locations, typically at low points along the existing road profile.

Huttonville Creek crosses Mississauga Road just south of the rail crossing via a concrete box culvert approximately 4.5 m wide by 1.5 m high. The Huttonville Creek crossing is approximately 800 m north of Bovaird Drive.

Figure 3. Catchment Areas of Existing Culverts Crossing Mississauga Road (North Half of Study Area)

Figure 4. Catchment Areas of Existing Culverts Crossing Mississauga Road (South Half of Study Area)



A summary of the existing crossings of Mississauga Road are included in the following Table.

Table 1.1: Summary of Existing Stormwater Drainage Outlets

Crossing Location (North to South)	Culvert Type and Size	Catchment Area (C=0.25) (ha)	Existing Mississauga Road Paved Area (in ultimate corridor) (9 m paved, 41.5 m unpaved, C=0.37) (ha)	Existing Invert Elevation (m)
5+090	750 mm CSP	3.9	200 m x 50.5m = 1.01ha	259.98
5+030	450 mm CSP	1.0	60 m x 50.5m = 0.30 ha	259.86
4+830	600 mm CSP	20.0	760 m x 50.5m = 3.83ha	257.73
4+300	450 mm CSP	3.0	150 m x 50.5m = 0.76ha	257.8
4+110	900 mm CSP	12.2	500 m x 50.5m = 2.52ha	255.48
3+580	450 mm CSP	9.4	250 m x 50.5 m =1.26ha	255.28
2+430	450 mm CSP	19.2	1100m x 50.5m =5.55ha	246.71
1+850	600 mm CSP	10.1	600 m x 50.5m = 3.03ha	242.3
1+450	4.5 m x 1.5 m concrete box	large	insignificant	237
1+150	1200 mm CSP	34.8	300 m x 50.5m = 1.52ha	235.18
1+010	600 mm CSP	7.2	150 m x 50.5m = 0.76ha	235.61

1.3 Relevant Standards and Design Criteria

The stormwater management plan for the proposed station considers a number of relevant standards and design criteria, including:

- The MOE Stormwater Management Planning and Design Manual (2003);
- The City of Brampton design criteria;
- The Region of Peel design criteria;
- CVC Sediment and Erosion Control Guidelines;
- CVC stormwater management guidelines;
- Permit and regulatory requirements of the CVC (related to fill regulated areas on Huttonville Creek downstream of the Mississauga Road crossing);
- Phase 3 Huttonville – Fletcher's Subwatershed Study (AMEC, January 2011)

1.4 Stormwater Management Objectives

The SWM objectives for development of the site, derived from the above guidelines, include the following standards:

- Water quality – Enhanced (Level 1) quality control, as per MOE SWM Planning and Design Manual guidelines, including 80% removal of TSS;
- Water quantity – no increase in 2 to 100 year flow in downstream outlets receiving drainage from the widened roadway. Storage requirements from the Subwatershed study:
  - 975 m3/ impervious hectare for 100-year storage.
  - an additional 841 m3 / impervious hectare for Regional storm storage.
- Erosion control – the widening roadway cannot increase the risk of erosion in downstream channels.

In addition to the above standards, several other design considerations include:

- Preserve water balance to the degree feasible;
- Preserve existing landforms as much as possible;
- Encourage naturalization in suitable areas;
- Create an erosion and sediment control plan during construction;
- Minimize area of stream bank alteration;
- Consider stormwater practices that encourage infiltration and recharge.

2. Post-Development Drainage

With the road widening alternatives, the catchment area to the storm outlets will increase, and potentially increase peak flow. A summary of the changes to the drainage area to each of the existing culvert crossings is provided in the following Table.

Table 2.1: Summary of Proposed Stormwater Drainage Outlets – Interim Conditions*

Crossing Location (North to South)	Culvert Type and Size	Existing External Catchment Area (C=0.25) (ha)	Existing Mississauga Road Paved Area (in ultimate corridor) (9 m paved, 41.5 m unpaved, C=0.37) (ha)	Proposed Mississauga Road Catchment Area (North of Sandalwood: 25 m paved, 25.5 m unpaved, C=0.58 South of Sandalwood: 32 m paved, 18.5 m unpaved, C=0.67) (ha)	Runoff Coefficient x Area Existing Catchment (ha)	Runoff Coefficient, x Area Proposed Catchment (ha)	Change in Runoff
5+090	750 mm CSP	3.9	200 m x 50.5m = 1.01ha	-	1.35	0.98	- 28 %
5+030	450 mm CSP	1.0	60 m x 50.5m = 0.30 ha	-	0.36	0.25	- 31 %
4+830	600 mm CSP	20.0	760 m x 50.5m = 3.83ha	3.83 ha	6.42	7.22	+ 12 %
4+300	450 mm CSP	3.0	150 m x 50.5m = 0.76ha	-	1.03	0.75	- 27 %
4+110	900 mm CSP	12.2	500 m x 50.5m = 2.52ha	3.28 ha	3.98	4.95	+ 24 %
3+580	450 mm CSP	9.4	250 m x 50.5 m =1.26ha	-	2.82	2.35	- 17 %
2+430	450 mm CSP	19.2	1100m x 50.5m =5.55ha	-	6.86	4.8	- 30 %
1+850	600 mm CSP	10.1	600 m x 50.5m = 3.03ha	-	3.65	2.52	- 31 %
1+450	4.5 m x 1.5 m concrete box	large	insignificant	insignificant	n/a	0	n/a
1+150	1200 mm CSP	34.8	300 m x 50.5m = 1.52ha	1.52 ha	9.26	9.72	+ 5 %
1+010	600 mm CSP	7.2	150 m x 50.5m = 0.76ha	0.76 ha	2.08	2.31	+ 10 %

* interim conditions are 4 lanes from Mayfield Road to Sandalwood Parkway, 6 lanes from Sandalwood Parkway to Bovaird Drive.

Table 2.2: Summary of Proposed Stormwater Drainage Outlets – Ultimate Conditions*

Crossing Location (North to South)	Culvert Type and Size	Existing External Catchment Area (C=0.25) (ha)	Existing Mississauga Road Paved Area (in ultimate corridor) (9 m paved, 41.5 m unpaved, C=0.37) (ha)	Proposed Mississauga Road Catchment Area (32 m paved, 18.5 m unpaved, C=0.67) (ha)	Runoff Coefficient x Area Existing Catchment (ha)	Runoff Coefficient, x Area Proposed Catchment (ha)	Change in Runoff
5+090	750 mm CSP	3.9	200 m x 50.5m = 1.01ha	-	1.35	0.98	- 28 %
5+030	450 mm CSP	1.0	60 m x 50.5m = 0.30 ha	-	0.36	0.25	- 31 %
4+830	600 mm CSP	20.0	760 m x 50.5m = 3.83ha	3.83 ha	6.42	7.56	+ 17 %
4+300	450 mm CSP	3.0	150 m x 50.5m = 0.76ha	-	1.03	0.75	- 27 %
4+110	900 mm CSP	12.2	500 m x 50.5m = 2.52ha	3.28 ha	3.98	5.25	+ 32 %
3+580	450 mm CSP	9.4	250 m x 50.5 m =1.26ha	-	2.82	2.35	- 17 %
2+430	450 mm CSP	19.2	1100m x 50.5m =5.55ha	-	6.86	4.8	- 30 %
1+850	600 mm CSP	10.1	600 m x 50.5m = 3.03ha	-	3.65	2.53	- 31 %
1+450	4.5 m x 1.5 m concrete box	large	insignificant	insignificant	n/a	n/a	n/a
1+150	1200 mm CSP	34.8	300 m x 50.5m = 1.52ha	1.52 ha	9.26	9.72	+ 5 %
1+010	600 mm CSP	7.2	150 m x 50.5m = 0.76ha	0.76 ha	2.08	2.31	+ 10 %

* ultimate conditions are 6 lanes from Mayfield Road to Bovaird Drive.

While the Mississauga Road widening adds an insignificant amount of flow to Huttonville Creek, several of the existing road crossings have relatively small catchment areas and the additional runoff volume potentially added by a widened road represents a relative increase if discharged to these small tributaries. The alternatives for future drainage are to:

- discharge the uncontrolled post-development peak flows to the existing outlets;
- to discharge to existing crossing locations at pre-development flow rates by detaining stormwater; or
- convey stormwater southward in the right of way to a single improved outlet or directly to Huttonville Creek.

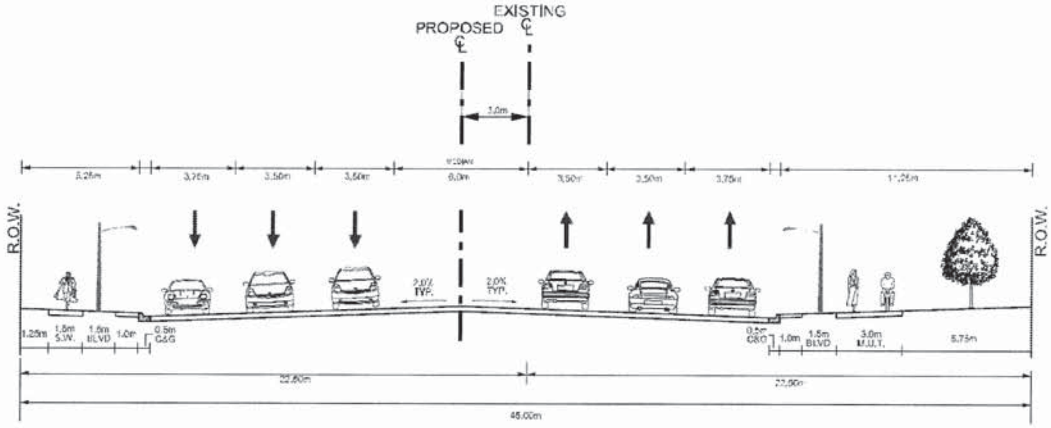
The first option may result in short duration increases in peak flow to some of the smaller crossings north of Wanless. However, this may be offset by changes in the upstream catchment in this area; as the external catchment east of Mississauga Road develops, the only storm drainage that will continue to discharge to the minor watercourses crossing Mississauga Road will be roof drainage and foundation drains. Note that more detailed hydrologic modeling might demonstrate a smaller increase or no increase, due to relative timing of the runoff from the pervious and impervious areas.

The third option is not feasible for crossings north of Wanless Drive, due to the existing and future profile of Mississauga Road. There is a high point in the existing and future profiles of Mississauga Road just south of Wanless Drive that will prevent drainage from the north of this point from being conveyed southward.

As a result, the preferred alternative is to discharge Mississauga Road drainage to the existing tributaries crossing the road. Opportunities to mitigate peak flow increases will be assessed at detailed design. Under interim conditions discussed later in this report, there will be opportunities to detain stormwater within the temporary enhanced swales constructed in the right-of-way north of Wanless Drive. Under ultimate conditions, much of the

Mississauga Road corridor drainage will be collected by storm sewers constructed as part of developing areas to the west, eliminating any potential increase in peak flow to the tributaries.

Figure 5. Proposed Ultimate Mississauga Road Cross Section



3. Stormwater Management Alternatives

The stormwater management plan for the site considers the potential use of a number of SWM alternatives to achieve the required treatment and flow rate control objectives, including swales, wet ponds, oil grit separators and bioretention areas. The integration of these management practices into a collective plan allows for the treatment and control of stormwater runoff through an economically and environmentally positive approach. Table 1 outlines the proposed stormwater management practices within the conceptual plan and their individual effectiveness for each of the design objectives.

Table 3.1: Summary of Proposed Stormwater Management Practices Effectiveness

SWMP	Effectiveness			
	Water Quality	Water Quantity	Erosion Control	Water Balance
Wet Pond	High	High	High	Low
Oil Grit Separator	Medium	Low	Low	Low
Grassed Swales	Medium	Medium	Low	Medium
Bioretention Areas	High	Low	Medium	High
Infiltration Trenches	High (with high risk of groundwater contamination)	Medium	High	High

Enhanced water quality (Level 1, as per MOE definitions) is provided for stormwater control, including design for 80% long term removal of total suspended solids. Typically, the only stand-alone measures in the above table that are capable of this degree of sediment control are wet ponds and infiltration facilities. A wet pond is only feasible for the present study if stormwater is collected and conveyed offsite to a regional SWM pond. Infiltration may have limited feasibility, and depends largely on the suitability of local soil conditions. As a result, if stormwater management is being controlled only within the right-of-way, a treatment train approach will be recommended, consisting of two or more of the above practices in-line to provide the required enhanced level of water quality control (such as oil grit separators discharging to an enhanced swale).

A brief discussion of the effectiveness and feasibility of each of the above measures is discussed in the following sections.

3.1 Wet Pond Facility (High Effectiveness)

Wet ponds achieve quality control through the settling of sediment and quantity control through provision of detention volume and controlling the outlet release rate. They typically require a large enough catchment area to function well (5 ha minimum, and better operation with larger catchments). There is not sufficient space within the existing right of way to construct wet ponds. As a result, their use is limited to off-site shared facilities, with road drainage from the study area combining with storm drainage from adjacent developments in Regional facilities. If this option is pursued, conveyance of storm drainage from the roadway in the study area to the outlet also needs to be considered, and would require construction of external storm infrastructure (pond, sewers, etc) in advance of road reconstruction.

Further details regarding the feasibility for off-site wet ponds for stormwater management are provided in Section 4.

3.2 Oil Grit Separators (Medium Effectiveness)

Oil grit separators are feasible for the road drainage, but typically cannot provide enhanced water quality control as a stand-alone measure. They would be required upstream of every storm outlet. Oil grit separators can partially address water quality concerns, but have no benefits for peak flow or erosion control requirements. Depending on the magnitude of flows entering the oil grit separators, they may be very expensive to install.

3.3 Grassed Swales (Medium Effectiveness)

Through the implementation of grassed swales, water quality can be improved through increased sediment removal and infiltration of stormwater runoff. Grassed swales can be implemented in the boulevard areas; however, it is difficult to convey drainage from the future urban roadway collected in catchbasins to a roadside swale that is not excessively deep.

Grassed conveyance swales allow for increased infiltration of storm water runoff which reduces the overall volume of runoff requiring treatment.

3.4 Bioretention Areas (High Effectiveness)

Bioretention areas improve quality by providing evapo-transpiration and infiltration areas. The inclusion of these areas can also improve the natural aesthetics of the site.

Enhanced swales, or bioswales, generally consist of naturalized high-retention low-lying areas utilizing native species with minimal maintenance requirements. This allows for natural onsite water treatment and minimizes the amount of runoff requiring treatment through other means such as oil grit separators and wet ponds. Similar to the discussion regarding grassed swales, it is difficult to convey drainage from the future urban roadway collected in catchbasins to a roadside bioswale that is not excessively deep.

3.5 Infiltration

Infiltration practices mimic the natural hydrologic cycle by offsetting the increase in runoff due to increased impervious areas. Infiltration provides a high level of water quality control by directing the first flush of drainage into the ground, with corresponding filtering through native soils.

Infiltration facilities, however, have maintenance concerns as the granular material may become clogged with fine sediment particles over time. In addition, there is a risk that hydrocarbons or chlorides from road salting may be directed to the groundwater. The soils in the road corridor are generally a clay loam (see Report No. 18 of the Ontario Soil Survey for Peel County), indicating that infiltration of stormwater will generally not be feasible.

3.6 Summary

There are two general strategies available for stormwater management for Mississauga Road:

- stormwater management for Mississauga Road drainage alone, either within the corridor or on adjacent lands; or
- shared stormwater management with adjacent developments.

The first strategy would identify the feasible outlet locations (consolidating to as few outlets as possible, to optimize SWM control measures) and employ either:

a) a wet pond for water quality and peak flow control for road corridor drainage alone at a limited number of outlets; or
b) oil grit separators discharging to enhance swales at a number of outlets.

The second strategy involves upsizing of the storm conveyance system in the downstream developing areas to accommodate uncontrolled flow from Mississauga Road, in addition to upsizing of SWM facilities constructed by development to provide quality control from the Mississauga Road areas as well.

The second strategy is the preferred solution identified in this Class EA, with interim control measures within the right-of-way for areas north of Wanless dependent upon the timing of facilities and required infrastructure west of Mississauga Road.

4. Proposed Stormwater Management Plan

4.1 General Approach to Stormwater Management in Corridor

The preferred stormwater management treatment for future widening of Mississauga Road from Mayfield Road to Bovaird Drive varies between reaches. The general approach in four reaches, from north to south, is described below.

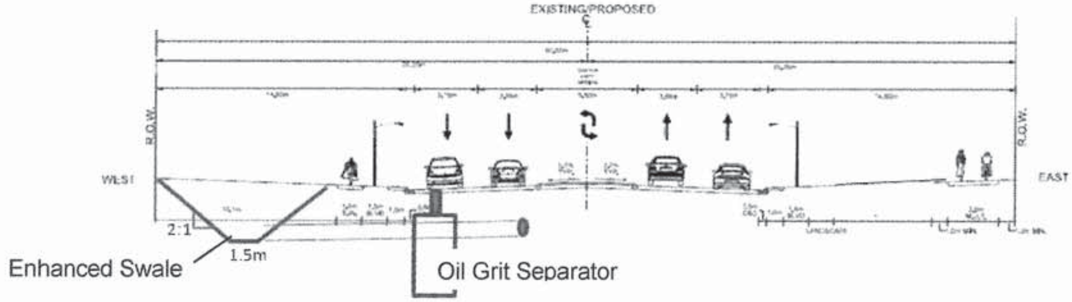
a) *From Mayfield Road, south to Wanless Drive (Station 4+086):*
Currently, five culverts cross Mississauga Road in this reach. External drainage crosses Mississauga Road from east to west in the southern three of these crossings. Adjacent external development to the east is required to preserve clean drainage as baseflow to each of these culverts; this is currently proposed to be achieved through a third storm pipe dedicated for clean roof top and lot drainage. As a result, the widening of Mississauga Road will be required to preserve these crossings, while avoiding discharging polluted stormwater runoff to the watercourses downstream of these crossings. The preferred alternative has two phases:

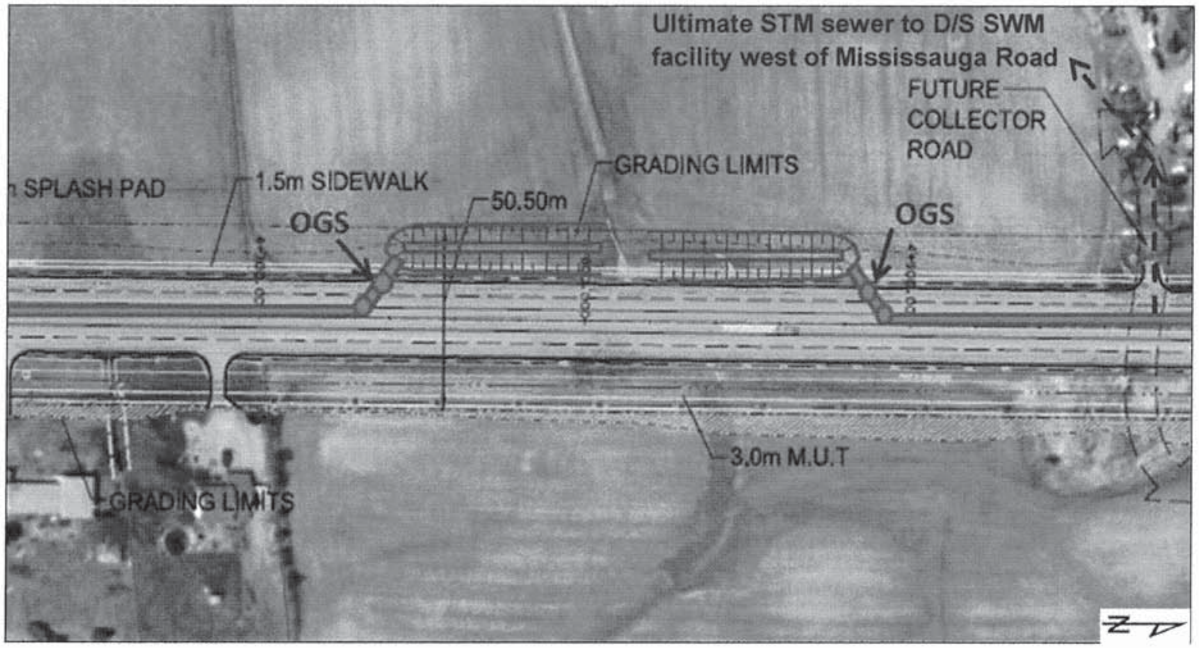
- With the initial roadway widened to four lanes, an interim solution will be employed that controls stormwater quality with a 'treatment train' approach. To provide enhanced water quality control, oil grit separators will be installed, discharging to an enhanced swale for 30 m upstream of the watercourse outlet. The enhanced swales are feasible during interim conditions, since there is adequate property within the ultimate right-of-way to accommodate the swales until the roadway expansion to six lanes is required. Oil grit separators and enhanced swales will be required at each storm outlet:
    - 4+830, north side of culvert crossing.
    - 4+830, south side of culvert crossing
    - 4+110 (just north of Wanless), north side of culvert crossing

  Storage within the enhanced swales can also be used to mitigate potential small increases in peak flow to the tributary crossing the road.

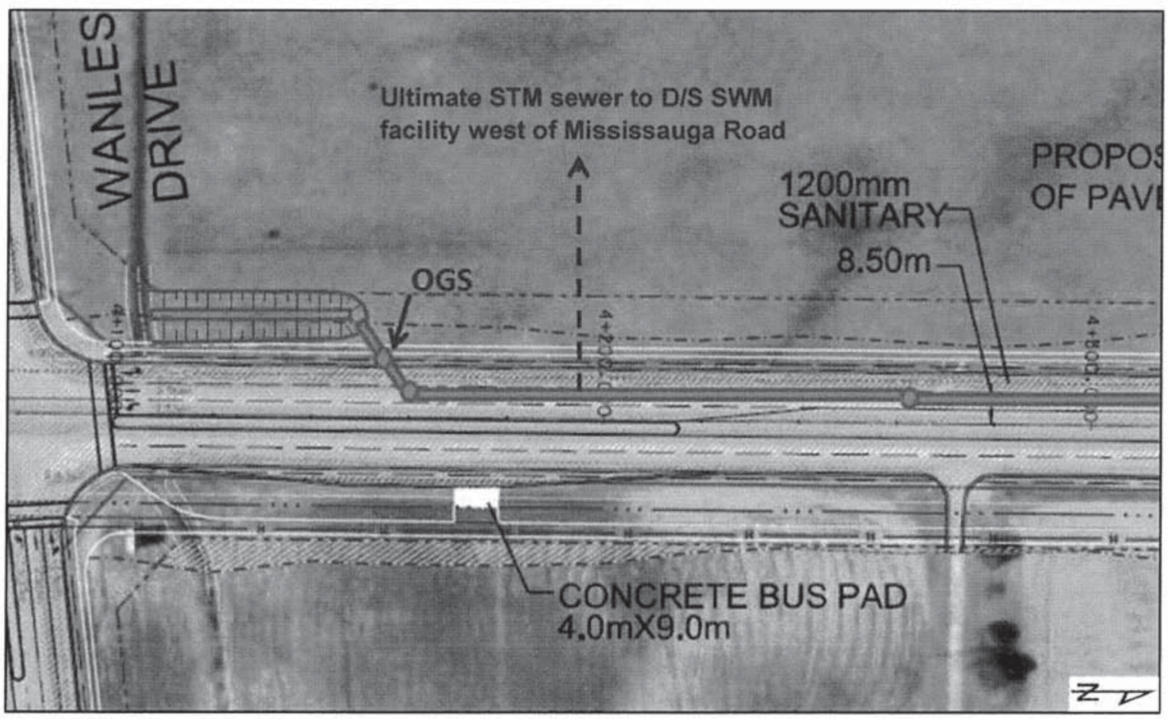
- When the road is widened to the ultimate six lanes, there will be no space available for the enhanced swales. When the enhanced swales are removed, the water quality treatment will be achieved in stormwater management facilities constructed in future developments west of Mississauga Road. New storm sewers constructed as part of these developments will be required to pick up the Mississauga Road storm sewers, and facilities constructed large enough to provide enhanced water quality control for both the developing areas and the Mississauga Road ROW.

A sketch of this





Interim SWM Strategy – OGS and Enhanced Swales at 4+830



Interim SWM Strategy – OGS and Enhanced Swales at 4+110 (similar swale and OGS required south of Wanless Drive)

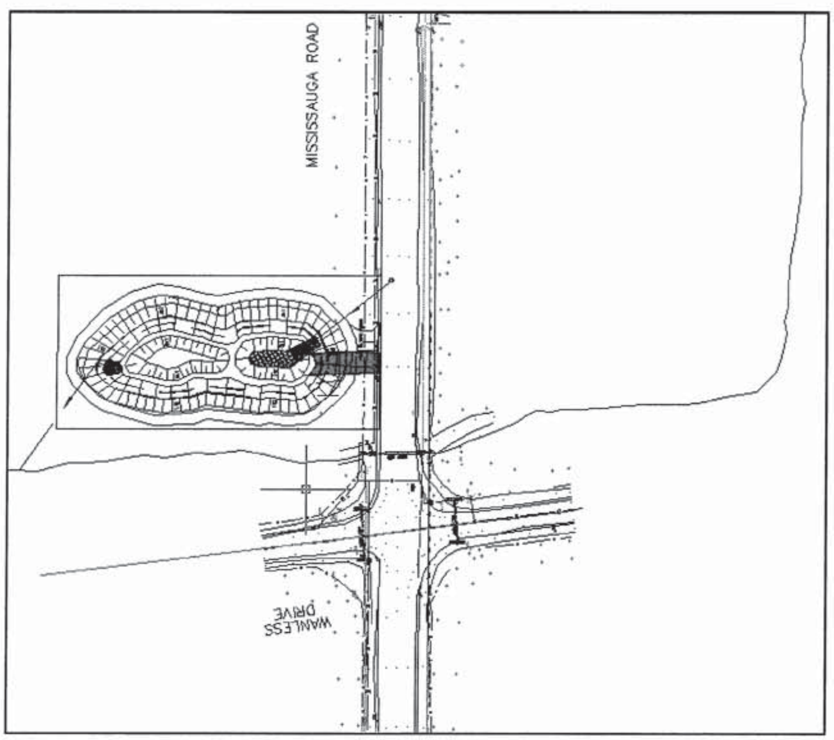
Required Oil Grit Separators

OGS Location	Catchment - From Station	Catchment- To Station	Total Catchment Area *	Impervious Area *	OGS Sizing (80 % TSS removal)
			(ha)	(ha)	
4+150	4+520	4+100	2.1	1.1	STC 4000 or equivalent
4+730	4+520	4+730	1.1	0.5	STC 1500 or equivalent
4+890	5+430	4+890	2.7	1.4	STC 5000 or equivalent

* Area based on 50.5 m ROW. Impervious area based on 50% impervious, with 4 lanes and 5.5 m median/turning lanes.

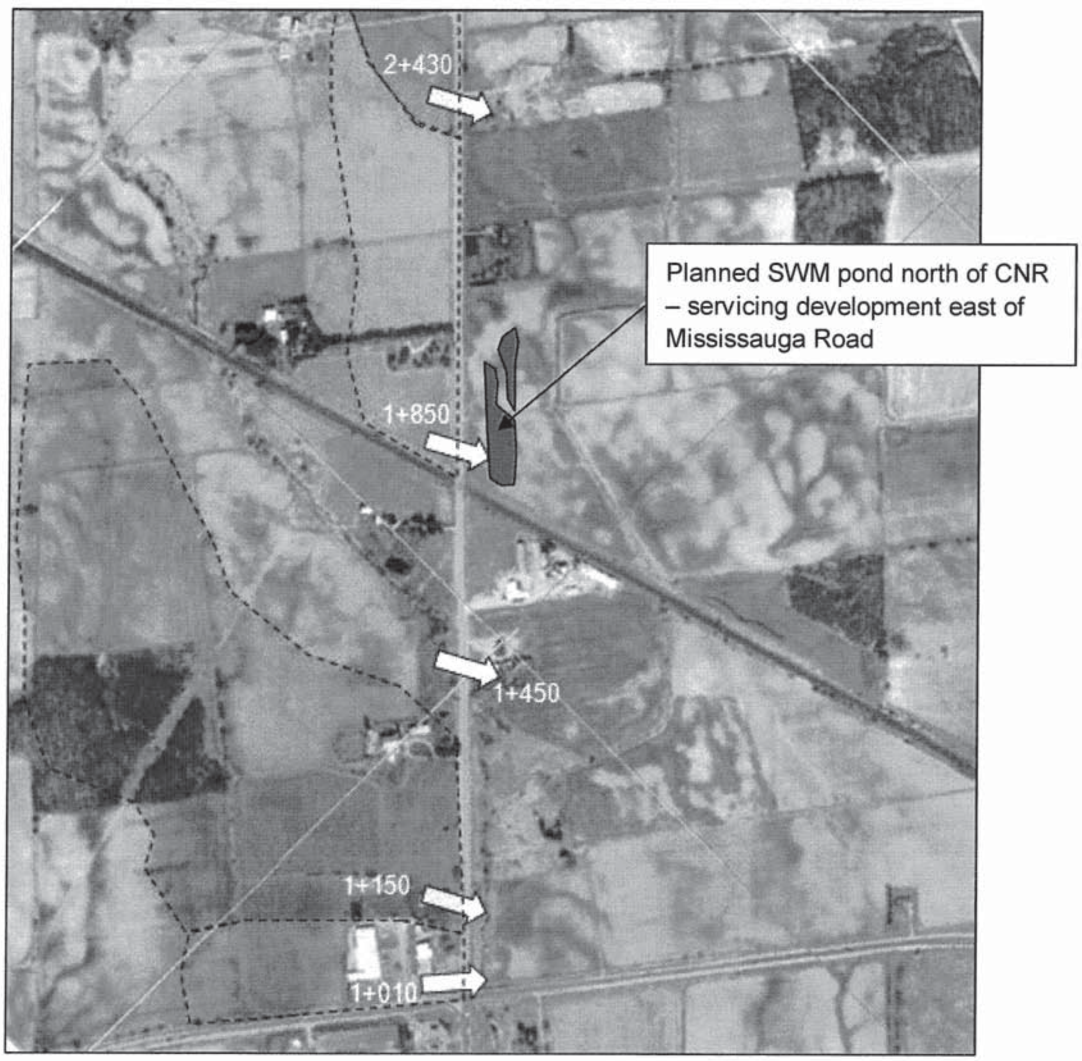
As identified in Section 3.6, an alternative to this approach is to collect stormwater from the entire reach to a single outlet and provide stormwater management in a wet pond. This approach is feasible, and could be implemented as an alternative if development west of Mississauga Road is not proceeding (or delayed for an extended period beyond the requirement for ultimate widening), or for any other reason that impedes the implementation of the preferred alternative. Conceptual design of a SWM pond servicing the entire reach (Mayfield to Wanless) are provided below. The SWM facility details are as follows:

- SWM property area: 0.7 ha
- SWM pond footprint area: 0.53 ha
- Permanent pool volume: 1100 m^3
- Extended detention volume: 180 m^3
- Active storage volume: 4000 m^3
- Total volume: 5280 m^3



b) *Wanless Drive (Station 4+086) south to high point in road (Station 3+862)*:
Drainage from the high point will flow northward to the Wanless Drive crossing. The Mississauga Road drainage for this short reach will be controlled with an oil-grit-separator. Peak flow control will not be required.

c) *From high point in road (Station 3+862) to future CNR overpass (Station 1+822)*:
There are two possible strategies for stormwater management in this reach. One strategy is to manage stormwater drainage from the road corridor alone. However, the preferred strategy is to discharge uncontrolled stormwater drainage from the roadway to the storm collection system of the downstream adjacent development, concurrently planned. Under the preferred strategy, the storm infrastructure in the downstream development (pipes and SWM facilitates) would be sized to accept drainage from Mississauga Road.



d) From CNR overpass (Station 1+822) to Boviard Drive:
Drainage from the high point in the CNR overpass will drain southward to a low point in the road just north of Bovaird Drive (culvert located a approximate station 1+180). Drainage from a short reach of Mississauga Road will also drain northward to from Bovaird Drive to the same low point. Oil grit separators are recommended on either side of this outlet. The drainage area on the north side is fairly large, so it is also recommended that the oil grit separator on the north side should discharge to an enhanced swale, approximately 30 m upstream of the culvert crossing.

4.2 Storm Sewer Conceptual Design

The proposed storm sewer system is based upon the proposed SWMF systems described above. The general approach considered for the storm sewer design is to convey the storm sewers just south of Wanless Drive (at 3+160) southward along Mississauga Road instead, to the low point north of the future CNR over pass (1+822).

Currently, a number of culverts cross Mississauga Road. These crossings will be preserved, conveying external drainage across Mississauga Road. Drainage from the road corridor itself will be conveyed in a storm sewer system which will cross under the centreline culverts which do not serve as storm outlets for the corridor drainage.

The Region of Peel requires that minor storm sewer systems are designed for the 10-year event, with a 15 minute inlet time. Intensity values were determined based on the 10-year return period with A and B parameters calculated from the City of Brampton Intensity Duration Frequency (IDF) curve. A weighted runoff coefficient of 0.62 was used for the future road corridor (0.9 for paved areas, 0.5 for shoulders, 0.25 for the remaining portion of the right-of-way).

Preliminary storm sewer sizing sheets are provided in Appendix A.

4.3 100-year and Regional Storm Storage Volumes

Utilizing a SWM facility constructed as part of adjacent development can address the peak flow, water quality, and erosion control requirements for stormwater drainage from Mississauga Road. According to the requirements of the Fletcher's Creek subwatershed study (AMEC, January 2011), there will be additional storage requirements for the 100-year storm and regional storm. These are:

- 975 m3/ impervious hectare for 100-year storage; and
- an additional 841 m3 / impervious hectare for Regional storm storage.

Reviewing the preliminary design of the proposed SWM facility, it was determined that minor acceptable grading changes could be made to the facility to accommodate the required 100-year storage volume for Mississauga Road drainage in the SWM pond.

Regional storm storage for the development areas east of Mississauga Road is to be provided in the reconstructed East Huttonville Creek channel. According to design details for the reconstructed East Huttonville Creek (east of Mississauga Road), there is adequate volume in the reconstructed channel to accommodate required storage from Mississauga Road drainage as well, and additional storage is not required in the channel. The only requirement for Mississauga Road drainage will be conveyance of the Regional storm flows offsite, under Mississauga Road, and ultimately to the reconstructed East Huttonville Creek.

5. Huttonville Creek Crossing

5.1 Introduction

The preferred alternative for the road design includes a new overpass crossing of the rail line approximately 350 m north of the Huttonville Creek crossing. As a result, the road profile at the subject crossing will be raised approximately 2 m. The existing culvert would require as a minimum an extension at both ends beyond the future fill of the approach embankment. As part of the EA, hydraulic and meander belt width assessments for Huttonville Creek were conducted by AECOM to establish culvert replacement recommendations.

The presence of species at risk (redside dace) required further assessment of crossing alternatives and consultation with MNR. As a result, the crossing alternatives considered substantially larger spans to mitigate the impact to species at risk. Hydraulic evaluations of the alternative crossings have been undertaken, but all options currently under consideration represent a significant larger span than currently exists at the location, and none of the options currently under consideration represent a potential hydraulic bottleneck. Every option under consideration significantly reduced flood elevations at the crossing compared to existing conditions.

The EA evaluations and recommendations for the crossing are provided in other sections of the ESR.

5.2 Hydraulic Assessment

Existing Culvert

The Credit Valley Subwatershed Study (2005) provides the following flows at the Huttonville Creek crossing of Mississauga Road:

- existing 100-year flow = 8.0 m^3/s
- existing regional flow = 17.1 m^3/s
- uncontrolled ultimate 100-year flow = 49.3 m^3/s
- uncontrolled ultimate regional flow = 48.8 m^3/s.

The existing culvert is a 4.5 m x 1.5 m concrete box. The capacity of the existing culvert is 13 m^3/s when flowing full, and approximately 23 m^3/s before overtopping the road.

Proposed Crossing

To convey the uncontrolled ultimate 100-year and regional flows without overtopping the road, the culvert is required to be a 9.5 m x 1.5 m box. To accommodate species at risk concerns at the crossing, a span of 42 m is proposed at the crossing. The theoretical hydraulic capacity of a 42 m span is over 200 m^3/s, but providing a span that large merely means that the crossing will have negligible effect on water levels for any magnitude of flow, and the water levels are determined by the natural channel configuration downstream and through the crossing.

6. Erosion and Sediment Control

The sediment and erosion control measures to be implemented as part of the construction and servicing of the site will include the following:

- heavy duty silt fencing
- light duty silt fencing
- rock check dams
- straw bale filters
- filter fabric under catchbasins frame and grates
- mud mats

Detailed grading and erosion control plans will be provided at the detailed design stages, and the details and locations of most of the proposed sediment and erosion control measures and will form part of the approved engineering drawings. The erosion control plans will be reviewed by the Region of Peel and CVC.

The erosion plan will minimize disturbance to existing channels and riparian vegetation of channels (with the exception of channels that are to be re-located). All disturbed areas will be restored with either a hard surface (i.e. asphalt or concrete) or with topsoil and hydroseed/sod. The use of a bonded fibre matrix (BFM) will be implemented during the construction of any SWM facilities to promote germination and to protect exposed surfaces from possible erosion.

The owners engineer will be required to ensure that the sediment and erosion controls are implemented during construction and are then subsequently decommissioned appropriately once the need for the sediment and erosion controls has lapsed.

A record of the sediment and erosion control implementation should be maintained from the initial stages during the storm/sanitary construction stage to the day to day maintenance and monitoring of the sediment and erosion controls. Such record keeping would include a submission of a certificate certifying that the sediment and erosion controls were installed and maintained during the initial servicing stage and then subsequent semiannual submission of inspection reports detailing how the sediment and erosion controls have been maintained and replaced/repaired as necessary.

It will be the responsibility of the Region to have the sediment and erosion controls measures installed and maintained throughout the development period of the specific site.

7. Conclusions

As part of the municipal Class EA for the widening of Mississauga Road, stormwater management alternatives were evaluated in terms of feasibility and means of addressing the objectives for control of stormwater quantity, quality, and downstream erosion control.

The recommended strategy employs a combination of wet ponds adjacent to the corridor and oil grit separators within the corridor in isolated areas. The preferred approach includes:

North of Wanless Drive

1. For interim conditions (initial 4 lanes from Sandalwood to Mayfield), storm sewers will discharge to oil grit separators and enhanced swales upstream of storm outlets. The enhanced swales will be constructed within the ultimate right-of-way. The additional road imperviousness will result in slightly higher flow to the storm outlets used; this will be mitigated by storage in the enhanced swales.
2. For ultimate conditions (6 lanes), the enhanced swales will be removed. Storm sewers servicing future development west of Mississauga Road will pick up Mississauga Road storm sewers, and water quality treatment will be provided in future downstream stormwater management facilities west of Mississauga Road.
3. An alternative to this approach is to collect stormwater from the entire reach to a single outlet and provide stormwater management in a wet pond. This approach is feasible, and could be implemented as an alternative if development west of Mississauga Road is not proceeding (or delayed for an extended period beyond the requirement for ultimate widening), or for any other reason that impedes the implementation of the preferred alternative.

South of Wanless Drive

4. An oil grit separator will receive Mississauga Road drainage from the high point south of Wanless Drive, draining northward to Wanless Drive.
5. From the high point south of Wanless Drive, storm drainage will be conveyed to a stormwater management pond constructed by development on adjacent lands east of Mississauga Road, which will provide quality, erosion, and quantity control.
6. Two additional oil grit separators, with an enhanced swale required for the Mississauga Road drainage south of the rail crossing, will be located just north of Bovaird Drive.

Other potential stormwater management alternatives within the right of way were assessed, and not considered feasible solutions. Bio-retention in the right-of-way could potentially be used, but would require a non-traditional approach such as road drainage discharging from the gutter to shallow roadside swales (without storm sewers), or deep trenches adjacent to the road to manage stormwater, which would gradually draw down following a storm. The benefits of these alternatives are outweighed by the uncertainties in the design approach, absence of applicable design standards, and uncertainty for approvals.

8. References

Region of Peel, July 2009. Public Works Design, Specification and Procedures Manual, Linear Infrastructure, Storm Sewer Design Criteria.

Appendix A

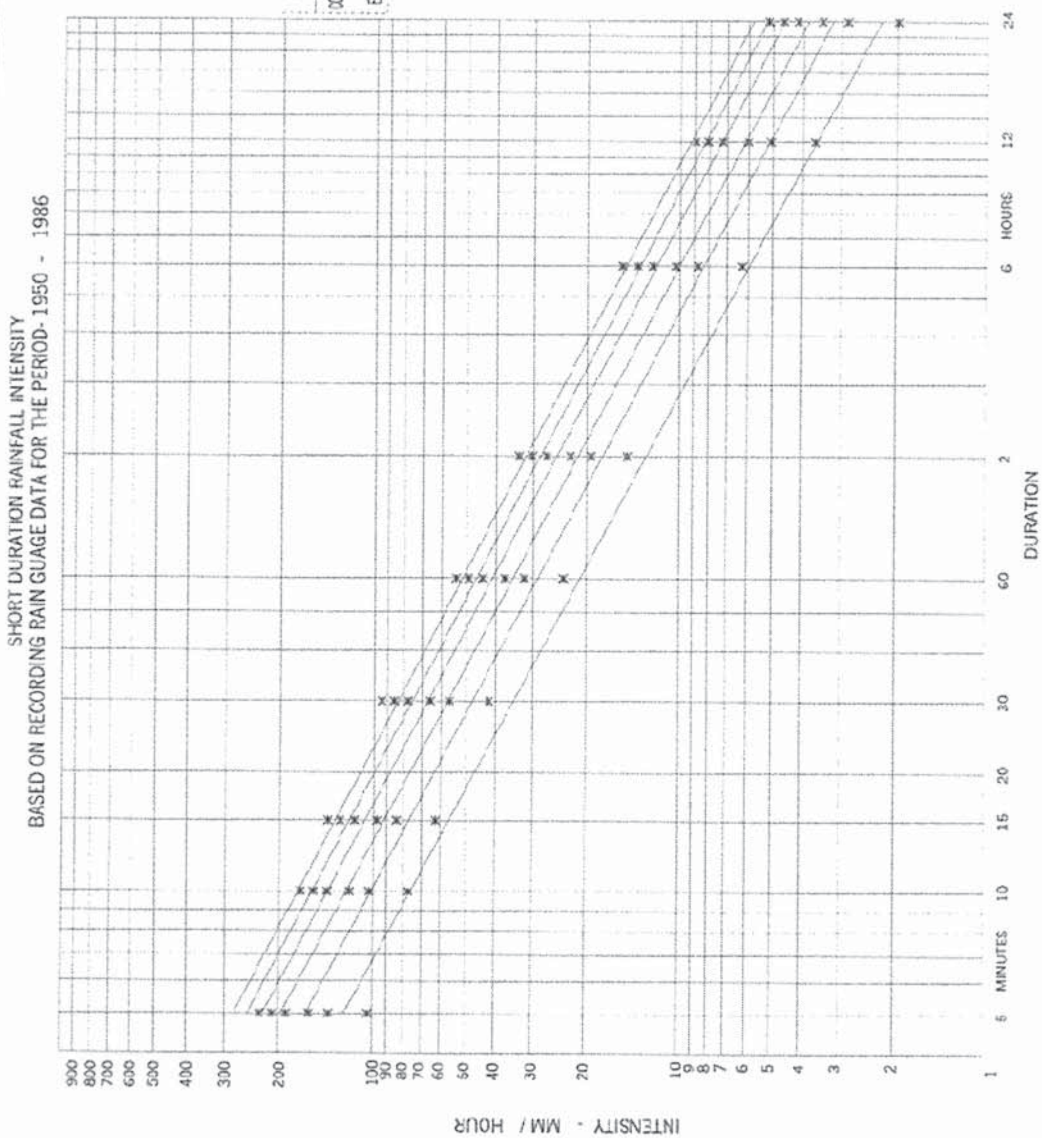
- Design Storms
- Stormwater Management Practice – Alternative Evaluations
- Storm Sewer Design Sheets

INTERPOLATION EQUATION

$R = A (T)^{B}$

R = RAINFALL RATE (mm/hr)
T = TIME IN HOURS

STATISTICS	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
COEFFICIENT (A)	22.1	29.9	35.1	41.6	46.5	51.3
EXPONENT (B)	-0.714	-0.701	-0.695	-0.691	-0.688	-0.686



CITY OF BRAMPTON
WORKS and TRANSPORTATION DEPARTMENT

RAINFALL INTENSITIES

REVISION --	REV. DATE:
DATE: 92 04 24	
CHECKED:	
APPROVED: T.W. Mulligan	
SCALE: N.T.S.	DWG. NO. 343

Widening Alternatives for Mississauga Road
Class EA
Stormwater Management and Storm Drainage Considerations
SWM in Road Corridor vs. Downstream SWM

SWM Criteria to be addressed	Stormwater Management in Corridor	Stormwater Management in SWM Ponds in Adjacent Areas	Summary
Peak Flow	Requirements will relate to capacity of any culverts retained, no increase in peak flow at drainage outlets Widening and urbanizing of the road is unlikely to increase peak flow at crossings or outlets, since additional pavement area will represent a very small portion of the catchment Only a potential increase in peak flow for outlets that are utlized that have extremely small catchment areas Potential increases could also just be addressed through adequate sizing of storm sewers and overland flow routes through developing areas to the east (between Mississauga Rd and realigned Huttonville Creek	Will have identical requirements for peak flow in corridor, since flows must be conveyed to SWM ponds adjacent to realigned portions of Huttonville Creek	- Likely not a major concern. - No advantage to providing SWM in adjacent SWM Ponds -Potential increases, where they occur, can be mitigated through downstream infrastructure sizing or storage in corridor
Erosion Control	Concern will only relate to existing watercourses which will continue to be used as an outlet	Will have identical requirements for erosion control in corridor, since flows must be conveyed to SWM ponds adjacent to realigned portions of Huttonville Creek	
Water Quality Control	Options Include : - StormCeptors with enhanced swales - Wet pond(s) in corridor - Bioretention / green space adjacent to road	Wet pond is the only feasible option	- Wet pond is a simpler concept to design and implement, but may be more costly

Summary: Each of the two approaches is feasible for managing stormwater.
Shared use of a SWM pond downstream is a simpler concept - but may be more expensive and involve increased conveyance costs as well.
Addressing water quality through SWM in the road corridor requires more innovative approaches, and would require approval in concept from agencies and acceptance from the Region for facilities in the corridor. The concept can be incorporated into an overall use concept (access, recreation path, naturalized areas, etc) for the open space in the corridor.

Widening Alternatives for Mississauga Road Class EA

Table: Stormwater Management and Storm Drainage Considerations for Road Widening Alternatives

	No median			
Criteria for Stormwater Management and Drainage	Widening to East	Widening to West	Widening about Centreline	Widening with a median
Flexibility to Manage Stormwater in Road Corridor	Provides maximum space to manage stormwater in corridor. SWM would be on downstream side of highway- preferred location ○	Provides maximum space to manage stormwater in corridor. SWM would be on upstream side of highway- less preferred location ◑	Provides less space to manage stormwater in corridor– rules out detention, but roadside swales could still be used. ◕	Least amount of space to manage stormwater in corridor. Suggests SWM would be required in shared adjacent community SWM facilities. ●
Storm servicing	No preference - all options with no median have the same servicing requirements and constraints ○	No preference - all options with no median have the same servicing requirements and constraints ○	No preference - all options with no median have the same servicing requirements and constraints ○	Drainage of median required. Larger catchment area and additional CBs required. Minor additional drainage requirement. ◑
Flexibility to Manage Stormwater in Adjacent Municpal SWM facilitites	No preference ○	No preference ○	No preference ○	No preference ○
Overall	○	◑	◕	●

Summary: While widening to the east is the preferred widening alternative from the standpoint of stormwater management, the only real advantage is that it provides more flexibility to manage stormwater completely within the road corridor as opposed to in a shared downstream facility.
If a decision is made to manage stormwater in a downstream area shared with an adjacent developing area, there is no clear widening preference from the standpoint of stormwater management and storm drainage

○ Most Preferred
◔
◑
◕
● Least Preferred

RUNOFF COEFFICIENT
'C'

- PARKS	-0.25
- SINGLE & DUPLEX	-0.5
- MULTIPLE, INSTITUTIONAL	-0.75
- COMMERCIAL	-0.9
- INDUSTRIAL	-0.9
- ROADWAYS	-0.9

CITY OF BRAMPTON

FLOW Q = 2.78 CIA
WHERE Q = PEAK FLOW (l/s)
A = AREA (ha)

C = RUNOFF COEFFICIENT
I = RAINFALL INTENSITY (mm/hr)
RETURN PERIOD : 10 YEARS (Using Brampton IDF curve)

INLET TIME = 15 min (Region of Peel Storm Sewer Design Criteria, July 2009)

DATE : 18-Sep-12
DESIGNED BY
CHECKED BY
FILE No. :
SHEET 1 of 1

LOCATION					AREA (A)			TOTAL (AxC)				Q	SEWER DESIGN									PROFILE								
AREA #	FROM STREET	TO STREET	FROM MH	TO MH	(ha)	TOTAL (ha)	C	A x C	SEWER	Accum.	INTENSITY (mm/hr)	(L/s)	SIZE (mm)	SLOPE %	n	VEL. (m/s)	CAP. (L/s)	Time of Flow (min)	Fall in Sewer (m)	LENGTH (m)	DROP (mm)	PROP.RD. EL. (m) From	PROP.RD. EL. (m) To	INVERT ELEV. U.S.	INVERT ELEV. D.S.	Cover (m) U.S.	Cover (m) D.S.	Depth* (m) U.S.	Depth* (m) D.S.	Depth* (m) Avg.
10-year storm - Post Development																														
NORTH SECTION																														
	Mayfield Road		5+435	4+840	3.00	3.00	0.67	2.01	2.01	15.00	56.9	318	450	1.11%	0.013	1.87	298	5.30	6.580	595.0		265.5	259.2	263.6	257.0	1.5	1.7	1.9	2.2	2.1
			4+516	4+840	1.64	1.64	0.67	1.10	1.10	15.00	56.9	173	450	0.63%	0.013	1.42	225	3.81	2.050	324.0		261.0	259.2	259.1	257.0	1.5	1.7	1.9	2.2	2.1
		Wanless Drive	4+516	4+086	2.17	2.17	0.67	1.45	1.45	15.00	56.9	230	600	0.12%	0.013	0.74	208	9.74	0.500	430.0		259.2	257.4	256.0	255.5	2.6	1.3	3.2	1.9	2.5
		Wanless Drive	3+862	4+086	1.13	3.30	0.67	0.76	0.76	24.74	42.3	89	300	1.38%	0.013	1.60	113	2.34	3.100	224.0		260.4	257.4	258.6	255.5	1.5	1.6	1.8	1.9	1.8
SOUTH SECTION																														
	High Point		3+862	3+687	0.88	0.88	0.67	0.59	0.59	15.00	92.0	151	375	1.43%	0.013	1.88	208	1.55	2.500	175.0	2.50	260.4	257.9	258.525	256.025	1.5	1.5	1.9	1.9	1.9
			3+687	3+560	0.64	1.53	0.67	0.43	1.02	16.55	85.9	244	450	1.10%	0.013	1.87	297	1.13	1.400	127.0	1.40	257.9	256.5	255.950	254.550	1.5	1.5	1.9	1.9	1.9
		Street A	3+560	3+160	2.02	3.55	0.67	1.35	2.38	17.68	82.1	542	675	0.65%	0.013	1.88	674	3.54	2.600	400.0	2.60	256.5	253.9	254.325	251.725	1.5		2.2	2.2	2.2
	Street A	Sandlewood Pkwy	3+160	2+850	1.57	5.11	0.67	1.05	3.42	21.22	72.3	688	750	0.71%	0.013	2.11	933	2.45	2.200	310.0	2.20	253.9	251.7	251.650	249.450	1.5	1.5	2.3	2.3	2.3
	Sandlewood Pkwy	Low Point	2+850	2+083	3.87	8.98	0.67	2.60	6.02	23.67	67.0	1,121	825	0.65%	0.013	2.15	1,150	5.94	4.975	767.0	4.97	251.7	247.4	249.375	244.400	1.5	2.2	2.3	3.0	2.7
	Top of CN	Low Point	1+822	2+083	1.32	1.32	0.67	0.88	0.88	15.00	92.0	226	375	3.27%	0.013	2.85	314	1.53	8.525	261.0	8.53	254.8	247.4	252.925	244.400	1.5	2.6	1.9	3.0	2.4
	Low Point	Pond HE-4	2+083	HE-4	0.00	10.30		0.00	6.90	23.67	67.0	1,286																		
	Low Point	Pond HE-4	Proposed 675 mm pipe designed by Urbantech for internal subdivision flows										675	0.35%	0.013	1.38	494													
	Low Point	Pond HE-4	Proposed upsizing for Mississauga Road flows									1,780	1200	0.35%	0.013	2.03	2,297													

Top of Slope	3+862
Street A	3+160
Sandlewood PKWY	2+850
Bottom of Slope	2+083
Top of CNR	1+822

Stormceptor CD Sizing Program Version 4.0.0

Country Canada

Date Aug 2012

Project Number	
Project Name	Mississauga Road
Project Location	Brampton
Company	AECOM
Designer	B. Richert

Notes

Rainfall Station	TORONTO CENTRAL
Rainfall File	ON100.NDC
Latitude =	N 45 deg 30 min
Longitude =	W 90 deg 30 min
Elevation =	100. m
Rainfall Period of Record	1982 to 1999

Site Parameters

Total Drainage Area	2.10 ha
Total Imperviousness (%)	50.00
Overland Flow Width	290. m
Overland Slope (%)	2.0
Impervious Depression Storage	0.508 mm
Pervious Depression Storage	5.080 mm
Impervious Mannings n	0.015
Pervious Mannings n	0.250

Infiltration Parameters

Horton Infiltration Used

Initial (Max) Infiltration Rate	61.98 mm/h
Final (Min) Infiltration Rate	10.16 mm/h
Infiltration Decay Rate (1/sec)	0.00055
Infiltration Regeneration Rate (1/sec)	0.010

Daily evaporation 2.540 mm/day

Sediment build-up reduces the storage volume for settling calculations
A maintenance cycle of 12 months was chosen
(The Stormceptor will be cleaned out every 12 months)

TSS Loading Calculations

Buildup / Washoff Loading Chosen

Buildup Washoff allocates more washoff in the rising limb of the hydrograph

Target Event Mean Concentration (mg/l)	125.
Buildup Exponent	0.400
Washoff Exponent	0.200
Availability Factors for Particles >=	400. um
Availability = A + Bi^C	
A =	0.057
B =	0.040
i =	rainfall intensity
C =	1.100

Stormwater Particle Size Distribution Table

Diameter (um)	Percent (%)	Specific Gravity	Settling Velocity m/s
20.0	20.0	1.30	0.0004
60.0	20.0	1.80	0.0016
150.0	20.0	2.20	0.0108
400.0	20.0	2.65	0.0647
2000.0	20.0	2.65	0.2870

Flocculated settling assumed for particles <= 20 um

Rainfall records	1982 to 1999
Total rainfall period	18 years
Total rainfall =	13190.7 mm
Average annual rainfall =	732.8 mm

Rainfall event analysis

2.0 hour inter event time used to determine # of events

< mm	Events	%	Vol mm	%
6.35	2397	79.4	3620.	27.4
12.70	347	11.5	3189.	24.2
19.05	130	4.3	2037.	15.4
25.40	66	2.2	1432.	10.9
31.75	38	1.3	1075.	8.2
38.10	16	0.5	545.	4.1
44.45	7	0.2	292.	2.2
50.80	13	0.4	611.	4.6
57.15	2	0.1	106.	0.8
63.50	2	0.1	121.	0.9
69.85	0	0.0	0.	0.0
76.20	0	0.0	0.	0.0
82.55	1	0.0	79.	0.6
88.90	1	0.0	85.	0.6
95.25	0	0.0	0.	0.0
101.60	0	0.0	0.	0.0
107.95	0	0.0	0.	0.0
114.30	0	0.0	0.	0.0
120.65	0	0.0	0.	0.0
127.00	0	0.0	0.	0.0
133.35	0	0.0	0.	0.0
139.70	0	0.0	0.	0.0
146.05	0	0.0	0.	0.0
152.40	0	0.0	0.	0.0
158.75	0	0.0	0.	0.0
165.10	0	0.0	0.	0.0
171.45	0	0.0	0.	0.0
177.80	0	0.0	0.	0.0
184.15	0	0.0	0.	0.0
190.50	0	0.0	0.	0.0
196.85	0	0.0	0.	0.0
203.20	0	0.0	0.	0.0
209.55	0	0.0	0.	0.0
> 209.55	0	0.0	0.	0.0

Total rain 13191. mm
Number of rain events 3020

Rainfall intensity analysis

Average intensity = 2.52 mm/h

< mm/h	Number	%	Vol mm	%
6.35	19743	94.5	9282.	70.4
12.70	787	3.8	1740.	13.2
19.05	185	0.9	703.	5.3
25.40	88	0.4	483.	3.7
31.75	35	0.2	248.	1.9
38.10	21	0.1	184.	1.4
44.45	10	0.0	102.	0.8
50.80	12	0.1	140.	1.1
57.15	3	0.0	40.	0.3
63.50	9	0.0	135.	1.0
69.85	2	0.0	33.	0.3
76.20	1	0.0	19.	0.1
82.55	0	0.0	0.	0.0
88.90	0	0.0	0.	0.0
95.25	0	0.0	0.	0.0
101.60	0	0.0	0.	0.0
107.95	1	0.0	27.	0.2
114.30	0	0.0	0.	0.0
120.65	0	0.0	0.	0.0
127.00	0	0.0	0.	0.0
133.35	0	0.0	0.	0.0
139.70	0	0.0	0.	0.0
146.05	0	0.0	0.	0.0
152.40	0	0.0	0.	0.0
158.75	0	0.0	0.	0.0
165.10	0	0.0	0.	0.0
171.45	0	0.0	0.	0.0
177.80	0	0.0	0.	0.0
184.15	0	0.0	0.	0.0
190.50	0	0.0	0.	0.0
196.85	0	0.0	0.	0.0
203.20	0	0.0	0.	0.0
209.55	0	0.0	0.	0.0
> 209.55	1	0.0	54.	0.4

Total rainfall = 13190.7 mm
Total evaporation = 666.5 mm
Total infiltration = 6572.8 mm
% Rainfall as runoff = 45.5 %

Average Event Mean Concentration for TSS (mg/l) 126.1

TSS Removal Simulation Results Table

Stormceptor Model	Treated Q cms	% Runoff Treated	Tank TSS Removal (%)	Overall TSS Removal (%)
STC 300	0.008	67.	68.	58.
STC 750	0.018	84.	75.	70.
STC 1000	0.018	84.	76.	71.
STC 1500	0.018	84.	77.	72.
STC 2000	0.030	90.	78.	76.
STC 3000	0.030	90.	80.	78.
STC 4000	0.050	95.	83.	82.
STC 5000	0.050	95.	84.	83.
STC 6000	0.070	97.	85.	85.
STC 9000	0.100	98.	89.	89.
STC 10000	0.100	98.	89.	89.
STC 14000	0.140	99.	91.	91.

Hydrology Table - Volume of Runoff Treated vs By-Pass Flow Rate

Treated Q cms	Treated Vol m3	Over Vol m3	Tot Vol m3	% Treated
0.001	22773.	103165.	125939.	18.1
0.004	60753.	65183.	125939.	48.2
0.009	88561.	37386.	125939.	70.3
0.016	103506.	22432.	125939.	82.2
0.025	111348.	14592.	125939.	88.4
0.036	116021.	9918.	125939.	92.1
0.049	119008.	6931.	125939.	94.5
0.064	121061.	4878.	125939.	96.1
0.081	122500.	3439.	125939.	97.3
0.100	123474.	2465.	125939.	98.0
0.121	124183.	1755.	125939.	98.6
0.144	124665.	1273.	125939.	99.0
0.169	125000.	939.	125939.	99.3
0.196	125156.	783.	125939.	99.4
0.225	125252.	687.	125939.	99.5
0.256	125335.	603.	125939.	99.5
0.289	125419.	520.	125939.	99.6
0.324	125472.	466.	125939.	99.6
0.361	125519.	419.	125939.	99.7
0.400	125560.	379.	125939.	99.7
0.441	125597.	342.	125939.	99.7
0.484	125635.	303.	125939.	99.8
0.529	125676.	263.	125939.	99.8
0.576	125718.	220.	125939.	99.8
0.625	125762.	176.	125939.	99.9
0.676	125801.	138.	125939.	99.9
0.729	125833.	106.	125939.	99.9
0.784	125866.	73.	125939.	99.9
0.841	125899.	40.	125939.	100.0
0.900	125916.	22.	125939.	100.0

End of Simulation

C.6 Noise Impact Study

AECOM

The Regional Municipality of Peel

Mississauga Road Environmental Assessment Traffic Noise Study

Prepared by:

AECOM
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Project Number:

60116610

Date:

September, 2012

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	X	The Regional Municipality of Peel

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
0	James Au	September 2008	Original Document
1	James Au	September 10, 2009	Updated Assessment With New Traffic Data
2	Leaman Chow	August 24, 2010	Traffic Data Update, Updated Receptors
3	Leaman Chow	September 18, 2012	Incorporate Client Comments – Final

AECOM Signatures

Report Prepared By:

Leaman Chow, P.Eng.
Acoustic Engineer

Report Reviewed By:

Buddy Ledger, P.Eng
Acoustics and Vibration Engineer

Executive Summary

AECOM was retained by The Regional Municipality of Peel to prepare a traffic noise study as part of the Class Environmental Assessment for the widening of Mississauga Road. The purpose of the noise study was to assess the resulting noise impact of road improvements to Mississauga Road between Bovaird Drive and Mayfield Road. These improvements include widening of sections of Mississauga Road and the construction of a new grade separation.

Noise sensitive areas in this traffic noise study were identified as defined in the Ministry of Transportation Provincial Highways Directive A-1 (QST A-1). Each noise sensitive area's qualification for noise mitigation was evaluated by comparing the expected traffic sound level for the future "Do Nothing" and future "With Improvements" scenarios. This was done to obtain the change in noise level above ambient (noise impact) as outlined in the MTO/MOE Protocol for Dealing with Noise Concerns During the Preparation, Review and Evaluation of Provincial Highways Environmental Assessments Guidelines.

Noise sensitive areas considered in this noise study included residential dwellings. The results of the noise impact analysis indicate that for each noise sensitive area the noise impact is expected to be negligible as defined by the MOE/MTO Noise Protocol (less than 5 dB increase). Traffic volumes for the future "Do Nothing" and future "With Improvements" scenarios are expected to be the same. According to the MTO/MOE protocol, where the expected noise impact is predicted to be less than 5 dB, no noise mitigation is required due to the proposed road improvements. Therefore, according to the MTO/MOE Protocol, consideration for noise mitigation is not required for Mississauga Road.

Additionally, it is acknowledged that the land within the study area which is not currently zoned for residential use, may potentially be re-zoned and developed for residential use in the future. It is recommended that for any future residential development within the study area, the developer be required to complete a noise study according to the Ministry of Environment noise guidelines documented in Ministry of Environment publication LU-131 (Noise Assessment Criteria in Land use Planning). The completed noise study should be required to present evidence of compliance with LU-131 prior to issuing building permit approval.

Table of Contents

List of Figures

List of Tables

Appendices

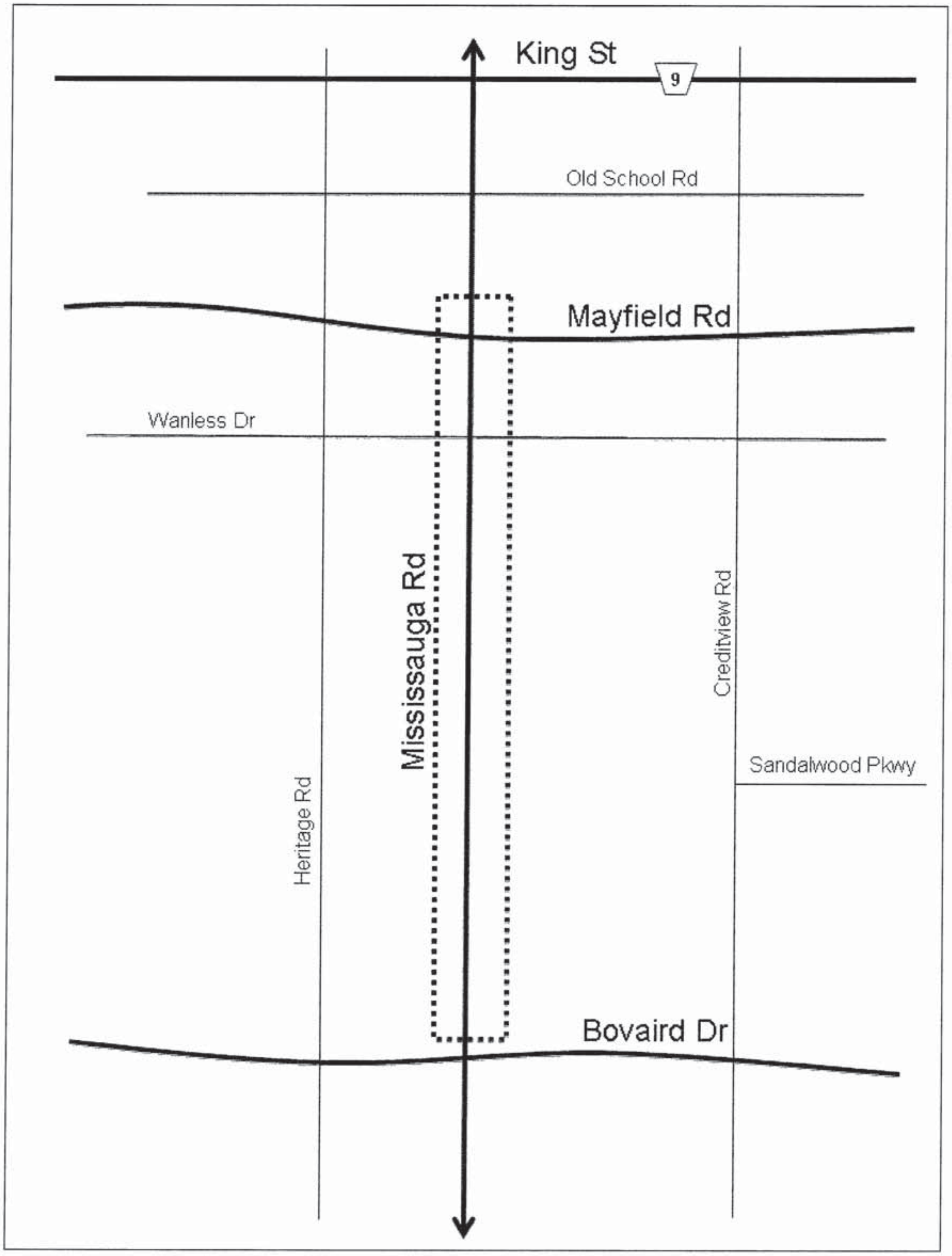
1. Introduction

AECOM was retained by The Regional Municipality of Peel to prepare a traffic noise study for the Mississauga Road Class Environmental Assessment Study for Mississauga Road from Bovaird Drive to Mayfield Road in Brampton, Ontario. The proposed undertaking would include the following:

- Widening of Mississauga Road from two lanes to four lanes between Wanless Drive and Mayfield by 2018
- Installation of new traffic signals at the future intersection of Sandalwood Parkway and Mississauga Road by 2018
- Installation of new traffic signals at the intersection of Wanless Drive and Mississauga Road by 2018
- Exclusive left turn lanes for each direction at the intersection of Sandalwood Parkway and Mississauga Road by 2018
- Exclusive right turn lane for the northbound direction of Mississauga Road at Wanless Drive by 2018
- Widening of Mississauga Road from four lanes to six lanes between Bovaird Drive and Sandalwood Parkway by 2031
- Widening of Mississauga Road from Two to four lanes between Sandalwood Parkway and Mayfield Road by 2031
- Building of an overpass on Mississauga Road over the existing rail line

Figure 1 shows the Class EA study area.

Figure 1: Study Area



2. Environmental Noise Guidelines

Environmental Assessments must evaluate projects according to all applicable municipal, provincial and federal guidelines available.

2.1 Municipal Guidelines

There are no City of Brampton environmental assessment noise guidelines which are applicable to this project

2.2 Provincial Noise Guidelines

The Ministry of Environment does not have specific noise guidelines related to the improvement or expansion of municipal roadways. However, the Ministry of Environment does have a protocol (Reference #2) with the MTO relating to Provincial Highway Expansions. The Ministry of Environment when asked to review Environmental Assessments of municipal road expansions will typically rely on this guideline for review criteria.

The MOE/MTO protocol states that if the expected impact (change in noise level above ambient) of implementing roadway improvements is expected to be within 0-5 dB no mitigation effort is required. However, if the change in noise level above ambient is expected to be greater than 5 dB investigation of mitigation effort is required. The objective sound level is specified as the greater of the predicted future “Do Nothing” ambient or 55 dBA. Table 1 and Figure 2 below represent the mitigation effort required based on the expected noise impact of implementing any proposed roadway improvements.

Table 1: MTO/MOE Protocol for Dealing with Noise Concerns During the Preparation, Review and Evaluation of Provincial Highways Environmental Assessments (Reference #2)

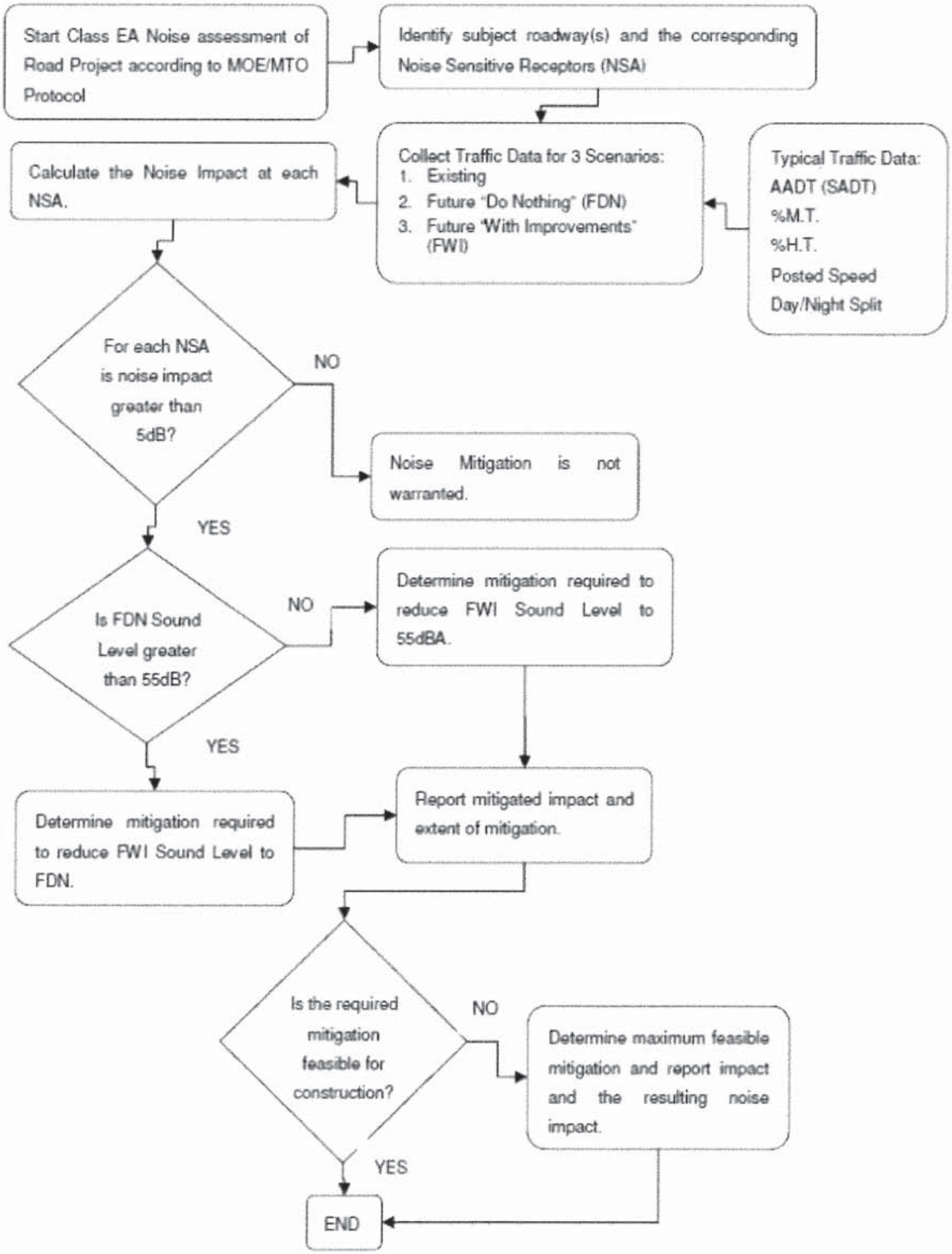
Change in Noise Level Above Ambient	Mitigation Effort Required
0 – 5 dB change	• None
> 5 dB change	• Investigate noise control measures on right-of-way • If project cost is not significantly affected, introduce noise control measures within the right-of-way. • Noise control measures, where introduced, should achieve a minimum of 5 dB attenuation, over first row receivers. • Mitigate to ambient, as administratively, economically, and technically feasible.

Noise investigation procedures and mitigation criteria for provincial highways and their effect on noise sensitive areas are also described in the MTO Quality and Standards Directive A-1 (Directive QST A-1, Reference #1). This directive contains information that complements the MTO/MOE Protocol for Highway Construction guideline for determining the requirement and feasibility of mitigation efforts. Additionally, the appendices found in the directive describe in detail the definitions of terminology used in evaluating road traffic noise.

2.3 Federal Guidelines

There are no federal environmental assessment noise guidelines which are applicable to this project.

Figure 2: MOE / MTO Protocol Assessment Flowchart



3. Noise Sensitive Areas

Land uses designated as noise sensitive by the MTO directive QST A-1 consist of the following:

- Private homes such as single family residences
- Townhouses
- Multiple unit buildings, such as apartments with OLA's for use by all occupants
- Hospitals, nursing homes for the aged, where there are OLA's for the patients

Land uses that do not qualify as noise sensitive by the MTO directive QST A-1 consist of the following:

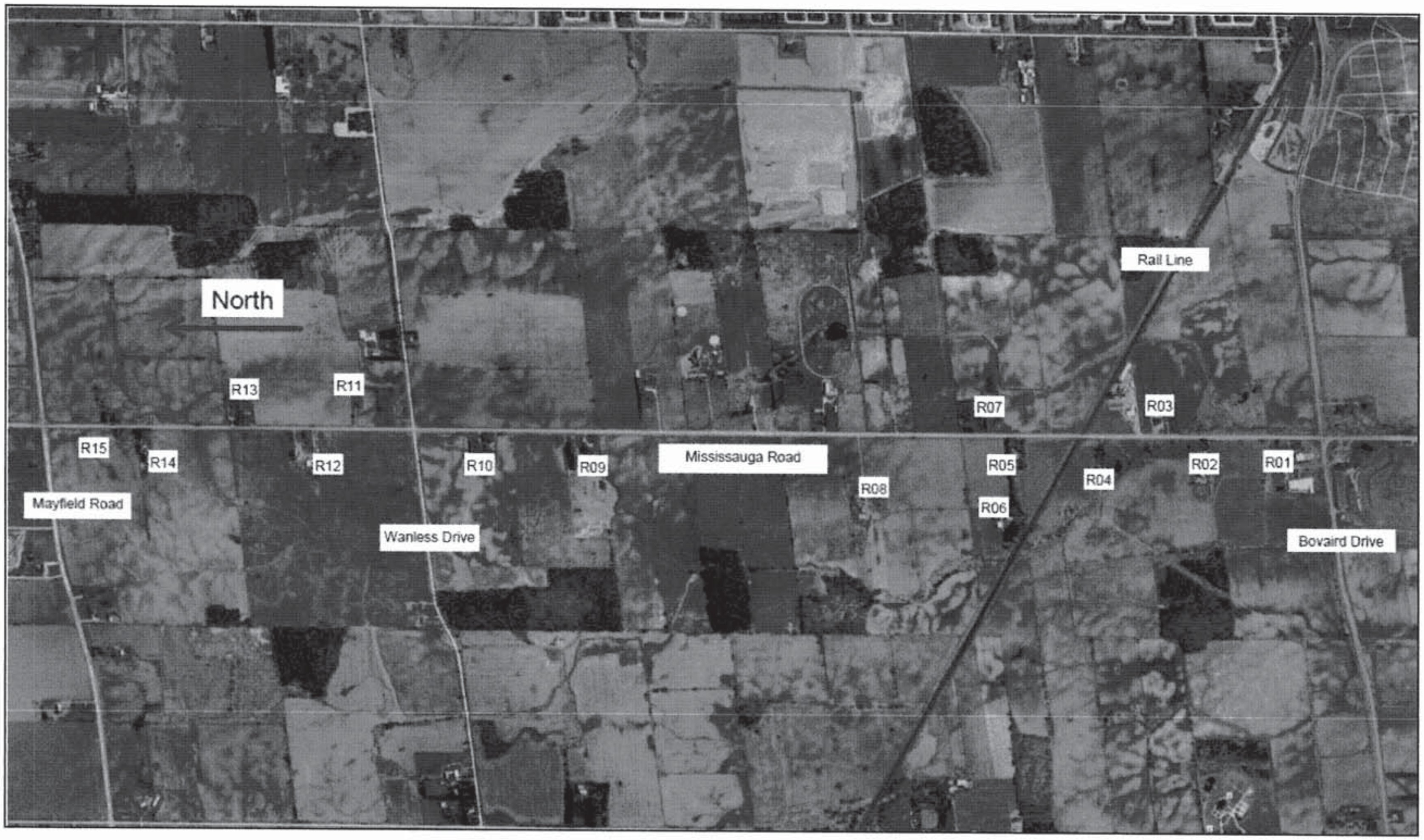
- Apartment balconies above ground floor
- Educational facilities (except dormitories with OLA's)
- Churches
- Cemeteries
- Parks and picnic areas which are not inherently part of a NSA
- Day care centres
- All commercial and industrial

There are a number of residential noise sensitive areas (NSAs) within the study area. Figure 3 below identifies receptor locations along Mississauga Road which were assessed. Other dwellings with similar setbacks and orientations to the roadway will receive similar sound exposures and associated noise impacts. Dwellings further removed from the roadway will receive reduced sound exposures due to increased distance attenuation.

According to QST A-1, Outdoor Living Areas (OLAs) are typically used as points of assessment for noise sensitive areas. OLAs include an area at ground level, adjacent to the wall of a building associated with an identified NSA which accommodates outdoor living activities. This area may be situated on any side of the NSA with a typical distance of 3m from the dwelling wall and a vertical height of 1.2m. Although MTO directive QST A-1 defines the height of an OLA to be 1.2m above ground, a height of 1.5m was used in the assessment of NSAs in accordance with the MOE Noise Assessment Criteria in Land Use Planning guideline LU-131 (Reference #3). Priority was given to MOE guidelines in instances where discrepancies between the MTO and MOE existed.

An additional requirement of the "most exposed side" has also been adopted by the MTO. The most exposed side refers to the closest side exposed to the noise, even if it is not an OLA. However, for the purpose of determining mitigation, the OLA is the point of consideration. For the purposes of this assessment, the most exposed side was used for the initial assessment, if mitigation was required; the OLA was then assessed to determine the required mitigation.

Figure 3: Noise Sensitive Receptors



4. Noise Impact Assessment

4.1 Traffic Data

All road traffic data presented below, including calculations, are provided in Appendix A. The road traffic data is also summarized in Table 2.

Existing traffic information for Mississauga Road was obtained from the Needs Assessment and Traffic Performance Report (Reference #6), hereafter referred to as the NATP. Traffic data in the form of AM/PM Peak Hour counts for the year 2008 was presented in the NATP. The peak hour data was multiplied by 10 to yield an estimate of the $AADT_{2008}$ 24 hour estimates (Reference #4). Similarly, traffic data for the year 2031 was presented as peak turning movement volumes. The peak hour count for each section of roadway was multiplied by 10 to obtain the AADT estimate. Where the lane count for a particular section of roadway exceeded four (4) lanes, the section of roadway was modeled in two segments (one for each direction) as per the requirements of ORNAMENT (Reference #7).

The Future "Do Nothing" and Future "With Improvements" traffic data is the same. The same number of vehicles were predicted to travel the same route with increasing queuing times at intersections in the "Do Nothing" Scenario.

A new grade separation is expected to be part of the Future "With Improvements" scenario. The grade profile of Mississauga Road and the proposed overpass was obtained from a road profile developed specifically for the Mississauga Road Environmental Assessment. A rail underpass is also being considered as an alternative to the overpass. However, due to an expected shallow road gradient of the underpass versus the overpass, modeling of the overpass (done for this report) was considered conservative.

Total medium and heavy truck volume along Mississauga road was determined to be approximately 10% based on Table 3.1 provided in the NATP report. However, individual medium and heavy truck percentages were not available. Therefore, these counts were predicted based on a conservative approach similar to Section 7.5 of the MTO/MOE Protocol. The resulting medium and heavy truck percentages were calculated to be 4% and 6%, respectively. It was also assumed that these percentages hold true for the surrounding roads and do not change in the future.

The day/night distribution of traffic was calculated from the 2008 – 24 hour traffic count on Mississauga Road north of Bovaird and south of Wanless. The day/night percentage split was 90/10 respectively. It was assumed that this distribution is the same for the surrounding roads and will not significantly change in the future.

Rail traffic data was obtained from various sources including CN Rail, VIA Rail, and GO Transit. The GO Transit trains are assumed to have two locomotives, and the freight trains are assumed to have 100 cars. An annual growth rate of 2.5% was assumed for the rail line.

Table 2: Road Traffic Data

Traffic Noise Source[1]	Existing 2008		Future "Do Nothing" (Year 2031)		Future "With Improvements"		Notes
	AADT	Posted Speed Limit (km/h)	AADT	Posted Speed Limit (km/h)	AADT	Posted Speed Limit (km/h)	
Mississauga Rd South of Bovaird (NB)	14540	80	29650	80	23550	80	2,4
Mississauga Rd South of Bovaird (SB)					6100		2,4
Mississauga Rd Bovaird to Wanless	6910	80	Segment Separated at Sandalwood Pkwy in Future				2
Mississauga Rd Bovaird to Sandalwood (NB)	Segment does not exist		23750	80	15800	80	2,3,6
Mississauga Rd Bovaird to Sandalwood (SB)					7950		2,3,6
Mississauga Rd Sandalwood to Wanless	Segment does not exist		22400	80	22400	80	2
Mississauga Rd Wanless to Mayfield	5990	80	15350	80	15350	80	2
Bovaird West of Mississauga Rd (WB)	16720	70	30300	70	16550	70	2,4
Bovaird West of Mississauga Rd (EB)					13750		2,4
Bovaird East of Mississauga Rd (WB)	18450	70	36000	70	19300	70	2,4
Bovaird East of Mississauga Rd (EB)					16700		2,4
Sandalwood West of Mississauga Rd	Segment does not exist		4900	60	4900	60	2,5
Sandalwood East of Mississauga Rd	Segment does not exist		17400	60	17400	60	2,5
Wanless West of Mississauga Road	2140	60	17750	60	17750	60	2
Wanless East of Mississauga Road	3530	60	23150	60	23150	60	2
Mayfield West of Mississauga Road	8740	80	21900	80	21900	80	2
Mayfield East of Mississauga Road	9130	60	23850	60	23850	60	2

Notes to Table 2:

1. All roadways: Medium Truck volume is 4% of AADT, Heavy Truck volume is 6% of AADT with day/night traffic split of 90/10
2. AADT with and without improvements are expected to be the same, only the queuing times are expected to change
3. Road widened to 6 lanes as part of improvements of this project, calculated as separate directions due to lane limitations of ORNAMENT
4. Road widened to 6 lanes not as part of this project, calculated as separate directions due to lane limitations of ORNAMENT
5. Road added not as part of this project
6. Sandalwood Parkway does not connect to Mississauga Road in the present existing scenario

Table 3: Rail Traffic Data

Train Type	Number of Trains / Period	Locomotives Per Train	Cars Per Train	Speed (km/hr)
Freight	43 / 24 hr	2	100	50
VIA Rail	6 / Daytime Only	1	4	70
Go-Transit	8 / Daytime Only	1	10	70

4.2 Procedure

Sound exposures were calculated using STAMSON V5.04-ORNAMENT, which is an accepted prediction model by the MOE.

The topography was assumed to be relatively flat between the receptors and the road/rail sources of noise. For the future with improvements scenario with the rail overpass, the road grading was obtained from a draft profile of the proposed roadway with the overpass in place prepared for the Mississauga Road Environmental Assessment. The elevation change at the overpass with respect to affected receptors was obtained from this drawing.

Using the road traffic data, daytime ($L_{eq,Day}$) sound exposures were calculated according to the MOE/MTO Protocol at each receptor location. $L_{eq,24}$ sound exposures were not calculated as none of the roadways in the proposed road network are considered freeways or highways. $L_{eq,16}$ sound exposures were used to assess daytime levels and included 90% of the 24 hour traffic volume (AADT). To assess the noise impact according to the MOE/MTO Protocol, the predicted future "Do Nothing" sound exposures were compared to those of the predicted future "With Improvements" sound exposures. Both the future "Do Nothing" and "With Improvements" scenarios occur in the year 2031 time horizon.

ORNAMENT limits the calculation of a roadway segment width to four (4) lanes of traffic, as such road sections with greater than four (4) lanes were separated into two (2) segments (one for each direction).

4.3 Assessment Results

Table 2 indicates that traffic counts provided in the NATP report for the future "Do Nothing" and future "With Improvements" are equal. Additionally, there is no known future re-alignment of Mississauga Road. Consequently, the resultant noise impact is expected to be nil for the entire study area. The noise impact due to the change in road centerline distance to the receiver for the six lane section of Mississauga Road (Bovaird Drive to Sandalwood Parkway) is expected to be negligible (1-2dB change). A summary of the predicted sound exposure levels at each noise sensitive receptor for the existing (2008), future "Do Nothing" (2031) and future "With Improvements" (2031) is provided in the table below.

It is acknowledged that land within the study area which is currently used for agricultural purposes is zoned for residential use and may potentially be developed in the future. It is recommended that any future development/developer within the study area be required to complete a noise study in accordance with the guidance provided by the City of Brampton by-laws, Peel Region policies and MOE publication LU-131 before building permits are granted. This report includes only assessments of existing dwellings and developments. Future or planned developments were not assessed nor was it possible to assess such developments accurately without detailed site and elevation plans. Therefore, noise assessments of future or planned developments shall be the sole responsibility of the developers.

Table 4: Unmitigated Noise Assessment Results

Location	Existing (2008) $L_{eq, Day}$ (dBA)[1]	Future (2031) $L_{eq, Day}$ (dBA)		Noise Impact (dB)	Required Mitigation
		Do Nothing	With Improvements		
R01	65	71	71	0	-
R02	66	71	71	0	-
R03	62	66	68	2	-
R04	63	66	67	1	-
R05	61	65	65	0	-
R06	64	67	67	0	-
R07	59	64	64	0	-
R08	52	56	56	0	-
R09	61	67	67	0	-
R10	58	64	64	0	-
R11	56	61	61	0	-
R12	60	64	64	0	-
R13	59	65	65	0	-
R14	63	67	67	0	-
R15	67	71	71	0	-

Notes to Table 4

1. Existing sound levels not required for assessment, and are presented for reference purposes only.

4.4 Noise Mitigation

Since the noise impact is expected to be negligible based on the results provided in Table 4, mitigation is not required for any identified receptors for the expansion of Mississauga Road according to the MOE/MTO Protocol Assessment. However, it has been acknowledged that new residences and/or subdivisions may be built in the future, as the land within the project study area may potentially be rezoned. Mitigation measures and setbacks for these future NSAs, with respect to noise guidelines should be assessed using MOE land use planning guideline LU-131 and are the responsibility of the developer. Setbacks and other noise mitigation measures for proposed residential development should be addressed during that assessment.

4.5 Construction Noise

Construction noise is temporary. The severity of construction noise impact at NSAs is dependent on various factors such as time of operation and size of equipment. Recommendations relating to the management of construction noise include:

- Adherence to applicable local bylaws. Instances where adherence to the local bylaws is not possible and mitigation is not feasible an exemption should be obtained from the municipality before construction.
- Construction equipment noise emissions should comply with MOE guideline NPC-115, NPC-118 and NPC-207.
- Contract documents provided to the contractor should contain general noise control measures to mitigate the noise impact at noise sensitive areas including two standard clauses regarding equipment noise:
    - Unnecessary noise caused by faulty or non-operating components must be addressed by regularly maintaining all equipment.
    - Duration of construction equipment idling is to be restricted to the minimum time necessary to complete the specific task.
- A noise complaint process may be set in place similar to the MTO directive QST A-1:
    - Any initial complaint from the public will require verification by the County that all noise control measures to be applied are in effect. The County will investigate any noise concerns, advise the contractor of any problems, and enforce its contract.

5. Conclusions

The proposed road widening of Mississauga Road between Bovaird Drive and Mayfield Road in Brampton, Ontario is expected to have a negligible noise impact (see Table 4) on existing noise sensitive areas according to the MOE/MTO Protocol assessment. Therefore, no noise mitigation measures are recommended for implementation in this project according to the MOE/MTO Protocol assessment method.

6. References

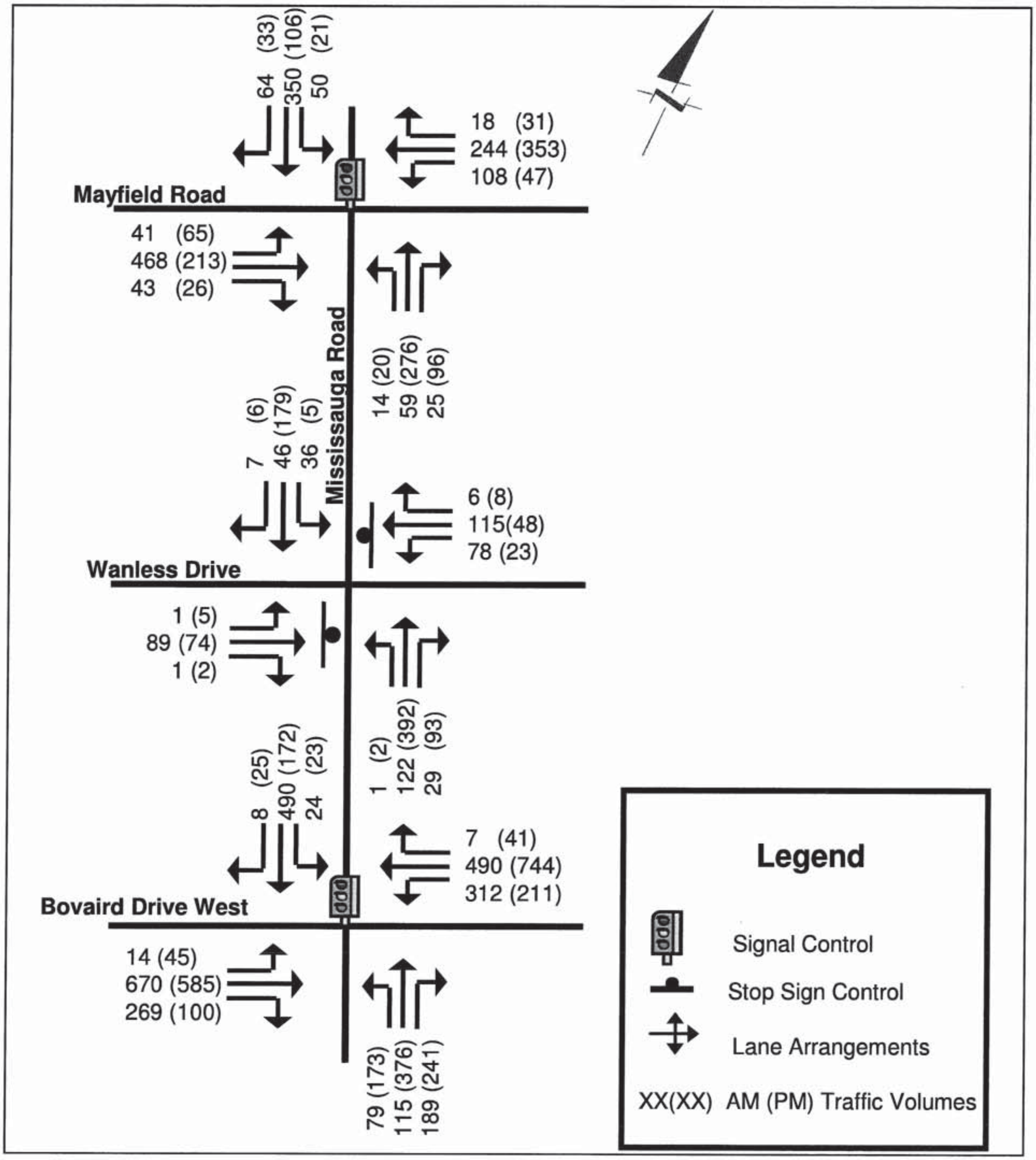
The following references were used in the preparation of this report:

1. MTO Provincial Highways Directive A-1 (QST A-1)
2. MTO/MOE, "A Protocol for Dealing with Noise Concerns during the Preparation, Review and Evaluation of Provincial Highways Environmental Assessments", February 1996
3. MOE, "Noise Assessment Criteria in Land Use Planning Publication LU-131", October 1997
4. "Traffic Volume Adjustments for Impact Analysis", Kames A. Bonneson, ITE Joournal, April 1987
5. Ministry of Transportation, "Environmental Guide for Noise", October 2006
6. Mississauga Road Class EA Study (North of Bovaird Drive to Mayfield Road) – Needs Assessment and Traffic Performance (January 2010)
7. MOE, "Ontario Road Noise Analysis Method for Environment and Transportation", October 1989

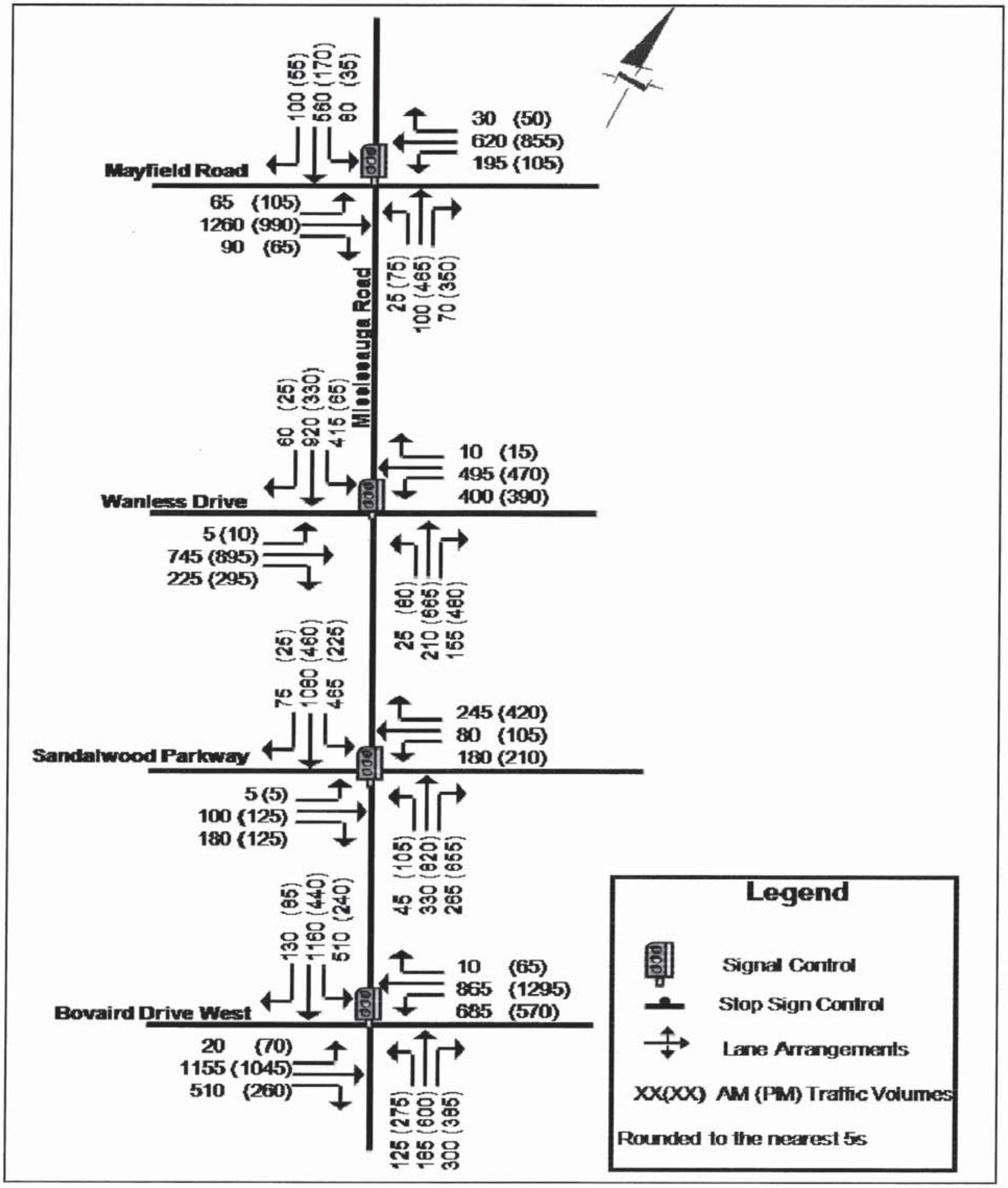
Appendix A

Traffic Data

Existing 2008 Turning Movement Traffic Volumes



Future 2031 Turning Movement Traffic Volumes



Appendix B

Traffic Noise Level Calculations

2008 (Present) Traffic Data	AVAILABLE AADT DATA		PROJECTED(FUTURE) AADT DATA						Road Only Parameters		
Source	Year	AADTe or 1hr or #Trains	Growth Rate/ Year	Over # Years	AADTf or #Autos or #Trains	%M.T. or #MT or #Loc	%H.T. or #HT or #Cars	Speed Limit (kph)	Grade %	Pavement Type	Day/Night Split
Mississauga Rd S.of Bovaird	2008	14540				4	6	80	0	1	90/10
Mississauga Rd, Bovaird to Wanless	2008	6910				4	6	80	0	1	90/10
Mississauga Rd, Wanless to Mayfield	2008	5990				4	6	80	0	1	90/10
Bovaird W.	2008	16720				4	6	70	0	1	90/10
Bovaird E	2008	18450				4	6	70	0	1	90/10
Wanless W	2008	2140				4	6	60	0	1	90/10
Wanless E	2008	3530				4	6	60	0	1	90/10
Mayfield W	2008	8740				4	6	80	0	1	90/10
Mayfield E	2008	9130				4	6	60	0	1	90/10
Rail Line (Freight)	2008	43				2	100	50			
Rail Line (VIA Rail)	2008	6				1	4	70			
Rail Line (Go Transit)	2008	8				1	10	70			

PROJECT NAME: Mississauga Road EA
PROJECT NUMBER: 60116610 (105163)
BASE DRAWING: Present (2008)

ENGINEER: Leaman Chow
DATE: August 24, 2010

UNMITIGATED/EXISTING

RECEIVER	SOURCE	θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)
R01	Miss Rd Bovaird to Wanless	-90	60	1	0			1	1.5	20.5					0				62.9
	Miss Rd S. of Bovaird	60	90	1	0			1	1.5	20.5					0				58.11
	Bovaird East	-90	0	1	0			1	1.5	71					0				56.5
	Bovaird West	0	90	2	0			2	1.5	71	0	90	4	3	0	0	0	0	48.59
Total																			64.94
R02	Miss Rd Bovaird to Wanless	-90	90	1	0			1	1.5	20					0				65.49
	Rail Line	-90	90	1	0			1	1.5	370					0				51.89
Total																			65.68
R03	Miss Rd Bovaird to Wanless	-90	90	1	0			1	1.5	45					0				59.65
	Rail Line	-90	90	1	0			1	1.5	160					0				57.71
Total																			61.80
R04	Miss Rd Bovaird to Wanless	-90	90	1	0			1	1.5	80					0				55.51
	Rail Line	-90	90	1	0			1	1.5	88					0				61.87
Total																			62.77
R05	Miss Rd Bovaird to Wanless	-90	90	1	0			1	1.5	76					0				55.87
	Rail Line	-90	90	1	0			1	1.5	118					0				59.83
Total																			61.30
R06	Miss Rd Bovaird to Wanless	-90	90	1	0			1	1.5	245					0				47.45
	Rail Line	-90	90	1	0			1	1.5	65					0				63.97
Total																			64.07
R07	Miss Rd Bovaird to Wanless	-90	90	1	0			1	1.5	60					0				57.58
	Rail Line	-90	90	1	0			1	1.5	320					0				52.90
Total																			58.85

MITIGATED/FUTURE

θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)	Leq (Night) (dBA)

PROJECT NAME: Mississauga Road EA

PROJECT NUMBER: 60118610 (105163)

BASE DRAWING: Present (2008)

Page 2 of 2

ENGINEER: Leaman Chow

DATE: August 24, 2010

UNMITIGATED/EXISTING

RECEIVER	SOURCE	θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)
R08	Miss Rd Bovaird to Wanless	-90	90	1	0			1	1.5	220					0				48.22
	Rail Line	-90	90	1	0			1	1.5	490					0				50.37
Total																			52.44
R09	Miss Rd Bovaird to Wanless	-90	90	1	0			1	1.5	35					0				61.46
Total																			61.46
R10	Miss Rd Bovaird to Wanless	-90	90	1	0			1	1.5	55					0				58.2
	Wanless East	0	90	1	0			1	1.5	220					0				39.92
	Wanless West	-90	0	1	0			1	1.5	220					0				39.91
Total																			58.33
R11	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5	70					0				55.84
	Wanless W	-90	10	1	0			1	1.5	165					0				38.12
	Wanless E	10	90	1	0			1	1.5	165					0				41.26
Total																			56.06
R12	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5	40					0				59.87
Total																			59.87
R13	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5	35					0				58.89
Total																			58.89
R14	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5	25					0				63.26
Total																			63.26
R15	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5	15					0				66.94
Total																			66.94

MITIGATED/FUTURE

RECEIVER	θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)	Leq (Night) (dBA)
R08																			
Total																			
R09																			
Total																			
R10																			
Total																			
R11																			
Total																			
R12																			
Total																			
R13																			
Total																			
R14																			
Total																			
R15																			
Total																			

2031 No Improvement Traffic Data	AVAILABLE AADT DATA		PROJECTED(FUTURE) AADT DATA						Road Only Parameters		
Source	Year	AADTe or 1hr or #Trains	Growth Rate/ Year	Over # Years	AADTf or #Autos or #Trains	%M.T. or #MT or #Loc	%H.T. or #HT or #Cars	Speed Limit (kph)	Grade %	Pavement Type	Day/Night Split
Mississauga Rd S.of Bovaird	2031	29650				4	6	80	0	1	90/10
Mississauga Rd, Bovaird to Sandalwood	2031	23750				4	6	80	0	1	90/10
Mississauga Rd, Sandalwood to Wanless	2031	22400				4	6	80	0	1	90/10
Mississauga Rd. Wanless to Mayfield	2031	15350				4	6	80	0	1	90/10
Bovaird W.	2031	30300				4	6	70	0	1	90/10
Bovaird E	2031	36000				4	6	70	0	1	90/10
Sandalwood W.	2031	4900				4	6	60	0	1	90/10
Sandalwood E.	2031	17400				4	6	60	0	1	90/10
Wanless W	2031	17750				4	6	60	0	1	90/10
Wanless E	2031	23150				4	6	60	0	1	90/10
Mayfield W	2031	21900				4	6	80	0	1	90/10
Mayfield E	2031	23850				4	6	60	0	1	90/10
Rail Line (Freight)	2008	43	2.5	23	75.2	2	100	50			
Rail Line (VIA Rail)	2008	6	2.5	23	10.6	1	4	70			
Rail Line (Go Transit)	2008	8	2.5	23	14.1	1	10	70			

PROJECT NAME: Mississauga Road EA
PROJECT NUMBER: 60116610 (105163)
BASE DRAWING: 2031 No Improvement

ENGINEER: Leaman Crow
DATE: August 24, 2010

UNMITIGATED/EXISTING

RECEIVER	SOURCE	θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)
R01	Miss Rd Bovaird to Sandalwood	-90	60	1	0			1	1.5	20.5					0				70.26
	Miss Rd S. of Bovaird	60	90	1	0			1	1.5	20.5					0				61.2
	Bovaird East	-90	0	1	0			1	1.5	115					0				59.4
	Bovaird West	0	90	2	0			2	1.5	115	0	90	4	3	0	0	0	0	51.17
Total																			71.12
R02	Miss Rd Bovaird to Sandalwood	-90	90	1	0			1	1.5	20					0				70.85
	Rail Line	-90	90	1	0			1	1.5	370					0				54.35
Total																			70.95
R03	Miss Rd Bovaird to Sandalwood	-90	90	1	0			1	1.5	45					0				65.01
	Rail Line	-90	90	1	0			1	1.5	160					0				60.18
Total																			66.24
R04	Miss Rd Bovaird to Sandalwood	-90	90	1	0			1	1.5	80					0				60.87
	Rail Line	-90	90	1	0			1	1.5	88					0				64.33
Total																			65.95
R05	Miss Rd Bovaird to Sandalwood	-90	90	1	0			1	1.5	76					0				61.24
	Rail Line	-90	90	1	0			1	1.5	134					0				62.29
Total																			64.81
R06	Miss Rd Bovaird to Sandalwood	-90	90	1	0			1	1.5	245					0				52.81
	Rail Line	-90	90	1	0			1	1.5	65					0				66.44
Total																			66.62
R07	Miss Rd Bovaird to Sandalwood	-90	90	1	0			1	1.5	60					0				62.94
	Rail Line	-90	90	1	0			1	1.5	320					0				55.36
Total																			63.64

MITIGATED/FUTURE

RECEIVER	SOURCE	θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)
R01	Miss Rd Bovaird to Sandalwood																		
	Miss Rd S. of Bovaird																		
	Bovaird East																		
	Bovaird West																		
Total																			
R02	Miss Rd Bovaird to Sandalwood																		
	Rail Line																		
Total																			
R03	Miss Rd Bovaird to Sandalwood																		
	Rail Line																		
Total																			
R04	Miss Rd Bovaird to Sandalwood																		
	Rail Line																		
Total																			
R05	Miss Rd Bovaird to Sandalwood																		
	Rail Line																		
Total																			
R06	Miss Rd Bovaird to Sandalwood																		
	Rail Line																		
Total																			
R07	Miss Rd Bovaird to Sandalwood																		
	Rail Line																		
Total																			

PROJECT NAME: Mississauga Road EA

PROJECT NUMBER: 60116610 (105163)

BASE DRAWING: 2031 No Improvement

ENGINEER: Leaman Chow

DATE: August 24, 2010

		UNMITIGATED/EXISTING																	
RECEIVER	SOURCE	θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)
R08	Miss Rd Bovaird to Sandalwood	-90	-45	1	0			1	1.5	220					0				52.75
	Miss Rd Sandalwood to Wanless	-45	90	1	0			1	1.5	220					0				45.74
	Sandalwood East	45	90	1	0			1	1.5	370					0				45.28
	Sandalwood West	-90	45	1	0			1	1.5	370					0				33.02
	Rail Line	-90	90	1	0			1	1.5	490					0				52.4
Total																			56.39
R09	Miss Rd Sandlewood to Wanless	-90	90	1	0			1	1.5	35					0				66.57
Total																			66.57
R10	Miss Rd Sandalwood to Wanless	-90	90	1	0			1	1.5	55					0				63.31
	Wanless East	0	90	1	0			1	1.5	220					0				48.08
	Wanless West	-90	0	1	0			1	1.5	220					0				46.93
Total																			63.53
R11	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5	65					0				60.47
	Wanless W	-90	10	1	0			1	1.5	165					0				49.63
	Wanless E	10	90	1	0			1	1.5	165					0				49.43
Total																			61.12
R12	Miss Rd Wanlss to Mayfield	-90	90	1	0			1	1.5	40					0				63.96
Total																			63.96
R13	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5	35					0				64.93
Total																			64.93
R14	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5	25					0				67.35
Total																			67.35
R15	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5	15					0				71.03
Total																			71.03

MITIGATED/FUTURE																	
θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)

2031 With Improvement Traffic Data	AVAILABLE AADT DATA		PROJECTED(FUTURE) AADT DATA						Road Only Parameters		
Source	Year	AADTe or 1hr or #Trains	Growth Rate/ Year	Over # Years	AADTf or #Autos or #Trains	%M.T. or #MT or #Loc	%H.T. or #HT or #Cars	Speed Limit (kph)	Grade %	Pavement Type	Day/Night Split
Mississauga Rd S.of Bovaird NB	2031	23550				4	6	80	0	1	90/9
Mississauga Rd S.of Bovaird SB	2031	6100				4	6	80	0	1	90/10
Mississauga Rd, Bovaird to Sandalwood NB	2031	15800				4	6	80	0	1	90/9
Mississauga Rd, Bovaird to Sandalwood SB	2031	7950				4	6	80	0	1	90/10
Mississauga Rd, Overpass NB	2031	15800				4	6	80	4.5	1	90/9
Mississauga Rd, Overpass SB	2031	7950				4	6	80	4.5	1	90/10
Mississauga Rd, Sandalwood to Wanless	2031	22400				4	6	80	0	1	90/10
Mississauga Rd, Wanless to Mayfield	2031	15350				4	6	80	0	1	90/10
Bovaird W, East bound	2031	13750				4	6	70	0	1	90/9
Bovaird W, West bound	2031	16550				4	6	70	0	1	90/10
Bovaird E, East bound	2031	16700				4	6	70	0	1	90/9
Bovaird E, West bound	2031	19300				4	6	70	0	1	90/10
Sandalwood W	2031	4900				4	6	60	0	1	90/10
Sandalwood E	2031	17400				4	6	60	0	1	90/10
Wanless W	2031	17750				4	6	60	0	1	90/10
Wanless E	2031	23150				4	6	60	0	1	90/10
Mayfield W	2031	21900				4	6	80	0	1	90/10
Mayfield E	2031	23850				4	6	60	0	1	90/10
Rail Line (Freight)	2008	43	2.5	23	75.2	2	100	50			
Rail Line (VIA Rail)	2008	6	2.5	23	10.6	1	4	70			
Rail Line (Go Transit)	2008	8	2.5	23	14.1	1	10	70			

2031 With Improvement Traffic Data

PROJECT NAME: Mississauga Road EA

PROJECT NUMBER: 60116610 (105163)

BASE DRAWING: 2031 With Improvement

Page 1 of 3

ENGINEER: Leaman Chow

DATE: August 24, 2010

RECEIVER	SOURCE	UNMITIGATED/EXISTING																		
		θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)
R01	Miss Rd Bovaird to Sandalwood (NB)	-90	60	1	0			1	1.5	25.75					0				66.85
	Miss Rd Bovaird to Sandalwood (SB)	-90	60	1	0			1	1.5	15.25					0				67.64
	Miss Rd S. of Bovaird (NB)	60	90	1	0			1	1.5	25.75					0				58.56
	Miss Rd S. of Bovaird (SB)	60	90	1	0			1	1.5	15.25					0				56.46
	Bovaird E (WB)	-90	0	1	0			1	1.5	65.75					0				57.25
	Bovaird E (EB)	-90	0	1	0			1	1.5	76.25					0				55.55
	Bovaird W (WB)	0	90	2	0			2	1.5	65.75	0	90	4	3	0	0	0	0	48.86
	Bovaird W (EB)	0	90	2	0			2	1.5	76.25	0	90	4	3	0	0	0	0	47.74
Total																			71.08
R02	Miss Rd Bovaird to Sandalwood (NB)	0	90	1	0			1	1.5	25.25					0				64.39
	Miss Rd Bovaird to Sandalwood (SB)	0	90	1	0			1	1.5	14.75					0				63.25
	Miss Rd Overpass (NB)	-90	0	1	0			1	1.5	25.25					0				64.99
	Miss Rd Overpass (SB)	-90	0	1	0			1	1.5	14.75					0				65.75
	Rail Line	-90	90	1	0			1	1.5	370					0				53.47
Total																			70.79
R03	Miss Rd Overpass (NB)	-90	90	3	0			1	1.5	39.75					5				65.63
	Miss Rd Overpass (SB)	-90	90	3	0			1	1.5	50.25					5				60.94
	Rail Line	-90	90	1	0			1	1.5	160					0				58.73
Total																			67.52
R04	Miss Rd Overpass (NB)	-90	90	3	0			1	1.5	84.25					9.5				61.92
	Miss Rd Overpass (SB)	-90	90	3	0			1	1.5	73.75					9.5				59.72
	Rail Line	-90	90	1	0			1	1.5	88					0				64.33
Total																			67.16

MITIGATED/FUTURE																	
θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)

AECOM Canada Ltd.

ANV GROUP STAMSON CALC SHEET Version 1.0 (BL)

2031 With Improvement Traffic Data

PROJECT NAME	Mississauga Road EA	Page	2 of 3
PROJECT NUMBER	60116610 (105163)	ENGINEER	Leaman Chow
BASE DRAWING	2031 With Improvement	DATE	August 24, 2010

UNMITIGATED/EXISTING

RECEIVER	SOURCE	θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)
R05	Miss Rd Bovaird to Sandalwood (NB)	-90	-60	1	0			1	1.5	81.25					0				46.55
	Miss Rd Bovaird to Sandalwood (SB)	-90	-60	1	0			1	1.5	70.75					0				46.56
	Miss Rd Overpass (NB)	-60	90	3	0			1	1.5	81.25					5				60.47
	Miss Rd Overpass (SB)	-60	90	3	0			1	1.5	70.75					5				56.19
	Rail Line	-90	90	1	0			1	1.5	118					0				62.29
Total																			65.24
R06	Miss Rd Bovaird to Sandalwood (NB)	-90	0	1	0			1	1.5	250.25					0				47.87
	Miss Rd Bovaird to Sandalwood (SB)	-90	0	1	0			1	1.5	239.75					0				45.2
	Miss Rd Overpass (NB)	0	90	1	0			1	1.5	250.25					0				48.47
	Miss Rd Overpass (SB)	0	90	1	0			1	1.5	239.75					0				45.8
	Rail Line	-90	90	1	0			1	1.5	65					0				66.44
Total																			66.64
R07	Miss Rd Bovaird to Sandalwood (NB)	0	90	1	0			1	1.5	54.75					0				58.82
	Miss Rd Bovaird to Sandalwood(SB)	0	90	1	0			1	1.5	65.25					0				54.57
	Miss Rd Overpass (NB)	-90	0	1	0			1	1.5	54.75					0				59.42
	Miss Rd Overpass (SB)	-90	0	1	0			1	1.5	65.25					0				55.17
	Rail Line	-90	90	1	0			1	1.5	320					0				55.36
Total																			64.14
R08	Miss Rd Sandalwood to Wanless	-90	-45	1	0			1	1.5	220					0				45.74
	Miss Rd Bovaird to Sandalwood (NB)	-45	60	1	0			1	1.5	225.25					0				50.31
	Miss Rd Bovaird to Sandalwood (SB)	-45	60	1	0			1	1.5	214.75					0				47.67
	Miss Rd Overpass (NB)	60	90	1	0			1	1.5	225.25					0				41.81
	Miss Rd Overpass (SB)	60	90	1	0			1	1.5	214.75					0				39.17
	Sandalwood E	45	90	1	0			1	1.5	370					0				45.28
	Sandalwood W	-90	45	1	0			1	1.5	370					0				33.02
	Rail Line	-90	90	1	0			1	1.5	490					0				52.4
Total																			56.40

MITIGATED/FUTURE

θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)

AECOM Canada Ltd.

ANV GROUP STAMSON CALC SHEET Version 1.0 (BL)

2031 With Improvement Traffic Data

PROJECT NAME: Mississauga Road EA

Page 3 of 3

PROJECT NUMBER: 60116610 (105163)

ENGINEER: Leaman Chow

BASE DRAWING: 2031 With Improvement

DATE: August 24, 2010

UNMITIGATED/EXISTING

RECEIVER	SOURCE	θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)
R09	Miss Rd Sandalwood to Wanless	-90	90	1	0			1	1.5	35					0				66.57
Total																			66.57
R10	Miss Rd Sandalwood to Wanless	-90	90	1	0			1	1.5	55					0				63.31
	Wanless East	0	90	1	0			1	1.5	220					0				48.08
	Wanless West	-90	0	1	0			1	1.5	220					0				46.93
Total																			63.53
R11	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5	65					0				60.47
	Wanless W	-90	10	1	0			1	1.5	165					0				49.63
	Wanless E	10	90	1	0			1	1.5	165					0				49.43
Total																			61.12
R12	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5						0				63.96
Total																			63.96
R13	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5	35					0				64.93
Total																			64.93
R14	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5	25					0				67.37
Total																			67.37
R15	Miss Rd Wanless to Mayfield	-90	90	1	0			1	1.5	15					0				71.03
Total																			71.03

MITIGATED/FUTURE

θ1	θ2	TOPO	WOODS	No. Rows	@ Density	Ground Surface Type	Receiver Height (r) (m)	Source Receiver Dist (m)	Barr θ1	Barr θ2	Barrier Height (m)	Barrier Receiver Distance (m)	Elevation Change (e) (m)	Source Ground Elevation (m)	Receiver Ground Elevation (m)	Base of Barrier Elevation (m)	Leq(Day) or Leq(1hr) (dBA)

Appendix C

Glossary of Terms and Acronyms

Glossary of Terms and Acronyms:

A-Weighting Network	A frequency weighting network intended to approximate the relative response of the healthy human ear to sounds of different frequencies. Overall sound levels calculated or measured using the A-weighting network are indicated by dBA rather than dB.
Acoustically Shielded	A noise emission source from which the sound path to the noise sensitive receptor is blocked by a solid object of sufficient size and mass to consider the noise impact of that source negligible.
Acoustics, Noise and Vibration (ANV)	A unified field of study. Each sub-field is described in a specific context briefly below.
Acoustics	The study of problems where sound is desirable and the quality of the sound is the focus of attention. Examples include conference halls, theatres, classrooms and recording studios.
Noise	The study of problems where sound is undesirable and the reduction of sound is the focus of attention. Examples include noise emissions from industrial facilities and transportation corridors.
Vibration	The study of problems where excessive vibration is undesirable and the reduction of vibration amplitudes or vibration transmission is the focus of attention. Examples include vibration impact of equipment on building structures and the vibration impact of transportation corridors on the occupants of residential dwellings.
Audible	Can be heard with the healthy human ear. The audibility of a noise emission source can vary with ambient noise and distance from the source. When close to a noise source the characteristics of that source are easily distinguishable. If at a practical distance that noise source is masked by other louder sources or is simply quieter than the ambient noise levels then that source is considered to not be audible at the referenced location. This can at times be used as justification for neglecting the noise impact of a specific noise source.
Frequency	Typically the rate in Hertz (Hz) - previously denoted cycles per second, at which an event is repeated. *Normal human hearing extends over a range of frequencies from about 15 Hz to about 15 kHz.*
Grade/Height References	AG – Above Grade, AR – Above Roof, BG – Below Grade, Grade – Ground level
L_{EQ} - "Equivalent sound level"	The value of a constant sound pressure level which would result in the same total sound energy as would the measured time-varying sound pressure level if the constant sound pressure level persisted over an equal time duration.
L_N - "N^{th} Exceedance level" where N = 0 to 100	Is the Sound Pressure Level which is exceeded N percent of the time. For a given data sample the N^{th} exeedance value is equal to the $(100\text{-}N)^{th}$ percentile of the data sample.
Noise Emissions	The sound energy radiating away from a noise source.
Noise Exposures	The sound pressure generated at a receptor.
Noise Impact	The contribution of a specific sound emission source or group of sound emission sources to the resultant SPL or L_{EQ} as measured or predicted at a nearby noise sensitive receptor.

Glossary of Terms and Acronyms:

Non-Negligible Noise Source *or equivalently* *Significant Noise Source*	A noise emission source which is determined to have a significant influence on the resultant noise exposures at a noise sensitive receptor. This is typically determined from a combination of site observations, measurements and available sound pressure or power data. Acoustical shielding effects or distance attenuation are often used as justification for excluding sources from this category.
Octave Band	A band of frequencies where the upper limiting frequency (u.l.f.) is twice the lower limiting frequency (l.l.f.). *Octave bands are identified by their centre-frequencies. The octave bands standardized for acoustic measurements include those centered at 31.5, 63, 125, 250, 500, 1000, 2000, 4000, & 8000 Hz.*
1/N Octave Band	A band of frequencies integrally divided from an Octave Band. The u.l.f. equals $2^{1/N}$ times the l.l.f. *The most commonly used frequency band is the 1/3 octave band.*
Outdoor Living Area (OLA)	An area at ground level, adjacent to a NSA and accommodating outdoor living activities. This area may be situated on any side of the NSA. The usual distance from the dwelling unit wall is 3 m. The vertical height is 1.2 m above the existing ground surface. Where unknown, the side closest to the highway should be assumed. Paved areas for multiple dwelling residential units may not be defined as an OLA.
Peak Particle Velocity (PPV)	The maximum instantaneous velocity experienced by the particles of a medium when set into transient vibratory motion.
Point of Reception *or* *Noise Sensitive Receptor*	Locations were excessive noise may disrupt the lives or activities of occupants/residents or in general were excessive noise would interfere with the intended use of the location under consideration.
Sound Pressure	The instantaneous difference between the actual pressure and the average barometric pressure at a given location.
Sound Pressure Level (SPL)	A measurement of instantaneous sound pressure and equal to 20 times the logarithm (base 10) of the ratio of the instantaneous sound pressure of a sound divided by the reference sound pressure of 20 μPa (0 dB). Reported and measured in decibels (dB or dBA).
Sound Quality or Characteristic	A descriptive qualifier which describes a sounds variation with either time or frequency. Specific qualifiers are described briefly below.
Cyclic Variation	A sound which has an audible cyclic variation in sound level such as beating or other amplitude modulation.
Tonal	A sound which has a pronounced audible tonal quality such as a whine, screech, buzz, or hum. A majority of the acoustic energy is present in a relatively narrow frequency band.
Quasi-Steady Impulsive	A sequence of impulsive sounds emitted from the same source, having a time interval of less than one half second (1/2-sec) between successive impulsive sounds.
Steady	A sound does not vary significantly with time and therefore the measured Sound Pressure Level does not vary significantly with time.
Impulsive	A single pressure pulse or a single burst of pressure pulses, as defined by IEC I79A, First supplement to IEC 1 79, Sections 3.1 and 3.2.

Glossary of Terms and Acronyms:

Transmission Loss (TL)	The measure of the airborne sound reduction provided by a partition. *Expressed in decibels (dB) it is a measure of ratio of the acoustic energy striking the partition relative to the energy which is transmitted through it.*
Root Mean Square (RMS) Vibration Velocity	Vibration velocity value obtained when the instantaneous velocity is exponentially averaged in a RMS network with a time constant of one second.
Vibration Sensitive Receptor	Locations were excessive vibration may disrupt the lives or activities of occupants/residents or in general were excessive vibration would interfere with the intended use of the location under consideration.

AECOM Canada Ltd. - Canada Central Region

Targeted Projects for Review - Completion Status as at September 16, 2012

Projects Requiring EACs

Projects with Completed EACs in September

Business Line	District	PM	Project #	Project Name	Last EAC
Water	CAN - Ontario West	BEATTIE, DAVID	60119607	113545-JUNGBUNZLAUER PLANT EXP	23-Aug-12
Water	CAN - Ontario West	HARVEY, J NEIL	60120331	91627-BECKETT SPROULE FEEDERMA	22-Aug-12
Water	CAN - Ontario West	OVEREND, STEVEN	60119046	112057-Pelham CIP Engineering	30-Aug-12
Water	CAN - Ontario West	SHIELDS, GORD	60220046	RR 81 Geometric Improvements	24-Aug-12
Water	CAN - Ontario West	SHIELDS, GORD	60143993	Welland-Ontario WM	11-Sep-12
Water	CAN - Ontario West	SWAN, MARK	60118533	110334-6200770152-DUNDAS STREE	20-Aug-12

AECOM

C.7 Air Quality Assessment

Region of Peel
Working for you

Mississauga Road Class EA Study for Mississauga Road (Regional Road 1) Bovaird Drive to Mayfield Road

Air Quality Impact Assessment Report

Prepared for:

Region of Peel
10 Peel Centre Drive
Brampton, Ontario
L6T 4B9

Prepared by:

AECOM
105 Commerce Valley Drive West
Markham, Ontario
L3T 7W3

May 11, 2010

Project No 60116610 (formerly 105163)

AECOM

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION

The Region of Peel has retained AECOM to undertake the Municipal Class Environmental Assessment (Schedule C) for Mississauga Road between Mayfield Road to just north of Bovaird Drive, located in the City of Brampton. Figure 1 shows the study area along the Mississauga Road corridor from Mayfield Road to Bovaird Drive West.

The Long Range Transportation Plan, Final Report prepared by the Region of Peel in September 2005 identified road improvements in the Region of Peel which are required to address transportation challenges expected to be encountered over the next 10, 15 and 25 years. These road improvements were based on predicted future population growth between the years 2001 to 2031 due to developments within the existing urban boundary. For the section of Mississauga Road being studied in this Environmental Assessment Study, the Long Range Transportation Plan identified the need to widen Mississauga Road from its current two lane section to a four lane section by the year 2021.

In addition to the Region of Peel Long Range Transportation Plan report, there have been numerous other studies undertaken by the City of Brampton indicating the need to provide additional road capacity in the north/south direction to accommodate future growth in this area. The expansion of the City of Brampton's urban boundary to include the development area referred to as the Northwest Brampton Area, which will add a population of approximately 84,500 residents and 19,600 employees, will further the need for additional transportation capacity in this corridor to accommodate the future growth.

This report assesses air quality impacts for sensitive receptors identified in and around the study area during peak hour traffic in the following scenarios:

1) The existing traffic scenario within the study area

2) The projected traffic scenario within the study area in 2018 after the Sandalwood Parkway is extended to Mississauga Road

3) The projected traffic scenario within the study area in 2031 after the recommended road improvements without the North South Transportation Corridor (NSTC)

4) The project traffic scenario within the study area in 2031 after the recommended road improvements with the NSTC.

5) The existing traffic scenario in four other road corridors within the region.

The estimated contaminant emissions based on current and future projected traffic data were used to develop an emissions inventory summarizing the five scenarios above. The emissions inventory was inputted into an AERMOD dispersion model to predict ground-level concentrations for CO, NO_x, VOCs and Particulate Matter (TSP, PM10, PM2.5) at all potential worst case sensitive receptors.

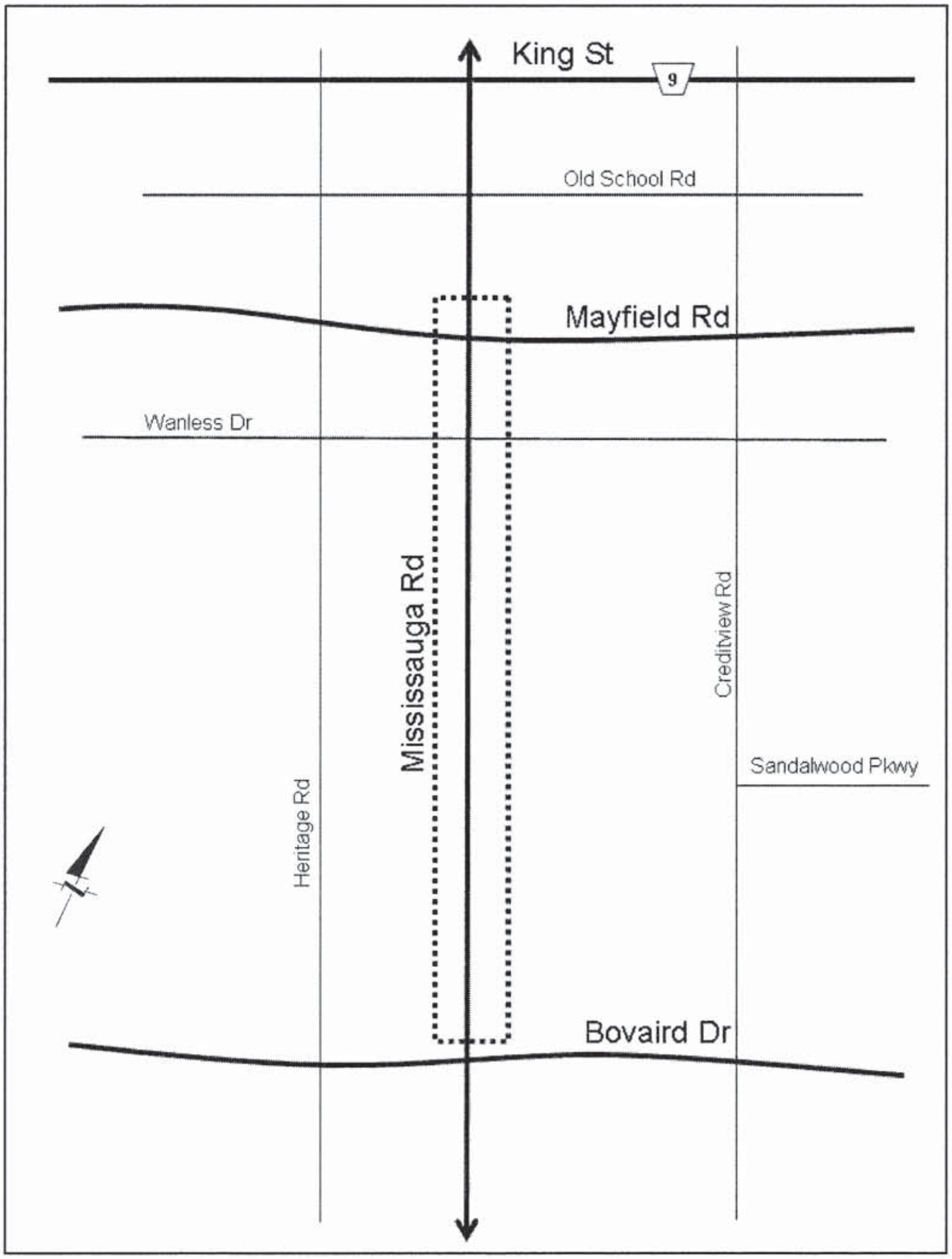


Figure 1: Mississauga Road Study Area – Existing Lane Configuration

2. EMISSIONS INVENTORY

2.1. Current and Future Projected Traffic Data

Current and future projected traffic data from the "Mississauga Class EA Study Needs Assessment and Traffic Performance Report (Revision 4)" was used to assess both the traffic volume and vehicle type breakdown within the study area. The current traffic data consisted of a 24 hour classification count in the study area along with peak hour traffic volumes. The future traffic data was presented as projected AM and PM peak hour volumes taking into account increased traffic and the proposed road improvements for 2018 and 2031 with and without the NSTC. The existing turning movement volumes were also used to assess traffic volumes on traffic corridors perpendicular to Mississauga Road: Mayfield Road, Wanless Drive, and Bovaird Drive West.

The 24 hour classification counts for the Mississauga Road traffic study conducted on October 31st, 2007 classified the total traffic into five vehicle categories: Cars & Trailers, 2 Axle Long, Buses, 2 Axle 6 Tire, and Other Trucks. In the emissions inventory, three vehicle categories were classified to adhere to the U.S. EPA's MOBILE6 vehicle emission model: Cars & Trailers are considered Light Duty Gasoline Vehicles (LDGVs), 2 Axle Long were considered Light Duty Gasoline Trucks (LDGT), and 2 Axle 6 Tire as well as Other Trucks were considered Heavy Duty Gasoline or Diesel Trucks (HDGT or HDDT). Buses were categorized as Medium-Duty Vehicles based on the U.S. EPA's 2000 "Federal and California Exhaust and Evaporative Emission Standards for Light-Duty Vehicles and Light-Duty Trucks". The breakdown of vehicle type along the study section of Mississauga Road is shown in Table 1 below and was assumed to apply to all five traffic scenarios presented in the emissions inventory.

Table 1: Vehicle Type Breakdown Summary

Vehicle Classification	Traffic Category	Percentage of Total Traffic Volume
LDGV	Cars & Trailers	69%
LDGT	2 Axle Long	25%
HDGT or HDDT	2 Axle 6 Tire, Other Trucks	5%
Medium-Duty Vehicles	Buses	1%

The Mississauga Road emissions inventory was created to identify contaminant emissions during the peak hour of traffic in each of the five scenarios described in Section 1. Peak hour traffic volumes for Mississauga Road at current condition were provided to the consulting team from the Region of Peel.

Peak hour traffic volumes for Mississauga Road at future conditions (2018, 2031 without NSTC and 2031 with NSTC) were taken from the Mississauga Road EA Final Traffic Report. Peak hour traffic volumes for Mayfield Road, Wanless Drive and Bovaird Drive West were based on the existing 2008 turning movement volumes, provided by the Region of Peel. No traffic volume data was available for Sandalwood Parkway, as it currently does not extend to Mississauga Road. The peak hour traffic volumes for all roads considered in each of the three scenarios are shown below in Table 2.

Table 2: Peak Traffic Volumes

Modeling Scenario	Location	Number of Vehicles Peak Traffic Volume (1 hour)
1	Mississauga Rd – Present	710
2	Mississauga Rd – 2018	1710
3	Mississauga Rd – 2031 w/o NSTC	2440
4	Mississauga Rd – 2031 w/ NSTC	1490
5a	Mayfield Rd – Present	890
5b	Wanless Dr – Present	280
5c	Bovaird Dr W – Present	1760

2.2. Emission Factors

Emission factors for CO, NOx, and VOCs for LDGVs, LDGTs, HDGTs and HDDTs were obtained from the EPA's MOBILE6 vehicle emissions model. Emission factors for CO, NO_x and VOCs for Buses were obtained from the EPA's 2000 "Federal and California Exhaust and Evaporative Emission Standards for Light-Duty Vehicles and Light-Duty Trucks". Emission factors for particulate matter (TSP, PM10, PM2.5) were obtained from the U.S. EPA AP42, Chapter 13 – Miscellaneous Sources, Paved Roads. The emission factors are presented in the full emissions inventory in Appendix A along with sample calculations in Appendix B.

2.3. Emissions Inventory

Based on the peak hour traffic volumes, vehicle type breakdown and associated emissions factors, the emissions inventory for the study area is shown below in Table 3.

Table 3: Peak Hour Emission Rates

PARAMETER	SCENARIO 1 EXISTING g/s	SCENARIO 2 2018 g/s	SCENARIO 3 2031 w/o NSTC g/s	SCENARIO 4 2031 w/ NSTC g/s	SCENARIO 5a MAYFIELD g/s	SCENARIO 5b WANLESS g/s	SCENARIO 5c BOVAIRD g/s
VOCs	0.331	0.798	1.142	0.697	0.418	0.133	0.823
NOx	0.414	0.999	1.429	0.873	0.524	0.166	1.031
CO	4.051	9.770	13.981	8.538	5.123	1.627	10.079
PM 2.5	0.018	0.043	0.061	0.037	0.022	0.007	0.044
PM 10	0.400	0.964	1.380	0.843	0.506	0.161	0.995
TSP	2.374	5.724	8.192	5.002	3.001	0.953	5.905

3. MODELLING

The AERMOD air dispersion modeling program was utilized in order to assess the ground level impacts from traffic related emissions. The modeled domain centered on the region of interest and extended for 3.0 km to the southwest and northeast.

3.1. Problem Definition

Vehicle emissions were simulated in two manners for the scenarios investigated. For simulations in which the effect of traffic along Mississauga Rd. was of interest (i.e. Scenarios 1 through 4), area sources were applied along the full length of Mississauga Rd. beginning approximately 400 m south of Bovaird Dr. and terminating approximately 400 m north of Mayfield Rd. When investigating the effects of traffic on the roads perpendicular to Mississauga Rd (Scenario 5), area sources were applied along the relevant traffic corridor beginning approximately 400 m to the west and terminating 400 m to the east of Mississauga Rd. Models were created to investigate the effects of each contaminant listed in Table 3

Using satellite imagery, all buildings immediately adjacent to Mississauga Rd. along the region of interest were identified and utilized as discrete receptors in the analysis. A supplementary cartesian receptor grid was also used. The buildings (and hence discrete receptor locations) identified were primarily of the residential, commercial and agricultural type. Buildings related to a golf course and a community centre, along the area of interest, were also noted. The residential and community centre receptors were considered to be the most sensitive in the assessment.

Meteorological data from the Ontario Meteorological Resource Center from the Central Region was used. This data covered the period from 1996 through 2000 inclusive. Land use was assumed to be rural for the majority of the modeled area. Land in an eastern section corresponding to a subdivision was assumed to be "suburban" and therefore land use characteristics corresponding to the urban land use type were utilized with modeling factors changed to account for the lower-rise buildings indicative of a suburban area.

3.2. Results and Discussion

Relevant regulations governing the use of dispersion modeling for emissions assessment (i.e. O. Reg. 419/05) do not apply to mobile sources. Emissions from mobile sources are regulated federally on an individual (source by source) basis.

Figure 2 below provides the visual representation of the ground level concentrations for Scenarios 1 through 4 of the different contaminants (purple representing lowest concentrations and red representing highest). Although Scenarios 1 through 4 each have different contaminant emission rates based on the varying traffic volumes, the highest POI concentrations are seen in the same areas, the highest values in general, occur in the northwest corner of the studied area within 700 m of the Mayfield Rd and Mississauga Rd intersection. Relatively high impact is also evident within 500 m of the Bovaird Dr. and Mississauga Rd intersection. The highest POI value for each contaminant is observed at a house in the northwest corner as indicated in the figure.

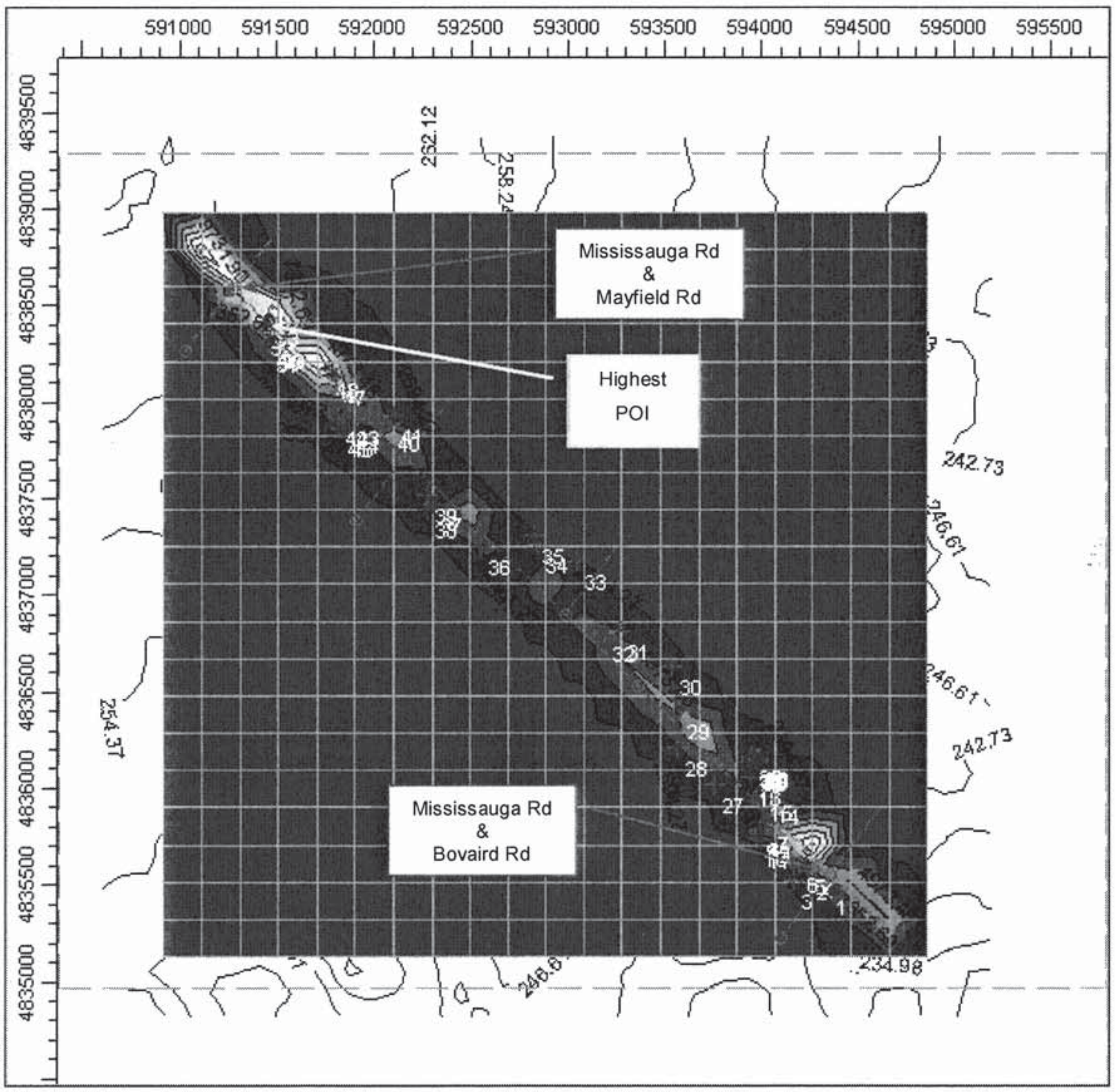


Figure 2: Predicted POI, Traffic Scenarios 1 through 4, Mississauga Road

The maximum POI concentrations predicted for each contaminant in Scenario 1, current utilization of Mississauga Road are presented in **Error! Not a valid bookmark self-reference.**.

Table 4: Scenario 1 Results: Current Traffic Scenario, Mississauga Road

Contaminant Information			Predicted POI	
Contaminant	**CAS #**	**Emission Rate g/s**	**POI µg/m³**	**Limiting Effect**
VOCs	--	0.331	124	--
NOx	10102-44-0	0.414	156	Health
CO	630-08-0	4.051	1,521	Health
PM 2.5	--	0.018	7	Visibility
PM 10	--	0.400	150	Visibility
TSP	--	2.374	891	Visibility

The maximum POI concentrations predicted for each contaminant in Scenario 2, future utilization of Mississauga Road 2018 are illustrated in Table 5.

Table 5: Scenario 2 Results: Future Traffic Scenario 2018, Mississauga Road

Contaminant Information			Predicted POI	
Contaminant	**CAS #**	**Emission Rate g/s**	**POI µg/m³**	**Limiting Effect**
VOCs	--	0.798	300	--
NOx	10102-44-0	0.999	375	Health
CO	630-08-0	9.770	3,669	Health
PM 2.5	--	0.043	16	Visibility
PM 10	--	0.964	362	Visibility
TSP	--	5.724	2,149	Visibility

The maximum POI concentrations predicted for each contaminant in Scenario 3, future utilization of Mississauga Road 2031 without NSTC are illustrated in Table 6.

Table 6: Scenario 3 Results: Future Traffic Scenario 2031 without NSTC, Mississauga Road

Contaminant Information			Predicted POI	
Contaminant	CAS #	Emission Rate g/s	POI µg/m^3	Limiting Effect
VOCs	--	1.189	429	--
NOx	10102-44-0	1.488	537	Health
CO	630-08-0	14.554	5,250	Health
PM 2.5	--	0.064	23	Visibility
PM 10	--	1.436	518	Visibility
TSP	--	8.528	3,076	Visibility

The maximum POI concentrations predicted for each contaminant in Scenario 4, future utilization of Mississauga Road 2031 with NSTC are illustrated in Table 9.

Table 7: Scenario 4 Results: Future Traffic Scenario 2031 with NSTC, Mississauga Road

Contaminant Information			Predicted POI	
Contaminant	CAS #	Emission Rate g/s	POI µg/m^3	Limiting Effect
VOCs	--	0.728	262	--
NOx	10102-44-0	0.911	328	Health
CO	630-08-0	8.910	3,206	Health
PM 2.5	--	0.039	14	Visibility
PM 10	--	0.879	316	Visibility
TSP	--	5.221	1878	Visibility

Figure 3 below provides the visual representation of the ground level concentrations for Scenario 5 of the different contaminants (purple representing lowest concentrations and red representing highest). The figure shows that there is little impact from Wanless Dr and moderate impact from Mayfield Rd and Bovaird Rd in the study area along Mississauga Rd. The highest ground level concentrations are seen northeast along Bovaird Rd, outside of the Mississauga Rd study area.

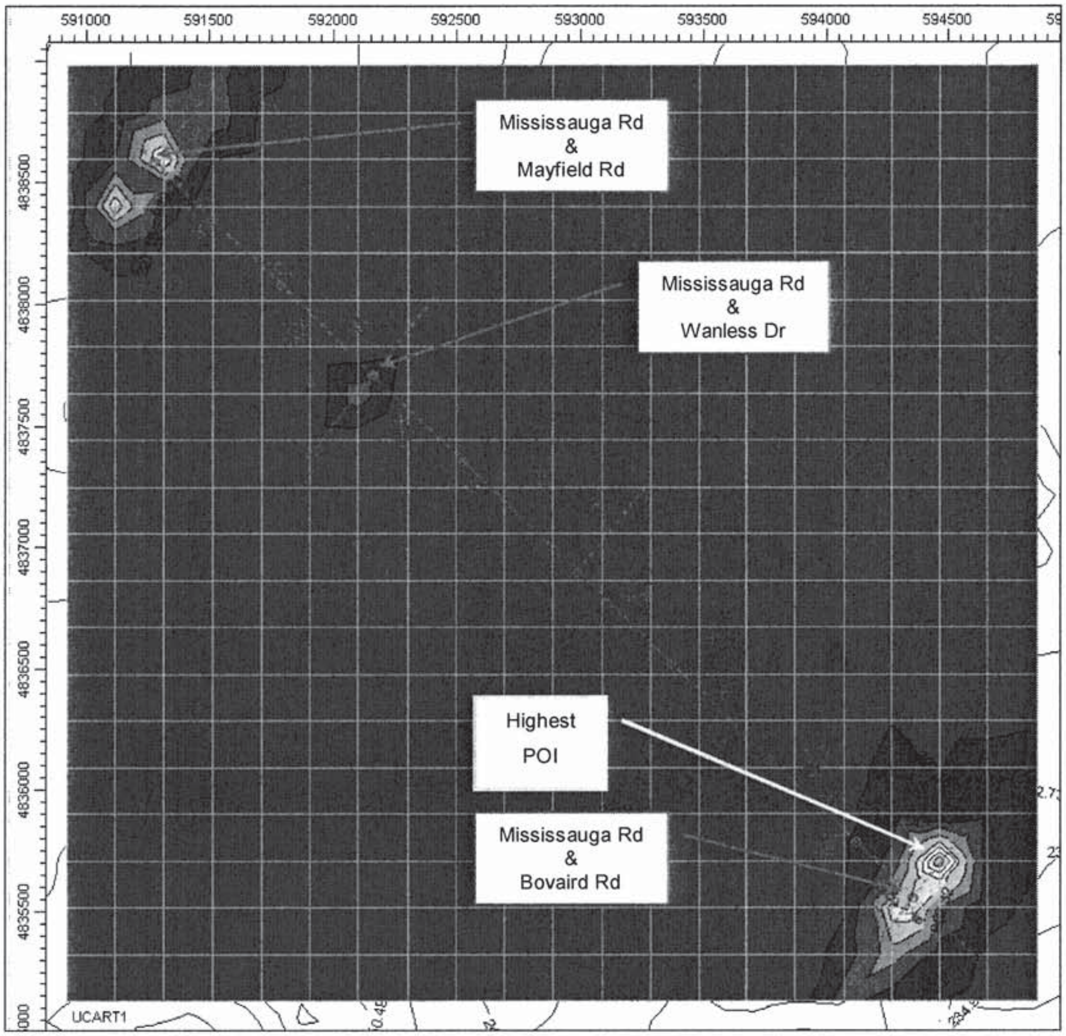


Figure 3: Predicted POI, Current Traffic Scenario, Perpendicular Roads

As shown in Figure 3, the current traffic patterns on the roads perpendicular to Mississauga Rd, the highest POI concentration values were seen to occur away from the discrete sensitive receptors of interest. Therefore, the model was re-run excluding the supplementary cartesian grid in order to assess the impact of current traffic patterns only on the discrete receptors in the Mississauga Road study area.

The maximum POI concentrations at a sensitive receptor for each contaminant under the current utilization of the Perpendicular Roads are illustrated in

Table 8. The highest impact is evident within 500 m of the Bovaird Dr. and Mississauga Rd. intersection. This is shown in Figure 4 which illustrates contours contaminate impingement (purple represents lowest concentrations and red the highest). The highest concentrations of contaminants are shown in Figure 3 to be caused by traffic along Bovaird Dr. These results were expected considering that the observed traffic volume on Bovaird Dr. was 190% the volume on Mayfield Rd. and 610% the volume Wanless Dr. It should also be noted that observed traffic volume on Bovaird Dr. was 220% higher than the volume on Mississauga Rd., therefore, the air quality impact from this side road is significant.

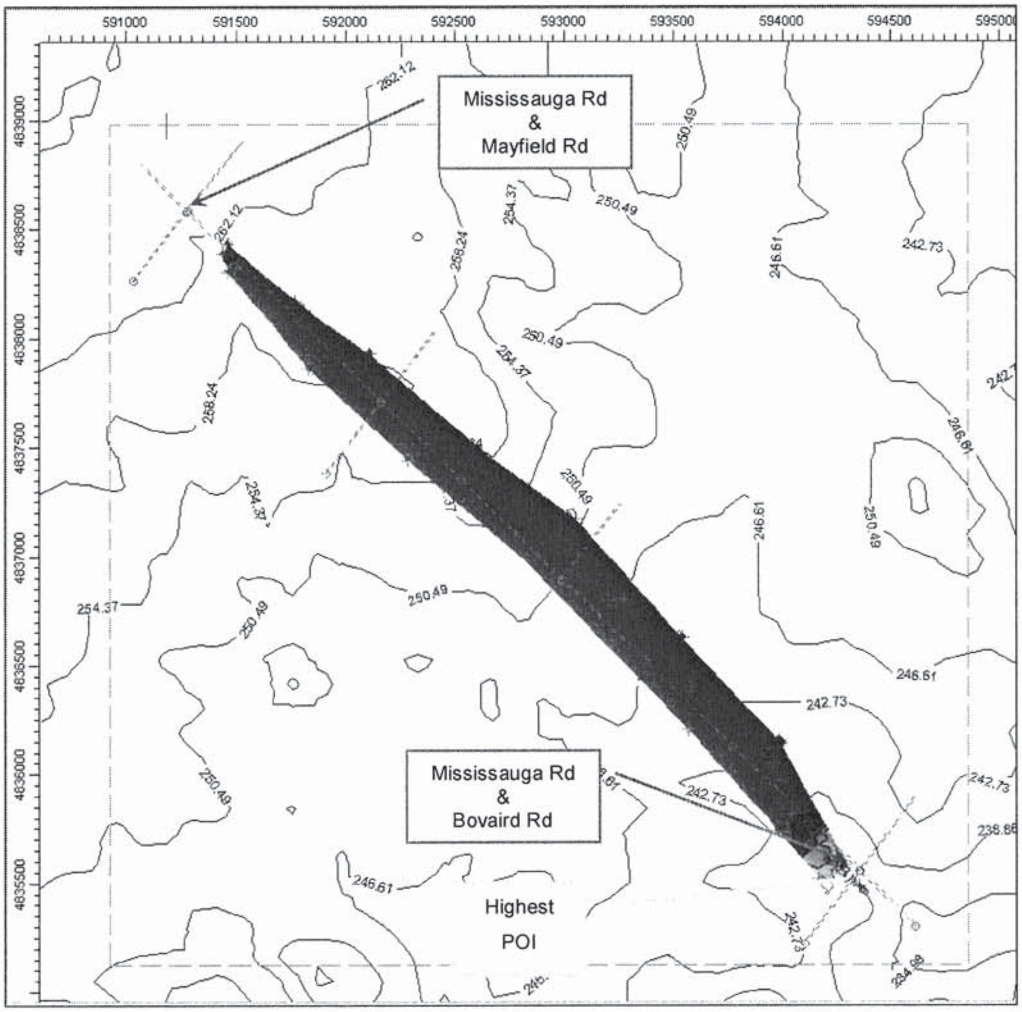


Figure 4: Predicted POI (sensitive receptors), Current Traffic Scenario, Perpendicular Roads

Table 8: Scenario 5 Results: Current Traffic Scenario, Perpendicular Roads

Contaminant Information					Predicted POI	
Contaminant	CAS #	Emission Rate (Mayfield) g/s	Emission Rate (Wanless) g/s	Emission Rate (Bovaird) g/s	POI ug/m3	Limiting Effect
VOCs	--	0.418	0.133	0.823	158	--
NOx	10102-44-0	0.524	0.166	1.031	197	Health
CO	630-08-0	5.123	1.627	10.079	1,923	Health
PM 2.5	--	0.022	0.007	0.044	8	Visibility
PM 10	--	0.506	0.161	0.995	190	Visibility
TSP	--	3.001	0.953	5.905	1,128	Visibility

4. SUMMARY OF RESULTS

Dispersion modeling was conducted to assess the ground level impacts from traffic related emissions. The region of interest was adjacent to Mississauga Rd. from Bovaird Dr. to Mayfield Rd. The maximum POI concentration for each contaminant of interest is presented in Table 9 for the following five scenarios:

1) The existing traffic scenario within the study area
2) The projected traffic scenario within the study area in 2018 after the Sandalwood Parkway is extended to Mississauga Road
3) The projected traffic scenario within the study area in 2031 after the recommended road improvements without the North South Transportation Corridor (NSTC)
4) The project traffic scenario within the study area in 2031 after the recommended road improvements with the NSTC.
5) The existing traffic scenario in four other road corridors within the region.

Relevant regulations governing the use of dispersion modeling for emissions assessment (i.e. O. Reg. 419/05) do not apply to mobile sources.

Table 9: Summary of POI Concentrations

Contaminant	CAS #	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Limiting Effect
		POI ug/m3	POI ug/m3	POI ug/m3	POI ug/m3	POI ug/m3	
VOCs	--	124	300	429	262	158	--
NOx	10102-44-0	156	375	537	328	197	Health
CO	630-08-0	1,521	3,669	5,250	3,206	1,923	Health
PM 2.5	--	7	16	23	14	8	Visibility
PM 10	--	150	362	518	316	190	Visibility
TSP	--	891	2,149	3,076	1,878	1,128	Visibility

For Scenarios 1 through 4, the highest POI values are seen to occur in the northwest and southeast intersections of the studied area. Future traffic patterns along Mississauga Rd. predict a 240% increase above current in contaminant ground level concentrations by 2018 (Scenario 2), a 340% increase by 2031 without the NSTC (Scenario 3) and a 210% increase by 2031 with the NSTC (Scenario 4).

The highest POI values in Scenario 5 (existing corridors) are seen to occur around the southeast intersection of the studied area (Mississauga Rd and Bovaird Dr). Predicted POI concentrations under Scenario 5 are 130% of the Scenario 1 (existing) impact in the vicinity of the Mississauga Rd and Bovaird Dr intersection and are significantly less for the remainder of Mississauga Rd. Traffic patterns under Scenario 5 can thus be considered to contribute significantly to ground level impacts in the south east corner of the region of interest.

Efficient traffic management at the intersections of Mississauga Rd. & Mayfield Rd and Mississauga Rd. & Bovaird Dr. is essential in order to moderate the most significant ground level impacts resulting from the anticipated increase in traffic in the study area.

Although not quantified in this report due to modeling constraints, it is expected that the two-lane roundabout option would decrease contaminant ground level concentrations in all of the future scenarios due to more efficient traffic flow and less idling in the study area.

APPENDIX 1

EMISSIONS INVENTORY

Region of Peel - Mississauga Road Class EA Study
Existing Study Area (Scenario 1) - Peak
Hour
Vehicle Emissions

Road Length 4.3 km
2.7 miles

Equipment Type	No. of Units per hour	Fuel Type
Cars & Trailers	491	Gasoline
Light Trucks	175	Gasoline
Heavy Trucks	37	Gasoline / Diesel
Buses	5	Diesel
Total	707	Gasoline / Diesel

	Emission Factors					Emission Rates							
Parameter	Cars and Trailers LDGV (g/mile)	Light Trucks LDGT12 (g/mile)	Heavy Trucks HDGV (g/mile)	Heavy Trucks HDDV (g/mile)	Buses (g/mile)	Cars & Trailers		Light Trucks		Heavy Trucks		Buses	
						kg/hr	g/s	kg/hr	g/s	kg/hr	g/s	kg/hr	g/s
VOCs	0.592	0.652	0.891	0.352	1.304	0.781	0.217	0.306	0.085	0.088	0.025	0.016	0.004
NOx	0.481	0.594	1.875	5.481	2.770	0.635	0.176	0.279	0.077	0.544	0.151	0.034	0.009
CO	7.470	8.090	8.130	1.418	10.300	9.855	2.737	3.798	1.055	0.807	0.224	0.125	0.035

	Emission Factors	Emission Rates	
PARTICULATE MATTER	All Vehicles	All Vehicles	
	g/mile	kg/hr	g/s
PM 2.5	0.033	0.064	0.018
PM 10	0.758	1.439	0.400
TSP	4.497	8.545	2.374

TOTAL EMISSIONS	g/s
VOCs	0.331
NOx	0.414
CO	4.051
PM 2.5	0.018
PM 10	0.400
TSP	2.374

Notes & Assumptions:

(1) All pollutant emission factors for cars and trailers, light trucks and heavy trucks based on U.S. EPA 2003 Mobile Source Emission Factor Model "Mobile6".

(2) All pollutant emission factors for buses based on U.S. EPA 2000 "Federal and California Exhaust and Evaporative Emission Standards for Light-Duty Vehicles and Light-Duty Trucks". Certification and Compliance Division, Office of Transporta

(3) Cars and Trailers are considered LDGVs (Light Duty Gasoline Vehicles), Light trucks are considered LDGT (Light Duty Gasoline Trucks, 0-6000 lbs GVWR), Heavy trucks are considered either HDGV (Heavy Duty Gasoline Trucks > 8,500 lbs < 60,000 lbs GVWR) or HDDV (Heavy Duty Diesel Trucks > 8,500 lbs < 60,000 lbs GVWR). The most conservative Emission Factor between the HDGV and GVWR was used to calculate emission rates.

(4) Buses are considered as medium duty (MDV5) vehicles for calculations purposed.

(5) Medium-Duty Vehicle definition (California): Any 1995 and subsequent model year heavy duty vehicle having a manufacturer's gross vehicle weight rating of 14,000 pounds or less.

(6) Particulate Matter Emission Factors are based on U.S. EPA AP42 "Chapter 13 : Miscellaneous Sources - Paved Roads"

(7) Emissions are based on the peak traffic hour

Region of Peel - Mississauga Road Class EA Study
Future 2018 Scenario (Scenario 2) - Peak Hour
Vehicle Emissions

Road Length 4.3 km
2.7 miles

Equipment Type	No. of Units per hour	Fuel Type
Cars & Trailers	1184	Gasoline
Light Trucks	421	Gasoline
Heavy Trucks	89	Gasoline / Diesel
Buses	11	Diesel
Total	1705	Gasoline / Diesel

	Emission Factors					Emission Rates							
Parameter	Cars and Trailers LDGV (g/mile)	Light Trucks LDGT12 (g/mile)	Heavy Trucks HDGV (g/mile)	Heavy Trucks HDDV (g/mile)	Buses (g/mile)	Cars & Trailers kg/hr	Cars & Trailers g/s	Light Trucks kg/hr	Light Trucks g/s	Heavy Trucks kg/hr	Heavy Trucks g/s	Buses kg/hr	Buses g/s
VOCs	0.592	0.652	0.891	0.352	1.304	1.883	0.523	0.738	0.205	0.213	0.059	0.038	0.011
NOx	0.481	0.594	1.875	5.481	2.770	1.530	0.425	0.672	0.187	1.312	0.365	0.081	0.022
CO	7.470	8.090	8.130	1.418	10.300	23.765	6.601	9.159	2.544	1.947	0.541	0.300	0.083

	Emission Factors	Emission Rates	
PARTICULATE MATTER	All Vehicles g/mile	All Vehicles kg/hr	All Vehicles g/s
PM 2.5	0.033	0.153	0.043
PM 10	0.758	3.471	0.964
TSP	4.497	20.607	5.724

TOTAL EMISSIONS	g/s
VOCs	0.798
NOx	0.999
CO	9.770
PM 2.5	0.043
PM 10	0.964
TSP	5.724

Notes & Assumptions:

(1) All pollutant emission factors for cars and trailers, light trucks and heavy trucks based on U.S. EPA 2003 Mobile Source Emission Factor Model "Mobile6".

(2) All pollutant emission factors for buses based on U.S. EPA 2000 "Federal and California Exhaust and Evaporative Emission Standards for Light-Duty Vehicles and Light-Duty Trucks". Certification and Compliance Division, Office of Transporta

(3) Cars and Trailers are considered LDGVs (Light Duty Gasoline Vehicles), Light trucks are considered LDGT (Light Duty Gasoline Trucks, 0-6000 lbs GVWR), Heavy trucks are considered either HDGV (Heavy Duty Gasoline Trucks > 8,500 lbs < 60,000 lbs GVWR) or HDDV (Heavy Duty Diesel Trucks > 8,500 lbs < 60,000 lbs GVWR). The most conservative Emission Factor between the HDGV and GVWR was used to calculate emission rates.

(4) Buses are considered as medium duty (MDV5) vehicles for calculations purposed.

(5) Medium-Duty Vehicle definition (California): Any 1995 and subsequent model year heavy duty vehicle having a manufacturer's gross vehicle weight rating of 14,000 pounds or less.

(6) Particulate Matter Emission Factors are based on U.S. EPA AP42 "Chapter 13 : Miscellaneous Sources - Paved Roads"

(7) Emissions are based on the peak traffic hour

Future 2031 Scenario w/o NSTC (Scenario 3) - Peak Hour
Vehicle Emissions

Road Length 4.3 km
2.7 miles

Equipment Type	No. of Units per hour	Fuel Type
Cars & Trailers	1694	Gasoline
Light Trucks	603	Gasoline
Heavy Trucks	128	Gasoline / Diesel
Buses	16	Diesel
Total	2440	Gasoline / Diesel

	Emission Factors					Emission Rates							
Parameter	Cars and Trailers LDGV (g/mile)	Light Trucks LDGT12 (g/mile)	Heavy Trucks HDGV (g/mile)	Heavy Trucks HDDV (g/mile)	Buses (g/mile)	Cars & Trailers		Light Trucks		Heavy Trucks		Buses	
						kg/hr	g/s	kg/hr	g/s	kg/hr	g/s	kg/hr	g/s
VOCs	0.592	0.652	0.891	0.352	1.304	2.695	0.749	1.056	0.293	0.305	0.085	0.054	0.015
NOx	0.481	0.594	1.875	5.481	2.770	2.190	0.608	0.962	0.267	1.878	0.522	0.116	0.032
CO	7.470	8.090	8.130	1.418	10.300	34.010	9.447	13.107	3.641	2.786	0.774	0.430	0.119

	Emission Factors	Emission Rates	
PARTICULATE MATTER	All Vehicles	All Vehicles	
	g/mile	kg/hr	g/s
PM 2.5	0.033	0.220	0.061
PM 10	0.758	4.968	1.380
TSP	4.497	29.490	8.192

TOTAL EMISSIONS	g/s
VOCs	1.142
NOx	1.429
CO	13.981
PM 2.5	0.061
PM 10	1.380
TSP	8.192

Notes & Assumptions:

(1) All pollutant emission factors for cars and trailers, light trucks and heavy trucks based on U.S. EPA 2003 Mobile Source Emission Factor Model "Mobile6".

(2) All pollutant emission factors for buses based on U.S. EPA 2000 "Federal and California Exhaust and Evaporative Emission Standards for Light-Duty Vehicles and Light-Duty Trucks". Certification and Compliance Division, Office of Transporta

(3) Cars and Trailers are considered LDGVs (Light Duty Gasoline Vehicles), Light trucks are considered LDGT (Light Duty Gasoline Trucks, 0-6000 lbs GVWR), Heavy trucks are considered either HDGV (Heavy Duty Gasoline Trucks > 8,500 lbs < 60,000 lbs GVWR) or HDDV (Heavy Duty Diesel Trucks > 8,500 lbs < 60,000 lbs GVWR). The most conservative Emission Factor between the HDGV and GVWR was used to calculate emission rates.

(4) Buses are considered as medium duty (MDV5) vehicles for calculations purposed.

(5) Medium-Duty Vehicle definition (California): Any 1995 and subsequent model year heavy duty vehicle having a manufacturer's gross vehicle weight rating of 14,000 pounds or less.

(6) Particulate Matter Emission Factors are based on U.S. EPA AP42 "Chapter 13 : Miscellaneous Sources - Paved Roads"

(7) Emissions are based on the peak traffic hour

Region of Peel - Mississauga Road Class EA Study
Future 2031 Scenario w/ NSCT (Scenario 4) - Peak Hour
Vehicle Emissions

Road Length 4.3 km
2.7 miles

Equipment Type	No. of Units per hour	Fuel Type
Cars & Trailers	1035	Gasoline
Light Trucks	368	Gasoline
Heavy Trucks	78	Gasoline / Diesel
Buses	9	Diesel
Total	1490	Gasoline / Diesel

	Emission Factors					Emission Rates							
Parameter	Cars and Trailers LDGV (g/mile)	Light Trucks LDGT12 (g/mile)	Heavy Trucks HDGV (g/mile)	Heavy Trucks HDDV (g/mile)	Buses (g/mile)	Cars & Trailers		Light Trucks		Heavy Trucks		Buses	
						kg/hr	g/s	kg/hr	g/s	kg/hr	g/s	kg/hr	g/s
VOCs	0.592	0.652	0.891	0.352	1.304	1.646	0.457	0.645	0.179	0.186	0.052	0.033	0.009
NOx	0.481	0.594	1.875	5.481	2.770	1.337	0.371	0.588	0.163	1.147	0.319	0.071	0.020
CO	7.470	8.090	8.130	1.418	10.300	20.768	5.769	8.004	2.223	1.701	0.473	0.263	0.073

	Emission Factors	Emission Rates	
PARTICULATE MATTER	All Vehicles	All Vehicles	
	g/mile	kg/hr	g/s
PM 2.5	0.033	0.134	0.037
PM 10	0.758	3.033	0.843
TSP	4.497	18.008	5.002

TOTAL EMISSIONS	g/s
VOCs	0.697
NOx	0.873
CO	8.538
PM 2.5	0.037
PM 10	0.843
TSP	5.002

Notes & Assumptions:

(1) All pollutant emission factors for cars and trailers, light trucks and heavy trucks based on U.S. EPA 2003 Mobile Source Emission Factor Model "Mobile6".

(2) All pollutant emission factors for buses based on U.S. EPA 2000 "Federal and California Exhaust and Evaporative Emission Standards for Light-Duty Vehicles and Light-Duty Trucks". Certification and Compliance Division, Office of Transporta

(3) Cars and Trailers are considered LDGVs (Light Duty Gasoline Vehicles), Light trucks are considered LDGT (Light Duty Gasoline Trucks, 0-6000 lbs GVWR), Heavy trucks are considered either HDGV (Heavy Duty Gasoline Trucks > 8,500 lbs < 60,000 lbs GVWR) or HDDV (Heavy Duty Diesel Trucks > 8,500 lbs < 60,000 lbs GVWR). The most conservative Emission Factor between the HDGV and GVWR was used to calculate emission rates.

(4) Buses are considered as medium duty (MDV5) vehicles for calculations purposed.

(5) Medium-Duty Vehicle definition (California): Any 1995 and subsequent model year heavy duty vehicle having a manufacturer's gross vehicle weight rating of 14,000 pounds or less.

(6) Particulate Matter Emission Factors are based on U.S. EPA AP42 "Chapter 13 : Miscellaneous Sources - Paved Roads"

(7) Emissions are based on the peak traffic hour

Existing Corridors - Mayfield (Scenario 5a) - Peak Hour
Vehicle Emissions

Road Length 4.3 km
2.7 miles

Equipment Type	No. of Units per day	Fuel Type
Cars & Trailers	621	Gasoline
Light Trucks	221	Gasoline
Heavy Trucks	47	Gasoline / Diesel
Buses	6	Diesel
Total	894	Gasoline / Diesel

	Emission Factors					Emission Rates							
Parameter	Cars and Trailers LDGV (g/mile)	Light Trucks LDGT12 (g/mile)	Heavy Trucks HDGV (g/mile)	Heavy Trucks HDDV (g/mile)	Buses (g/mile)	Cars & Trailers kg/hr	Cars & Trailers g/s	Light Trucks kg/hr	Light Trucks g/s	Heavy Trucks kg/hr	Heavy Trucks g/s	Buses kg/hr	Buses g/s
VOCs	0.592	0.652	0.891	0.352	1.304	0.988	0.274	0.387	0.108	0.112	0.031	0.020	0.006
NOx	0.481	0.594	1.875	5.481	2.770	0.802	0.223	0.353	0.098	0.688	0.191	0.042	0.012
CO	7.470	8.090	8.130	1.418	10.300	12.461	3.461	4.802	1.334	1.021	0.284	0.158	0.044

	Emission Factors	Emission Rates	
PARTICULATE MATTER	All Vehicles g/mile	All Vehicles kg/hr	All Vehicles g/s
PM 2.5	0.033	0.080	0.022
PM 10	0.758	1.820	0.506
TSP	4.497	10.805	3.001

TOTAL EMISSIONS	g/s
VOCs	0.418
NOx	0.524
CO	5.123
PM 2.5	0.022
PM 10	0.506
TSP	3.001

Notes & Assumptions:

(1) All pollutant emission factors for cars and trailers, light trucks and heavy trucks based on U.S. EPA 2003 Mobile Source Emission Factor Model "Mobile6".

(2) All pollutant emission factors for buses based on U.S. EPA 2000 "Federal and California Exhaust and Evaporative Emission Standards for Light-Duty Vehicles and Light-Duty Trucks". Certification and Compliance Division, Office of Transporta

(3) Cars and Trailers are considered LDGVs (Light Duty Gasoline Vehicles), Light trucks are considered LDGT (Light Duty Gasoline Trucks, 0-6000 lbs GVWR), Heavy trucks are considered either HDGV (Heavy Duty Gasoline Trucks > 8,500 lbs < 60,000 lbs GVWR) or HDDV (Heavy Duty Diesel Trucks > 8,500 lbs < 60,000 lbs GVWR). The most conservative Emission Factor between the HDGV and GVWR was used to calculate emission rates.

(4) Buses are considered as medium duty (MDV5) vehicles for calculations purposed.

(5) Medium-Duty Vehicle definition (California): Any 1995 and subsequent model year heavy duty vehicle having a manufacturer's gross vehicle weight rating of 14,000 pounds or less.

(6) Particulate Matter Emission Factors are based on U.S. EPA AP42 "Chapter 13 : Miscellaneous Sources - Paved Roads"

(7) Emissions are based on the peak traffic hour

Region of Peel - Mississauga Road Class EA Study
Existing Corridors - Wanless (Scenario 5b) - Peak Hour
Vehicle Emissions

Road Length 4.3 km
2.7 miles

Equipment Type	No. of Units per day	Fuel Type
Cars & Trailers	197	Gasoline
Light Trucks	70	Gasoline
Heavy Trucks	15	Gasoline / Diesel
Buses	2	Diesel
Total	284	Gasoline / Diesel

Parameter	Emission Factors: Cars and Trailers LDGV (g/mile)	Light Trucks LDGT12 (g/mile)	Heavy Trucks HDGV (g/mile)	Heavy Trucks HDDV (g/mile)	Buses (g/mile)	Emission Rates: Cars & Trailers kg/hr	Cars & Trailers g/s	Light Trucks kg/hr	Light Trucks g/s	Heavy Trucks kg/hr	Heavy Trucks g/s	Buses kg/hr	Buses g/s
VOCs	0.592	0.652	0.891	0.352	1.304	0.314	0.087	0.123	0.034	0.036	0.010	0.006	0.002
NOx	0.481	0.594	1.875	5.481	2.770	0.255	0.071	0.112	0.031	0.219	0.061	0.013	0.004
CO	7.470	8.090	8.130	1.418	10.300	3.959	1.100	1.526	0.424	0.324	0.090	0.050	0.014

PARTICULATE MATTER	Emission Factors: All Vehicles g/mile	Emission Rates: All Vehicles kg/hr	All Vehicles g/s
PM 2.5	0.033	0.026	0.007
PM 10	0.758	0.578	0.161
TSP	4.497	3.432	0.953

TOTAL EMISSIONS	g/s
VOCs	0.133
NOx	0.166
CO	1.627
PM 2.5	0.007
PM 10	0.161
TSP	0.953

Notes & Assumptions:

(1) All pollutant emission factors for cars and trailers, light trucks and heavy trucks based on U.S. EPA 2003 Mobile Source Emission Factor Model "Mobile6".

(2) All pollutant emission factors for buses based on U.S. EPA 2000 "Federal and California Exhaust and Evaporative Emission Standards for Light-Duty Vehicles and Light-Duty Trucks". Certification and Compliance Division, Office of Transporta

(3) Cars and Trailers are considered LDGVs (Light Duty Gasoline Vehicles), Light trucks are considered LDGT (Light Duty Gasoline Trucks, 0-6000 lbs GVWR), Heavy trucks are considered either HDGV (Heavy Duty Gasoline Trucks > 8,500 lbs < 60,000 lbs GVWR) or HDDV (Heavy Duty Diesel Trucks > 8,500 lbs < 60,000 lbs GVWR). The most conservative Emission Factor between the HDGV and GVWR was used to calculate emission rates.

(4) Buses are considered as medium duty (MDV5) vehicles for calculations purposed.

(5) Medium-Duty Vehicle definition (California): Any 1995 and subsequent model year heavy duty vehicle having a manufacturer's gross vehicle weight rating of 14,000 pounds or less.

(6) Particulate Matter Emission Factors are based on U.S. EPA AP42 "Chapter 13 : Miscellaneous Sources - Paved Roads"

(7) Emissions are based on the peak traffic hour

Existing Corridors - Bovaird (Scenario 5c) - Peak Hour
Vehicle Emissions

Road Length 4.3 km
2.7 miles

Equipment Type	No. of Units per day	Fuel Type
Cars & Trailers	1221	Gasoline
Light Trucks	435	Gasoline
Heavy Trucks	92	Gasoline / Diesel
Buses	11	Diesel
Total	1759	Gasoline / Diesel

Parameter	Emission Factors: Cars and Trailers LDGV (g/mile)	Light Trucks LDGT12 (g/mile)	Heavy Trucks HDGV (g/mile)	Heavy Trucks HDDV (g/mile)	Buses (g/mile)	Emission Rates: Cars & Trailers kg/hr	Cars & Trailers g/s	Light Trucks kg/hr	Light Trucks g/s	Heavy Trucks kg/hr	Heavy Trucks g/s	Buses kg/hr	Buses g/s
VOCs	0.592	0.652	0.891	0.352	1.304	1.943	0.540	0.762	0.212	0.220	0.061	0.039	0.011
NOx	0.481	0.594	1.875	5.481	2.770	1.579	0.439	0.694	0.193	1.354	0.376	0.083	0.023
CO	7.470	8.090	8.130	1.418	10.300	24.518	6.811	9.449	2.625	2.008	0.558	0.310	0.086

PARTICULATE MATTER	Emission Factors: All Vehicles g/mile	Emission Rates: All Vehicles kg/hr	All Vehicles g/s
PM 2.5	0.033	0.158	0.044
PM 10	0.758	3.581	0.995
TSP	4.497	21.260	5.905

TOTAL EMISSIONS	g/s
VOCs	0.823
NOx	1.031
CO	10.079
PM 2.5	0.044
PM 10	0.995
TSP	5.905

Notes & Assumptions:

(1) All pollutant emission factors for cars and trailers, light trucks and heavy trucks based on U.S. EPA 2003 Mobile Source Emission Factor Model "Mobile6".

(2) All pollutant emission factors for buses based on U.S. EPA 2000 "Federal and California Exhaust and Evaporative Emission Standards for Light-Duty Vehicles and Light-Duty Trucks". Certification and Compliance Division, Office of Transporta

(3) Cars and Trailers are considered LDGVs (Light Duty Gasoline Vehicles), Light trucks are considered LDGT (Light Duty Gasoline Trucks, 0-6000 lbs GVWR), Heavy trucks are considered either HDGV (Heavy Duty Gasoline Trucks > 8,500 lbs < 60,000 lbs GVWR) or HDDV (Heavy Duty Diesel Trucks > 8,500 lbs < 60,000 lbs GVWR). The most conservative Emission Factor between the HDGV and GVWR was used to calculate emission rates.

(4) Buses are considered as medium duty (MDV5) vehicles for calculations purposed.

(5) Medium-Duty Vehicle definition (California): Any 1995 and subsequent model year heavy duty vehicle having a manufacturer's gross vehicle weight rating of 14,000 pounds or less.

(6) Particulate Matter Emission Factors are based on U.S. EPA AP42 "Chapter 13 : Miscellaneous Sources - Paved Roads"

(7) Emissions are based on the peak traffic hour

APPENDIX 2

SAMPLE CALCULATIONS

Sample Calc #1: Emission Factors – Particulate Matter

Reference: U.S. EPA AP42 "Chapter 13: Miscellaneous Sources – Paved Roads"

$$E = k * \left(\frac{sL}{2}\right)^{0.65} * \left(\frac{W}{3}\right)^{1.5} - C$$

Where, E = Particulate emission factor (units matching the units of k)
k = Particle size multiplier for particle size range (ref. EPA) = 1.1 g/VMT
sL = Road surface silt loading (g/m^2) = 0.1 g/m^2
W = Average weight (tons of the vehicles traveling the road) = 2.7 ton
C = Emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear

Note: VMT = Vehicle Mile Traveled

<u>For PM2.5:</u>

$$E = 1.1\frac{g}{VMT} * \left(\frac{0.1\frac{g}{m^2}}{2}\right)^{0.65} * \left(\frac{2.7ton}{3}\right)^{1.5} - 0.1005\frac{g}{VMT} = 0.033\frac{g}{VMT}$$

Sample Calc #2: Emission Rate – Scenario 1 (current Mississauga Rd) Particulate Matter (PM2.5)

$$R = \frac{E * L * N}{3600}$$

Where, R = Emission Rate (g/s)
E = Particle emission factor (g/VMT) = 0.033 g/VMT
L = Length of road traveled (miles) = 2.7 miles
N = Peak number of vehicles on road (vehicles / hour) = 707 vehicles / hour

$$R = \frac{E * L * N}{3600}$$

$$R = \frac{0.033\frac{g}{VMT} * 2.7miles * 707\frac{vehicles}{hr}}{3600\frac{s}{hr}}$$

$$R = 0.018\frac{g}{s}$$

AECOM

C.8 Geotechnical/Hydrogeology Report

REPORT ON GEOTECHNICAL/ PRELIMINARY HYDROGEOLOGICAL INVESTIGATION MISSISSAUGA RD. CLASS EA BOVAIRD DR. TO MAYFIELD RD. CITY OF BRAMPTON, REGION OF PEEL

AECOM
105 Commerce Valley Drive West, 7th floor
Markham, Ontario L3T 7W3

Ref. No. G-08.0607
December 2008

Coffey Geotechnics Inc.
351 Steelcase Rd. W., Unit 10 Markham Ontario L3R 4H9 Canada

CONTENTS

PART A - FACTUAL DATA

PART B – GEOTECHNICAL/HYDROGEOLOGICAL INTERPRETATION AND RECOMMENDATIONS

CONTENTS

PART A - FACTUAL DATA

1. INTRODUCTION

Coffey Geotechnics, formally Geo-Canada ltd., was retained by AECOM, on behalf of the Region of Peel, to carry out a geotechnical /preliminary hydrogeological investigation in connection with the Municipal Class EA study for the widening of Mississauga Road between Mayfield Road and Bovaird Dr., located in the City of Brampton, Ontario. The project also includes a structure over Huttonville Creek and grade separation at the Canadian National Railway tracks.

To investigate the subsurface soil and groundwater conditions, fourteen (14) boreholes were drilled along Mississauga Rd., beginning with Borehole 08-1 (approximately 60m north of Bovaird Dr.) at the southern limit and ending with Borehole 08-14 (50m south of Mayfield Rd.) at the north end (approximate length 5.3km). To assess the thickness of the existing pavement structure, e
ight (8) 100mm dia. cores were drilled through the existing asphaltic concrete pavement beginning with C 1 (near Borehole 08-1) and ending with C 14 (near Borehole 08-14). Codes C 3 through C 8 were not used.

The report is presented in two parts: **Part A** contains the factual data of the investigation, including a description of the site, geology and hydrogeological setting, the method of investigation, the field and laboratory work and test results. **Part B** contains the interpretation of the data, and the evaluation of the anticipated geotechnical, pavement and hydrogeological related construction conditions of the project.

The anticipated construction conditions are described in this report for the benefit of the design engineer (AECOM) in order that their impact on the design can be evaluated and constructibility established. Construction methods described in this report must not be considered as specifications or recommendations to the contractor or as the only suitable methods. Prospective contractors should evaluate all of the factual information, obtain additional subsurface data as they might deem necessary, and select their construction methods, sequencing and equipment based on their own experience.

2 SITE AND GEOLOGY

The site is located along Mississauga Rd. from Mayfield Rd. to Bovaird Dr. in Brampton, Ontario. The lands on both sides of Mississauga Road are predominantly farm land.

The existing grade along the centreline of Mississauga Rd. falls gently from El. 238.2±m at Sta. 1+00 (Bovaird Dr.) to El. 237.2±m at Sta. 1+200, from where it rises gently to El. 260.1± m at Sta 3+900 and remains more or less at this elevation to Sta. 5+000. From this point continuing for another 300m, the grade rises to El. 264.5±m at Mayfield Rd.

Within the study limits, Mississauga Rd. crosses an existing CN railway right of way (Sta. 1+830±) as well as Huttonville Creek (Sta. 1+480±) which is located just south of the railway tracks. The creek is approximately 1m wide and flows through an open footing concrete box culvert. The CN crossing is presently a signalled level crossing with single track.

At this EA stage, conceptual designs for both a road/rail overpass or underpass are under consideration.

The surficial geology of the project site is relatively consistent, typically consisting of Halton till of silty clay to silty sand texture over bedrock of the Queenston Shale Formation. Interbedded within the till at random locations and of variable thickness are cohesionless granular deposits.

3 PREVIOUS GEOTECHNICAL STUDIES

The records of previous investigations were examined, but only one was found to contain relevant information.

- Alston Associates Inc. carried out an investigation for construction of a feedermain along Mississauga between Bovaird Dr. and Mayfield rd and along Mayfield Rd. between Mississauga Rd. and Creditview Rd. Boreholes 4 to 17 are located along this section of Countryside Drive and the logs of these boreholes are included in **Appendix D** for the convenience of the reader.

The approximate locations of the boreholes drilled as part of the previous investigation are presented on **Drawings No. 1 to 6** together with the boreholes put down by Coffey Geotechnics during the present investigation. The Coffey Geotechnics boreholes are denoted as 08-1 through 08-14.

4 METHOD OF INVESTIGATION

The field work for the present investigation consisted of putting down fourteen (14) boreholes (Boreholes 08-1 to 08-14) and eight (8) 100mm dia. asphalt concrete cores (C 1 to C 2 and C 9 to C 14) at the locations shown on **Drawings No. 1 to 6**. Photographs of the recovered asphalt core samples are shown in **Appendix C.**

The boreholes were drilled between August 28 and 29, 2008 by Canadian Soil Drilling Inc., using 110mm dia. solid stem augers. Engineering staff from Coffey Geotechnics provided technical supervision of the drilling and sampling procedures, recorded the sampling details and soil stratigraphy, classified the soil samples by tactile and visual methods and checked the groundwater levels.

All of the boreholes were drilled from the existing shoulders of Mississauga Road. The ground elevations at the location of the boreholes were estimated based on the geodetic elevations shown in the electronic site plan provided to us by AECOM. As such, the borehole elevation should be considered accurate to no better than ±0.3m.

The soil stratigraphy was recorded by observing the augered materials which were withdrawn from the boreholes, and by sampling the soils at 0.75m intervals of a depth to 5m to 6.6m then at 1.5m intervals to the end of borings at depths ranging from 9.2m to 10m below the ground surface using a 50 mm O.D. split spoon sampler, in accordance with the standard penetration test (ASTM D 1586) method. This sampling method recovers samples from the soil strata, and the number of blows required to drive the sampler 0.3m into the undisturbed soil (SPT 'N'-values) gives an indication of the compactness condition or consistency of the sampled soil material.

Groundwater levels were measured in every borehole after completion of drilling, and for the observation of the long-term groundwater conditions, stand-pipe type piezometers/monitoring wells were installed within seven (7) boreholes (Boreholes 08-1, 08-3 through 08-5, 08-8, 08-11 and 08-14). Water levels in the piezometers/wells were measured on September 8, 2008, 10 days after they were installed. Recorded piezometric levels are shown on the borehole log sheets presented in **Appendix A** and are also tabulated on Table 5.9.1.

The soil samples were taken to our laboratory where they were re-examined and classified by a senior geotechnical engineer. Selected representative samples were subjected to laboratory testing. The testing program consisted of the measurement of the natural moisture contents of all samples, grain size analyses for fifteen (15) selected samples and consistency (Atterberg) limits for one (1) selected sample of plastic, cohesive soil. Test results are shown on the individual borehole log sheets presented in **Appendix A**. The grain size distribution curves and the results of the consistency (Atterberg) limits tests are plotted on Figures 1 to 7 attached to this report in **Appendix B**.

To assess options for on-site reuse or offsite disposal, six (6) soil samples were analyzed for metals and inorganic parameters listed in the soil standards for use under part xv.1 of the environmental protection act.

In addition, a basic pavement evaluation was carried out in order to provide a general impression of the relative condition of the existing pavement. The pavement evaluation was not designed to detail the exact nature and extent of all of the pavement defects across the site. The distress of the existing pavement was assessed in terms of cracking, surface defects (flushing and raveling) and surface deformations (rutting, shoving etc.). Pavement cracking was the predominant form of distress observed during the evaluation. Pavement cracking was assessed in general accordance with the guide for describing severity of pavement distress as presented in the Ontario Ministry of Transportation Pavement Design and Rehabilitation Guide (1990). The evaluation was carried out across all lanes of the roadway along the length under consideration. However, it is noted that due to traffic all observations were made from the shoulder areas only. The results of the pavement evaluation are shown in **Appendix C.**

5 SUMMARIZED SURFACE AND SUBSURFACE CONDITIONS

The following description of the sub-surface conditions and stratigraphy encountered in the boreholes is of a general nature only. For more specific details, the pavement evaluation in **Appendix C** and individual borehole logs in **Appendix A** should be consulted.

5.1 Pavement

Mississauga Rd. is asphalt surfaced. The pavement structure appears to be a "deep-strength" design. Existing asphalt pavement is generally in a good condition. Evidence of distress, such as patches, longitudinal cracking, transversal cracking, crocodile cracking and some flushing and rutting were observed locally along the roadway. Photographs 1 to 17 in **Appendix C** show the pavement conditions. Table C1 in **Appendix C** summaries the pavement evaluation based on the MTO "Pavement Design and Rehabilitation Manual" (1990).

Asphalt concrete coring was carried out in the centre of a lane. The thickness of asphalt ranges from 190mm to 235mm at the coring locations. 3 to 5 asphalt layers were observed in the asphalt core samples, some of which are debonded from one another. Steel fibres are present in one layer at some locations. The pavement core data are summarized in Table C2 in **Appendix C**. The photographs of the recovered asphalt core samples are shown in **Appendix C**. Table 5.1 shows the asphalt thickness at the coring locations.

All boreholes were drilled from Mississauga Road or at the shoulder, where the ground surface was covered by 200mm asphalt and/or 350 to 3000mm of granular fill. The thicknesses of asphalt and granular base/fill at borehole location are summarized in Table 5.1. The value of Granular Base Equivalency (GBE) has been estimated based on 1.25 and 0.7 for the existing asphaltic concrete and existing granular fill respectively, in accordance with MTO practise.

The density of **granular fill** was found to be very loose to compact, as inferred from SPT 'N' values of 2 to 23 blows per 0.3m penetration. The natural moisture content measured in the test samples from the granular materials ranged from 3 to 7%. Two (2) tested samples of the granular fill contain 39 to 40% gravel, 45 to 48% sand, 10 to 11% silt and 3 to 4% clay size particles. The grain size distribution curves for the samples are presented on Figure 1 in **Appendix B**. The upper limits and lower limits of OPSS Granular "B" Type I and Type II are also shown in Figure 1. The fines contents in the two test samples are higher than the upper limit of 8%/10% of Granular "B" Type I and Type II.

Table 5.1: Thicknesses of Asphalt and Granular Fill at Core/Borehole Locations

Location	Borehole no.	Core no.	Asphaltic concrete (mm)	Granular fill (mm)	Granular base equivalency (mm) (*)
Sta. 1+050 sbl		1	235		609
Sta. 1+050 sbl	08-1		200	450	565
Sta. 1+280 sbl		2	190		553
Sta. 1+280 sb shoulder	08-2			450	
Sta. 1+470 nb shoulder	08-3			500	
Sta. 1+490 sb shoulder	08-4			750	
Sta. 1+790 nb shoulder	08-5			3000	
Sta. 1+795 sb shoulder	08-6			600	
Sta. 1+845 nb shoulder	08-7			600	
Sta. 1+855 sb shoulder	08-8			600	
Sta. 2+050 sbl		9	210		683
Sta. 2+050 sb shoulder	08-9			600	
Sta. 2+275 sbl		10	200		499
Sta. 2+275 shoulder	08-10			355	
Sta. 2+960 nbl		11	215		654
Sta. 2+960 nb shoulder	08-11			550	
Sta. 3+790 nbl		12	215		619
Sta. 3+790 nb shoulder	08-12			500	
Sta. 4+550 nbl		13	220		590
Sta. 4+550 nb shoulder	08-13			450	
Sta. 5+280 nbl		14	190		658
Sta. 5+280 nb shoulder	08-14			600	
Minimum			190	355	499
Maximum			235	3000	683
Average			207	539	603

(*) The granular fill under the asphaltic concrete was taken as the same as encountered in the nearby borehole in the calculation of granular base equivalency.

5.2 Topsoil and Fill

Topsoil was encountered at the ground surface in some of Alston's boreholes, generally mixed with gravel, sand, silt and clay. Where encountered, the thickness of these materials varied between 0.1m and 0.2m.

Fill deposits were found in the majority of boreholes extending to depths of 0.6m to 3.0m below existing ground surface. The fills are mainly composed of silty clay to sand and gravel. The consistency of the cohesive fills was found to be firm to stiff, as inferred from SPT 'N' values of 5 to 9 blows per 0.3m penetration. The compaction condition of cohesionless fills ranged from very loose to compact, as inferred from SPT 'N' values of 2 to 12 blows per 0.3m penetration. The natural moisture content measured in the test samples from the fill materials ranged from 4 to 25%.

5.3 Probable Fill

Further probable fill of clayey silt texture was noted below the upper fill material identified in Boreholes 08-4, 08-7 and 8-11 to the depths of 1.5 to 3.0m. The natural moisture contents measured in the test samples was very high and ranged from 18 to 35%. On the basis of SPT 'N' values of 2 to 8 blows/300mm, this layer is considered to be very soft to stiff.

Probable fill of gravelly sand to sand and gravel texture was found below the upper fill material in Boreholes 08-7 and 08-8 to depths of 2.3m to 2.4m (El. 242.4m to 242.5m). The state of compaction of the material varies from loose to compact.

Consistency (Atterberg) limit test on one (1) sample of the clayey silt fill indicates a liquid limit of 41%, plastic limit of 23% and plasticity index of 18% (see Figure 7 in **Appendix B**). These values indicate that the clayey silt fill is categorized as low plasticity silty clay (CL) under the unified soil classification system

5.4 Silty Clay

Silty clay directly underlies the fill/probable fill in Boreholes 08-8, 08-9, 08-10 and 08-13. It extends to depths of 1.4 to 2.3m below ground level and is stiff in consistency.

Figure 2 in **Appendix B** shows the result of one (1) particle size analysis performed on a sample of silty clay. The tested sample contains 1% gravel, 7% sand, 57% silt and 35% clay size particles.

5.5 Silty Clay Till To Clayey Silt Till

Cohesive glacial tills of silty clay and clayey silt texture were encountered in the majority of boreholes below the granular fill/fill/probable fill or silty clay at depths ranging from 1.5 to 7.0m below ground level. The consistency of these soils were found to be very stiff to hard, as inferred from SPT 'N' values of 23 to greater than 50 blows per 0.3m penetration. The natural moisture content measured in the test samples from the till materials ranged from 7 to 18%.

Figure 3 in **Appendix B** shows the results of three (3) particle size analyses performed on selected samples of clayey silt till to silty clay till. The tested samples contain 2 to 13% gravel, 24 to 33% sand, 37 to 49% silt and 17 to 25% clay size particles.

On the basis of SPT samples, the presence of shale and limestone fragments as well as cobbles and occasional boulders in the till soil is inferred.

5.6 Sandy Silt Till to Silty Sand Till

Low-plastic sandy silt to silty sand glacial tills were encountered in compact to very dense conditions in the majority of boreholes embedded within or above the silty clay till to clayey silt till. The natural moisture content measured in the test samples from the till materials ranged from 6 to 21%.

Figure 4 in **Appendix B** shows the results of four (4) particle size analyses performed on selected samples of sandy silt to silty sand till. The tested samples contain 9 to 19% gravel, 30 to 45% sand, 35 to 39% silt and 9 to 13% clay size particles. Similar to the silty clay till, occasional cobbles and boulders should also to be expected in the sandy silt/silty sand till.

5.7 Silt to Gravelly Sand

Cohesionless silt to gravelly sand were encountered in compact to very dense conditions in the majority of boreholes within or above the glacial till. The natural moisture content measured in the test samples of these materials ranged from 7 to 22%.

Figure 5 in **Appendix B** shows the results of three (3) particle size analyses performed on selected samples of silt (non-plastic) to sand and silt. The tested samples contain 0 to 4% gravel, 11 to 41% sand, 52 to 79% silt and 6 to 10% clay size particles. These soils are dilatant in nature.

Figure 6 in **Appendix B** shows the results of two (2) particle size analyses performed on selected samples of sand to gravelly sand. The tested samples contain 8 to 28% gravel, 55 to 81% sand, 7 to 13% silt and 4% clay size particles.

5.8 Queenston Formation

Bedrock was encountered in Boreholes 08-1, 08-5, 08-6, 08-7, 08-8 and 08-11. The bedrock in these boreholes was penetrated by augering with moderate to hard effort. Visual examination of the spoon samples indicates that the rock belongs to the Queenston Formation, which generally consists of horizontally bedded, weak to medium strong, reddish brown shale interbedded with grey, strong siltstone and limestone.

5.9 Groundwater

5.9.1 Groundwater Level in Open Boreholes And Piezometers

One (1) of fourteen (14) boreholes (Borehole 08-9) was dry upon completion of drilling. The remaining boreholes encountered water at some depths. Beware, however, that these are short-term observations which may not be indicative of the longer term groundwater level.

Piezometers were installed in seven (7) boreholes (Boreholes 08-1, 08-3, 08-4, 08-5, 08-8, 08-11, and 08-14) for long-term water-level observations. Ten (10) days after they were installed (i.e. on September 8, 2008), the groundwater levels in the piezometers were between 1.5 and 2.8m depth (between El. 235.7 and 262.4m). Over the long term, seasonal fluctuations in the groundwater level are expected. We recommend that the piezometric levels be further monitored.

Groundwater measurements in the piezometers installed in this investigation are shown on the attached borehole logs and are also summarized on Table 5.9.1.

Table 5.9.1: Measured Water Levels in Piezometers

BH No.	Ground Surface El. (m)	Piezometer Dia. (mm)	Depth/Water Level El. (m) [Sept. 8/08]
08-1	237.7	19	1.8 / 235.9
08-3	240.0	38	2.5 / 237.5
08-4	240.0	38	2.7 / 237.3
08-5	244.3	38	2.7 / 241.6
08-8	244.7	38	2.8 / 241.9
08-11	251.9	19	1.5 / 250.4
08-14	263.9	19	1.5 / 262.4

5.9.2 Groundwater Use

Records of MOE registered water wells in the MOE database located within a 1000m radius of the project limits were obtained. **Drawing Nos. 7 to 10** show the approximate locations of these registered water wells.

The information on these registered wells is provided in **Appendix F**. Well depths range from 4.3 to 54.9m below grade with an average depth of approximately 20m. The pump levels ranges from 2.1 to 42.7m below grade with an average value of approximately 15m.

Table 5.9.2 summaries details of the registered wells within a 100m radius of the project limits which are of greater relevance to this project. The groundwater levels in these wells range from 1.2 to 12.5m. Well depths range from 5.2 to 21.3m below grade with an average depth of approximately 9.7m. The pump levels range from 2.4 to 18.3m below grade with an average value of approximately 8.8m.

Table 5.9.2: List of Registered Wells Within 100m Radius Of Project Limits

Well Number	Water Level Depth (m)	Pump Level Depth (m)	Water Use	Well Depth (m)	Soil Types At Possible Screen Location
4907736	3.05	10.67	Domestic	10.97	Grey clay
4905250	3.66		Domestic	10.97	
4905393	1.22		Domestic	10.36	
4905392	1.22	9.75	Domestic	9.75	Red shale
4901914	3.66		Domestic	7.01	
4909607			Not used	7.92	
4909608			Not used		
4905929	2.13		Domestic	9.75	
4901918	4.57		Domestic	9.45	
4901920	12.5		Domestic Livestock	16.5	
4902024	1.83		Domestic Livestock	6.1	
4902021	2.44	2.44	Domestic	13.72	Grey clay medium sand
4905363	3.66	7.01	Domestic	8.84	Brown gravel sand stones
4902022			Industrial	6.1	
4903176	9.14	18.29	Domestic	21.34	Red shale
4907874	2.44	8.23	Domestic Livestock	13.41	Blue shale
4903275	1.52		Domestic	5.18	
4902025	6.1		Domestic	10.97	
4906871			Domestic	10.06	
4906878	3.35	5.49	Domestic	9.75	Grey sand
4908838	3.66		Domestic	8.23	
7102522				5.79	
7106424					
7052301				5.18	
7052306				5.18	

PART B – GEOTECHNICAL/HYDROGEOLOGICAL INTERPRETATION AND RECOMMENDATIONS

6 DISCUSSION OF RESULTS

6.1 General

The following sections contain the interpretation of the collected data and the evaluation of the anticipated behaviour of the various soil deposits during the construction of the road upgrading and widening. It should be noted that the opinions expressed in this report should not be considered as recommendations with respect to construction methodology. Instead, the purpose of the opinions expressed is to provide the designer (AECOM) with information to evaluate construction feasibility and to emphasize items for consideration when preparing the construction specifications.

Contractors planning to submit tenders for the construction of this project should make their own evaluation and interpretation of the factual data presented and summarized in this report, and select the most suitable and economical construction methods based on their knowledge and previous experience under similar subsurface conditions. Further limitations are outlined in the attached document entitled 'Important Information about Your Coffey Report'.

For the purposes of discussion and design recommendations, the project is divided into three parts. The first part deals with the watercourse crossing structure at Sta. 1+470, the second part covers the possible Mississauga Rd./CNR grade separation, and the third part presents pavement design recommendations.

6.2 Watercourse Crossing Structure at Sta. 1+470

Mississauga Road presently crosses the Huttonville Creek at Sta. 1+470 in the form of a concrete box culvert. Since the improvements and possible widening of the road are required, the existing culvert will be extended or replaced. A stratigraphic profile along Mississauga Road at the existing culvert location is provided in the attached **Drawing No. 1**. The subsurface conditions are listed in Table 6.2.

Table 6.2: Subsurface Condition at Existing Culvert

Location	Sta.	Borehole No.	Soil type	Water Table
Huttonville Creek	1+470	08-3; 08-4	2.3 to 3.0m thick fill/probable	2.5 to 2.7m below

			fill underlain by compact/very stiff sandy silt till to clayey silt till embedded with compact to dense gravelly sand	grade (Elev. 247.3 to 237.5m)

6.2.1 Foundation

The culvert should be supported on compact/very stiff native sandy silt to clayey silt till. In their undisturbed conditions, these soils will provide adequate support to the foundation. An allowable (SLS) bearing resistance value of 200 kPa and factored ULS bearing capacity of 300 kPa can be assumed for strip footing foundations at El. 237m. Total and differential settlements under a vertical working load equal to SLS capacity are estimated to be less than 20 and 15mm respectively.

Soil conditions at shallower depths are not suitable for founding. Similarly excavation for footings below El. 237m should be as avoided since this will be well below the water table in cohesionless soils, prone to flowing.

6.2.2 Lateral Earth Pressure

Computation of earth pressure can be calculated from the parameters (unfactored) shown in Table 6.2.2.

Table 6.2.2: Geotechnical Parameters (Unfactored) for Design of Rigid Box Culvert

Backfill Material	Unit Weight	Coefficient of Lateral Earth Pressure
	(kN/m^3)	Ko
Compacted Granular 'A'	22	0.43
Compacted Granular 'B'	21	0.47

The values shown in Table 6.2.2 are based on the assumption that the backfill behind the retaining structure is free-draining and adequate drainage is provided. As well, it is assumed that the ground behind the retaining structure is level.

The effect of compaction should also be taken into account in the selection of the appropriate earth pressure coefficients in accordance with Section 6.9 of the CHBDC.

6.2.3 Subgrade Preparation

Upon reaching the design foundation level, the subgrade at the base of the excavation should be inspected by geotechnical personnel familiar with this report. Where boulders protrude into the subgrade, they should be removed and replaced with low strength concrete (10MPa). It is recommended that the subgrade on which the concrete box culvert will be supported be protected, shortly after the excavation is completed and inspected, by placing a minimum thickness of 75mm **working mat** of lean mix concrete.

The base of the culvert should be provided with a minimum of 1.2m earth cover or its thermal equivalent of exterior-grade extruded polystyrene insulation for frost protection.

6.2.4 Construction Conditions

The groundwater level was recorded at 2.5 to 2.7m below the existing ground surface in the borings and piezometers, but should be expected to lie at creek level for practical purposes. Standing surface water should be expected in the flood plains.

The hydraulic conductivity (permeability) of the glacial till and granular soil is estimated to range from 10^{-3} to 10^{-5} cm/s. Perched groundwater will be directly recharged by the creek and a gravity drain system will not be adequate. Considerable over-land surface water flow is also expected to occur towards the low-lying areas. We therefore recommend that the excavation for the construction of culvert be carried out inside a "watertight" cofferdam consisting of driven interlocking steel sheet piles. The toe of the sheet piles should be driven at least 1.5m below the excavation level to reduce the potential of uplift failure. The construction of cofferdam and excavation may be carried out in a progression such that surface creek flow is maintained. If only one cofferdam is employed for the excavation, the surface creek flow may be accommodated by a deviated channel or by by-pass pumping, if permitted by the regulatory agencies.

Inside the sheet piling, assumes it is toed deep enough onto cohesive soils well below the base of excavation, the rate of groundwater seepage through glacial till/granular soils is expected to be slow to medium, and can be handled by gravity drainage and pumping from filtered sumps established at the base of the excavation.

For the design of steel sheet piling, the coefficient of active lateral earth pressure K_a can be taken as 0.3 and coefficient of passive lateral earth pressure K_p can be taken as 3.0.

Backfill behind the concrete box culvert should consist of non-frost susceptible, free draining granular material (OPSS Granular 'A') in accordance with the Ontario Provincial Standards (OPSD-3501.00). Backfill should be placed in lifts not exceeding 300 mm before compaction and each lift should be uniformly compacted to at least 98% of the material's Standard Proctor Maximum Dry Density (SPMDD) at a placement water content of ±2% of optimum. The fill must be placed simultaneously on either side of the culvert such that at no time is the fill level on one side more than 0.5m higher than the other side.

6.3 Mississauga Rd./CNR Grade Separation

Mississauga Road crosses CN rail at Sta. 1+820. This project may include the construction of a grade separation at the railway tracks. The separation could be either an overpass or underpass of the railway. For the overpass, the road grade will be raised some 8 to 10m above its existing profile and the road will be connected by a new bridge in order to pass over the railway. For the underpass, the road grade will be dropped some 8 to 10m below its existing profile in order to pass underneath a new CNR overhead bridge.

6.3.1 Overview of Subsurface Conditions

Subsurface conditions at the Mississauga Road/CNR grade separation site were investigated in boreholes 08-5, 08-6, 08-7 and 08-8. A stratigraphic profile along Mississauga Road at this location is provided in the attached **Drawing No. 2**.

In simplified terms, the subsurface profile consists of very loose to compact fill/probable fill underlain by a native clayey silt to sandy silt glacial till sheets intersected by a layer of silt to gravelly sand. These native deposits are in a dense to very dense condition or are stiff to hard in consistency. The glacial till was found to contain cobbles/boulders.

The till sheet is, in turn underlain by the Queenston Formation of shale embedded with siltstone/limestone at 8 to 10m below the ground surface.

The groundwater table lies near El. 241.9 or about 3m below rail grade at the crossing.

6.3.2 Overpass Road Bridge Option

A review of the available four (4) boreholes at the possible bridge structure locations suggests that there are two (2) possible alternatives for founding the structure. The most economical option is conventional spread footings. As an alternative to the spread footings (semi-integral abutments) constructed as "perched" abutments on an engineered fill embankment or directly on native soils. The use of perched abutments would, however, require pre-loading. As an alternative to the spread footing, the use of driven steel H-piles could be considered which are amenable to integral type abutments. Drilled cast-in-place piles (caissons) could also be considered but are not suitable for integral abutments.

6.3.2.1 *Spread Footing*

For the overpass road bridge, the bridge abutments could be supported on an engineered fill embankment or on the very stiff to hard clayey silt till or dense sandy silt till. In their current undisturbed state, an allowable (SLS) bearing resistance value of 250 kPa and factored ULS bearing capacity of 375 kPa can be assumed for the foundations at or below El. 241m at Boreholes 08-7 and 08-8 and at or below El. 239 at Boreholes 08-5 and 08-6.

Resistance against basal sliding of the footing may be calculated as 0.67 x tan ø, where ø = 35°, and this is the ultimate value against which a factor of safety of 1.25 is needed in working stress design.

The available passive pressure acting to restrain the footings in front of the footings can be calculated based on an unfactored K_p value of 3.5. A factor of safety of 2.0 should be applied to the passive soil resistance.

Subgrade preparation is discussed in **Section 6.2.3**. Subexcavation to 3m inside fill/probable fill is expected for the construction of spread footing. Excavations deeper than 3m to 4m below the existing ground surface will penetrate pervious strata. The excavations should be carried out with 2h:1v side slopes. The base of the excavation should be kept dry. For excavations <3m deep, this could possibly be achieved by providing filtered interceptor trenches around the excavation, where perched water and surface water can be removed by pumping. For deeper excavations, a double line closely spaced vacuum wellpoint system is needed.

6.3.2.2 *Driven Steel Piles*

For piles driven to practical refusal into hard clayey silt till/very dense silty sand/shale bedrock at elevations of 234 to 235m, the factored axial, uplift and lateral capacities at the ultimate limit state (ULS) for steel H-piles are outlined in Table 6.3.2.2a. An allowance for corrosion of 0.02 mm/year (i.e. 0.01mm per side) over a life of 100 years has been considered for the H-pile in the calculation of lateral pile capacity.

If integral abutments are not constructed, then the lateral resistance of the piles can be supplemented, if desired, by the horizontal components of battered piles. In this instance, we recommend that that batter be limited to no more than 4:1, since greater batter may require special pile driving leads. As well, minimizing batter is necessary to prevent excessive bending of battered piles, as the overlying soils settle under the load imposed by the high approach fills.

The minimum spacing between piles should be in accordance with Clause 6.8.9.2 of the CAN/CSA-S6-00, Canadian Highway Bridge Design Code.

Table 6.3.2.2a: Factor ULS Capacities For Piles

Pile type	Factored ULS Axial Capacity (kN)	Factored ULS Lateral Capacity (kN)	Factored ULS Uplift Capacity (kN)
HP310x110 steel H pile Grade 350w	1000	130	180

The lateral movement can be calculated from the coefficient of horizontal subgrade reaction, k_s. The value of k_s may be computed using the following equation:

In cohesionless soils: $k_s = n_h z/b$

In cohesive soils: $k_s = 67\, c_u/b$

Where

z = depth (m)

b = pile width (m)

n_h = constant of horizontal subgrade reaction (kN/m³)

= 800 kN/m³ for silt to gravelly sand/silty sand till for SPT N-values of 2 to 10

= 4400 kN/m³ for silt to gravelly sand/silty sand till for SPT N-values of 11 to 30

= 10700 kN/m³ for silt to gravelly sand/silty sand till for SPT N-values > 30

c_u = undrained shear strength of clayey soil (kPa)

= 20 kPa for SPT N-value of 2 to 7

= 60 kPa for SPT N-value of 8 to 14

= 100 kPa for SPT N-value > 15

The pile capacities under the serviceability limit state (SLS) are provided in Table 6.3.2.2b. For calculating pile settlement, the soil and weathered rock elastic modulus can be taken as 50000 kPa. Total settlements under the vertical working load equal to SLS capacity, including the elastic compression of the piles, are estimated to be less than 15mm. The lateral movements under the lateral working load equal to the SLS capacity are expected to be less than 15mm.

Table 6.3.2.2B: SLS Capacity for Piles

Pile type	Axial Capacity (kN)	Lateral Capacity (kN)	Uplift Capacity (kN)
Φ324mmx16mm wall steel tubular pile, closed ended grade 350W	650	70	100
HP310x110 steel H pile, Grade 350W	750	90	130

At least two (2) static pile load tests are recommended (minimum 1 per each bridge site) to verify the pile capacities shown in Tables 6.3.2.2A and 6.3.2.2B at this site.

For the driving of HP310x110 steel piles, the hammer should be capable of delivering a rated energy of at least 55 kJ/blow. After reaching the approximate founding elevations, the driving should be controlled using the Hiley Formula assuming an ultimate capacity of 2500 kN for HP310x110 steel H piles.

HP310x110 piles should be fitted with flange plates as per OPSD 3301.00.

It is possible that the piles may drive several metres below the estimated pile tip elevations. In order to minimize construction claims associated with shorter or longer-than-anticipated pile lengths, the piling contract should be flexible and equitable in payment by unit rates, with close supervision during driving to avoid overdriving.

Overdriving in bedrock can cause shattering of the rock, leading to pile relaxation problems.

At least 25% of the piles driven at each support element should be re-tapped not less than 24 hours after the driven of the piles to check that relaxation has not occurred. If it has, all piles should be re-tapped.

The base of the pile caps should be provided with a minimum of 1.2m earth cover or its thermal equivalent of exterior-grade extruded polystyrene insulation for frost protection.

6.3.2.3 *Abutments and Lateral Earth Pressure*

Backfill behind the abutments must consist of free-draining OPS Granular "A" or 'B' fill material compacted to 95% of its standard proctor maximum dry density (SPMDD) at a placement water content within ±2% of Optimum. For the geotechnical design parameters refer to table 6.3.2.3.

The geometry of the backfill wedge and drainage provisions should follow OPSD-3501. Computation of earth pressure should be in accordance with the Canadian Highway Bridge Design Code. For design purposes, the parameters (unfactored) shown in Table 6.3.2.3 can be used.

Table 6.3.2.3: Geotechnical Parameters (Unfactored) For Design of Abutment Wall

Backfill Material	**Unit Weight**	**Coefficient Of Lateral Earth Pressure**	
	(kN/m^3)	$Ka^{(1)}$	$Ko^{(2)}$
Compacted Granular 'A'	22	0.27	0.43
Compacted Granular 'B'	21	0.31	0.47

Note : (1) K_a for walls which deflect $\delta > 0.001h$ were h = wall height and

Rotation exceeds $\delta/h > 0.002$ at the base of the wall

(2) K_o for rigid, restrained walls

The earth pressure distribution on the abutments and wing-walls can be taken as equivalent hydrostatic, that is increasing uniformly with depth according to the formula:

$$P_h = K.\gamma.h + K.q$$

Where

P_h = horizontal pressure at depth h (kN/m²) for a horizontal ground surface condition

γ = unit weight of soil as shown in Table 6.3.2.3

h = depth below top of fill (m)

q = equivalent surcharge (kPa)

K = coefficient of lateral earth pressure as shown in Table 6.3.2.3

To the earth pressure, surcharge load due to live load should be added.

A uniform compaction surcharge of 15 kPa should be added to the backfill pressure distribution.

Drainage to the granular backfill above the finished grade in front of the walls must be provided (i.e. Filtered weeping holes), in which case water pressure behind the wall will not have to be considered.

For the construction considerations, refer to **Section 6.3.2.1**.

6.3.2.4 *Approach Fills and Embankments*

Topsoil, organic material or other unsuitable soils should be removed prior to the placement of earth fill material and pre-loading/surcharging in the widening. After stripping, the exposed subgrade should be inspected, proof rolled using a half-loaded triaxle truck and approved by a geotechnical engineer who is familiar with this report.

The existing granular fill found at the south approach fill area needs to be improved prior to constructing the embankment. We recommend that the top 11.5mof fill be stripped and placed at the north approach. The south approach should then be roller compacted using a minimum 60" vibratory smooth drum roller (10 passes) prior to embankment fill placement.

The new fill material should be inorganic clean fills at moisture contents suitable to be compacted to a high density. The new fill should be placed in lifts not exceeding 300 mm before compaction and each lift should be uniformly compacted to at least 95% of the Standard Proctor Maximum Dry Density (SPMDD), increasing to 98% within the top 1.5m of the subgrade, at a placement water content of ±2% of optimum.

Assuming properly compacted suitable fill is used, 2 horizontal in 1 vertical side slopes can be used. Proper erosion control measures should be implemented both during the construction and permanently. This can be achieved by immediate seeding or sodding (OPSS 572) in according with the conservation authority requirements.

Benching of new fill into the existing soil slope should be applied as per Ontario Provincial Standards (OPSD-208.01).

6.3.3 CNR Overhead Bridge Option

If the CNR overhead bridge option is chosen for the separation, the bridge abutments/columns can be supported either on spread footings or pile foundations. If a piled foundation is chosen, the use of drilled, cast-in-place concrete piles (caissons) could be considered. Use of driven steel piles could also be considered but this will induce vibrations which could cause settlements of the loose granular fills.

It is important to understand that dewatering measures would be required in advance of construction for both the footing and caisson foundation options. It is also noted that a permanent drainage system will be needed to drawdown the groundwater level and some nearby existing water wells have the potential to be significantly affected unless mitigative measures are taken (i.e. drill new, deeper replacement walls).

6.3.3.1 *Spread Footing*

Considering that the road grade will be dropped some 8 to 10m below the existing grade, the bridge abutments/columns can be supported on the Queenston Formation of bedrock. An allowable (SLS) bearing resistance value of 3000 kPa and factored ULS bearing capacity of 4500 kPa can be assumed for the foundations at el. 235m or below on fresh bedrock.

A lean mix concrete mud slab must be placed on the prepared shale base after inspection and approval by the geotechnical engineer, to minimize slaking deterioration.

Resistance against basal sliding of the footing may be calculated as 0.67 x tan ø, where ø = 45°, and this is the ultimate value against which a factor of safety of 1.25 is needed in working stress design.

6.3.3.2 *Drilled Cast-In-Place Piles*

If the designers wish to adopt the use of drilled cast-in-place concrete piles for either the temporary or permanent CNR support, these should be terminated below El. 235.0m into the fresh bedrock. The allowable axial resistances for various caisson diameters are summarized in the following Table 6.3.3.2A:

Table 6.3.3.2A: Summary of Caisson Capacities

(for Caissons with rock sockets min. 2x caisson diameter)

Caisson dia. (mm)	Factored ULS axial resistance (kN)	SLS axial resistance In compression (kN)
760	1300	1100
900	1900	1500
1200	3300	2800
1500	5300	4400

The ultimate lateral resistance of a single fixed-headed caisson of various diameters assessed using Brom's method installed 3m inside the bedrock is provided in the following Table 6.3.3.2B:

Table 6.3.3.2B: Ultimate Lateral Resistance of Fixed-Headed Caissons

Founded at Elev. 232.0m with min. 1.0% Steel

Caisson Dia. (mm)	Ultimate Lateral Resistance (kN)	Allowable Lateral Resistance (kN)
760	230	150
900	300	200
1200	400	270
1500	510	340

6.3.3.3 *Lateral Earth Pressures and Earth Retaining Structures*

Refer to **Section 6.3.2.3** for the calculation of lateral earth pressure for the permanent structures.

6.3.3.4 *Construction Considerations and Drainage Systems*

Excavation up to depths of 8 to10m are expected. The excavation should be supported by temporary earth retaining structures. The temporary earth retaining structures may be designed in accordance with the latest edition of the Canadian Foundation Engineering Manual, assuming a rectangular earth pressure envelope plus the surcharge loading as calculated from the Boussinesq equation.

The lateral earth pressure p, acting at any depth h maybe calculated as:

$$p= 0.65\ K_a\ (\gamma_s H)$$

Where

K_a = 0.3

γ_s = 21 kN/m³

H = maximum depth of excavation to horizontal ground surface (m)

This relationship assumes that free-draining lagging boards will be used between soldier piles so there will be no hydrostatic pressure buildup behind the wall. The lagging boards must be back-lined with non-woven geotextile to prevent loss of soil fines.

For the design of pile toes, the k_p value of 4.6 may be used. If utilized, an allowable (SLS) bond stress for post-grouted tiebacks bonded in very stiff to hard glacial till and compact to very dense silt to granular sand can be taken as 200 kPa.

Before the excavation has been staged down to about Elev. 242m, it will be necessary to dewater the area of the bridge foundations and earth retaining structures, and to maintain the groundwater level at least 1m below the base of the excavation. Please note that some densification of the loose granular fill will occur as a result of this dewatering which will cause settlement which could be of concern depending on the proximity of a rail diversion track.

The maximum excavation for the Mississauga Road CNR crossing is estimated to be about 7.0 meters below the current static water level. To maintain a stable and reasonably "dry" excavation for the bridge foundations and earth retaining structures, we estimate that about 200 m^3/d would have to be pumped in the steady state condition for an excavation of 20mx400m in plan, and therefore, recommend that an MOE

Permit to Take Water (PTTW) be obtained for this project should the CNR overhead bridge option be adopted.

The operation of permanent sumps may also require an MOE PTTW under new policies.

The groundwater level was recorded at 2.7 to 2.8m below the existing ground surface at the proposed underpass location. As the road grade will be dropped some 8 to 10m below its existing profile in order to pass underneath a new CNR overhead bridge, the groundwater level willneed to be drawn down permanently 5 to 6m. The drawdown of water level can be achieved by permanent drainage systems along both sides of Mississauga Road at this section. Assuming the road grading is 4% to 5%, the length of the permanent drainage along one side of the road will be approximately 400m. The drainage systems should have a capacity to discharge water of approximately 200 m^3/d plus rainwater precipitation. Counterfeit drains and rip-rap sheeting (underlined with geotextile will likely suffice for the excavation side slope groundwater depression.

A hydraulic investigation with well pumping testing is required to verify the estimation of water taking for construction excavation and permanent groundwater drawdown. This information is needed to support a PTTW application.

Monitoring of ground settlements just above the tunnel crown is recommended. The settlement monitoring system should consist of deep settlement points grouted 0.3m into the rock surface and surface marks on the CN rails. Potential ground movements of these points should be monitored at frequent intervals during the tunneling operations. Should unacceptable ground movements be observed, the tunneling and ground support operations should be immediately modified.

6.3.5 General Comments on Separation Options

Among the options discussed previously, the overpass road bridge option will have least influence to the groundwater as no large scale construction dewatering is required. The construction cost is also likely to be the lowest among the options.

For the CNR overhead bridge option, additional hydrogeological investigations are required to assess the long term effects of the permanent drainage system to the groundwater table.

6.4 Pavement Structure

An assessment for a conventional flexible pavement was performed for Mississauga Road.

6.4.1 Equivalent Single Axle Load (ESAL's)

The traffic volumes of Mississauga Road as provided by AECOM are shown in Table 6.4.1a.

Table 6.4.1A: Traffic Volume

Location	2008 AADT	Annual Growth Rate	Truck Fraction	No. Of Lanes After Widening
Bovaird dr. To Sandalwood Pkwy	1820	2.8% for first 10 years; 1.5% for next 15 years	0.31	4
Sandalwood Pkwy to Wanless dr.	2485	2.8% for first ten years; 1.5% for next 15 years	0.31	4
Wanless Dr. to Mayfield Rd.	2485	2.8% for first ten years; 1.5% for next 15 years	0.31	4

The equivalent single axle loads (ESAL's) for the proposed improvement and widening of Mississauga Road were calculated using traffic data presented in table 6.4.1b for design period of 25 years. The input parameters for the design lane ESAL calculation were derived from the MTO Pavement Design and Rehabilitation Manual (SDO-90-01). Figure 6.4.1A shows the AADT growth and Figure 6.4.1B illustrates the ESAL accumulation over a 25-year period for a 4-lane road. Please note that a 25 year design life means 25 year life-cycle with ongoing regular maintenance and resurfacing.

Table 6.4.1B: Input Parameters for ESAL Calculation – Mississauga Road

Base year (2008) AADT	% heavy commercial truck	Truck fraction	Avg. Truck factor	Directional distribution	Annual Traffic growth (%)	Lane distribution	Design period (years)	Accumulated number of equivalent standard axles
2,485	18	0.31	0.65	0.5	2.8% for first 10 year; 1.5% for next 15 years	0.85	25	2.12 million

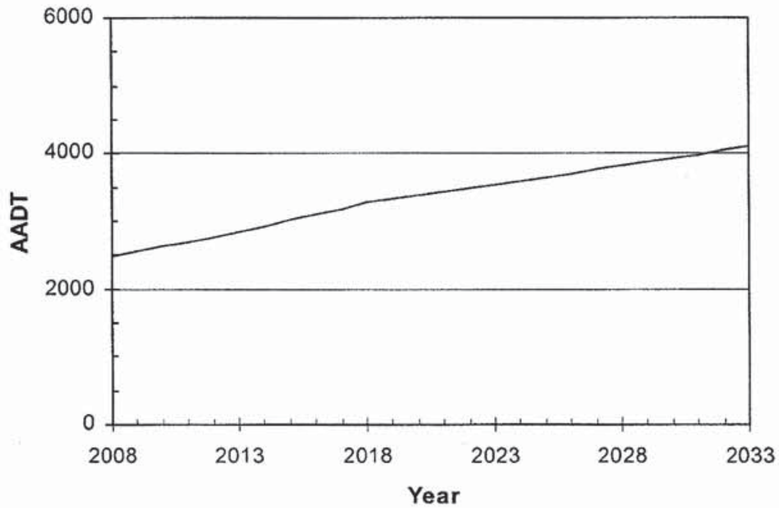


Figure 6.4.1B 25 year life cycle AADT growth on Mississauga Road

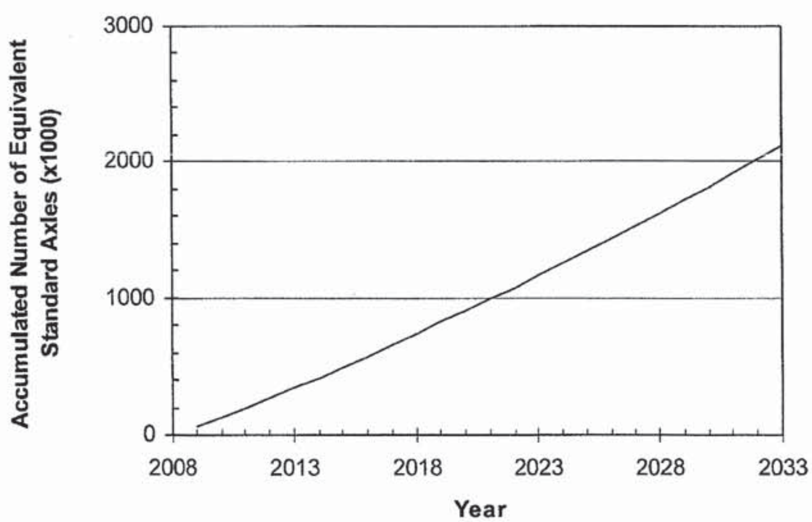


Figure 6.4.1B 25 year life cycle accumulation numbers of equivalent standard axles

6.4.2 Thickness Design

Pavement structure thickness design for the design lane on Mississauga Road was determined using the AASHTO 1993 design method and considering a medium frost susceptible subgrade. The input parameters are shown in Table 6.4.2 and the analysis sheets are attached in **Appendix G.**

Table 6.4.2: Input Parameters for Pavement Design

Input Parameter	Selected Values
Initial/Terminal Serviceability	p_i = 4.4 p_t = 2.2
Design Period	25 years
Traffic	See Table 6.4.1.B
Cumulative esal's	See Table 6.4.1.B
Subgrade Resilient Modulus (M_r)	20 MPa
Structural Coefficients ('a' values)	Asphalt = 0.42 New Granular 'A' or 'B' = 0.14 Existing Granular Base/Fill = 0.08
Drainage Coefficient	m = 1.0 for New Granular 'A' or 'B', Asphalt m = 0.9 for Existing Granular Base/Fill
Reliability and Standard Deviation	R = 90% SD = 0.45

Based on the above analysis, a recommended minimum structural number is 128 for new pavement.

6.4.3 Recommended Minimum Pavement Design For New Pavement

Table 6.4.3 provides a minimum requirement for the pavement. The analysis sheet is attached in **Appendix G**.

Table 6.4.3 - Pavement Design Alternatives – New Pavement

Pavement option	Recommended Pavement Design	SN	GBE
Conventional flexible pavement	45mm Superpave 12.5 80mm Superpave 19.0 150mm Granular 'A' base[1] 400mm Granular 'B' Type Ii sub-base[2]	129.5	668

[1] 19mm crusher run limestone compacted to 100% of SPMDD at ±2% of optimum

[2] 50mm crusher run limestone compacted to 99% of SPMDD at ±2% of optimum

All granulars to be made of 100% virgin crushed aggregates with no recycled ac or concrete content.

The site subgrade and weather conditions (i.e. Wet) at the time of construction may necessitate the placement of thicker granular sub-base layer in order to facilitate the construction. Furthermore, heavy construction equipment may have to be kept off the newly constructed roads before the placement of asphalt and/or immediately thereafter, to avoid damaging the weak subgrade by heavy truck traffic.

The granular base and sub-base materials should be placed in layers not exceeding 150mm (uncompacted thickness), and should be compacted to at least 100% of their respective spmdd. The grading of the material should conform to current ops specifications.

6.4.4 Pavement Upgrade for Existing Pavement

The granular base equivalent values of the existing pavement are found to range from 499 to 683 (see Table 5.1). Considering the existing asphalt pavement is generally in good condition, hot mix resurfacing methods could be considering for pavement upgrade. The hot mix resurfacing methods should be completed in accordance with OPSS 310 and 1150. The required thickness is shown in Table 6.4.4. Consideration should be given to treatment of the cracks prior to resurfacing.

It is noted that the upgrade road surface will be 45mm high than the existing grade. In order to make a gentle transformation from existing to upgrade pavements, the existing pavement can be grinded 0 to 45mm and replaced with Superpave 12.5 at the tie-in between the existing and the upgrade pavements.

Table 6.4.4 : Pavement Upgrade for Existing Pavement

Pavement Upgrade Method	Recommended Pavement Design	SN	GBE
Hot Mix Resurfacing	45mm Superpave 12.5 Min. 200mm existing asphalt Min. 355mm existing granular base	128.5	Min. 589

6.5 Seismic Design

Based on table 4.1.8.4.a of the Ontario Building Code, 2006, the site for the proposed watercourse crossing structure and Mississauga Rd./CNR grade separation structure can be classified as "Class D" for seismic site response.

6.6 Reuse of Excavated Materials

Reference to the borehole logs suggests that the excavated materials with respect to their compaction characteristics can be divided into three groups:

- Group 1 comprises the gravelly sand layers as well as granular fill materials encountered near the surface. These materials are expected to have good compaction characteristics and could be reused as backfill provided that they are carefully segregated from the more silty or clayey soil strata. Some drying of the sand excavated from below the groundwater level will likely be required.

- Group 2 comprises the fine grained glacial tills of sandy silt to clayey silt encountered in all boreholes. The recompaction of these materials to a density higher than 90% of the spmdd will be possible only if the natural moisture contents are within ±3% of the optimum moisture content of the materials. Even with this limitation, considerable compaction effort will be required, i.e. Shallow (less than 200mm) lifts and heavy equipment, the use of which may not be possible in the confined space of a trench. The reuse of these materials under roadways or areas where surface settlements cannot be tolerated is therefore questionable, particularly in cold or wet months of the year. In these areas, they may have to be replaced by imported granular material.

- Group 3 soils comprise the cohesionless silt deposit. The compaction of the soil will require an even tighter control of their moisture content during placement and compaction. At moisture contents more than 3% below the optimum, the soil will likely be dusty and "flour" like while at moisture contents ±1% higher than optimum, the soil will be "spongy" and will "pump".

- Group 4 soils consist of unsuitable materials because of their high moisture or organic inclusions, and some of the existing fill materials especially the soft to firm clayey fill. These soils should be either disposed off-site or should be used only in "soft" landscaping areas where they can be placed with nominal compaction, and where surface settlements are acceptable.

7 ENVIRONMENTAL QUALITY OF EXCAVATED SOILS

To provide a general measure of the environmental quality of the excavated soils with respect to on-site reuse or off-site disposal, six (6) soil samples were analyzed for the metals and inorganic parameters listed in the moe soil standards for use under part xv.1 of the environmental protection act. The locations and depths of tested samples are listed in Table 7.0.

Table 7.0: Summary of Environmental Soil Tests

BH No.	Sample No.	Depth (m) from - to	Part XV.1
08-1	SS2	0.8 – 1.2	√
08-3	SS4	2.3 – 2.7	√
08-5	SS5	3.0 – 3.5	√
08-9	SS2	0.8 – 1.2	√
08-11	SS1	0 – 0.6	√
08-13	SS2	0.8 - 1.2	√

The analytical data are attached to this report in **Appendix E**.

Of the six (6) samples analyzed for inorganic and general parameters, with the exceptions of Electrical conductivity and Sodium Absorption Ratio, all samples meet the limits set out in "Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition" of Part VX.1 of the Environmental Protection Act. Sodium Absorption Ratio (SAR) was in excess of the residential criterion of 5.0 and commercial-industrial criterion of 12 in all soil samples. Electrical conductivity (EC) of all soil samples was higher than the residential criterion of 0.7. EC of soil samples obtained from Borehole 08-1, 08-3, 08-9, and 08-13 was higher than the commercial-industrial criterion of 1.4. Elevated SAR and EC values may be a result of road salt application.

Based on the available test results and in absence of other aesthetic indicators of impact, such as staining or odours, the site soils are generally considered suitable for reuse on site if kept within the municipal right of way (where geotechnically suitable) or for off-site disposal at an approved receiver of commercial landuse fill who will accept the elevated SAR and EC values. Cost premiums will likely apply for the disposal of this SAR/EC impacted soil. However, Coffey Geotechnics makes no warranty, express or implied, as to whether or not excavated soils will be accepted by receivers. Off-site receivers will likely require additional testing prior to acceptance of any soils. They may also reject soils based on other criteria, such as presence of organic material, peat, topsoil, rubble, or elevated moisture content.

Notwithstanding the test results provided herein, vigilance must be kept on the excavated soils. Soils with any evidence of anomalous fill, staining or odours should be stockpiled separately, covered with tarps, and this office should be immediately contacted so that additional testing may be performed to reassess their environmental quality.

8 POTENTIAL IMPACTS ON GROUNDWATER AND SURFACE WATER RESOURCES AND NEED FOR MOE PERMIT TO TAKE WATER

The location of MOE registered water wells within one (1) kilometer radius of the site are shown on the attached D**rawing Nos. 7 to 10**.

Based on the results of geotechnical borings, the watercourse crossing structures of culverts will mainly be constructed through the glacial till. Active dewatering (predrainage) during construction will not be necessary, provided that sheet piling is used, although the surface water at creek locations will need to be diverted. Pumping from filtered sumps will be necessary to deal with seepage through the soils and leakage through sheet piling interlocks. Seepage through sheet pile interlocks can be minimized, but never eliminated, by using a tight hot-rolled sheet pile interlock and with good installation practices.

For the Mississauga Rd./CNR grade separation, should the overpass road bridge option be adopted, extensive dewatering (predrainage) during construction will not be necessary.

If the CNR overhead bridge and depressed roadway are considered, active dewatering (predrainage) during construction will be needed. Existing water wells in the vicinity would be likely impacted. In order to comment on the potential for baseflow impact to Huttonville Creek, more studies would be need. A more detailed hydrogeological investigation would need to carry out and an MOE Permit To Take Water will be required in such case.

For the road upgrade and widening, the construction dewatering will be primarily surface water and perched water in the fill, and no significant amount of well interference is expected. Pumped surface water will need to be clarified before being re-introduced into the surface water system.

9 LIMITATIONS

The findings within this report are the result of discrete/specific investigation methodologies used in accordance with normal practices and standards. Subsurface conditions can change over relatively short distances and the subsurface conditions revealed at the test locations may not be representative of subsurface conditions across the site. We recommend that a geotechnical engineer be engaged during construction to confirm the subsurface conditions are consistent with design assumptions.

The reader's attention is drawn to the attached document entitled 'Important Information about Your Coffey Report', which presents additional information on the uses and limitations of this report.

For and on behalf of Coffey Geotechnics Inc.

Laifa Cao, Ph.D., P.Eng.

Scott M. Peaker, P.Eng.

Attachments
LC/SMP:sf
CDSR/08/G-08.0607 AECOM

Appendix A

Log of Boreholes (Enclosures 1 To 14)

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LOG OF BOREHOLE 08-1

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 1

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 29, 2008

REF. NO.: G-08.0607
ENCL NO.: 1

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	WATER CONTENT (%)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
237.7	Ground Surface							
0.0	**200mm Asphalt** **450mm Granular Fill** Sand and Gravel, brown, compact	1	SS	12			~7	
	FILL Clayey Sand brown, organic odour, very loose to loose	2	SS	6		237	~10	
					Bentonite			
		3	SS	4	W. L. 235.90 m Sep 08, 2008	236	~25	
		4	SS	2		235	~25	Wet spoon at 2.3m
					Sand			
234.7 / 3.0	**SILTY SAND** (Glacial Till) some gravel and clay, brown, compact to dense	5	SS	21			~14	16 39 35 10
					Screen/Sand	234		
233.6 / 4.1	**QUEENSTON FORMATION** Shale reddish brown, interbedded with grey limestone/siltstone	6	SS	42			~9	Augers grinding at 4.0m (hard layer)
		7	SS	78/ 225mm	Caved	233	~7	
232.7 / 5.0	**END OF BOREHOLE**							

Water level readings in 19 mm dia. piezometer

Date	W.L. Depth
Sept. 08, 2008	1.8m

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, X LAB VANE; 20 40 60 80 100
PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30
UNIT WEIGHT γ (kN/m³)

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; $O^{\varepsilon=3\%}$ Strain at Failure

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LOG OF BOREHOLE 08-2

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 1

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 25, 2008

REF. NO.: G-08.0607
ENCL NO.: 2

(m) ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	WATER CONTENT (%) (approx.)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
237.7	Ground Surface					
0.0	**450mm Granular Fill** Sand and Gravel brown, compact	1	SS	20		
237.1 / 0.6	**SANDY SILT TO SILTY SAND** (Glacial Till) trace gravel and clay, brown, dense	2	SS	33		9 45 36 10
		3	SS	47		
		4	SS	38		
234.7 / 3.0	**SILT** some sand, trace gravel and clay, dilatant, grey, dense	5	SS	34		Spoon wet at 3.0m; 4 12 78 6
233.9 / 3.8	**SILTY SAND** (Glacial Till) trace gravel and clay, brown, very dense	6	SS	52		
		7	SS	82/250mm		
232.7 / 5.0	**END OF BOREHOLE** Water level at completion: 3.7m BGL					

Column headings: SOIL PROFILE; STRATA PLOT; SAMPLES; GROUND WATER CONDITIONS; ELEVATION (237, 236, 235, 234, 233); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH (kPa) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) (10 20 30); UNIT WEIGHT γ (kN/m³); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; O ε=3% Strain at Failure

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LOG OF BOREHOLE 08-3

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 1

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 28, 2008

REF. NO.: G-08.0607
ENCL NO.: 3

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	WATER CONTENT	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
240.0	Ground Surface							
0.0	**600 mm Granular Fill** brown, compact; **FILL** Sandy Silt trace gravel, brown, loose	1	SS	25	Bentonite			
		2	SS	8		239		
		3	SS	5				
	Clayey Silt brown, firm				Cuttings	238		
237.7 / 2.3	**SANDY SILT** (Glacial Till) trace gravel and clay, compact	4	SS	23	W. L. 237.48 m Sep 08, 2008			Spoon wet at 2.6m
237.0 / 3.0	**GRAVELLY SAND** some silt, trace clay reddish brown, compact to dense	5	SS	18		237		28 55 13 4
		6	SS	20	Bentonite			
					Sand			
		7	SS	43		235		
					Screen/Sand			
234.5 / 5.5	**CLAYEY SILT** (Glacial Till) some sand, trace gravel, brown, hard	8	SS	52				
		9	SS	94/200mm	Caved	234		
233.5 / 6.5	**END OF BOREHOLE**							

Water level readings in 38 mm dia. piezometer

Date	W.L. Depth
Sept. 08, 2008	2.5m

Chart axes: DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH (kPa) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100; PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ (kN/m³)

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; O $^{\varepsilon=3\%}$ Strain at Failure

coffey geotechnics

LOG OF BOREHOLE 08-4

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 1

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 29, 2008

REF. NO.: G-08.0607
ENCL NO.: 4

(m) ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
240.0	Ground Surface						
0.0	**750mm Granular Fill** Sand and Gravel brown	1	AS				
	FILL Sandy Silt trace gravel, brown, compact	2	SS	10		239	
238.5 / 1.5	**CLAYEY SILT** (Probable Fill) trace gravel and sand, brown with black, firm to stiff	3	SS	4		238	
					Cuttings		
		4	SS	8	W. L. 237.27 m Sep 08, 2008		
237.0 / 3.0	**CLAYEY SILT** (Glacial Till) sandy, trace gravel, trace sand seams grey, very stiff	5	SS	23		237	Spoon wet at 3.0m; 13 33 37 17
235.9 / 4.1	**GRAVELLY SAND** some silt, compact	6	SS	26	Sand	236	
		7	SS				
235.3 / 4.7	**SILT AND SAND** (Glacial Till) trace gravel and clay, occ. stone fragments, brown, compact to dense	7A	SS	27		235	
		8	SS	28	Screen/Sand	234	
	gravelly	9	SS	31	Caved		
233.4 / 6.6	**END OF BOREHOLE**						

Water level readings in 38mm dia. piezometer

Date	W.L. Depth
Sept. 08, 2008	2.7m

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE: 20 40 60 80 100
PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L
WATER CONTENT (%): 10 20 30
UNIT WEIGHT γ (kN/m³)

41

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; O $^{\varepsilon=3\%}$ Strain at Failure

COFFEY SOIL LOG G-08.0607 BH LOG.GPJ GEO-CANADA.GDT 17/12/08

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 2

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 28, 2008

REF. NO.: G-08.0607
ENCL NO.: 5

(m) ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
244.3	Ground Surface						
0.0	**3000mm Granular Fill** Gravelly Sand to Sand and Gravel brown, very loose to compact	1	AS		Bentonite		
		2	SS	12		243	
		3	SS	7		242	
		4	SS	2	W. L. 241.58 m Sep 08, 2008		Spoon wet at 2.4m
241.3 / 3.0	**SILTY CLAY TO CLAYEY SILT** (Glacial Till) some sand, trace gravel, occ. stone fragments, brown, stiff to very stiff	5	SS	14		241	
		6	SS	19		240	
239.9 / 4.4	**SILT** some sand and clay, brown, dense	7	SS	37			11 79 10
239.1 / 5.2	**SILTY SAND** (Glacial Till) trace gravel, brown, dense	8	SS	38	Bentonite / Sand	239	
	boulders/cobbles (inferred)	9	SS	55		238	Augers grinding at 6.1m
237.3 / 7.0	**SILTY CLAY TO CLAYEY SILT** (Glacial Till) sandy, trace gravel, reddish brown, hard				Screen/Sand	237	
		10	SS	65			

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30
UNIT WEIGHT γ (kN/m³)

Continued Next Page

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; O ⁸=3% Strain at Failure

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 2

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 28, 2008

REF. NO.: G-08.0607
ENCL NO.: 5

(m) ELEV DEPTH	DESCRIPTION (SOIL PROFILE)	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
236.3 8.0	**SILTY CLAY TO CLAYEY SILT** (Glacial Till) sandy, trace gravel, reddish brown, hard(continued)						236 Caved				
235.8 8.5	**QUEENSTON FORMATION** Shale reddish brown, interbedded with grey limestone/siltstone		11	SS	50/ initial 75mm				o		Augers grinding at 8.4m and 8.8m (hard layers)
235.1 9.2	**END OF BOREHOLE** Water level readings in 38 mm dia. piezometer Date — W.L. Depth Sept. 08, 2008 — 2.7m										

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; O $^{\varepsilon=3\%}$ Strain at Failure

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 2

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 29, 2008

REF. NO.: G-08.0607
ENCL NO.: 6

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
244.3	Ground Surface				
0.0	**600 mm Granular Base** compact **FILL** Clayey Silt, some gravel and sand, brown, firm	1	SS	20	
	Silty Sand trace gravel, some clay, brown, loose	2	SS	6	
	Sand and Gravel brown, loose	3	SS	4	
		4	SS	5	Spoon wet at 2.4m
241.3 3.0	**CLAYEY SILT TO SILTY CLAY** (Glacial Till) sandy, trace gravel, very stiff to hard	5	SS	26	
		6	SS	33	
240.0 4.3	**SILT** brown, dense	7	SS	34	
238.8 5.5	**SILTY SAND** (Glacial Till) some gravel, trace clay, brown, very dense	8	SS	56	19 37 35 9
		9	SS	50/100mm	
237.3 7.0	**CLAYEY SILT** (Glacial Till) some sand, trace gravel, trace to some reddish brown shale fragments, hard	10	SS	36	

Column headings also include: STRATA PLOT; GROUND WATER CONDITIONS; ELEVATION (244, 243, 242, 241, 240, 239, 238, 237); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH (kPa) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L, WATER CONTENT (%) (10 20 30); UNIT WEIGHT γ (kN/m³).

Continued Next Page

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; O $^{\varepsilon=3\%}$ Strain at Failure

coffey geotechnics

LOG OF BOREHOLE 08-6

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 2

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 29, 2008

REF. NO.: G-08.0607
ENCL NO.: 6

(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
236.3 / 8.0							236				
235.8 / 8.5	**QUEENSTON FORMATION** Shale, reddish brown, interbedded with grey limestone/siltstone										Augers grinding from 8.5m to 9.1m (hard layer)
235.2 / 9.1	**END OF BOREHOLE**		11	SS	50/ initial 0mm						No recovery

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; O $^{\varepsilon=3\%}$ Strain at Failure

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 2

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 28, 2008

REF. NO.: G-08.0607
ENCL NO.: 7

ELEV (m) / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	WATER CONTENT (%)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
244.9	Ground Surface					
0.0	**600mm Granular Fill** Sand and Gravel brown, compact	1	SS	28	o (plotted near 1)	39 48 10 3
	FILL Clayey Silt to Silty Clay brown, firm	2	SS	5	o (plotted near 20)	
243.5 / 1.4	**GRAVELLY SAND** (Probable Fill) brown, compact	3	SS	10	o (plotted near 5)	
242.5 / 2.4	**SILTY CLAY** (Probable Fill) trace sand, organic odour, dark grey, soft	4	SS	2	o (plotted near 35)	
241.9 / 3.0	**CLAYEY SILT** (Glacial Till) trace sand and gravel, brown, very stiff	5	SS	20	o (plotted near 10)	
241.1 / 3.8	**SILTY SAND** (Glacial Till) trace clay and gravel, brown, dense	6	SS	45	o (plotted near 22)	
240.5 / 4.4	**CLAYEY SILT** (Glacial Till) trace sand to sandy, trace gravel, hard	7	SS	47	o (plotted near 25)	
	brown / grey	8	SS	52	o (plotted near 8)	
	trace shale fragments	9	SS	61	o (plotted near 8)	
237.0		10	SS	52	o (plotted near 10)	

Elevation scale: 244, 243, 242, 241, 240, 239, 238, 237

Column headings: SOIL PROFILE; STRATA PLOT; SAMPLES; GROUND WATER CONDITIONS; ELEVATION; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH (kPa) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE (20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT W_L, WATER CONTENT (%) (10 20 30); UNIT WEIGHT γ (kN/m³)

Continued Next Page

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; $O^{\varepsilon=3\%}$ Strain at Failure

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LOG OF BOREHOLE 08-7

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 2

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 28, 2008

REF. NO.: G-08.0607
ENCL NO.: 7

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
236.9 8.0	**QUEENSTON FORMATION** Shale reddish brown, interbedded with grey limestone/siltstone(continued)						236				Augers grinding at 8.5m and 9.1m (hard layers)
			11	SS	50/ initial 150mm				o (approx. 10)		
235.6 9.3	**END OF BOREHOLE** Water level at completion: 3.6m BGL										

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity   O $^{\varepsilon=3\%}$ Strain at Failure

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 2

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 29, 2008

REF. NO.: G-08.0607
ENCL NO.: 8

(m) ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS / 0.3 m	GROUND WATER CONDITIONS	WATER CONTENT (%)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
244.7	Ground Surface						
0.0	**600 mm Granular Fill** Sand and Gravel borwn, compact	1	SS	15	Bentonite	o	
	FILL Silty Clay brown, organic odour firm	2	SS	5		o	
243.3 / 1.4	**SAND AND GRAVEL** (Probable Fill) brown, loose	3	SS	6		o	Spoon wet at 2.1m
242.4 / 2.3	**SILTY CLAY** trace sand and gravel brown, stiff	4	SS	15	W. L. 241.92 m Sep 08, 2008	o	1 7 57 35
241.8 / 2.9	**SILTY CLAY** (Glacial Till) sandy, trace gravel brown, very stiff to hard	5	SS	21		o	
240.7 / 4.0	**GRAVELLY SAND** brown, dense	6	SS	38		o	
		7	SS	39		o	
239.5 / 5.2	**SANDY SILT** dilatant, brown, dense	8	SS	38	Bentonite; Sand	o	
238.8 / 5.9	**CLAYEY SILT TO SILTY CLAY** (Glacial Till) some sand, trace gravel brown with grey, hard	9	SS	35		o	
237.7 / 7.0	**SILTY SAND** trace gravel, brown, very dense	10	SS	50	Screen/Sand	o	

Elevation scale: 244, 243, 242, 241, 240, 239, 238, 237

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30
UNIT WEIGHT γ (kN/m³)

Continued Next Page

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; O $^{\varepsilon=3\%}$ Strain at Failure

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 2

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 29, 2008

REF. NO.: G-08.0607
ENCL NO.: 8

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
236.7											
8.0	**SILTY SAND** trace gravel, brown, very dense(continued)						236				
	trace shale fragments		11	SS	50/ initial 100mm				o		
235.1 9.6	**QUEENSTON FORMATION** Shale, reddish brown, interbedded with grey limestone/siltstone						Caved 235				
234.7			12	SS	50/ initial 125mm				o		
10.0	**END OF BOREHOLE**										

Water level readings in 38 mm dia. piezometer

Date	W.L. Depth
Sept. 08, 2008	2.8m

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity   O $^{\varepsilon=3\%}$ Strain at Failure

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LOG OF BOREHOLE 08-9

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 2

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 27, 2008

REF. NO.: G-08.0607
ENCL NO.: 9

(m) ELEV DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
245.8	Ground Surface						
0.0	**600 mm Granular Fill** Sand and Gravel, Brown, compact	1	SS	23			
	FILL Silty Clay, black to brown, organic odour, firm	2	SS	6		245	
244.6 / 1.2	**SILTY CLAY** brown with grey, stiff	3	SS	15		244	
243.7 / 2.1	**CLAYEY SILT** (Glacial Till) sandy, trace gravel, very stiff	4	SS	28		243	
242.9 / 2.9	**SANDY SILT** (Glacial Till) some gravel and clay, brown, compact to very dense	5	SS	27		242	18 30 39 13
	boulders/cobbles (inferred)	6	SS	88			Augers grinding at 4.3m
		7	SS	43		241	
240.8 / 5.0	**END OF BOREHOLE** Borehole dry upon completion						

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE; 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30
UNIT WEIGHT γ (kN/m³)

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; O ε=3% Strain at Failure

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LOG OF BOREHOLE 08-10

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 2

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 27, 2008

REF. NO.: G-08.0607
ENCL NO.: 10

(m) ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
247.6	Ground Surface						
0.0	**355 mm Granular Fill** Sand and Gravel brown, compact	1	SS	20			
	FILL Clayey Silt brown, stiff					247	
		2	SS	9			
246.5 / 1.1	**SILTY CLAY** brown, stiff					246	
		3	SS	11			
245.3 / 2.3	**SAND AND SILT** trace clay, brown, compact	4	SS	13		245	41 52 7
244.7 / 2.9	**SAND AND GRAVEL** trace silt, dense	5	SS	30		244	
		6	SS	36		243	
		7A	SS				
242.7 / 4.9	**SANDY SILT** (Glacial Till) trace clay and gravel, very dense	7B	SS	62			
242.6 / 5.0	**END OF BOREHOLE** Water level at completion: 2.7m BGL						

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%): 10 20 30
UNIT WEIGHT γ (kN/m³)

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; O $^{\varepsilon=3\%}$ Strain at Failure

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LOG OF BOREHOLE 08-11

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 3

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 28, 2008

REF. NO.: G-08.0607
ENCL NO.: 11

ELEV (m) / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	WATER CONTENT (%)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
251.9	Ground Surface							
0.0	**550mm Granular Fill** Sand and Gravel brown, compact	1	SS	24			~4	
251.3 / 0.6	**SILTY CLAY** (Probable Fill) brown with grey, firm	2	SS	8		251	~18	
250.4 / 1.5	**CLAYEY SILT** (Glacial Till) sandy, trace gravel, very stifff	3	SS	21	Bentonite; W. L. 250.38 m Sep 08, 2008	250	~10	Spoon wet at 1.7m; 2 24 49 25
249.6 / 2.3	**SANDY SILT** (Glacial Till) trace clay, trace gravel and shale fragments, dense to very dense	4	SS	59	Sand		~10	
		5	SS	41			~9	
	trace stone fragments	6	SS	58	Screen/Sand	248	~7	
247.5 / 4.4	**QUEENSTON FORMATION** Shale, reddish brown, interbedded with grey limestone/siltstone	7	SS	70	Caved	247	~8	
246.9 / 5.0	**END OF BOREHOLE**							

Water level readings in 19 mm dia. piezometer

Date	W.L. Depth
Sept. 08, 2008	1.5m

Plot headings: DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH (kPa) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE 20 40 60 80 100; PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ (kN/m³)

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; O $^{\varepsilon=3\%}$ Strain at Failure

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LOG OF BOREHOLE 08-12

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 4

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 28, 2008

REF. NO.: G-08.0607
ENCL NO.: 12

(m) ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
259.7	Ground Surface					
0.0	**500mm Granular Fill** Sand and Gravel, brown, compact	1	SS	16		
	FILL Silty Clay brown with black, organic odour, firm	2	SS	5	259	
258.3 / 1.4	**SILTY SAND** brown, compact	3	SS	11	258	Wet spoon at 1.7m
		4	SS	20	257	
256.7 / 3.0	**SAND** trace gravel, silt and clay, brown, compact	5	SS	17		8 81 7 4
256.0 / 3.7	**SILTY SAND** trace gravel, brown, dense	6	SS	42	256	
255.3 / 4.4	**SILTY SAND** (Glacial Till) trace gravel and clay, brown, very dense	7	SS	94	255	
254.7 / 5.0	**END OF BOREHOLE**					

Column headings: STRATA PLOT; GROUND WATER CONDITIONS; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH (kPa): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, X LAB VANE (20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) (10 20 30); UNIT WEIGHT γ (kN/m³)

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; O $^{\varepsilon=3\%}$ Strain at Failure

coffey geotechnics

LOG OF BOREHOLE 08-13

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 5

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: August 28, 2008

REF. NO.: G-08.0607
ENCL NO.: 13

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.9	Ground Surface					
0.0	**450mm Granular Fill** Sand and Gravel, brown, compact	1	SS	16		40 45 11 4
260.3 / 0.6	**SILTY CLAY** brown with grey, stiff	2	SS	12	260	
259.5 / 1.4	**SILTY CLAY TO CLAYEY SILT** (Glacial Till) some sand, trace gravel, brow, very stiff to hard	3	SS	25	259	
		4	SS	30		
258.2 / 2.7	**SILT** dilatant, grey, dense	5	SS	47	258	Wet spoon at 3.0m
	trace sandy silt seams	6	SS	32	257	
		7	SS	34	256	
255.9 / 5.0	**END OF BOREHOLE**					

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE; 20 40 60 80 100
PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30
UNIT WEIGHT γ (kN/m³)

GRAPH NOTES: +3, X3: Numbers refer to Sensitivity; O ε=3% Strain at Failure

coffey geotechnics

LOG OF BOREHOLE 08-14

PROJECT: Mississauga Rd.Class EA
CLIENT: Earth Tech Canada Inc.
PROJECT LOCATION: Mississauga Road, Brampton
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: Drawing No. 6

DRILLING DATA
Method: Solid stem augering
Diameter: 110mm
Date: April 29, 2008

REF. NO.: G-08.0607
ENCL NO.: 14

(m) ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	WATER CONTENT (%)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
263.9	Ground Surface							
0.0	**600mm Granular Fill** Sand and Gravel brown, compact	1	SS	19			~5	
	FILL Silty Clay black to brown, organic odour, firm	2	SS	5		263	~14	Wet spoon at 0.9m
262.7 / 1.2	**CLAYEY SILT** (Glacial Till) some sand to sandy, trace gravel, brown, very stiff to hard				Bentonite; W. L. 262.38 m Sep 08, 2008			
		3	SS	23		262	~13	
		4	SS	32			~10	8 27 46 19
261.0 / 2.9	**SANDY SILT** (Glacial Till) trace gravel and clay, brown to grey, dense to very dense	5	SS	48	Sand		~8	
	trace shale and limestone fragments	6	SS	52	Screen/Sand	260	~8	
		7	SS	40	Caved	259	~8	
258.9 / 5.0	**END OF BOREHOLE**							

Water level readings in 19 mm dia. piezometer

Date	W.L. Depth
Sept. 08, 2008	1.5m

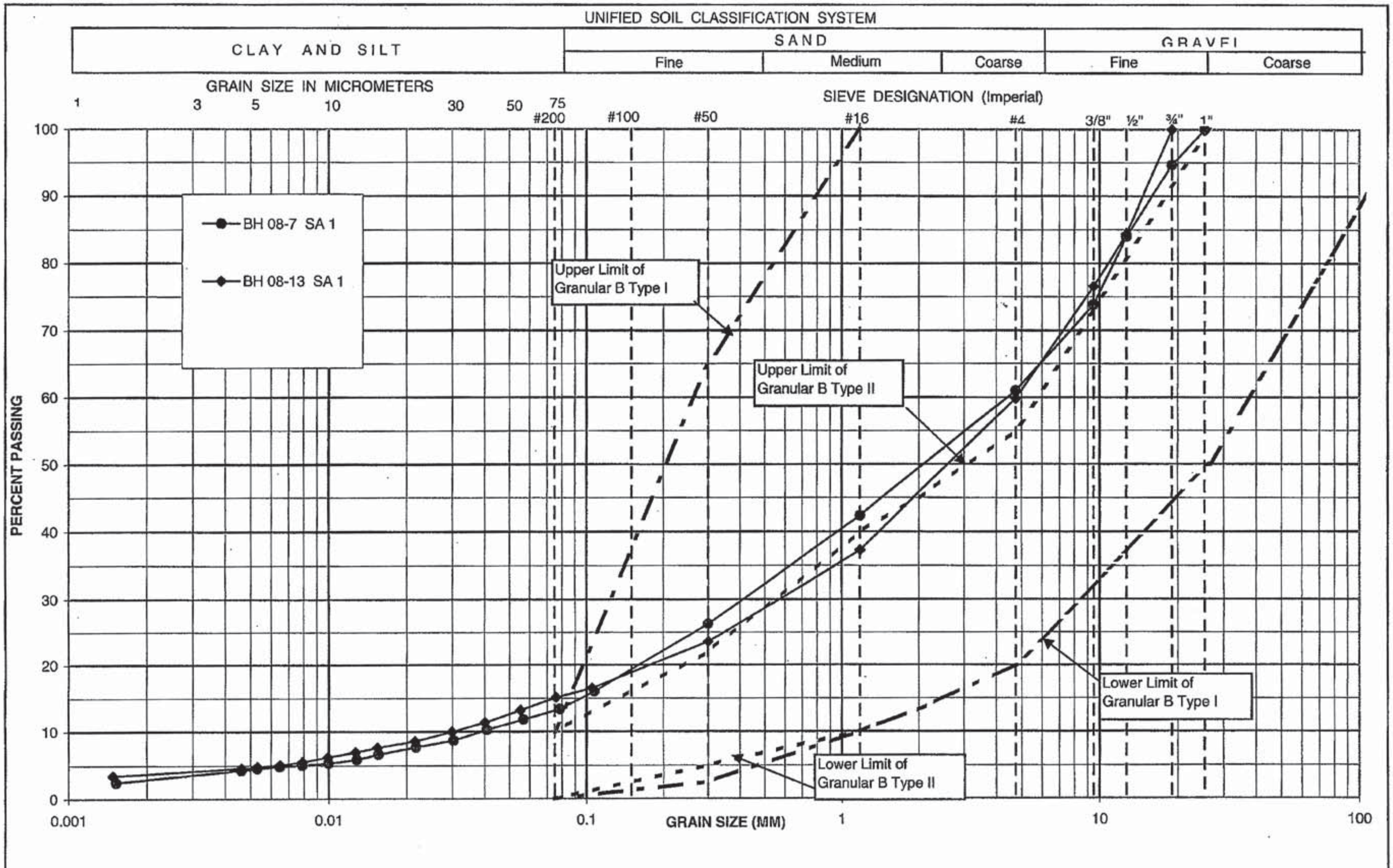
Plot headers: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH (kPa): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT W_L; WATER CONTENT (%) (10 20 30); UNIT WEIGHT γ (kN/m³)

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity   O $^{\varepsilon=3\%}$ Strain at Failure

Appendix B

Grain Size Distribution Curves (Figures 1 – 6)

Plasticity Charts (Figure 7)

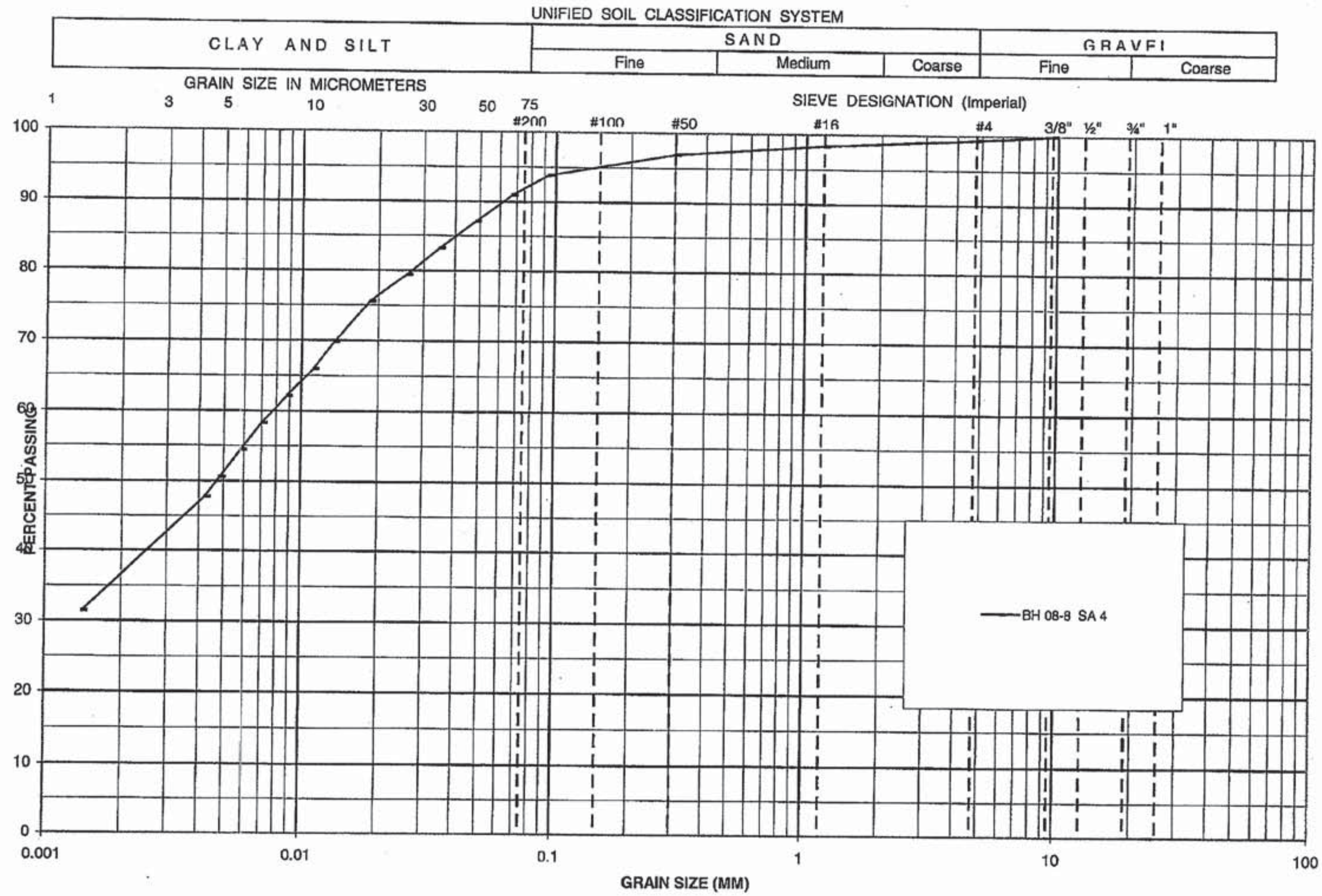


coffey geotechnics

GRAIN SIZE DISTRIBUTION

Granular Fill

FIGURE No. 1
Job No. G-08.0607
Date: Oct. 2008

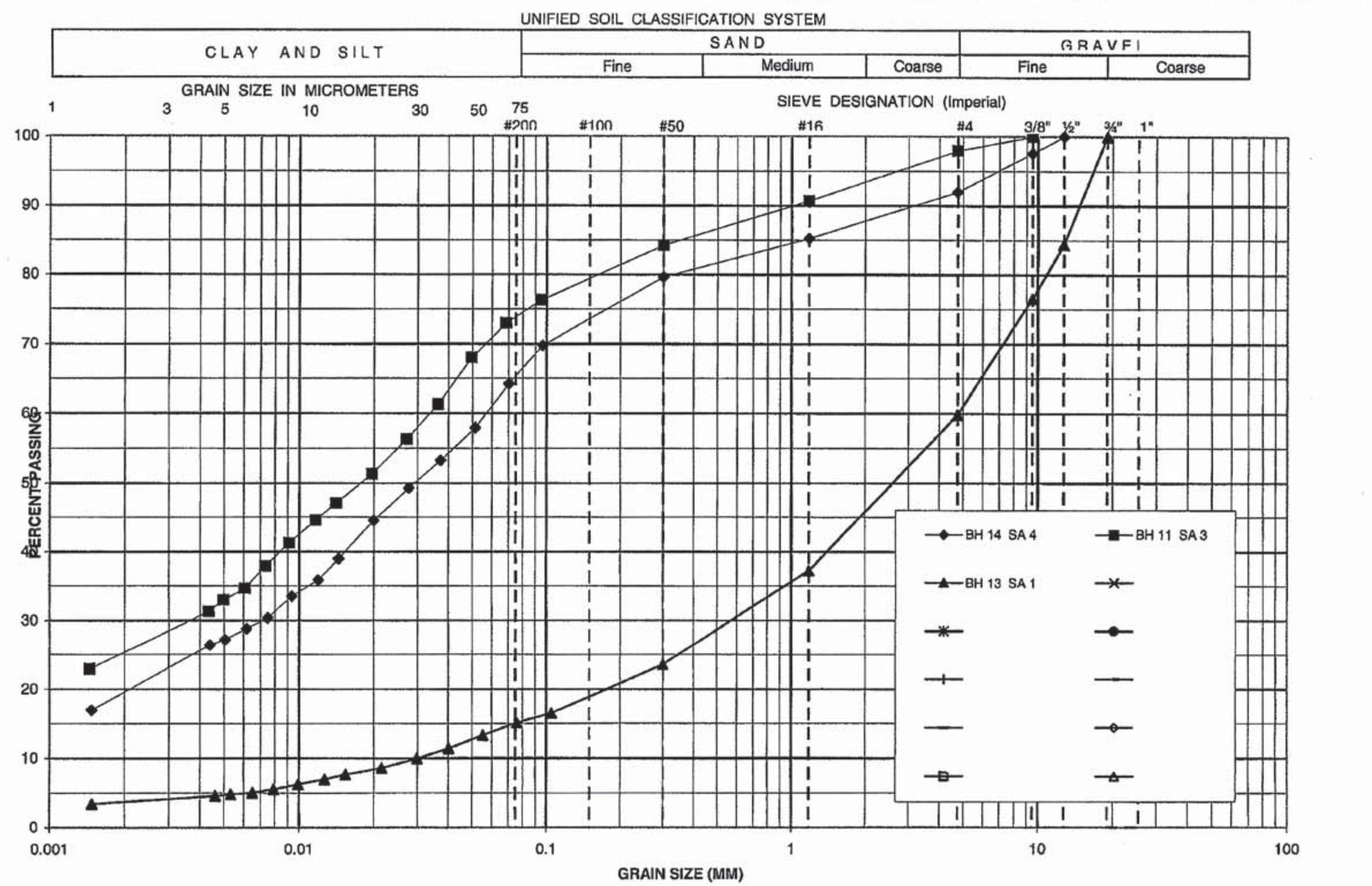


coffey geotechnics

GRAIN SIZE DISTRIBUTION
Silty Clay

FIGURE No.:	2
PROJECT No.:	G-08.0607
DATE:	Oct. 2008

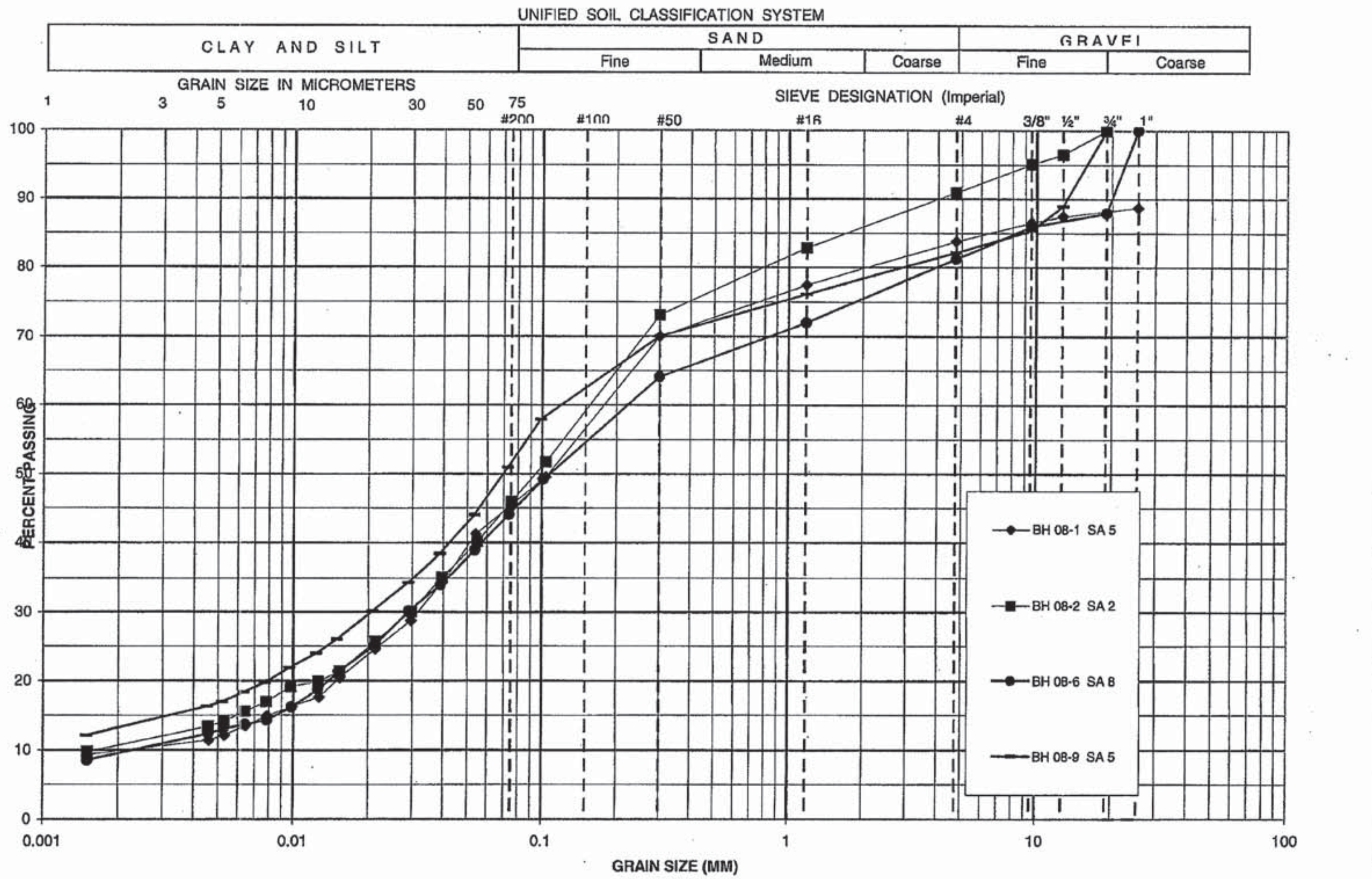
\\passport\public\Geotechnical\G-08\G-08.0607\Figure 2



coffey geotechnics	GRAIN SIZE DISTRIBUTION

FIGURE No. : 3
PROJECT No. : G-08.0607
DATE: Oct. 2008

\\passport\public\Geotechnical\G-08\G-08.0607\figure 3



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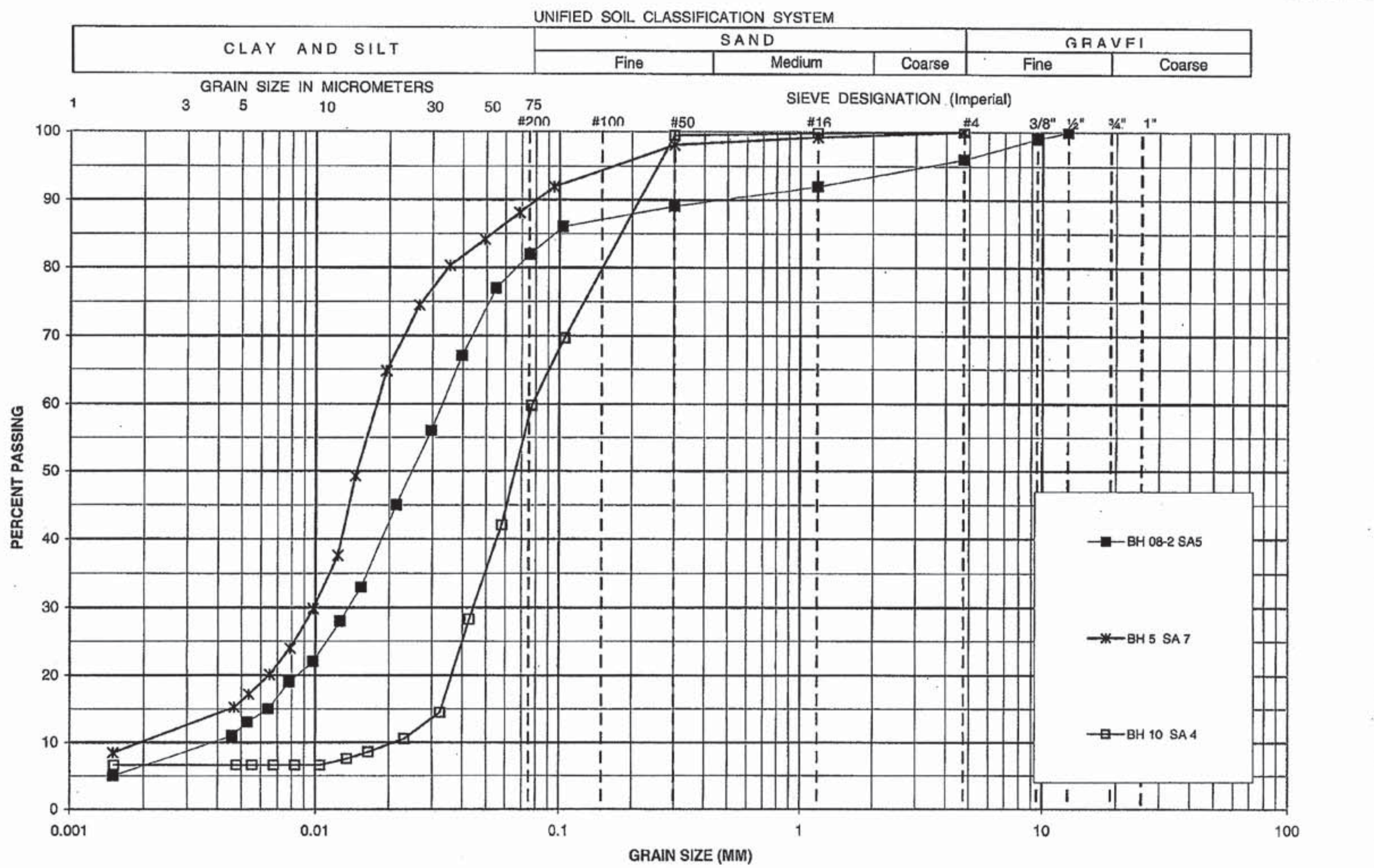
GRAIN SIZE DISTRIBUTION

Sandy Silt Till/Silty Sand Till

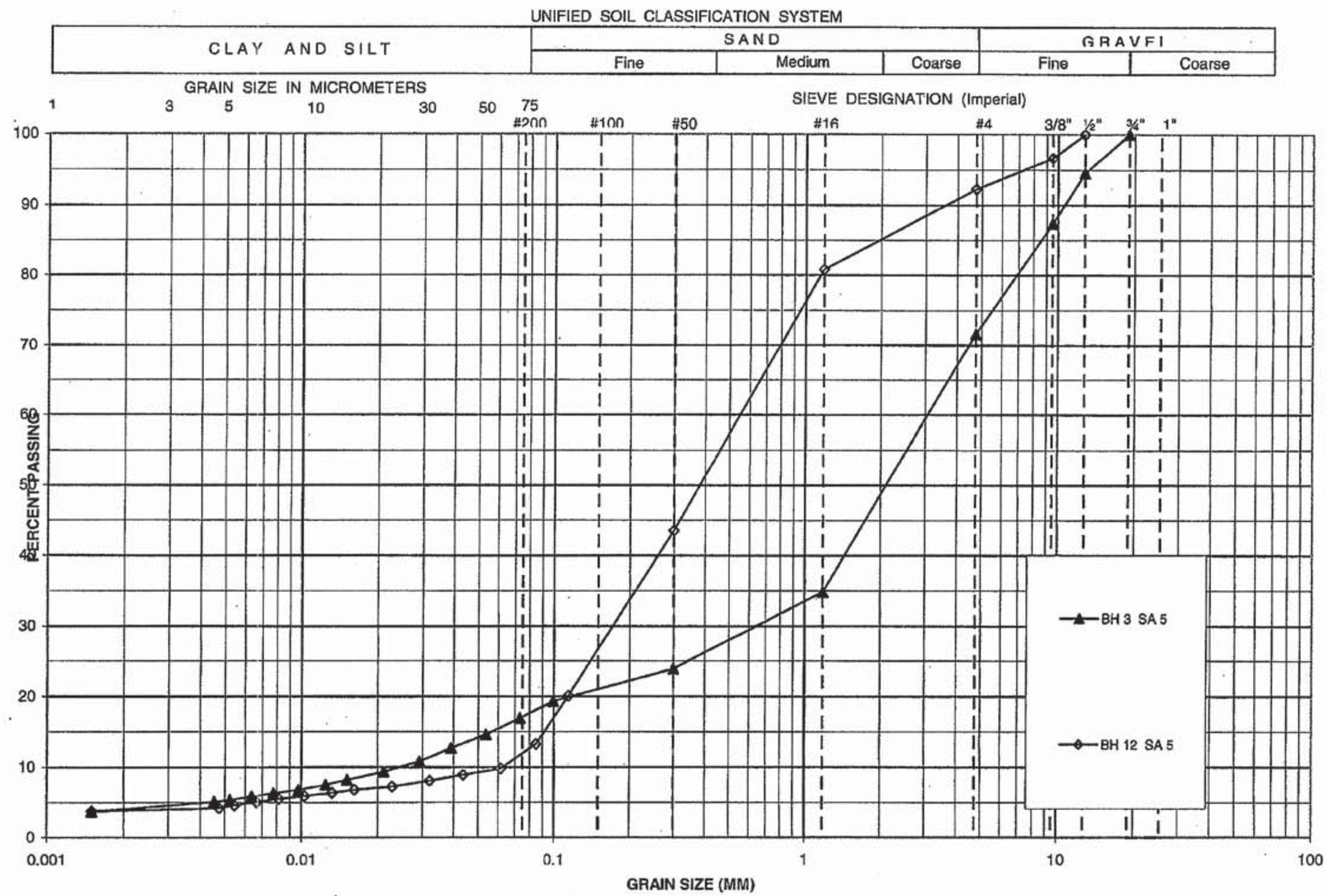
FIGURE No. :	4
PROJECT No. :	G-08.0607
DATE:	Oct. 2008

\\passport\public\Geotechnical\G-08\G-08.0607\Figure 4



coffey geotechnics	GRAIN SIZE DISTRIBUTION Silt/Sand and Silt	FIGURE No.: 5 PROJECT No.: G-08.0607 DATE: Oct. 2008

\\passport\public\Geotechnical\G-08\G-08.0607\Figure 5



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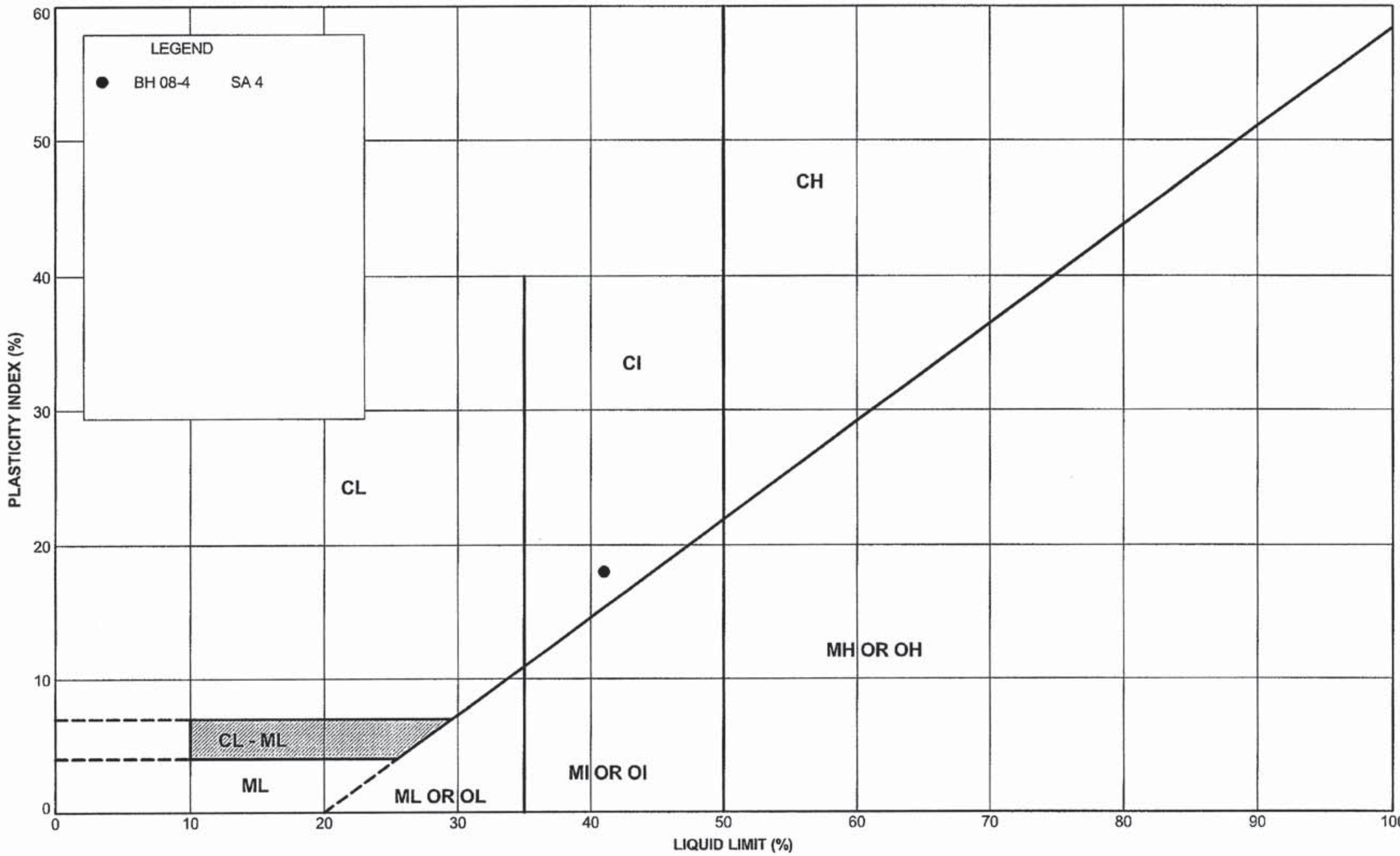
GRAIN SIZE DISTRIBUTION

Gravelly Sand/Sand

FIGURE No. :	6
PROJECT No. :	G-08.0607
DATE:	Oct. 2008

\\passport\public\Geotechnical\G-08\G-08.0607\Figure 6



coffey geotechnics

PLASTICITY CHART

FIGURE NO.	7
JOB NO.	G-08.0607
DATE	Oct. 2008

Appendix D

LOGS OF ALSTON BOREHOLES (BH4 TO BH17)

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		**BH No.: 4**
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

Column headings: DEPTH (m) | INSTRUMENTATION DATA | REMARKS | Shear Strength (kPa) 40 80 120 160 / N-Value (Blows/300mm) 20 40 60 80 | PL W.C. LL 20 40 60 80 | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO. | SPT(N) | ELEVATION (m)

REMARKS:

Borehole open and water level at 4.4 m below ground surface on completion.

Split spoon wet on retrieval of sample 3.

N-Value plot: 8; 14; 17; 50/150; 50/150; 50/100; 50/140

Depth scale (m): 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5

SOIL DESCRIPTION	SAMPLE NO.	SPT(N)
TOPSOIL	1A	8
loose, damp, brown sandy silt trace organics, FILL	1B	
dark brown TOPSOIL	1C	
compact, damp, brown sandy silt, trace organics, FILL	1D	
stiff, brown silty clay, some sand, trace gravel, trace topsoil (PROBABLE FILL)	2	14
compact, wet, brown, trace grey SILTY fine SAND	3A	17
very stiff, brown SILTY CLAY some sand, trace gravel occasional oxidized fissure	3B	
very dense, moist, grey SANDY SILT	4	50/150
hard, dark grey SILTY CLAY occasional thin silt seam	5	50/150
very dense, moist reddish brown weakly plastic SILTY SAND trace clay trace shale fragments	6	50/100
	7	50/140

END OF BOREHOLE

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	REVIEWED BY: DM	Page 1 of 1

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		**BH No.: 5**
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) 40 80 120 160 / N-Value (Blows/300mm) 20 40 60 80	PL W.C. LL 20 40 60 80	SOIL DESCRIPTION	SAMPLE NO.	SPT(N)	ELEVATION (m)
0 – 0.9		Borehole cave-in at 3.4 m and water level at 3.3 m below ground surface on completion.	21	5	compact, damp, brown sand and angular gravel FILL	1	21	
0.9 – 1.6			10	9	stiff, brown and dark brown silty clay, some sand, trace gravel occasional topsoil pocket, FILL	2	10	
1.6 – 2.3			23	12	very stiff brown veined grey SILTY CLAY some sand, trace gravel	3	23	
2.3 – 3.0		Water strike	36	17	dense, moist to wet, faintly layered to layered SILTY medium to fine SAND, brown and grey	4	36	
3.0 – 3.8	▽ (3.3)		53	18	very dense, moist to wet, faintly layered to layered SILTY medium to fine SAND, brown	5	53	
3.8 – 4.5			50/275	10	hard, grey SILTY CLAY trace sand, trace gravel occasional thin silt seams	6	50/275	
4.5 – 5			50/250	9	very dense damp, grey faintly layered SILT, some sand	7	50/250	
					END OF BOREHOLE			

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	REVIEWED BY: DM	Page 1 of 1

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		BH No.: 6
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) 40 80 120 160 / N-Value (Blows/300mm) 20 40 60 80	PL W.C. LL 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
0 – 0.5		Borehole cave-in at 3.5 m and water level at ___ m below ground surface on completion. Trace intermixing at base of granular.	11			compact, damp, brown sand and angular gravel occasional clay pocket, FILL		1A / 1B	11	
0.5 – 1						stiff, brown silty clay some sand, trace gravel (PROBABLE FILL)				
1			12			SILTY CLAY some sand trace gravel — stiff, brown		2	12	
1.5 – 2			36			hard; brown veined grey		3	36	
2.5			27			very stiff		4	27	
3 – 3.5		Water strike	40			dense moist to wet SILTY SAND trace gravel — fine		5	40	
4			36			medium to fine		6A / 6B	36	
4.5 – 5			30			hard, grey SILTY CLAY some sand to SANDY trace gravel		7	30	
5						END OF BOREHOLE				

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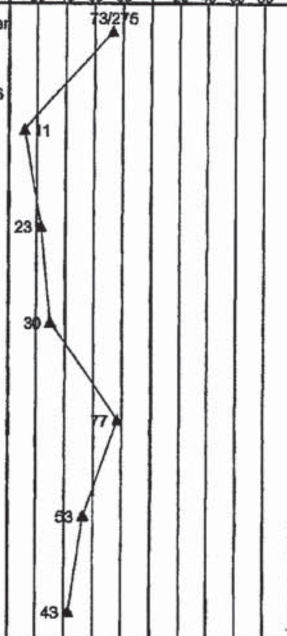
DRILLING DATE: 17 September
Page 1 of 1

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		**BH No.: 7**
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

Column headings: DEPTH (m) | INSTRUMENTATION DATA | REMARKS | Shear Strength (kPa) 40 80 120 160; N-Value (Blows/300mm) 20 40 60 80 | PL W.C. LL 20 40 60 80 | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO. | SPT(N) | ELEVATION (m)



DEPTH (m)	REMARKS	SOIL DESCRIPTION	SAMPLE NO.	SPT(N)
0 – 1.2	Borehole open and water level at 4.2 m below ground surface on completion. Boulder contacted at 0.6 m depth	very dense / loose; damp, brown sand and angular gravel, occasionla clay pocket FILL	1; 2A	73/275; 11
1.2 – 1.5		stiff, brown and dark brown silty clay, occasional sand pocket, trace organics (FILL)	2B	
1.5 – 2.9		very stiff / hard; SILTY CLAY, trace sand, trace gravel; brown veined grey / brown	3; 4	23; 30
2.9 – 3.6	Water strike	very dense, damp to moist, brown, weakly plastic SANDY SILT, trace clay	5	77
3.6 – 5		very dense / dense; brown, moist to wet SILTY fine SAND	6; 7	53; 43
		END OF BOREHOLE		

Water level symbol at approx. 4.2 m (instrumentation data column).

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	REVIEWED BY: DM	Page 1 of 1

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		BH No.: 8
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) 40 80 120 160 / N-Value (Blows/300mm) 20 40 60 80	PL W.C. LL 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
0		Borehole open and water level at 4.1 m below ground surface on completion.	17			compact, damp, brown sand and angular gravel trace organics, FILL		1A, 1B, 1C	17	
0.5–1			38			very stiff – hard; brown SILTY CLAY trace sand, trace gravel		2	38	
1.5–2			28			compact; moist, brown weakly plastic SANDY SILT trace clay		3	28	
2.5		Water strike	42			dense		4	42	
3–3.5			56			very dense; moist to wet, brown, trace rock fragments; SILTY SAND trace gravel		5A, 5B	56	
4	▽		25			compact; wet, grey		6	25	
4.5–5			34			dense		7	34	
						END OF BOREHOLE				

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	REVIEWED BY: DM	Page 1 of 1

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		**BH No.: 9**
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

Columns: DEPTH (m) | INSTRUMENTATION DATA | REMARKS | Shear Strength (kPa) 40 80 120 160 / N-Value (Blows/300mm) 20 40 60 80 | PL W.C. LL 20 40 60 80 | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO. | SPT(N) | ELEVATION (m)

REMARKS

Borehole open and water level at 8.7 m below ground surface on completion. Borehole water level measured as 1.6 m below ground surface on 2 October 2007.

Water strike (approx. 4.7 m)

SOIL DESCRIPTION

Depth (m)	Soil Description
0 – 0.6	loose, brown sand and gravel trace organics, FILL (wet / moist)
0.6 – 1.5	firm to stiff, brown silty clay, trace sand, trace gravel trace organics (PROBABLE FILL)
1.5 – 4.4	SILTY CLAY some sand trace gravel; stiff – brown veined grey, occasional oxidized fissures; hard – brown; SANDY; reddish grey
4.4 – 5.9	very dense damp reddish grey SILTY SAND trace gravel
5.9 – 9.3	very dense damp reddish grey SILTY SAND trace gravel trace rock fragments
	END OF BOREHOLE

SAMPLES

Sample No.	N-Value	W.C. (%)	SPT(N)
1A		513	
1B	9	21	9
1C			
2	9	16	9
3	9	21	9
4	51	11	51
5	50/100	7	50/100
6	50/100	10	50/100
7	50/125	7	50/125
8	50/75	4	50/75
9	50/75	5	50/75
10	50/75	4	50/75

Depth scale: 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9

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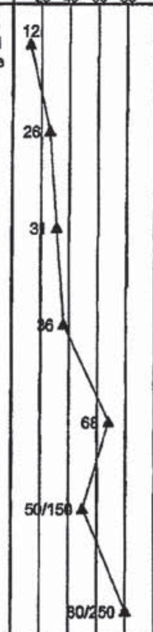
	REVIEWED BY: DM	Page 1 of 1

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		**BH No.: 10**
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) 40 80 120 160 / N-Value (Blows/300mm) 20 40 60 80	PL W.C. LL 20 40 60 80	SOIL DESCRIPTION	SAMPLE NO.	SPT(N)	ELEVATION (m)
0		Borehole cave-in at 4.3 m and water level at 4.1 m below ground surface on completion.	12		270 mm SANDY TOPSOIL	1A	12	
0.5					stiff — SILTY CLAY trace sand trace gravel — brown, trace organics	1B		
1			26		very stiff — SILTY CLAY trace sand trace gravel — brown veined grey	2	26	
1.5			31		hard — brown	3	31	
2.5			36		dense — moist brown SILTY SAND trace gravel	4	36	
3			68		very dense	5A / 5B	68	
3.5					SILTY CLAY some sand some gravel — reddish brown			
4	▽		50/150			6	50/150	
4.5			80/250		reddish brown, trace grey	7	80/250	
					END OF BOREHOLE			



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	REVIEWED BY: DM	Page 1 of 1

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		BH No.: 11
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) 40 80 120 160 / N-Value (Blows/300mm) 20 40 60 80	PL W.C. LL 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
0		Borehole dry and open on completion.				150 mm SANDY TOPSOIL		1A		
0.5			12			very stiff, brown SILTY CLAY some sand trace to some gravel, trace organics		1B	12	
1			41					2	41	
1.5 – 2			37			hard		3A / 3B	37	
2.5			66/280			compact, moist, brown SILTY fine SAND		4A / 4B	66/280	
3 – 3.5			50/130			very dense moist reddish brown SILTY SAND trace gravel; weakly plastic, trace to some clay		5	50/130	
4		Augers grinding	50/100			trace clay		6	50/100	
4.5		Augers grinding	50/150					7	50/150	
						END OF BOREHOLE				

Shear strength value plotted near 0.3 m: 3 (plotted beyond 160 kPa).

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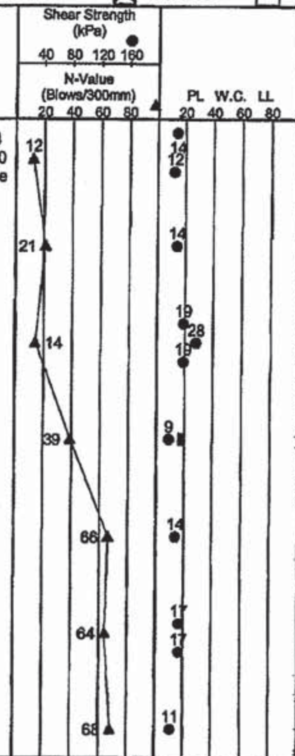
	REVIEWED BY: DM	Page 1 of 1

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		**BH No.: 12**
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	SOIL DESCRIPTION	SAMPLE NO.	SPT(N)	ELEVATION (m)
0		Borehole cave-in at 3.4 m and water level at 3.0 m below ground surface on completion.	200 mm SANDY TOPSOIL	1A		
0.5			stiff – SILTY CLAY some sand trace gravel; brown, trace organics	1B	12	
1				2	21	
1.5			very stiff; reddish brown, SANDY	3A		
			compact, wet, dark brown SILTY SAND	3B	14	
2			wet, weakly plastic, trace to some clay	3C		
2.5			compact – dense, reddish brown SILTY SAND trace gravel; moist, trace clay	4	39	
3	(water level)	Split spoon wet on retrieval of sample 5.	very dense, wet reddish brown coarse SAND some silt trace gravel	5	66	
4			brown sandy silt seam	6A	64	
				6B		
5				7	68	
			END OF BOREHOLE			



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	REVIEWED BY: DM	Page 1 of 1

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		**BH No.: 13**
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) ● 40 80 120 160 / N-Value (Blows/300mm) ▲ 20 40 60 80	PL W.C. LL 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
0		Borehole dry and cave-in at 4.1 m below ground surface on completion.	16			190 mm SANDY TOPSOIL		1A		
0.5						very stiff, greyish brown SILTY CLAY trace sand trace gravel trace rootlets		1B	16	
1			31			hard, greyish brown veined grey		2	31	
1.5			50/150			GRAVELLY		3	50/150	
2–3.5			50/150			very dense, damp reddish brown weakly plastic SILTY SAND trace to some clay some gravel		4	50/150	
3			50/150					5	50/150	
3.5–4		Split spoon wet on retrieval of sample 6.	50/100			hard, reddish brown SILTY CLAY some sand, some gravel		6A	50/100	
4						very dense, damp, reddish brown SILTY fine SAND		6B		
4.5			50/150			hard, reddish brown faintly layered SILTY CLAY parted by sand seams		7	50/150	
						END OF BOREHOLE				

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	REVIEWED BY: DM	Page 1 of 1

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		BH No.: 14
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) 40 80 120 160 / N-Value (Blows/300mm) 20 40 60 80	PL W.C. LL 20 40 60 80	SOIL DESCRIPTION	SAMPLE NO.	SPT(N)	ELEVATION (m)
0		Borehole open dry and on completion.			250 mm TOPSOIL	1A		
0.5			14		SILTY CLAY some sand trace gravel trace organics (brown / brown veined grey)	1B	14	
1			48			2	48	
1.5		Augers grinding	50/150		hard brown and reddish brown SILTY CLAY, some sand trace shale fragments	3	50/150	
2–2.5			50/80		hard reddish brown faintly layered to layered SHALY CLAY some sand	4	50/80	
3–3.5			62			5	62	
4			50/150			6	50/150	
4.5			50/120			7	50/120	
					END OF BOREHOLE			

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	REVIEWED BY: DM	Page 1 of 1

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		BH No.: 15
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

Shear Strength (kPa) ● 40 80 120 160 — N-Value (Blows/300mm) ▲ 20 40 60 80 — PL W.C. LL 20 40 60 80

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	N-Value	W.C.	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
0					TOPSOIL		1A		
0.5			11	15, 15	stiff — greyish brown SILTY CLAY some sand, trace gravel trace organics (possible fill)		1B	11	
1			22	12	very stiff		2	22	
1.5–2			68	8	hard SILTY CLAY trace sand trace gravel — reddish brown		3	68	
2.5			58	10	brown veined grey, occasional oxidized fissure		4	58	
3–3.5			64	14	grey, parted by silt layers		5	64	
4			32	9			6	32	
4.5–5			56	9	very dense, moist reddish brown to grey weakly plastic SILTY SAND trace clay, trace gravel		7	56	

END OF BOREHOLE

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	REVIEWED BY: DM	Page 1 of 1

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		**BH No.: 16**
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	N-Value (Blows/300mm)	SOIL DESCRIPTION	SAMPLE NO.	SPT(N)	ELEVATION (m)
0		Borehole open and water level at 4.2 m below ground surface on completion.		TOPSOIL	1A		
			11	stiff – firm, brown, trace grey silty clay, some sand, trace gravel, occasional topsoil pocket (PROBABLE FILL)	1B	11	
1			24		2A / 2B	24	
1.5			29	compact, moist, brown SANDY SILT, trace gravel	3	29	
2.5			31	SILTY CLAY, some sand, trace gravel — brown, trace reddish brown, SANDY	4	31	
3.3			82	brown, occasional oxidized fissure	5	82	
4	▽ (4.2)		81	grey, trace red, parted by silt layers	6	81	
4.6			50/150		7	50/150	
				END OF BOREHOLE			

Chart scales: Shear Strength (kPa) 40 80 120 160; N-Value (Blows/300mm) 20 40 60 80; PL W.C. LL 20 40 60 80

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	REVIEWED BY: DM	Page 1 of 1

CLIENT: Earth Tech Canada	METHOD: Augering and Split Spoon Sampling		**BH No.: 17**
PROJECT: Feedermain	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Mississauga Road, Peel Region	NORTHING:	EASTING:	PROJECT NO.: 07-014

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) ● 40 80 120 160 / N-Value (Blows/300mm) ▲ 20 40 60 80	PL W.C. LL 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
0		Borehole cave-in at 3.4 m and water level at 2.5 m below ground surface on completion.				250 mm TOPSOIL		1A		
0.5			16	10, 10		very stiff — brown SILTY CLAY some sand, trace gravel trace organics		1B	16	
1			14	14		stiff		2	14	
1.5–2			10	15		compact; brown SAND trace gravel — moist		3	10	
2.5	▽	Split spoon wet on retrieval of sample 4.	15	18		wet, fine		4	15	
3–3.5			24	12		SILTY, medium to fine		5	24	
4			40	15		dense; trace silt, medium to coarse		6	40	
4.5–5			67	13		very dense		7	67	
						END OF BOREHOLE				

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	REVIEWED BY: DM	Page 1 of 1

Appendix E
ENVIRONMENTAL AND CHEMICAL TEST RESULTS

Certificate of Analysis

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
L4Z 1Y2

TEL: (905) 712-5100
FAX: (905) 712-5122
www.agatlabs.com

AGAT WORK ORDER: 08T291714
PROJECT NO: 6-08.0607

CLIENT NAME: GEO-CANADA LIMITED

ATTENTION TO: LaiFa Cao

O. Reg. 153 Metals & Inorganics in Soil

DATE SAMPLED: Aug 27, 2008 | DATE RECEIVED: Sep 05, 2008 | DATE REPORTED: Sep 15, 2008 | SAMPLE TYPE: Soil

	Unit	G / S	RDL	BH08-1, SS2 1067532	BH08-3, SS4 1067533	BH08-5, SS5 1067534	BH08-9, SS2 1067535	BH08-11, SS1 1067536	BH08-13, SS2 1067538
Antimony	µg/g	40	1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Arsenic	µg/g	40	0.6	4.9	2.8	3.3	4.3	3.4	3.7
Barium	µg/g	1500	0.3	58.2	47.3	112	76.6	54.8	89.1
Beryllium	µg/g	1.2	0.4	0.6	0.4	0.7	0.9	<0.4	0.7
Boron (Hot Water Extractable)	µg/g	2.0	0.10	0.20	0.21	0.18	0.18	0.26	0.11
Cadmium	µg/g	12	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	µg/g	750	0.6	16.9	12.5	24.8	22.2	10.2	19.5
Cobalt	µg/g	80	0.3	10.0	7.2	10.9	11.6	5.6	9.9
Copper	µg/g	225	0.3	40.4	29.4	22.9	31.7	27.9	26.3
Lead	µg/g	1000	0.5	10.7	9.7	9.5	11.5	19.9	8.8
Molybdenum	µg/g	40	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel	µg/g	150	0.6	16.9	9.8	22.3	20.6	7.7	18.2
Selenium	µg/g	10	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Silver	µg/g	40	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Thallium	µg/g	32	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Vanadium	µg/g	200	0.4	25.4	17.6	35.8	32.3	15.5	31.1
Zinc	µg/g	600	0.4	53.3	43.7	51.9	61.2	47.4	43.6
Chromium, Hexavalent	µg/g	8	0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Cyanide, Free	µg/g	100	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mercury	µg/g	10	0.011	0.024	0.015	0.014	0.025	<0.011	0.015
Electrical Conductivity (2:1)	mS/cm	1.4	0.002	2.46	2.27	0.897	2.83	0.732	5.14
Sodium Adsorption Ratio (2:1)	N/A	12	N/A	67.5	46.8	12.1	31.3	29.9	58.1
pH (2:1)	N/A		N/A	9.05	8.90	8.55	8.13	9.74	8.61

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T2(ICC)

Certified By:

Results relate only to the items tested

Appendix F

LISTING OF MOE-REGISTERED WATER WELLS

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND5,11
HALTON HILLS TOWN (E CON 11(012)	17 591755 4834123[W]	1980/11 5206	08 08	FR 0135	040 / 140 004 / 3:0	DO		2805597 () BRWN SAND GRVL BLDR 0019 GREY LMSN HARD 0022 GREY HPAN 0043 RED SHLE LYRD 0143
HALTON HILLS TOWN (E CON 11(012)	17 591815 4834023[W]	1978/11 4640				NU		2805317 () BRWN CLAY SNDS 0007 STNS GRVL SAND 0020
HALTON HILLS TOWN (E CON 11(013)	17 591588 4834369[W]	1966/05 2519	30	FR 0042	042 / 049 004 / 4:0	PS		2801595 () GREY CLAY 0011 BRWN MSND CLAY 0012 BRWN MSND 0014 GREY HPAN 0022 RED SHLE BLDR 0025 MSND GRVL CLAY 0039 BLUE SHLE GRVL 0042 BRWN GRVL 0052
HALTON HILLS TOWN (E CON 11(013)	17 591543 4834048[W]	1958/02 4838	06 06	FR 0107 FR 0085	040 / 108 001 / 2:30	PS		2801594 () CLAY 0020 GRVL CLAY 0041 MSND 0063 GRVL CLAY 0073 RED SHLE 0108
HALTON HILLS TOWN (E CON 11(014)	17 591265 4834633[W]	1962/07 4101	06 06	FR 0054	020 / 057 010 / 5:0	DO		2801601 () BRWN CLAY 0015 RED CLAY 0035 RED CLAY MSND 0037 RED SHLE 0060
HALTON HILLS TOWN (E CON 11(014)	17 591321 4834630[W]	2002/12 3349	06 06	FR 0065	030 / 058 005 / 2:0	DO		2809722 (228754) BLCK LOAM 0001 BRWN CLAY 0016 RED CLAY 0027 RED SHLE 0070
HALTON HILLS TOWN (E CON 11(014)	17 591075 4834683[W]	1962/10 4101	05 05	FR 0080	020 / 055 008 / 5:0	ST DO		2801603 () BLUE CLAY 0040 GREY MSND 0060 HPAN 0068 RED SHLE 0088
HALTON HILLS TOWN (E CON 11(014)	17 591195 4834673[W]	1970/10 1307	30	FR 0028	024 / 030 015 / 1:0	DO		2803473 () BRWN OBDN MSND 0028 BRWN GRVL 0034
HALTON HILLS TOWN (E CON 11(014)	17 591140 4834473[W]	1970/12 4813	07	FR 0065	040 / 062 004 / 4:0	DO	0066 04	2803480 () BRWN CLAY 0016 GRVL 0065 CSND 0070
HALTON HILLS TOWN (E CON 11(014)	17 591168 4834786[W]	1994/11 1660	06 06	FR 0092	026 / 091 005 / 1:0	DO		2808358 (74904) PRDG 0022 GREY CLAY CGVL 0031 GREY CLAY 0046 BRWN SAND GRVL 0049 RED SHLE HARD 0098
HALTON HILLS TOWN (E CON 11(014)	17 591235 4834653[W]	1962/06 4101	06 06	FR 0040 FR 0070	030 / 075 008 / 3:0	DO		2801600 () BRWN CLAY 0014 RED CLAY 0028 RED SHLE 0092
HALTON HILLS TOWN (E CON 11(014)	17 591055 4834748[W]	1961/12 1307	30	FR 0025	025 / 001 / :0	DO		2801599 () BRWN LOAM CLAY 0025 CSND 0027 GREY CLAY 0042
HALTON HILLS TOWN (E CON 11(014)	17 591465 4834353[W]	1959/02 1613	04 04	FR 0111	017 / 032 004 / 1:0	DO		2801598 () PRDG 0018 GRVL 0034 BRWN MSND 0058 RED SHLE 0111
HALTON HILLS TOWN (E CON 11(014)	17 591535 4834338[W]	1958/12 2904	06 06	SA 0085	018 / 085 002 / 4:0	DO		2801597 () BRWN CLAY 0006 BRWN CLAY STNS 0034 GREY CLAY 0039 GREY CLAY STNS 0042 RED HPAN STNS 0059 RED SHLE 0100
HALTON HILLS TOWN (E CON 11(014)	17 591130 4834703[W]	1962/08 1309	07	FR 0032	019 / 024 002 / 3:0	DO		2801602 () PRDG 0022 CLAY 0029 CLAY GRVL 0032

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND5,11
BRAMPTON CITY (CHING HS W 04(016)	17 592775 4838563[W]	1978/11 3637	21 32 30	FR 0022 FR 0040	002 / 018 035 / 2:0	PS		4905552 () BRWN LOAM 0001 BRWN CLAY STNS PCKD 0012 GREY SILT CLAY STNS 0015 BRWN CLAY STNS PCKD 0020 GREY CLAY SILT LYRD 0021 BLCK SAND GRVL LOOS 0024 GREY CLAY SILT PCKD 0029 BRWN CLAY STNS PCKD 0035 BRWN FSND CSND LOOS 0037 BLCK GRVL STNS 0044
BRAMPTON CITY (CHING HS E 06(013)	17 591375 4834697[W]	1995/06 3349	06 06	FR 0061	025 / 046 004 / 3:0	DO		4908106 (158667) BLCK LOAM 0001 RED CLAY 0028 RED SHLE 0065
BRAMPTON CITY (CHING HS W 02(011)	17 595955 4838054[W]	1988/09 1663	06 06	FR 0060	006 / 035 / 1:30	CO		4907037 () BRWN CLAY GRVL 0008 RED CLAY GRVL 0010 GREY CLAY GRVL 0012 RED CLAY SHLE GRVL 0024 RED SHLE HARD 0065
BRAMPTON CITY (CHING HS W 02(013)	17 593721 4838258[W]	2002/07 1663				NU		4909032 (240097)
BRAMPTON CITY (CHING HS W 02(013)	17 593674 4838290[W]	2002/07 1663				NU		4909033 (240096)
BRAMPTON CITY (CHING HS W 02(013)	17 593662 4838067[W]	2002/07 1663				NU		4909034 (240095)
BRAMPTON CITY (CHING HS W 03(010)	17 595216 4836709[W]	1952/09 3514	06 06	FR 0059	030 / 030 008 / :0	CO		4901805 () RED CLAY 0003 RED SHLE 0060
BRAMPTON CITY (CHING HS W 03(010)	17 595208 4836724[W]	1961/04 3108	06 06	FR 0025 FR 0047	010 / 047 008 / 1:0	DO		4901807 () BRWN CLAY 0002 RED SHLE 0060
BRAMPTON CITY (CHING HS W 03(010)	17 595548 4836993[W]	1962/10 3514	06 06	FR 0055 FR 0040	014 / 014 004 / 5:0	ST DO		4901808 () BRWN CLAY 0009 RED SHLE 0060
BRAMPTON CITY (CHING HS W 03(010)	17 595211 4836659[W]	1959/05 1718	07 07	FR 0040	020 / 040 010 / 10:0	CO		4901806 () RED CLAY 0005 RED SHLE 0060
BRAMPTON CITY (CHING HS W 03(011)	17 595742 4837649[W]	1965/05 3513	05 05	FR 0045	009 / 025 006 / 2:0	DO		4901812 () BRWN CLAY 0012 RED SHLE 0065
BRAMPTON CITY (CHING HS W 03(011)	17 595272 4836865[W]	1963/11 1309	07 07	FR 0033 FR 0065	018 / 065 003 / 5:0	ST		4901811 () BRWN CLAY 0007 RED SHLE 0080
BRAMPTON CITY (CHING HS W 03(011)	17 595158 4836741[W]	1952/09 3514	04 04	FR 0057	030 / 060 004 / 3:0	DO		4901810 () RED CLAY 0005 RED SHLE 0060
BRAMPTON CITY (CHING HS W 03(011)	17 595323 4836951[W]	1959/12 1718	07 07	FR 0065	008 / 042 005 / 1:0	ST DO		4901809 () LOAM 0001 YLLW CLAY 0005 RED CLAY 0008 RED SHLE 0070
BRAMPTON CITY (CHING HS W 03(011)	17 595391 4837398[L]	1999/11 1663				NU		4908545 (213427)
BRAMPTON CITY (CHING HS W 03(011)	17 595294 4836667[W]	1987/07 3349	06 06	FR 0058 FR 0033	026 / 054 007 / 1:0	PS		4906809 () BLCK LOAM 0001 RED CLAY 0009 RED SHLE 0062

Well Computer Print Out Data as of July 21 2008

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND5,11
BRAMPTON CITY (CHING HS W 03(012)	17 595130 4838219[W]	1959/07 3513	04					4901815 () LOAM 0001 RED CLAY 0022
BRAMPTON CITY (CHING HS W 03(012)	17 595475 4838265[W]	1957/08 1718	06 06	FR 0031 FR 0045	012 / 027 005 / 2:0	DO		4901814 () YLLW CLAY 0010 RED CLAY 0018 RED SHLE 0045
BRAMPTON CITY (CHING HS W 03(012)	17 594613 4837329[W]	1956/11 3128	06 06	FR 0065	025 / 035 006 / 2:0	DO		4901813 () CLAY 0010 RED SHLE 0080
BRAMPTON CITY (CHING HS W 03(012)	17 594521 4837511[W]	1991/12 2336	06 06			DO		4907597 () BRWN CLAY STNS 0005 RED SHLE 0030 BLUE SHLE 0035 RED SHLE 0060
BRAMPTON CITY (CHING HS W 03(012)	17 594716 4837604[W]	1991/12 2336	06 06	FR 0033	014 / 058 002 / :0	DO		4907598 () BRWN CLAY STNS 0005 RED SHLE 0030 BLUE SHLE 0045 RED SHLE 0060
BRAMPTON CITY (CHING HS W 03(012)	17 594371 4837501[W]	1987/11 1660	06 06	FR 0036 FR 0018	008 / 017 024 / 1:0	DO ST		4906798 () BRWN CLAY 0001 RED SHLE SOFT 0012 RED SHLE HARD 0040
BRAMPTON CITY (CHING HS W 03(012)	17 594541 4837417[W]	2002/01 1663				NU		4908896 (240082)
BRAMPTON CITY (CHING HS W 03(012)	17 593471 4838697[W]	2006/04 3108				NU		4910247 (Z30603) PRDG 0013
BRAMPTON CITY (CHING HS W 03(013)	17 595078 4838632[W]	1995/07 3349	06 06	FR 0055	008 / 048 005 / 1:0	DO		4908104 (158658) BLCK LOAM 0001 BRWN CLAY STNS 0016 GREY CLAY SAND 0032 RED SHLE HARD 0060
BRAMPTON CITY (CHING HS W 03(013)	17 593924 4837930[W]	2002/12 1663				NU		4909082 (253093)
BRAMPTON CITY (CHING HS W 03(013)	17 594718 4838987[W]	1973/07 1660	06 06	FR 0047	006 / 010 024 / 1:0	DO		4904134 () CLAY FILL 0004 CLAY STNS 0033 RED SHLE 0051
BRAMPTON CITY (CHING HS W 03(013)	17 594039 4837808[W]	2002/06 6418				NU		4909015 (213196)
BRAMPTON CITY (CHING HS W 03(013)	17 593896 4837948[W]	2002/12 1663				NU		4909081 (253092)
BRAMPTON CITY (CHING HS W 03(014)	17 593665 4838243[W]	1980/06 5206	06 06	FR 0070	020 / 080 001 / 2:0	DO		4905652 () GRVL 0001 GREY CLAY SAND GRVL 0034 RED SHLE SOFT FCRD 0040 RED SHLE HARD LYRD 0080
BRAMPTON CITY (CHING HS W 03(014)	17 593635 4838223[W]	1970/06 4813	07	FR 0060	009 / 053 004 / 1:0	DO		4903454 () BRWN CLAY 0012 BRWN CLAY GRVL 0044 RED SHLE 0061
BRAMPTON CITY (CHING HS W 03(014)	17 593455 4838423[W]	1968/09 1612	05 05	FR 0038	012 / 014 005 / 2:0	DO		4903097 () LOAM 0001 GREY CLAY STNS 0025 GREY CLAY MSND 0031 CLAY STNS 0033 CLAY GRVL 0036 RED SHLE 0040
BRAMPTON CITY (CHING HS W 03(014)	17 593535 4838373[W]	1968/11 2643	06 06	FR 0050	008 / 050 005 / 2:0	DO		4903096 () MSND GRVL 0021 RED SHLE 0055

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND5,11
BRAMPTON CITY (CHING HS W 03(014)	17 593515 4838373[W]	1968/11 2643	06 06	FR 0060	009 / 060 003 / 2:0	DO		4903095 () MSND GRVL 0017 RED SHLE 0065
BRAMPTON CITY (CHING HS W 03(014)	17 593675 4838303[W]	1976/11 3637	30 32	FR 0018 FR 0032 FR 0042	020 / 007 / 1:0	ST		4905058 () BRWN LOAM 0002 BRWN CLAY CLAY SNDY 0012 GREY CLAY 0013 GREY CLAY SNDY STNS 0018 RED SAND STNS 0032 RED SHLE VERY HARD 0044
BRAMPTON CITY (CHING HS W 04(007)	17 595977 4834022[W]	2006/06 3108				NU		4910250 (Z30610) 0007 PRDR 0067
BRAMPTON CITY (CHING HS W 04(008)	17 595875 4835003[L]	1993/02 1508						4907889 (144934)
BRAMPTON CITY (CHING HS W 04(009)	17 595444 4835439[L]	2003/11 4005	06	UK 0175 UK 0185	090 / 185 001 / 2:0	DO		4909293 (258733) GREY SAND SILT GRVL 0104 GREY CLAY 0150 BRWN CLAY GRVL 0167 GREY SHLE 0190
BRAMPTON CITY (CHING HS W 04(009)	17 595689 4835993[W]	1957/08 1612	04 04	FR 0067	005 / 007 008 / 2:0	DO		4901905 () LOAM 0001 BRWN CLAY 0006 RED SHLE 0067
BRAMPTON CITY (CHING HS W 04(009)	17 595629 4836185[W]	1963/06 1307	30	FR 0015	004 / 010 / :0	DO		4901906 () BRWN LOAM 0004 RED SHLE 0015
BRAMPTON CITY (CHING HS W 04(009)	17 595188 4834828[W]	1964/08 1612	04 04	FR 0072	028 / 028 004 / 3:0	DO		4901907 () LOAM 0002 MSND CLAY 0038 RED SHLE 0074
BRAMPTON CITY (CHING HS W 04(009)	17 595175 4834845[W]	1966/06 1612	05 05	FR 0080	026 / 047 006 / 3:0	DO		4901908 () LOAM 0002 GREY CLAY 0012 GREY FSND 0043 RED SHLE 0083
BRAMPTON CITY (CHING HS W 04(009)	17 595660 4836160[W]	1967/04 1612	07 07	FR 0072	006 / 009 005 / 2:0	DO		4901909 () LOAM 0001 BRWN CLAY 0010 BRWN CLAY BLDR 0023 RED SHLE 0076
BRAMPTON CITY (CHING HS W 04(009)	17 595195 4834788[W]	1971/11 3513	05	FR 0040	018 / 025 010 / 2:0	DO		4903749 () BRWN CLAY 0009 BRWN MSND 0033 RED SHLE 0050
BRAMPTON CITY (CHING HS W 04(009)	17 595447 4835439[L]	1993/02 1508						4907888 (144932)
BRAMPTON CITY (CHING HS W 04(009)	17 595447 4835439[L]	1993/02 1508						4907893 (144930)
BRAMPTON CITY (CHING HS W 04(009)	17 595444 4835438[L]	2003/08 4005	06	UK 0094	080 / 092 002 / 2:0	DO		4909229 (258678) BRWN CLAY SNDY 0012 GREY CLAY 0078 GREY SAND GRVL 0092 GREY GRVL SAND 0096
BRAMPTON CITY (CHING HS W 04(010)	17 594996 4835876[L]	1993/02 1508						4907891 (144927)
BRAMPTON CITY (CHING HS W 04(010)	17 595149 4836626[W]	1962/08 1309	08 08	FR 0031 FR 0048	025 / 045 002 / 8:0	DO		4901910 () BLCK LOAM 0002 RED SHLE 0055
BRAMPTON CITY (CHING HS W 04(010)	17 594996 4835876[L]	1993/02 1508						4907890 (144924)

Well Computer Print Out Data as of July 21 2008

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND5,11
BRAMPTON CITY (CHING HS W 04(010)	17 594306 4835469[W]	1992/03 4919	30	UK 0010 UK 0020	010 / 035 010 / 1:0	DO		4907736 () BRWN LOAM HARD 0001 BRWN CLAY HARD 0020 GREY CLAY HARD 0036
BRAMPTON CITY (CHING HS W 04(010)	17 594996 4835876[L]	1993/03 1508						4907892 (144928)
BRAMPTON CITY (CHING HS W 04(010)	17 595485 4836277[W]	1974/12 4919	30 30	FR 0012	012 / 020 / 0:30	DO		4904581 () BRWN LOAM 0001 BRWN SAND 0017 GREY CLAY BLDR 0028
BRAMPTON CITY (CHING HS W 04(011)	17 594715 4836123[W]	1978/03 3637	30 24	FR 0016 FR 0012	007 / 018 / 3:0	DO		4905387 () BRWN LOAM 0001 BRWN CLAY 0004 RED SHLE HARD 0020
BRAMPTON CITY (CHING HS W 04(011)	17 594035 4835903[W]	1977/05 3637	30 32	FR 0017	012 / 007 / :0	DO		4905250 () BRWN LOAM 0001 BRWN CLAY SAND WBRG 0017 BRWN SAND STNS 0027 GREY CSND SAND 0036
BRAMPTON CITY (CHING HS W 04(011)	17 594830 4836680[W]	1962/10 1309	07 07	FR 0033 FR 0053	018 / 035 005 / 2:0	ST DO		4901912 () BRWN CLAY 0004 RED SHLE 0055
BRAMPTON CITY (CHING HS W 04(011)	17 594554 4836316[L]	1997/06 3317	10 10	FR 0050	029 / 060 001 / 1:30	ST DO		4908278 (181315) RED CLAY 0004 RED SHLE SOFT 0008 RED SHLE LYRD 0070
BRAMPTON CITY (CHING HS W 04(011)	17 594903 4836823[W]	1969/10 5459	34	FR 0024	012 / 034 / :0	DO		4903400 () LOAM 0003 BRWN CLAY 0014 BLUE CLAY STNS 0024 BLUE CLAY FSND 0034
BRAMPTON CITY (CHING HS W 04(011)	17 595151 4836666[W]	1951/05 4838	05 05	FR 0066	022 / 022 002 / :0	DO		4901911 () CLAY 0009 RED SHLE 0066
BRAMPTON CITY (CHING HS W 04(011)	17 594554 4836316[L]	1997/06 3317				NU		4908277 (181314)
BRAMPTON CITY (CHING HS W 04(012)	17 594839 4836991[W]	1994/10 3413	12	FR 0016	008 / 059 003 / 6:0	DO	0025	4907908 (116636) BRWN CLAY 0010 GREY SAND LYRD CLAY 0016 RED SHLE 0030 GREY SHLE 0060
BRAMPTON CITY (CHING HS W 04(012)	17 594839 4836991[W]	1994/10 3413	24	FR 0026	008 / 062 050 / 2:0	DO		4907907 (116634) BRWN CLAY 0008 RED SHLE 0030 GREY SHLE 0064
BRAMPTON CITY (CHING HS W 04(012)	17 594117 4836755[L]	1994/09 6624	06 06	FR 0050 FR 0027	008 / 080 002 / 1:30	DO		4907905 (093849) LOAM 0001 BRWN CLAY GRVL SHLE 0003 BLUE SHLE LYRD 0018 BLUE SHLE 0030 BRWN SHLE 0082
BRAMPTON CITY (CHING HS W 04(012)	17 594117 4836755[L]	1994/08 6624	06 06	FR 0030	/ / :0	DO		4907904 (093847) LOAM 0001 BRWN CLAY SAND GRVL 0008 RED CLAY GRVL 0016 BRWN SHLE LYRD 0050
BRAMPTON CITY (CHING HS W 04(012)	17 593655 4836293[W]	1978/05 3637	30 32	FR 0027	004 / 020 / 16:0	DO		4905393 () BRWN CLAY 0010 GREY CLAY PCKD 0024 GREY CLAY SAND 0027 BRWN SAND GRVL LOOS 0034
BRAMPTON CITY (CHING HS W 04(012)	17 593675 4836273[W]	1978/05 3637	30	FR 0027 FR 0032	004 / 032 025 / 24:0	DO		4905392 () BRWN CLAY 0008 BRWN SAND MUCK 0010 BRWN CLAY PCKD 0022 BRWN SAND CLAY 0030 RED SHLE HARD 0032
BRAMPTON CITY (CHING HS W 04(012)	17 594529 4837175[W]	1958/11 3513	05	FR 0080	015 / 115 003 / 4:0	ST DO		4901913 () PRDR 0080 RED SHLE 0115

Well Computer Print Out Data as of July 21 2008

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND5,11
BRAMPTON CITY (CHING HS W 04(012)	17 594503 4837152[W]	2006/06 1663	02			NU		4910240 (Z36827)
BRAMPTON CITY (CHING HS W 04(012)	17 594514 4837159[W]	2006/06 1663	02			NU		4910241 (Z36828)
BRAMPTON CITY (CHING HS W 04(013)	17 593209 4836733[W]	1960/10 1325	30	FR 0012	012 / / :0	DO		4901914 () CLAY MSND BLDR 0012 MSND 0017 RED SHLE 0023
BRAMPTON CITY (CHING HS W 04(013)	17 594524 4837245[W]	1962/08 1309	07	FR 0014	009 / 012 004 / 4:0	ST DO		4901915 () PRDG 0010 RED SHLE 0060
BRAMPTON CITY (CHING HS W 04(013)	17 593279 4836848[W]	1999/11 6865	06 05	FR 0100	007 / 041 004 / 1:0	DO		4908505 (203988) LOAM 0001 BRWN SAND CLAY 0009 GREY CLAY 0017 GREY SHLE GRVL 0026 BRWN GRVL SAND 0030 GREN SHLE SAND FCRD 0049 GREN SHLE LMSN LYRD 0100
BRAMPTON CITY (CHING HS W 04(013)	17 595064 4838618[W]	2002/07 1663				NU		4909020 (240094)
BRAMPTON CITY (CHING HS W 04(013)	17 595060 4838619[W]	2002/07 1663				NU		4909021 (240093)
BRAMPTON CITY (CHING HS W 04(013)	17 595053 4838365[W]	2002/07 1663				NU		4909022 (240092)
BRAMPTON CITY (CHING HS W 04(013)	17 593397 4836609[W]	2004/11 3108				NU		4909607 (Z05911) 0131 0115 0092 0026
BRAMPTON CITY (CHING HS W 04(013)	17 593384 4836588[W]	2004/11 3108				NU		4909608 (Z05910)
BRAMPTON CITY (CHING HS W 04(014)	17 592825 4837242[W]	1981/08 3637	30	FR 0025	007 / 014 / 1:0	DO		4905929 () BRWN LOAM 0001 BRWN CLAY 0003 GREN CLAY HARD PCKD 0005 RED SAND 0010 RED CLAY STNS 0016 RED CLAY STNS PCKD 0025 RED SHLE 0032
BRAMPTON CITY (CHING HS W 04(014)	17 592983 4837195[W]	1984/07 3317	05	FR 0009	007 / 014 011 / 10:0	PS		4906276 () CLAY 0009 GRVL 0012 CLAY 0014 GRVL 0015 CLAY 0024
BRAMPTON CITY (CHING HS W 04(015)	17 592594 4838297[W]	1950/04 1532	06	FR 0070	020 / 035 020 / 1:0	ST		4901916 () CLAY STNS 0034 FSND 0070 GRVL 0077
BRAMPTON CITY (CHING HS W 04(016)	17 592611 4838821[W]	1973/07 3513	08 08	FR 0033 FR 0085	018 / 080 010 / 2:0	DO		4904129 () BRWN LOAM 0001 BRWN CLAY 0022 BLUE CLAY 0033 RED GRVL 0042 RED CLAY SAND 0076 RED SHLE 0095
BRAMPTON CITY (CHING HS W 04(016)	17 592562 4838181[W]	1966/05 1307	30	FR 0047	015 / 002 / :0	DO		4901919 () BRWN LOAM CLAY 0018 RED CLAY 0035 GREY CLAY 0045 MSND 0047
BRAMPTON CITY (CHING HS W 04(016)	17 592079 4837924[W]	1962/11 1307	30	FR 0015	015 / 010 / :0	DO		4901918 () BRWN LOAM 0015 BRWN CSND 0031

Well Computer Print Out Data as of July 21 2008

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTENDS,11
BRAMPTON CITY (CHING HS W 04(016)	17 592209 4838003^W	1962/07 4101	07 07	FR 0070	020 / 070 010 / 8:0	ST DO		4901917 () PRDG 0028 HPAN 0040 QSND 0055 GRVL MSND 0065 RED SHLE 0075
BRAMPTON CITY (CHING HS W 04(017)	17 591429 4838493^W	1962/09 1325	30	FR 0043	041 / 001 / 1:0	DO ST		4901920 () BRWN CLAY MSND BLDR 0011 RED CLAY BLDR 0021 RED SHLE 0053
BRAMPTON CITY (CHING HS W 05(007)	17 595597 4834271^W	1954/06 3514	05 05	FR 0048	020 / 020 008 / :0	DO		4902013 () RED CLAY 0010 RED SHLE 0048
BRAMPTON CITY (CHING HS W 05(008)	17 595265 4834603^W	1968/08 3513	05 05	FR 0050	034 / 080 002 / 2:0	DO		4903173 () BRWN CLAY 0018 MSND GRVL 0038 RED SHLE 0080
BRAMPTON CITY (CHING HS W 05(009)	17 595125 4834763^W	1968/08 1612	05 05	FR 0058	026 / 034 005 / 4:0	DO		4902906 () LOAM 0001 BRWN CLAY MSND 0030 BLUE CLAY 0036 RED SHLE 0064
BRAMPTON CITY (CHING HS W 05(009)	17 594109 4834040^W	1962/05 3512	05					4902019 () BRWN CLAY 0010 RED CLAY 0028 RED SHLE 0140
BRAMPTON CITY (CHING HS W 05(009)	17 594454 4834565^W	1966/07 3513	05	FR 0045	012 / 035 006 / 2:0	DO ST		4902020 () PRDG 0020 RED SHLE 0049
BRAMPTON CITY (CHING HS W 05(009)	17 594626 4834339^L	1999/09 4005	06 06		/ / :0	DO		4908471 (204450) BRWN CLAY 0004 RED CLAY 0014 RED SHLE 0048
BRAMPTON CITY (CHING HS W 05(011)	17 593973 4835817^W	1967/07 1307	30	FR 0020	006 / 002 / :0	DO ST		4902024 () BRWN LOAM CLAY MSND 0018 GRVL 0020
BRAMPTON CITY (CHING HS W 05(011)	17 593479 4834670^W	1967/01 1612	07 07	FR 0073	013 / 028 004 / 1:0	ST DO		4902023 () BRWN CLAY BLDR 0022 RED SHLE 0076
BRAMPTON CITY (CHING HS W 05(011)	17 594209 4835689^W	1962/06 3514	05 05	FR 0040	008 / 008 010 / 4:0	DO		4902021 () GREY CLAY MSND 0023 RED SHLE 0045
BRAMPTON CITY (CHING HS W 05(011)	17 594075 4835683^W	1978/06 4919	30	UK 0012	012 / 023 / 0:30	DO		4905363 () BRWN LOAM HARD 0001 BRWN CLAY HARD 0010 BRWN GRVL SAND STNS 0029
BRAMPTON CITY (CHING HS W 05(011)	17 594173 4835604^W	1965/06 1307	30	FR 0010	/ 025 / :0	IN		4902022 () BRWN LOAM MSND 0010 GRVL 0020
BRAMPTON CITY (CHING HS W 05(011)	17 593257 4834870^W	1991/08 6396	06 06	FR 0038 FR 0008 FR 0059	005 / 007 008 / 1:0	DO		4907571 () BRWN TILL LOOS 0008 RED SHLE SAND SOFT 0070
BRAMPTON CITY (CHING HS W 05(012)	17 593665 4836123^W	1968/10 3513	05 05	FR 0040 FR 0060	030 / 060 002 / 2:0	DO		4903176 () LOAM 0002 BRWN CLAY 0018 MSND GRVL 0048 RED SHLE 0070
BRAMPTON CITY (CHING HS W 05(013)	17 592487 4835536^W	1981/05 3637	30 32	FR 0013 FR 0022	011 / 022 030 / 1:0	DO		4905843 () BRWN LOAM 0001 BRWN CLAY 0005 BRWN CLAY SNDS GRVL 0011 BRWN CSND GRVL STNS 0022 BRWN CLAY SAND PCKD 0023
BRAMPTON CITY (CHING HS W 05(013)	17 593090 4836551^W	1983/08 3317	08 08	UK 0045	014 / 060 003 / :0	DO ST		4906137 () CLAY STNS 0018 RED SHLE 0070

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTENDS,11
BRAMPTON CITY (CHING HS W 05(013)	17 593566 4836245[W]	1994/08 3317	06 06	FR 0037 FR 0009	008 / 027 011 / 5:0	DO ST		4907874 (149954) CLAY SAND 0004 SAND GRVL 0016 BLUE SHLE 0044
BRAMPTON CITY (CHING HS W 05(013)	17 592537 4835453[W]	2002/09 3349	06 06	FR 0056	008 / 046 006 / 6:0	DO		4909123 () BLCK LOAM 0001 BRWN CLAY 0012 RED CLAY 0020 RED SHLE 0060
BRAMPTON CITY (CHING HS W 05(013)	17 592537 4835453[W]	2002/01 3349				NU DO		4909124 ()
BRAMPTON CITY (CHING HS W 05(013)	17 593035 4836503[W]	1978/05 4919	30	UK 0017	002 / 020 / 0:30	ST DO		4905362 () BRWN LOAM HARD 0001 BRWN CLAY HARD 0010 GREY CLAY 0017 RED SHLE 0020
BRAMPTON CITY (CHING HS W 05(014)	17 592436 4836503[L]	1993/02 1508						4907886 (144938)
BRAMPTON CITY (CHING HS W 05(015)	17 592515 4837323[W]	1969/06 4919	36	FR 0005	005 / / :0	DO		4903275 () LOAM 0003 MSND STNS 0017
BRAMPTON CITY (CHING HS W 05(015)	17 591996 4836933[L]	1999/07 1737			/ 005 / :15	NU		4908472 (200573) BRWN SAND CLAY STNS 0026 BRWN CLAY SILT STNS 0069 GREY SILT SOFT 0084 RED SHLE 0132
BRAMPTON CITY (CHING HS W 05(016)	17 591427 4836639[W]	1996/06 4919	30	UK 0040 UK 0020 UK 0045	014 / 047 010 / 1:0	DO		4908150 (161519) BRWN LOAM HARD 0001 BRWN CLAY HARD 0020 GREY CLAY SAND LYRD 0050
BRAMPTON CITY (CHING HS W 05(016)	17 591767 4837225[W]	1990/04 3349	06 06	FR 0078	011 / 075 005 / 1:30	DO		4907486 () BLCK LOAM 0001 BRWN SAND CLAY 0023 GREY CLAY STNS 0054 RED SAND STNS 0060 RED SHLE 0082
BRAMPTON CITY (CHING HS W 05(016)	17 591876 4837954[W]	1962/11 1307	30	FR 0036	020 / 004 / :0	DO		4902025 () BRWN LOAM CLAY 0018 GREY CLAY MSND 0034 MSND 0036
BRAMPTON CITY (CHING HS W 05(016)	17 591104 4836268[W]	1990/07 4868	36 30	FR 0025	016 / 022 005 / 1:0	DO		4907360 () BRWN LOAM LOOS 0002 BRWN CLAY STNS HARD 0009 GREY CLAY SILT HARD 0019 BRWN CLAY SAND 0025 BRWN SAND LOOS 0028 BRWN CLAY 0041
BRAMPTON CITY (CHING HS W 05(016)	17 591835 4837261[W]	1990/02 3349	06 06	FR 0080 FR 0088	009 / 085 004 / 4:0	DO		4907377 () BLCK LOAM 0001 BRWN SAND CLAY 0021 GREY SAND STNS 0058 BRWN MSND 0064 RED SHLE 0092
BRAMPTON CITY (CHING HS W 06(010)	17 593515 4834223[W]	1977/05 2336	06 06	FR 0121	009 / 100 001 / 1:0	IN		4905135 () BRWN LOAM 0001 BRWN CLAY 0005 RED SHLE 0121
BRAMPTON CITY (CHING HS W 06(010)	17 593550 4834000[W]	2002/12 4011				NU		4909099 (244019)
BRAMPTON CITY (CHING HS W 06(010)	17 593565 4834223[W]	1977/05 2336	06 06	FR 0110	011 / 090 003 / 1:0	IN		4905136 () BRWN LOAM 0001 BRWN CLAY STNS 0010 RED SHLE 0121

Well Computer Print Out Data as of July 21 2008

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND5,11
BRAMPTON CITY (CHING HS W 06(010)	17 593715 4834223[W]	1977/05 2336	06 06	FR 0047	006 / 080 001 / 1:0	IN		4905138 () LOAM 0001 BRWN CLAY 0008 RED SHLE 0090
BRAMPTON CITY (CHING HS W 06(010)	17 593605 4834033[W]	1977/08 2336	06	FR 0097 FR 0045	012 / 065 008 / 3:0	IN		4905195 () PRDG 0035 RED SHLE 0100
BRAMPTON CITY (CHING HS W 06(010)	17 593500 4834000[W]	2002/12 4011				NU		4909100 (244020)
BRAMPTON CITY (CHING HS W 06(010)	17 593700 4834000[W]	2002/12 4011				NU		4909098 (244017)
BRAMPTON CITY (CHING HS W 06(010)	17 593550 4834000[W]	2002/12 4011						4909096 (244016)
BRAMPTON CITY (CHING HS W 06(011)	17 593461 4834439[W]	1958/03 3513	04 04	FR 0030	008 / 028 003 / 4:0	DO		4902094 () RED CLAY 0008 RED SHLE 0050
BRAMPTON CITY (CHING HS W 06(011)	17 593459 4834406[W]	1958/04 3513	04 04	FR 0035	008 / 020 003 / 4:0	DO		4902095 () RED CLAY 0014 RED SHLE 0052
BRAMPTON CITY (CHING HS W 06(011)	17 593233 4834211[W]	1967/09 2613	07 07	FR 0080	022 / 027 020 / 5:0	IN		4902096 () BRWN CLAY 0020 RED SHLE 0102
BRAMPTON CITY (CHING HS W 06(011)	17 593269 4834306[W]	1973/04 2604	05	FR 0056	010 / 060 020 / 2:10	PS		4904314 () LOAM 0001 YLLW CLAY 0007 RED CLAY SHLE 0019 RED SHLE CLAY 0022 RED SHLE 0108
BRAMPTON CITY (CHING HS W 06(011)	17 593365 4834363[W]	1968/08 3513	06 06	FR 0045	015 / 040 005 / 2:0	DO		4903172 () LOAM 0001 BRWN CLAY 0007 RED SHLE 0055
BRAMPTON CITY (CHING HS W 06(011)	17 593092 4834319[W]	1973/04 2604						4904216 () LOAM 0001 YLLW CLAY STNS 0008 RED SHLE CLAY 0029 RED SHLE 0180
BRAMPTON CITY (CHING HS W 06(011)	17 593298 4834294[W]	1973/04 2604	05	FR 0052	016 / 060 020 / 3:20	PS		4904217 () LOAM 0001 YLLW CLAY 0007 RED CLAY SHLE 0019 RED SHLE CLAY 0022 RED SHLE 0105
BRAMPTON CITY (CHING HS W 06(012)	17 592642 4835291[W]	1973/07 3637	30 21	FR 0015 FR 0025	007 / 017 006 / 1:0	DO		4904345 () BRWN LOAM 0001 BRWN CLAY 0003 RED SHLE 0032
BRAMPTON CITY (CHING HS W 06(012)	17 591885 4834123[W]	1976/06 4320	06	FR 0163	045 / 015 / 3:0	DO		4905409 () BRWN CLAY 0018 RED CLAY BLDR HARD 0048 RED SHLE 0165
BRAMPTON CITY (CHING HS W 06(012)	17 591793 4834313[W]	1973/03 1660	06 06	FR 0067	014 / 060 006 / 1:0	DO		4904133 () LOAM 0001 BRWN CLAY STNS 0019 BRWN CLAY SAND 0023 SAND CLAY STNS 0037 RED SHLE 0070
BRAMPTON CITY (CHING HS W 06(012)	17 591942 4834136[W]	1990/12 5206	06	UK 0095 UK 0105 FR 0088	/ 008 / 2:0	DO		4907422 () BRWN CLAY SAND 0016 BLUE SHLE 0088 GREY SHLE 0110
BRAMPTON CITY (CHING HS W 06(013)	17 591705 4834303[W]	1972/11 3349	05	FR 0059	023 / 057 002 / 1:0	DO		4903960 () BRWN LOAM 0002 BRWN CLAY 0017 RED SHLE STNS 0064

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTENDS,11
BRAMPTON CITY (CHING HS W 06(013)	17 591795 4834293[W]	1971/11 3349		FR 0073	046 / 046 010 / 1:0	DO		4903806 () BRWN LOAM STNS 0001 GREY CLAY STNS 0060 BRWN MSND GRVL 0067 RED SHLE 0076
BRAMPTON CITY (CHING HS W 06(013)	17 592603 4835285[W]	3513		FR 0045	012 / 035 / :0	DO		4905688 () BRWN CLAY 0009 RED CLAY 0014 RED SHLE 0055
BRAMPTON CITY (CHING HS W 06(013)	17 592664 4835270[W]	1991/11 3349	06 06	FR 0076	021 / 032 010 / 2:0	DO		4907648 () BLCK LOAM 0002 GREY CLAY 0008 RED CLAY SHLE 0027 RED SHLE 0080
BRAMPTON CITY (CHING HS W 06(013)	17 592621 4835317[W]	1991/11 3349	06 06	FR 0075	021 / 032 010 / 2:0	DO		4907647 () BLCK LOAM 0002 GREY CLAY 0009 RED CLAY SHLE 0028 RED SHLE 0080
BRAMPTON CITY (CHING HS W 06(013)	17 591664 4834335[W]	1986/08 1660	06 06	FR 0048	022 / 032 005 / 3:0	DO		4906618 () BRWN LOAM 0003 GREY CLAY 0048 GRVL 0050
BRAMPTON CITY (CHING HS W 06(013)	17 591476 4834554[W]	1962/06 1307	38					4902097 () BRWN LOAM CLAY 0008 RED SHLE 0036
BRAMPTON CITY (CHING HS W 06(013)	17 592583 4835303[W]	3513		FR	015 / 040 010 / 4:0	DO		4905687 () BRWN CLAY 0006 RED CLAY 0012 RED SHLE 0065
BRAMPTON CITY (CHING HS W 06(014)	17 591345 4834653[W]	1971/05 1660	06	FR 0077	012 / 077 006 / 1:30	DO		4903611 () BRWN LOAM 0001 BRWN CLAY STNS 0014 RED SHLE 0082
BRAMPTON CITY (CHING HS W 06(014)	17 591559 4835386[L]	1993/02 1508						4907887 (144939)
BRAMPTON CITY (CHING HS W 06(014)	17 591295 4834673[W]	1972/03 4320	04 04	MN 0078 MN 0051	030 / 078 003 / 2:30	DO		4903830 () BLCK LOAM 0002 BRWN CLAY STNS 0008 RED SHLE 0092
BRAMPTON CITY (CHING HS W 06(015)	17 591060 4835954[W]	1967/06 1307	30	FR 0032	015 / 002 / :0	DO		4902100 () BRWN LOAM CLAY 0012 GREY CLAY 0029 MSND 0032
BRAMPTON CITY (CHING HS W 06(016)	17 591264 4836606[W]	1975/02 5211	05 05	MN 0093	060 / 075 008 / 1:0	DO		4904594 () BRWN LOAM 0003 GREY CLAY SAND GRVL 0020 RED CLAY SAND 0040 GREY CLAY SAND 0060 RED CLAY SAND 0080 RED CLAY 0090 RED SHLE 0098
BRAMPTON CITY (CHING HS W (012)	17 593658 4836165[W]	1987/08 3637	30 24 32	FR 0031 FR 0020	/ / 24:0	DO		4906871 () BRWN LOAM 0001 BRWN CLAY 0020 BRWN SAND 0026 BRWN CLAY PCKD 0031 GREY SAND 0033
BRAMPTON CITY (CHING HS W (014)	17 592864 4837280[W]	1988/07 4868	30 30	FR 0030	011 / 019 005 / 1:0	DO		4906880 () BRWN LOAM SOFT 0001 BRWN CLAY 0010 BLDR HARD 0011 GREY CLAY SILT 0014 BRWN CLAY SAND 0030 BRWN SAND LOOS 0033
BRAMPTON CITY (CHING HS W (014)	17 592499 4837279[W]	1988/07 4868	30 30 00	FR 0017	011 / 018 005 / 1:0	DO		4906878 () BRWN LOAM SOFT 0001 BRWN CLAY STNS 0012 BRWN CLAY SAND 0016 GREY SAND 0032
BRAMPTON CITY (CHING HS W (015)	17 592617 4838248[W]	1988/07 4868	30 30	FR 0030	012 / 019 005 / 1:0	DO		4906879 () BRWN LOAM SOFT 0001 BRWN CLAY 0008 RED CLAY SNDS 0018 GREY CLAY STNS 0028 GREY SAND CLAY 0030 BRWN SAND GRVL LOOS 0037

Well Computer Print Out Data as of July 21 2008

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND5,11
BRAMPTON CITY (CHING HS W (016)	17 591834 4837260[W]	1984/02 3637	30 32	FR 0020 FR 0038	005 / 014 / 1:0	DO		4906274 () BRWN LOAM 0001 BRWN CLAY GRVL HARD 0011 BLUE CLAY STNS 0020 BRWN SAND STNS 0025 BLUE CLAY CLAY 0030 GREY GRVL STNS 0039
BRAMPTON CITY (CHING HS W (016)	17 591765 4837227[W]	1984/03 3637	32 21 30	FR 0022 FR 0041	/ 008 / 1:0	DO		4906273 () BRWN LOAM 0001 BRWN CLAY 0008 RED CLAY STNS PCKD 0014 BLUE CLAY 0022 RED CLAY GRVL 0040 GREY GRVL STNS 0042
BRAMPTON CITY (CHING HS W ()	17 594503 4835409[W]	2001/08 3030	36 24	FR 0015 FR 0020 FR 0022 FR 0012	012 / / :0	DO		4908838 (229568) BRWN LOAM 0001 BRWN CLAY 0012 BLUE CLAY 0015 GREY SAND 0020 GREY SAND GRVL 0025 RED SHLE 0027
BRAMPTON CITY (CHING 03(025)	17 593170 4838337[W]	2004/12 3030	36	0012	/ / :0	DO		4909629 (Z23398) A017307 BRWN FILL 0004 BRWN CLAY 0012 GREY CLAY STNS HARD 0018 GREY SAND GRVL 0028
BRAMPTON CITY (CHING 04(011)	17 594883 4836534[W]	2006/11 3349	06					4910386 (Z71497)
BRAMPTON CITY (CHING 04(011)	17 594950 4836548[W]	2006/11 3349	79					4910385 (Z71496)
BRAMPTON CITY (CHING 04(011)	17 594841 4836407[W]	2005/07 7075	07 05	FR 0036	017 / 035 003 / 1:0	DO	0023 13	4909872 (Z32427) A027129 BRWN CLAY 0006 RED CLAY SHLE 0021 RED SHLE 0036
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BRAMPTON CITY (CHING 04(011)	17 594872 4836156[W]	2006/11 3349	36			NU		4910394 (Z71808)
BRAMPTON CITY (CHING 04(015)	17 592375 4837922[W]	2008/06 3108				NU		7107509 (Z66936) 0073
BRAMPTON CITY (CHING 05(009)	17 595203 4834713[W]	2007/10 3349	00		/ / :0	NU		7051678 (Z69796)
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CALEDON TOWN (CHINGU HS W 04(018)	17 591110 4838750[W]	2000/02 1737						4908611 (213883) BRWN CLAY SOFT SILT 0014 GREY CLAY SILT SOFT 0021 GREY SAND SILT CLAY 0028 GREY SAND GRVL SOFT 0030 GREY SAND SILT SOFT 0032 GREY TILL SILT HARD 0040 RED SHLE SOFT 0046 RED SHLE HARD 0060

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND5,11
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CALEDON TOWN (CHINGU HS W 04(018)	17 591100 4838890[W]	2000/03 1737	06	FR 0058	019 / 056 001 / 6:0	IN		4908606 (213887) BRWN CLAY SILT SOFT 0014 GREY CLAY SILT SOFT 0032 GREY SAND GRVL SILT 0034 GREY SILT CLAY GRVL 0039 GREY SILT CLAY SOFT 0047 RED SHLE SOFT 0055 GREY STNS GRVL SOFT 0058 RED SHLE HARD 0065
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CALEDON TOWN (CHINGU HS W 04(018)	17 591077 4838943[W]	1992/07 1413	06	FR 0076	006 / 050 004 / 1:30	IR IN		4907660 () BRWN CLAY DNSE 0008 BRWN CLAY SAND LYRD 0013 GREY CLAY STNS HARD 0017 GREY SILT CLAY SOFT 0023 GREY CLAY SOFT 0026 GREY CLAY DNSE 0027 GREY GRVL CLAY CMTD 0034 GREY GRVL CLAY CMTD 0038 RED GRVL CMTD 0039 RED CLAY STNS HARD 0043 RED CLAY SOFT 0047 RED GRVL SAND CMTD 0052 RED CLAY STNS HARD 0057 RED SHLE SOFT 0076
CALEDON TOWN (CHINGU HS W 04(018)	17 591194 4838868[W]	1984/11 3637	32 30	FR 0024 FR 0038	014 / 022 010 / 1:0	DO		4906270 () BRWN LOAM 0001 BRWN CLAY PCKD 0014 BLUE CLAY SOFT 0017 GREY CLAY STNS PCKD 0023 RED SHLE SOFT HARD 0038
CALEDON TOWN (CHINGU HS W 04(018)	17 591009 4838969[W]	1984/08 3317	05	FR 0034	005 / 027 005 / 2:0	DO		4906275 () CLAY STNS 0028 RED SHLE 0050
CALEDON TOWN (CHINGU HS W 04(018)	17 591038 4838904[W]	1984/06 3317	06 05 05	FR 0038	005 / 030 / :0	DO		4906277 () CLAY STNS 0009 SAND 0012 CLAY 0036 SHLE LYRD 0041 SHLE 0062
CALEDON TOWN (CHINGU HS W 04(018)	17 591238 4838964[W]	1984/11 3637	30 32	FR 0025 FR 0034	017 / 010 / 1:0	IR		4906269 () BRWN LOAM 0001 BRWN CLAY SOFT PCKD 0017 GREY CLAY SOFT 0025 RED CLAY SAND STNS 0032 RED SHLE SOFT HARD 0041
CALEDON TOWN (CHINGU HS W 05(018)	17 591034 4838416[W]	1985/05 3132	06 06	FR 0110	011 / 105 004 / 1:30	DO		4906313 () BRWN LOAM STNS LOOS 0003 GREY CLAY STNS DNSE 0017 BLUE CLAY STNS DNSE 0041 RED CLAY STNS DNSE 0073 BLUE CLAY STNS DNSE 0083 RED CLAY STNS DNSE 0094 RED SHLE HARD 0120
BRAMPTON CITY (008)	17 595421 4834510[W]	2007/05 6607	02	FR			0020 00	7046414 (Z70483) A054641 BRWN SILT SAND FILL 0005 BRWN SILT SAND 0010 BRWN SHLE 0020
BRAMPTON CITY (008)	17 595824 4836076[W]	2007/04 6607	02	FR 0013			0010 10	7046413 (Z70498) A049104 BRWN SILT SAND GRVL 0009 BRWN SILT SHLE 0022

Well Computer Print Out Data as of July 21 2008

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BRAMPTON CITY ()	17 594195 4835776W	2007/11 1129	02		/ / :0			7102522 (Z79001) A060917 BRWN LOAM 0001 RED SILT CLYY 0010 RED TILL FSND TILL 0015 RED WTHD 0019
BRAMPTON CITY ()	17 593983 4837138W	2007/11 1129	02		/ / :0			7102521 (Z67580) A060918 BLCK LOAM SILT CLAY 0001 GREY CLAY SILT DNSE 0017 RED TILL SAND SILT 0035 RED SHLE HARD 0041
BRAMPTON CITY ()	17 592895 4837641W	2008/05 6809						7106426 (M02755) A066782
BRAMPTON CITY ()	17 593560 4837537W	2008/05 6809						7106422 (Z80074) A066784
BRAMPTON CITY ()	17 593450 4836613W	2008/05 6809						7106424 (Z80071) A066780
BRAMPTON CITY ()	17 594264 4836089W	2008/05 6809						7106425 (Z80070) A066779
BRAMPTON CITY ()	17 592000 4838726W	2007/10 6809	02		/ / :0			7052300 (Z69278) A059646 BRWN SILT TILL HARD 0030 GREY SAND SLTY 0037
BRAMPTON CITY ()	17 593009 4836954W	2007/10 6809	02		/ / :0			7052301 (Z69281) A062222 BRWN SILT TILL HARD 0010 GREY SILT WBRG 0017
BRAMPTON CITY ()	17 593908 4836498W	2007/10 6809	02		/ / :0			7052302 (Z69279) A059647 BRWN SILT TILL GRVL 0020 GREY SILT 0030
BRAMPTON CITY ()	17 593094 4838059W	2007/10 6809	02		/ / :0			7052305 (Z69284) A062225 BRWN SILT TILL DRY 0012 GREY SILT 0022
BRAMPTON CITY ()	17 594075 4835990W	2007/10 6809	02		/ / :0			7052306 (Z69287) A062228 BRWN SILT TILL HARD 0007 GREY CLAY SLTY SOFT 0015 BRWN SAND GRVL WBRG 0017
BRAMPTON CITY ()	17 594506 4836116W	2007/01 6809	02		/ / :0			7052307 (Z69286) A062227 RED TILL SHLE 0017
BRAMPTON CITY ()	17 593263 4838080W	2007/10 6809	02		/ / :0			7052308 (Z69285) A062226 BRWN SILT TILL 0022 BRWN SAND GRVL 0030
BRAMPTON CITY ()	17 592275 4837874W	2007/10 6809	02		/ / :0			7052310 (Z69288) A062229 BRWN SILT TILL GRVL 0010 BRWN SAND WBRG 0014 BRWN SAND WBRG 0015
BRAMPTON CITY ()	17 595716 4837526W	2007/10 7241	02		/ / :0			7052457 (Z63667) A063723 BRWN LOAM LOOS 0001 BRWN SILT CLAY DNSE 0008 BRWN SILT CLAY WBRG 0014

Well Computer Print Out Data as of July 21 2008

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND5,11
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MISSISSAUGA CITY ()	17 595462 4834576[W]	2007/06 6607	04	FR 0010			0010 11	7050463 (Z72431) A049159 BRWN SILT SAND 0009 BRWN SILT FSND 0014 BRWN SILT SILT 0020 RED SHLE SAND 0021
HIBBERT TOWNSHIP ()	17 593309 4834301[W]	2004/11 2604	36		004 / / :0			5005780 (Z08216) 0032
KITCHENER CITY ()	17 593309 4834301[W]	2004/11 2604	06		256 / / :0			6509991 (Z08211) 0108
PILKINGTON TOWNSHIP A(004)	17 594302 4835204[W]	2007/10 1737						7053371 (Z72781)

Well Computer Print Out Data as of July 21 2008

Notes:

1. UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
2. Date Work Completed
3. Well Contractor Licence Number
4. Casing diameter in inches
5. Unit of Depth in Feet
6. See Table 4 for Meaning of Code
7. STAT LVL: Static Water Level in Feet ; PUMP LVL: Water Level After Pumping in Feet
8. Pump Test Rate in GPM, Pump Test Duration in Hour : Minutes
9. See Table 3 for Meaning of Code
10. Screen Depth and Length in feet
11. See Table 1 and 2 for Meaning of Code

1. Core Material and Descriptive terms

Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
BLDR	BOULDERS	FCRD	FRACTURED	IRFM	IRON FORMATION	PORS	POROUS	SOFT	SOFT
BSLT	BASALT	FGRD	FINE-GRAINED	LIMY	LIMY	PRDG	PREVIOUSLY DUG	SPST	SOAPSTONE
CGRD	COARSE-GRAINED	FGVL	FINE GRAVEL	LMSN	LIMESTONE	PRDR	PREV. DRILLED	STKY	STICKY
CGVL	COARSE GRAVEL	FILL	FILL	LOAM	TOPSOIL	QRTZ	QUARTZITE	STNS	STONES
CHRT	CHERT	FLDS	FELDSPAR	LOOS	LOOSE	QSND	QUICKSAND	STNY	STONEY
CLAY	CLAY	FLNT	FLINT	LTCL	LIGHT-COLOURED	QTZ	QUARTZ	THIK	THICK
CLN	CLEAN	FOSS	FOSILIFEROUS	LYRD	LAYERED	ROCK	ROCK	THIN	THIN
CLYY	CLAYEY	FSND	FINE SAND	MARL	MARL	SAND	SAND	TILL	TILL
CMTD	CEMENTED	GNIS	GNEISS	MGRD	MEDIUM-GRAINED	SHLE	SHALE	UNKN	UNKNOWN TYPE
CONG	CONGLOMERATE	GRNT	GRANITE	MGVL	MEDIUM GRAVEL	SHLY	SHALY	VERY	VERY
CRYS	CRYSTALLINE	GRSN	GREENSTONE	MRBL	MARBLE	SHRP	SHARP	WBRG	WATER-BEARING
CSND	COARSE SAND	GRVL	GRAVEL	MSND	MEDIUM SAND	SHST	SCHIST	WDFR	WOOD FRAGMENTS
DKCL	DARK-COLOURED	GRWK	GREYWACKE	MUCK	MUCK	SILT	SILT	WTHD	WEATHERED
DLMT	DOLOMITE	GVLY	GRAVELLY	OBDN	OVERBURDEN	SLTE	SLATE		
DNSE	DENSE	GYPS	GYPSUM	PCKD	PACKED	SLTY	SILTY		
DRTY	DIRTY	HARD	HARD	PEAT	PEAT	SNDS	SANDSTONE		
DRY	DRY	HPAN	HARDPAN	PGVL	PEA GRAVEL	SNDY	SANDY		

2. Core Color

Code	Description
WHIT	WHITE
GREY	GREY
BLUE	BLUE
GREN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED
BLCK	BLACK
BLGY	BLUE-GREY

3. Water Use

Code	Description	Code	Description
DO	Domestic	OT	Other
ST	Livestock	TH	Test Hole
IR	Irrigation	DE	Dewatering
IN	Industrial	MO	Monitoring
CO	Commercial		
MN	Municipal		
PS	Public		
AC	Cooling And A/C		
NU	Not Used		

4. Water Detail

Code	Description	Code	Description
FR	Fresh	GS	Gas
SA	Salty	IR	Iron
SU	Sulphur		
MN	Mineral		
UK	Unknown		

Appendix G

PAVEMENT DESIGN ANALYSIS

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Flexible Design Inputs

Agency:

Company: Geo-Canada Ltd.

Contractor:

Project Description: Mississauga Rd. Class EA

Location: New Pavement

Flexible Pavement Design/Evaluation

Structural Number	128.37	**Soil Resilient Modulus**	20.00 **MPa**
Design ESALs	2,120,000.00	**Initial Serviceability**	4.40
Reliability	90.00 **percent**	**Terminal Serviceability**	2.20
Overall Deviation	0.45		

Layer Thickness Determination

Layer Material	Layer Coefficient	Drainage Coefficient	Layer Thickness	Layer SN
Asphalt Cement Concrete	0.42	1.00	125.00	52.50
Granular A	0.14	1.00	150.00	21.00
Granular B	0.14	1.00	400.00	56.00
			Σ SN	129.50

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Engineer: ______________________

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Flexible Design Inputs

Agency:

Company: Geo-Canada Ltd.

Contractor:

Project Description: Mississauga Rd. Class EA

Location: Hot Mix Resurfacing

Flexible Pavement Design/Evaluation

Structural Number	128.37	**Soil Resilient Modulus**	20.00 **MPa**
Design ESALs	2,120,000.00	**Initial Serviceability**	4.40
Reliability	90.00 **percent**	**Terminal Serviceability**	2.20
Overall Deviation	0.45		

Layer Thickness Determination

Layer Material	Layer Coefficient	Drainage Coefficient	Layer Thickness	Layer SN
Asphalt Cement Concrete	0.42	1.00	45.00	18.90
Existing Asph	0.42	1.00	200.00	84.00
Existinting b	0.08	0.90	355.00	25.56
			Σ SN	128.46

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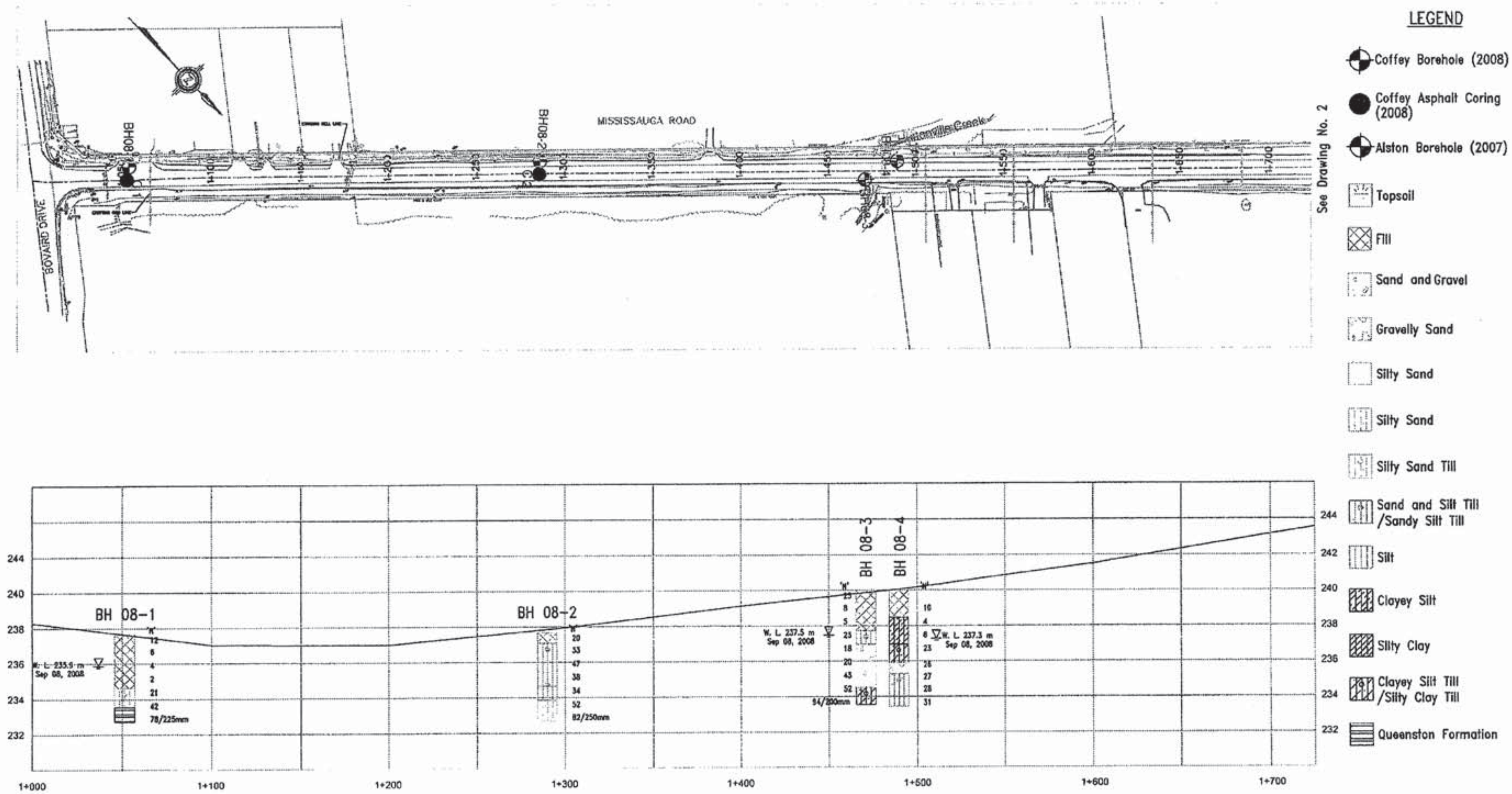
Engineer: ____________________

Drawing



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approved	SCOTT		project:	Class EA Study for Mississauga Road (Regional Road 1) from Bovaird Drive to Mayfield Road
date	OCT. 2008			
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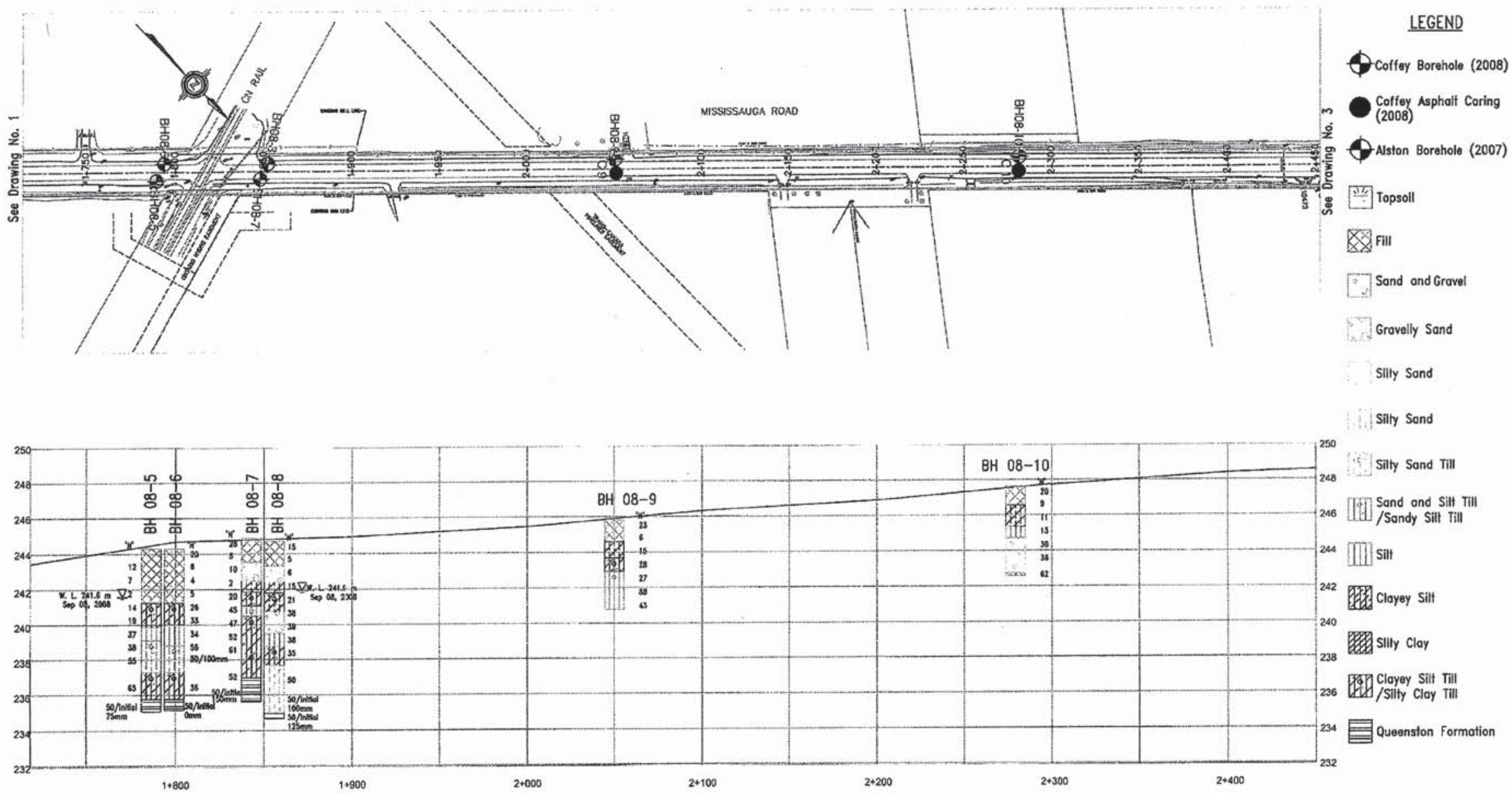

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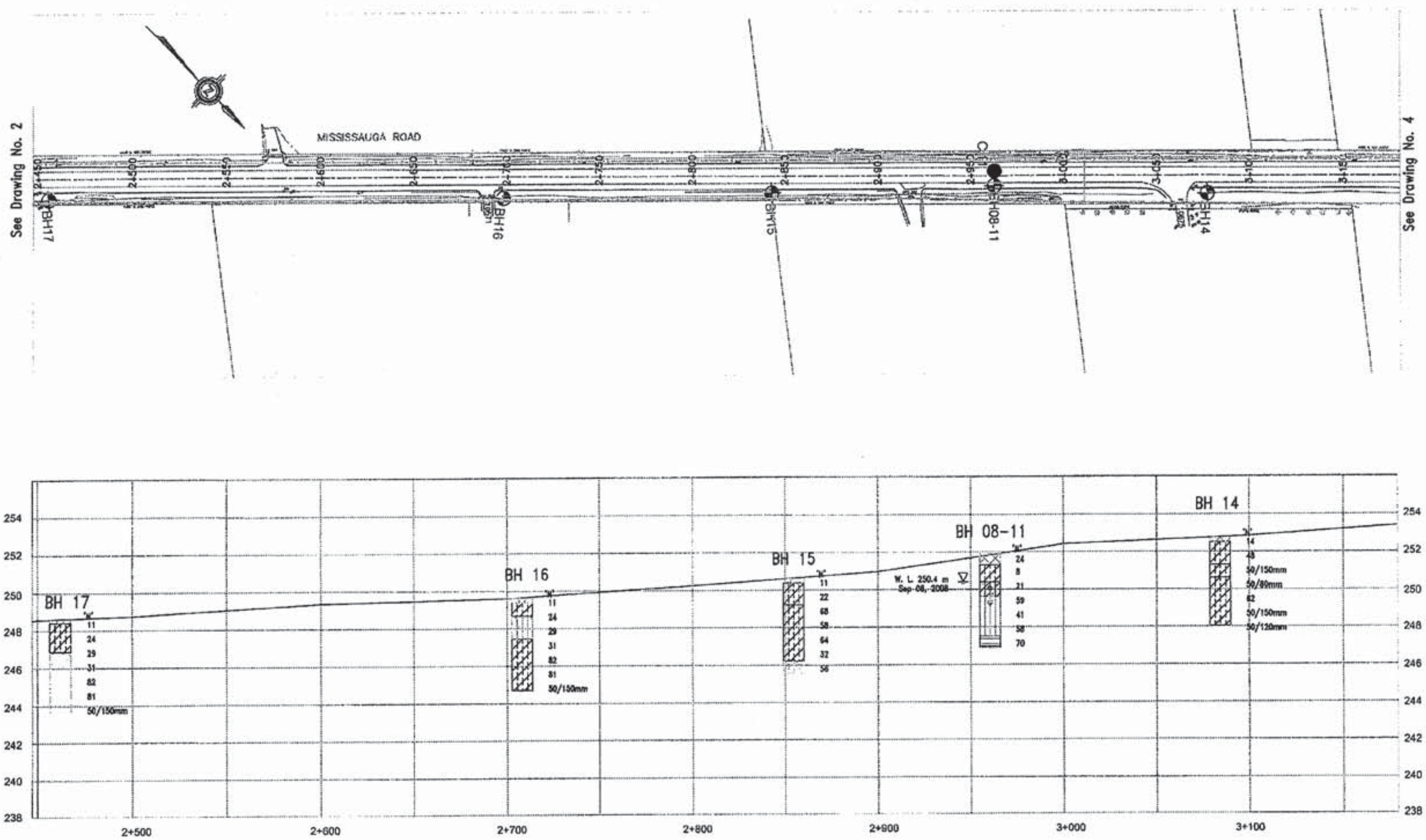

LEGEND

- Coffey Borehole (2008)
- Coffey Asphalt Coring (2008)
- Alston Borehole (2007)
- Topsoil
- Fill
- Sand and Gravel
- Gravelly Sand
- Silty Sand
- Silty Sand
- Silty Sand Till
- Sand and Silt Till /Sandy Silt Till
- Silt
- Clayey Silt
- Silty Clay
- Clayey Silt Till /Silty Clay Till
- Queenston Formation

drawn	LAIFA	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	REGIONAL MUNICIPALITY OF PEEL C/O AECOM
approved	SCOTT		project:	Class EA Study for Mississauga Road (Regional Road 1) from Bovaird Drive to Mayfield Road
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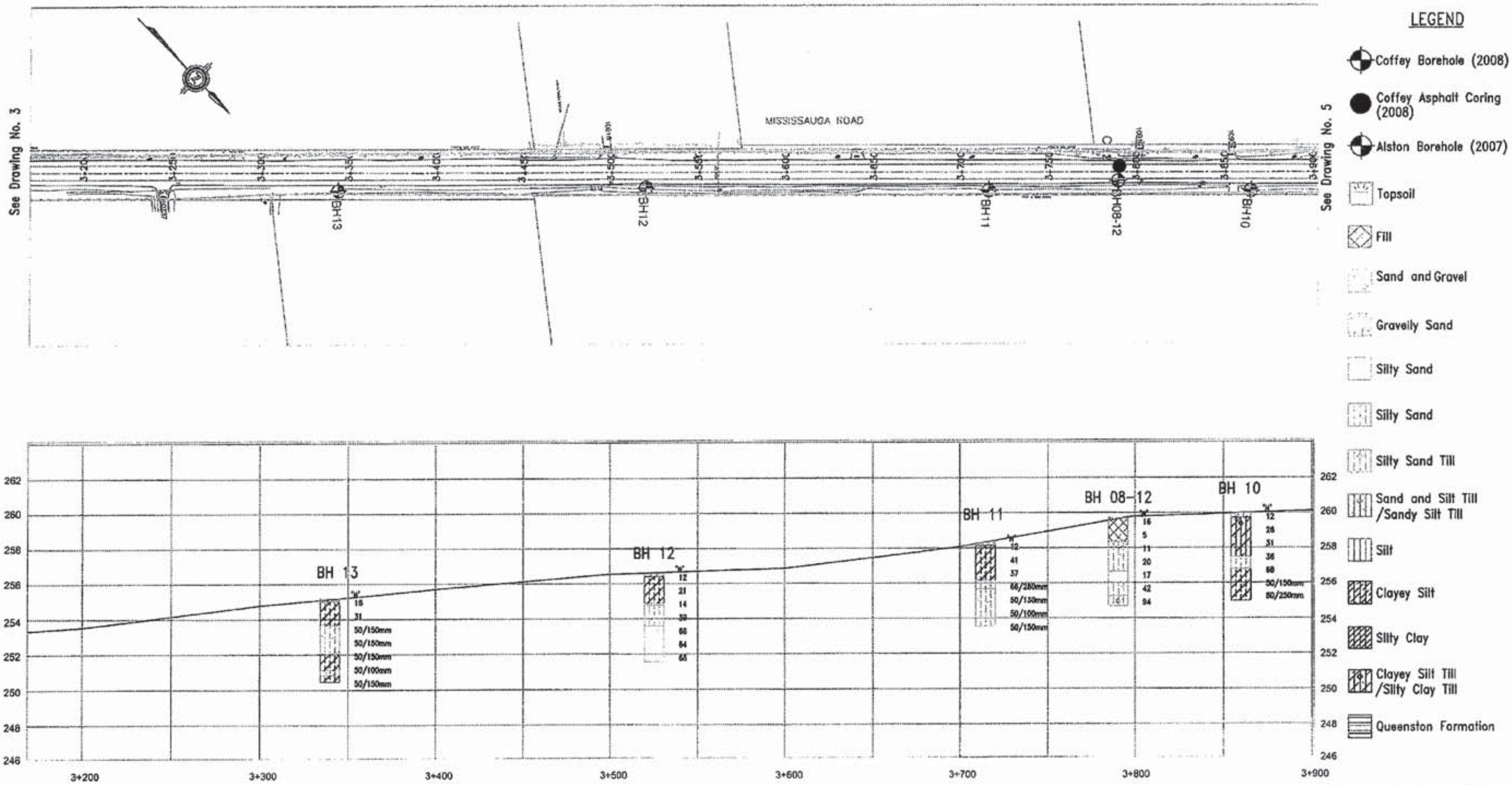

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approved	SCOTT		project:	Class EA Study for Mississauga Road (Regional Road 1) from Bovaird Drive to Mayfield Road
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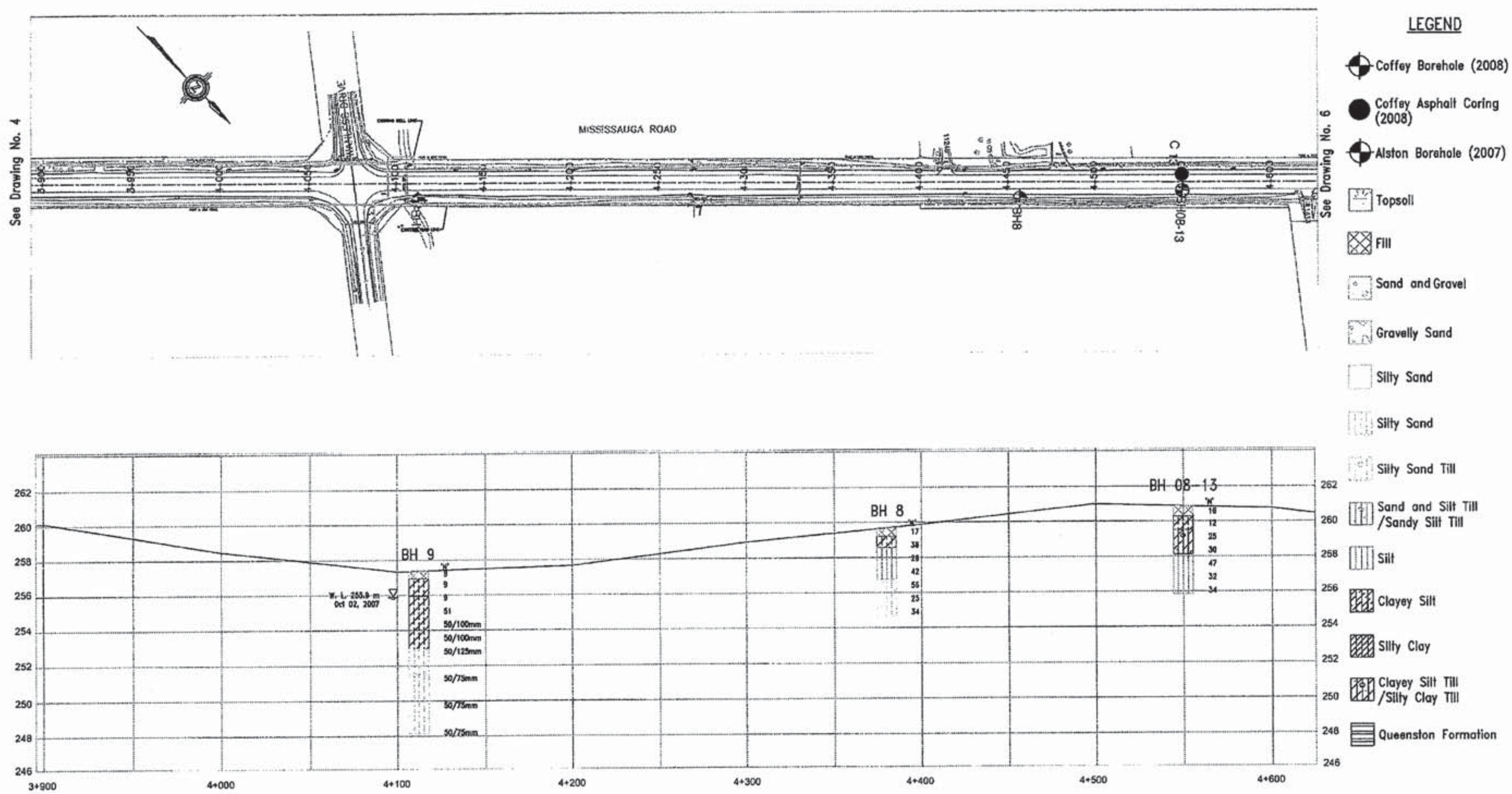
original size	Tabloid			



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approved	SCOTT		project:	Class EA Study for Mississauga Road (Regional Road 1) from Bovaird Drive to Mayfield Road
date	OCT. 2008			
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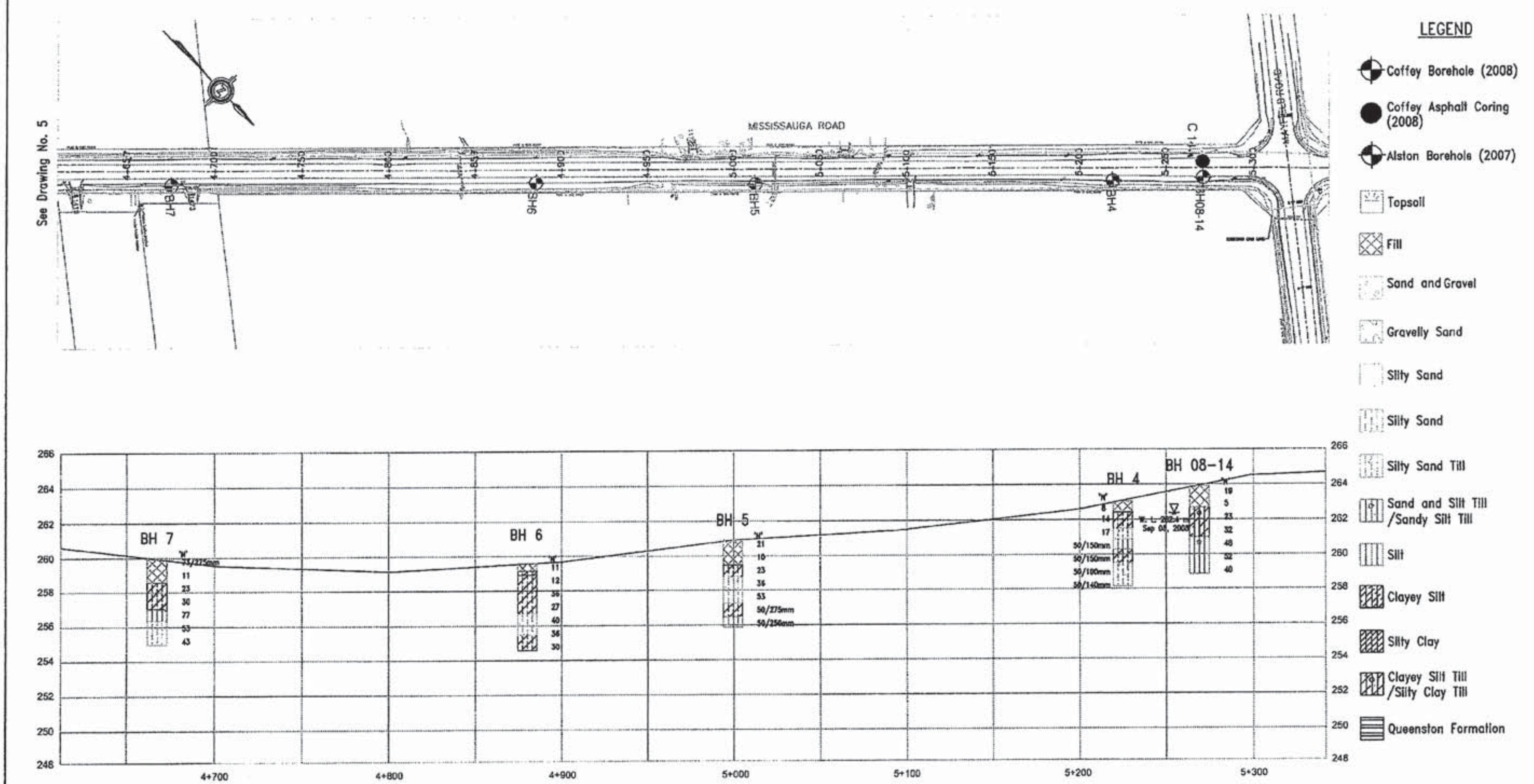

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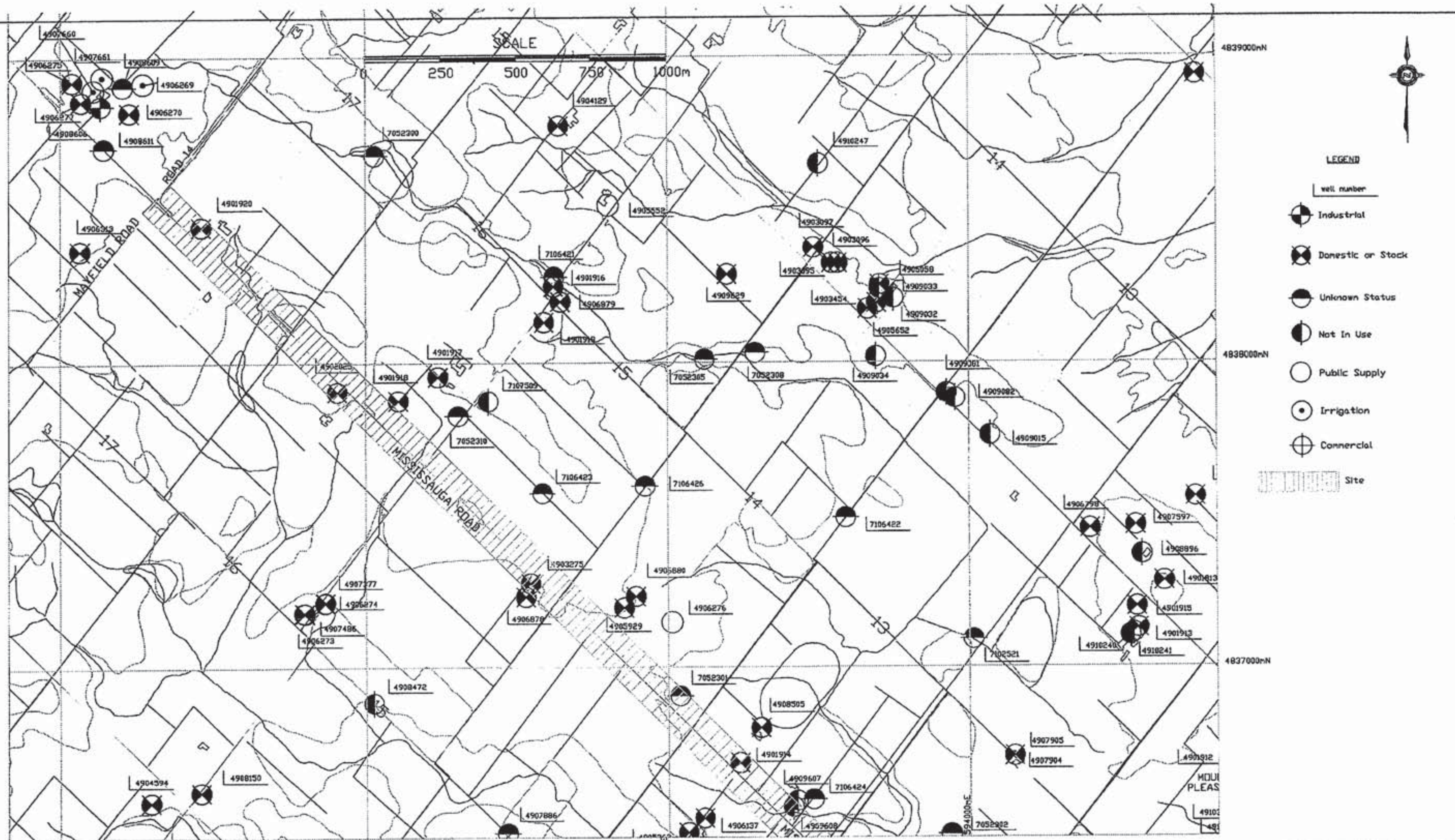

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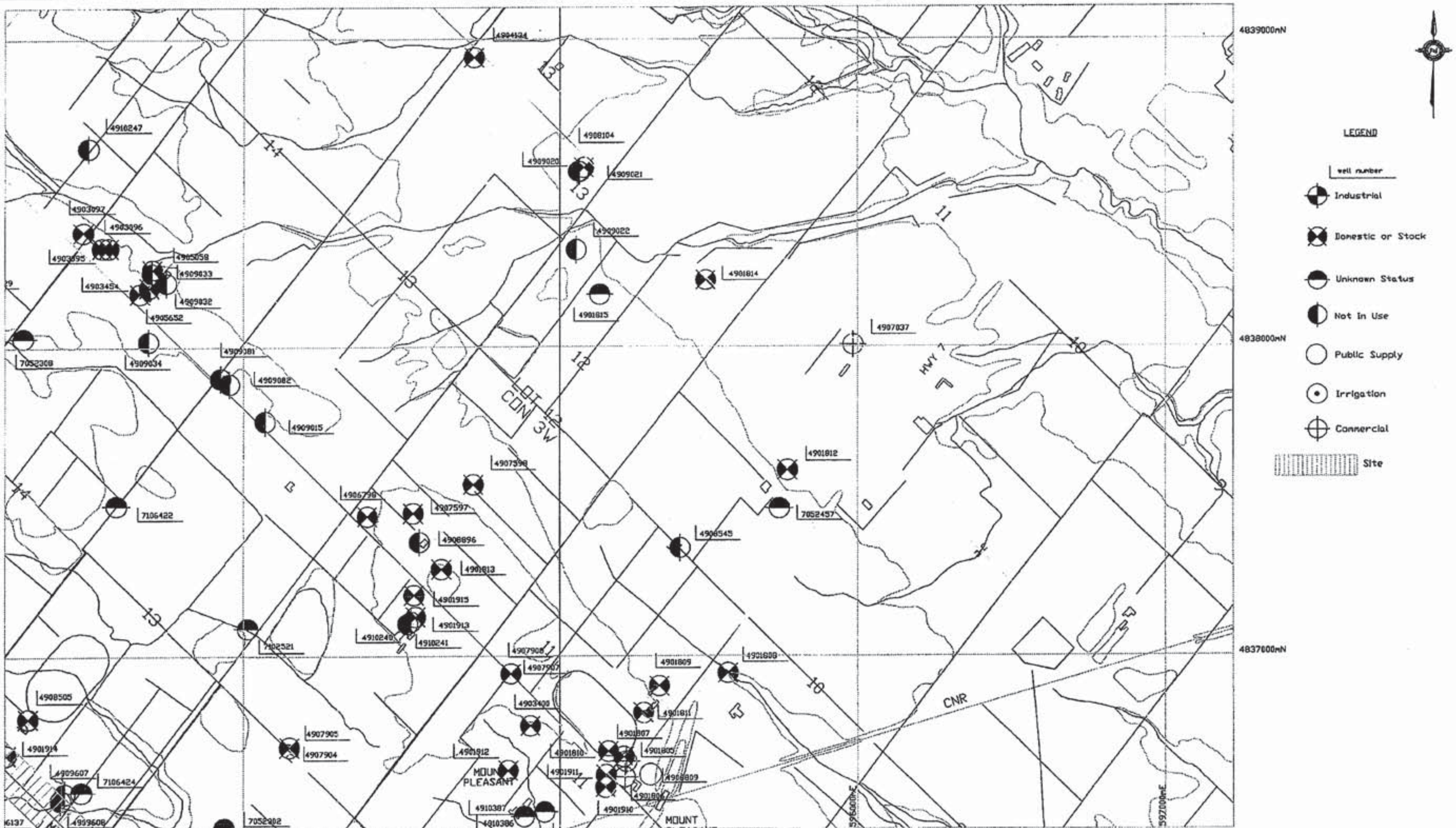

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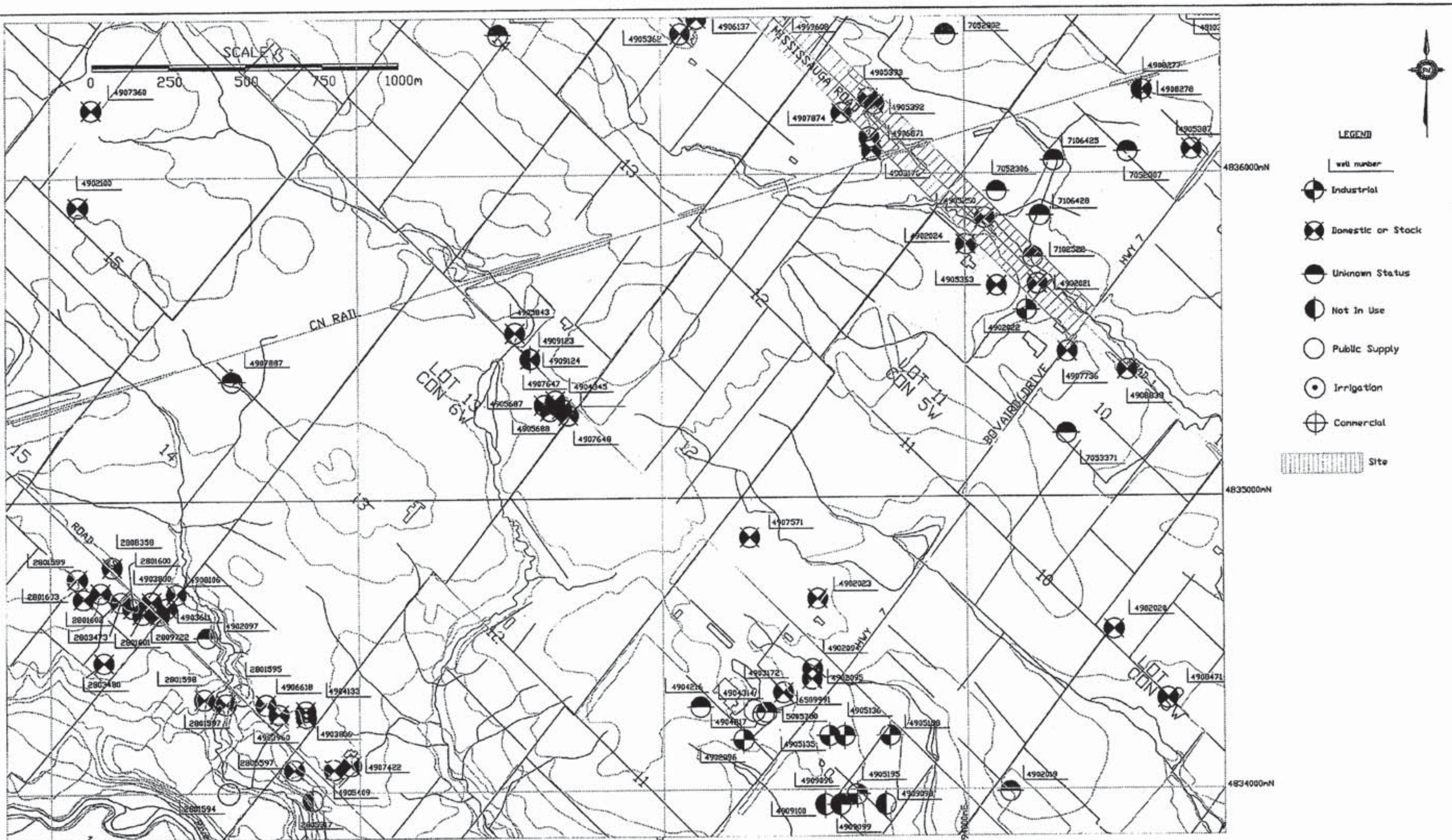

drawn	LAIFA
approved	SCOTT
date	AUG. 2008
scale	AS SHOWN
original size	Tabloid

coffey
geotechnics
SPECIALISTS MANAGING THE EARTH

client:	REGIONAL MUNICIPALITY OF PEEL C/O AECOM
project:	Class EA Study Mississauga Road (Regional Road 1) from Bovaird Drive to Mayfield Road
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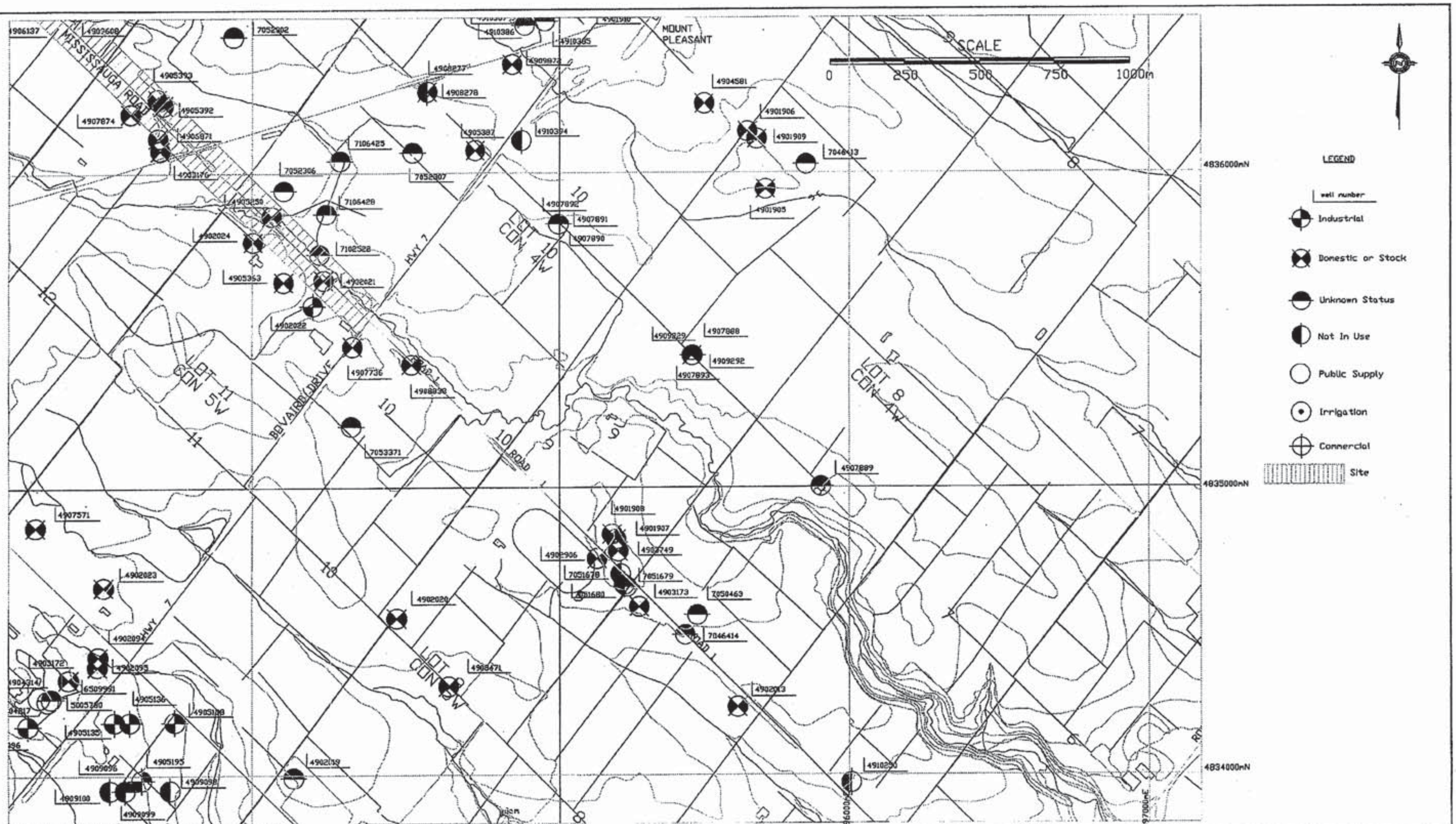

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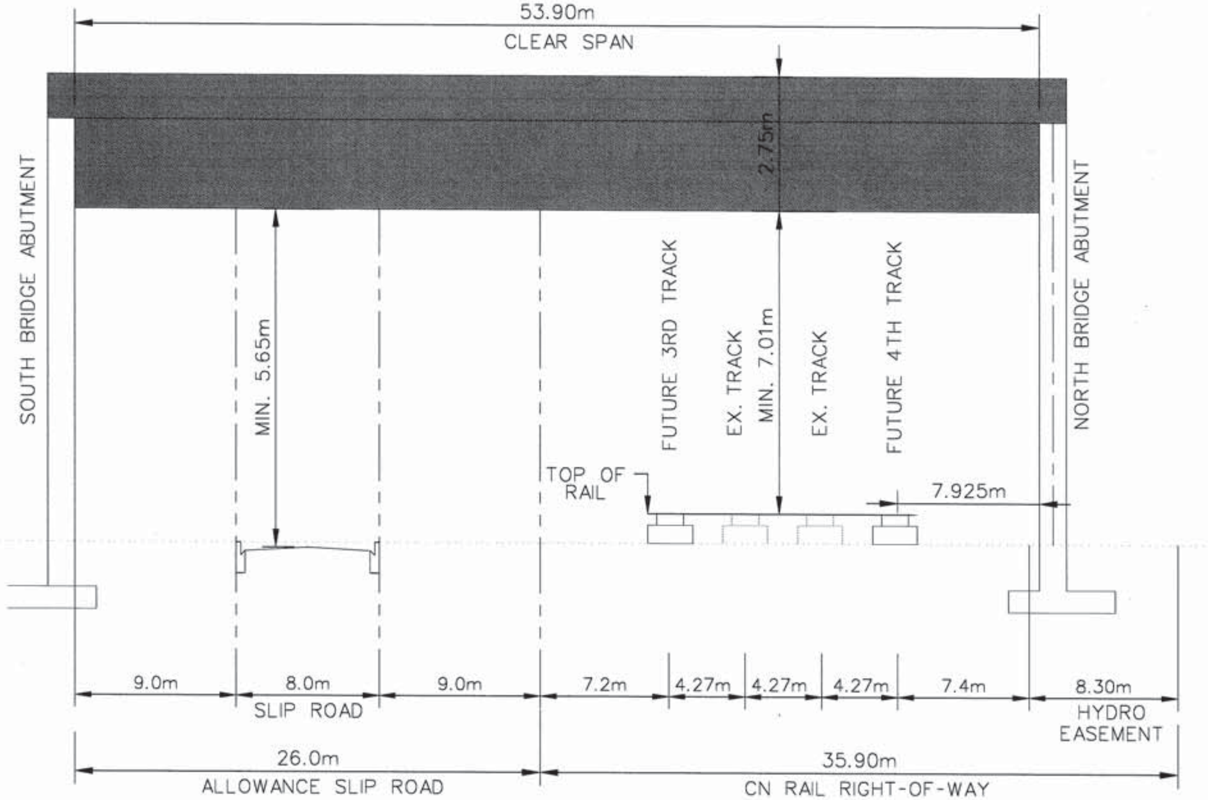
Appendix D

Plan and Profile Drawings – Road Widening

AECOM

Appendix E

General Arrangement Drawing – Grade Separation



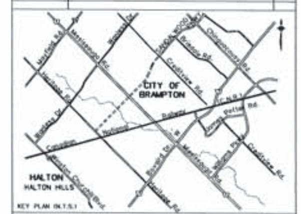
BRIDGE SECTION IN PERPENDICULAR
2 CN TRACKS + 2 GO TRANSIT TRACKS + 26.0m SLIP ROAD ALLOWANCE

SERVICE DATA

SERVICE	DATE	INIT.	SERVICE	DATE	INIT.
SAN. SEWERS			GAS MAINS		
STORM SEWERS			BELL U/G CABLE		
WATERMAINS			HYDRO U/G CABLE		
TRANSIT			ONT. HYDRO		
PARKS & REC.			CTV		
ONT. CLEAN WATER					

REVISIONS

DATE	DETAILS	INIT.



AECOM

AECOM CANADA Ltd.
300 TOWN CENTRE BLVD., MARKHAM,
ONTARIO, CANADA L3R 5Z6
T905.477.8700 F905.477.1456

General Notes

All Driveways ASPHALT Unless Otherwise Noted
All Service Locations Are Approximate And Must Be Located Accurately In The Field
Denotes Building — Not Located
Denotes Building Located
Type 'B' Bedding Unless Otherwise Noted (SAN)

B.M. No. Elev.

The Contractor Is Responsible For Locating And Protecting All Existing Utilities Prior To And During Construction Location of Existing Utilities Approximate Only, To Be Verified In Field By Contractor.

Designed by ______ Chkd ______ Approved by ______

NOTICE TO CONTRACTOR
48 HOURS PRIOR TO COMMENCING WORK NOTIFY THE FOLLOWING
THE REGIONAL MUNICIPALITY OF PEEL
CITY OF MISSISSAUGA WORKS DEPT.
CITY OF BRAMPTON WORKS DEPT.
TOWN OF CALEDON WORKS DEPT.
BELL TELEPHONE COMPANY
CONSUMERS GAS COMPANY
MINISTRY OF TRANSPORTATION
ONTARIO CLEAN WATER AGENCY
HYDRO ELECTRIC POWER COMM. OF ONTARIO
HYDRO ELECTRIC COMM. CITY OF MISSISSAUGA
HYDRO ELECTRIC COMM. CITY OF BRAMPTON
CABLE TELEVISION

HORIZONTAL SCALE 10m 0 10 20 30m
VERTICAL SCALE 1m 0 1 2 3m

Region of Peel
Working for you

MISSISSAUGA ROAD
(FROM BOVAIRD DR. TO MAYFIELD RD.)
GRADE SEPARATION

Lots	Area	Project No. 105163
Checked by P.C.	Drawn by V.M.	Plan No. BRG01
Date NOV 2012	Sheet	

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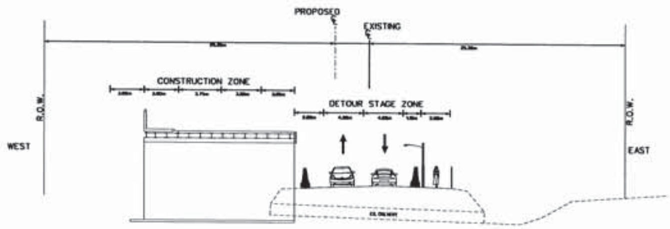
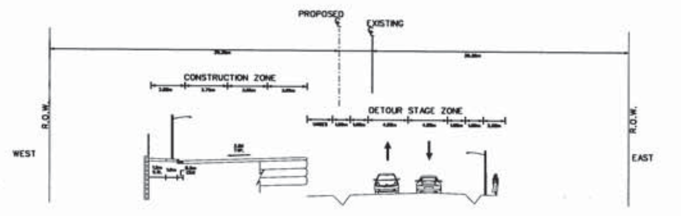
AECOM

Appendix F

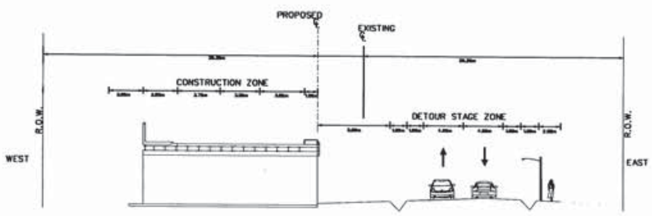
Grade Separation Construction-Detour Plan



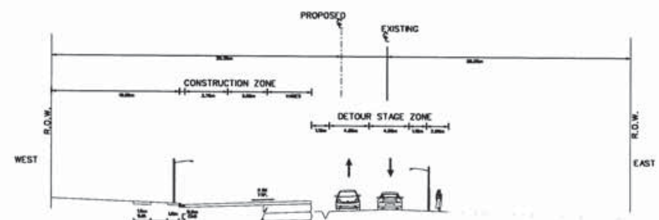
STA. 1+500
CROSS SECTION A-A



STA. 1+740
CROSS SECTION B-B



STA. 1+820
CROSS SECTION C-C



STA. 2+250
CROSS SECTION D-D

CN RAIL BRIDGE CONSTRUCTION - DETOUR PLAN

STAGE 1

SERVICE DATA

SERVICE	DATE	INIT.	SERVICE	DATE	INIT.
SAN. SEWERS			GAS MAINS		
STORM SEWERS			BELL U/G CABLE		
WATERMAINS			HYDRO U/G CABLE		
TRANSIT			ONT. HYDRO		
PARKS & REC.			CTV		
ONT. CLEAN WATER					

REVISIONS

DATE	DETAILS	INIT.

KEY PLAN (N.T.S.)

AECOM

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300 TOWN CENTRE BLVD., MARKHAM,
ONTARIO, CANADA L3R 5Z6
T905.477.8700 F905.477.1456

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CONSUMERS GAS COMPANY
MINISTRY OF TRANSPORTATION
ONTARIO CLEAN WATER AGENCY
HYDRO ELECTRIC POWER COMM. OF ONTARIO
HYDRO ELECTRIC COMM. CITY OF MISSISSAUGA
HYDRO ELECTRIC COMM. CITY OF BRAMPTON
CABLE TELEVISION

HORIZONTAL SCALE: 10m 0 10 20 30m
VERTICAL SCALE: 1m 0 1 2 3m

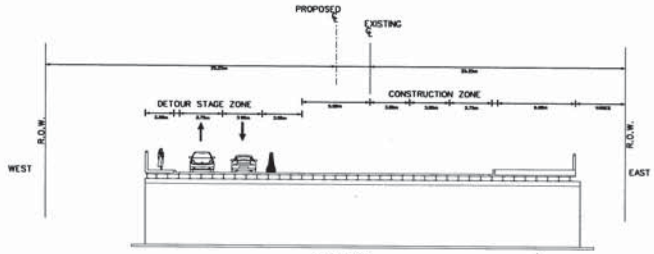
Region of Peel
Working for you

MISSISSAUGA ROAD
(FROM BOVAIRD DR. TO MAYFIELD RD.)
STAGE 1

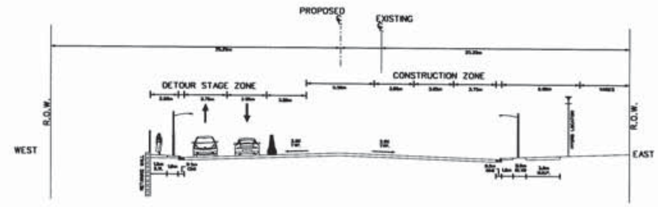
Sta. 1+335.00 To Sta. 5+435.38

Lots		Area		Project No.	105163
Checked by	P.C.	Drawn by	V.M.	Plan No.	DET01
Date	NOV 2012	Sheet	of		

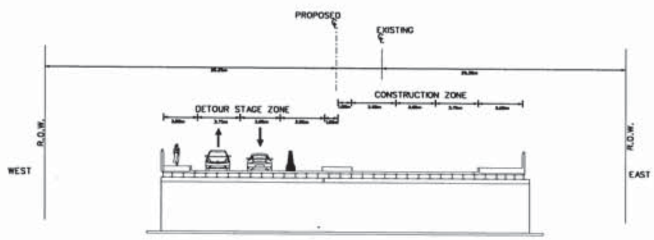
ESR_Detour_Stage_1.dgn 11/12/2012 11:39:53 AM



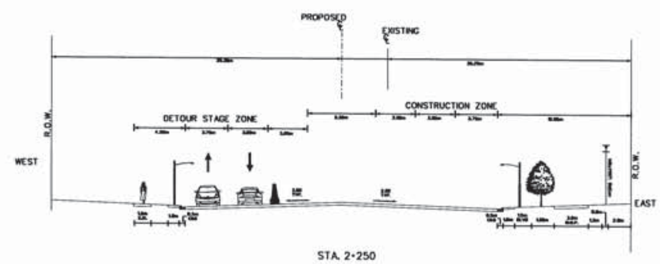
STA. 1+500
CROSS SECTION A-A



STA. 1+500
CROSS SECTION B-B



STA. 1+820
CROSS SECTION C-C



STA. 2+250
CROSS SECTION D-D

CN RAIL BRIDGE CONSTRUCTION - DETOUR
STAGE 2

SERVICE DATA

SERVICE	DATE	INIT.	SERVICE	DATE	INIT.
SAN. SEWERS			GAS MAINS		
STORM SEWERS			BELL U/G CABLE		
WATERMAINS			HYDRO U/G CABLE		
TRANSIT			ONT. HYDRO		
PARKS & REC.			CTV		
ONT. CLEAN WATER					

REVISIONS

DATE	DETAILS	INIT.

KEY PLAN (N.T.S.)

AECOM

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300 TOWN CENTRE BLVD., MARKHAM
ONTARIO, CANADA L3R 5Z6
T905.477.8700 F905.477.1456

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HYDRO ELECTRIC COMM. CITY OF BRAMPTON
CABLE TELEVISION

10m 0 10 20 30m HORIZONTAL SCALE
1m 0 1 2 3m VERTICAL SCALE

Region of Peel
Working for you

MISSISSAUGA ROAD
(FROM BOVAIRD DR. TO MAYFIELD RD.)

STAGE 2

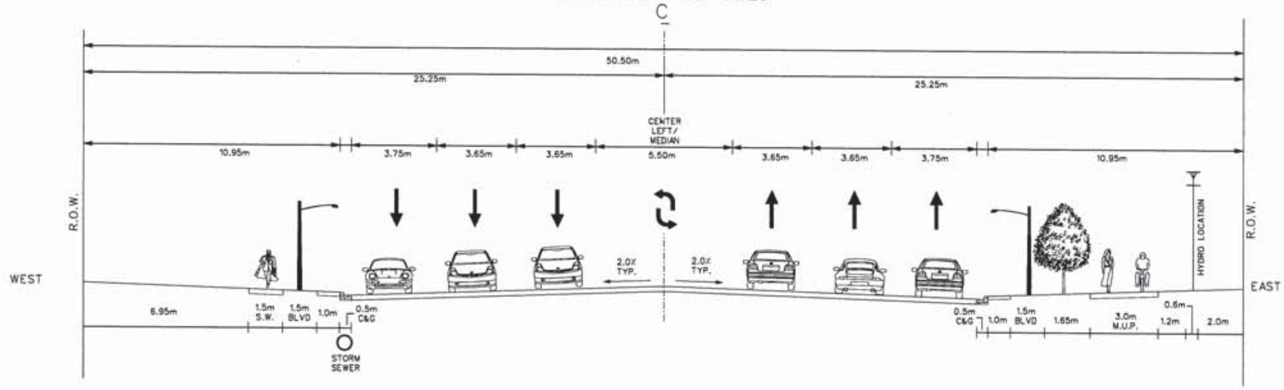
Sta. 1+335.00 To Sta. 5+435.38

Lots		Area			
Checked by	P.C.	Drawn by	V.M.	Project No.	105163
Date	NOV 2012	Sheet	of	Plan No.	DET02

Appendix G

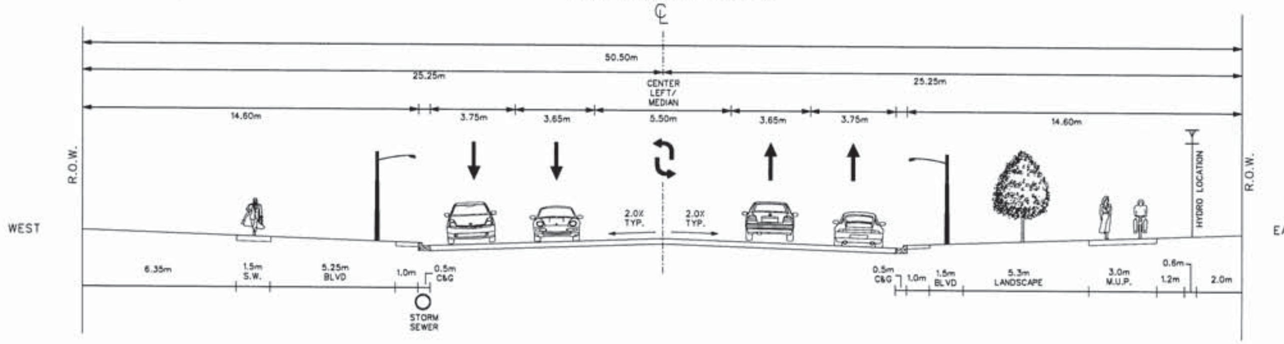
Typical Cross Sections - Roadway

EXISTING/PROPOSED



TYPICAL CROSS SECTION
6 LANES WITHOUT MEDIAN
FROM BOVAIRD DR. TO SANDALWOOD PKWY

EXISTING/PROPOSED



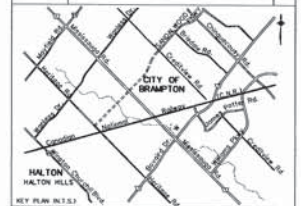
TYPICAL CROSS SECTION
4 LANES WITHOUT MEDIAN
FROM SANDALWOOD PKWY TO MAYFIELD RD

SERVICE DATA

SERVICE	DATE	INT.	SERVICE	DATE	INT.
SAN. SEWERS			GAS MAINS		
STORM SEWERS			BELL U/G CABLE		
WATERMAINS			HYDRO U/G CABLE		
TRANSIT			ONT. HYDRO		
PARKS & REC.			CTV		
ONT. CLEAN WATER					

REVISIONS

DATE	DETAILS	INT.



KEY PLAN (N.T.S.)

AECOM

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300 TOWN CENTRE BLVD., MARKHAM,
ONTARIO, CANADA L3R 5Z6
T905.477.8700 F905.477.1456

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Designed by
Chkd
Approved by

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HYDRO ELECTRIC COMM. CITY OF BRAMPTON
CABLE TELEVISION

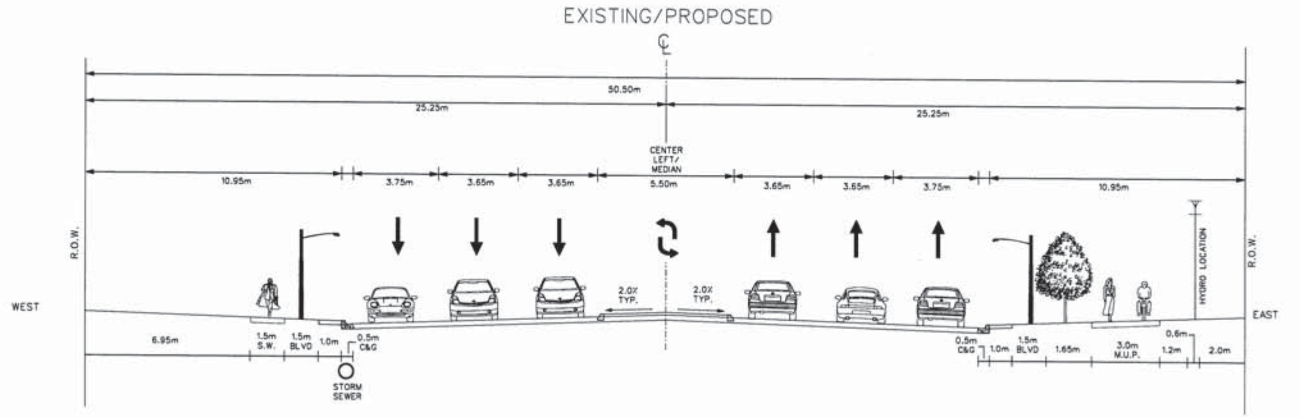
10m 0 10 20 30m HORIZONTAL SCALE
1m 0 1 2 3m VERTICAL SCALE

Region of Peel
Working for you

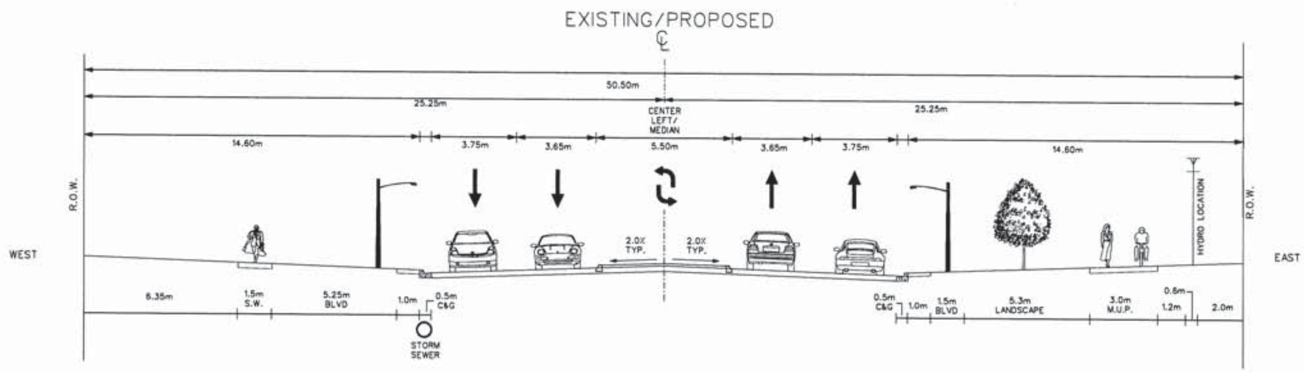
MISSISSAUGA ROAD
(FROM BOVAIRD DR. TO MAYFIELD RD.)
TYPICAL CROSS SECTIONS
(WITHOUT MEDIAN)

Sta. 1+000.00 To Sta. 5+435.38

Lots	Area	Project No. 105163
Checked by P.C.	Drawn by V.M.	Plan No. TYP01
Date NOV 2012	Sheet 1 of 2	



TYPICAL CROSS SECTION
6 LANES WITH MEDIAN
FROM BOVAIRD DR. TO SANDALWOOD PKWY



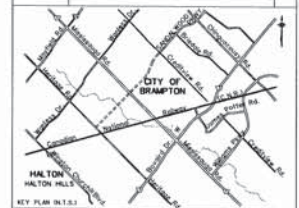
TYPICAL CROSS SECTION
4 LANES WITH MEDIAN
FROM SANDALWOOD PKWY TO MAYFIELD RD

SERVICE DATA

SERVICE	DATE	INIT.	SERVICE	DATE	INIT.
SAN. SEWERS			GAS MAINS		
STORM SEWERS			BELL U/G CABLE		
WATERMAINS			HYDRO U/G CABLE		
TRANSIT			ONT. HYDRO		
PARKS & REC.			CTV		
ONT. CLEAN WATER					

REVISIONS

DATE	DETAILS	INIT.



KEY PLAN (N.T.S.)

AECOM

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300 TOWN CENTRE BLVD., MARKHAM,
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T905.477.8700 F905.477.1456

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HYDRO ELECTRIC COMM. CITY OF BRAMPTON
CABLE TELEVISION

HORIZONTAL SCALE 10m 0 10 20 30m
VERTICAL SCALE 1m 0 1 2 3m

Region of Peel
Working for you

MISSISSAUGA ROAD
(FROM BOVAIRD DR. TO MAYFIELD RD.)
TYPICAL CROSS SECTIONS (WITH MEDIAN)

Sta. 1+000.00 To Sta. 5+435.38

Lots	Area	Project No. 105163
Checked by P.C.	Drawn by V.M.	Plan No. TYP02
Date NOV 2012	Sheet 2 of 2	

Appendix H

Preliminary Cost Estimates

MISSISSAUGA ROAD GRADE SEPARATION - COST ESTIMATE

Item No.	Description	Unit	Est. Qty.	Unit Price	Total
1	Railway Protection (Falsework)	LS	1	$150,000	$150,000
2	Railway Flagging (CN staff)	Month	16	$25,000	$400,000
3	Temporary Cofferdam - Track Protection	LS	1	$200,000	$200,000
4	Remove Existing Crossing Signals & Arms	LS	1	$50,000	$50,000
5	Temporary Roadway Detour	Sq. M.	6000	$75	$450,000
6	Temporary Crossing Signals & Arms for Detour	LS	1	$200,000	$200,000
7	Excavate Abutment Foundations	Cu. M.	520	$55	$28,600
8	Excavate Retaining Walls Foundations	Cu. M.	150	$55	$8,250
9	Supply Equipment for Driving Piles	LS	1	$40,000	$40,000
10	Piles (Abutments)	M	975	$450	$438,750
11	Piles (Wing Walls)	M	300	$450	$135,000
12	Concrete in Abutment Footings	Cu. M.	520	$650	$338,000
13	Concrete in Abutments	Cu. M.	585	$900	$526,500
14	Crash Walls	Cu. M.	325	$850	$276,250
15	Concrete in Wing Walls	Cu. M.	90	$900	$81,000
16	Concrete in Retaining Wall Footings	Cu. M.	120	$650	$78,000
17	Concrete in Retaining Wall	Cu. M.	90	$900	$81,000
18	Granular Backfill behind Structure	Cu. M.	650	$75	$48,750
19	Girders	M	756	$1,000	$756,000
20	Bearings	Each	28	$800	$22,400
21	Rebar	Tonne	319	$2,600	$829,920
22	Coated Rebar	Tonne	137	$3,600	$492,480
23	Mechanical Connectors	Each	500	$60	$30,000
24	Expansion Joints	M	64	$1,500	$96,600
25	Concrete in Deck	Cu. M.	439	$1,000	$438,750
26	Concrete in Diaphragms	Cu. M.	176	$850	$149,175
27	Concrete in Sidewalk	Cu. M.	135	$800	$108,000
28	Concrete in Parapet Walls	Cu. M.	26	$800	$21,120
29	Bridge Railing	M	194	$300	$58,200
30	Concrete in Approach Slab	Cu. M.	90	$550	$49,500
31	Concrete Traffic Median	Sq. M.	1000	$65	$65,000
32	Waterproofing	Sq. M.	1323	$40	$52,920
33	Concrete Slope Paving	Sq. M.	620	$60	$37,200
34	Earth Fill (Grading)	Cu. M.	225000	$15	$3,375,000
35	Steel Beam Guide Rail	M	1700	$100	$170,000
			ESTIMATED TOTAL		$10,282,365

PRELIMINARY ESTIMATE - Huttonville Creek - 42 m Bridge Span				
ITEM	UNIT	QTY.	PRICE	TOTAL
Maintenance of Creek Flow	LS	1	$25,000	$25,000
Unwatering & Temporary Cofferdams	LS	1	$150,000	$150,000
Remove Existing Culvert	LS	1	$150,000	$150,000
Excavate Abutment Foundations	Cu. M.	1104	$55	$60,720
Piles	M	1104	$450	$496,800
Concrete in Footings	Cu. M.	696	$650	$452,400
Concrete in Abutment	Cu. M.	552	$900	$496,800
Concrete in Wing Walls	Cu. M.	43	$850	$36,720
Granular Backfill	Cu. M.	2208	$75	$165,600
Bearings	Each	38	$800	$30,667
Pre-Cast Girders Girders	M	798	$800	$638,400
Concrete in Diaphragms	Cu. M.	104	$900	$93,150
Concrete in Deck	Cu. M.	483	$1,000	$483,000
Concrete in Approach Slab	Cu. M.	166	$550	$91,080
Concrete in Sidewalk	Cu. M.	126	$800	$100,800
Concrete in Parapet Walls	Cu. M.	22	$800	$17,280
Coated Rebar	Tonne	79	$3,600	$283,941
Rebar	Tonne	184	$2,600	$478,493
Expansion Joints	M	92	$1,500	$138,000
Bridge Railing	M	108	$300	$32,400
Waterproofing	Sq. M.	1932	$40	$77,280
Asphalt Paving - Base	Tonne	154	$80	$12,298
Asphalt Paving - Top	Tonne	123	$95	$11,683
Valley Slope Protection	LS	1	$100,000	$100,000
Regulated Area Plantings	LS	1	$40,000	$40,000
		Estimated Total		$4,662,511

Region of Peel
Working for you

Environment Transporation and Planning Services
Transportation Division

PRELIMINARY CONSTRUCTION ESTIMATE

MISSISSAUGA ROAD — **September 15, 2012**

From: North of Bovaird Drive — **To:** Mayfield Road

Description: 4-6 lane widening

Component/ Category	Item Description	Units	Unit Price	Quantity	Sub Total	Total
Utility Relocation	Overhead Hydro Relocation	lump sum	$200,000	1	**$200,000**	**$900,000**
	Underground Hydro - CN Easement	lump sum	$550,000	1	**$550,000**	
	Contingency (20 %)				**$150,000**	
	Sub Total				**$900,000**	
Roadwork - 200 m north of Bovaird to Sandalwood (6 lanes) plus Sandalwood to Mayfield (4 lanes)	Excavation	m3	$15	92400	**$1,386,000**	**$19,278,999**
	Fill	m3	$15	100000	**$1,500,000**	
	Install storm sewer	m	$300	5000	**$1,500,000**	
	Granular 'A' (Roadway)	tonne	$20	42017	**$840,340**	
	Granular 'B' (Roadway)	tonne	$15	93371	**$1,400,565**	
	Asphalt Base	tonne	$80	16909	**$1,352,720**	
	Asphalt Top	tonne	$95	10568	**$1,003,960**	
	Install curb and gutter	m	$45	10164	**$457,380**	
	Install subdrains	m	$20	10164	**$203,280**	
	Install catch-basin	each	$1,300	140	**$182,000**	
	Install manhole	each	$4,000	70	**$280,000**	
	Oil/Grit Separators	each	$40,000	4	**$160,000**	
	SWM Pond at Wanless	lump sum	$350,000	1	**$350,000**	
	Top Soil & Sod	m2	$5	75000	**$375,000**	
	Traffic medians	m2	$65	8000	**$520,000**	
	Steel beam guide rail	m	$95	700	**$66,500**	
	Extruders (Energy ends)	each	$10,000	4	**$40,000**	
	Granualr 'A' (Boulevard)	tonne	$25	1600	**$40,000**	
	Asphalt (Boulevard)	tonne	$150	1000	**$150,000**	
	Bio-Walls	m2	$350	1100	**$385,000**	
	Retaining walls	m2	$500	2000	**$1,000,000**	
	Transit stops	each	$25,000	12	**$300,000**	
	Traffic control/staging	lump sum	$200,000	1	**$200,000**	
	Culvert removal	m	$40	455	**$18,200**	
	Highway fence removal	m	$10	6200	**$62,000**	
	Erosin and sediment control	lump sum	$100,000	1	**$100,000**	
	Asphalt removal	m2	$3	33800	**$97,344**	
	Construction adjustment (15%)				**$2,095,543**	
	Contingency (20%)				**$3,213,166**	
	Sub Total				**$19,278,999**	
Intersections Tie Ins (Both sides of Mississauaga Road)	Additional turning lane (specify extra lanes and Municipal split)					**$1,442,100**
	Slip Road (to daylighting)	lump sum	$65,000	1	**$65,000**	
	Future Collector (to daylighting)	lump sum	$70,000	1	**$70,000**	
	Sandalwood Pkwy (to daylighting)	lump sum	$100,000	1	**$100,000**	
	Future Collector (to daylighting)	lump sum	$70,000	1	**$70,000**	
	Wanless Drive (to 200 m from C/L)	lump sum	$300,000	1	**$300,000**	
	Future Collector (to daylighting)	lump sum	$70,000	1	**$70,000**	
	Future Collector (to daylighting)	lump sum	$70,000	1	**$70,000**	
	Mayfield Road (to 200 m from C/L)	lump sum	$300,000	1	**$300,000**	
	Construction adjustment (15%)				**$156,750**	
	Contingency (20%)				**$240,350**	
	Sub Total				**$1,442,100**	
Streetlights	Both sides	km	$300,000	4.1	**$1,230,000**	**$1,476,000**
	Contingency (20%)				**$246,000**	
	Sub Total				**$1,476,000**	
Traffic Signals	Permanent - Slip Road	each	$150,000	1	**$150,000**	**$1,530,000**
	Permanent - Future Collector	each	$150,000	1	**$150,000**	
	Permanent - Sandalwood Pkwy	each	$150,000	1	**$150,000**	
	Permanent - Future Collector	each	$150,000	1	**$150,000**	
	Permanent - Wanless Drive	each	$150,000	1	**$150,000**	
	Permanent - Future Collector	each	$150,000	1	**$150,000**	
	Permanent - Future Collector	each	$150,000	1	**$150,000**	
	Permanent - Mayfield Road	each	$150,000	1	**$150,000**	
	Temporary - Mayfield Road	each	$75,000	1	**$75,000**	
	Contingency (20%)				**$255,000**	
	Sub Total				**$1,530,000**	
Bridge - Huttonville Creek	42 m Span Bridge	lump sum	$4,662,511	1	**$4,662,511**	**$5,595,013**
	Contingency (20%)				**$932,502**	
	Sub Total				**$5,595,013**	
Bridge - Railway Grade Separation	53.9 Clear Span	lump sum	$10,282,365	1	**$10,282,365**	**$12,338,838**
	Contingency (20%)				**$2,056,473**	
	Sub Total				**$12,338,838**	
Landscaping/ Sidewalks	1.5 m Con. sidewalk (west side)	m2	$55	6150	**$338,250**	**$2,029,500**
	3.0 m Con. MUP (east side)	m2	$60	12300	**$738,000**	
	Tree planting and streetscaping	km	$150,000	4.1	**$615,000**	
	Contingency (20%)				**$338,250**	
	Sub Total				**$2,029,500**	
				ESTIMATE		$44,590,450
				HST		$5,796,759
				PROJECT TOTAL		$50,387,209