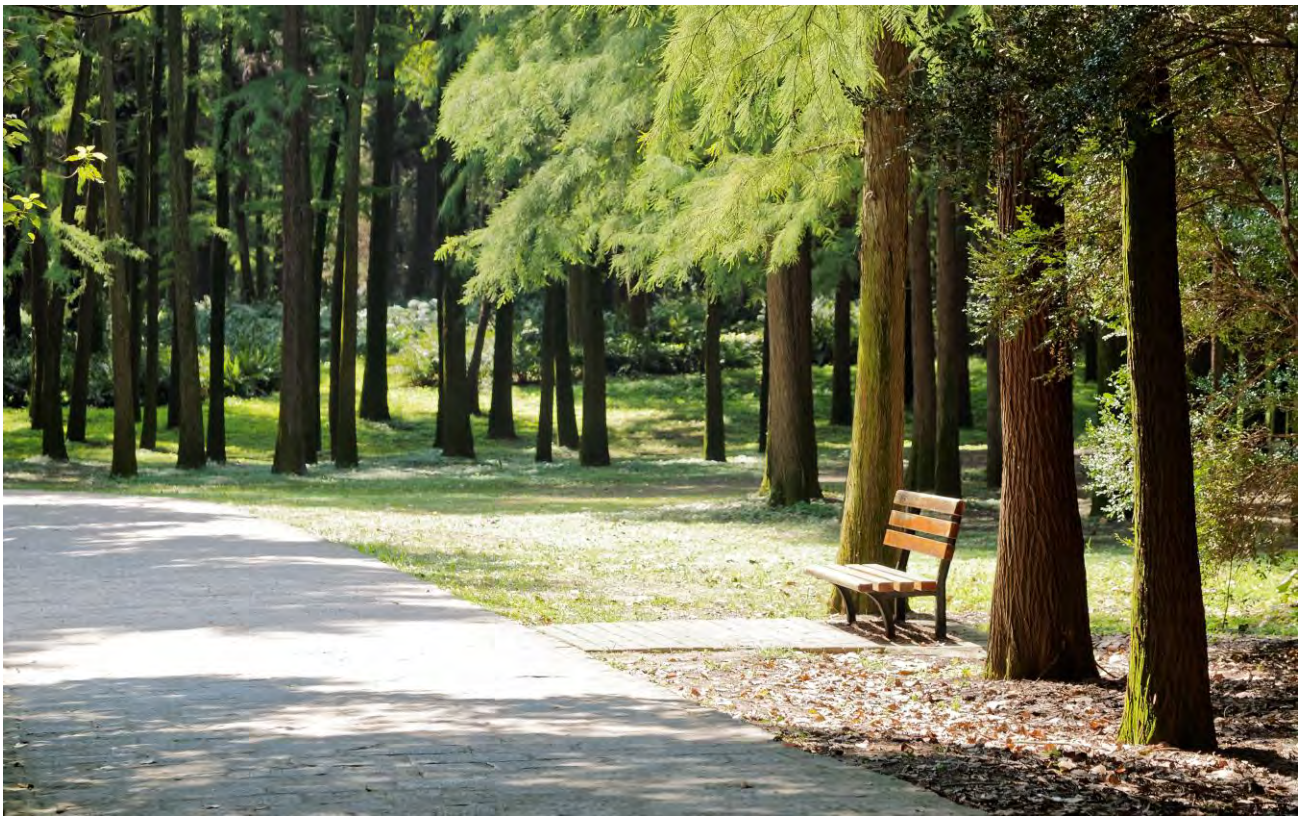
APPENDIX C: TECHNICAL SUPPORTING DOCUMENTS

APPENDIX C-6: AIR QUALITY EXISTING CONDITIONS AND AIR QUALITY STUDY

PART 1/1



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Hamilton LRT EA

Hamilton, Ontario

Report

Air Quality – Existing Conditions

RWDI #1011063
October 12, 2016

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1. INTRODUCTION

The City of Hamilton is proposing to develop a 5 line rapid transit network, as shown in Figure 1, below. The B-Line from McMaster University, via the Downtown to Eastgate Square has been identified as the first route. The second route is the A-Line, which runs along the James Street / Upper James Street corridor from the Waterfront, via the Downtown to Hamilton Airport. Light Rail Transit (LRT) has been selected as the preferred mode for the B-Line with LRT and Bus Rapid Transit (BRT) both under consideration for the A-Line.

Figure 1: Proposed Hamilton Rapid Transit System

Figure excerpted from Steer Davies Gleave "Hamilton Rapid Transit Preliminary Design and Feasibility Study"

The purpose of this report is to describe existing conditions in the study area of the Hamilton LRT project in terms of climatic conditions as well as current background levels for airborne contaminants of concern.

2. CLIMATIC CONDITIONS

Hamilton is located on the Western shore of Lake Ontario. The city of Hamilton extends up onto Hamilton Mountain, varying from an elevation of approximately 70-80 meters above sea level near the waterfront to

220-230 meters above sea level at the airport. Environment Canada provides climate normals for 4 stations within the Hamilton area. These stations consist of the Hamilton Airport, Hamilton Municipal Lab, Hamilton Psych Hospital, and Hamilton Royal Botanical Gardens (RBG). The locations of these stations are presented on Figure 2.

Figure 2: Location of Environment Canada Meteorological Stations

Climate normals based on data from each of these four stations are presented in order to bracket the range of climate conditions throughout the Hamilton area. The Hamilton Psych Hospital station is the most representative for conditions along the B-Line, which runs in a generally east-west direction. The Hamilton Royal Botanical Gardens, Hamilton Psych Hospital, and Hamilton Airport stations are all representative for portions of the A-Line, which runs in a north-south direction from the waterfront to the airport. Data from each of these four stations are summarized in Table 1. The information presented in this Table and the following discussion were obtained from Environment Canada's Canadian Climate Normals, 1971-2000 for the Hamilton Municipal Lab and Hamilton Psych Hospital stations, and 1981-2010 for the Hamilton Airport and Hamilton RBG stations.

Table 1: Hamilton Climate Normals

Parameter	Hamilton Royal Botanical Gardens	Hamilton Psych Hospital	Hamilton Airport	Hamilton Municipal Lab
General Location	Near Waterfront	Mid-town Hamilton	On top of Mountain	Near Waterfront
Station Elevation	102 m	198 m	238 m	76 m
Mean wind speed - January	13.8 km/hr	n/a	19.5 km/hr	n/a
Mean wind speed - July	9.6 km/hr	n/a	12.6 km/hr	n/a
Extreme gust speed	n/a	n/a	133 km/hr	n/a
Daily max/min temperature - January	-0.9 / -8.5 ºC	-1.7 / -8.9 ºC	-1.7 / -9.3 ºC	-0.4 / -6.8 ºC
Daily max/min temperature - July	27.3 / 16.7 ºC	26.8 / 16.5 ºC	26.5 / 15.2 ºC	27 / 17.9 ºC
Extreme minimum temperature	-28.3 ºC	-27 ºC	-30 ºC	-25 ºC
Extreme maximum temperature	38.8 ºC	38 ºC	37.4 ºC	38.5 ºC
Average afternoon relative humidity	n/a	n/a	65.3%	n/a
Annual snowfall	118.1 cm	119 cm	156.5 cm	113.2 cm
Annual rainfall	780.0 mm	821.7 mm	791.7 mm	750.8 mm
Average snow depth - February	n/a	n/a	10 cm	n/a
Rainfall greater than 0.2mm	120.9 days/year	113.4 days/year	117.8 days/year	120.3 days/year
Snowfall greater than 0.2 cm	36.2 days/year	27.1 days/year	54.2 days/year	28.8 days/year

Note: n/a = “not applicable”, data for this parameter were not available at a given station.

The Hamilton region generally has warm, humid summers and cold winters. Due to the moderating effect of the Great Lakes, the climate is relatively temperate, compared to mid-continental locations that are away from the lakes. During the summer months, the daytime temperatures are usually below 30 ºC and the nighttime temperatures are typically around 17 ºC, based on the Hamilton Municipal Lab and RBG stations, which are located near the waterfront. Temperatures from the Airport Station, located at a higher elevation, are typically 1-2 ºC lower than temperatures from the other stations. Daytime humidity during the summer is moderate, usually averaging between 50 and 60% at the airport station, which is the only station in the area that records this statistic. Winter weather conditions are also moderate, with high temperatures usually above -10 ºC, and low temperatures seldom below -20 ºC.

The area receives between 113 and 157cm of snowfall on an average winter, with the depth of snow on the ground averaging at less than 10cm. Snowfall occurs often through the winter, with appreciable amounts (greater than 0.2 cm) occurring on an average of 27 to 54 days/year, depending on location.

Annual rainfall varies from 751 to 822 mm. Like snowfall, rain also occurs fairly often during the warmer months, with appreciable rainfall (greater than 0.2mm) occurring on 113 to 121 days/year, on average.

The months with the fewest number of days of precipitation are June through August, which average approximately 10 to 11 days precipitation above 0.2mm.

Table 2 presents data on hazardous weather conditions in the vicinity of Hamilton, Ontario. The information presented in this table were obtained from the Canadian Climate Normals as well as from the Weather Network's Farmzone website. Records from Hamilton were used, where available.

Table 2: Data on Atmospheric Hazards

Parameter	Value
Freezing Rain	10 days/year
Snowfall greater than 10 cm	3 days/year
Extreme snowfall	31 – 43 cm
Fog, ice fog, or freezing fog	42 days/year
Rainfall greater than 25 mm	4 – 6 days/year
Tornadoes	~2.0 Tornadoes/yr/10,000 km^2

Freezing rain is infrequent, typically occurring on about 10 days/year, which is similar to most other parts of Southern Ontario. Heavy snowfall events are also infrequent, with daily snowfalls greater than 10cm generally occurring only about 3 days/year. Very heavy snowfall events occur from time to time, with the extreme being in the range of 31 to 43 cm. Similarly, heavy rainfall events (greater than 25mm) are infrequent, occurring 4 to 6 days/year on average.

The area is susceptible to tornadoes, with the annual average frequency being in the range of 2.0 tornadoes/ 10,000km2. This is similar to much of Southwestern Ontario, where the frequency is between 1.5 and 3 tornadoes/10,000km2.

3. AIRBORNE CONTAMINANTS OF INTEREST

Airborne contaminants are produced from a variety of sources, including industrial activities and vehicular traffic. Hamilton is known for its many heavy industries, including large steel production facilities. Some of the main emission sources in Hamilton, according to 2009 NPRI data, include the U.S Steel and Dofasco Steel Plants, Columbian Chemicals Canada Plant, the Hamilton Specialty Bar Plant and the Hamilton Community Energy Centre. Vehicular traffic also emits a variety of air contaminants as a result of fuel combustion inside the engine, evaporation of fuel from the tank, brake and tire wear, and re-suspension (as known as re-entrainment) of loose particles on the road surface (silt) as the vehicle travels over the road. Table 3 lists the most common of the air contaminants of potential concern from the industrial and vehicular sources.

Table 3: Contaminants of Interest

Contaminant	Symbol or Chemical Formula
Carbon Monoxide	CO
Nitrogen Oxides	NO_x
Respirable Particulate Matter	$PM_{2.5}$
Inhalable Particulate Matter	PM_{10}
Sulphur Dioxide	SO_2
Benzene	C_6H_6
1-3 Butadiene	C_4H_6
Formaldehyde	CH_2O
Acetaldehyde	CH_3CHO
Acrolein	C_3H_4O
Benzo(a)pyrene	$C_{20}H_{12}$

3.1 Relevant Guidelines

The Province of Ontario has established both criteria and standards for concentrations of airborne contaminants. The Ambient Air Quality Criteria (AAQC's) are effects-based levels in air, based on health and/or other effects. They are used in environmental assessments, special air monitoring studies, and assessments of general air quality to determine the potential for adverse effects. The standards, on the other hand, are established by Ontario Regulation 419/05, and are legal requirements which emitters in Ontario must meet. Most of the standards are based on the AAQC's but, in some cases, the standard and AAQC for a contaminant differ from each other.

In addition to the provincial AAQC's, the Federal Government and the Canadian Council of Ministers of the Environment have established Canadian Ambient Air Quality Standards for some of the contaminants. Of particular relevance are the CAAQS for PM2.5¬ (respirable particulate matter).

The AAQC and CAAQS are summarized in Table 4. These AAQC and CWS were used as benchmarks for assessing the existing conditions in the Hamilton area.

Table 4: Summary of Relevant Air Quality Thresholds for Ontario

Pollutant	Threshold (µg/m³)	Averaging Period	Source

$PM_{2.5}$	28 (98th percentile)	24 hours	CAAQS
	10	1 year	CAAQS
PM_{10}	50	24 hours	AAQC
CO	36,200	1 hour	AAQC
	15,700	8 hours	AAQC
NO_2	400	1 hour	AAQC
	200	24 hours	AAQC
SO_2	690	1 hour	AAQC
	275	24 hours	AAQC
	55	1 year	AAQC
Benzene	2.3	24 hours	AAQC
	0.45	1 year	AAQC
1,3-Butadiene	10	24 hours	AAQC
	2	1 year	AAQC
Acrolein	4.5	1 hour	AAQC
	0.4	24 hours	AAQC
Acetaldehyde	500	30 minutes	AAQC
	500	24 hours	AAQC
Formaldehyde	65	24 hours	AAQC
Benzo(a)Pyrene	0.00005	24 hours	AAQC
	0.00001	1 year	AAQC

The World Health Organization (WHO) published new air quality guidelines for several contaminants in the year 2000 with updates in 2005 for PM2.5, PM10, NO2 and SO2. Some jurisdictions have adopted these globally applicable guidelines as their own and, as such, it was considered prudent to include them for reference purposes, even though they have not been officially adopted in Ontario at this time. The WHO guidelines are listed in Table 5.

Table 5: Summary of Relevant Air Quality Thresholds from the World Health Organization

Pollutant	Criterion (µg/m³)	Averaging Period	Source
$PM_{2.5}$	25	24-hour	WHO
	10	Annual	WHO
PM_{10}	50	24-hour	WHO
	20	Annual	WHO
CO	30,000	1-hour	WHO
	10,000	8-hour	WHO
NO_2	200	1-hour	WHO
	40	Annual	WHO
SO_2	500	10-minute	WHO
	20	24-hour	WHO
Formaldehyde	100	30-minute	WHO

4. BACKGROUND AIR QUALITY CONDITIONS

Current air quality conditions were determined by looking at historical air pollutant monitoring data from stations throughout the Hamilton area. These data are available from a variety of sources, including:

- Ontario Ministry of the Environment (MOE) stations;
- Hamilton Air Monitoring Network (HAMN) stations; and,
- National Air Pollutant Surveillance Network (NAPS) stations.

Where monitoring results for a specific contaminant were not available from the Hamilton area monitoring stations, data from the most representative available stations in Southern Ontario were used as surrogates. The air pollutant monitoring data were used as a representation of present-day outdoor concentrations of the contaminants of concern (CACs, VOCs, and PAHs) in the Hamilton area. These are referred to as background concentrations. Background concentrations can vary widely from day-to-day, depending on the weather conditions, and also vary from place-to-place.

4.1 B-Line Background Air Quality Conditions

The proposed B-Line runs in a general east-west direction, from Eastgate Square to McMaster University. The following table summarizes the air quality monitoring stations used to develop the background concentrations for the B-Line study. Based on their location, the MOE Hamilton Downtown, the MOE Hamilton West, NAPS Hamilton Downtown and the HAMN stations are the most representative in terms of background concentrations for the B-Line. Formaldehyde, acetaldehyde, and acrolein are not monitored at any of the Hamilton-area stations; therefore, ambient concentrations of these contaminants were obtained from the nearest available station, NAPS Toronto Ruskin & Perth.

Table 6: Summary of Ambient Monitoring Stations – B-Line Study

Pollutant	Stations / Data Period
Nitrogen Dioxide (NO2)	MOECC Hamilton Downtown: 2010-2014 MOECC Hamilton West: 2010-2014 HAMN - Station 29102: 2010-2014 HAMN - Station 29567: 2010-2014
Carbon Monoxide (CO)	MOE Hamilton Downtown: 2010-2014
Respirable Particulate Matter (PM2.5)	MOE Hamilton Downtown: 2010-2014 MOE Hamilton West: 2010-2014
Inhalable Particulate Matter (PM10)	HAMN - Station 29567: 2010-2014

	HAMN - Station 29113: 2010-2014 HAMN - Station 29102: 2010-2014 HAMN - Station 29168: 2010-2014 HAMN - Station 29170: 2010-2014 HAMN - Station 29565: 2010-2014 HAMN - Station 29153: 2010-2014 HAMN - Station 29154: 2010-2014
Sulphur Dioxide (SO2)	MOECC Hamilton Downtown: 2010-2014 HAMN - Station 29567: 2010-2014 HAMN - Station 29102: 2006-2009
Formaldehyde	NAPS Toronto Ruskin & Perth: 1999-2003
Acetaldehyde	NAPS Toronto Ruskin & Perth: 1999-2003
Benzene	HAMN - Station 29102: 2010-2014 HAMN - Station 29113/29180: 2010-2014 HAMN - Station 29567: 2010-2014
1,3-Butadiene	NAPS Elgin & Kelly, Hamilton Downtown: 1999-2003
Acrolein	NAPS Toronto Ruskin & Perth: 1999-2003
Benzo(a)Pyrene	HAMN - Station 29567: 2010-2014 HAMN - Station 29113/29180: 2010-2014 HAMN - Station 29547: 2010-2014

The locations of these stations, with the exception of the NAPS Toronto Station, are shown in Figure 3, below.

Figure 3: Location of Hamilton-Area Ambient Monitoring Stations – B-Line Study.

Table 7 presents summary statistics for the pollutants and monitoring stations listed in Table 6. These background concentrations are applicable to the B-Line.

Table 7: Ambient Monitoring Results for the MOE Hamilton Downtown, the MOE Hamilton West, NAPS and HAMN stations

Pollutant	Statistic	Result (Over all Years and Stations)		AAQC or CAAQS (µg/m³)
		Maximum	Average	
NO_2 (µg/m³)	1-hr Max	145	116	400
	24-hr Max	93	73	200
	Annual Mean	32	26	- -
	1hr-90th Percentile	52	25	- -
	Times > 1-hr AAQC (400)	0	0	- -
	Times > 24-hr AAQC (200)	0	0	- -
CO (µg/m³)	1-hr Max	3,473	2,549	36,200
	8-hr Max	1,387	1,237	15,700
	Annual Mean	313	289	- -
	1hr-90th Percentile	506	473	- -

	Times > 1-hr AAQC (36,200)	0	0	- -
	Times > 24-hr AAQC (15,700)	0	0	- -
$PM_{2.5}$ (µg/m³)	1-hr Max	111	75	- -
	24-hr Max	46	36	28 (98th %-ile)
	Annual Mean	11	8.5	10
	1hr-90th Percentile	21	18.1	- -
	Days > 30 (28 after 2012)	5	2.4	- -
PM_{10} (µg/m³)	1-hr Max	1,000	292	- -
	24-hr Max	190	84	50
	Annual Mean	39	21	- -
	Times > 24-hr AAQC (50) *	177	27	- -
SO_2 (µg/m³)	1-hr Max	650	396	690
	24-hr Max	220	125	275
	Annual Mean	28	17	55
	1hr-90th Percentile	47	40	- -
	Times > 1-hr AAQC (690)	0	0	- -
	Times > 24-hr AAQC (275)	0	0	- -
Formaldehyde (µg/m³)	24-hr Max	11.1	7.1	65
	Annual Mean	2.8	2.7	- -
	1hr-90th Percentile	5.8	4.6	- -
Acetaldehyde (µg/m³)	24-hr Max	5.1	4.4	500
	Annual Mean	1.8	1.7	- -
	1hr-90th Percentile	3.2	2.7	- -
Benzene (µg/m³)	24-hr Max	55	11	2
	Annual Mean	4	2	0.45
1,3-Butadiene (µg/m³)	24-hr Max	0.72	0.54	10
	Annual Mean	0.15	0.13	2
	1hr-90th Percentile	0.43	0.29	- -
Acrolein (µg/m³)	24-hr Max	0.90	0.44	4.5
	Annual Mean	0.10	0.10	0.4
	1hr-90th Percentile	0.30	0.22	- -
Benzo(a)Pyrene (ng/m³)	24-hr Max	9.0	4.6	0.05
	Annual Mean	2.2	1.0	0.01

The majority of the air contaminants of concern have concentrations less than their relevant air quality thresholds, indicating that the levels are within the acceptable ranges for these contaminants. The exceptions are PM10, benzene, and benzo(a)pyrene.

PM10 has maximum 24-hour levels at the various HAMN monitoring sites around the industrial basin that are well above the applicable AAQC for PM10. The average number of days per year when the PM10 AAQC is exceeded is 27, or about 7% of the time.

For benzene and benzo(a)pyrene, the concentrations are well above the current AAQC's for these contaminants, for both the 24-hour and 1-year averaging periods, at all monitoring sites in the downtown and industrial basin areas.

Note that the stations where PM10, benzene and benzo(a)pyrene are measured are in closer proximity to the industrial basin, or more frequently downwind of it than the Downtown Hamilton, where the LRT will be located. Therefore, the measured levels of these contaminants represent somewhat of an overestimate of the actual levels in the LRT study area.

4.2 A-Line Background Air Quality Conditions

The proposed A-Line runs in a generally north-south direction, from the Waterfront to the Airport, climbing the escarpment as it travels from north to south. The northern portion of the A-Line route, below the escarpment, will have approximately the same baseline air quality conditions as the B-Line. Therefore, the ambient air quality conditions for the northern portion of the A-Line are the same as those described previously in Section 4.1.

The southern portion of the A-Line extends above the escarpment. The background air quality conditions above the escarpment differ from those found below the escarpment, since this location is well removed from industrial areas near the waterfront. Based on its location, the MOE Hamilton Mountain station is the most representative in terms of background concentrations for the portion of the A-Line above the escarpment.

Table 8: Summary of Ambient Monitoring Stations – A-Line Study, above Escarpment

Pollutant	Stations / Data Period
Nitrogen Dioxide (NO2)	MOE Hamilton Mountain: 2010-2014
Carbon Monoxide (CO)	not measured
Respirable Particulate Matter (PM2.5)	MOE Hamilton Mountain: 2010-2014
Inhalable Particulate Matter (PM10)	not measured
Sulphur Dioxide (SO2)	MOE Hamilton Mountain: 2010-2014
Formaldehyde	not measured

Acetaldehyde	not measured
Benzene	not measured
1,3-Butadiene	not measured
Acrolein	not measured
Benzo(a)Pyrene	not measured

The location of this station is shown in Figure 4, below.

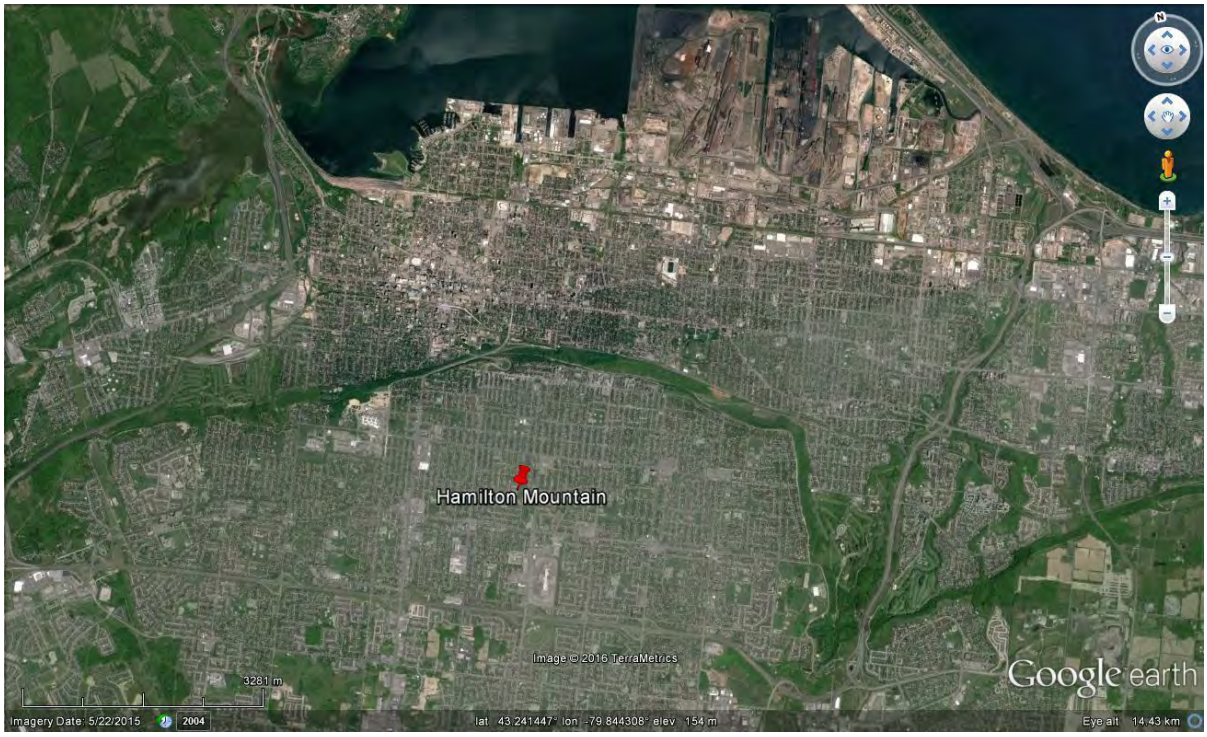

Figure 4: Location of Hamilton-Area Ambient Monitoring Stations – A-Line Study, above Escarpment

Table 9 summarizes pollutant concentration statistics for the MOE Hamilton Mountain Station. These background concentrations are applicable to the portions of the A-Line that are located above the escarpment.

Table 9: Ambient Monitoring Results for Hamilton Mountain Station

Pollutant	Statistic	Result (Over all Years and Stations)		AAQC or CAAQS (µg/m³)
		Maximum	Average	
NO_2 (µg/m³)	1-hr Max	127	111	400
	24-hr Max	69	62	200
	Annual Mean	20	18	- -
	1hr-90th Percentile	40	39	- -
	Times > 1-hr AAQC (400)	0	0	- -
	Times > 24-hr AAQC (200)	0	0	- -
CO (µg/m³)	contaminant not measured at this station			
$PM_{2.5}$ (µg/m³)	1-hr Max	115	79	- -
	24-hr Max	42	32	28 (98^{th} %-ile)
	Annual Mean	9	7.6	- -
	1hr-90th Percentile	19	14.8	- -
	Times > 30 (28 after 2012)	3	1.0	- -
PM_{10} (µg/m³)	contaminant not measured at this station			
SO_2 (µg/m³)	1-hr Max	295	255	690
	24-hr Max	119	80	275
	Annual Mean	11	9	55
	1hr-90th Percentile	28	22	- -
	Times > 1-hr AAQC (690)	0	0	- -
	Times > 24-hr AAQC (275)	0	0	- -
Formaldehyde (µg/m³)	contaminant not measured at this station			
Acetaldehyde (µg/m³)	contaminant not measured at this station			
Benzene (µg/m³)	contaminant not measured at this station			
1,3-Butadiene (µg/m³)	contaminant not measured at this station			
Acrolein (µg/m³)	contaminant not measured at this station			
Benzo(a)Pyrene (ng/m³)	contaminant not measured at this station			

The MOE Hamilton Mountain station measures ambient concentrations of NO2, SO2, and PM2.5 only. The concentrations of these contaminants are below the applicable thresholds, indicating that the concentrations are within the acceptable ranges.

In comparison to the stations below the escarpment, the ambient concentrations from the Hamilton Mountain station were generally lower. The average NO2 concentration is about 30% lower, the average PM2.5 concentration is about 10% lower, and the average SO2 concentration is almost 50% lower. Although not measured at the Hamilton Mountain Station, all other relevant contaminants are expected to be lower at the Hamilton Mountain station than at the Hamilton Downtown and Hamilton West stations and the various HAMN monitoring stations.

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Hamilton LRT EPR Addendum

Hamilton, Ontario

Air Quality Study Update

RWDI # 1601544
March 6, 2017

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Appendices

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1. INTRODUCTION

This air quality study update has been prepared as part of the EPR Addendum for the Hamilton LRT B-Line. It updates the previous air quality study that was prepared in support of the EPR, to reflect proposed changes to the project associated with the addendum, which are as follows:

- Minor design modifications to the B-Line alignment set out in the 2011 EPR;
- A spur line along James Street North connecting the new West Harbour Go Station and potentially down to the City's redeveloping Waterfront area;
- A proposed Operations Maintenance and Storage Facility (OMSF) where light rail vehicles would be maintained and stored.

Figure 1 presents a map of the proposed Project.

2. AIR QUALITY IMPACTS FROM CHANGES IN ROAD TRAFFIC

Since the proposed Hamilton LRT is an electrified rail system, it does not produce any significant local air emissions. Rather, it displaces emissions that otherwise would be generated by alternative methods of carrying its passengers, either automobile or bus. Thus, the proposed LRT generally will have a beneficial effect on various air pollutants of concern in the Hamilton area, including fine particulate matter, oxides of nitrogen, and various hydrocarbons such as benzene, 1,3-butadiene and benzo(a)pyrene.

However, existing roads and road traffic conditions will be altered to accommodate the B-Line LRT. For example, the present-day volume of road traffic on King Street in the downtown area will be significantly reduced with the LRT in place, while some other streets will pick up overflow from the King Street corridor and experience increased traffic. It is of interest to know whether the increased traffic and corresponding increase in tailpipe emissions on these other streets will have undesirable local implications for air quality, in spite of the general benefit of the proposed LRT.

Steer Davies Gleave provided information on the latest projected traffic volumes for two future scenarios: Business as Usual 2031 (BAU 2031) and LRT 2031. The year 2031 has been widely used for environmental assessments in Ontario as the future horizon year for traffic modelling studies. The necessary land use, population and employment projections that serve as input to the traffic modelling are available for that year. The latest traffic projections reflect the effects of the proposed changes to the Hamilton LRT B-Line, including the potential link to the Waterfront area. RWDI received this information in October, 2016.

Compared to the PM peak hour, the AM peak hour is worst-case in terms of projected traffic increases. Table 1 summarizes the predicted changes in traffic flow on major east-west streets between BAU 2031 and LRT 2031, for the AM peak hour. The detailed traffic data from which Table 1 was derived are presented in Appendix A.

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Table 1: Summary of Traffic Changes on Major East-West Streets from BAU 2031 to LRT 2031

Roadway	Start Point	End Point	Traffic Change
York Boulevard	Dundurn Street	Cannon Street	20 to 26% increase
Cannon Street	Queen Street	James Street	46 to 62% increase
	James Street	Wellington Street	14 to 18% increase
	Wellington Street	Sanford Avenue	Up to 8% increase
	Sanford Avenue	Gage Avenue	20 to 47% increase
	Gage Avenue	Brittania Avenue	Up to 10% increase
King Street	Dalewood Avenue	Cline Avenue	35% to 100% increase
	Cline Avenue	Centennial Parkway	Up to 90% decrease
Main Street	Cootes Drive	Bay Street	Up to 56% decrease
	Bay Street	James Street	Slight increase
	James Street	Parkdale Avenue	Up to a 44% decrease
Wilson Street	York Boulevard	Sherman Avenue	Up to 17% increase
Barton Street	Queen Street	Cope Street	Up to 33% increase
	Cope Street	Centennial Parkway	Slight increase or decrease (-3.3% to +1.8%)
Queenston Road	Cochrane Road	Walter Avenue	43 to 55% increase
	Walter Avenue	Greenford	Up to a 15% decrease

Table 1 shows that, while traffic volumes are expected to decrease on most of Main Street and King Street, they are projected to increase on York Boulevard, Cannon Street, Wilson Street and Barton Street, as well as on a section of King Street in the west end, and a small section of Queenston Road.

The implications of these increases in traffic for local air quality were assessed by reviewing previous air quality modelling for the Hamilton LRT B-Line, completed by RWDI in 2011. The technical details of that modelling are described in a technical report entitled “Hamilton LRT B-Line, Hamilton, Ontario, Final Report, Air Quality Assessment,” dated October 3, 2011 (RWDI report #1011063).

At that time, two sections of roadway with projected traffic increases were modelled: York Boulevard, from Dundurn Street to Cannon Street; and Barton Street, between Kennilworth Avenue and Strathearne Avenue. Table 2 below compares the projected traffic volumes used in the 2011 modelling to a selection of the latest projected traffic volumes for the Hamilton LRT EPR Addendum. The traffic volumes and changes in traffic are comparable in magnitude, indicating that the air quality modelling done in 2011 continues to provide a good representation of the air quality impacts that can be expected in areas where the LRT will cause traffic increases.

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Table 2: Traffic Data used in 2011 Assessment, Compared to the Latest Traffic Data

Roadway	Location	2031 AM Peak - BAU	2031 AM Peak with LRT	% Change
2011 Air Quality Modelling				
York Boulevard	Dundurn Street	3413	4283	+25%
	Queen Street	3786	4954	+31%
Barton	Kenilworth Avenue	1616	2746	+70%
	Strathearne Avenue	1648	2760	+67%
2017 EPR Addendum				
York Boulevard	Dundurn Street	3324	3306	-0.5%
	Queen Street	1825	2187	+20%
Cannon Street	Bay Street	1617	2392	+48%
King Street	Cline Avenue	1006	2012	+100%
Wilson Street	York Boulevard	1795	2188	+22%
Barton Street	Mary Street	3298	4392	+33%
Barton Street	Strathearne Avenue	2811	3043	+8%
Queenston Road	Walter Avenue	2045	3174	

The results from the 2011 air quality modelling are summarized in Tables 3 and 4. Further details can be found in the 2011 report.

Table 3: Maximum Predicted Concentrations from 2011 Study: Barton Street (2021 with LRT)

Contaminant	Averaging Period	Predicted Conc. ($\mu g/m^3$)	90th Percentile Background ($\mu g/m^3$)	Cumulative Conc. ($\mu g/m^3$)	Threshold ($\mu g/m^3$)	% of Threshold
CO	1 hr	1132	747	1879	36,200	5%
CO[2]	8 hr	632	747	1379	15,700	9%
NO_2	1 hr	79	40	119	400	30%
NO_2	24 hr	22	34	56	200	28%
$PM_{2.5}$	24 hr	2.2	18	20.2	30	67%
PM_{10}	24 hr	6.6	34	40.6	50	81%
Formaldehyde	24 hr	0.31	4.6	4.9	65	8%
Acetaldehyde	24 hr	0.12	2.7	2.82	500	1%
Acetaldehyde	30 min	0.48	8.1	8.6	500	2%
Benzene	24 hr	0.63	3.6	4.23	2.3	184%
Benzene	Annual	0.15	1.4	1.55	0.45	345%
1,3-Butadiene	24 hr	0.07	0.29	0.36	10	4%
1,3-Butadiene	Annual	0.02	0.13	0.15	2	7%
Acrolein	24 hr	0.02	0.22	0.24	0.4	59%
Acrolein	1-hr	0.054	0.22	0.27	4.5	6%

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Table 4: Maximum Predicted Concentrations from 2011 Study: York Blvd. (2021 with LRT)

Contaminant	Averaging Period	Predicted Conc. (µg/m^3)	90th Percentile Background (µg/m^3)	Cumulative Conc. (µg/m^3)	Threshold (µg/m^3)	% of Threshold
CO	1 hr	1702	747	2449	36,200	5%
CO[2]	8 hr	951	747	1698	15,700	11%
NO_2	1 hr	98	40	138	400	34%
NO_2	24 hr	37	34	71	200	36%
$PM_{2.5}$	24 hr	5	18	22.5	30	75%
PM_{10}	24 hr	17	34	50.6	50	101%
Formaldehyde	24 hr	0.53	4.6	5.1	65	8%
Acetaldehyde	24 hr	0.20	2.7	2.90	500	1%
Acetaldehyde	30 min	0.71	8.1	8.8	500	2%
Benzene	24 hr	1.12	3.6	4.72	2.3	205%
Benzene	Annual	0.30	1.4	1.70	0.45	377%
1,3-Butadiene	24 hr	0.115	0.29	0.41	10	4%
1,3-Butadiene	Annual	0.031	0.13	0.16	2	8%
Acrolein	24 hr	0.026	0.22	0.25	0.4	62%
Acrolein	1-hr	0.078	0.22	0.30	5	7%

The results can be summarized as follows:

- Predicted maximum concentrations at the most-impacted receptors are within the desired ranges for all air contaminants that were studied, with two principal exceptions: benzene and benzo(a)pyrene (not shown in the tables). PM_{10} was also slightly above its desired range.
- The elevated levels of the latter three contaminants are mainly due to elevated background levels, partly caused by heavy industries located near the downtown area.
- With the increased traffic in place, the predicted contribution from the roadway to these air contaminants at local sensitive impact locations is modest, i.e., less than a third of the background level for benzene and benzo(a)pyrene, and less about half of background for PM_{10}, at the most impacted receptor adjacent to the roadway).
- The increase in levels of benzene and benzo(a)pyrene adjacent to the roadway, due to traffic increases caused by the proposed LRT, is small and localized (on the order of 10% for benzene and benzo(a)pyrene, and 15-20% for PM_{10}, at the worst-affected receptor).

Based on these findings, the negative impact of proposed Hamilton LRT B-Line on local air quality adjacent to the relevant sections of Cannon, Wilson and Barton Street is expected to be relatively minor. The project will have a positive effect on benzene, benzo(a)pyrene, PM_{10} and other air pollutants along the other major east-west arteries listed in Table 1 where traffic is expected to decrease significantly.

The findings summarized in the bullets above were based on vehicle emissions data projected to the year 2021. Beyond the year 2021, the localized increase in air contaminant levels along Cannon, Wilson and Barton Street caused by the project will be mitigated by future decreases in tailpipe emissions from on-

road vehicles. The Canadian government has established On-Road Vehicle and Engine Emissions Regulations (SOR/2003-2) to reduce air pollutant emissions from on-road motor vehicles. As a result of these regulations, exhaust emissions from the average on-road vehicle have been declining for many years, and are expected to continue to decline in the foreseeable future.

Potential local mitigation measures for vehicle emissions, including benzene, benzo(a)pyrene and PM_{10}, were discussed in the original 2011 report. Published studies have indicated that tall vegetation (trees) and barriers (e.g., noise barriers) can reduce pollutant levels locally. The feasibility of such measures should be considered in areas where significant traffic increases due to the project are expected, particularly those areas where residential uses are located adjacent to the roadway.

3. AIR QUALITY IMPACTS FROM THE OPERATION, MAINTENANCE AND SERVICING FACILITY (OMSF)

The proposed location of the OMSF is on Chatham Street, west of Dundurn Street. It is in an industrial zone, just south of Highway 403, between the Aberdeen and Main Street interchanges. Residential uses are located to the south of the site, and are separated from it by an existing rail corridor.

One of the advantages of the proposed site is that rail access can be created without using a residential street corridor. Therefore, the rail traffic to and from the site will have no impact on local road traffic in the vicinity of the residences. The site will generate some employee traffic on the local roads, as evidenced by the 236 parking spaces that are included in the current site layout. This traffic will contribute a small increase in local levels of vehicle exhaust pollutants. However, the site layout is designed to provide access to Longwood Road, and much of the employee traffic is likely to use that access, avoiding the residential streets. Therefore, the proposed facility is not expected to cause impacts to local road traffic that would significantly affect the local air quality in the residential areas.

The OMSF has the following components:

- Major repairs
- Bogie Maintenance
- Paint/Body Repair
- Wheel Truing
- Inspection
- Daily Service/Sand & Washer
- Utilities
- Stores
- Depot Offices
- Maintenance of Way (M.O.W.) Facility
- Traction Power Substation (TPSS)
- Employee Parking

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The operations at the facility will include activities and equipment that have the potential to generate air pollutant emissions, including sandblasting, spray painting, welding, wheel truing, sand handling system, compressed air blow-downs, steam cleaning, boilers and emergency generators. These activities and equipment will be located inside the OMSF building.

The air contaminant of greatest concern that could be emitted by the facility is dust particles, which can be categorized as total suspended particulate matter (TSP), inhalable particulate matter (PM_{10}) and respirable particulate matter ($PM_{2.5}$). Downtown Hamilton currently experiences levels of particulate matter that are relatively high compared to other parts of Southern Ontario. The proposed LRT will contribute a beneficial effect on airborne particulate matter by displacing a significant amount of bus and automobile travel in the downtown area but, nevertheless, it is desirable to minimize the amount of particulate matter generated by the OMSF.

In order to comply with provincial regulations (Ontario Environmental Protection Act and Regulation 419/05), the facility must be designed so that off-site concentrations of air contaminants emitted from it are below the provincial standards at all times. This has to be documented in an emission summary and dispersion modelling (ESDM) report, which is submitted to the Ontario Ministry of Environment and Climate Change (MOECC), together with an application for environmental compliance approval (ECA). This must be done prior to construction and operation of the facility.

Sufficient details on the potential air emission sources at the facility are not available at the present time to predict off-site air contaminant concentrations using a computer dispersion model. This will be done in conjunction with detailed design. Based on past experience, however, it is anticipated that the emissions will need various control measures in order to comply with both the provincial air quality standards in the outside air and provincial occupational exposure limits for workers inside the facility. All activities capable of generating significant airborne particles (traction motor blow downs, steam cleaning, sandblasting, sand handling, welding, wheel truing, etc.) should be subject to either general ventilation or localized capture systems that are equipped with particle filtration.

The paint booth exhaust(s), in addition to having appropriate paint arrestors, should be designed with sufficient exhaust flow and stack height to ensure that off-site concentrations are below the standards for any regulated volatile organic compounds that are contained in the paint formulations, and are released into the air during spraying and curing. Any boilers and emergency generators should conform to the current tier of emission limits that are in place for new equipment at the time of procurement, and the exhaust stacks should be designed to provide appropriate dispersion. The specifics of these control measures, including locations, configurations and dimensions of exhaust vents, air flow rates of exhaust vents, type of filtration equipment and expected efficiency of filtration equipment should be documented in the ESDM report, which should be prepared when sufficient information on the specifics is available, i.e., after detailed design is under way.

The employee parking will consist of spaces for 236 vehicles. While the emissions from vehicles accessing the parking lot are expected to be minor in relation to other nearby sources of vehicle emissions (e.g., Highway 403 and local arterial roads), it is relatively practical to mitigate the emissions from idling vehicles, through an anti-idling policy that includes signage and employee awareness training.

In 2012, an air quality study was completed for a proposed Maintenance and Storage Facility (MSF) associated with the Finch West LRT project (Maintenance and Storage Facility, Final Revised Air Quality Assessment Report, prepared by AECOM, Project No. 60318592). Emission rates were estimated and air pollutant dispersion modelling was completed using the AERMOD model. The simulation included the following emission sources: dust collectors associated with compressed air cleaning and sand system; painting operations; maintenance welding; comfort heating; emergency generators; and vehicle emissions in the parking lot. Maximum concentrations were predicted for 15 air contaminants of interest. This was done at the property boundary of the site, at a grid of off-site locations, and at 13 specific receptor locations of interest.

The predicted maximum concentrations contributed by the MSF were far below the applicable provincial air quality standards. When combined with background levels of the air contaminants, the maximum cumulative concentrations remained well below the applicable air quality criteria, except in the case of the annual average concentration of benzene, for which the background concentration was above the criterion on its own. The predicted maximum contribution of the facility to benzene levels was insignificant compared to the background level. These results for the Finch West LRT show that such a maintenance facility can be designed to comply easily with provincial standards.

4. EMISSIONS DURING CONSTRUCTION OF THE LRT AND OMSF

The potential for temporary air quality impacts during construction of the LRT were addressed in RWDI's previous report for the Hamilton LRT B-Line, prepared in 2011. It was recommended that an emissions management plan be developed for construction, setting out the various practices to be undertaken to minimize dust and other air pollutants. A list of standard practices was provided.

The City of Hamilton has expressed interest in an air quality monitoring program for the Hamilton LRT project. Such a monitoring program could be used to help ensure that emission management activities during construction are effective. For this purpose, RWDI would recommend that the program consist of monitoring for particulate matter (PM_{10} and $PM_{2.5}$) and oxides of nitrogen (NO_X and NO_2). It will not be possible to monitor air pollutants everywhere that construction takes place throughout the project. Instead, we recommend that monitoring be conducted at two to three key locations where construction will occur in close proximity to residential uses with outdoor living areas, or other key sensitive receptors. The program should include collection of baseline data during a pre-construction period (a minimum of 3 months), and continue throughout the period when construction activities occur in proximity to the given monitoring site. Further details of the monitoring requirements can be specified during preparation of construction tender documents.

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5. SUMMARY

- The proposed LRT will have a beneficial effect on air quality in Downtown Hamilton, by displacing bus and automobile traffic.
- The LRT corridor will alter traffic patterns in the downtown area, causing decreased vehicle traffic on some streets, and increased traffic on others. While traffic volumes are expected to decrease on most of Main Street and King Street, they are projected to increase on York Boulevard, Cannon Street, Wilson Street and Barton Street, as well as on a section of King Street in the west end, and a small section of Queenston Road
- Air contaminant levels along the latter roadways are expected to remain with the desired range, except for three contaminants (PM_{10}, benzene and benzo(a)pyrene). These contaminants have relatively high background level. The increase in concentration of these contaminants due to the project is expected to be small and localized.
- Mitigation of motor vehicle emissions is addressed by the federal On-Road Vehicle and Engine Emission Regulations. In addition, the feasibility of local mitigation consisting of tree plantings (preferably coniferous), or other comparable barriers should be considered for areas where significant traffic increases due to the project are expected, with residential or other sensitive uses adjacent to the roadway.
- The proposed Operations, Maintenance and Servicing Facility (OMSF) is laid out in a manner that minimizes any impact to local road traffic that could affect the local air quality.
- The proposed OMSF will have the potential to produce air contaminant emissions, especially particulate matter, from the various activities that take place there. It is recommended that emission-generating activities be subject to either general or local ventilation that is equipped with particle filtration.
- Paint booth exhausts at the OMSF should have appropriate paint arrestors, and should be designed with appropriate exhaust vent parameters to ensure that any regulated volatile organic compounds emitted during paint spraying and curing are adequately dispersed before leaving the site.
- Combustion equipment (emergency generators, boilers) at the OMSF should conform to the current tier of emission limits that are in place for new equipment at time of procurement, and the exhaust stacks should be designed for appropriate dispersion.
- Previous studies of other LRT maintenance and storage facilities have shown that these facilities can comply easily with provincial air quality standards.
- Once detailed design is under way and sufficient details on the ventilation systems are available, an application to the MOECC for Environmental Compliance Approval (ECA) should be made for the OMSF, which will include submission of an emission summary and dispersion modelling report (ESDM) that documents the anticipated off-site air contaminant levels due to the facility's emissions and demonstrates compliance with provincial standards.
- An air quality management plan should be developed and implemented to minimize temporary air quality impacts during construction of the LRT and OMSF. The plan can include a program of air quality monitoring leading up to and during construction.

APPENDIX A

Route Name	Intersection Description	AM BAU 2031						AM LRT 2031						% change (LRT - BAU)
		Cars		Trucks		Buses		Cars		Trucks		Buses		
		WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	
York, Cannon, Britannia	Dundurn and York	1195	1953	77	99	3	0	945	2182	59	120	0	3	-0.5%
York, Cannon, Britannia	Strathcona and York	0	1669	0	81	0	3	0	2071	0	114	0	3	24.8%
York, Cannon, Britannia	Locke and York	0	1637	0	80	0	3	0	2056	0	107	0	3	25.9%
York, Cannon, Britannia	Pearle and York	0	1680	0	83	0	3	0	2069	0	107	0	3	23.4%
York, Cannon, Britannia	Cannon and Queen/ York	0	1735	0	87	0	3	0	2076	0	108	0	3	19.8%
York, Cannon, Britannia	Cannon and York	0	1711	0	84	3	0	0	2080	0	108	3	0	21.9%
York, Cannon, Britannia	Cannon and Hess	1533	0	128	0	3	0	2250	0	182	0	3	0	46.3%
York, Cannon, Britannia	Cannon and Bay	1494	0	120	0	3	0	2205	0	184	0	3	0	47.9%
York, Cannon, Britannia	Park and Cannon	1185	0	76	0	0	0	1833	0	139	0	0	0	56.4%
York, Cannon, Britannia	Cannon and MacNab	1145	0	71	0	0	0	1825	0	139	0	0	0	61.5%
York, Cannon, Britannia	James and Cannon	1454	0	66	4	4	0	2224	0	130	0	10	0	54.7%
York, Cannon, Britannia	Cannon and Hughson	1437	0	88	4	4	0	1685	0	115	0	10	0	18.1%
York, Cannon, Britannia	Cannon and John	1321	0	82	4	4	0	1517	0	108	0	10	0	15.9%
York, Cannon, Britannia	Cannon and Catharine	1416	0	95	4	4	0	1642	0	116	0	10	0	16.4%
York, Cannon, Britannia	Mary and Cannon	1616	0	127	4	4	0	1902	0	125	0	10	0	16.3%
York, Cannon, Britannia	Cannon and Ferguson	1666	0	127	0	4	0	1960	0	126	0	10	0	16.6%
York, Cannon, Britannia	Cannon and Wellington	1575	0	123	0	4	0	1816	0	116	0	10	0	14.1%
York, Cannon, Britannia	West and Cannon	1718	0	107	0	4	0	1841	0	120	0	10	0	7.8%
York, Cannon, Britannia	Cannon and Victoria	3984	0	108	0	4	0	4306	0	122	0	10	0	8.3%
York, Cannon, Britannia	Emerald and Cannon	1858	0	109	0	4	0	1911	0	123	0	10	0	3.7%
York, Cannon, Britannia	Cannon and Wentworth	1828	0	109	0	4	0	1872	0	120	0	10	0	3.1%
York, Cannon, Britannia	Cannon and Sanford	1532	0	81	0	4	0	1610	0	96	0	10	0	6.1%
York, Cannon, Britannia	Stirton and Cannon	1255	0	76	0	4	0	1577	0	93	0	10	0	25.8%
York, Cannon, Britannia	Cannon and Birch	1183	0	71	0	4	0	1747	0	96	0	10	0	47.3%
York, Cannon, Britannia	Cannon and Sherman	2231	0	38	0	4	0	3212	0	88	0	10	0	45.6%
York, Cannon, Britannia	Cannon and Lottridge	955	1079	65	23	4	4	1205	1232	84	35	10	4	20.7%
York, Cannon, Britannia	Cannon and Gage	928	501	57	23	4	4	1121	578	75	37	10	4	20.3%
York, Cannon, Britannia	Cannon and Belmont	934	718	47	43	4	4	1063	733	75	51	10	4	10.6%
York, Cannon, Britannia	Cannon and Balmoral (Peds)	889	649	49	36	4	4	947	642	67	44	10	4	5.1%
York, Cannon, Britannia	Cannon and Ottawa	889	649	49	36	4	4	971	642	69	45	10	4	6.7%
York, Cannon, Britannia	Cannon and Frederick	1009	630	54	35	4	4	991	619	71	41	10	4	0.0%
York, Cannon, Britannia	Cannon and Kenilworth	960	686	51	36	4	4	916	655	69	43	10	4	-2.5%
York, Cannon, Britannia	Garside and Cannon	1092	534	52	31	0	0	1087	536	72	31	6	0	1.3%
York, Cannon, Britannia	Barons and Cannon	998	540	52	31	0	0	1054	547	72	31	6	0	5.5%
York, Cannon, Britannia	Weir and Britannia	1013	541	54	31	4	4	1101	547	75	31	10	4	7.3%
York, Cannon, Britannia	Britania and Strathearne	1051	493	60	20	4	4	1097	426	74	14	10	4	-0.4%
York, Cannon, Britannia	Walter and Britannia	759	369	46	15	4	4	757	182	61	5	10	4	-14.9%
King Street	Dalewood and King	375	773	39	9	12	8	410	293	37	9	18	10	-36.1%
King Street	Cline and King	555	361	63	7	12	8	1429	503	42	10	18	10	100.0%
King Street	Sterling and King	1033	361	44	7	12	8	1423	481	42	5	18	10	35.1%
King Street	Longwood and King	745	1110	50	13	12	8	1167	632	44	9	18	10	-3.0%
King Street	King and Paradise	895	400	56	12	12	8	1004	204	40	10	18	10	-7.0%
King Street	King and Macklin	1673	0	73	0	12	8	1101	0	48	0	18	10	-33.4%
King Street	King and Ontario403	1533	0	122	0	16	8	1787	0	94	0	18	10	13.7%
King Street	King and Dundurn	5731	0	283	0	22	0	3173	0	236	0	18	0	-43.2%
King Street	King and New	5934	0	268	0	22	0	2309	148	92	2	18	0	-58.7%
King Street	King and Strathcona	2522	0	268	0	22	0	1078	148	92	2	18	0	-52.4%
King Street	King and Locke	2376	0	263	0	22	0	985	74	77	3	18	0	-56.5%
King Street	Pearl and King (Ped)	2246	0	246	0	22	0	751	109	57	3	18	0	-62.7%
King Street	Ray and King	2159	0	242	0	22	0	766	171	59	5	18	0	-57.9%
King Street	King and Queen	2295	0	244	0	24	0	829	171	59	5	23	0	-57.6%
King Street	King and Hess	2070	0	199	0	24	0	644	0	30	0	23	0	-69.6%
King Street	King and Caroline	1911	0	200	0	24	0	712	7	36	0	23	0	-63.6%
King Street	King and Bay	1865	0	213	0	24	0	483	119	25	6	23	0	-68.8%
King Street	Summers and King	1737	0	231	0	24	0	119	0	12	0	23	0	-92.3%
King Street	King and Summers (ped)	1639	0	195	0	24	0	119	244	12	65	23	0	-75.1%
King Street	MacNab and King	1639	0	195	0	24	0	119	237	12	61	23	0	-75.7%
King Street	King and MacNab	2523	0	202	0	24	0	986	232	20	61	23	0	-51.9%
King Street	James and King	2320	0	200	0	24	0	741	218	18	55	23	0	-58.5%
King Street	Hughson and King	2068	0	186	0	18	0	417	0	9	0	10	0	-80.8%
King Street	John and King	1889	0	182	0	18	0	495	0	11	0	10	0	-75.3%
King Street	Catharine and King	1803	0	166	0	10	0	249	49	7	6	0	0	-84.3%
King Street	King and Mary (ped)	1770	0	136	0	10	0	0	203	0	17	0	0	-88.5%
King Street	King and Walnut	1770	0	135	0	10	0	0	203	0	18	0	0	-88.5%
King Street	Ferguson and King (ped)	1645	0	133	0	10	0	0	161	0	15	0	0	-90.2%
King Street	Jarvis and King (ped)	1705	0	136	0	10	0	0	161	0	15	0	0	-90.5%
King Street	King and Wellington	3782	0	136	0	10	0	0	161	0	15	0	0	-95.5%
King Street	King and West	4992	0	170	0	10	0	1103	130	33	7	0	0	-75.4%
King Street	King and Victoria	4778	0	170	0	10	0	1028	129	33	7	0	0	-75.9%
King Street	King and East	4763	0	159	0	10	0	960	393	25	13	0	0	-71.8%
King Street	Emerald and King	2120	0	159	0	10	0	432	393	25	13	0	0	-62.3%
King Street	King and Tisdale	5119	0	186	0	10	0	1229	466	33	46	0	0	-66.6%
King Street	King and Grant	5418	0	192	0	10	0	1290	1317	35	56	0	0	-52.0%
King Street	King and Wentworth	2437	0	192	0	10	0	591	1317	35	56	0	0	-24.3%
King Street	King and Sanford	5105	0	192	0	10	0	1766	436	57	45	0	0	-56.6%
King Street	King and Arthur	5041	0	184	0	10	0	1987	1374	63	52	0	0	-33.6%
King Street	Holton and King	4952	0	185	0	10	0	2056	1336	65	51	0	0	-31.8%
King Street	King and Sherman	5243	0	189	0	10	0	2122	1020	67	43	0	0	-40.2%
King Street	King and Barnesdale	5376	0	218	0	10	0	1666	697	68	35	0	0	-56.0%
King Street	King and Melrose	5020	0	188	0	10	0	1923	696	75	35	0	0	-47.7%
King Street	King and Balsam	5031	0	183	0	10	0	1780	635	63	33	0	0	-51.9%
King Street	Gage and King	4725	0	184	0	10	0	1632	634	63	33	0	0	-52.0%
King Street	King and Dunsmure	4470	0	165	0	10	0	1854	381	82	12	0	0	-49.9%
King Street	Glendale and King	1998	0	165	0	10	0	891	381	82	12	0	0	-37.1%
King Street	King and Main East	1967	0	161	0	10	0	1969	201	87	12	0	0	6.1%
King Street	King and Balmoral (ped)	1182	929	122	60	6	0	444	2935	30	92	0	0	52.3%
King Street	King & Ottawa	1241	929	124	60	6	0	444	1353	30	91	0	0	-18.7%
King Street	King and Edgemount (ped)	1247	1034	126	53	6	0	768	1409	87	84	0	0	-4.8%
King Street	King & Graham	2858	1034	134	53	6	0	1660	1408	87	84	0	0	-20.7%

Route Name	Intersection Description	AM BAU 2031						AM LRT 2031						% change (LRT - BAU)
		Cars		Trucks		Buses		Cars		Trucks		Buses		
		WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	
King Street	King and Kenilworth	1345	2181	129	54	14	8	832	3057	79	85	10	10	9.2%
King Street	King and Cameron	1487	1163	129	53	14	8	993	1344	81	84	10	10	-11.6%
King Street	King and Rosedale	1504	1157	130	53	14	8	1087	1264	86	75	10	10	-11.7%
King Street	King and Rodgers (ped)	1488	1151	125	55	14	8	1103	1241	84	75	10	10	-11.2%
King Street	King and Cochrane	1488	1152	125	55	14	8	1103	1241	84	75	10	10	-11.2%
King Street	King and Glenholme	1548	1096	128	54	8	2	1268	1107	86	62	4	4	-10.8%
King Street	King and Parkdale	1547	1073	128	52	8	2	1281	986	88	56	4	4	-13.9%
King Street	King and RHVP West Ramp	1725	1063	141	50	8	2	1671	842	106	45	4	4	-10.6%
King Street	King and RHVP East Ramp	1618	970	113	48	8	2	1639	865	85	48	4	4	-4.1%
King Street	King and Potruff Road	1267	976	64	49	8	2	1283	922	55	47	4	4	-2.2%
King Street	King and Quigley	1281	941	64	49	8	2	1276	883	55	47	4	4	-3.2%
King Street	King and Nash	1156	861	52	34	12	2	1160	800	44	32	10	4	-3.2%
King Street	King and Greenhill	1107	886	54	35	12	2	1089	803	47	32	10	4	-5.3%
King Street	King and Centennial	1137	822	55	35	10	0	1094	762	47	33	6	0	-5.7%
Main Street	Main and Cootes/Leland	692	1423	8	59	12	18	574	1276	6	53	16	16	-12.3%
Main Street	Main and Emerson	2518	1951	8	122	16	22	1028	1651	7	93	24	24	-39.0%
Main Street	Main and McMaster Stop	3078	4433	29	135	16	18	1263	1863	37	126	24	16	-56.8%
Main Street	Main and Bowman	1449	4433	29	135	8	18	1263	4229	37	126	14	16	-6.4%
Main Street	Main and Dalewood	1494	1959	29	135	8	18	1262	1868	37	126	14	16	-8.8%
Main Street	Main and Haddon	3092	2270	29	139	8	18	2081	1856	34	108	14	16	-26.0%
Main Street	Main and Cline	3339	5132	48	139	8	18	2431	4727	41	116	14	16	-15.4%
Main Street	Main and Hwy 403	2651	5119	50	139	8	18	2275	4727	45	116	14	16	-9.9%
Main Street	Main and Paisley (ped)	913	1535	28	100	8	18	326	1221	16	64	14	16	-36.3%
Main Street	Main and Longwood	1426	1575	32	102	8	22	354	1221	17	65	14	24	-46.4%
Main Street	Main and Longwood Stop	1129	3495	11	93	8	22	549	2923	18	67	14	24	-24.4%
Main Street	Main and Paradise	623	3495	11	93	8	22	242	2923	18	67	14	24	-22.7%
Main Street	Main and Macklin	0	2031	0	111	4	22	0	1322	0	67	6	24	-34.5%
Main Street	Main and Ontario403	0	2199	0	98	0	22	0	1387	0	59	0	24	-36.6%
Main Street	Main and Dundurn	0	3302	0	268	0	22	0	3048	0	267	0	24	-7.0%
Main Street	Strathcona and Main	0	3508	0	280	0	22	0	2967	0	258	0	24	-14.7%
Main Street	Main and Locke	0	3457	0	279	0	25	0	2954	0	258	0	24	-14.0%
Main Street	Pearl and Main	0	3695	0	287	0	25	0	3128	0	264	0	24	-14.7%
Main Street	Main and Queen	0	3586	0	286	0	25	0	3054	0	262	0	24	-14.3%
Main Street	Main and Hess	0	3232	0	254	0	27	0	2956	0	260	0	29	-7.6%
Main Street	Main and Caroline	0	3020	0	233	0	27	0	2987	0	221	0	29	-1.3%
Main Street	Main and Bay	0	3196	0	228	0	27	0	3170	0	232	0	29	-0.6%
Main Street	Main and Summers (ped)	0	2506	0	211	0	24	0	2556	0	212	0	29	2.0%
Main Street	Main and MacNab	0	2506	0	211	0	24	0	2556	0	212	0	29	2.0%
Main Street	James and Main	0	2299	0	211	0	24	0	2337	0	215	0	29	1.9%
Main Street	Hughson and Main	0	2449	0	229	0	10	0	2253	0	234	0	6	-7.3%
Main Street	John and Main	0	2593	0	245	0	10	0	2518	0	272	0	6	-1.8%
Main Street	Catharine and Main	0	2906	0	297	0	10	0	2687	0	296	0	6	-7.0%
Main Street	Main and Walnut	0	2954	0	299	0	10	0	2724	0	297	0	6	-7.2%
Main Street	Main and Wellington	0	3014	0	313	0	10	0	2811	0	314	0	6	-6.2%
Main Street	Main and Victoria	0	2840	0	309	0	10	0	2804	0	323	0	6	-0.8%
Main Street	East and Main	0	2679	0	305	0	10	0	2494	0	304	0	6	-6.3%
Main Street	Emerald and Main	0	2622	0	300	0	10	0	2476	0	302	0	6	-5.0%
Main Street	Main and Tisdale	0	2679	0	289	0	10	0	2223	0	256	0	6	-16.6%
Main Street	Main and Wentworth	0	2680	0	292	0	10	0	2141	0	246	0	6	-19.8%
Main Street	Main and Sanford	0	2351	0	212	0	10	0	1805	0	138	0	6	-24.3%
Main Street	Fairleigh and Main	0	2351	0	212	0	10	0	1843	0	138	0	6	-22.8%
Main Street	Main and Sherman	0	2366	0	213	0	10	0	2022	0	143	0	6	-16.1%
Main Street	Main and Springer	0	2189	0	167	0	10	0	2014	0	148	0	6	-8.4%
Main Street	Main and Melrose	0	2236	0	168	0	10	0	2037	0	148	0	6	-9.2%
Main Street	Gage and Main	0	2198	0	169	0	10	0	1874	0	141	0	6	-15.0%
Main Street	King and Main East	0	2033	0	153	0	10	0	1854	0	145	0	6	-8.7%
Main Street	Balmoral and Main (ped)	909	1104	49	93	4	4	557	1643	62	65	6	6	8.1%
Main Street	Main and Ottawa	1971	1084	51	90	4	4	1016	702	63	65	6	6	-42.0%
Main Street	Graham and Main	2227	2255	60	71	4	4	1198	1308	34	44	6	6	-43.8%
Main Street	Kenilworth and Main	1310	2031	59	69	4	4	908	1243	37	41	6	6	-35.5%
Main Street	Cameron and Main (ped)	998	926	67	65	4	4	650	908	37	49	6	6	-19.8%
Main Street	Cope and Main	972	820	63	56	4	4	649	983	37	52	6	6	-9.7%
Main Street	Fairfield and Main (ped)	873	755	56	50	4	4	427	983	33	52	6	6	-13.5%
Main Street	Main and Queenston	953	962	61	52	4	4	579	982	39	52	6	6	-18.3%
Main Street	Main and Walter	472	152	13	5	4	4	209	415	7	6	6	6	-0.2%
Main Street	Main and Parkdale	204	704	11	7	4	4	126	685	5	8	6	6	-10.5%
York, Wilson	Cannon and York	0	1711	0	84	0	0	0	2080	0	108	0	0	21.9%
York, Wilson	York and Hess	0	2070	0	125	0	0	0	2350	0	124	0	0	12.7%
York, Wilson	York and Caroline	0	2254	0	131	0	0	0	2237	0	126	0	0	-0.9%
York, Wilson	York and Bay	0	1734	0	90	0	0	0	1753	0	109	0	0	2.1%
York, Wilson	York and Park	0	1531	0	80	0	0	123	1514	5	65	0	0	6.0%
York, Wilson	York and MacNab	21	1534	4	91	0	0	123	1558	5	74	0	0	6.7%
York, Wilson	Wilson/ York and James	311	1530	13	91	0	4	447	1542	15	73	0	4	6.8%
York, Wilson	Wilson and Hughson	374	1368	15	81	0	4	519	1449	20	66	0	4	11.7%
York, Wilson	Wilson and John	346	1098	11	68	0	4	446	1180	18	54	0	4	11.5%
York, Wilson	Wilson and Catharine	391	975	30	64	0	4	567	1054	27	60	0	4	16.9%
York, Wilson	Wilson and Mary	501	974	33	65	0	4	672	1005	36	58	0	4	12.6%
York, Wilson	Wilson and Ferguson	501	989	33	66	0	4	672	1018	36	59	0	4	12.3%
York, Wilson	Wilson and Wellington	598	887	35	57	0	4	733	888	37	55	0	4	8.6%
York, Wilson	Wilson and Victoria	358	874	9	65	0	4	431	891	14	62	0	4	7.0%
York, Wilson	Wilson and Steven	0	2843	0	90	0	4	0	2936	0	88	0	4	3.1%
York, Wilson	Wilson and Wentworth	0	1315	0	91	0	4	0	1330	0	89	0	4	0.9%
York, Wilson	Wilson and Sanford	0	1273	0	73	0	4	0	1451	0	106	0	4	15.6%
York, Wilson	Wilson and Birch	0	1190	0	69	0	4	0	1295	0	101	0	4	10.8%
York, Wilson	Wilson and Chesnut	0	1326	0	76	0	4	0	1421	0	107	0	4	9.0%

Route Name	Intersection Description	AM BAU 2031						AM LRT 2031						% change (LRT - BAU)
		Cars		Trucks		Buses		Cars		Trucks		Buses		
		WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	
York, Wilson	Wilson and Sherman	0	1192	0	70	0	4	0	1292	0	101	0	4	10.3%
Barton Street	Barton and Queen	1251	1004	50	33	0	0	1574	982	150	31	0	0	17.1%
Barton Street	Barton and Hess	1715	894	81	28	0	0	1709	796	125	24	0	0	-2.4%
Barton Street	Barton and Bay	973	1188	79	35	0	0	927	1401	116	31	0	0	8.8%
Barton Street	Barton and MacNab	698	396	66	33	0	0	870	363	76	29	0	0	12.2%
Barton Street	Barton and James	312	373	42	26	4	8	312	387	45	24	10	16	3.8%
Barton Street	Barton and Hughson	524	539	40	33	4	8	545	578	66	31	10	16	8.5%
Barton Street	Barton and John	677	701	48	40	4	8	760	768	76	38	10	16	12.9%
Barton Street	Barton and Catharine	928	998	65	55	4	4	1005	1148	90	54	10	10	12.8%
Barton Street	Barton and Mary	2273	897	67	53	4	4	3177	1045	98	52	10	10	33.2%
Barton Street	Barton and Ferguson	2270	2277	67	56	4	4	3174	2405	98	55	10	10	23.0%
Barton Street	Barton and Wellington	1190	2558	73	67	4	4	1477	2613	103	61	10	10	9.7%
Barton Street	Barton and Victoria	1247	853	74	47	4	4	1455	1129	95	49	10	10	23.3%
Barton Street	Barton and Smith (ped)	1050	843	71	29	4	4	1344	991	93	37	10	10	24.2%
Barton Street	Barton and Wentworth	1075	900	72	32	4	4	1347	1019	94	39	10	10	20.7%
Barton Street	Barton and Sanford	1322	1099	108	39	4	4	1711	1117	116	41	10	10	16.7%
Barton Street	Barton and Stirton	1367	1133	108	40	4	4	1571	1162	111	42	10	10	9.4%
Barton Street	Barton and Birch	1445	1127	112	40	4	4	1646	1185	115	41	10	10	10.1%
Barton Street	Barton and Sherman	1326	1117	101	40	4	4	1564	1178	112	42	10	10	12.5%
Barton Street	Barton and Ruth (ped)	1395	1199	102	42	4	4	1608	1197	111	41	10	10	8.4%
Barton Street	Barton and Lottridge	1398	1196	105	40	4	4	1611	1194	114	38	10	10	8.4%
Barton Street	Barton and Gage	1443	1201	116	39	4	4	1722	1152	122	34	10	10	8.7%
Barton Street	Barton and Carell	1451	1086	122	31	4	4	1483	1128	144	32	10	10	4.0%
Barton Street	Barton and Lincoln	3620	1107	137	31	4	4	3882	1147	162	32	10	10	6.9%
Barton Street	Barton and Ottawa	1584	2349	137	32	4	4	1678	2408	163	32	10	10	4.6%
Barton Street	Barton and Fraser (ped)	1457	1092	126	29	4	4	1683	1101	155	28	10	10	10.1%
Barton Street	Barton and Frederick	1421	1091	121	27	4	4	1649	1090	150	25	10	10	10.0%
Barton Street	Barton and Kenilworth	1544	1137	113	31	4	4	1677	1138	141	29	10	10	6.1%
Barton Street	Barton and Cope	1424	1094	113	27	4	4	1663	1089	145	26	10	10	10.4%
Barton Street	Barton and Strathearne	1458	1203	113	29	4	4	1663	1191	142	27	10	10	8.3%
Barton Street	Barton and Walter	3196	1212	111	29	4	4	3247	1209	136	27	10	10	1.8%
Barton Street	Barton and Parkdale	1342	2626	106	25	4	4	1391	2576	133	22	10	10	0.9%
Barton Street	Barton and Woodward	1295	1043	103	22	4	4	1178	1052	122	18	10	10	-3.3%
Barton Street	Barton and RHVP West	1833	1149	123	30	4	4	1776	1148	138	27	10	10	-1.1%
Barton Street	Barton and RHVP East	1747	980	111	27	4	4	1755	989	110	23	10	10	0.8%
Barton Street	Barton and Nash	1761	1385	84	26	4	4	1739	1418	92	25	10	10	0.9%
Barton Street	Barton and Kenora	883	944	56	10	4	4	844	961	55	9	10	10	-0.6%
Barton Street	Barton and Centennial	845	910	55	9	4	4	843	922	55	8	10	10	1.1%
Queenston Road	Cochrane and Queenston	929	915	57	51	6	7	1649	1048	46	54	9	9	43.3%
Queenston Road	Queenston and Walter	916	1009	52	55	6	7	758	2287	49	62	9	9	55.2%
Queenston Road	Parkdale and Queenston	1037	1117	57	56	6	7	788	1223	52	65	9	9	-5.9%
Queenston Road	Queenston and Reid	1248	1406	83	66	6	7	1068	1522	99	76	6	6	-1.4%
Queenston Road	Queenston and RHVP West	1483	1498	99	53	6	7	1277	1609	115	63	6	6	-2.2%
Queenston Road	Queenston and RHVP East	3204	1235	98	60	6	7	2476	1285	90	67	6	6	-14.8%
Queenston Road	Queenston and Potruff	2978	2502	71	50	6	7	2434	2435	60	48	6	6	-11.1%
Queenston Road	Queenston and Woodman	1291	2502	71	50	6	7	1084	2433	61	49	6	6	-7.3%
Queenston Road	Nash and Queenston	1075	969	52	30	6	7	878	913	43	29	6	6	-12.3%
Queenston Road	Greenford and Queenston	2246	958	46	29	6	7	1897	986	55	32	6	6	-9.4%