APPENDIX S

Air Quality Impact Assessment

SOUTHWEST AGINCOURT TRANSPORTATION CONNECTIONS STUDY EA

AIR QUALITY IMPACT ASSESSMENT

CITY OF TORONTO

PROJECT NO.: 19M-01888-00
DATE: MARCH 07, 2023

WSP
UNIT 2
126 DON HILLOCK DRIVE
AURORA, ON, CANADA L4G 0G9

T: +1 905 750-3080
F: +1 905 727-0463
WSP.COM

TABLE OF CONTENTS

TABLES

FIGURES

1 INTRODUCTION

The City of Toronto is currently undertaking a Schedule C Municipal Class Environmental Assessment (EA) study for the proposed Agincourt North-South Street and Grade Separation (herein referred to as the Project). The Study Area of the Agincourt EA, as show in **Figure 1-1**, is located west of Kennedy Road and extends east to the east side of the Stouffville GO Train line, and from Village Green Square extending north to the Agincourt GO Station located on Dowry Street. The Study Area is experiencing significant growth which is constrained by the surrounding rail corridor and West Highland Creek. This has resulted in disconnected transportation networks in the area. As part of the plan to expand the transportation network to accommodate growth in the area, an EA is required to evaluate alternatives to provide for the planned transportation network and grade separation. Improvements to surrounding infrastructure will support growth within the focus area and improve access to surrounding amenities such as schools, parks, and the Agincourt GO Station.

As part of the Agincourt EA, an Air Quality Impact Assessment (AQIA) is required to evaluate the impact of traffic related air pollution (TRAP) concentrations in the focus area. This AQIA will evaluate existing and future air quality conditions in accordance with the Ministry of Transportation (MTO) Environmental Guide for Assessing and Mitigating Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Facilities (October 2019) (MTO Guide) and following the guidance of the Ministry of the Environment, Conservation and Parks (MECP) Central Region Draft Document "Traffic Related Air Pollution: Mitigation Strategies and Municipal Class Environmental Assessment Air Quality Impact Assessment Protocol" (MECP Protocol). The MECP Protocol provides guidance on assessment methodologies that can be applied to AQIA for transportation related projects.

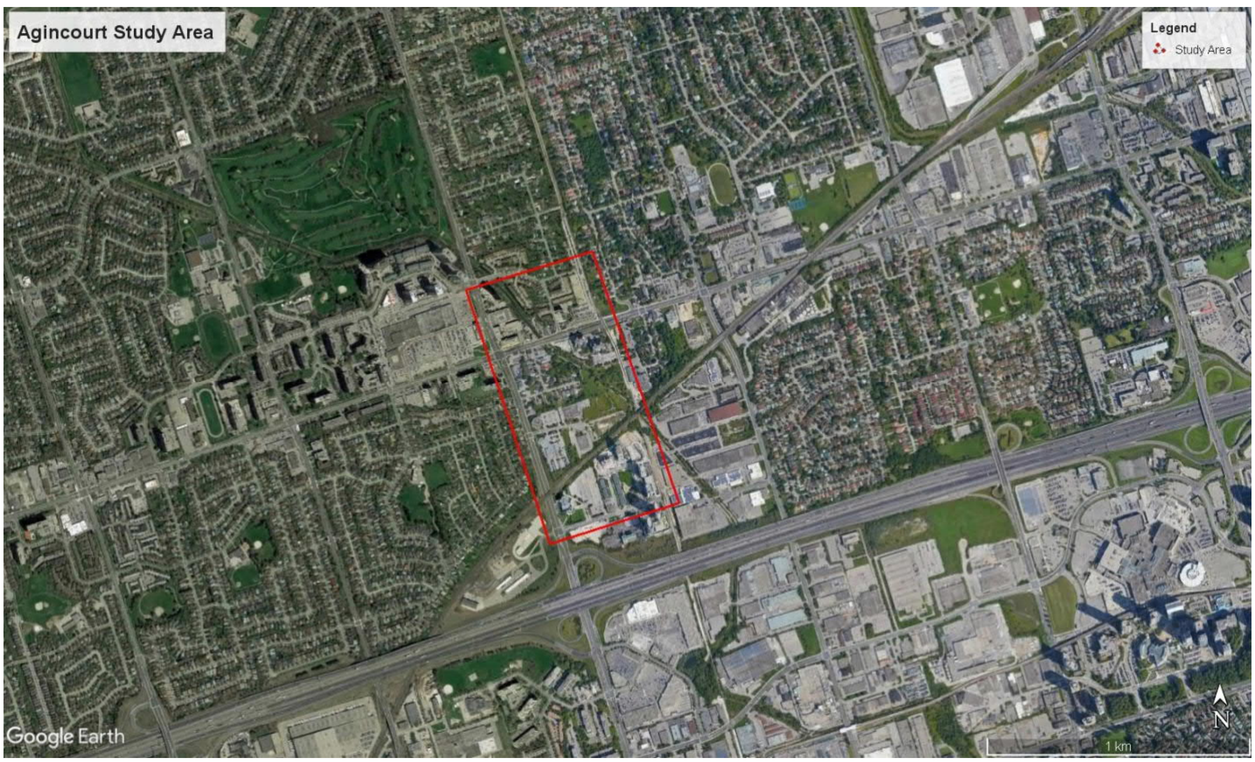

Figure 1-1: Agincourt Study Area

2 METHODOLOGY

2.1 APPROACH

As part of the Agincourt EA study, an AQIA assessing TRAP concentrations in the Study Area was completed following the MTO Guide and MECP Protocol. The MTO Guide and MECP Protocol provide guidance on assessment methodologies that can be applied to AQIA for transportation related projects. Based on the nature and complexity of the project, it was determined that the AQIA could be completed as a qualitative assessment as outlined in the MECP Protocol. The intent of this approach is to provide a summary of the existing local air quality conditions and nearby sensitive receptors. The assessment will also discuss the potential air quality impacts that could arise from the project during construction and operation to both existing and future sensitive receptors.

The main objectives of this AQIA are as follows:

- Gather baseline ambient air quality data in the vicinity of the project from public sources (i.e., National Air Pollution Surveillance (NAPS) Program Stations or the MECP Ambient Monitoring Network) to establish existing conditions in the Study Area;
- Compare ambient air quality data in the vicinity of the project to applicable provincial and federal air quality thresholds;
- Identifying sensitive receptors in the Study Area;
- Identify emission sources from surrounding industrial activities;
- Gather and examine road traffic data (annual average daily traffic) for current (2021) and proposed enhancement in the future year (2035) to estimate local road emissions;
- Conduct emissions estimation for vehicles in the Study Area of the Project using the United States Environmental Protection Agency's (US EPA) Motor Vehicle Emission Simulator (MOVES3);
- Quantifying the potential emissions of air contaminant releases to the environment;
- Evaluate the change between the existing and future emissions (including GHG (CO_{2eq}) emissions);
- Discuss potential air quality impacts that could arise from the Project during construction and operations to the receptors; and
- Discuss potential mitigation measures, if required.

The methodology, findings, conclusions and recommendations of this air quality impact assessment are presented in the subsequent sections of this report.

2.2 CRITERIA AIR CONTAMINANTS

As outlined in the MECP Protocol, the assessment of existing air quality in the Study Area focused on criteria air contaminants (CACs), compounds that are expected to be released from mobile sources, and contaminants which are generally accepted as indicators of changing air quality. These compounds are emitted from fuel combustion from vehicles travelling on roadways. The CACs assessed for the Project include:

- particulate matter less than 10 microns in diameter (PM_{10});
- particulate matter less than 2.5 microns in diameter ($PM_{2.5}$);
- total suspended particulates (TSP);
- nitrogen oxides, expressed as nitrogen dioxide (NO_2);
- carbon monoxide (CO);
- benzo(a)pyrene; and,

– selected volatile organic compounds (VOCs), including benzene, 1-3 butadiene, formaldehyde, acetaldehyde, and acrolein.

It is assumed that emissions from construction operations will be managed through best management practices for construction operations and monitoring and mitigation requirements will be considered as part of the special provisions written to the construction tender documents.

2.3 AIR QUALITY INDICATORS

The ambient air contaminant concentrations will be compared to the applicable Canadian Ambient Air Quality Standards (CAAQS) created by the Canadian Council of Ministers of the Environment (CCME) and the MECP Ontario Ambient Air Quality Criteria (AAQC).

The CAAQS and AAQC are referred to as "air quality indicators" in this AQIA. Predicted concentrations of each contaminant were compared to applicable criteria or standard for each contaminant and averaging period. **Table 2-1** outlines the applicable air quality objective for each contaminant assessed in this study. A value above an air quality indicator does not indicate a concern but is used to describe the air quality qualitatively.

Table 2-1 Applicable Air Quality Indicators

CONTAMINANT	AVERAGING PERIOD	CAAQS[1] (µg/m³)	AAQC[2] (µg/m³)	EXPLANATION FOR THRESHOLD
PM_{10}	24 h	—	50	3-year average of the most recent consecutive annual 98th percentile of the daily 24-hour average concentrations - converted from $PM_{2.5}$
$PM_{2.5}$	24 h	**27**	27	3-year average of the most recent consecutive annual 98th percentile of the daily 24-hour average concentrations
	Annual	**8.8**	8.8	3-year average of the most recent consecutive annual average of all 1-hour concentrations
TSP	24 h	—	120	3-year average of the most recent consecutive annual 98th percentile of the daily 24-hour average concentrations – converted from $PM_{2.5}$
	Annual	—	60	3-year average of the most recent consecutive annual average of all 1-hour concentrations – converted from $PM_{2.5}$
Nitrogen Dioxide	1 h	**79**	400	3-year average of the most recent consecutive annual 98th percentile of the daily maximum 1-hour average concentrations
	24 h	—	200	5-year average of 90th percentile
	Annual	23	—	5-year average of the most recent consecutive annual average of all 1-hour averages
CO	1 h	—	36,200	5-year average of 90th percentile
	8 h	—	15,700	5-year average of 90th percentile
1,3-Butadiene	24 h	—	10	5-year average of 90th percentile

CONTAMINANT	AVERAGING PERIOD	CAAQS[1] (µg/m³)	AAQC[2] (µg/m³)	EXPLANATION FOR THRESHOLD
	Annual	—	2	5-year average of 24-hour concentrations converted to an annual averaging period
Acetaldehyde	30 min	—	500	5-year average of 24-hour concentrations converted to a 30 min averaging period
	24 h	—	500	5-year average of 90th percentile
Acrolein	1 h	—	4.5	5-year average of 90th percentile
	24 h	—	0.4	5-year average of 90th percentile
Benzene	24 h	—	2.3	5-year average of 90th percentile
	Annual	—	0.45	5-year average of 24-hour concentrations converted to an annual averaging period
Formaldehyde	24 h	—	65	5-year average of 90th percentile
Benzo(a)pyrene	24 h	—	0.00005	5-year average of 90th percentile
	Annual	—	0.00001	5-year average of 24-hour concentrations converted to an annual averaging period

Notes:
[1] CAAQS obtained from the Canadian Council of Ministers of the Environment (CCME). 2022.
[2] AAQC obtained from the Ontario Ministry of the Environment, Conservation and Parks (MECP). 2020. Ambient Air Quality Criteria publication.
X – a bolded value indicates that the value was used as the applicable Project threshold.

3 BACKGROUND AIR QUALITY

3.1 METEOROLOGICAL DATA AND AMBIENT MONITORING STATIONS

The concentrations of the selected contaminants resulting from background sources were estimated by analyzing historical monitoring data from Environment and Climate Change Canada (ECCC) National Air Pollution Surveillance (NAPS) stations and the MECP air monitoring stations in the vicinity of the Study Area. Consideration was given to assess the representativeness of the data for the stations selected for use in this assessment. Publicly available data was obtained from these stations for the latest available years and excludes data that has not been through rigorous quality assurance and quality control (QA/QC) or data that may have been influenced by the COVID-19 pandemic, therefore, 2019 is the most recent year of data presented in this assessment.

As part of the analysis for prevailing wind direction (showing the direction the winds are "blowing from") in the vicinity of the Study Area were reviewed. **Figure 3-1** presents the wind data for the closest and most representative station (ECCC Station #6158409) located in Markham, Ontario, approximately 10 km north northwest of the Study Area.

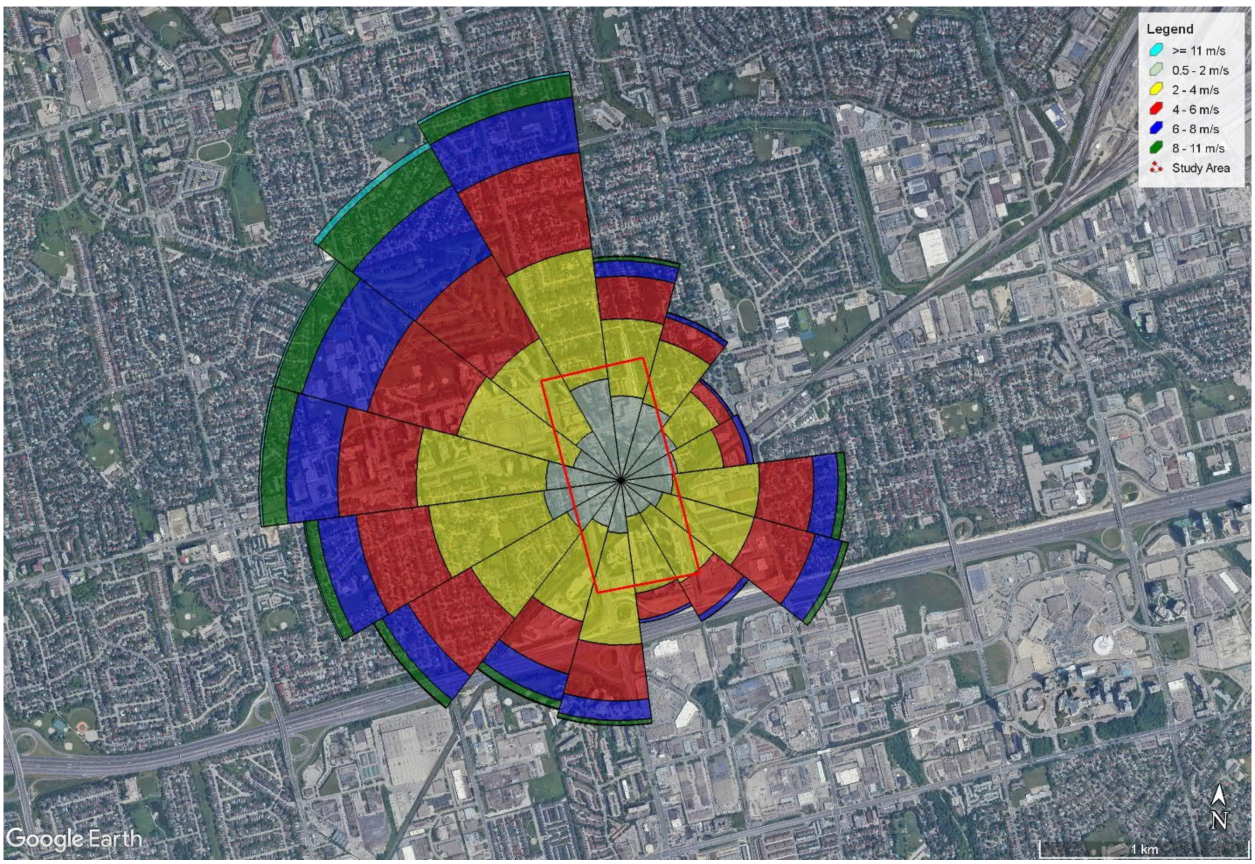

Figure 3-1: Toronto – Buttonville Wind Rose (blowing from)

The time period for the background data varies for each contaminant based on the availability of quality assured data from ECCC and the MECP. Representative stations based on their surrounding land use, proximity to similar sources and proximity to the Study Area were selected to use as existing background data. The representative station information, contaminants monitored, period of analysis and distance from the Study Area are listed in **Table 3-1**. Multiple stations were required due to some contaminants not being measured at the closest station or due to stations not being sited in geographically or representative locations. The location of the selected stations is presented in **Figure 3-2**.

Table 3-1 Air Monitoring Stations and Data Availability for Selected Contaminants

STATION NAME	NAPS STATION ID	DATA AVAILABLE							YEARS OF DATA AVAILABLE	DISTANCE FROM PROJECT (KM)
		$PM_{2.5}$	CO	NO_x	B(a)P	Benzene, 1,3-Butadiene	Acetaldehyde, Formaldehyde	Acrolein		
Toronto North - Downsview	60440	**Y**[1]	**Y**[1]	**Y**[1]	N	**Y**[1]	N	N	2017-2019	15 WNW
401W - Toronto	60438	Y	Y	Y	**Y**[2]	Y	**Y**[2]	**Y**[2]	2017-2019	22 WSW

Notes:
[1] Due to data availability from the Toronto North - Downsview station (60440), three years of data were available for PM2.5, carbon monoxide nitrogen oxides and benzene from 2017-2019.
[2] Due to data availability from the 401 W – Toronto station (60438), three years of data were available for B(a)P, acetaldehyde, formaldehyde, and acrolein from 2017-2019.
Bold text indicates that the station was selected to provided representative data for the applicable contaminant.

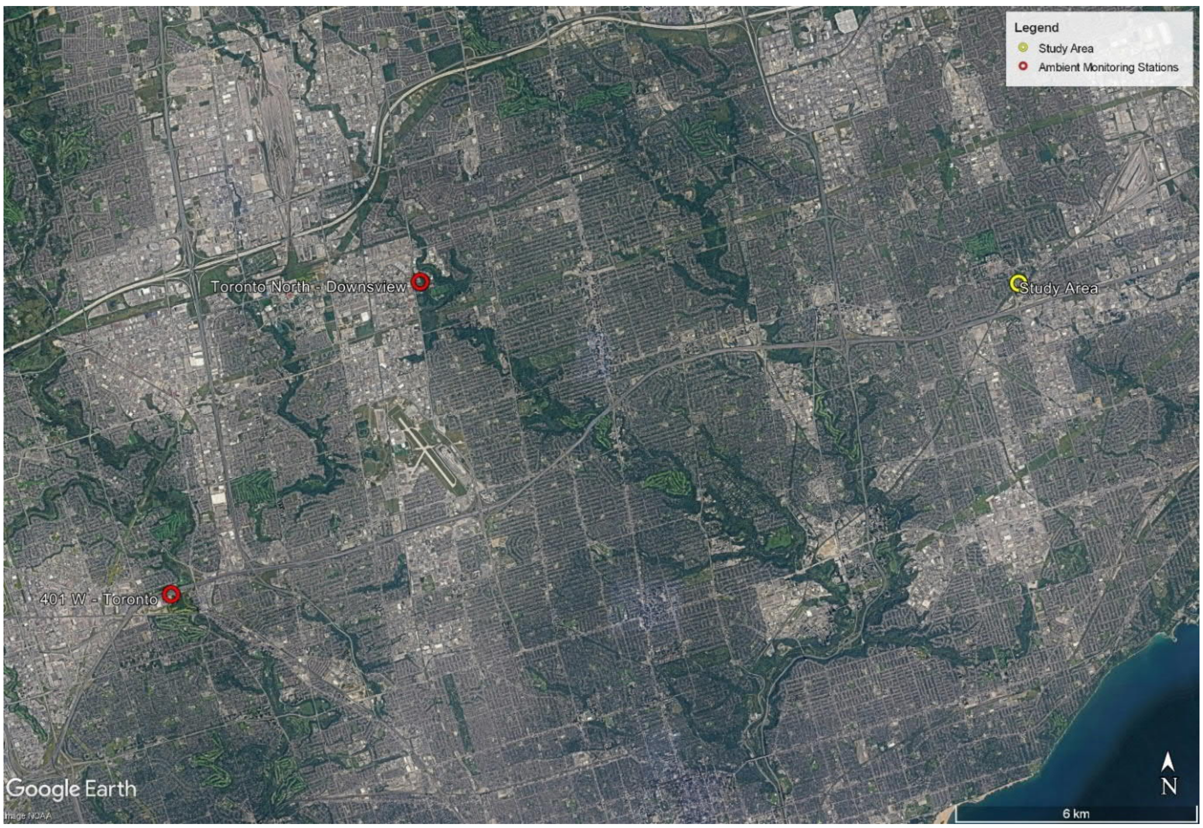

Figure 3-2: Location of Ambient Monitoring Stations

The 90th percentile background concentration for each contaminant was determined from the stations listed in **Table 3-1**. The average concentrations recorded above the 90th percentile was considered outliers and were removed from calculations to avoid extreme, rare, and transient events. For contaminants with an AAQC threshold, the 90th percentile is considered the most representative of ambient background conditions for averaging periods of 30-minutes, one-hour, eight-hour, and 24-hours. For contaminants with an annual averaging period, the three-year average of 24-hour measurements was converted to an annual averaging period. For contaminants with a CAAQS threshold, the 98th percentile over a three-year data set was used for a 24-hour and annual averaging periods.

There is no monitoring data available for PM_{10} and TSP, however, an approximation of the background PM_{10} and TSP concentrations can be estimated from the available $PM_{2.5}$ monitoring results. $PM_{2.5}$ is a subset of PM_{10} and TSP; therefore, it is reasonable to assume that the ambient concentrations of PM_{10} and TSP concentrations will be greater than the corresponding levels of $PM_{2.5}$. The mean levels of $PM_{2.5}$ in Canadian locations are found to be about 56% of the PM_{10} concentrations and 30% of TSP concentrations (Lall et al. 2004). By applying this ratio, it is possible to estimate the background TSP and PM_{10} concentrations for the Study Area.

Table 3-2 summarizes the background concentrations representative of the Study Area, and the associated ambient air quality criteria.

Table 3-2 Summary of Ambient Background Concentrations

CONTAMINANT	AVERAGING PERIOD	BACKGROUND CONCENTRATION (µg/m³)	AIR QUALITY CRITERIA (µg/m³)	% OF AIR QUALITY CRITERIA
PM_{10}[1]	24 h	34	50	69%
$PM_{2.5}$	24 h	19	27	71%
	Annual	7	8.8	83%
TSP[2]	24 h	64	120	53%
	Annual	24	60	40%
NO_2	1 h	66	79	83%
	24 h	36	200	18%
	Annual	20	23	88%
CO	1 h	355	36,200	1%
	8 h	325	15,700	2%
Acrolein	1 h	0.18[3]	4.5	4%
	24 h	0.08	0.4	19%
Benzene	24 h	0.80	2.3	35%
	Annual	0.10	0.45	21%
1,3-Butadiene	24 h	0.043	10	0.4%
	Annual	0.005	2	0.2%
Acetaldehyde	30 min	9.15[4]	500	2%
	24 h	3.09	500	0.6%

CONTAMINANT	AVERAGING PERIOD	BACKGROUND CONCENTRATION (µg/m³)	AIR QUALITY CRITERIA (µg/m³)	% OF AIR QUALITY CRITERIA
Formaldehyde	24 h	2.7	65	4%
Benzo(a)pyrene (B(a)P)	24 h	**1.72E-04**	0.00005	**344%**
	Annual	**1.77E-05**	0.00001	**177%**

Notes:

[1] $PM_{10} = PM_{2.5}/0.56$. References: Lall et al., 2004 ("Estimation of historical annual PM2.5 exposures for health effects assessment", published in the Journal of Atmospheric Environment).

[2] TSP = PM2.5/0.3. Reference: Lall et al., 2004 ("Estimation of historical annual PM2.5 exposures for health effects assessment", published in the Journal of Atmospheric Environment).

[3] The 1-hour concentration was converted from the 24-hour concentration. Reference: Ontario Ministry of the Environment, Conservation, and Parks, 2018 ("Procedure for Preparing an Emission Summary and Dispersion Modelling Report").

[4] The 30-minute concentration was converted from the 24-hour concentration. Reference: Ontario Ministry of the Environment, Conservation, and Parks, 2018 ("Procedure for Preparing an Emission Summary and Dispersion Modelling Report").

X – bold red text indicates value is greater than the air quality criteria

The air quality objectives listed in **Table 3-2** represent desirable levels of contaminants in ambient air and are not enforceable within any jurisdiction; they represent a 'road map' for ambient air quality provincially.

Based on existing ambient data presented in **Table 3-2**, the existing air quality, with the exception of B(a)P, is good as the air quality criteria are met for the indicator contaminants selected for this assessment. The available background B(a)P data is limited but is consistent with levels found across Ontario (Tevlin et al., 2020).

3.2 SURROUNDING INDUSTRIAL FACILITIES

Nearby industrial and commercial facilities have the potential to impact existing air quality conditions surrounding the Study Area. Eighteen (18) facilities have been identified within 5 km of the Study Area which may contribute to existing air quality conditions. These facilities have been identified based on National Pollutant Release Inventory (NPRI) data from 2021 which corresponds to the latest available year with data that has been quality assured by ECCC and are shown in **Table 3-3**. It should be noted that COVID-19 shutdowns may have impacted industrial emissions during this time.

Table 3-3 Summary of Surrounding Industrial Releases

FACILITY	APPROXIMATE DISTANCE TO STUDY AREA (KM)	VOC	TSP	PM_{10}	$PM_{2.5}$
Amvic Inc. - McNicol	4.5	134.4	-	-	-
Amvic Inc. - Passmore	4.9	109.9			
City of Toronto – Victoria Park Transfer Station	4.3	-	1.2	0.2	0.06
Cintas Canada Limited	4.9	9.4	-	1.2	1.02
Precisioneering DKG Corp	1.8	8.6	-	-	-
Allied Halo Industries	1.7	253	-	-	-
Shorewood Packaging Corp. of Canada ULC	0.5	14.6	-	-	-
Atlantic Packaging Products Ltd.	0.8	-	-	0.9	0.91
New Forest Paper Mills LP	1.3	-	-	1.7	1.5
TS Tech Trimont Mfg	2.7	25.9	-	-	-
Crystal Care Cosmetics Inc.	3.3	28.5	-	-	-
The International Group Inc.	0.5	53.7	-	1.2	0.5
Olympic Kitchens Inc.	2.6	13.9	-	-	-
Lynnpak Packaging Ltd.	3.1	53.7	-	-	-
Vacuum Metallizing Ltd.	3.2	27.9	-	-	-
City of Toronto, Scarborough Transfer Station	3.5	-	3.9	0.8	0.19

FACILITY	APPROXIMATE DISTANCE TO STUDY AREA (KM)	VOC	TSP	PM_{10}	$PM_{2.5}$
DART Canada Inc.	4.0	-	-	0.64	-
Polyson Polyethylene Products (1986) Ltd.	3.8	12.3	-	-	0.0076
Total Emissions		**745.8**	**5.1**	**6.6**	**4.2**
Ontario Total Emissions		**47,844**	**29,654**	**16,060**	**8,048**
% of Study Area Emissions to Ontario Total		**1.6%**	**0.02%**	**0.041%**	**0.05%**

3.3 SENSITIVE RECEPTORS

As outlined in the MECP Protocol, sensitive receptors within a 300 m radius of the Project were identified in the assessment. The area surrounding the Project is comprised of residential, commercial, and industrial land use types. Various sensitive receptors have been identified within the Study Area of the Project including residential developments, places of worship, schools, and seniors' homes.

- Place of Worship:
  - Two places of worship are located within 300 m of the Study Area.
- Schools:
  - Five schools are located within 300 m of the Study Area.
- Seniors' Home:
  - One seniors' home is located within 300 m of the Study Area.

The location of sensitive receptors is shown in **Figure 3-3**.

Figure 3-3: Location of Surrounding Sensitive Receptors

3.4 LOCAL ROAD EMISSIONS

The Project site is located in Toronto, Ontario and is experiencing significant growth which is constrained by the surrounding rail corridor and West Highland Creek. This has resulted in disconnected transportation networks in the area. Due to this, an expanded transportation network is required to accommodate growth in the area. The surrounding road network has high traffic flow rates and emissions from vehicles travelling on them which contribute to local air quality and cumulative effects, particularly Sheppard Avenue and Kennedy Road.

Vehicle emission rates were estimated using the US EPA MOVES model, version MOVES3, released November 10, 2020. MOVES is the latest motor vehicle emission estimate model which has replaced the Canadian version of MOBILE6.2 and is approved and recommended for use by the MTO and the MECP. The MOVES model has the capability to cover multiple geographic scales and can generate emission estimates for various time periods (hour, day, month, and year). Emission factors for the Project site were estimated using the maximum of peak AM, peak PM, and Saturday midday traffic volume data provided by the WSP transportation team, and default highway vehicle fleet (age and vehicles type distribution), emissions inspection and maintenance, fuel properties were adjusted to reflect the geographic area of the Project (Ontario).

Particulate matter resuspension (also called re-entrainment) is the disturbance from vehicular traffic of the dust already deposited on the road which is disturbed, mixed and reintroduced into the air. Particulate matter resuspension from vehicles travelling on road surfaces was estimated using the methodology found in US EPA AP-42 Chapter 13.2.1 for Paved Roads. Emission rates were calculated using the following equation:

13.2.1.3 Predictive Emission Factor Equations[10,29]

The quantity of particulate emissions from resuspension of loose material on the road surface due to vehicle travel on a dry paved road may be estimated using the following empirical expression:

$$E = k\,(sL)^{0.91} \times (W)^{1.02} \qquad (1)$$

where: E = particulate emission factor (having units matching the units of k),
k = particle size multiplier for particle size range and units of interest (see below),
sL = road surface silt loading (grams per square meter) (g/m^2), and
W = average weight (tons) of the vehicles traveling the road.

The parameters used in the particulate matter resuspension calculation are presented in **Table 3-4** and **Table 4-1**, for each scenario. Vehicle emission factors for the existing scenario for each road segment are presented in **Table 3-4**.

Table 3-4 Existing Conditions (2021) Particulate Matter Resuspension Assumptions

	Road Segment					
	1	2	3	4	5	6
Parameter	Sheppard Avenue (Kennedy Road to Reidmount Avenue)	Gordon Avenue (Sheppard Avenue to Jade Street /Collingwood Street)	N-S Street (Jade Street/Collingwood Street to Village Green Square)	Jade Street/Collingwood Street (Kennedy Road to dead end)	Cowdray Court (Kennedy Road to N-S Street)	Village Green Square (Village Green Square to dead end)
W (weighted average US tons)	2.48	2.48	N/A	2.48	2.48	N/A

Parameter	Road Segment 1 Sheppard Avenue (Kennedy Road to Reidmount Avenue)	2 Gordon Avenue (Sheppard Avenue to Jade Street /Collingwood Street)	3 N-S Street (Jade Street/Collingwood Street to Village Green Square)	4 Jade Street/Collingwood Street (Kennedy Road to dead end)	5 Cowdray Court (Kennedy Road to N-S Street)	6 Village Green Square (Village Green Square to dead end)
k	1.0	1.0	1.0	1.0	1.0	1.0
sL (g/m^2)	0.20	0.60	0.60	0.60	0.60	0.60

Table 3-5 Existing Conditions (2021) Vehicle Emission Factors

Contaminant	Road Segment					
	Sheppard Avenue (Kennedy Road to Reidmount Avenue)	Gordon Avenue (Sheppard Avenue to Jade Street /Collingwood Street)	N-S Street (Jade Street/Collingwood Street to Village Green Square)	Jade Street/Collingwood Street (Kennedy Road to dead end)	Cowdray Court (Kennedy Road to N-S Street)	Village Green Square (Village Green Square to dead end)
	Emission Factor (g/vkt)					
Carbon Monoxide (CO)	3.54E+00	4.26E+00	N/A	3.60E+00	6.11E+00	N/A
Benzene	2.10E-03	2.58E-03	N/A	2.14E-03	3.61E-03	N/A
1,3-Butadiene	1.02E-04	1.24E-04	N/A	1.04E-04	1.50E-04	N/A
Formaldehyde	1.03E-03	1.28E-03	N/A	1.05E-03	1.37E-03	N/A
Acetaldehyde	5.82E-04	7.22E-04	N/A	5.94E-04	8.25E-04	N/A
Acrolein	7.10E-05	8.90E-05	N/A	7.25E-05	9.21E-05	N/A
NO_2 [1]	2.13E-02	2.63E-02	N/A	2.17E-02	2.38E-02	N/A
CO_2-Equivalent	5.60E+02	7.00E+02	N/A	5.72E+02	1.06E+03	N/A
PM_{10} [2]	4.65E-01	1.12E+00	N/A	1.09E+00	1.19E+00	N/A
$PM_{2.5}$ [2]	1.07E-01	2.67E-01	N/A	2.63E-01	2.78E-01	N/A
TSP [3]	4.65E-01	1.12E+00	N/A	1.09E+00	2.18E+00	N/A
Benzo(a)pyrene gas	9.45E-09	1.14E-08	N/A	9.62E-09	1.49E-08	N/A

Notes:
Emission factors in g/vkt calculated from emission rates (g/s) which account for vehicle idling time.
[1] Assumes full conversion of NO_X to NO_2
[2] Particulate Matter emission rates include running exhaust, brake wear, tire wear, and resuspension emissions.
[3] TSP emissions assumed to be the equivalent of PM10
N/A – proposed new road, no existing emissions

4 PROJECT EMISSIONS

The Project will expand the transportation network in the Agincourt Study Area to accommodate growth and allow for a more connected transportation network. The expanded transportation network will include a new N-S Street between Jade Street/Collingwood Street and Village Green Square.

For the purposes of this air quality impact assessment, only emissions from vehicular sources were considered. Vehicle emission rates were calculated as described above for the existing and future scenarios. Results are presented as emissions per vehicle kilometre travelled (g/VKT) for each scenario and are presented in **Table 4-2** to **Table 4-7**. Existing Annual Average Daily Traffic (AADT) is based on data provided by WSP's transportation division. A summary of AADT data is provided in **Table 4-8**. Approximate Project area road segments are identified in Figure **4-1**.

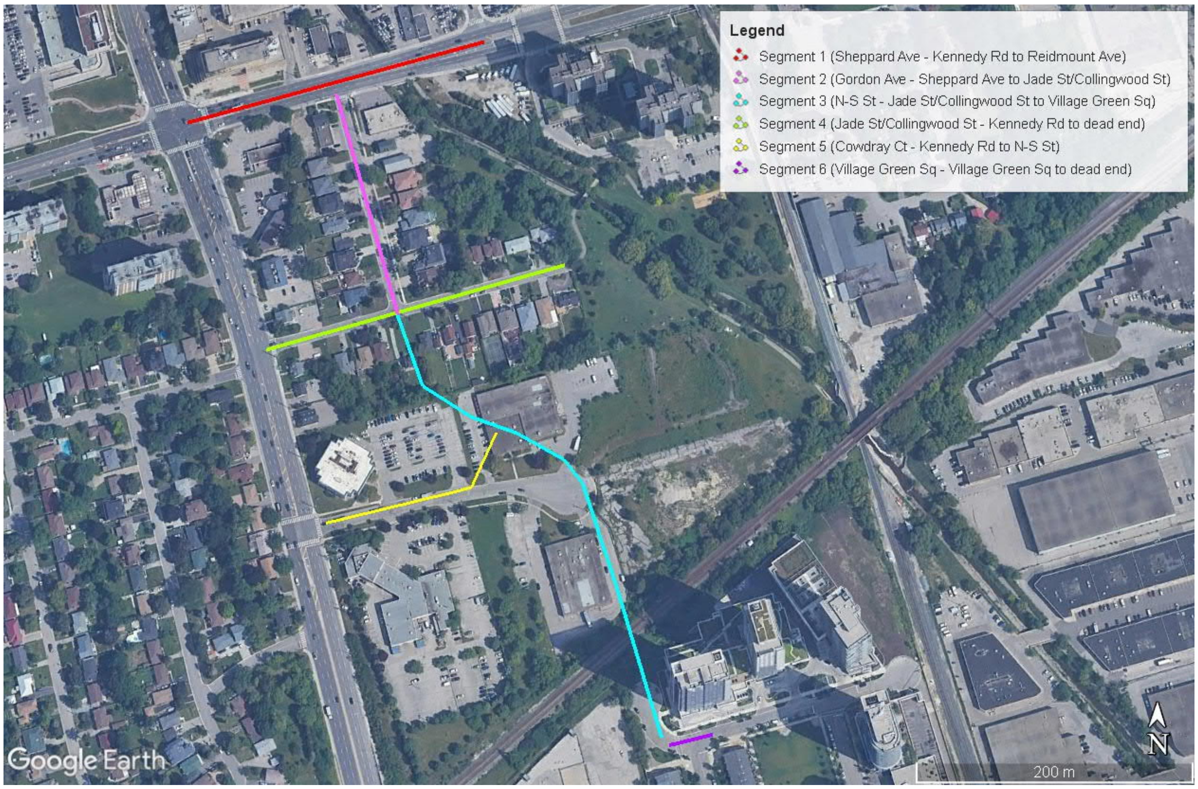

Figure 4-1: Study Area Road Segments

Table 4-1 Future Conditions (2035) Particulate Matter Resuspension Assumptions

Parameter	Road Segment 1: Sheppard Avenue (Kennedy Road to Reidmount Avenue)	2: Gordon Avenue (Sheppard Avenue to Jade Street /Collingwood Street)	3: N-S Street (Jade Street/Collingwood Street to Village Green Square)	4: Jade Street/Collingwood Street (Kennedy Road to dead end)	5: Cowdray Court (Kennedy Road to N-S Street)	6: Village Green Square (Village Green Square to dead end)
W (weighted average US tons)	2.48	2.48	2.48	2.48	2.48	2.48
k	1.0	1.0	1.0	1.0	1.0	1.0
sL (g/m^2)	0.06	0.20	0.20	0.60	0.20	0.60

Table 4-2 Vehicle Emission Rates for Existing and Future Scenarios – Road Segment 1

Contaminant	Existing (2021) Emissions (g/vkt)	Future (2035) Emissions (g/vkt)	Percent Change (+/-)
Carbon Monoxide (CO)	3.54E+00	1.52E+00	-57%
Benzene	2.10E-03	7.99E-04	-62%
1,3-Butadiene	1.02E-04	1.75E-07	-100%
Formaldehyde	1.03E-03	1.70E-04	-83%
Acetaldehyde	5.82E-04	1.03E-04	-82%
Acrolein	7.10E-05	1.09E-05	-85%
NO_2 [1]	2.13E-02	5.20E-03	-76%
CO_2-Equivalent	5.60E+02	4.29E+02	-23%
PM_{10} [2]	4.65E-01	2.20E-01	-53%
$PM_{2.5}$ [2]	1.07E-01	4.42E-02	-59%
TSP [3]	4.65E-01	2.20E-01	-53%
Benzo(a)pyrene gas	9.45E-09	2.70E-09	-71%

Notes:
Emission factors in g/vkt calculated from emission rates (g/s) which account for vehicle idling time.

Contaminant	Existing (2021) Emissions (g/vkt)	Future (2035) Emissions (g/vkt)	Percent Change (+/-)

[1] Assumes full conversion of NO_X to NO_2
[2] Particulate Matter emission rates include running exhaust, brake wear, tire wear, and resuspension emissions.
[3] TSP emissions assumed to be the equivalent of PM10
N/A – proposed new road, no existing emissions

Table 4-3 Vehicle Emission Rates for Existing and Future Scenarios – Road Segment 2

Contaminant	Existing (2021) Emissions (g/vkt)	Future (2035) Emissions (g/vkt)	Percent Change (+/-)
Carbon Monoxide (CO)	4.26E+00	1.83E+00	-57%
Benzene	2.58E-03	9.94E-04	-62%
1,3-Butadiene	1.24E-04	2.25E-07	-100%
Formaldehyde	1.28E-03	2.07E-04	-84%
Acetaldehyde	7.22E-04	1.27E-04	-82%
Acrolein	8.90E-05	1.34E-05	-85%
NO_2 [1]	2.63E-02	6.67E-03	-75%
CO_2-Equivalent	7.00E+02	5.37E+02	-23%
PM_{10} [2]	1.12E+00	4.89E-01	-56%
$PM_{2.5}$ [2]	2.67E-01	1.08E-01	-59%
TSP [3]	1.12E+00	4.89E-01	-56%
Benzo(a)pyrene gas	1.14E-08	3.25E-09	-71%

Notes:
Emission factors in g/vkt calculated from emission rates (g/s) which account for vehicle idling time.
[1] Assumes full conversion of NO_X to NO_2
[2] Particulate Matter emission rates include running exhaust, brake wear, tire wear, and resuspension emissions.
[3] TSP emissions assumed to be the equivalent of PM10

Table 4-4 Vehicle Emission Rates for Existing and Future Scenarios – Road Segment 3

Contaminant	Existing (2021) Emissions (g/vkt)	Future (2035) Emissions (g/vkt)	Percent Increase (+/-)
Carbon Monoxide (CO)	N/A	1.21E+00	N/A
Benzene	N/A	6.06E-04	N/A
1,3-Butadiene	N/A	1.25E-07	N/A

Contaminant	Existing (2021) Emissions (g/vkt)	Future (2035) Emissions (g/vkt)	Percent Increase (+/-)
Formaldehyde	N/A	1.34E-04	N/A
Acetaldehyde	N/A	8.01E-05	N/A
Acrolein	N/A	8.50E-06	N/A
NO_2 [1]	N/A	3.75E-03	N/A
CO_2-Equivalent	N/A	3.23E+02	N/A
PM_{10} [2]	N/A	4.35E-01	N/A
$PM_{2.5}$ [2]	N/A	1.01E-01	N/A
TSP [3]	N/A	4.35E-01	N/A
Benzo(a)pyrene gas	N/A	2.15E-09	N/A

Notes:
Emission factors in g/vkt calculated from emission rates (g/s) which account for vehicle idling time.
[1] Assumes full conversion of NO_X to NO_2
[2] Particulate Matter emission rates include running exhaust, brake wear, tire wear, and resuspension emissions.
[3] TSP emissions assumed to be the equivalent of PM10
N/A – proposed new road, no existing emissions

Table 4-5 Vehicle Emission Rates for Existing and Future Scenarios – Road Segment 4

Contaminant	Existing (2021) Emissions (g/vkt)	Future (2035) Emissions (g/vkt)	Percent Change (+/-)
Carbon Monoxide (CO)	3.60E+00	1.55E+00	-57%
Benzene	2.14E-03	8.16E-04	-62%
1,3-Butadiene	1.04E-04	1.79E-07	-100%
Formaldehyde	1.05E-03	1.73E-04	-83%
Acetaldehyde	5.94E-04	1.05E-04	-82%
Acrolein	7.25E-05	1.11E-05	-85%
NO_2 [1]	2.17E-02	5.33E-03	-75%
CO_2-Equivalent	5.72E+02	4.38E+02	-23%
PM_{10} [2]	1.09E+00	1.09E+00	0%

Contaminant	Existing (2021) Emissions (g/vkt)	Future (2035) Emissions (g/vkt)	Percent Change (+/-)
$PM_{2.5}$ [2]	2.63E-01	2.61E-01	-1%
TSP [3]	1.09E+00	1.09E+00	0%
Benzo(a)pyrene gas	9.62E-09	2.75E-09	-71%

Notes:
Emission factors in g/vkt calculated from emission rates (g/s) which account for vehicle idling time.
[1] Assumes full conversion of NO_X to NO_2
[2] Particulate Matter emission rates include running exhaust, brake wear, tire wear, and resuspension emissions.
[3] TSP emissions assumed to be the equivalent of PM10

Table 4-6 Vehicle Emission Rates for Existing and Future Scenarios – Road Segment 5

Contaminant	Existing (2021) Emissions (g/vkt)	Future (2035) Emissions (g/vkt)	Percent Increase (+/-)
Carbon Monoxide (CO)	6.11E+00	1.78E+00	-71%
Benzene	3.61E-03	9.61E-04	-73%
1,3-Butadiene	1.50E-04	2.16E-07	-100%
Formaldehyde	1.37E-03	2.00E-04	-85%
Acetaldehyde	8.25E-04	1.23E-04	-85%
Acrolein	9.21E-05	1.30E-05	-86%
NO_2 [1]	2.38E-02	6.42E-03	-73%
CO_2-Equivalent	1.06E+03	5.18E+02	-51%
PM_{10} [2]	1.19E+00	4.84E-01	-59%
$PM_{2.5}$ [2]	2.78E-01	1.08E-01	-61%
TSP [3]	1.19E+00	4.84E-01	-61%
Benzo(a)pyrene gas	1.49E-08	3.16E-09	-79%

Notes:
Emission factors in g/vkt calculated from emission rates (g/s) which account for vehicle idling time.
[1] Assumes full conversion of NO_X to NO_2
[2] Particulate Matter emission rates include running exhaust, brake wear, tire wear, and resuspension emissions.
[3] TSP emissions assumed to be the equivalent of PM10

Table 4-7 Vehicle Emission Rates for Existing and Future Scenarios – Road Segment 6

Contaminant	Existing (2021) Emissions (g/vkt)	Future (2035) Emissions (g/vkt)	Percent Increase (+/-)
Carbon Monoxide (CO)	N/A	7.18E+00	N/A
Benzene	N/A	4.37E-03	N/A
1,3-Butadiene	N/A	1.10E-06	N/A
Formaldehyde	N/A	8.40E-04	N/A
Acetaldehyde	N/A	5.30E-04	N/A
Acrolein	N/A	5.57E-05	N/A
NO_2 [1]	N/A	3.21E-02	N/A
CO_2-Equivalent	N/A	2.40E+03	N/A
PM_{10} [2]	N/A	1.57E+00	N/A
$PM_{2.5}$ [2]	N/A	3.27E-01	N/A
TSP [3]	N/A	1.57E+00	N/A
Benzo(a)pyrene gas	N/A	1.28E-08	N/A

Notes:
Emission factors in g/vkt calculated from emission rates (g/s) which account for vehicle idling time.
[1] Assumes full conversion of NO_X to NO_2
[2] Particulate Matter emission rates include running exhaust, brake wear, tire wear, and resuspension emissions.
[3] TSP emissions assumed to be the equivalent of PM10
N/A – proposed new road, no existing emissions

Table 4-8 Existing and Future Traffic Data

Road Segment	Location	Existing AADT (2021)[1]	Future AADT (2035)[1]	Percent Change (+/-)
1	Sheppard Avenue (Kennedy Road to Reidmount Avenue)	4.30E+04	5.02E+04	17%
2	Gordon Avenue (Sheppard Avenue to Jade Street /Collingwood Street)	5.71E+02	4.07E+03	613%
3	N-S Street (Jade Street/Collingwood Street to Village Green Square)	N/A	8.08E+03	N/A

Road Segment	Location	Existing AADT (2021)[1]	Future AADT (2035)[1]	Percent Change (+/-)
4	Jade Street/Collingwood Street (Kennedy Road to dead end)	6.97E+02	6.90E+02	-1%
5	Cowdray Court (Kennedy Road to N-S Street)	1.49E+03	7.62E+03	411%
6	Village Green Square (Village Green Square to dead end)	N/A	1.15E+02	N/A
Study Area Total AADT		4.58E+04	7.07E+04	54%

Notes:
[1] AADT calculated using peak AM and peak PM traffic volumes.
N/A – proposed new road, no existing AADT

Table 4-2, Table 4-3, Table 4-5 and Table 4-6 above demonstrate that when comparing existing to future emission factors, there is a decrease of emissions of each contaminant on existing road segments that can be explained by the introduction of more environmentally friendly and efficient vehicles. **Table 4-4** and **Table 4-7** show an increase in emissions; however, these segments would introduce new roads and therefore an increase in emissions in expected. The results presented are expected to be conservative as AADT values are based on maximum traffic volumes and no electric or compressed/renewable natural gas (CNG or RNG) vehicles were included in the default fleet assessed.

Based on traffic data presented in **Table 4-8**, the Project area is expected to see traffic increase by 54% in the Future (2035) scenario. Based on emission rates presented above, vehicle emissions for each contaminant are expected to decrease from existing to future scenarios on existing roadways. Vehicle emissions are expected to increase on new roadways; however, the overall air quality in the Project area is not expected to be adversely impacted. As a result, a substantial change in road traffic emissions is not expected from the Project.

5 GREENHOUSE GAS IMPACTS

Greenhouse gases (GHGs) are contributors to the radiative warming effect of the environment that results in global climate change. To investigate the impact of the Project on GHG emissions, the GHG emissions from the Future (2035) scenario were compared with those of the Existing (2021) scenario.

The major GHGs include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) which are emitted from fuel combustion as well as other anthropogenic and natural sources. Carbon dioxide is the main product of combustion while the other two gases are by-products of incomplete combustion. Methane and nitrous oxide have lower concentrations in the atmosphere than carbon dioxide, but their potential impact on global warming per molecule is larger than for carbon dioxide.

On a local geographical scale, the warming effects of black carbon may be more prominent than GHGs, especially on a shorter time scale. Black carbon is present in particulate matter generated by fuel combustion processes and absorbs solar radiation at all wavelengths. Given its shorter residence time in the atmosphere than GHGs, the use of the 100-year global warming potential (GWP) factors to determine CO_2 equivalency may not be appropriate. Other components of diesel combustion such as sulphates, nitrates, and organic carbon (OC) present in particulate matter generally reflect light and have a cooling effect that may partially offset the warming effect of black carbon but are not fully understood. The potential for black carbon and other constituents to impact GHG emissions have not been examined as part of this assessment. The 100-year GWP values for major GHGs were utilized in this assessment.

To assess GHGs the potential global warming of each chemical is taken into account to express the GHGs in a single parameter called CO_2 equivalent (CO_{2eq}). The 100-year GWP factors from MOVES were used and a single parameter, CO_{2eq}, formed the output.

5.1 GHG EMISSION ESTIMATES

To assess the impact of the Project on local GHG emissions, the CO_{2eq} emissions for vehicles for all scenarios in the Project area were estimated. The GHG emissions were calculated using the emission factors generated by the US EPA's MOVES3 model for 2021 and 2035 for vehicles. It should be noted that as electric, CNG or RNG vehicles are not included in this assessment the results presented are considered conservative as a significantly higher market share of electric vehicles is expected in 2035.The distance travelled within the Project area was calculated as the length of each road segment multiplied by the number of vehicles within the road segment to yield the vehicle kilometres travelled (VKT). The average annual VKT estimates for each road segment and scenario are listed in **Table 5-1**.

Table 5-1 Annualized VKT per Road Segment

Road Segment	Location	Existing (2021) Max VKT/year	Future (2035) Max VKT/year	Future with Project Impact Max VKT/year
1	Sheppard Avenue (Kennedy Road to Reidmount Avenue)	3.85E+06	**4.49E+06**	6.38E+05
2	Gordon Avenue (Sheppard Avenue to Jade Street /Collingwood Street)	3.67E+04	**2.61E+05**	2.25E+05
3	N-S Street (Jade Street/Collingwood Street to Village Green Square)	N/A	**1.18E+06**	1.18E+06
4	Jade Street/Collingwood Street (Kennedy Road to dead end)	**6.03E+04**	5.97E+04	-5.97E+02

Road Segment	Location	Existing (2021) Max VKT/year	Future (2035) Max VKT/year	Future with Project Impact Max VKT/year
5	Cowdray Court (Kennedy Road to N-S Street)	1.01E+05	**5.14E+05**	4.14E+05
6	Village Green Square (Village Green Square to dead end)	N/A	**1.26E+03**	1.26E+03

Notes: The largest values for each road segment are bolded
N/A – proposed new road, no existing AADT

The CO_{2eq} emission rates for each scenario were multiplied by the annual VKT estimates to calculate the total GHG emissions for each road segment. The results for the Existing (2021) and Future (2035) scenarios are listed in **Table 5-2**. For each road segment, a comparison of the percent change in GHG emission estimates between the Existing and Future scenarios was performed. Note that the increase in GHG emissions for both proposed Road Segment 3 and Road Segment 6 for the Future scenario is attributed to an increase in the 2035 projected VKT in the area as these are new road segments that would be built as part of the Project.

Table 5-2 Total GHG Emissions (as CO_{2eq}) Per Road Segment

Road Segment	Location	Existing (2021) CO_{2eq} tonnes/year	Future (2035) CO_{2eq} tonnes/year	2021-2035 % Change
1	Sheppard Avenue (Kennedy Road to Reidmount Avenue)	**2.15E+03**	1.92E+03	-11%
2	Gordon Avenue (Sheppard Avenue to Jade Street /Collingwood Street)	2.57E+01	**1.40E+02**	447%
3	N-S Street (Jade Street/Collingwood Street to Village Green Square)	N/A	**3.80E+02**	N/A
4	Jade Street/Collingwood Street (Kennedy Road to dead end)	**3.45E+01**	2.62E+01	-24%
5	Cowdray Court (Kennedy Road to N-S Street)	1.06E+02	**2.66E+02**	151%
6	Village Green Square (Village Green Square to dead end)	N/A	**3.02E+00**	N/A

Notes: The largest values for each road segment are bolded
N/A – proposed new road, no existing emissions

The results of the GHG emissions are compared to the provincial GHG emission total in **Table 5-3**. The provincial estimate presented includes the latest publicly available data that has been through rigorous quality assurance and quality control. The Provincial GHG emission total was extracted from the Canada Energy Regulator Provincial and Territorial Energy Profiles for Ontario for the year 2020.

Table 5-3 Annual GHG Emissions per Road Segment and Provincial GHG Emissions

Road Segment	Location	2020 Provincial Emissions (tonnes)[1]	Existing (2021) % of Provincial Total	Future (2035) % of Provincial Total	Future (2035) Project Impact %
1	Sheppard Avenue (Kennedy Road to Reidmount Avenue)	1.50E+08	<0.01%	<0.01%	<0.01%
2	Gordon Avenue (Sheppard Avenue to Jade Street /Collingwood Street)		<0.01%	<0.01%	<0.01%
3	N-S Street (Jade Street/Collingwood Street to Village Green Square)		<0.01%	<0.01%	<0.01%
4	Jade Street/Collingwood Street (Kennedy Road to dead end)		<0.01%	<0.01%	<0.01%
5	Cowdray Court (Kennedy Road to N-S Street)		<0.01%	<0.01%	<0.01%
6	Village Green Square (Village Green Square to dead end)		<0.01%	<0.01%	<0.01%

Notes:
[1] Canada Energy Regulator, Provincial and Territorial Energy Profiles - Ontario

Table 5-4 Annual GHG Emissions per Road Segment and 2030 Provincial GHG Targets

Road Segment	Location	2030 Provincial Target (tonnes)[1]	Existing (2021) % of Provincial Total	Future (2035) % of Provincial Total	Future (2035) Project Impact %
1	Sheppard Avenue (Kennedy Road to Reidmount Avenue)	1.43E+08	<0.01%	<0.01%	<0.01%
2	Gordon Avenue (Sheppard Avenue to Jade Street /Collingwood Street)		<0.01%	<0.01%	<0.01%
3	N-S Street (Jade Street/Collingwood Street to Village Green Square)		<0.01%	<0.01%	<0.01%
4	Jade Street/Collingwood Street (Kennedy Road to dead end)		<0.01%	<0.01%	<0.01%
5	Cowdray Court (Kennedy Road to N-S Street)		<0.01%	<0.01%	<0.01%
6	Village Green Square (Village Green Square to dead end)		<0.01%	<0.01%	<0.01%

Notes:
[1] Climate Change: Ontario’s Plan to Reduce Greenhouse Gas Emissions – Chapter 3

The estimated VKT by vehicles shown in **Table 5-1** increased in the 2035 Future scenario for the road segments in the Study Area except for Segment 4. Two of these road segments are expected to have increased AADT and VKT as they are new roads proposed as part of the Project, therefore they have no values for the Existing scenario.

Based on GHG emission estimates presented in **Table 5-2** for each road segment, the Project is not expected to significantly impact overall GHG emissions in the Project area. An increase in GHG emissions is expected for Road Segment 3 and Road Segment 6; however, this is due to the fact that these are new proposed roads as part of the Project. An increase in GHG emissions for Road Segment 2 and Road Segment 5 was noted; however, this increase is less than the projected increase in AADT along these road segment. The increase in GHG emissions for these road segments is not expected to be significant when compared to Provincial GHG emissions as discussed below. For all other road segments, GHG emissions are expected to decrease in the Future scenario.

To show that the Project emissions can be considered insignificant when compared to the Provincial 2020 emission total and the Provincial 2030 GHG target, the expected emissions for each scenario and road segment are discussed below and shown in **Table 5-3** and **Table 5-4**.

For all scenarios considered for all road segments, the CO_{2eq} emissions were less than 0.01% of the total 2020 Provincial emissions. The Project impact is also expected to be less than 0.01% when compared to the 2020 Provincial emission total. Therefore, it can be concluded from the results that the proposed Project does not significantly impact the Provincial GHG inventories.

The Project was also compared to the future Ontario Provincial GHG target for 2030 of 143,300,000 t/year. The total estimated CO_{2eq} from the sum of the road segments for the Future scenario is less than 0.01% of the Ontario Provincial target. Therefore, the GHG emissions for the Future scenario are negligible compared to the 2030 Provincial target.

6 CONSTRUCTION AND OPERATION MITIGATION

During construction, which would include the construction of new roadways in the Project area, there is potential for air quality impacts to occur for a limited duration. Construction related air quality impacts may arise from construction vehicle emissions and the creation of dust within the specific areas of construction. Construction activities that have the potential to generate dust include the following:

- Mobilization of construction equipment;
- Vehicle and equipment engine emissions;
- Tree cutting, specifically for new proposed roads;
- Stripping, loading, and stockpiling of Site materials;
- Transportation on haul routes;
- Transport of fill material to the site;
- Placement, grading, and compaction of material.
- Cutting, grinding and drilling;
- Mixing processes; and
- Paving of roadways.

The potential construction emissions are typically highly variable, and prediction is difficult, depending on the specific activities that are taking place and the effectiveness of the mitigation measures. To address potential impacts related to air quality, the following mitigation measures will be applied:

- Implementation of Construction Code of Practice, operating procedures such as application of dust suppressants, efficient staging of construction activities and minimization of haul distances, covering up stockpiles, etc.;
- The construction tendering process should include requirements for implementation of an emissions management plan within the umbrella of the Environmental Management Plan;
- Standard construction practices for the control of dust will be implemented during construction to minimize the generation and spread of dust;
- The use of dust suppressants to ensure dust is effectively managed and kept to a minimum;
- The use of reformulated fuels, emulsified fuels, exhaust catalyst and filtration technologies, cleaner engine repowers, and new alternative-fueled trucks to reduce emissions from construction equipment;
- Regular cleaning of construction sites and access roads to remove construction caused debris and dust;
- Ensure loads hauling fine-grained materials are covered;
- Compliance with posted speed limits and, as appropriate, further reductions in speeds when travelling sites on unpaved surfaces;
- Restrictions on the idling of construction equipment unnecessarily so that idling is kept to a minimum;
- Re-stabilize and revegetate exposed soil surfaces as soon as possible using native seed mixes appropriate to the study area; and
- Wash vehicles and equipment prior to leaving the construction site to minimize the potential release of dust off-site.

During operation, local dust emissions near the newly constructed road may increase as traffic from arterial roads (Kennedy Road and Sheppard Avenue) divert to the new roadways. Future increases may also occur as traffic volumes increase due to proposed residential developments in the Study Area. These dust emissions would typically be managed through best management practices and routine maintenance of the roadway.

7 CONCLUSION

Existing air quality conditions in the Study Area indicate existing air quality is good as the air quality criteria, with the exception of B(a)P, are met for the indicator contaminants selected for this assessment. The available background B(a)P data is limited but is consistent with level founds across Ontario (Tevlin et al., 2020).

The proposed Project is expected to result in significant changes to traffic volumes, particularly where new roadways are proposed; however, the overall air quality in the Project area is not expected to be adversely impacted. As a result, a substantial change in road traffic emissions is not expected from the Project.

During construction, dust impacts should be mitigated through the use of a dust control plan in accordance with Ontario Provincial Standard Specification 100 (OPSS). During the operation, dust should be managed through best management practices and routine maintenance of roadways.

8 REFERENCES

Canada Energy Regulator: Provincial and Territorial Energy Profiles – Ontario

Canadian Council of Ministers of the Environment (CCME). 2022. Canadian Ambient Air Quality Standards.

Human Toxicology and Air Standards Section, Technical Assessment and Standards Development Branch, Ontario Ministry of the Environment, Conservation and Parks (MECP). 2020. Ambient Air Quality Criteria. MECP, Toronto, ON, Canada.

Lall, R., Kendall., M., Ito, K., Thurston, G.D. (2004) Estimation of Historical Annual $PM_{2.5}$ Exposures for Health Effects Assessment. Atmospheric Environment 38 (2004) 5217 – 5226. Accessed December 2022. https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.files/fileID/13226.

Ministry of the Environment, Conservation and Parks (MECP) Central Region. 2017. Draft Document "Traffic Related Air Pollution: Mitigation Strategies and Municipal Class Environmental Assessment Air Quality Impact Assessment Protocol

Ministry of the Environment, Conservation, and Parks (MECP), 2022: Ontario Environmental Registry accessed December 2022. https://ero.ontario.ca/

Ontario Regulation 419/05 Air Pollution – Local Air Quality (O.Reg.419/05)

Ontario Environmental Protection Act, R.S.O. 1990, c.E19

Ontario Ministry of Transportation (MTO) Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects, May 2020

Office of the Auditor General (2021). Follow-up on Value-for-Money Audit: Climate Change: Ontario's Plan to Reduce Greenhouse Gas Emissions Chapter 3

Tevlin et al (2020). Tevlin, A., Galarneau, E., Zhang, T., and Hung, H. Polycyclic aromatic compounds (PACs) in the Canadian environment: Ambient air and deposition. Journal of Environmental Pollution 271:116232 (2021).