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Appendix U: AIR QUALITY ASSESSMENT

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REPORT

CLARKSON RD AND LAKESHORE RD INTERSECTION EA

MISSISSAUGA, ONTARIO

AIR QUALITY ASSESSMENT

RWDI #2004435

June 30, 2022

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI was retained by CIMA+ to conduct an air quality assessment in support of the Clarkson Road and Lakeshore Road Intersection Municipal Class Environmental Assessment Study located in Mississauga, Ontario. The objective of the assessment was to quantify how the project will affect air quality in the study area.

The intersections of Lakeshore Road West and Clarkson Road North/ Clarkson Road South are off set by approximately 75 m, resulting in two closely spaced signalized intersections. The objective of the study was to review the Lakeshore Road West and Clarkson Road North/ Clarkson Road South intersections and improve the operations, safety, and mobility for all road users at the intersections.

The study investigated several alternative solutions to improve traffic operations at both intersections and has recommended an Interim Preferred Solution and Preferred Solution that will be implemented on a phased basis in the short to medium term and the longer term, respectively. The Interim Preferred Solution improvements include the introduction of a center median and side by side left turn lanes on Lakeshore Road West. The Preferred Solution improvements include the realignment of Clarkson Road North.

The emission modelling was completed using the U.S. Environmental Protection Agency's roadway traffic emissions model, MOVES version 2014b, and the dispersion modelling was completed using the US EPA's dispersion model AERMOD version 19191. The background concentrations were obtained from air quality monitoring data collected by Environment and Climate Change Canada (ECCC).

The Interim Preferred Solution illustrated in Figure 1 and includes the introduction of separate left-turning lanes on the Lakeshore Road West section between Clarkson Road North and Clarkson Road South instead of the existing back to back left turn lane configuration. Thus, there will be no major re-alignments or significant changes in the roadway geometries, as per the information provided by CIMA+. is not anticipated to impact the road traffic volumes and consequently the operational air quality impacts (i.e. the same traffic volumes are anticipated for the future build and future no build scenarios).

Four worst-case air contaminants were chosen to assess the effects of the project on the surrounding air quality: Nitrogen Dioxide (NO_2), Benzo(a)pyrene, Particulate Matter less than 2.5 microns ($PM_{2.5}$) and benzene.

The proposed new design of the intersection at Clarkson and Lakeshore West is not expected to have significant impacts on nearby sensitive receptors. Although the assessment indicates exceedances of the applicable thresholds for some contaminants, these exceedances are primarily the result of existing elevated background concentrations within the study area.

The Preferred Solution is illustrated in Figure 2. This solution includes the realignment of Clarkson that would result in a single intersection instead of two, with resulting improvements to traffic flow. This solution was not specifically analyzed as part of this assessment however changes in air quality impacts would be expected to be minor - if anything they would decrease because of the improved traffic flow.

1 INTRODUCTION

RWDI was retained by CIMA+ to conduct an air quality assessment in support of the Clarkson Road and Lakeshore Road Intersection Municipal Class Environmental Assessment Study proposed new design of the intersection between Clarkson and Lakeshore West roads located in Mississauga, Ontario. The objective of the assessment was to quantify how the project will affect the air quality within the study area.

The primary tasks completed as part of this study are itemized below:

- Use the US EPA vehicle emissions modelling MOVES2014b to predict tailpipe emissions associated with the traffic for the;
- Use the US EPA atmospheric dispersion model AERMOD version 19191 to predict maximum contaminant concentrations at representative sensitive receptors due to emissions from the project related traffic movement;
- Use representative historical monitoring data to establish background concentrations for each contaminant of interest, due to various other sources in the surrounding area other than those associated with the proposed project; and,
- Combine the dispersion model results with the background concentrations and compare to applicable air quality thresholds.

The assessment methodology and results are presented in the following sections.

2 PROJECT DESCRIPTION

The intersections of Lakeshore Road West and Clarkson Road North/ Clarkson Road South are offset by approximately 75 m, resulting in two closely spaced signalized intersections. The objective of the study was to review the Lakeshore Road West and Clarkson Road North / Clarkson Road South intersections and improve the operations, safety, and mobility for all road users at the intersection.

The study investigated several alternative solutions to improve traffic operations at both intersections and has recommended an Interim Preferred Solution and Preferred Solution that will be implemented on a phased basis in the short to medium term and the longer term, respectively. The Interim Preferred Solution improvements include the introduction of a center median and side by side left turn lanes on Lakeshore Road West. The Preferred Solution improvements includes the realignment of Clarkson Road North.

The Interim Preferred Solution is illustrated in Figure 1 and includes the introduction of separate left turning lanes on the Lakeshore Road West section between Clarkson Road North and Clarkson Road South instead of the existing back to back left turn lane configurations.

Thus, there will be no major re-alignments or significant changes in the roadway geometries, as per the information provided by CIMA+. This Interim Preferred Solution is not anticipated to impact the road traffic volumes and consequently the operational air quality impacts (i.e. the same traffic volumes are anticipated for the future build and future no build scenarios).

Although the current assessment is based on the Interim Preferred Solution, it should be noted that a “Preferred Solution” for the realignment will be protected for implementation at a later date (see Figure 2). The “Preferred Solution” would avoid the offset alignment assumed in the preferred design and would result in a single intersection instead of two – with resulting improvements to traffic flow. Should this “Preferred Solution” be implemented, the changes in air quality impacts would be expected to be minor – if anything they would decrease because of the improved traffic flow.

3 INPUT DATA AND MODELS

3.1 Traffic Data

The City of Mississauga provided CIMA+ with the Turning Movement Counts (TMCs) for the intersection of Lakeshore Road West with Clarkson Road South, Clarkson Road North, Meadow Wood Road, and Plaza Entrance at 1865 Lakeshore Road West. The TMCs were conducted in 2019 at the peak AM and PM periods. The AADTs were estimated from the peak hourly volumes using the conversion factors from HCM methodology[1] (HCM, 2010). TMCs provided the vehicle breakdown data into autos and trucks. The trucks were further split into medium and heavy trucks based on the typical breakdown percentages documented in the MTO Environmental Guide for Noise[2]. The future traffic volumes were estimated as part of the traffic study completed by CIMA+ for 20-year horizon (i.e. 2041). The traffic and vehicle distribution data used for this assessment are provided in **Appendix A**.

The hourly traffic distributions for 2041 eastbound and westbound traffic on Lakeshore Road West and for combined northbound and southbound traffic on Clarkson Road North and Clarkson Road South were estimated using a typical traffic distribution as described in the published document “Typical Hourly Traffic Distribution for Noise Modelling” from *VanDelden et al,* 2008. The current posted speed limits were used as the traffic speed for this assessment. Table A1 in **Appendix A** provides a summary of the modelled traffic volumes and speed data.

3.2 Land Use

Figure 3 shows the study area for the air quality assessment, the surrounding land use is primarily commercial and residential. Clarkson Road has private homes along both sides of the street on the north and south links. Most of the first-row buildings on Lakeshore West are commercial in nature and thus are considered non-sensitive.

[1] Transportation Research Board, National Research Council, Washington, DC, 2010, Manual, Highway Capacity (HCM).
[2] Ontario Ministry of Transportation (MTO), 2006, Environmental Guide for Noise updated July 2008.

3.3 Emissions Model

The U.S. EPA's Motor Vehicle Emission Simulator (MOVES) is a model that has been developed for the purpose of estimating vehicular emissions using computer simulation techniques based on extensive previous testing of a wide range of vehicles. MOVES2014b was used to generate the vehicle emission factors for the emissions horizon year of 2041, which corresponds to the horizon year for this assessment.

MOVES allows the user to generate emission factors by time of day, which accounts for diurnal fluctuations in temperature and relative humidity. In the present analysis, hourly emission factors were generated.

Exhaust emissions vary widely by type of vehicle and MOVES provides emission factors for several different categories. These individual emission factors were aggregated to produce a composite emission factor for each pollutant, representing the vehicle distribution.

For particulate matter, emissions result from the re-suspension of dust as vehicles travel over a roadway surface, in addition to tailpipe emissions. The road dust emissions were calculated based on the revised version of U.S. EPA's AP-42, Chapter 13.2.1 (EPA, 2011) (**Appendix B**). The tailpipe emission factor for particulate matter, from MOVES, was added to the road dust emission factors (**Appendix B**) to account for both emission sources.

Emissions from moving vehicles were represented as if coming from stationary sources distributed along the route of travel. Each stationary segment of the street was represented as an area source in AERMOD. The emissions from each area source corresponds to the amount of emissions produced by vehicles while travelling on that segment of the route. Emissions from the idling vehicles were modelled as an area source representing each intersection on Lakeshore Road.

3.4 Dispersion Model

Air contaminants emitted from vehicles on a roadway will drift downwind and disperse as they travel. The degree to which the contaminants disperse depends on the weather-related factors, such as wind speed and amount of turbulence. The typical approach to determine potential future downwind concentrations from a proposed project is to use a computer simulation that predicts the dispersal of air pollutants as they drift away from the roads. These simulations are referred to as dispersion models.

Dispersion modelling is a common approach for assessing local air quality near an emission source such as vehicular traffic. The U.S. EPA developed a model known as AERMOD. This is an approved dispersion model used for regulatory modelling in Ontario. The model considers contaminant emission data, historical hourly meteorological data, local terrain data, and the configuration of the roadway. The model uses this information to predict roadway contributions to air quality levels at selected locations (sensitive receptors) adjacent to the study area under a variety of meteorological conditions.

3.5 Meteorological Data

The Ministry of Environment, Conservation, and Parks (MECP) publishes meteorological datasets based on the location and land use of the study site. For this assessment, the "suburban" dataset applicable to the project location, which is in the Ontario Central Region, was selected. This data set consists of five years of meteorological data spanning 1996-2000.

4 ASSESSMENT METHODOLOGY

4.1 Modelled Scenario

The Interim Preferred Solution will not impact the road traffic volumes (i.e. the same traffic volumes are anticipated for the future build and future no build scenarios). In order to quantify the effects of the project on the surrounding air quality, vehicle emissions were represented using projected 2041 traffic volumes and 2041 vehicle emission factors.

4.2 Selection of Sensitive Receptors

Receptors were placed to ensure the worst-case impact was captured. Receptors were placed at residential dwellings and other sensitive receptors located closest to the two intersections. The receptors were chosen to represent operable windows and outdoor amenity areas at nearby residences. Additionally, a receptor grid was used for areas further away from the intersections. Figure 3 shows the receptor locations selected for modelling. Commercial and industrial buildings were not considered as part of this analysis.

4.3 Modelled Air Contaminants

The following key contaminants have commonly been assessed in air quality studies for Ontario roadway EA's: nitrogen dioxide (NO_2), carbon monoxide, inhalable particulate matter (PM_{10}), respirable particulate matter ($PM_{2.5}$), benzene, 1,3-butadiene, formaldehyde, acetaldehyde and acrolein. For this study, four worst-case air contaminants were chosen, consisting of those having the highest ratios of emission rate to air quality threshold: NO_2, Benzo(a)pyrene, $PM_{2.5}$ and benzene.

4.4 Air Quality Thresholds

The MECP has ambient air quality criteria (AAQCs) that are used to assess the acceptability of airborne concentrations of NO_2 and Benzene. The province does not have an AAQC for $PM_{2.5}$. Instead, the federal Environment and Climate Change Canada (ECCC) has established Canadian Ambient Air Quality Standards (CAAQS) for $PM_{2.5}$. The criteria and standards are collectively referred to as air quality thresholds in this report. The thresholds are summarized in Table 4.1.

Table 4.1: Summary of Relevant Air Quality Thresholds (μg/m³)

Pollutant	Criterion (μg/m³)	Averaging Period	Source of Threshold Value
$PM_{2.5}$	27	24-hour	CAAQS
	8.8	Annual	CAAQS
NO_2	400	1-hour	AAQC
	200	24-hour	AAQC
	83	1-hour*	CAAQS (2025)
	24	Annual**	CAAQS (2025)
Benzene	0.45	Annual	AAQC
	2.3	24-hour	AAQC
B(a)P	5.0E-05	24-hr	AAQC
	1.0E-05	Annual	AAQC

*The 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations.
**The average over a single calendar year of all the 1-hour average NO_2 concentrations.

4.5 Background Air Quality Data

AERMOD predicted the contribution of the modelled roadways to concentrations of contaminants at the nearby sensitive receptors. The predicted maximum concentrations were combined with estimated background concentrations that are due to other emission sources in the surrounding area (primarily other roadways), thus providing a prediction of maximum cumulative concentrations.

The background concentrations were estimated using air quality monitoring data collected by the Ontario MECP and/or ECCC under its National Air Pollution Surveillance (NAPS) program. Background data for nitrogen dioxide, $PM_{2.5}$, and ozone are from the Bay St./Wellesley St. W. (Toronto downtown) station (NAPS ID 60433). Background data for Benzo(a)pyrene and benzene was considered to be the average of several nearby representative stations where data was available (Toronto - Gage Institute, Toronto West and Roadside-Wallberg (UofT)).

For the purpose of predicting maximum 1-hour and 24-hour cumulative concentrations of NO_2, the maximum modelled concentration at each receptor location was combined with the 90th percentile hourly background concentration from the monitoring data, as per common practice in Ontario EA's. A 5-year average (2013 through 2017) of these 90th percentile values was used. For the purpose of predicting maximum annual cumulative concentrations the average annual background concentration for the same 5-year period was used.

Table 4.2 shows the background concentrations that were entered to the dispersion model for the NO_2 1-hour and 24-hour dispersion modelling. Background concentrations for contaminants with annual averaging time are shown in Table 4.3. 1-hr and 24-hr average background concentrations for all other contaminants can be found in the result tables in **Appendix C**.

Table 4.2: Ambient Hourly Background Concentrations

Hour of Day	Pollutant Concentration (ppb)	
	NO_2	O_3
1	25.8	37.5
2	25.6	37.0
3	26.5	35.5
4	26.1	35.2
5	25.7	34.4
6	27.5	31.9
7	29.9	29.8
8	31.9	29.8
9	30.5	32.1
10	26.8	35.6
11	22.8	39.4
12	20.2	43.2
13	19.0	46.8
14	17.9	49.0
15	18.2	49.9
16	18.4	49.8
17	19.3	50.0
18	19.8	49.6
19	21.2	47.4
20	22.9	44.8
21	23.9	42.2
22	24.5	40.4
23	25.7	39.1
24	25.6	37.9

Table 4.3: Ambient Air Measurements used for Annual Background

Pollutant	5-Year Average Concentration ($\mu g\ m^{-3}$)
$PM_{2.5}$	8.0
Benzene	0.52
NO_2	28.1

4.6 Assessment of Construction Impacts

Construction impacts were not considered in this assessment as construction activities are temporary and would not pose any risk of long-term health impacts at the studied receptors.

5 RESULTS

Table 5.1 presents a summary of the predicted concentrations at the most-impacted sensitive receptor for the future build scenario (Interim Preferred Solution). The resultant concentrations are compared to applicable thresholds. Predicted maximum concentrations for the most impacted receptors are provided in **Appendix C**.

Although the assessment indicates exceedances of the applicable thresholds for NO_2, benzene and B(a)P for annual averaging time periods, and B(a)P 24-hr averaging time, the exceedances are primarily the result of elevated background concentration within the study area. moreover, B(a)P and Benzene background concentrations for these averaging times, already exceeded their thresholds. The contributions of Lakeshore Road West, Clarkson Road and the intersections at these roads are all less than 10 % of the respective background levels, which is considered insignificant. It is important to note that the same traffic volumes are anticipated for the future build and future no build scenarios.

Table 5.1: Maximum Predicted Concentrations for the Future Build Scenario

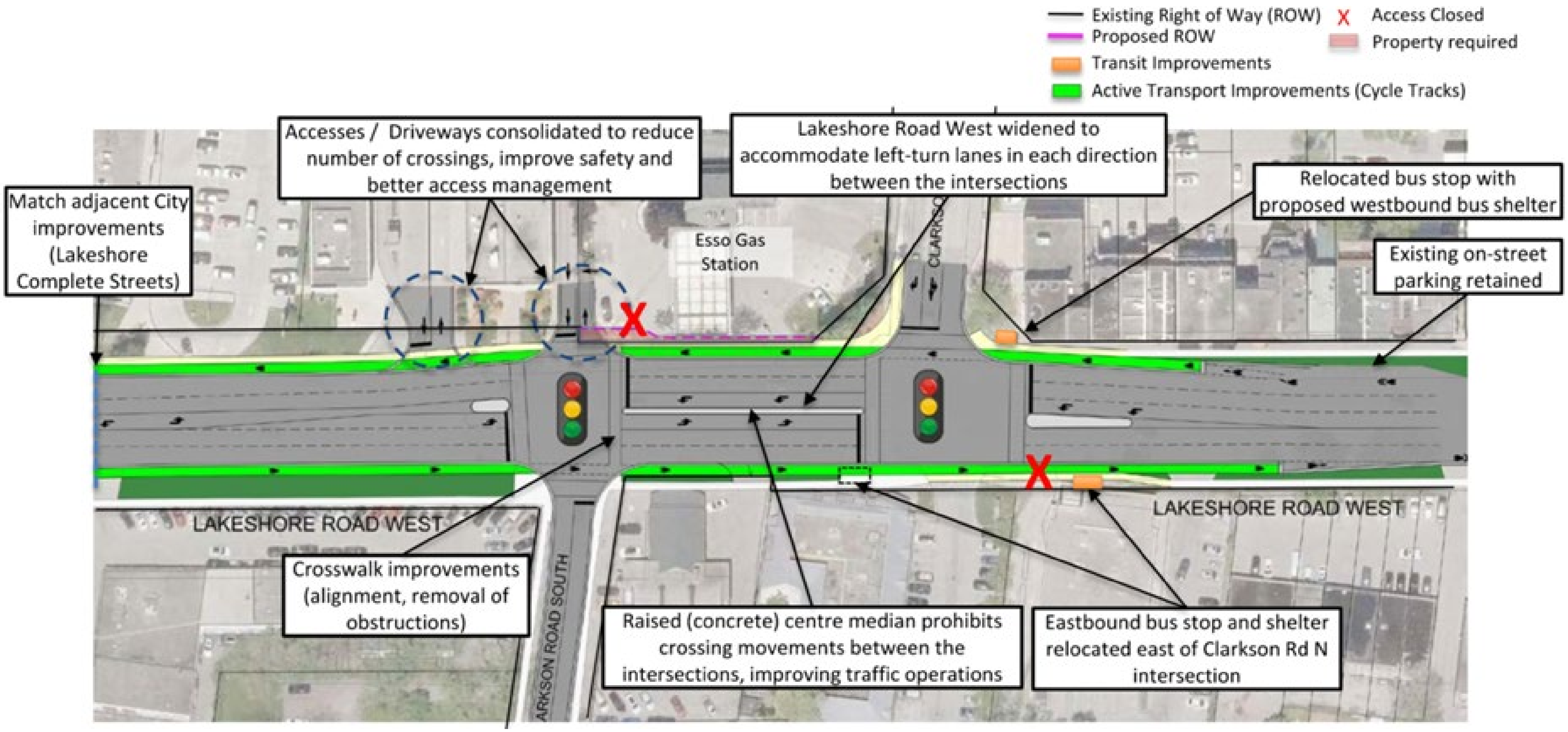
Pollutant	Averaging Time	Ambient Background Level (µg/m³)	Predicted Highway contribution (µg/m³)	Roadway contribution (% of Background)	Cumulative Concentration (µg/m³)	Objective (µg/m³)	Percentage of Criteria, Total Concentration
AAQC							
NO_2	1-hr	59	8	14%	67	400	17%
	24-hr	45	4	8%	49	200	25%
Benzene	24-hr	0.80	0.03	3%	0.83	2.30	36%
	Annual	0.52	0.01	1%	0.53	0.45	117%
B(a)P	24-hr	9.5E-05	7.8E-06	8%	1.0E-04	5.0E-05	206%
	Annual	5.5E-05	3.1E-06	6%	5.8E-05	1.0E-05	581%
CAAQS							
NO_2 [1]	1-hr	59	7	11%	66	83	79%
NO_2 [2]	Annual	28.1	0.8	3%	29	23.8	121%
$PM_{2.5}$ [3]	24-hr	14.0	1.2	8%	15.2	27.0	56%
$PM_{2.5}$	Annual	8.0	0.5	6%	8.5	8.8	96%

[1] Modelled Project Impact corresponds to the 3-year average of the annual 98th percentile daily maximum 1-hour average concentrations (highest 3-year average between 1996 and 2000).
[2] Modelled Project Impact corresponds to the average over a single calendar year of all the 1-hour average concentrations (highest concentration between 1996 and 2000)
[3] Modelled Project Impact corresponds to the 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.

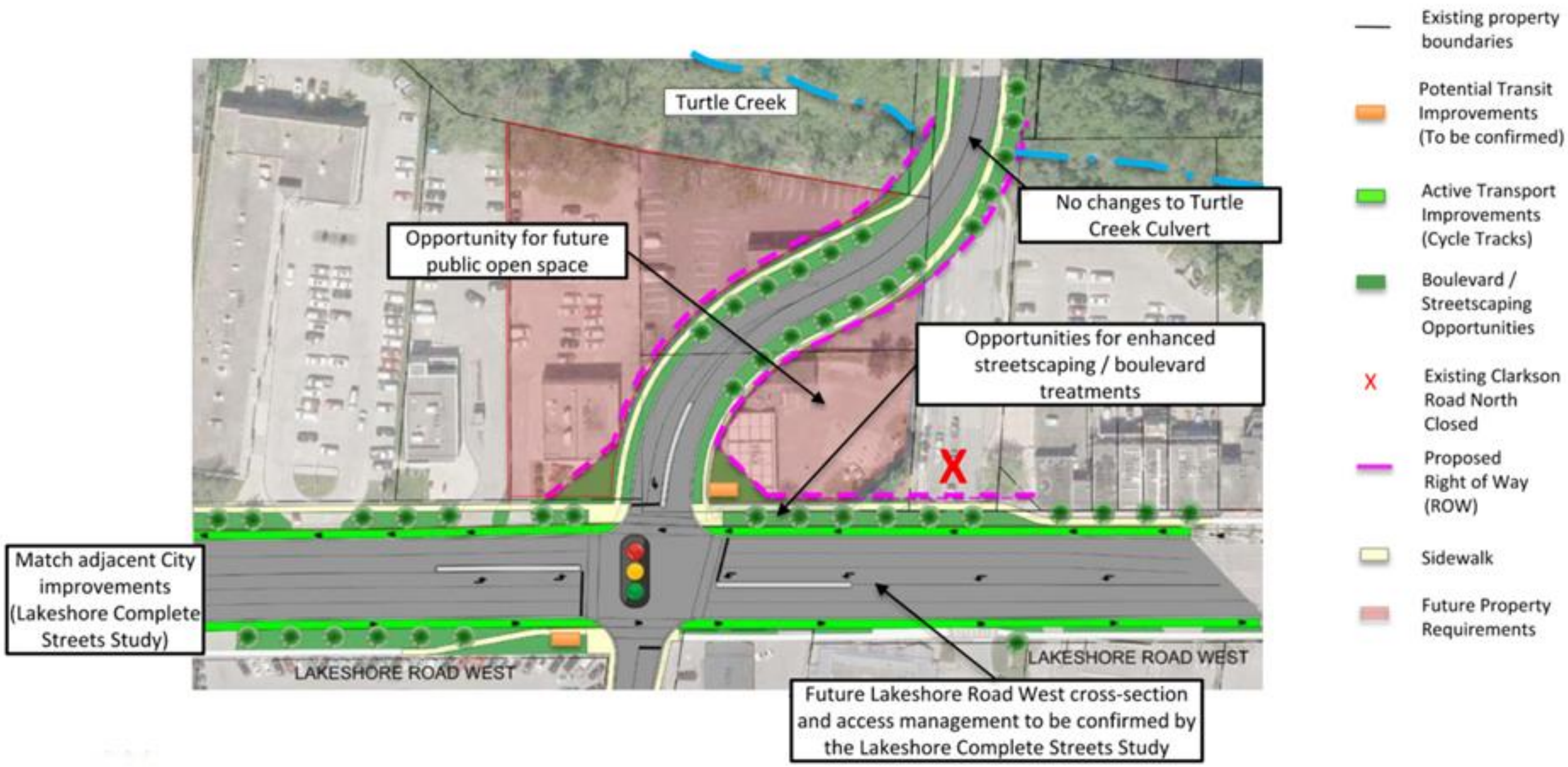
6 CONCLUSIONS

The Proposed Interim Preferred and Preferred Solutions for the Clarkson Road and Lakeshore Road Intersection Municipal Class Environmental Assessment Study are not expected to have significant impacts on nearby sensitive receptors. Although the assessment indicates exceedances of the applicable thresholds for some contaminants, these exceedances are primarily the result of existing elevated background concentrations within the study area.

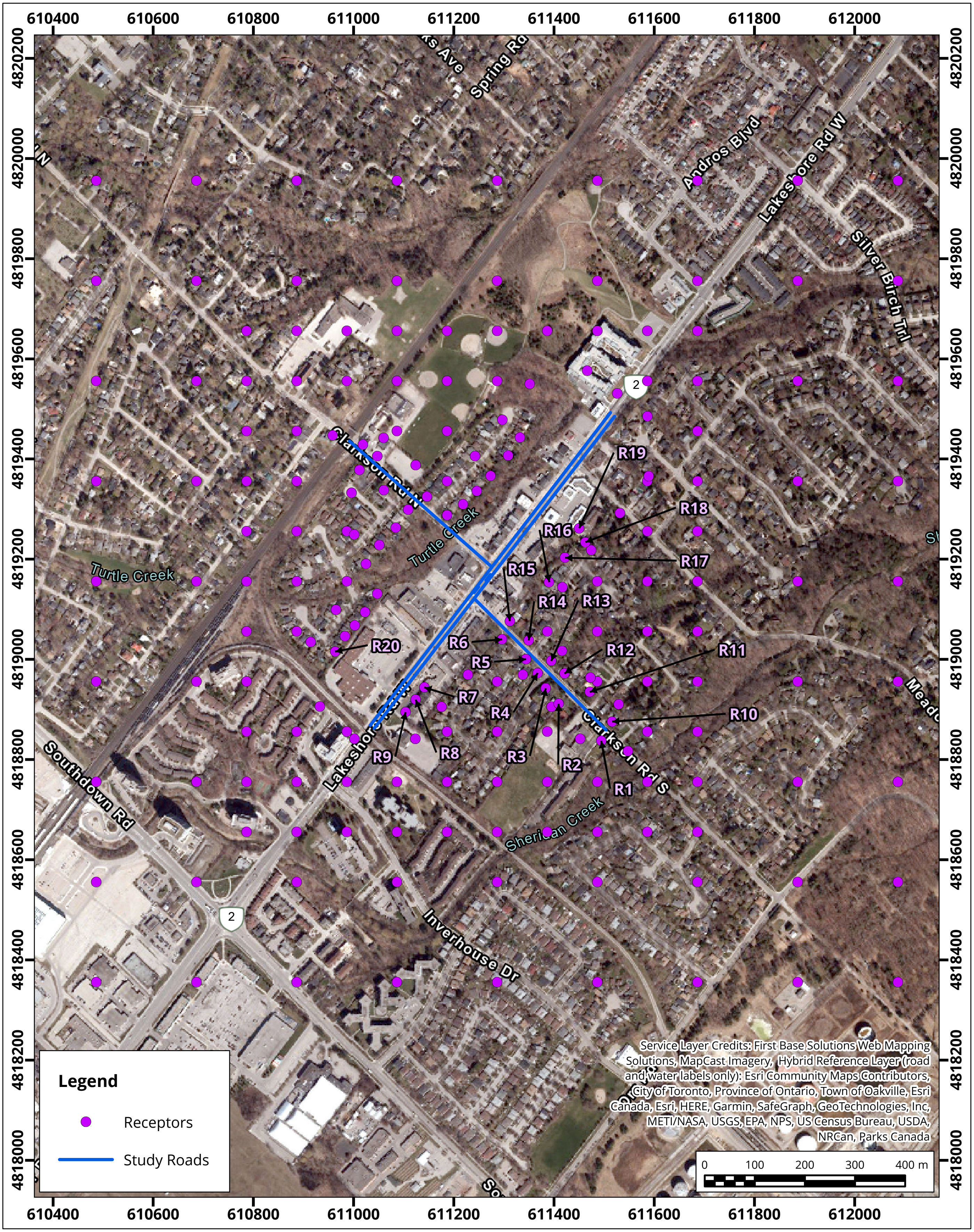
FIGURES



Interim Preferred Solution for the Undertaking Mississauga, Ontario	Figure No. 1	
Project Name – Clarkson Rd and Lakeshore Rd Intersection EA — Project #2004435	Date: June 30, 2022	



Preferred Solution Mississauga, Ontario	Figure No. 2	
Project Name – Clarkson Rd and Lakeshore Rd Intersection EA — Project #2004435	Date: June 30, 2022	



Map Document: C:\GIS\Tara's Mess\GIS\P2004435_LakeshoreClarkson.aprx

Site Plan Showing Receptors and Modelled Roadways

Map Projection: NAD 1983 UTM Zone 17N

Clarkson Road and Lakeshore Road Intersection - Mississauga, ON

True North

Project #: 2004435

Drawn by: RL	Figure: 3
Approx. Scale:	1:10,500
Date Revised:	Jun 30, 2022

APPENDIX A

Clarkson Road and Lakeshore Road Intersection

Table A1. Projected 2041 Traffic Hourly Distribution

			Time - Hour Starting																							
Description	**Daily Traffic [1]**	**Speed (km/hr)**	**24**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
Eastbound Traffic on Lakeshore Road	14,543	50	127	71	52	44	52	138	400	734	953	817	800	878	942	910	960	1078	1137	1113	912	745	595	496	350	243
Westbound Traffic on Lakeshore Road	11,905	50	104	58	43	36	43	113	327	601	780	669	655	719	771	745	786	882	931	911	746	610	487	406	287	199
Traffic on Clarkson Road South	2,769	40	24	14	10	8	10	26	76	140	181	156	152	167	179	173	183	205	217	212	174	142	113	94	67	46
Traffic on Clarkson Road North	8,829	40	77	43	32	26	32	84	243	446	578	496	486	533	572	553	583	654	690	675	554	452	361	301	213	147

[1] from CIMA+ Memo "B001266 Clarkson-Lakeshore EA – Microsimulation Analysis" Figure 14.

Table A2. Traffic distribution data [1]

Hour	24	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
% daily Traffic	0.87%	0.49%	0.36%	0.30%	0.36%	0.95%	2.75%	5.05%	6.55%	5.62%	5.50%	6.04%	6.48%	6.26%	6.60%	7.41%	7.82%	7.65%	6.27%	5.12%	4.09%	3.41%	2.41%	1.67%

[1] Vandelden (RWDI) Typical Hourly Traffic Distribution for Noise Modelling, 2008

Table A3. Vehicle Distribution

	Vehicle Fraction				
Vehicle Type [1]	Eastbound Lakeshore	Westbound Lakeshore	Clarkson South	Clarkson North	Average
Cars	93.3%	95.0%	96.4%	95.6%	95.1%
Buses & Single Unit Trucks	2.6%	1.9%	1.4%	1.7%	1.9%
Combination Trucks	4.1%	3.1%	2.2%	2.7%	3.0%

[1] From CIMA+ with the Turning Movement Counts (TMCs) and MTO Environmental Guide for Noise (MTO, 2008)

APPENDIX B

Appendix B1: Roads Emission Factors

Project # 2004435

Table B4. Eastbound Lakeshore Total Vehicle Emission Factors

Hour Starting	Total Emission Factor (g/s-mile)			
	BEN	Benzo_a_pyrene_Particle	NOx	PM25
1	1.65E-05	2.88E-08	2.74E-03	2.56E-04
2	1.22E-05	2.11E-08	2.01E-03	1.88E-04
3	1.01E-05	1.76E-08	1.68E-03	1.57E-04
4	1.22E-05	2.11E-08	2.01E-03	1.88E-04
5	3.21E-05	5.57E-08	5.31E-03	4.97E-04
6	9.28E-05	1.61E-07	1.54E-02	1.44E-03
7	1.70E-04	2.96E-07	2.82E-02	2.64E-03
8	2.21E-04	3.84E-07	3.66E-02	3.42E-03
9	1.90E-04	3.30E-07	3.14E-02	2.94E-03
10	1.86E-04	3.23E-07	3.07E-02	2.88E-03
11	2.04E-04	3.54E-07	3.37E-02	3.16E-03
12	2.19E-04	3.80E-07	3.62E-02	3.39E-03
13	2.11E-04	3.67E-07	3.50E-02	3.27E-03
14	2.23E-04	3.87E-07	3.69E-02	3.45E-03
15	2.50E-04	4.35E-07	4.14E-02	3.87E-03
16	2.64E-04	4.59E-07	4.37E-02	4.09E-03
17	2.58E-04	4.49E-07	4.27E-02	4.00E-03
18	2.12E-04	3.68E-07	3.50E-02	3.28E-03
19	1.73E-04	3.00E-07	2.86E-02	2.68E-03
20	1.38E-04	2.40E-07	2.28E-02	2.14E-03
21	1.15E-04	2.00E-07	1.90E-02	1.78E-03
22	8.14E-05	1.41E-07	1.35E-02	1.26E-03
23	5.64E-05	9.80E-08	9.33E-03	8.73E-04
24	2.94E-05	5.11E-08	4.86E-03	4.55E-04

Table B5. Westbound Lakeshore Total Vehicle Emission Factors

Hour Starting	Total Emission Factor (g/s-mile)			
	BEN	Benzo_a_pyrene_Particle	NOx	PM25
1	1.34E-05	2.38E-08	1.87E-03	1.96E-04
2	9.82E-06	1.75E-08	1.37E-03	1.44E-04
3	8.18E-06	1.46E-08	1.14E-03	1.20E-04
4	9.82E-06	1.75E-08	1.37E-03	1.44E-04
5	2.59E-05	4.62E-08	3.63E-03	3.80E-04
6	7.50E-05	1.34E-07	1.05E-02	1.10E-03
7	1.38E-04	2.46E-07	1.93E-02	2.02E-03
8	1.79E-04	3.19E-07	2.50E-02	2.62E-03
9	1.53E-04	2.73E-07	2.14E-02	2.25E-03
10	1.50E-04	2.68E-07	2.10E-02	2.20E-03
11	1.65E-04	2.94E-07	2.30E-02	2.42E-03
12	1.77E-04	3.15E-07	2.47E-02	2.59E-03
13	1.71E-04	3.05E-07	2.39E-02	2.51E-03
14	1.80E-04	3.21E-07	2.52E-02	2.64E-03
15	2.02E-04	3.61E-07	2.83E-02	2.97E-03
16	2.13E-04	3.80E-07	2.98E-02	3.13E-03
17	2.09E-04	3.72E-07	2.92E-02	3.06E-03
18	1.71E-04	3.05E-07	2.39E-02	2.51E-03
19	1.40E-04	2.49E-07	1.95E-02	2.05E-03
20	1.12E-04	1.99E-07	1.56E-02	1.64E-03
21	9.30E-05	1.66E-07	1.30E-02	1.36E-03
22	6.57E-05	1.17E-07	9.20E-03	9.65E-04
23	4.55E-05	8.12E-08	6.37E-03	6.68E-04
24	2.37E-05	4.23E-08	3.32E-03	3.48E-04

Table B6. Clarkson South Total Vehicle Emission Factors

Hour Starting	Total Emission Factor (g/s-mile)			
	BEN	Benzo_a_pyrene_Particle	NOx	PM25
1	3.40E-06	6.27E-09	3.67E-04	5.41E-05
2	2.50E-06	4.61E-09	2.70E-04	3.97E-05
3	2.08E-06	3.84E-09	2.25E-04	3.31E-05
4	2.50E-06	4.61E-09	2.70E-04	3.97E-05
5	6.60E-06	1.22E-08	7.12E-04	1.05E-04
6	1.91E-05	3.52E-08	2.06E-03	3.03E-04
7	3.51E-05	6.46E-08	3.78E-03	5.57E-04
8	4.55E-05	8.38E-08	4.91E-03	7.23E-04
9	3.90E-05	7.19E-08	4.21E-03	6.20E-04
10	3.82E-05	7.04E-08	4.12E-03	6.07E-04
11	4.19E-05	7.73E-08	4.53E-03	6.66E-04
12	4.50E-05	8.29E-08	4.86E-03	7.15E-04
13	4.35E-05	8.01E-08	4.69E-03	6.91E-04
14	4.58E-05	8.45E-08	4.95E-03	7.28E-04
15	5.15E-05	9.48E-08	5.55E-03	8.18E-04
16	5.43E-05	1.00E-07	5.86E-03	8.63E-04
17	5.31E-05	9.79E-08	5.73E-03	8.44E-04
18	4.35E-05	8.02E-08	4.70E-03	6.92E-04
19	3.56E-05	6.55E-08	3.84E-03	5.65E-04
20	2.84E-05	5.23E-08	3.07E-03	4.51E-04
21	2.37E-05	4.36E-08	2.56E-03	3.76E-04
22	1.67E-05	3.08E-08	1.81E-03	2.66E-04
23	1.16E-05	2.14E-08	1.25E-03	1.84E-04
24	6.04E-06	1.11E-08	6.52E-04	9.60E-05

Table B7. Clarkson North Total Vehicle Emission Factors

Hour Starting	Total Emission Factor (g/s-mile)			
	BEN	Benzo_a_pyrene_Particle	NOx	PM25
1	1.09E-05	1.99E-08	1.31E-03	1.78E-04
2	8.03E-06	1.46E-08	9.64E-04	1.31E-04
3	6.69E-06	1.22E-08	8.03E-04	1.09E-04
4	8.03E-06	1.46E-08	9.64E-04	1.31E-04
5	2.12E-05	3.85E-08	2.54E-03	3.45E-04
6	6.13E-05	1.11E-07	7.36E-03	1.00E-03
7	1.13E-04	2.05E-07	1.35E-02	1.84E-03
8	1.46E-04	2.65E-07	1.75E-02	2.38E-03
9	1.25E-04	2.28E-07	1.50E-02	2.04E-03
10	1.23E-04	2.23E-07	1.47E-02	2.00E-03
11	1.35E-04	2.45E-07	1.62E-02	2.20E-03
12	1.44E-04	2.63E-07	1.73E-02	2.36E-03
13	1.40E-04	2.54E-07	1.68E-02	2.28E-03
14	1.47E-04	2.68E-07	1.77E-02	2.40E-03
15	1.65E-04	3.00E-07	1.98E-02	2.69E-03
16	1.74E-04	3.17E-07	2.09E-02	2.84E-03
17	1.71E-04	3.10E-07	2.05E-02	2.78E-03
18	1.40E-04	2.54E-07	1.68E-02	2.28E-03
19	1.14E-04	2.08E-07	1.37E-02	1.86E-03
20	9.12E-05	1.66E-07	1.09E-02	1.49E-03
21	7.60E-05	1.38E-07	9.13E-03	1.24E-03
22	5.37E-05	9.77E-08	6.45E-03	8.76E-04
23	3.72E-05	6.77E-08	4.47E-03	6.07E-04
24	1.94E-05	3.53E-08	2.33E-03	3.16E-04

Appendix B2: Idling vehicles emission rate estimation

Project # 2004435

Clarkson Road and Lakeshore Road Intersection

Idling vehicles emission rate estimation

Number of vehicles Idling =	3	cars
Source Width =	3.30	m
Source Length =	14.50	m
Idling Source Area =	47.85	m^2

[1] Area sources representing idling vehicles were added at the intersections of Lakeshore with Clarkson North and South. Idling assumed 24 hrs a day.

	Emission Factor			
Emission Rate	BEN	Benzo_a_pyrene_Particle	NOx	PM25
Single car (FHWA1-3) [1] [g/h]	7.29E-03	1.10E-05	9.55E-02	2.50E-02
Overall (3 cars) [g / s m^2]	1.27E-07	1.92E-10	1.66E-06	4.36E-07

[1] Emission rate from MOVES modelling at a speed of [0 km/hr]

Appendix B3: Road Particulate - Fugitive Dust **Project # 2004435**

Clarkson Road and Lakeshore Road Intersection

PAVED ROAD SECTIONS - AP-42 Section 13.2.1

Paved Roads: $E = k\,(sL)^{0.91}\,(W)^{1.02}$

E particulate emission factor (g/VKT)
k particle size multiplier (see below)
sL road surface silt loading (g/m²)
W average weight of the vehicles traveling the road (US short tons)

Hour Starting	Road Surface [1]	Roadway Type [2]	Average Vehicle Weight [3] (tons)	Road Surface Silt Loading [4] (g/m²)	$PM_{2.5}$ AP42 Emission Factor (g/VKT)	Clarkson North		West Bound Lakeshore		East Bound Lakeshore		Clarkson South	
						Hourly Traffic (#/h)	Emission Rate (g/s-mile)	Hourly Traffic (#/h)	Emission Rate (g/s-mile)	Hourly Traffic (#/h)	Emission Rate (g/s-mile)	Hourly Traffic (#/h)	Emission Rate (g/s-mile)
1	Paved	Public	3.0	0.06	3.6E-02	43	6.9E-04	58	9.3E-04	71	1.1E-03	14	2.2E-04
2	Paved	Public	3.0	0.06	3.6E-02	32	5.1E-04	43	6.8E-04	52	8.3E-04	10	1.6E-04
3	Paved	Public	3.0	0.06	3.6E-02	26	4.2E-04	36	5.7E-04	44	6.9E-04	8	1.3E-04
4	Paved	Public	3.0	0.06	3.6E-02	32	5.1E-04	43	6.8E-04	52	8.3E-04	10	1.6E-04
5	Paved	Public	3.0	0.06	3.6E-02	84	1.3E-03	113	1.8E-03	138	2.2E-03	26	4.2E-04
6	Paved	Public	3.0	0.06	3.6E-02	243	3.9E-03	327	5.2E-03	400	6.4E-03	76	1.2E-03
7	Paved	Public	3.0	0.06	3.6E-02	446	7.1E-03	601	9.6E-03	734	1.2E-02	140	2.2E-03
8	Paved	Public	3.0	0.06	3.6E-02	578	9.2E-03	780	1.2E-02	953	1.5E-02	181	2.9E-03
9	Paved	Public	3.0	0.06	3.6E-02	496	7.9E-03	669	1.1E-02	817	1.3E-02	156	2.5E-03
10	Paved	Public	3.0	0.06	3.6E-02	486	7.7E-03	655	1.0E-02	800	1.3E-02	152	2.4E-03
11	Paved	Public	3.0	0.06	3.6E-02	533	8.5E-03	719	1.1E-02	878	1.4E-02	167	2.7E-03
12	Paved	Public	3.0	0.06	3.6E-02	572	9.1E-03	771	1.2E-02	942	1.5E-02	179	2.9E-03
13	Paved	Public	3.0	0.06	3.6E-02	553	8.8E-03	745	1.2E-02	910	1.4E-02	173	2.8E-03
14	Paved	Public	3.0	0.06	3.6E-02	583	9.3E-03	786	1.2E-02	960	1.5E-02	183	2.9E-03
15	Paved	Public	3.0	0.06	3.6E-02	654	1.0E-02	882	1.4E-02	1078	1.7E-02	205	3.3E-03
16	Paved	Public	3.0	0.06	3.6E-02	690	1.1E-02	931	1.5E-02	1137	1.8E-02	217	3.4E-03
17	Paved	Public	3.0	0.06	3.6E-02	675	1.1E-02	911	1.4E-02	1113	1.8E-02	212	3.4E-03
18	Paved	Public	3.0	0.06	3.6E-02	554	8.8E-03	746	1.2E-02	912	1.4E-02	174	2.8E-03
19	Paved	Public	3.0	0.06	3.6E-02	452	7.2E-03	610	9.7E-03	745	1.2E-02	142	2.3E-03
20	Paved	Public	3.0	0.06	3.6E-02	361	5.7E-03	487	7.7E-03	595	9.5E-03	113	1.8E-03
21	Paved	Public	3.0	0.06	3.6E-02	301	4.8E-03	406	6.5E-03	496	7.9E-03	94	1.5E-03
22	Paved	Public	3.0	0.06	3.6E-02	213	3.4E-03	287	4.6E-03	350	5.6E-03	67	1.1E-03
23	Paved	Public	3.0	0.06	3.6E-02	147	2.3E-03	199	3.2E-03	243	3.9E-03	46	7.4E-04
24	Paved	Public	3.0	0.06	3.6E-02	77	1.2E-03	104	1.7E-03	127	2.0E-03	24	3.8E-04

Constants for Mobile Emission Equations

Roadway Type	Contaminant	k
Paved Roads:	**PM_2**	0.15
	PM_1	0.62
	PM_3	3.23
	TSP	4.79

[1] Paved surfaces include asphalt, concrete, and recycled asphalt (if it forms a relatively consistent surface).
[2] Publicly accessible and dominated by light vehicles
The average vehicle weight reflects the average vehicle weight of the fraction of Cars, Buses & Single Unit Trucks and Combination
[3] Trucks traveling in both directions.
[4] Required only for publicly accessible unpaved roads.

Sample calculation for PM2.5 emission factor for hour 1Clarkson North:

EF = 3.6E-02

43 vehicles	1 km	3.6E-02 g $_{PM2.5}$	1 h	
1 h	0.62137 miles	1 vehicle km	3600 s	= 6.9E-04 g $_{PM2.5}$ / s - mile

APPENDIX C

Summary of Maximum Predicted Concentrations

Pollutant	Averaging Time	Ambient Background Level (µg/m³)	Predicted Highway contribution (µg/m³)	Roadway contribution (% of Background)	Cumulative Concentration (µg/m³)	Objective (µg/m³)	Percentage of Criteria, Total Concentration
AAQC							
NO_2	1-hr	59	8	14%	67	400	17%
	24-hr	45	4	8%	49	200	25%
Benzene	24-hr	0.80	0.03	3%	0.83	2.30	36%
	Annual	0.52	0.01	1%	0.53	0.45	117%
B(a)P	24-hr	9.5E-05	7.8E-06	8%	1.0E-04	5.0E-05	206%
	Annual	5.5E-05	3.1E-06	6%	5.8E-05	1.0E-05	581%
CAQQS							
NO_2 [1]	1-hr	59	7	11%	66	83	79%
NO_2 [2]	Annual	28.1	0.8	3%	29	23.8	121%
$PM_{2.5}$ [3]	24-hr	14.0	1.2	8%	15.2	27.0	56%
$PM_{2.5}$	Annual	8.0	0.5	6%	8.5	8.8	96%

[1] Modelled Project Impact corresponds to the 3-year average of the annual 98th percentile daily maximum 1-hour average concentrations (highest 3-year average between 1996 and 2000).

[2] Modelled Project Impact corresponds the average over a single calendar year of all the 1-hour average concentrations (highest concentration between 1996 and 2000)

[3] Modelled Project Impact corresponds to the 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.

Summary of Predicted Concentrations at Receptor # 2

Pollutant	Averaging Time	Ambient Background Level (µg/m³)	Predicted Highway contribution (µg/m³)	Roadway contribution (% of Background)	Cumulative Concentration (µg/m³)	Objective [4] (µg/m³)	Percentage of Criteria, Total Concentration
AAQC							
NO_2	1-hr	59	8	13%	67	400	17%
	24-hr	45	3	8%	49	200	24%
Benzene	24-hr	0.80	0.03	3%	0.83	2.3	36%
	Annual	0.52	0.005	1%	0.53	0.45	117%
B(a)P	24-hr	9.5E-05	7.3E-06	8%	1.0E-04	5.0E-05	205%
	Annual	5.5E-05	2.9E-06	5%	5.8E-05	1.0E-05	579%
CAQQS							
NO_2 [1]	1-hr	59	6	11%	66	83	79%
NO_2 [2]	Annual	28.1	1	3%	29	24	121%
$PM_{2.5}$ [3]	24-hr	14	1	8%	15	27	56%
$PM_{2.5}$	Annual	8.0	0.4	5%	8.4	8.8	96%

Summary of Predicted Concentrations at Receptor # 3

Pollutant	Averaging Time	Ambient Background Level (µg/m³)	Predicted Highway contribution (µg/m³)	Roadway contribution (% of Background)	Cumulative Concentration (µg/m³)	Objective [4] (µg/m³)	Percentage of Criteria, Total Concentration
AAQC							
NO_2	1-hr	59	8	13%	67	400	17%
	24-hr	45	3	7%	49	200	24%
Benzene	24-hr	0.80	0.02	3%	0.82	2.3	36%
	Annual	0.52	0.005	1%	0.52	0.45	117%
B(a)P	24-hr	9.5E-05	7.2E-06	8%	1.0E-04	5.0E-05	204%
	Annual	5.5E-05	2.8E-06	5%	5.8E-05	1.0E-05	578%
CAQQS							
NO_2 [1]	1-hr	59	7	11%	66	83	79%
NO_2 [2]	Annual	28.1	1	2%	29	24	121%
$PM_{2.5}$ [3]	24-hr	14	1.1	8%	15	27	56%
$PM_{2.5}$	Annual	8	0.4	5%	8.4	8.8	96%

Appendix C2: Most Impacted Receptors Locations

Receptor ID	X (UTM)	Y (UTM)
R1	611141.19	4818943.92
R2	611123.86	4818919.59
R3	611103.85	4818894.58
R4	611186.62	4819287.64
R5	611311.88	4819076.46
R6	611047.28	4819405.98
R7	611018.58	4819428.74
R8	611146.3	4819325.02
R9	611296.16	4819039.88
R10	611280.56	4819033.43
R11	611450.13	4819261.42
R12	611421.62	4819202.98
R13	611349.52	4819037.99
R14	611228.1	4818969.33
R15	611389.9	4819154.26
R16	611108.91	4819298.98
R17	611344.18	4819000.32
R18	611175.64	4818905.22
R19	611218.45	4819309.52
R20	611359.51	4819070.18