Environment

Halton Region

Trafalgar Road (Regional Road 3) Corridor Improvements Class EA Study, from Cornwall Road to Highway 407 Air Quality Assessment Report

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Executive Summary

AECOM was retained by Halton Region to conduct a Class Environmental Assessment (Class EA) Study for the proposed improvements along Trafalgar Road from Cornwall Road to Highway 407, in the Town of Oakville. This expansion includes the addition of High Occupancy Vehicle (HOV) lanes including the long-term provision for dedicated Bus Rapid Transit (BRT) lanes by 2031.

The purpose of this Air Quality Assessment Report is to predict the potential air quality impacts of the proposed Bus Rapid Transit system. Four scenarios are investigated in order to assess different design alternatives, namely:

- Current (2010)
- Future No Build (2031)
- Future Build, Centre Lane BRT (2031)
- Future Build, Curb Lane BRT (2031)

The objective of the report is to provide a comparison of the air quality impacts resulting from the proposed expansion to an established future baseline and evaluate how the proposed expansion may potentially affect air quality in the Study Area. The pollutants of concern are Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Sulphur Dioxide (SO_2) and Particulate Matter (PM). Select Volatile Organic Compound (VOC) emissions were also assessed including acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde.

Local air quality impacts were determined by comparing predicted modelled concentrations and ambient levels at representative sensitive receptors of CO, NO_x, SO_2, PM and VOCs to established standards or guidelines. Regional air quality impacts were determined by estimating and comparing the differences in air pollutant emissions from the total transportation mix, using an emission inventory approach. All analysis was performed for the year 2031 based on the Future No Build and Future Build scenarios.

Ambient data for Total Suspended Particulates (TSP) and PM_{10} are not readily available. Background values for TSP and PM_{10} were calculated using Ministry of the Environment (MOECC) approved ratios ($PM_{2.5}$ / PM_{10} = 0.54 and $PM_{2.5}$ / TSP = 0.3).

As discussed in Section 2 "Approach and Methodology" of this report, the Base Case for this specific project was assessed using ambient air concentrations for the pollutants of interest and were extracted from Ministry of Environment and Climate Change (MOECC) and the Federal National Air Pollution Surveillance (NAPS) program. These data was used to represent the current base year. The background contaminant concentration levels may include emissions resulting from current traffic levels. The modelled point of impingement (POI) adds local traffic values to this background contaminant concentration resulting in a highly conservative analysis.

Future traffic maps, plans and reports were reviewed to build the road networks and links around the proposed BRT corridor. Sensitive receptor locations were evaluated and extracted from secondary sources. Using the traffic information, representative emissions rates were developed for vehicular flow using MOBILE6.2.

The collected data and generated vehicular emission rates were used in an air dispersion model, CAL3QHCR. The CAL3QHCR air dispersion model is a recognized tool developed by the US EPA for assessing emissions from linear sources such as roadways. The main inputs used in the model include, a base map of road network, the location of receptors and road segments, vehicle exhaust emission factors (i.e., grams of pollutant emitted per vehicle miles travelled, or g/VmT) for the road segments, the overall peak hourly traffic flow in each area, traffic signal timing used to calculate idle times and length of traffic queuing; and one year (2000) of meteorological data.

The CAL3QHCR model was run using urban settings as outlined in the US EPA document entitled "Guideline on Air Quality Models"[1] . The gaseous contaminants such as CO, SO_2, NO_x and Volatile Organic Compounds (VOCs) were modelled using the CO option, while the particulate contaminants used the PM option. Presented results are based on a 1-hour, 8-hour, 24-hour and annual averaging time to facilitate comparison to the applicable guidelines. The maximum concentration predicted by CAL3QHCR is considered conservative as the maximum emission factors and peak traffic flows are used for all hours of the one-year modelling period. Realistically, the actual emission factors and traffic flow are frequently less (not peak).

For the highest impacted receptors (an apartment building and a residence), the primary findings of the air quality assessment are outlined below:

- The local effects of the two Future Build scenarios are limited to receptors close to Trafalgar Road.
- The modelled impact and concentration levels greatly decrease with increasing distance from the Trafalgar Road Corridor and the main arterial roads feeding into Trafalgar Road. The modelling results comparing the current impact and the future 2031 scenarios are shown in **Table E-1**.
- Both the BRT Centre and BRT Curb Lane Future Build scenarios result in a decreased predicted concentration at the highest impacted receptor for NOx, CO, and VOCs.
- The BRT Curb Lane Future Build scenario results in the lowest predicted concentration at the highest impacted receptor for NOx, CO, and VOCs.
- A reduction in NOx, PM and some VOCs is seen for the Future No Build case. The reduction seen in the Future No Build case is primarily due to improvements in technology.

Table E-1 Difference in Maximum Predicted Concentrations - Current vs. Future 2031

Pollutant	Averaging Time	Percentage Change		
		Future No Build	*Future Build Centre Lane BRT*	*Future Build Curb Lane BRT*
NOx	1	-15%	-25%	-28%
	24	-13%	-22%	-24%
CO	1	21%	-12%	-15%
	24	18%	-10%	-12%
SO_2	24	1%	0%	0%
$PM_{2.5}$	24	-4%	-1%	-3%
PM_{10}	24	-4%	-3%	-4%
PM_{TSP}	24	-5%	-1%	-3%
Acetaldehyde	24	-3%	-3%	-4%
Acrolein	24	6%	-5%	-6%
Benzene	24	-15%	-15%	-17%
1,3-Butadiene	24	-17%	-19%	-22%
Formaldehyde	24	-3%	-3%	-3%

As the re-suspension of road dust on paved roads should also be considered to estimate the particulate impacts at the most-impacted receptors, additional modelling was completed to incorporate the particulate matter (PM) emission contribution from re-suspension of road dust. Table E-1 was updated to include particulate matter emissions from re-suspension of road dust. As shown in Table E-1, the overall impact of PM contaminants will still decrease in the future build scenario compared to the current scenario.
The overall impacts of targeted contaminants will decrease due to commuters using the proposed BRT and reducing vehicle use on a regional level. The reduction in annual emissions is shown in **Table E-2** along with mobile emission inventories for Ontario and Canada.

1. *40 CFR Part 51, Appendix W, 2005*

From an air quality perspective, the implementation of the BRT Curb Lane scenario is the preferred design option since it results in reductions of regional air quality impacts while minimizing local POI impacts.

Table E-2 Regional Impacts, Change in Annual Mobile Emissions Due to Future Build

Contaminant	Project 2031		Project (2031) Total Emissions (Net Change) (kTonnes/year)	Ontario 2009 (kTonnes/year)	Canada 2009 (kTonnes/year)
	Vehicle Traffic Removed [Tonnes/year]	*BRT Emissions [Tonnes/year]*			
Composite VOC*	-5.14	0.11	-5.03E-03	151	510
Composite CO	-114.02	0.92	-1.13E-01	2,050	6,606
Composite NOx	-11.48	4.95	-6.53E-03	284	1,132
SO_2**	-0.06	0.01	-4.54E-05	15	95
PM_{TSP}	-0.52	0.19	-3.33E-04	17	69
PM_{10}	-0.29	0.10	-1.85E-04	17	68
$PM_{2.5}$	-0.16	0.06	-9.99E-05	15	61

*Notes: * For road vehicles, "Composite VOC" is as defined by the US EPA code MOBILE6.2.*
*** Values for SO_x are presented.*

Table of Contents

AECOM Halton Region Trafalgar Road (Regional Road 3) Corridor Improvements Class EA Study, from Cornwall Road to Highway 407 Air Quality Assessment Report

List of Figures

List of Tables

Appendices

1. Introduction

In 2009, AECOM Canada Limited (AECOM) was retained by Halton Region to conduct a Class Environmental Assessment (Class EA) Study for the proposed improvements along Trafalgar Road from Cornwall Road to Highway 407, in the Town of Oakville. This expansion includes the addition of High Occupancy Vehicle (HOV) lanes including the long-term provision for dedicated Bus Rapid Transit (BRT) lanes by 2031.

The purpose of this Air Quality Assessment is to predict the potential air quality impacts as they relate to the long-term provision for BRT by 2031 within the Study Area. The objective of the report is to provide a comparison of the airborne contaminant emissions from the proposed expansion to an established future baseline, and evaluate how the proposed expansion may potentially affect air quality in the Study Area.

1.1 Approach and Methodology

The Air Quality Assessment is broadly defined in terms of local and regional air quality impacts:

Local air quality impacts were assessed by estimating contaminant concentrations at representative sensitive receptors within the Study Area and comparing them to applicable regulatory limits. Within the Study Area, a comparison was completed between background contaminant concentration levels and anticipated contaminant concentration levels resulting from the project, including future traffic volumes. Ambient concentrations and current traffic volumes were used to represent the current base year. Four scenarios were investigated in order to assess different design alternatives:

- Current (2010)
- Future No Build (2031)
- Future Build, Centre Lane BRT (2031)
- Future Build, Curb Lane BRT (2031

Regional air quality impacts were assessed by estimating and comparing the differences in air pollutant emissions from the total transportation mix for the year 2031 based on the Future No Build and future-build scenarios. An emission inventory approach was thus used to determine the regional air quality impacts.

The study assessed impacts from transportation emissions such as Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Sulphur Dioxide (SO_2) and Particulate Matter (PM). Select Volatile Organic Compound (VOC/VOCs) emissions were also assessed as directed by the Ministry of the Environment and Climate Change (MOECC), including acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde.

Ambient data for Total Suspended Particulates (TSP) and PM_{10} were not readily available. Background values for TSP and PM_{10} were calculated using MOECC approved ratios ($PM_{2.5}$ / PM_{10} = 0.54 and $PM_{2.5}$ / TSP = 0.3).

Emission and dispersion models used in the assessment included MOBILE6.2 and United States Environmental Protection Agency (US EPA) CAL3QHCR. Further model input details are described in the corresponding section.

1.2 Relevant Guidelines

The maximum predicted concentrations at the sensitive receptors in this study were compared with the corresponding standards, criteria, and guidelines:

- Ontario Regulation 419/05 Air Pollution – Local Air Quality Regulation, Schedule 3;
- MOECC Ambient Air Quality Criteria (AAQC);
- Proposed Canada Wide Standards (CCME).

A summary of standards proposed for the Air Quality Assessment is shown below in **Table 1.1**. Where multiple sources of standards are available, the most stringent values are shown. The MOECC interim 24-hour reference level for PM_{10} was added for comparison.

Table 1.1 Summary of Applicable Guidelines and Standards

Contaminant	Source	Averaging Time (*hr*)	Value (*μg/m³*)
NOx	Reg. 419/05 Schedule 3	1	400
	Reg. 419/05 Schedule 3	24	200
NO_2	AAQC	1	400
	AAQC	24	200
CO	Reg. 419/05 Schedule 3	1	36,200
	Reg. 419/05 Schedule 3	8	15,700
SO_2	Reg. 419/05 Schedule 3	1	690
	Reg. 419/05 Schedule 3	24	275
PM - TSP	Reg. 419/05 Schedule 3	24	120
	AAQC	Annual	60
PM_{10}	MOECC Interim Reference Level	24	50
$PM_{2.5}$	Canada Wide Standard (CCME)	24	30
	Proposed 2020 Canada Wide Standard (CCME)	24	27
		Annual	8.8
Acetaldehyde	Reg. 419/05 Schedule 3	24	500
Acrolein	Reg. 419/05 Schedule 3	24	0.4
Benzene	AAQC	24	2.3
	AAQC	Annual	0.45
1,3-Butadiene	AAQC	24	10
	AAQC	Annual	2
Formaldehyde	Reg. 419/05 Schedule 3	24	65

AAQCs are acceptable effects-based levels in ambient air. Limits are set based on the “limiting effect” and are the lowest concentrations at which an adverse effect may be experienced. Effects considered may be health, odour, vegetation, soiling, visibility, corrosion or others and limits have variable averaging times appropriate for the effect that they are intended to protect against. AAQCs are used for assessing general air quality and the potential for causing an adverse effect. They are set at levels below which adverse health and/or environmental effects are not expected. If a contaminant has more than one AAQC, all must be used for assessment purposes as each represents a different type of effect linked to a particular averaging period.

The CCME has developed Canada Wide Standards for a variety of contaminants. These standards are developed jointly by various provincial jurisdictions based on scientific and risk-based approach. Standards are presented to the Ministers along with a timetable for implementation and monitoring and public reporting programs. Ministers are responsible for implementing the standards within their own jurisdictions and promoting consistency across the country. Applicable standards include the Canada Wide Standard for $PM_{2.5}$ (particles smaller than 2.5 μm in diameter), which was established for the year 2010. This standard is based on the 98^{th} percentile ambient measurement (24-hour), annually averaged over three years. Also included is the proposed PM2.5 Canadian Ambient Air Quality Criteria (CAAQ) for the year 2020, which will replace the Canada Wide Standards for PM2.5 that was established in 2000.

1.3 Study Area

The proposed project would provide new BRT service along the Trafalgar Road corridor from north of Iroquois Shore Road/Leighland Avenue to south of Highway 407 in the Town of Oakville, Ontario.

The spatial extent of the Study Area was selected to encompass potential project air quality impacts. It includes the layer of air near the earth’s surface, known as the troposphere, which extends from the surface to approximately 10 km in altitude. It is bounded by 500 m in each direction northeast and southwest of the Trafalgar Road corridor in order to encompass Highway 407 and capture emission, accumulation and dispersion of air contaminants. Furthermore, this study considered 500 m of any roads intersecting Trafalgar Road in the Study Area. As discussed in Section 2.3, this study was based on the consideration of sensitive receptors within 500 m of Trafalgar Road.

The Study Area limits are from south of Cornwall Road to south of Highway 407, generally depicted in **Figure 1-1**. Parking structures related to the GO Station near Cornwall Road and all rail related emissions from the Lakeshore East corridor (i.e., VIA Rail, GO Transit, and freight) are excluded from this study.

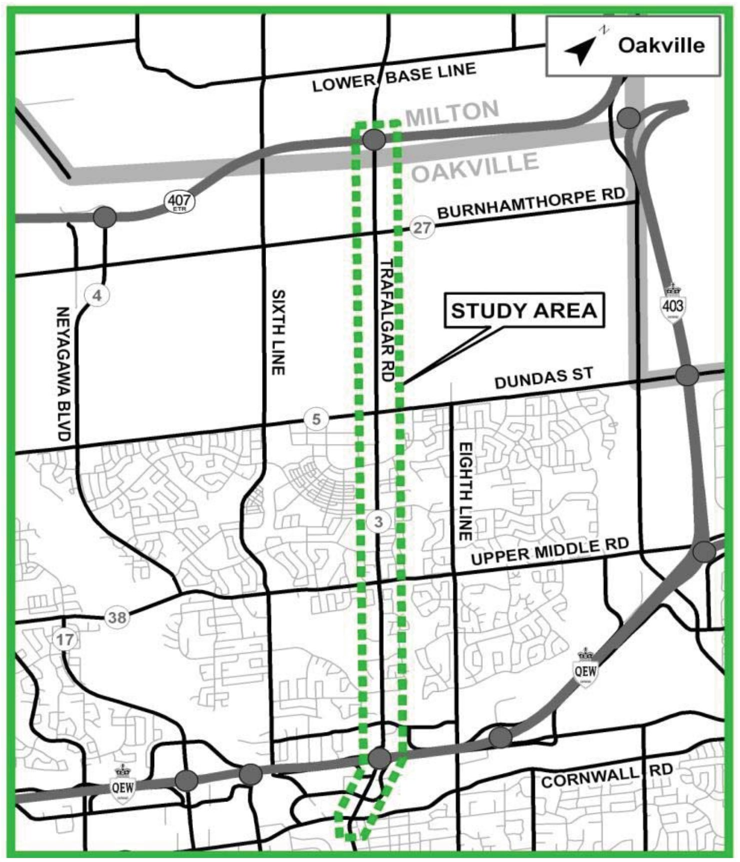

Figure 1-1 Trafalgar Road Study Area

1.4 Existing Ambient Air Quality

A general estimate of the baseline ambient air quality was made using publicly available historical air quality data from ambient air quality monitoring stations within Ontario (**Appendix A**). Data utilized was the latest publicly available at the time of the study commencement. It was assumed that the historic ambient air quality will be the same for both the Future Build and Future No Build scenarios (2031). This is a conservative estimate as there are numerous federal, provincial, and municipal initiatives which are currently being implemented to reduce the levels of ambient air pollutants. For vehicle emissions in particular, it is anticipated that due to more stringent vehicle emission limits the on-road emissions will decrease despite increasing traffic. In addition, ambient monitoring data[2] typically shows decreasing concentrations of $PM_{2.5}$, NO_x, SO_2 and CO over the past several years.

2. *MOECC, 2008, "Air Quality in Ontario, 2007 Report", Monitoring & Reporting Section, Environmental Monitoring and Reporting Branch MOECC Document: 6930e, http://www.ene.gov.on.ca/publications/6930e.pdf*

AECOM Halton Region Trafalgar Road (Regional Road 3) Corridor Improvements Class EA Study, from Cornwall Road to Highway 407 Air Quality Assessment Report

Hourly, daily and annual ambient concentrations of air quality pollutants ($PM_{2.5}$, NO_x, and SO_2) were obtained from the Oakville monitoring station (**Table 1.2**).

Ambient monitoring data for air quality pollutants was extracted as follows for ($PM_{2.5}$, NO_x, and SO_2):

- 1 and 24 hour ambient concentrations for the contaminants were obtained from the 90th percentile of hourly measurements from the Oakville station.
- The annual ambient concentrations for the contaminants consisted of the maximum annual average of the hourly measurements from the Oakville station
- As TSP and PM_{10} were not monitored, MOECC approved ratios ($PM_{2.5}$ / PM_{10} = 0.54 and $PM_{2.5}$ / TSP = 0.3) were used to estimate ambient concentrations.

Table 1.2 Oakville Monitoring Station Information

	Oakville Information
Station Name:	Oakville
NAPS Number	N/A
Address:	Eighth Line/Glenashton Drive, Halton Res.
Latitude:	43.486917
Longitude:	-79.702278
Station Type:	Urban
Height of Air Intake:	12 m
Elevation ASL:	165 m
Pollutants Measured:	O_3, $PM_{2.5}$, NO_2, NO_x, SO_2

Most of the data was extracted from the annual MOECC publication "Air Quality in Ontario" (http://www.airqualityontario.com/history/). Data from 2006 to 2010 was used.

Ambient air monitoring for VOCs is less common and the available monitoring stations were not close to the Study Area as compared to stations monitoring NO_x, SO_2 and PM. The MOECC's Mississauga monitoring station (**Table 1.3**) was chosen for ambient background CO concentrations. Data for CO was obtained for the period from 2006 to 2010.

Table 1.3 Mississauga Monitoring Station Information

	Mississauga Information
Station Name:	Mississauga
NAPS Number	60434
Address:	3359 Mississauga Road, Ontario
Latitude:	43.547
Longitude:	-79.6587
Station Type:	Urban
Height of Air Intake:	5 m
Elevation ASL:	110 m
Pollutants Measured:	CO

The Toronto Etobicoke monitoring station (**Table 1.4**) was chosen for ambient background Benzene and 1,3-Butadiene concentrations. Data in the form of 24-hour averages for the VOCs was provided by the MOECC to AECOM for 45 days in 2008.

Table 1.4 Toronto Etobicoke Monitoring Station Information

	Toronto Etobicoke Information
Station Name:	Toronto Etobicoke
NAPS Number	60413
Address:	Elemcrest Road
Latitude:	43.6485
Longitude:	-79.5914
Station Type:	Urban
Height of Air Intake:	-
Elevation ASL:	137 m
Pollutants Measured:	Benzene, 1,3-Butadiene

Additional VOC data was obtained from the Windsor West monitoring station (**Table 1.5**). Data for acetaldehyde, acrolein and formaldehyde was provided as an annual average for the period from 2000 to 2004. For each contaminant, the average of 90th percentile values was used as the 24-hour background contaminant value. The highest annual average was selected to be the annual background contaminant value.

Table 1.5 Windsor West Monitoring Station Information

	Windsor West Information
Station Name:	Windsor West
NAPS Number	60211
Address:	College Ave./South St
Latitude:	42.292889
Longitude:	--83.073139
Station Type:	Urban
Height of Air Intake:	4 m
Elevation ASL:	180 m
Pollutants Measured:	Acetaldehyde, Acrolein, Formaldehyde

The monitoring stations at which these values were obtained are located in areas that are more industrial than the location of the Study Area, and hence may have higher contaminant concentrations than the area of interest. Furthermore, the background contaminant concentration levels already include emissions resulting from current traffic levels. The modelled point of impingement (POI) adds local traffic values to this background contaminant concentration and this double accounting of traffic emissions results in a highly conservative analysis.

Table 1.6 shows the ambient concentration values used as the background concentration. The ambient concentration for NO_2 (24-hour), acrolein, benzene and $PM_{2.5}$, represent 20% or more of the contribution to the relevant standard or guideline. Of significance, for benzene the 24-hour average background value is 43% of the associated air quality threshold while the annual background value is 138% of the associated air quality threshold.

Table 1.6 Ambient Air Quality 24-Hour Concentrations Used in Air Dispersion Modelling

Contaminant	90th Percentile Concentration (*μg/m^3*)
NOx	57.82
NO_2	39.95
CO	386
SO_2	18.57
$PM_{2.5}$	13.5
PM_{10}	25.02
PM_{TSP}	45.04
Acetaldehyde	2.62
Acrolein	0.19
Benzene	0.98
1,3-Butadiene	0.105
Formaldehyde	4.45

1.5 Meteorology

Five years of pre-processed regional meteorological data from 1996 to 2000 for Central Region (Toronto, York-Durham Region, and Halton-Peel Region) was obtained from the MOECC. The meteorological data (surface) was collected at Pearson Airport, Toronto, Ontario, and is generally accepted by the MOECC for Environmental Assessment (EA) and Air Quality Assessment purposes. The wind rose for the five year period showing the wind direction (blowing from) and wind speed is presented in **Figure 1-2**. The predominant wind direction is blowing from the northwest sector.

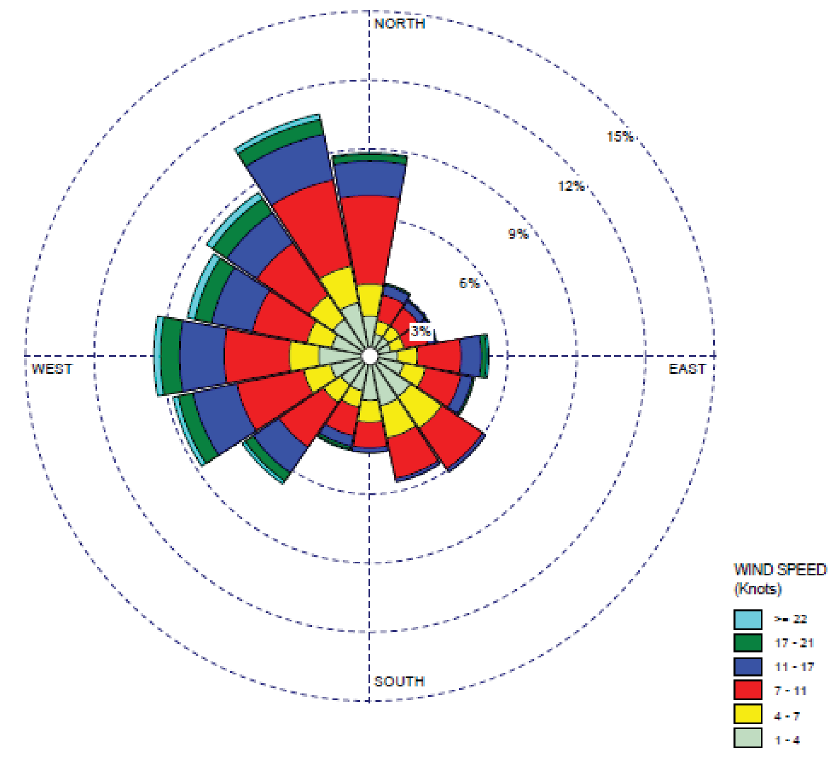

Figure 1-2 Wind Rose for Toronto Pearson Airport, Toronto, Ontario

1.5.1 Dispersion Modelling

One year of regional meteorological data was selected as a representative year for dispersion modelling purposes. The meteorological data spans the year 2000 (the most recent year of the dataset) and includes a sufficient timeframe to capture a wide degree of varying meteorological conditions.

Internal studies at AECOM have shown that variations due to meteorology are dependent on the contaminant. For some (i.e., PM_{10}, $PM_{2.5}$, SO_x) there is no variation from the mean. For others the variation from the mean due to meteorology is less than the difference between the more conservative Tier 1 modelling (used in this study) and the more realistic Tier 2 modelling as discussed in Section 5.2. Further, the use of a single year of meteorological data are consistent with other EAs.[3,4,5]

3. *"Air Quality Assessment Georgetown, South Service Expansion & Union Pearson Rail Link Toronto, Ontario" (RWDI) July, 2009.*
4. *Georgetown South & Air Rail Link Air Quality Impact Assessment-Enhanced Analysis (RWDI). September, 2010.*
5. *GO Transit Rail Service Expansion from Oshawa to Bowmanville and New Rail Maintenance Facility in Whitby Air Quality Assessment Report (AECOM). January 2011*

2. Data Collection and Analysis

2.1 Roadway Links, Traffic and Fleet Composition

The Air Quality Assessment focused on the road network that covers the proposed BRT route and infrastructure. It is bounded by 500 m in each direction northeast and southwest of the Trafalgar Road corridor in order to encompass Highway 407 and capture the emission, accumulation and dispersion of air contaminants.

Traffic data used in the current, Future Build and Future No Build scenarios was based on traffic assessments performed in support of this EA. The relevant traffic data used in the Air Quality Assessment is included in **Appendix B**. The default MOBILE6.2 fleet composition was used for all scenarios.

2.2 Zoning

Zoning maps within the Study Area are included in **Appendix C**. Land along the Trafalgar Road corridor in Oakville is primarily zoned as residential with some Public Use/Education, Mixed Use and Commercial Zones. Environmentally protected (e.g., Open Space, Conservation) areas are located to the southwest and northeast of the Study Area along creeks, and tributaries. Lands zoned as Agricultural are located to the southwest of Trafalgar Road between Upper Middle Road and Glenashton Drive.

2.3 Receptor Data

Receptors considered in the Air Quality Assessment include potentially sensitive receptors such as residences, education facilities, healthcare facilities, day care facilities, places of worship and community centres (see **Appendix D**). This Study Area was based on the consideration of sensitive receptors within 500 m of Trafalgar Road. This is consistent with the expected release characteristics of the emission sources. The closest sensitive receptors surrounding the sources (in all directions) were identified and it was assumed that receptors further away will have lower impacts.

Data on the identification and location of the sensitive receptors, described below, was obtained from the following source:

- Listings of education, healthcare, day care facilities, places of worship, and community centres.

Locations of the receptors are provided in a base map included in **Appendix D**. **Table 2.1** lists all of the sensitive receptors considered in the model. The receptor height for all sensitive receptors was assumed to be 1.8 m, which is considered to be the typical breathing height.

Table 2.1 Sensitive Receptors

Number	Name	Description	UTM Co-ordinate X (m)	UTM Co-ordinate Y (m)
Rcpt_1	Closest Residence (Litchfield Rd)	Residence	605164.9	4814287.4
Rcpt_2	Trafalgar Ridge Montessori School	School	603969	4815425.6
Rcpt_3	Glenashton Daycare Centre	Daycare	604392.6	4814871.5
Rcpt_4	Croatian Catholic Mission	Church	604646.8	4814615.7
Rcpt_5	St. Simons Anglican Church	Church	605228.7	4814215.5
Rcpt_6	Faith Baptist Church	Church	605411.5	4814068.5
Rcpt_7	Residence on Rosegate Way	Residence	604164.6	4815227.2
Rcpt_8	Rabba Apartments 1	Residence	605629	4813870

Number	Name	Description	UTM Co-ordinate X (m)	UTM Co-ordinate Y (m)
Rcpt_9	Rabba Apartments 2	Residence	605629	4813870
Rcpt_10	Wallace Pines Apartments	Residence	605657.9	4813651.9
Rcpt_11	Apartment Building	Residence	605843.2	4813493
Rcpt_12	Sunrise Senior Living	Senior Living	606726	4812064.9
Rcpt_13	Queens Ave Retirement Residence	Senior Living	606054.7	4813165.8
Rcpt_14	Sheridan College	School	605238.8	4813805.6
Rcpt_15	Grace Lutheran	Church	607066.9	4812128
Rcpt_16	Mary Mother of God Parish	Church	604064	4815909.4
Rcpt_17	Sheridan Hills Church	Church	603026.5	4816379.7
Rcpt_18	Trafalgar Presbyterian Church	Church	605124.9	4814468.9
Rcpt_19	Trinity United	Church	605701.9	4813298.5
Rcpt_20	MacLaughlan College	College	607164.9	4811935.5
Rcpt_21	Residence on Forest Hill Drive	Residence	605793.37	4813689.64
Rcpt_22	White Oaks Townhouse	Residence	606071.9	4813772.5
Rcpt_23	Sheridan College Skills Centre	School	606521.1	4813631.4
Rcpt_24	Allan Rd. Residence 1	Residence	607137.2	4812419.3
Rcpt_25	Halton Healthcare	Hospital	607248.2	4812039.3
Rcpt_26	St Michaels Catholic School/Church	Church	605572.4	4813107.9
Rcpt_27	Lorne Skuce Public School	School	605792.7	4812766.3
Rcpt_28	White Oaks Secondary School	School	605091.6	4813207.8
Rcpt_29	MontClair Elementary	School	605218.5	4813040.7
Rcpt_30	Georgian Drive Residence 1	Residence	603455.5	4814890.1
Rcpt_31	Wembly Rd. Residence	Residence	604128.6	4814654.1
Rcpt_32	Oak Springs Residence	Residence	604681.7	4814236
Rcpt_33	Riverside Dr. Residence	Residence	606778.1	4811794.7
Rcpt_34	Robarts Rd Residence	Residence	606131.7	4812687.3
Rcpt_35	Burnhamthorpe Residence 1	Residence	601685.2	4816793.5
Rcpt_36	Trafalgar Road Residence 1	Residence	602232.1	4816949.1
Rcpt_37	Trafalgar Road Residence 2	Residence	602836.5	4816591.3
Rcpt_38	Trafalgar Road Residence 3	Residence	602386.9	4817033.3
Rcpt_39	Trafalgar Road Residence	Residence	600903.01	4818320.1
Rcpt_40	Al-Falah Islamic Centre & School	School	602151.3	4817554.1
Rcpt_41	The Villas on Marlborough Ct	Residence	605741.68	4813798.28
Rcpt_42	Residence on Old Orchard Circle	Residence	604875.23	4814531.85

3. Construction Activities

Air emissions generated during construction activities will result in the creation and inhalation of vapours and PM, both by construction workers and the surrounding community. Potential "air-impacting" activities include, but are not limited to:

- material removal (cutting, chiseling, grinding, etc.);
- materials processing and handling;
- transportation operation and maintenance;
- construction machinery operation and maintenance;
- material replacement (concrete pouring and patching, paving, etc.);
- soil excavation; and
- soil transport and stockpiling.

Based on the wind rose information presented in **Figure 1-2** and local zoning described in (**Section 2.2**), construction activities would predominantly affect areas zoned as residential. The predominant wind directions are somewhat aligned with Trafalgar Road itself. Factors that will affect construction-related air quality impacts include a person's proximity to the construction activity, the number of machines operating at that location and the meteorological conditions at the time those activities occur. When considering mitigation strategies and practices, special consideration should be given to areas zoned as Open Space and Conservation (**Section 2.2**), as well as the predominant wind directions.

Air quality impacts can be effectively mitigated during the planning, staging, and scheduling of construction activities to ensure that:

- Construction activities are scheduled to avoid overlapping construction activities in any one area; and,
- The number of machines operating in any one area is minimized.

Other means of mitigating exposure to construction related emissions can include:

- Ensuring the use of heavy equipment in good condition of maintenance and compliant with applicable federal regulations for off-road diesel engines;
- Ensuring all machinery is maintained and operated in accordance with the manufacturers specifications;
- Using equipment sized for the particular job and operating equipment at optimum rated loads;
- Minimizing idling time and posting signage to this effect around the construction site;
- Locating stationary equipment (e.g., generators, compressors etc.) as far away from sensitive receptors as practical; and
- Implementing those measures specified in the Dust Control Plan (to be developed during the Detailed Design Phase) to minimize the generation of dust via materials handling, vehicle movement and wind erosion.
- Finally, since any road widening works will bring the road closer to certain residential developments and other sensitive receptors, it is recommended that the areas most impacted by particulate levels are vegetated to reduce the cumulative particulate impacts. Planting coniferous trees should be prioritized in these areas.

4. Emission Inventory

The Air Quality Assessment included the development of emission factors and quantification of emission rates related to vehicle emissions (i.e., vehicular engine exhaust, evaporative losses, tire wear and brake wear). Emission factors and emission rates were developed for various scenarios as summarized in the following section.

4.1 Vehicle Emission Factors from MOBILE6.2

Mobile vehicle emissions are categorized as:

- Exhaust emissions that are the products of fuel combustion;
- Evaporative emissions; and,
- Particulate emissions associated with brake wear and tire wear.

Evaporative emissions are divided into five emission sub-categories (i.e., hot soak, diurnal, running, resting and refuelling losses) that describe the different phases of a vehicle operating cycle that include a standing hot or cold engine, a running engine, fuel tank vapour losses due to the diurnal air temperature cycle and vapour displacement losses due to refuelling.

The US EPA has developed an emission factor model (MOBILE6.2) for estimating both exhaust and evaporative emissions from a defined fleet of vehicles operating with a defined driving cycle. The most recent available version of the model is MOBILE6.2. The default files provided with MOBILE6.2 are typical of the vehicle fleet, vehicle operating patterns and emission regulations in the United States. The MOBILE6.2 model allows the user to override the default data with site specific data in order to estimate site specific emissions; this capability has been used in the Air Quality Assessment to estimate mobile source emissions.

This model was used to generate composite emission factors (i.e., grams of pollutant emitted per vehicle mile traveled, or g/VmT) for CO, NO_x, $PM_{2.5}$, and VOCs. Emission factors were developed for the months of January (typical winter condition) and July (typical summer condition) for the Future Build and Future No Build scenarios.

The input data required by MOBILE6.2 is presented in **Table 4.1** and **Table** 4.2 along with a summary of data sources. Details on fleet composition are presented in **Section 2.1**. Where default data included in MOBILE6.2 are deemed appropriate for the Study Area, these default data have been used.

Table 4.1 MOBILE6.2 Input Data

	Parameter	Input	Reference
External Conditions	*Year of Evaluation*	2010/2031	
	Month of Evaluation	January/July	(1)
	Temperature	-13/25 ˚C	Environment Canada weather normals
	Humidity	65/83 %	Environment Canada weather normals
	Altitude	Low	(1)
Fuel Options	*Reid Vapour Pressure (RVP)*	8.9 PSI (summer)/ 14.7 PSI (winter)	(2)
	Diesel Sulphur Content	15 ppm (2021)	(3)
	Gasoline Sulphur Content	25 ppm (2021)	(2)
Air Toxics	*Gasoline Aromatics*	28.4 %	(2)
	Gasoline Olefin	10.3 %	(2)
	Gasoline Benzene	0.8 %	(2)
	Vapour Pressure of gasoline at 200 F	47.3 %(summer) / 53.7 %(winter)	(2)
	Vapour Pressure of gasoline at 300 F	83.3%	(2)
	Oxygenate Volume % of Ethanol or Ethyl Alcohol (Ethanol)	(10% volume, 20% market share in 2021)	(4)

	Parameter	Input	Reference
Vehicle Activity	*Fractions of Vehicle Miles Travelled (VMT)*	Appendix E	
	VMT by facility, hour and speed	default	Default file for MOBILE6.2
	Starts per day	Default for all Local Roads 0 for all Arterial Roads	
	Distribution of vehicle starts during day	Default	Default file for MOBILE6.2
	Soak Distribution	Default	Default file for MOBILE6.2
	Hot Soak activity	Default	Default file for MOBILE6.2
	Diurnal Soak activity	Default	Default file for MOBILE6.2
	Weekday trip length distribution	Default	Default file for MOBILE6.2
	Weekend trip length distribution	Default	Default file for MOBILE6.2
	Weekend use vehicle activity	Default	Default file for MOBILE6.2
Vehicle Fleet Characteristics	*Distribution of Vehicle Registrations*	Default	Default file for MOBILE6.2
	Diesel Fractions	Default	Default file for MOBILE6.2
	Annual Mileage accumulation rates	Ontario - Created by Environment Canada	Default file for MOBILE6.2
	Vehicle Miles Travelled (VMT) fraction	Default	Default file for MOBILE6.2
	Natural gas vehicles (NGV) fraction	Default	Default file for MOBILE6.2
	Alternate emission factor for NGVs	Default	Default file for MOBILE6.2

Notes: (1) US EPA. Office of Transportation and Air Quality. "Technical Guidance on the use of MOBILE6.2 for emission inventory preparation. EPA420-R-04-013,
(2) Emission of air toxics from on-highway sources in Canada: Estimated impacts of various vehicle and fuel control strategies. Environment Canada Technical Report M6C-02-E, Prepared by SENES Consultants Limited and Air Improvement Resource Inc.
(3) MOECC Drive Clean Program
(4) http://www.ec.gc.ca/cleanair-airpur/CAOL/transport/publications/ethgas/ethgas3.htm

Table 4.2 MOBILE6.2 Input Data; Vehicle Speed

Road		Class	Free Flow Speed *[km/h]*	Idle Speed *[km/h]*
Trafalgar Road Corridor	*407*	Freeway	97	N/A
	QEW	Freeway	88	N/A
	Trafalgar Rd. (south of Dundas St.)	Arterial	60	4
	Trafalgar Rd. (north of Dundas St.)	Arterial	80	4
	Upper Middle Rd.	Arterial	60	4
	East-West Roads	Local	50	4

A summary of emission factors developed along with the MOBILE6.2 input/output files are provided in **Appendix E**.

4.2 Re-Suspended Road Dust

Emission factors for re-suspended $PM_{2.5}$ and PM_{10} were estimated using the following equations from Chapter 13.2.1 (Section 13.2.1.3) of the US EPA's AP-42 document:

The emission factor equation is given in **Equation 4.2**.

$$E_i = k * (sL)^{0.91} * (W)^{1.02} \quad \text{Equation 4.2}$$

Where: E_i = particulate emission factor, g/VKT
k = the particle size multiplier, g/VKT
sL = road silt loading, g/m²
W = average vehicle weight (assumed 3 tons as recommended by MTO)

The emission factors for re-suspended PM2.5, PM10 and TSP for the scenarios being investigated are summarized in **Appendix E**.

The re-suspended road dust emissions factors were combined with emission factors generated by MOBILE6.2 to develop the total particulate matter emission factors used in the dispersion models.

5. Dispersion Modelling

The CAL3QHCR air dispersion model is a recognized tool developed by the US EPA for assessing emissions from linear sources such as roadways. The main inputs to the model are described in detail in **Appendix F** and summarized in **Section 5.1**.

5.1 Dispersion Modelling Input Data

The modelling input data includes the following:

- Base map of road network;
- The location of receptors (**Section 2.3**);
- The location and length of each road;
- Vehicle/transit bus exhaust emission factors (i.e., g/VmT) for the road segments within the Study Area and each emission scenario as described in **Section 4.1**);
- The overall peak hourly traffic flow in each area for all hours of the day (i.e., the overall peak flow is assumed for all hours of the day);
- Traffic signal timing used to calculate idle times and length of traffic queuing; and,
- One-year (2000) meteorological data set.

5.1.1 Road Network

A base map of the road network in an image format was obtained from AECOM's GIS team. Receptor co-ordinates were imported into CALRoads (graphical interface for CAL3QHCR model). The base map was used to develop the location and length of road links and segments within CALRoads. Arterial roads were modelled for approximately 500 m on either side of the intersection of interest. "Freeflow" links were used to define all roads and dedicated transit lanes. Supplementary "queue links" were used to define intersections.

5.1.2 Receptors

Receptors considered in the Air Quality Assessment include potentially sensitive receptors such as residences, education facilities, healthcare facilities, day care facilities, places of worship and community centres. Locations of the receptors are provided in base maps included in **Appendix D**. **Table 2.1** in **Section 2.3** lists all the sensitive receptors considered for modelling.

5.1.3 Source Parameters

The developed emission factors were input into the CAL3QHCR dispersion model along with the established peak traffic flow data for the Future Build and Future No Build scenarios. Traffic signal data from traffic reports was used to calculate traffic queuing and the queue specific links in CALRoads. The Future Build scenarios feature additional free flow links to account for BRT traffic flows. The differences between the Curb Lane and Centre Lane BRT cases are related to traffic signalling and the placement of additional lanes.

5.1.4 M odelling Details

The CAL3QHCR model was run using urban settings as outlined in the US EPA Guideline on Air Quality Models: 40 CFR Part 51, Appendix W, because when “the land use within a 3 km radius around the facility sources is examined […] more than 50% of the area is accounted for by land use categories ranging from multi-family dwelling to commercial and industrial use” (US EPA, 2005). Lower coefficients resulting from the urban settings produced higher concentrations and were chosen for conservatism.

The gaseous contaminants such as CO, SO_2, NO_x and VOCs were modelled using the CO option (for gaseous contaminants), whereas the particulate contaminants were modelled using the PM option. The settling velocity of CO and gases is typically 0, as outlined by the CAL3QHC manual. The settling velocity of $PM_{2.5}$ was 0.02 cm/s and the settling velocity for PM_{10} and TSP was 0.3 cm/s. The deposition velocity of $PM_{2.5}$ was 0.1 cm/s and the deposition velocity for PM_{10} and TSP was 0.5 cm/s.

The model was run according to MOECC requirements to produce contour plots of ground level concentrations of NO_x, CO and PM encompassing the nearest sensitive receptors to the proposed BRT corridor. A unit dispersion method was used for VOCs (See **Section 5.3**). Since the MOECC standards are based on different averaging times for each of the contaminants, the results were converted following the Air Dispersion Modelling Guideline for Ontario (ADMGO)[6] (see Equation 5.0). CO POI values were based on a 1-hour averaging time and scaling factors were used to obtain 24-hour and annual values to facilitate comparison to the applicable guidelines. $PM_{2.5}$ and PM_{10} POI values were based on a 24-hour averaging time and scaling factors were used to obtain 1-hour and annual values to facilitate comparison to the applicable guidelines.

$$C_o = C_t \times \left(\frac{t_1}{t_o}\right)^n$$

$$C_{24hr} = C_t \times \left(\frac{t_1}{t_o}\right)^n = C_{60\min} \times \left(\frac{60\min}{24hr \times 60\frac{\min}{hr}}\right)^{0.28} = C_{60\min} \times 0.41 \qquad \text{Eqn 5.0}$$

Where:
- C_o = the concentration at the averaging period t_0
- C_t = the concentration at the averaging period t_1
- t_1 = averaging period t_1
- t_o = averaging period t_0
- n = 0.28

5.2 Tier 1 Modelling

The maximum concentration predicted by CAL3QHCR is considered very conservative as the maximum emission factors and peak traffic flow are used for all hours of the one-year modelling period (Tier 1 CAL3QHCR modelling) when in reality the actual emission factors and traffic flow are less at non-peak times. The maximum impacted receptors were used in assessing all contaminants for this project.

6. *Air Dispersion Modelling Guideline for Ontario v2.0, March 2009*

If values at the impacted receptors significantly exceed regulatory limits/guidelines, Tier 2 modelling can be pursued. Tier 2 modelling incorporates time of day traffic flows using CAL3QHCR, and has been shown in previous studies[7] to reduce the predicted maximum POI concentration by at least 20% for almost all contaminants. Tier 2 modelling was not performed as part of the Air Quality Assessment

5.3 Unit Dispersion Modelling

A unit dispersion modelling approach was adapted for modelling gaseous contaminants. The current, Future No Build and two Future Build models (2031) were modified by changing all of the emission rates to a ‘unit’ value. Emission rates for all free flow links were changed to 500 g/VmT and all queue links were changed to 500 g/hr. These emission rates were selected in order to avoid round-off and precision errors in the CAL3QHCR software. The CAL3QHCR model has the ability to output the contaminant contribution for each traffic link for each receptor. Assuming a linear relationship between emission rate and contaminant concentration, the contribution for each traffic link can then be scaled by the unit model. For example, if the free flow link actually has an emission rate of 50 g/VmT, then the link should produce a concentration that is 10% of the unit model (50 / 500). All other parameters of the link remain the same such as lane widths, traffic volume, height, etc. Once all of the link contributions are added together, they represent the overall contaminant concentration at the receptor.

7. *“GO Transit Rail Service Expansion from Oshawa to Bowmanville and New Rail Maintenance Facility in Whitby Air Quality Assessment Report”, January 2011*

6. Assessment of Results

The maximum air quality concentration within the Study Area was simulated by adding the maximum concentrations predicted by dispersion modelling at a given receptor to the established background concentration. This approach provides a very conservative assessment of the maximum air quality concentration since the selected background for urban areas already includes impacts from roadways. The contaminant concentrations were also evaluated between the Future No Build and Future Build scenarios to determine the actual impact. The maximum air quality concentration results are summarized in the following sections.

Vehicle emissions for these pollutants of interest are predicted to decline due to future improvements to fuel standards and emission controls. The policy assumptions considered by US EPA in the development of the model (MOBILE6.2) used to estimate current and future vehicle emissions are detailed in the model documentation.

Sections 6.1 presents the results for Current and Future Build Curb Lane BRT scenarios. Results for the Future No Build scenario can be found in **Appendix G**, while results for the Future Build Centre Lane BRT scenario can be found in **Appendix H**, respectively[8]. Contours for all scenarios can be found in **Appendix I**.

6.1 Local Impacts

6.1.1 M aximum Modelling Concentrations

As shown in **Table 6.1** and **Table 6.2**, within the Study Area, the maximum pollutant impact occurred at receptor number 11 (apartment building) for the all scenarios with the exception of PM_{10} (Current and Future No Build) and TSP (Current and Future No Build) which occurred at receptor 12 (senior living community); the maximum contaminant impact locations were consistent for all three future 2031 cases (same 24-hour averages).

For all contaminants except CO, the background levels represent a significant portion of the total contaminant concentration. As discussed in **Section 1.4**, the background (ambient) concentrations of benzene are 43% and 138% of the 24-hour and annual air quality thresholds, respectively.

In the Current scenario (**Table 6.1**), all contaminants with the exception of benzene (24-hour and annual average) are below respective standards or guidelines. Emission reductions seen in the Future No Build scenario are due to improvements in vehicle emissions technology[9].

In the Future Build Curb Lane BRT scenario (**Table 6.2**), all contaminants with the exception of benzene (24-hour, annual average) are below respective standards or guidelines. In addition, the Future Build Curb Lane BRT scenario is seen to have the greatest reduction in the targeted contaminants. Sample contour plot figures for the Study Area are provided in **Appendix I**.

8. *The Future No Build scenario and Future Build Centre Lane BRT scenario were included in the analysis as a comparable to the preferred alternative 'Future Build Curb Lane BRT scenario' and are not being considered as part of the preferred design. Therefore, this report does not include a detailed discussion of these alternatives.*
9. *Improvements in vehicle emissions technology are captured in the emission factors generated using MOBILE6.2. See **Section 4.1** for further details*

Table 6.1 Maximum Predicted Concentrations – Current

	Pollutant	Modelled	Background	Total	Air Quality Threshold	Percentage of Threshold	Impact at Receptor ID
		$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	%	
1-Hour Averaging Period	***NOx***	472.61	63.76	536.37	-	-	11
	NO_2	139.87	48.74	188.61	400	47.2%	11
	CO	3,088.2	386.0	3,474.22	36,200	9.6%	11
	SO_2	3.0	21.5	24.54	690	3.6%	11
	Acetaldehyde	1.221	-	1.22	500	0.2%	11
	Acrolein	0.174	-	0.17	-	-	11
	Benzene	13.65	-	13.65	-	-	11
	1,3-Butadiene	1.28	-	1.28	-	-	11
	Formaldehyde	1.80	-	1.80	-	-	11
8-Hour Average Period	***CO***	1,725	-	1,725	15,700	11%	11
24-Hour Average Period	***NOx***	194.11	57.82	251.93	-	-	11
	NO_2	102.45	39.95	142.40	200	71.2%	11
	CO	1,268.4	386.0	1,654.38	-	-	11
	SO_2	1.2	18.6	19.80	275	7.2%	11
	$PM_{2.5}$[10]	3.01	13.51	16.52	30	55.1%	11
	$PM_{2.5}$[11]	3.01	13.51	16.52	27	61.2%	11
	PM_{10}	9.08	25.02	34.10	50	68.2%	12
	PM_{TSP}	10.03	45.03	55.06	120	45.9%	12
	Acetaldehyde	0.502	2.620	3.12	500	0.6%	11
	Acrolein	0.072	0.190	0.26	0.40	65.4%	11
	Benzene	5.61	0.98	6.59	2.30	286.3%	11
	1,3-Butadiene	0.53	0.11	0.63	10	6.3%	11
	Formaldehyde	0.74	4.45	5.19	65	8.0%	11
Annual Averaging Period	***NOx***	38.82	30.52	69.34	-	-	11
	NO_2	20.49	22.91	43.40	-	-	11
	CO	253.68	-	253.68	-	-	11
	SO_2	0.25	8.64	8.89	55	16.2%	11
	$PM_{2.5}$	0.94	6.54	7.48	8.8	85.0%	11
	PM_{10}	2.82	12.11	14.93	-	-	11
	PM_{TSP}	3.13	21.80	24.93	60	41.6%	-
	Acetaldehyde	0.10	1.67	1.77	-	-	11
	Acrolein	0.014	0.110	0.12	-	-	11
	Benzene	1.12	0.62	1.74	0.45	386.9%	11
	1,3-Butadiene	0.11	0.06	0.16	2.0	8.2%	11
	Formaldehyde	0.15	2.61	2.76	-	-	11

10. *PM2.5 maximum predicted concentrations compared with existing ambient air quality standards*
11. *PM2.5 maximum predicted concentrations compared with proposed 2020 ambient air quality standards*

Table 6.2 Maximum Predicted Concentrations 2031 – Future Build Curb Lane BRT Scenario

	Pollutant	Modelled	Background	Total	Air Quality Threshold	Percentage of Threshold	Impact at Receptor ID
		μg/m³	μg/m³	μg/m³	μg/m³	%	
1-Hour Averaging Period	NOx	322.69	63.76	386.45	-	-	11
	NO2	124.88	48.74	173.62	400	43.4%	11
	CO	2,564.0	386.0	2,949.96	36,200	8.1%	11
	SO2	2.9	21.5	24.42	690	3.5%	11
	Acetaldehyde	0.946	-	0.95	500	0.2%	11
	Acrolein	0.135	-	0.13	-	-	11
	Benzene	10.53	-	10.53	-	-	11
	1,3-Butadiene	0.96	-	0.96	-	-	11
	Formaldehyde	1.38	-	1.38	-	-	11
8-Hour Average Period	CO	1,432	-	1,432	15,700	9%	11
24-Hour Average Period	*NOx*	132.53	57.82	190.35	-	-	11
	NO_2	96.29	39.95	136.24	200	68.1%	11
	CO	1,053.1	386.0	1,439.06	-	-	11
	SO_2	1.2	18.6	19.75	275	7.2%	11
	$PM_{2.5}$[12]	2.51	13.51	16.02	30	53.4%	11
	$PM_{2.5}$[13]	2.51	13.51	16.02	27	59.3%	11
	PM_{10}	7.56	25.02	32.58	50	65.2%	11
	PM_{TSP}	8.36	45.03	53.39	120	44.5%	11
	Acetaldehyde	0.388	2.620	3.01	500	0.6%	11
	Acrolein	0.055	0.190	0.25	0.40	61.3%	11
	Benzene	4.32	0.98	5.30	2.30	230.6%	11
	1,3-Butadiene	0.39	0.11	0.50	10	5.0%	11
	Formaldehyde	0.57	4.45	5.02	65	7.7%	11
Annual Averaging Period	*NOx*	26.51	30.52	57.03	-	-	11
	NO_2	19.26	22.91	42.17	-	-	11
	CO	210.61	386.00	596.61	-	-	11
	SO_2	0.24	8.64	8.88	55	16.1%	11
	$PM_{2.5}$	0.79	6.54	7.33	8.8	83.3%	11
	PM_{10}	2.42	12.11	14.53	-	-	11
	PM_{TSP}	2.63	21.80	24.43	60	40.7%	11
	Acetaldehyde	0.08	1.67	1.75	-	-	11
	Acrolein	0.011	0.110	0.12	-	-	11
	Benzene	0.86	0.62	1.48	0.45	330.0%	11
	1,3-Butadiene	0.08	0.06	0.14	2.00	6.9%	11
	Formaldehyde	0.11	2.61	2.72	-	-	11

6.2 Regional Impacts

Regional impacts were determined by assessing the overall change in vehicle use, due to the implementation of the BRT and changes in automotive emissions regulations.

6.2.1 Regional Impacts Sample Calculations

In order to determine the air quality impact on a regional level due to the introduction of the BRT service, both the effects of vehicles removed from the road and the additional Bus service must be considered.

12. PM2.5 maximum predicted concentrations compared with existing ambient air quality standards
13. PM2.5 maximum predicted concentrations compared with proposed 2020 ambient air quality standards

For the purposes of this analysis, it is assumed that the BRT service has the following schedule:

Weekdays:
- 6:00 am to 9:00 am and 3:30 pm to 6:30 pm – 5 minute headways
- 5:00 am to 6:00 am, 9:00 am to 3:30 pm, 6:30 pm to 7:30 pm – 10 minute headways
- 7:30 pm to 10:30 pm – 15 minute headways

Weekends/Holidays:
- 15 minute headways 6:00 am to close

As the BRT provider has not been determined, the buses to be used for the BRT service for this assessment have been assumed to be 12.5 m long, single deck, non-articulated vehicles. A (15 minute duration) peak passenger loading would consist of 42 seated and 17 standing passengers (i.e., 59 passengers). The average loading during peak hours (i.e., those with a 5-minute headway) would be 79% of this peak, while the remainder of the schedule (including weekends) would feature a passenger loading of 39.5% of the peak. This schedule results in a passenger loading of 4,453 passengers per weekday and 1,564 passengers per weekend/holiday in each travel direction.

In order to determine the number of vehicles removed from the road, anticipated BRT passenger demand is calculated as follows (assuming either of the 2031 Future Build scenarios)[14]:

Given that:

Weekday Passenger Loading = 4,453 passengers/day *Eqn 1*

and

Weekend/ Holiday = 1,564 passengers/day *Eqn 2*

Then, noting that Ontario has 10 statutory holidays per year:

Annual Holiday/ Weekend Days $= 52\frac{weeks}{year}\times 2\frac{weekenddays}{week}+10\frac{holidays}{year}$ *Eqn 3a*

$= 114\frac{weekenddays}{year}$

Annual Weekday Days $= 365\frac{days}{year}-114\frac{weekend\&holidays}{year}$ *Eqn 3b*

$= 251\frac{weekdays}{year}$

Annual Passengers $= 2\times\left(114\frac{weekenddays}{year}\times 1564\frac{passengers}{weekendday}+251\frac{weekdays}{year}\times 4453\frac{passengers}{weekday}\right)$ *Eqn 3*

$= 2{,}591{,}998\frac{passengers}{year}$

14. At a Regional level, the difference between Curb Lane BRT versus Centre Lane BRT Scenarios is negligible

Vehicle Emissions

Assuming that 0.8 cars would be used per passenger (if the BRT service was not available), the passenger cars displaced per year by the BRT services can be calculated.

Annual Displaced Cars $= 2{,}591{,}998 \frac{passengers}{year} \times 0.8 \frac{cars}{passengers}$ *Eqn 4*

$= 2{,}073{,}599 \frac{cars}{year}$

Assuming each car trip would be at least the half way distance from the GO Station at Cross Road to the north end of the Study Area, we can calculate the total vehicle kilometres/miles travelled using results obtained from Equation 4. Assuming a car trip along Trafalgar Road of 4.5 km (2.813 miles):

Vehicle Miles Traveled $= 2{,}073{,}599 \frac{cars}{year} \times 2.813 \frac{miles}{car}$ *Eqn 5*

$= 5{,}831{,}996 \frac{miles}{year}$

The composite emission factors obtained from MOBILBE6.2 are also utilized as provided in **Table 6.3**. Note that "Composite" pollutants listed are defined by the US EPA code embedded in MOBILE6.2.

Table 6.3 Vehicle Emission Factors; Trafalgar Road

Contaminant	Trafalgar Road *[g/mile]*
Composite VOC	8.820E-01
Composite CO	1.955E+01
Composite NO_x	1.969E+00
SO_2	9.500E-03
1,3 Butadiene	4.270E-03
Formaldehyde	1.131E-02
Acetaldehyde	5.160E-03
Acrolein	5.800E-04
Benzene (Tot)	3.086E-02
PM	4.970E-02

Using the displaced vehicle miles travelled (calculated in Equation 5), and the emissions information presented in **Table 6.3**, the amount of car related VOC that is displaced by the BRT service can be calculated.

Car VOC $= 5{,}831{,}996 \frac{miles}{year} \times \left(0.882 \frac{g}{TrafalgarRd \;\; mile} \right)$ *Eqn 6*

$= 5{,}143{,}820 \frac{g}{year}$

$= 5.14 \frac{tonnes}{year}$

The car related emissions that are displaced (indicated by the minus sign) by the introduction of the BRT service is indicated in **Table 6.4** below. A summary of emission factors developed along with the MOBILE6.2 input/output files are provided in **Appendix E**.

Table 6.4 Displaced Vehicle Emissions

Contaminant	Trafalgar Road *[Tonnes/year]*
Composite VOC	-5.14
Composite CO	-114.02
Composite NO_x	-11.48
SO_2	-0.055
1,3 Butadiene	-0.025
Formaldehyde	-0.066
Acetaldehyde	-0.030
Acrolein	-0.003
Benzene (Tot)	-0.18
PM_{TSP}	-0.52
PM_{10}	-0.29
$PM_{2.5}$	-0.16

Note that the US EPA code MOBILE6.2 does not differentiate the various constituents of PM. Consequently, values for TSP and PM_{10} were calculated using MOECC approved ratios ($PM_{2.5}$ / PM_{10} = 0.54 and $PM_{2.5}$ / TSP = 0.3).

BRT Emissions

To calculate the regional impact of the proposed BRT system, the BRT schedule discussed at the beginning of this section is utilized.

The proposed BRT schedule results in the following bus volume:

Weekdays:
- 131 buses/day (each direction)

Weekends/Holidays:
- 68 buses/day (each direction)

Annual Busses $= 2 \times \left(114 \frac{weekenddays}{year} \times 68 \frac{busses}{weekendday} + 251 \frac{weekdays}{year} \times 131 \frac{busses}{weekday} \right)$ *Eqn 7*

$= 81{,}266 \frac{bus\,trips}{year}$

Noting that each bus trip would be the full distance from the GO Station at Cross Road to the north end of the Study Area, the total vehicle kilometres/miles travelled using results obtained from Equation 4 can be calculated. Assuming a car trip along Trafalgar Road of 9 km (5.625 miles):

Bus Miles Travelled $= 81{,}266 \frac{bus\,trips}{year} \times 5.625 \frac{miles}{bus\,trips}$ *Eqn 8*

$= 457{,}121 \frac{miles}{year}$

The composite emission factors for the buses obtained from MOBILE6.2 are also utilized as provided in **Table 6.5**.

Table 6.5 Bus Emission Factors; Trafalgar Road

Contaminant	Trafalgar Road [g/mile]
Composite VOC	2.430E-01
Composite CO	2.015E+00
Composite NO_x	1.083E+01
SO_2	1.550E-03
1,3 Butadiene	1.988E-02
Formaldehyde	7.320E-03
Acetaldehyde	8.900E-04
Acrolein	1.550E-03
Benzene (Tot)	2.670E-03
PM	2.292E-01

Using the total BRT miles travelled (calculated in Equation 8) and the emissions information presented in **Table 6.5**, the amount of bus-related VOC that is emitted by the BRT service can be calculated.

$$\textbf{Bus VOC} = 457{,}121\frac{miles}{year}\times\left(0.243\frac{g}{TrafalgarRd\ \ mile}\right) \quad \textit{Eqn 9}$$

$$= 111{,}080\frac{g}{year}$$

$$= 0.11\frac{tonnes}{year}$$

The BRT related emissions that are created by the introduction of the BRT service is indicated in **Table 6.6** below. A summary of emission factors developed with MOBILE6.2 along with the associated input/output files are provided in **Appendix E**.

Table 6.6 Proposed BRT Emissions

Contaminant	Trafalgar Road *[Tonnes/year]*
Composite VOC	0.11
Composite CO	0.92
Composite NO_x	4.95
SO_2	0.01
1,3 Butadiene	0.00071
Formaldehyde	0.0091
Acetaldehyde	0.0033
Acrolein	0.00041
Benzene (Tot)	0.0012
PM_{TSP}	0.19
PM_{10}	0.10
$PM_{2.5}$	0.06

6.2.2 Regional Impacts Summary

Using ridership data developed for the proposed BRT, the annual reduction in vehicular emissions is shown in **Table 6.7**. When compared to the mobile emission inventories for Ontario and Canada, the regional decreases are small. Mobile emission inventories for Ontario and Canada are provided by the National Pollutant Release Inventory (NPRI). The overall impacts of targeted contaminants will decrease due to commuters using the proposed BRT and reducing vehicle use on a regional level.

Table 6.7 Regional Impacts in Annual Mobile Emissions Due to Future Build

Contaminant	Project 2031		Project (2031) Total Emissions *(Net Change) kTonnes/year*	Ontario 2009 *kTonnes/year*	Canada 2009 *kTonnes/year*
	Vehicle Traffic Removed [Tonnes/year]	*BRT Emissions [Tonnes/year]*			
Composite VOC*	-5.14	0.11	-5.03E-03	151	510
Composite CO	-114.02	0.92	-1.13E-01	2,050	6,606
Composite NOx	-11.48	4.95	-6.53E-03	284	1,132
SO_2	-0.06	0.01	-4.54E-05	15	95
PM_{TSP}	-0.52	0.19	-3.33E-04	17	69
PM_{10}	-0.29	0.10	-1.85E-04	17	68
$PM_{2.5}$	-0.16	0.06	-9.99E-05	15	61

*Notes: * For road vehicles, "Composite VOC" is as defined by the US EPA code MOBILE 6.2*
*** Values for SO_x are presented.*

7. Conclusions and Recommendations

The impacts to air quality have been investigated for the proposed BRT in 2031, within the Trafalgar Road Study Area in the Town of Oakville, Ontario.

7.1 Construction

Air emissions generated during construction activities will result in the creation and inhalation of vapours and PM, both by construction workers and the surrounding community. An investigation of zoning and average wind data indicates that construction activities would predominantly affect areas zoned as residential. Lands identified as environmentally protected (i.e., Open Space and Conservation) have been identified. The air quality impacts of construction related activities can be effectively mitigated through the following actions:

- Consideration of construction activities in order to minimize the number of machines operating in any one area;
- Consideration of the type of equipment selected for identified construction activities;
- Ensuring the use of heavy equipment in good condition of maintenance and compliant with applicable federal regulations for off-road diesel engines;
- Operational procedures including those measures to be specified in the Dust Control Plan (to be developed during the detailed design); and,
- Ensuring that the areas most impacted by particulate levels are vegetated to reduce the cumulative particulate impacts.

During construction; it is recommended that mitigation measures as detailed in Section 3 be implemented. It is further recommended that mitigation measures detailed in *"Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities (March 2005)"* prepared by Cheminfo for Environment Canada be implemented, where practical.

7.2 Modelling

The Air Quality Assessment reviewed current standards and guidelines for air contaminants of CO, NO_x, SO_2, PM and VOCs. Ambient air concentrations were taken from local monitoring stations. Four scenarios were developed in order to assess different design alternatives, namely:

- Current (2010)
- Future No Build (2031)
- Future Build, Centre Lane BRT (2031)
- Future Build, Curb Lane BRT (2031)

Emission factors for CO, NO_x, SO_2, PM and VOCs, using MOBILE6.2, were developed for several road types and fleets. A conservative air dispersion model using CAL3QHCR was developed using all of the information collected. For the highest impacted receptors, the main findings of the air quality assessment are outlined below:

- The Future Build Curb Lane BRT Scenario features the greatest reduction of the majority of contaminants when compared to the Current scenario (**Table 7.1)**

- All contaminants, with the exception of benzene (1-hour, 24-hour average), are below their respective standard, guideline or interim reference level around all intersections in the Trafalgar Road corridor. The impact of benzene (1-hour, 24-hour average) is seen to exceed guidelines under the Current and Future No Build scenarios.
- In many cases, the ambient concentrations contribute to a large percentage of the total concentrations. They are as follows:
  - NO_2 (24-hour average) background concentrations are approximately 20% of the relevant limit;
  - $PM_{2.5}$, PM_{10} (24-hour average) background concentrations are approximately 45% and 50% of their respective limits;
  - PM_{TSP} (24-hour, annual average) background concentrations are approximately 35% of respective limits;
  - Acrolein (24-hour average) background concentrations are approximately 50% of the relevant limit;
  - Benzene (24-hour average) background concentrations are approximately 43% of the relevant limit;
  - Benzene (annual average) background concentrations are approximately 138% of the relevant limit.
- For the completed comparative assessments, emission reductions for the Future Build Curb Lane BRT and Future Build Centre Lane BRT are similar.
- Emission reductions for the Future Build cases are more significant than reductions seen in the Future No Build case for the majority of contaminants.

Table 7.1 Difference in Maximum Predicted Concentrations – Current vs. Future 2031

Pollutant	Averaging Time	Percentage Change		
		Future No Build	*Future Build Centre Lane BRT*	*Future Build Curb Lane BRT*
NOx	1	-15%	-25%	-28%
	24	-13%	-22%	-24%
CO	1	21%	-12%	-15%
	24	18%	-10%	-12%
SO_2	24	1%	0%	0%
$PM_{2.5}$	24	-4%	-1%	-3%
PM_{10}	24	-4%	-3%	-4%
PM_{TSP}	24	-5%	-1%	-3%
Acetaldehyde	24	-3%	-3%	-4%
Acrolein	24	6%	-5%	-6%
Benzene	24	-15%	-15%	-17%
1,3-Butadiene	24	-17%	-19%	-22%
Formaldehyde	24	-3%	-3%	-3%

As the re-suspension of road dust on paved roads should also be considered to estimate the particulate impacts at the most-impacted receptors, additional modelling was completed to incorporate the particulate matter (PM) emission contribution from re-suspension of road dust. Table 7.1 was updated to include particulate matter emissions from re-suspension of road dust. As shown in Table 7.1, the overall impact of PM contaminants will still decrease in the future build scenario compared to the current scenario.

The overall impacts of targeted contaminants will decrease due to commuters using the proposed BRT and reducing vehicle use on a regional level (**Table 7.2**).

Table 7.2 Comparison of Project Net Emission Change

Contaminant	Project (2031) Total Emissions *(Net Change) Tonnes/year*	Ontario 2009 *Tonnes/year*	Canada 2009 *Tonnes/year*
Composite VOC*	-5.03	150,525.05	509,575.04
Composite CO	-113.10	2,049,657.06	6,605,698.82
Composite NO_x	-6.53	283,819.19	1,132,078.69
SO_2	-0.05	14,536.63	95,355.16
PM_{TSP}	-0.33	17,467.72	68,760.19
PM_{10}	-0.19	17,380.09	68,226.93
$PM_{2.5}$	-0.10	15,332.00	61,151.06

*Notes: * For road vehicles, "Composite VOC" is as defined by the US EPA code MOBILE 6.2.*

From an air quality perspective, the implementation of the BRT Curb Lane scenario is the preferred design option since it results in reductions of regional air quality impacts while minimizing local POI impacts.

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Appendix A

Air Quality Monitoring Data

Electronic (CD) Submission

Appendix B

AADT Data

Electronic (CD) Submission

AECOM

Appendix C

Zoning Maps

16. DIVISION INTO ZONES

For the purposes of this by-law, the Town of Oakville is divided into the following zones, the boundaries of which are shown on the maps comprising Part VII and identified by the following symbols:

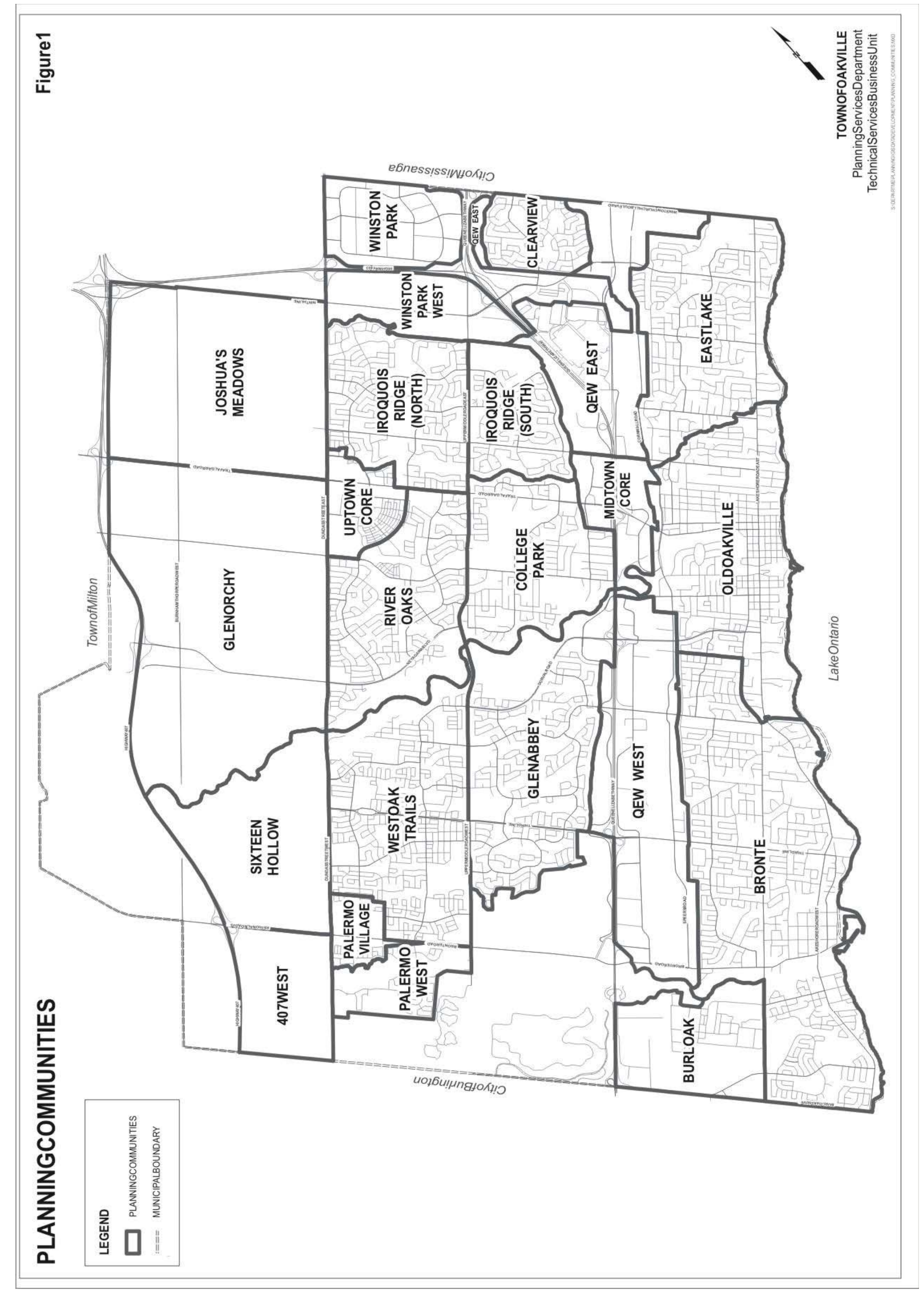
Class	Zone Designation	Symbol *
Residential	Detached Dwellings	R1 or R01, R2 or R02 R3 or R03, R4 or R04 R5 or R05, R10, R13
	Mixed Dwellings	R6 or R06, R7 or R07 R8 or R08, R11, R12
	Apartment Zone	R9
Commercial	Local Shopping Centre	C1
	Community Shopping Centre	C2
	Central Business District	C3
	Central Business District - Residential	C3R
	Arterial Commercial	C3A
	Rural Commercial	C4
	Highway Commercial	C5
	Service Station Zone	C6 or C3A
	Travellers' Service Zone	C7
Employment	Light Employment	E1
	General Employment	E2
	Transition Employment	T1
Industrial	Light Industrial	M1
	Medium Industrial	M2
	Heavy Industrial	M3

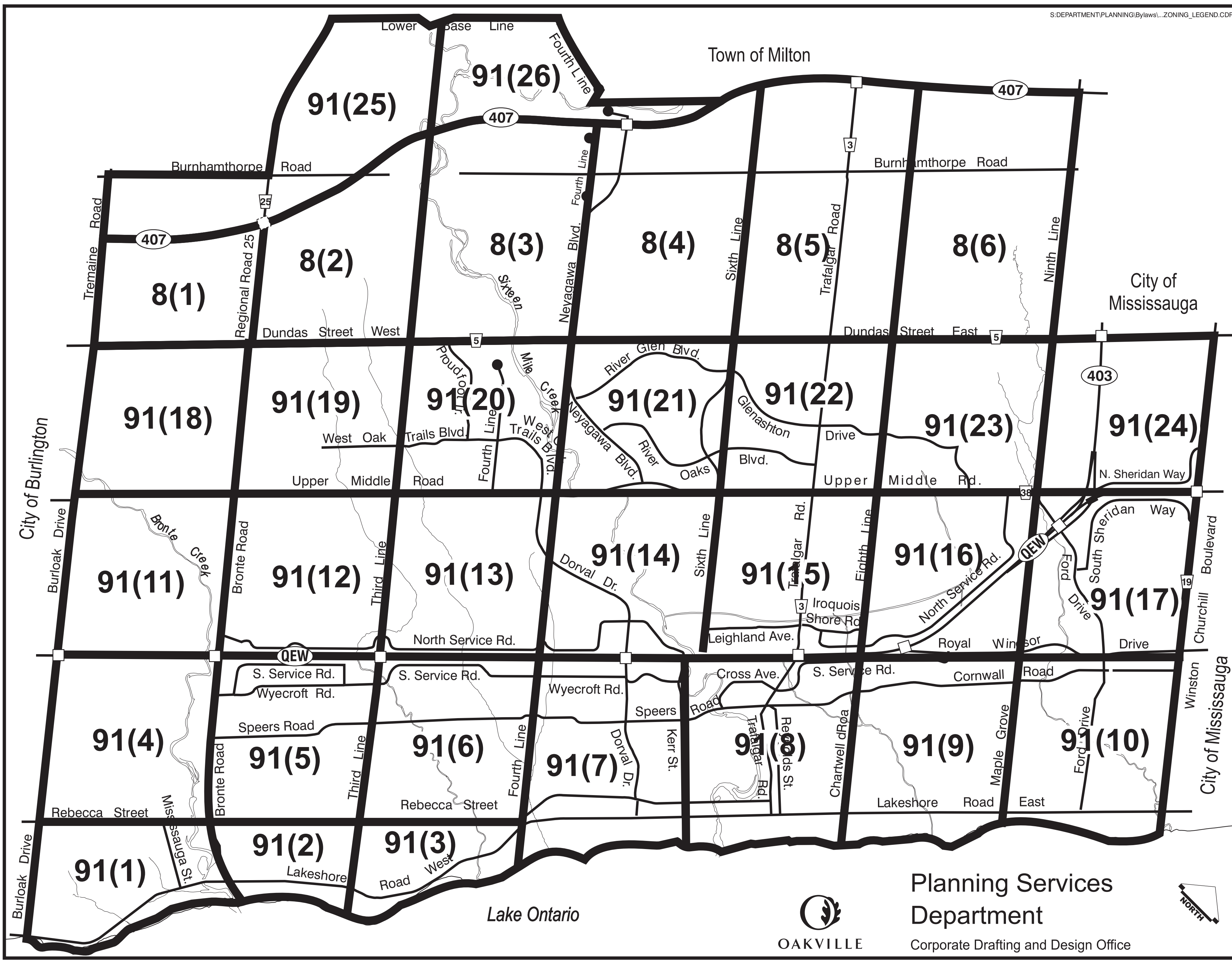
Class	Zone Designation	Symbol *
Open Space	Public Open Space	01
	Private Open Space	02
	Semi-Public	03
	Conservation	04
	Parkway Belt Public Use	05
	Marine Commercial	06
Public Use	Public Use	G
	Public Use/Education	P/E
Agricultural	Agricultural	A
Mixed Use	Mixed Use One	MU1
	Mixed Use Three	MU3
	Mixed Use Four	MU4
Parkway Belt	Parkway Belt Agricultural	PBA
	Parkway Belt Rural	PBR
	Parkway Belt	PB

* Where the symbol for a zone is used in conjunction with another notation, that symbol shall be deemed to be a reference to the relevant zone subject to such modifications as are contained in the relevant special provision of this by-law.

16A P <u>LANNING COMMUNITIES</u>

The Planning Communities of the Town of Oakville are depicted on the following Figure 1 and may be referred to by the names identified in Figure 1.





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City of Burlington
Lake Ontario
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91(26)
Lower Base Line
Fourth Line
Burnhamthorpe Road
Tremaine Road
Regional Road 25
Dundas Street West
Dundas Street East
Neyagawa Blvd.
Sixth Line
Trafalgar Road
Ninth Line
Sixteen Mile Creek
Proudfoot
River Glen Blvd.
Glenashton Drive
West Oak Trails Blvd.
River Oaks Blvd.
Upper Middle Road
Upper Middle Rd.
N. Sheridan Way
South Sheridan Way
Bronte Creek
Burloak Drive
Bronte Road
Third Line
Dorval Dr.
Eighth Line
North Service Rd.
Iroquois Shore Rd.
Leighland Ave.
Royal Windsor Drive
Ford Drive
Churchill Boulevard
Winston Churchill Boulevard
QEW
S. Service Rd.
Wyecroft Rd.
Speers Road
Cross Ave.
Cornwall Road
Kerr St.
Trafalgar Rd.
Reynolds St.
Chartwell Road
Maple Grove
Rebecca Street
Lakeshore Road East
Lakeshore Road West
Mississauga St.
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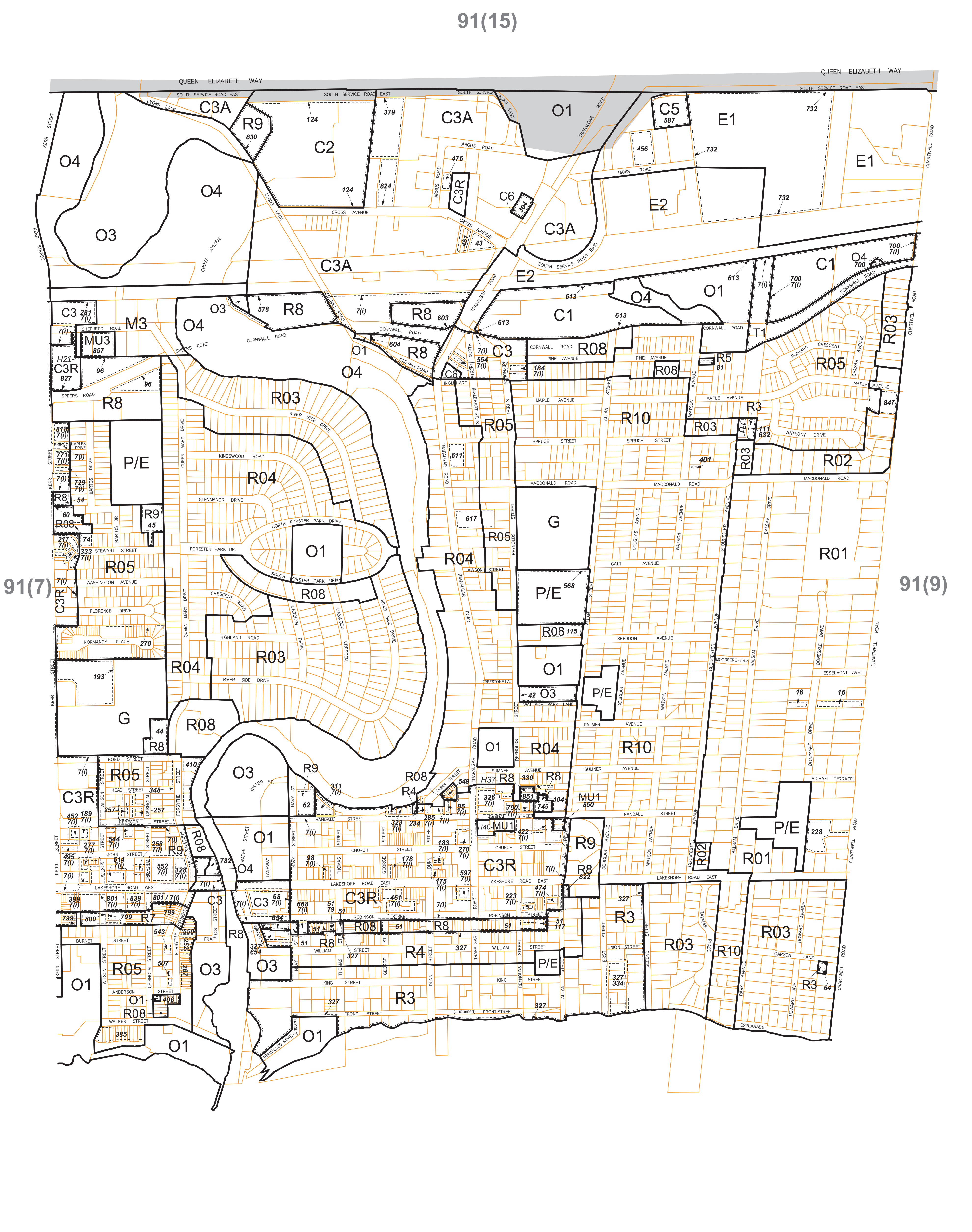
NORTH
OAKVILLE
Planning Services Department
Corporate Drafting and Design Office



■ HIGHWAY CORRIDOR

— ZONING BOUNDARY

- - - SPECIAL PROVISION BOUNDARY

TOWN OF OAKVILLE

Planning Services Department
Corporate Drafting and Design Office

0 250 500 750 1,000 Meters

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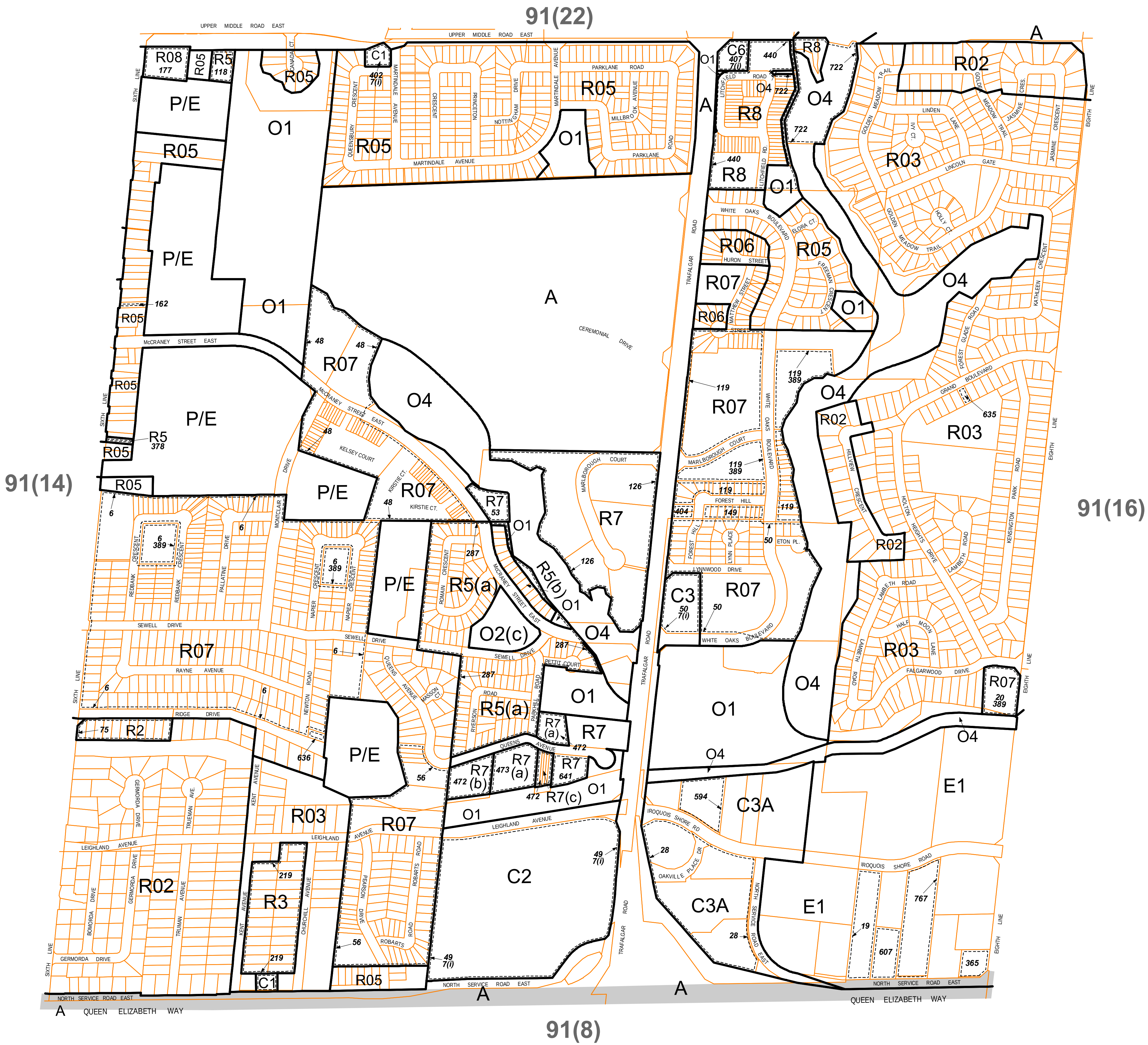

HIGHWAY CORRIDOR

ZONING BOUNDARY

SPECIAL PROVISION BOUNDARY

TOWN OF OAKVILLE

Planning Services Department

Corporate Drafting and Design Office

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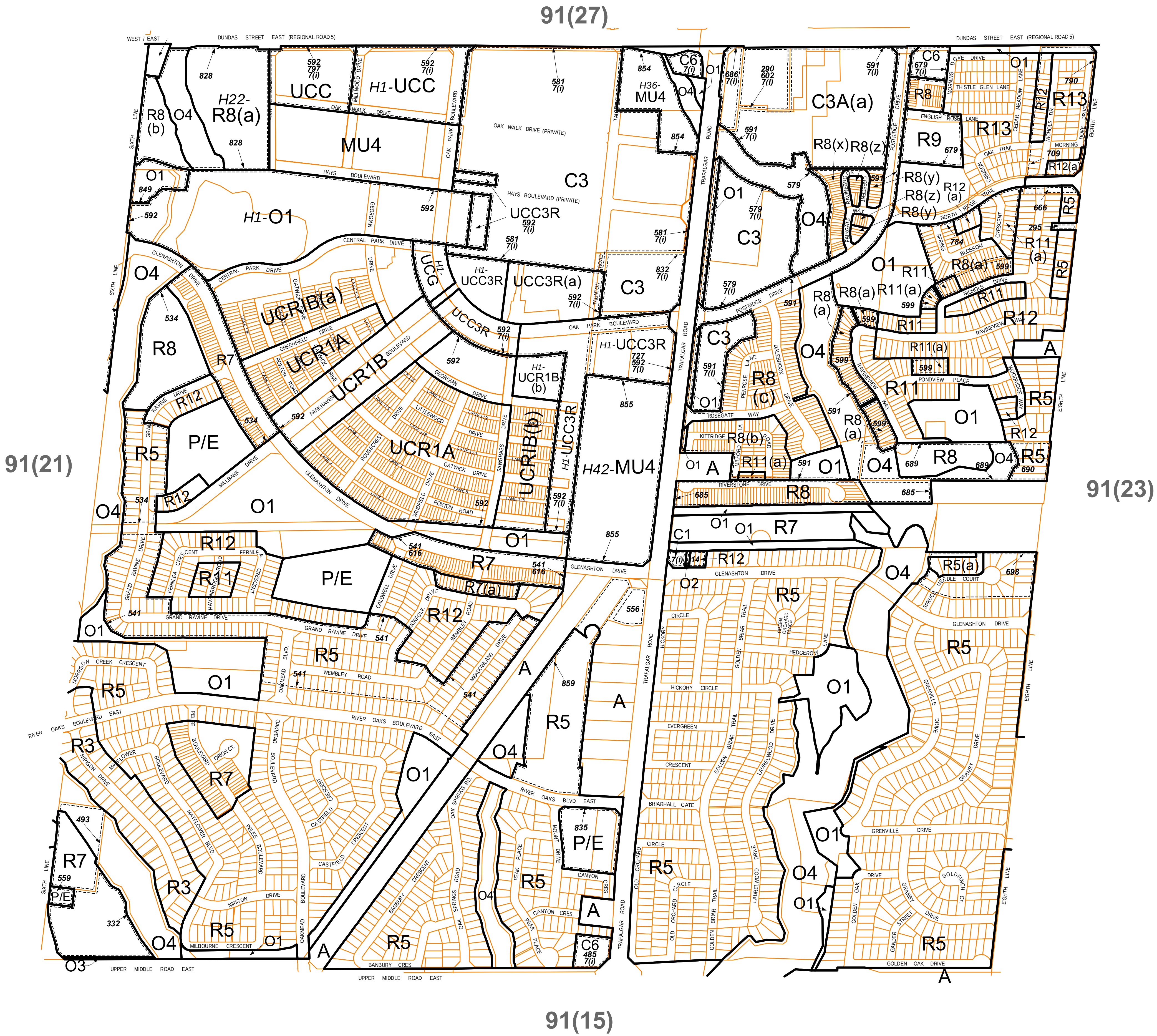

ZONING BOUNDARY

SPECIAL PROVISION BOUNDARY

TOWN OF OAKVILLE

Planning Services Department
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Appendix D

Sensitive Receptors

Legend

RCPT RECEPTOR LOCATIONS

Closest Residence (1587 Litchfield Rd)	Rcpt_1
Trafalgar Ridge Montessori School	Rcpt_2
Glenashton Daycare Center	Rcpt_3
Croatian Catholic Mission	Rcpt_4
St. Simons Anglican Church	Rcpt_5
Faith Baptist Church	Rcpt_6
Residenec on Rosegate Way	Rcpt_7
Rabba Apartments 1	Rcpt_8
Rabba Apartments 2	Rcpt_9
Wallace Pines Apartments	Rcpt_10
Apartment Building	Rcpt_11
Sunrise Senior Living	Rcpt_12
Queens Ave Retirement Residence	Rcpt_13
Sheridian College	Rcpt_14
Grace Lutheran	Rcpt_15
Mary Mother of God Parish	Rcpt_16
Sheridan Hills Church	Rcpt_17
Trafalgar Presbyterian Church	Rcpt_18
Trinity United	Rcpt_19
MacLaughlan College	Rcpt_20
Residence on Forest Hill Drive	Rcpt_21
White Oaks Townhouse	Rcpt_22
Sheridan College Skills Centre	Rcpt_23
Allan Rd. Residence 1	Rcpt_24
Halton Healthcare	Rcpt_25
St Michaels Catholic School/Church	Rcpt_26
Lorne Skuce Public School	Rcpt_27
White Oaks Secondary School	Rcpt_28
MontClair Elementary	Rcpt_29
Georgian Drive Residence 1	Rcpt_30
Wembly Rd. Residence	Rcpt_31
Oak Springs Rsidence	Rcpt_32
Riverside Dr. Residence	Rcpt_33
Robarts Rd Residence	Rcpt_34
Burnhamthorpe Residence 1	Rcpt_35
Trafalgar Rd Residence 1	Rcpt_36
Trafalgar Rd Residence 2	Rcpt_37
Trafalgar Rd Residence 3	Rcpt_38
Trafalgar Rd Residence	Rcpt_39
Al-Falah Islamic Centre & School	Rcpt_40
The Villas on Marlborough Ct	Rcpt_41
Residence on Old Orchard Circle	Rcpt_42

1 : 10,000

DO NOT SCALE THIS DOCUMENT.
ALL MEASUREMENTS MUST BE OBTAINED FROM STATED DIMENSIONS.

AECOM

Halton Region
Trafalgar Road Corridor
BRT Air Quality Assessment

Receptor Locations

PROJECT NUMBER	DATE	FIGURE
60119993	Sept. 2011	1

Appendix E

Emission Factors and MOBILE6.2 Input/Output

Electronic (CD) Submission

Appendix F

CAL3QHCR Input/Output

Electronic (CD) Submission

Appendix G

Future Build Centre Lane BRT Results

Table G1. Maximum Predicted Concentrations 2031 – Future Build Centre Lane BRT Scenario

	Pollutant	Modelled	Background	Total	Air Quality Threshold	Percentage of Threshold	Impact at Receptor ID
		μg/m^3	μg/m^3	μg/m^3	μg/m^3	%	
1-Hour Averaging Period	***NOx***	337.60	63.76	401.36	-	-	11
	NO_2	126.37	48.74	175.11	400	43.8%	11
	CO	2,656.1	386.0	3,042.06	36,200	8.4%	11
	SO_2	3.0	21.5	24.51	690	3.6%	11
	Acetaldehyde	0.985	-	0.98	500	0.2%	11
	Acrolein	0.140	-	0.14	-	-	11
	Benzene	10.95	-	10.95	-	-	11
	1,3-Butadiene	1.00	-	1.00	-	-	11
	Formaldehyde	1.44	-	1.44	-	-	11
8-Hour Average Period	***CO***	1,484	386.00	1,870	15,700	12%	11
24-Hour Average Period	NOx	138.66	57.82	196.48	-	-	11
	NO2	96.90	39.95	136.85	200	68.4%	11
	CO	1,090.9	386.0	1,476.88	-	-	11
	SO2	1.2	18.6	19.79	275	7.2%	11
	PM2.5	2.82	13.51	16.33	30	54.4%	11
	PM2.5	2.82	13.51	16.33	27	60.5%	11
	PM10	8.00	25.02	33.02	50	66.0%	11
	PM TSP	9.40	45.03	54.43	120	45.4%	11
	Acetaldehyde	0.405	2.620	3.02	500	0.6%	11
	Acrolein	0.058	0.190	0.25	0.40	61.9%	11
	Benzene	4.50	0.98	5.48	2.30	238.2%	11
	1,3-Butadiene	0.41	0.11	0.51	10	5.1%	11
	Formaldehyde	0.59	4.45	5.04	65	7.8%	11
Annual Averaging Period	***NO_x***	27.73	30.52	58.25	-	-	11
	NO_2	19.38	22.91	42.29	-	-	11
	CO	218.18	-	218.18	-	-	11
	SO_2	0.25	8.64	8.89	55	16.2%	11
	$PM_{2.5}$	0.89	6.54	7.43	8.8	84.4%	11
	PM_{10}	2.54	12.11	14.65	-	-	11
	PM_{TSP}	2.97	21.80	24.77	60	41.3%	-
	Acetaldehyde	0.081	1.670	1.75	-	-	11
	Acrolein	0.012	0.110	0.12	-	-	11
	Benzene	0.899	0.620	1.52	0.45	337.7%	11
	1,3-Butadiene	0.082	0.059	0.14	2.00	7.0%	11
	Formaldehyde	0.118	2.610	2.73	-	-	11

Appendix H

Future No Build Results

Table H1. Maximum Predicted Concentrations 2031 – Future No Build Scenario

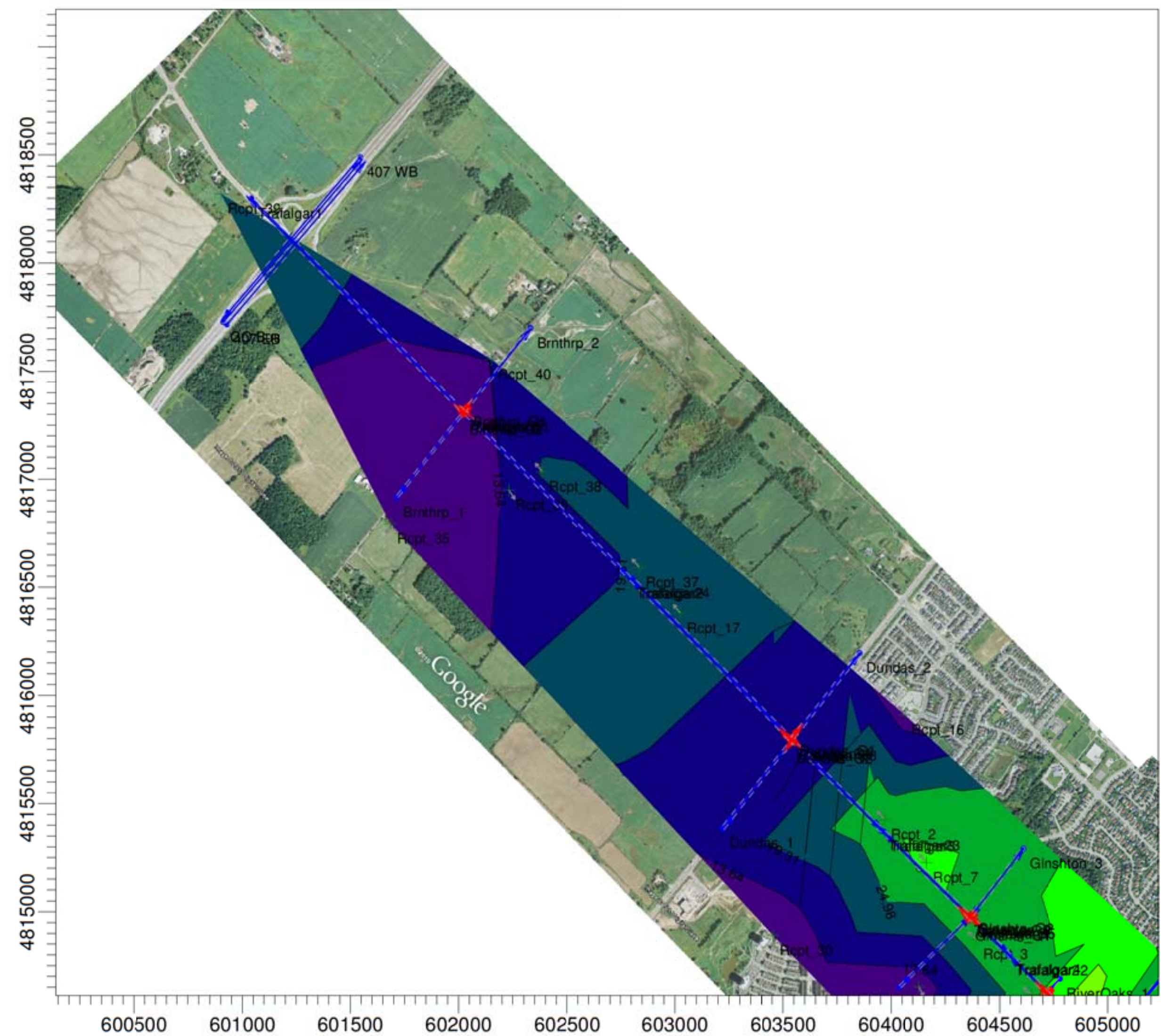
	Pollutant	Modelled	Background	Total	Air Quality Threshold	Percentage of Threshold	Impact at Receptor ID
		µg/m³	µg/m³	µg/m³	µg/m³	%	
1-Hour Averaging Period	*NOx*	392.05	63.76	455.81	-	-	11
	NO_2	131.81	48.74	180.55	400	45.1%	11
	CO	3,846.3	386.0	4,232.29	36,200	11.7%	11
	SO2	3.6	21.5	25.09	690	3.6%	11
	Acetaldehyde	0.969	-	0.97	500	0.2%	11
	Acrolein	0.213	-	0.21	-	-	11
	Benzene	10.99	-	10.99	-	-	11
	1,3-Butadiene	1.03	-	1.03	-	-	11
	Formaldehyde	1.42	-	1.42	-	-	11
8-Hour Average Period	*CO*	2,149	386.00	2,535	15,700	16%	11
24-Hour Average Period	*NOx*	161.02	57.82	218.84	-	-	11
	NO_2	99.14	39.95	139.09	200	69.5%	11
	CO	1,579.7	386.0	1,965.73	-	-	11
	SO_2	1.5	18.6	20.03	275	7.3%	11
	$PM_{2.5}$	2.40	13.51	15.91	30	53.0%	11
	$PM_{2.5}$	2.40	13.51	15.91	27	58.9%	11
	PM_{10}	7.28	25.02	32.30	50	64.6%	12
	PM_{TSP}	8.00	45.03	53.03	120	44.2%	12
	Acetaldehyde	0.398	2.620	3.02	500	0.6%	11
	Acrolein	0.087	0.190	0.28	0.40	69.4%	11
	Benzene	4.51	0.98	5.49	2.30	238.8%	11
	1,3-Butadiene	0.42	0.11	0.53	10	5.3%	11
	Formaldehyde	0.58	4.45	5.03	65	7.7%	11
Annual Averaging Period	*NOx*	32.20	30.52	62.72	-	-	11
	NO_2	19.83	22.91	42.74	-	-	11
	CO	315.95	-	315.95	-	-	11
	SO_2	0.29	8.64	8.93	55	16.2%	11
	$PM_{2.5}$	0.71	6.54	7.25	8.8	82.4%	11
	PM_{10}	2.06	12.11	14.17	-	-	11
	PM_{TSP}	2.37	21.80	24.17	60	40.3%	-
	Acetaldehyde	0.08	1.67	1.75	-	-	11
	Acrolein	0.017	0.110	0.13	-	-	11
	Benzene	0.90	0.62	1.52	0.45	338.3%	11
	1,3-Butadiene	0.08	0.06	0.14	2.00	7.2%	11
	Formaldehyde	0.12	2.61	2.73	-	-	11

Appendix I

Sample Concentration Contour Plots

PROJECT TITLE:

Current - North of Dundas (CO)



Contours ppm

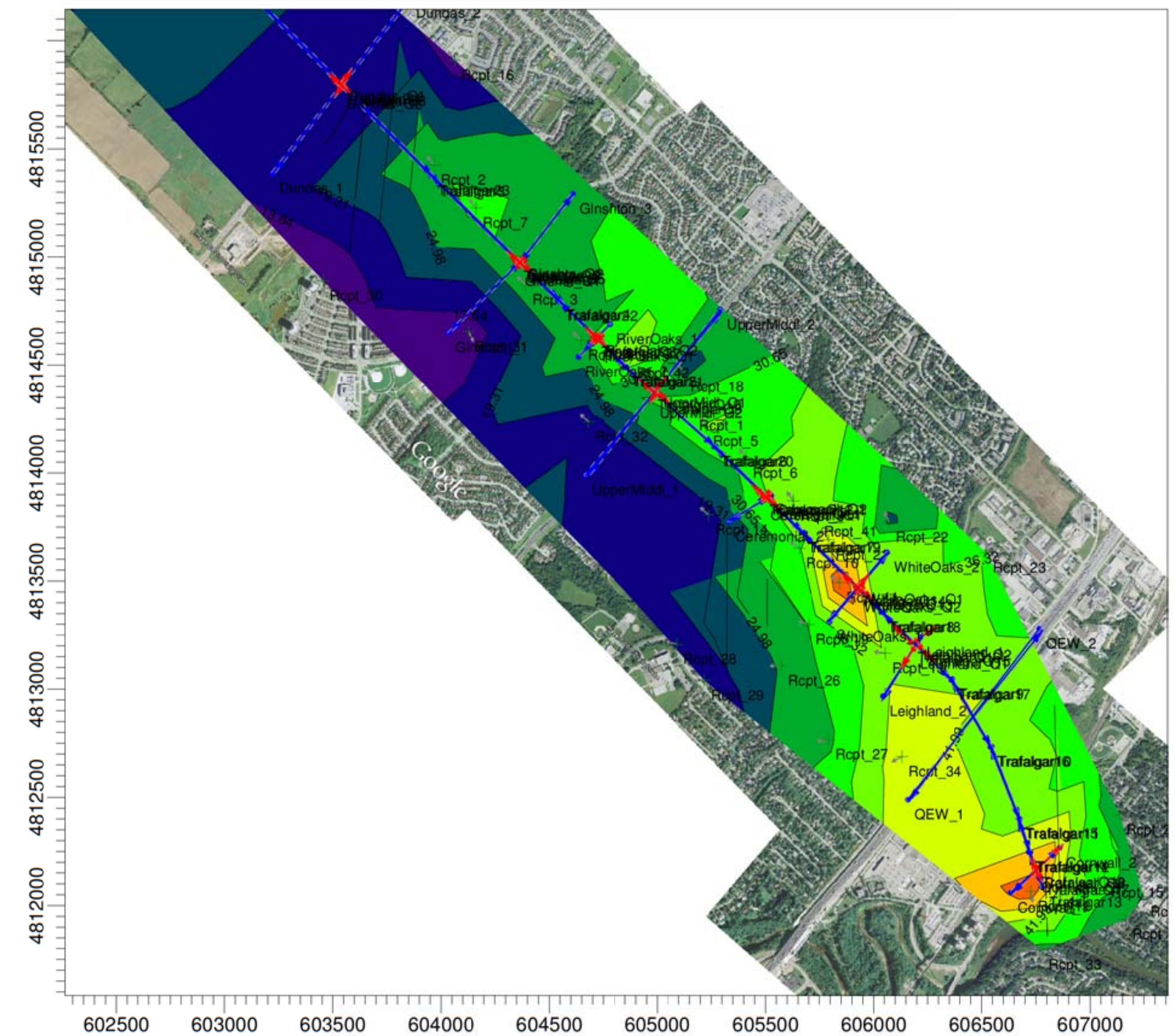
8.00 | 13.64 | 19.31 | 24.98 | 30.65 | 36.32 | 41.99 | 47.66 | 53.33 | 59.00

COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Current - North of Dundas (CO)	**CAL3QHCR**	**CO**	**AECOM**	
			MODELER: **MS/TB/TW**	
	LINKS: **85**	RECEPTORS: **42**		
	SCALE: 1:31,093 (0 — 1 m)		DATE: **9/28/2011**	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software — C:\Trafalgar NO GO Train\Current\CO\TrafalgarCurrentCO.clv

PROJECT TITLE:

Current - South of Dundas (CO)



Contours ppm

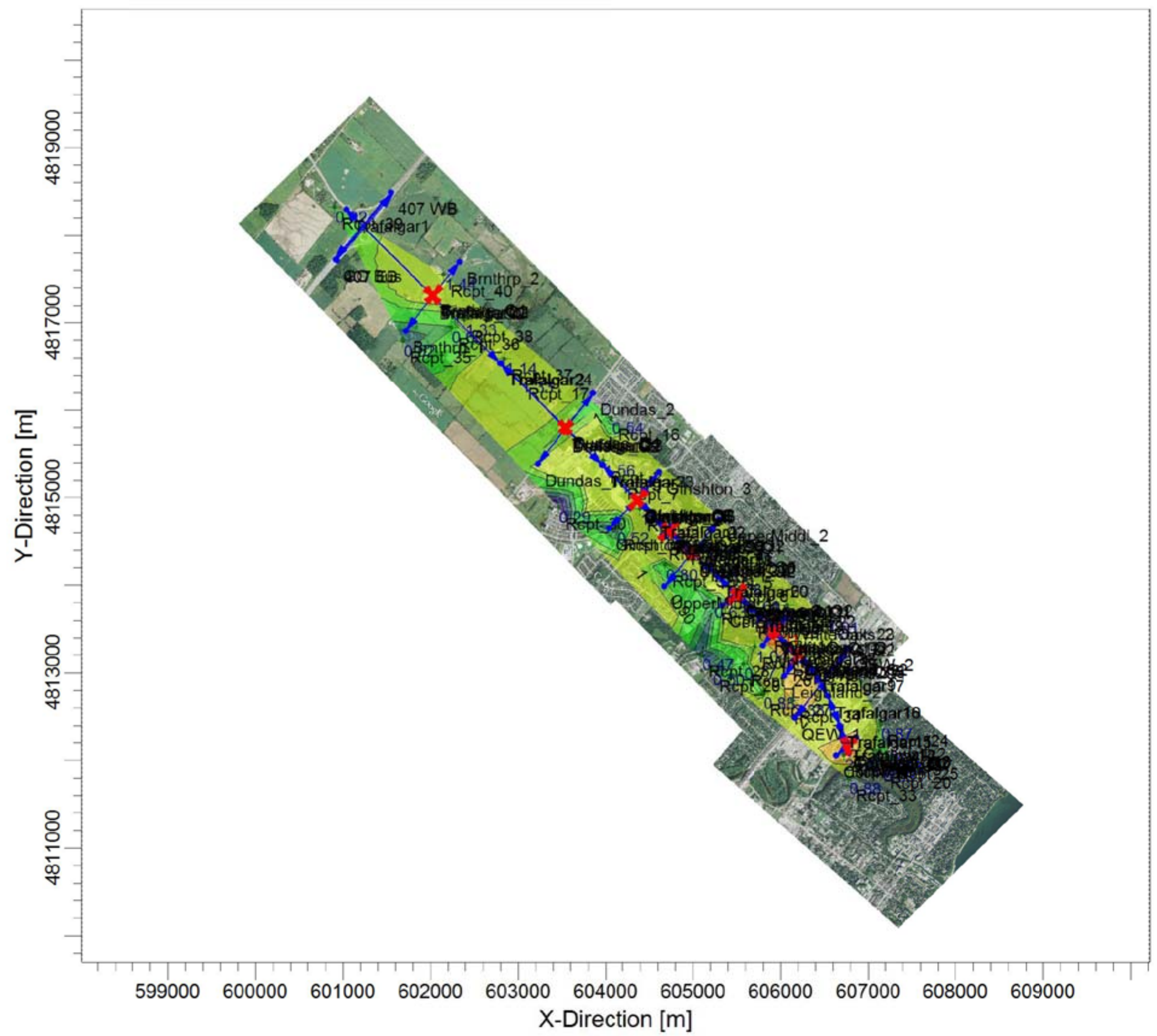
8.00 | 13.64 | 19.31 | 24.98 | 30.65 | 36.32 | 41.99 | 47.66 | 53.33 | 59.00

COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Current - South of Dundas (CO)	**CAL3QHCR**	**CO**	**AECOM**	
			MODELER: **MS/TB/TW**	
	LINKS: **85**	RECEPTORS: **42**		
	SCALE: 1:31,093 (0 — 1 m)		DATE: **9/28/2011**	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software — C:\Trafalgar NO GO Train\Current\CO\TrafalgarCurrentCO.clv

PROJECT TITLE:

Current - (PM2.5)



Contours ug/m**3

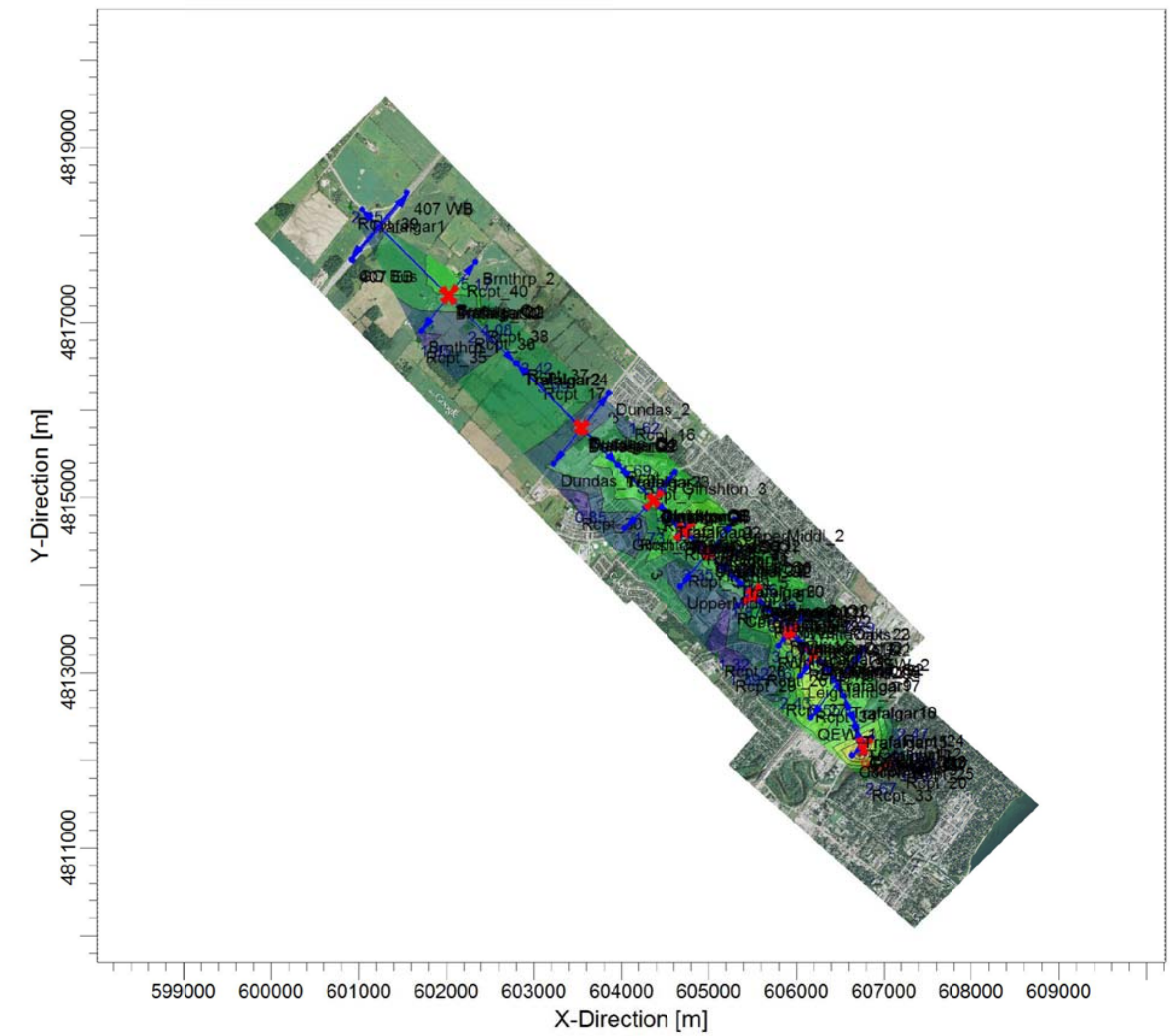
0.29	0.40	0.50	0.60	0.70	0.90	1.00	2.00	3.00	3.01

COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Current - (PM2.5)	CAL3QHCR	Particulate		
	MAX: 3.01	UNITS: ug/m**3	MODELER:	
	LINKS: 85	RECEPTORS: 42		
	SCALE: 1:76,729 (0 — 2 m)		DATE: 4/9/2015	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software   C:\Lakes\CALRoads View\Trafalgar Rd EA\Appendix D. CAL3QHCR InputOutput\TrafalgarCurrentPM25.clv

PROJECT TITLE:

Current -PM10



Contours ug/m**3

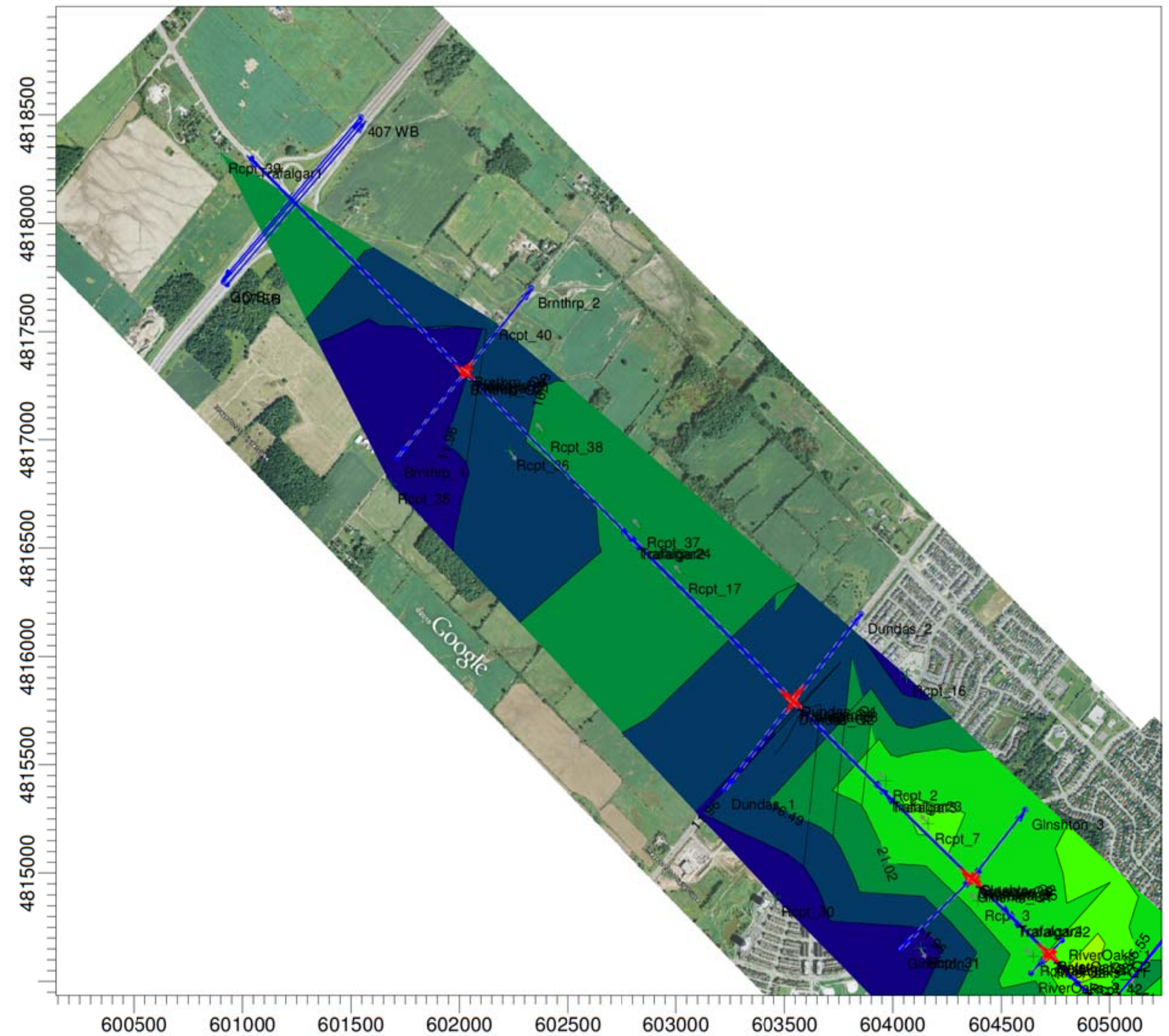
0.85	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	9.08

COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Current - PM10	CAL3QHCR	Particulate		
	MAX: 9.08	UNITS: ug/m**3	MODELER:	
	LINKS: 85	RECEPTORS: 42		
	SCALE: 1:76,729 (0 — 2 m)		DATE: 4/9/2015	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software   C:\Lakes\CALRoads View\Trafalgar Rd EA\Appendix D. CAL3QHCR InputOutput\TrafalgarCurrentPM10.clv

PROJECT TITLE:

Future No Build - North of Dundas (CO)



Contours ppm

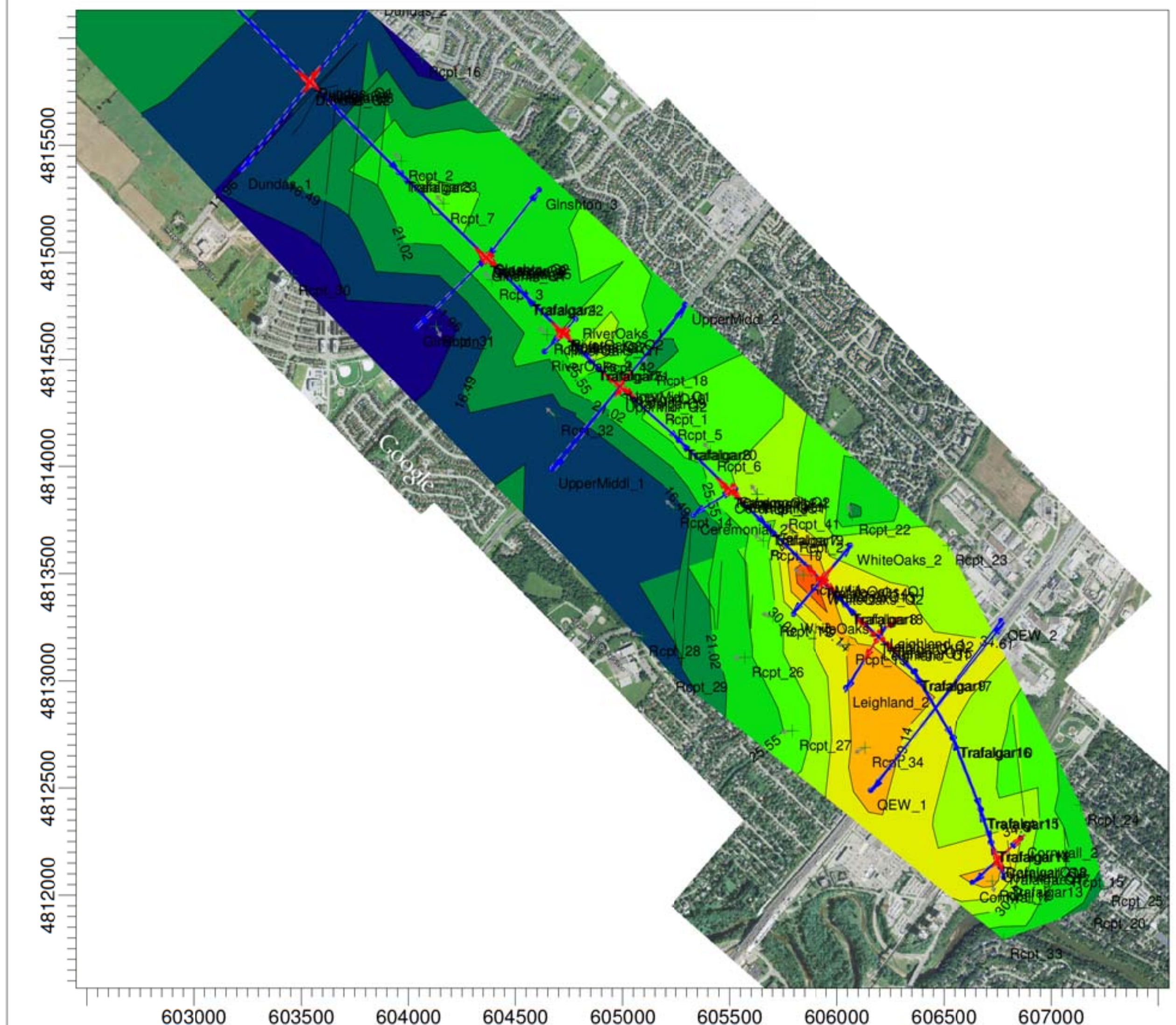
7.40 | 7.43 | 11.96 | 16.49 | 21.02 | 25.55 | 30.08 | 34.61 | 39.14 | 43.67 | 48.20

COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Future No Build - North of Dundas (CO)	CAL3QHCR	CO	AECOM	
			MODELER: MS/TB/TW	
	LINKS: 85	RECEPTORS: 42		
	SCALE: 1:31,111 (0 — 1 m)		DATE: 9/29/2011	PROJECT / PLOT NO.: 60119993

CALRoads View - Lakes Environmental Software C:\Trafalgar NO GO Train\FNB\CO\TrafalgarFNBCO.clv

PROJECT TITLE:

Future No Build - South of Dundas (CO)



Contours ppm

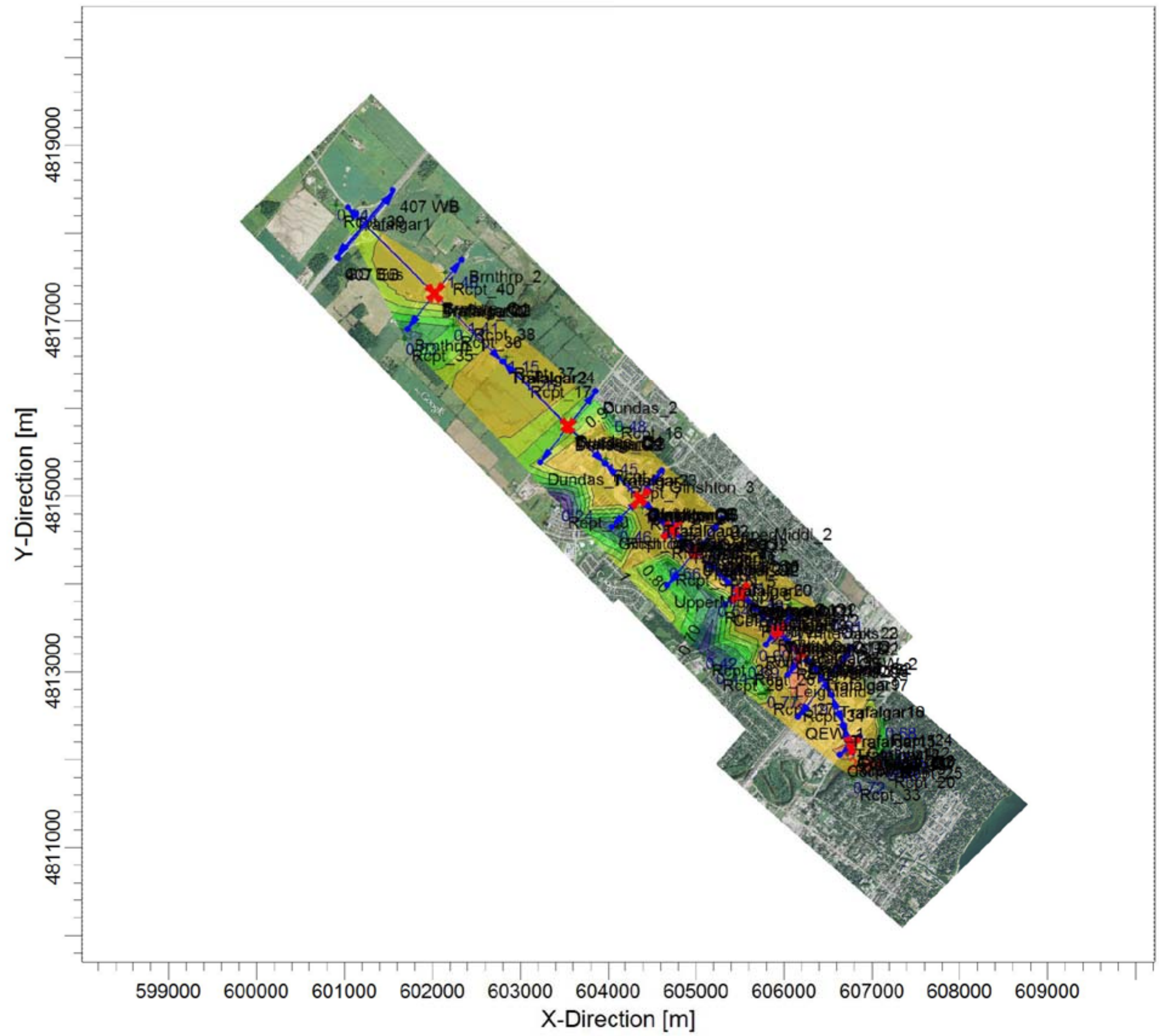
7.40 | 7.43 | 11.96 | 16.49 | 21.02 | 25.55 | 30.08 | 34.61 | 39.14 | 43.67 | 48.20

COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Future No Build - South of Dundas (CO)	CAL3QHCR	CO	AECOM	
			MODELER: MS/TB/TW	
	LINKS: 85	RECEPTORS: 42		
	SCALE: 1:31,111 (0 — 1 m)		DATE: 9/29/2011	PROJECT / PLOT NO.: 60119993

CALRoads View - Lakes Environmental Software C:\Trafalgar NO GO Train\FNB\CO\TrafalgarFNBCO.clv

PROJECT TITLE:

Future No Build - PM2.5



Contours ug/m**3

0.24 | 0.40 | 0.50 | 0.60 | 0.70 | 0.80 | 0.90 | 1.00 | 2.00 | 2.40

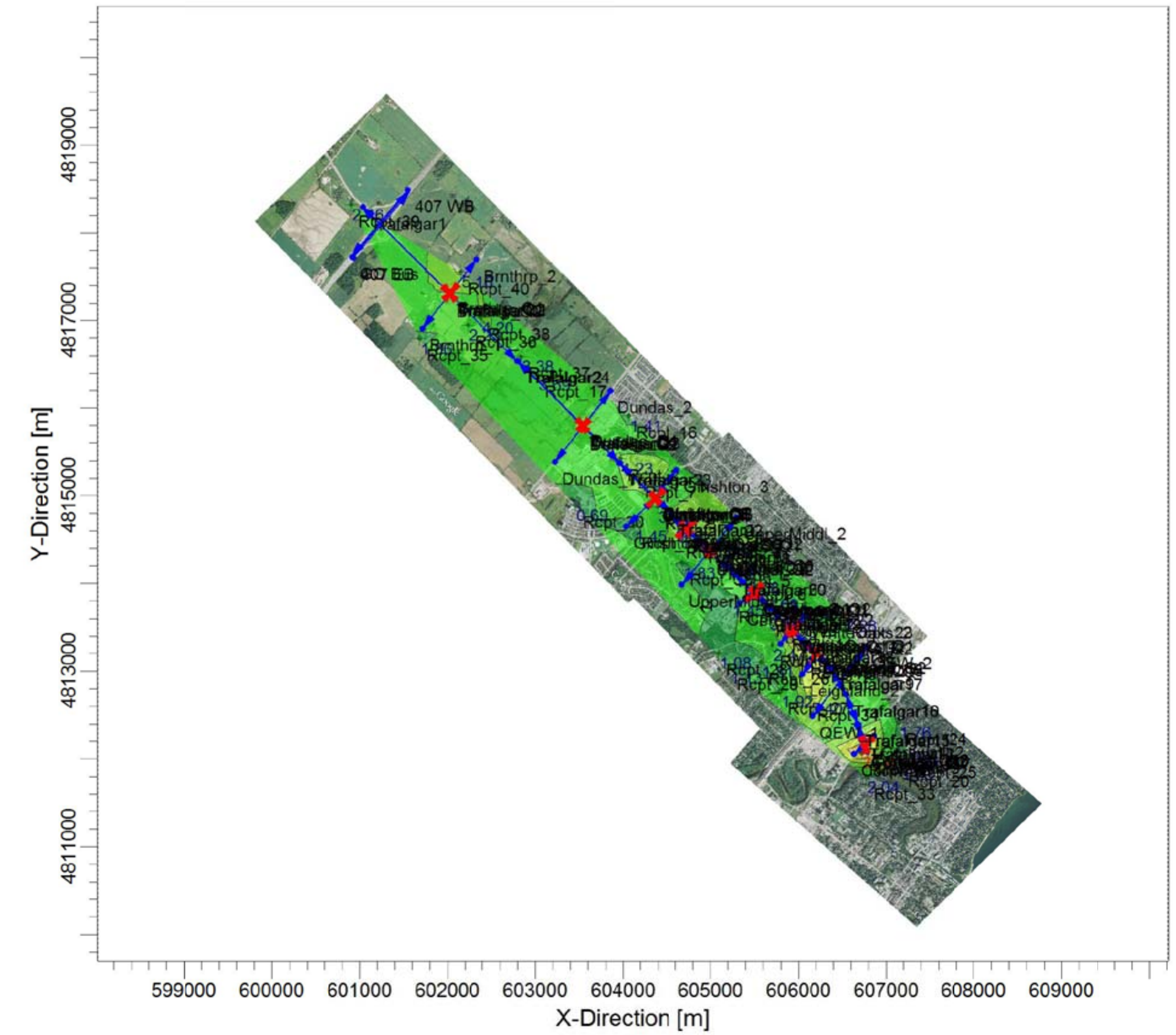
COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Future No Build - PM2.5	**CAL3QHCR**	**Particulate**		
	MAX: **2.40**	UNITS: **ug/m**3**	MODELER:	
	LINKS: **85**	RECEPTORS: **42**		
	SCALE: 1:76,729 (0 — 2 m)		DATE: **4/9/2015**	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software

C:\Lakes\CALRoads View\Trafalgar Rd EA\Appendix D. CAL3QHCR InputOutput\TrafalgarFNBPM25.clv

PROJECT TITLE:

Future No Build - PM10



Contours ug/m**3

0.69 | 0.80 | 0.90 | 1.00 | 2.00 | 4.00 | 5.00 | 6.00 | 7.00 | 7.28

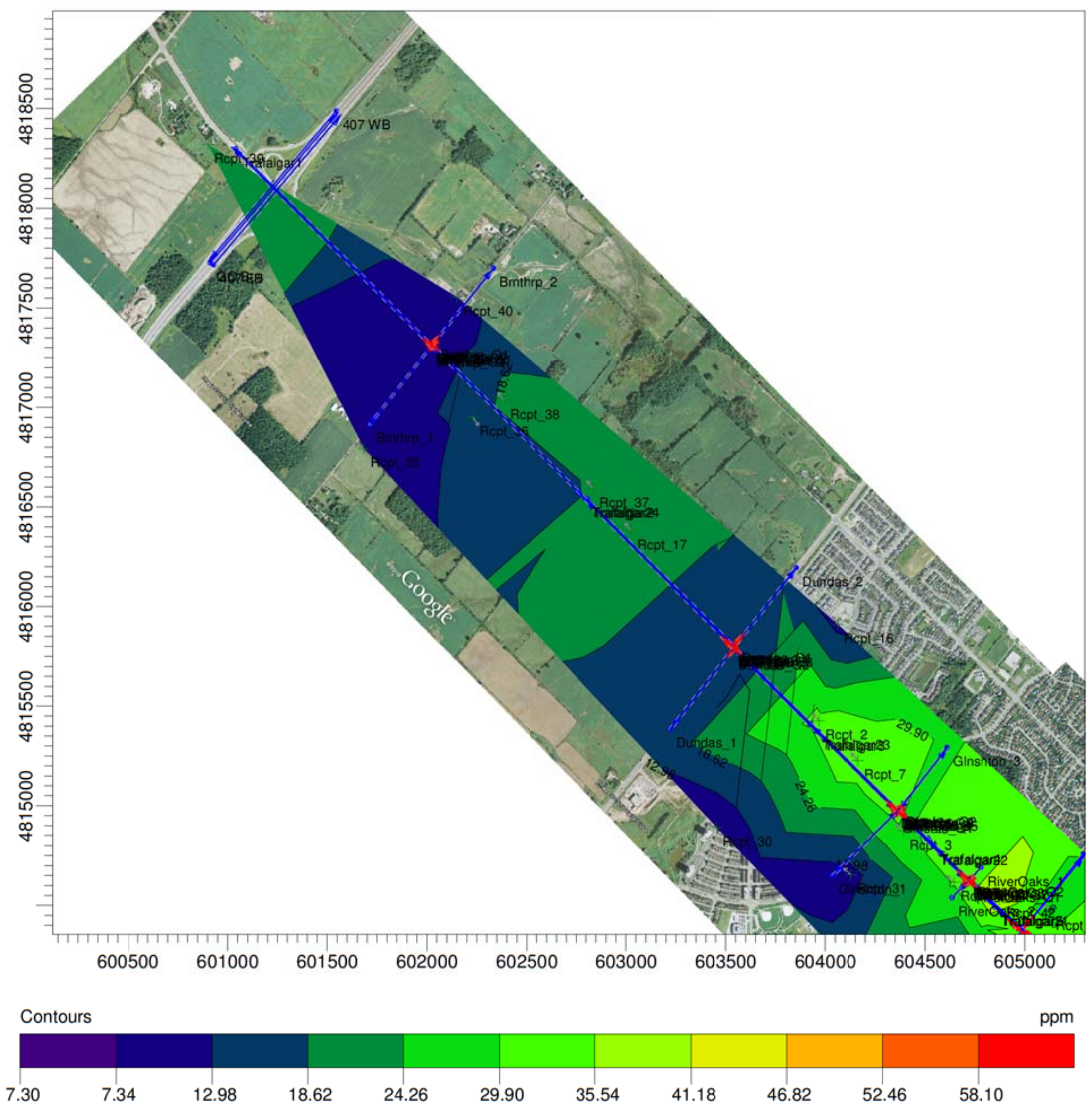
COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Future No Build - PM10	**CAL3QHCR**	**Particulate**		
	MAX: **7.28**	UNITS: **ug/m**3**	MODELER:	
	LINKS: **85**	RECEPTORS: **42**		
	SCALE: 1:76,729 (0 — 2 m)		DATE: **4/9/2015**	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software

C:\Lakes\CALRoads View\Trafalgar Rd EA\Appendix D. CAL3QHCR InputOutput\TrafalgarFNBPM10.clv

PROJECT TITLE:

Future Center BRT - North of Dundas (CO)

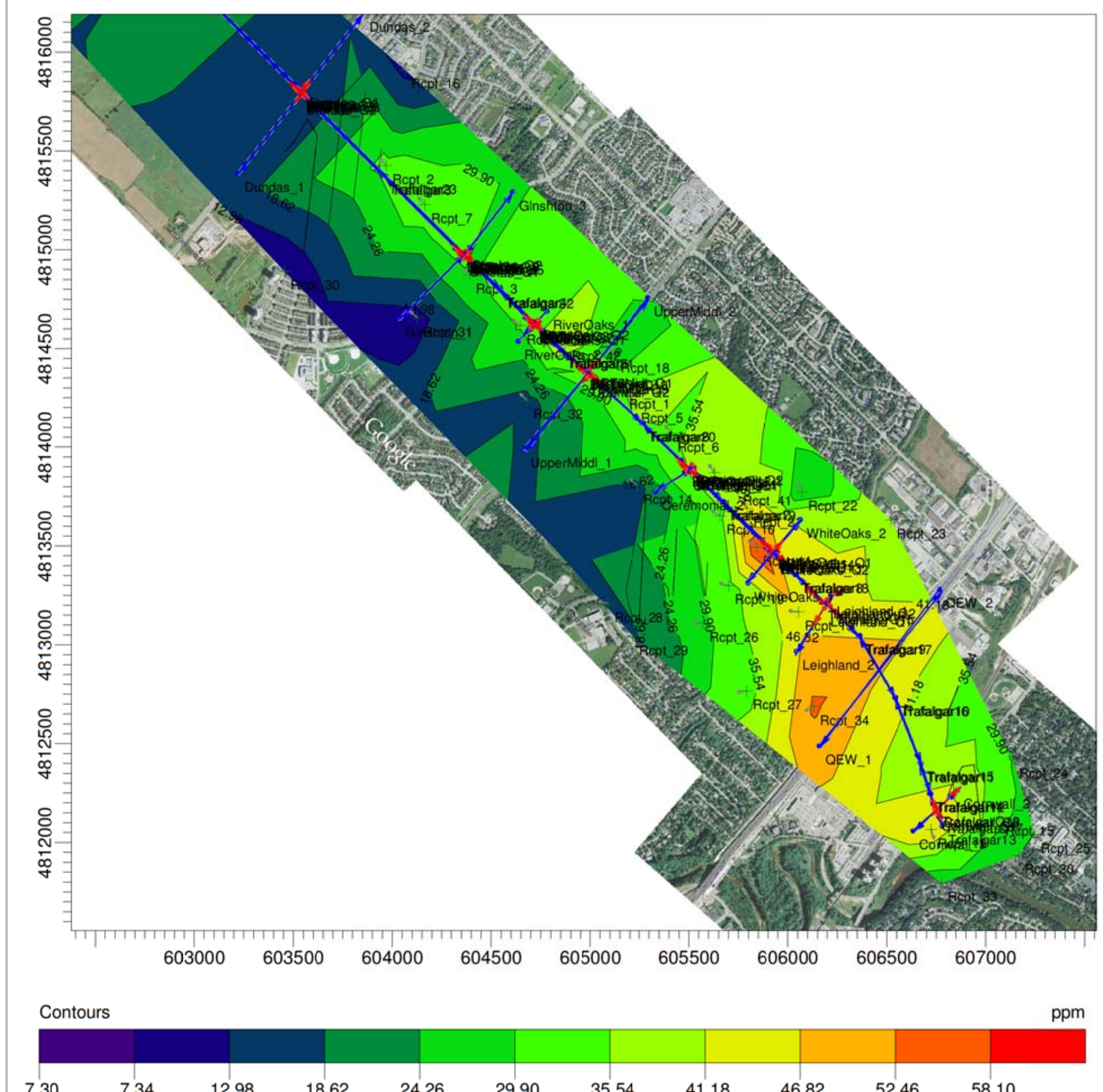


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Future Center BRT - North of Dundas (CO)	**CAL3QHCR**	**CO**	**AECOM**	
			MODELER: **MS/TB/TW**	
	LINKS: **111**	RECEPTORS: **42**		
	SCALE: 1:31,604 (0 — 1 m)		DATE: **9/29/2011**	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software C:\Trafalgar NO GO Train\FB1\CO\TrafalgarFB1CO.clv

PROJECT TITLE:

Future Center BRT - South of Dundas (CO)

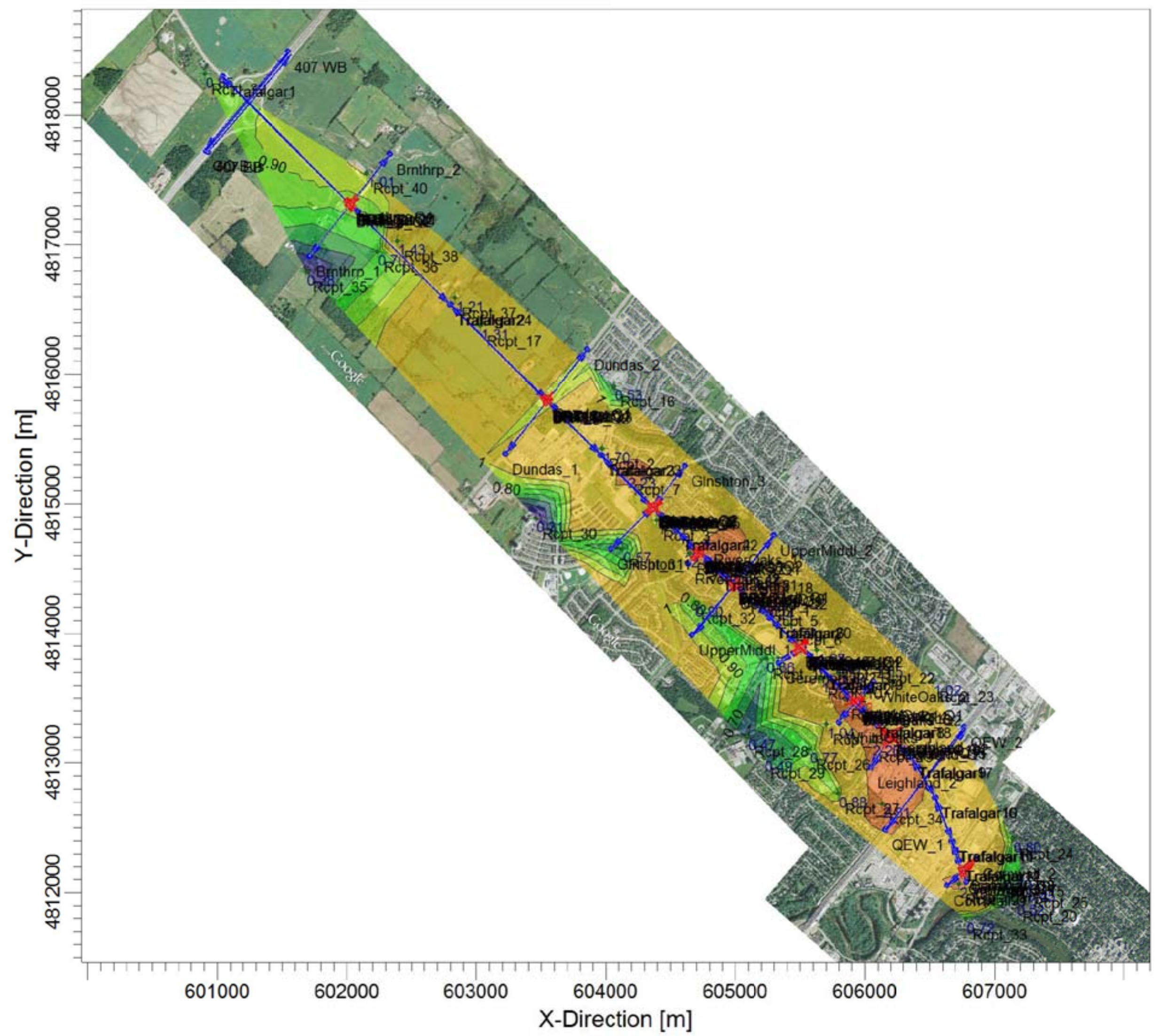


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Future Center BRT - South of Dundas (CO)	**CAL3QHCR**	**CO**	**AECOM**	
			MODELER: **MS/TB/TW**	
	LINKS: **111**	RECEPTORS: **42**		
	SCALE: 1:31,604 (0 — 1 m)		DATE: **9/29/2011**	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software C:\Trafalgar NO GO Train\FB1\CO\TrafalgarFB1CO.clv

PROJECT TITLE:

Future Center BRT - North of Dundas (PM2.5)



Contours ug/m**3

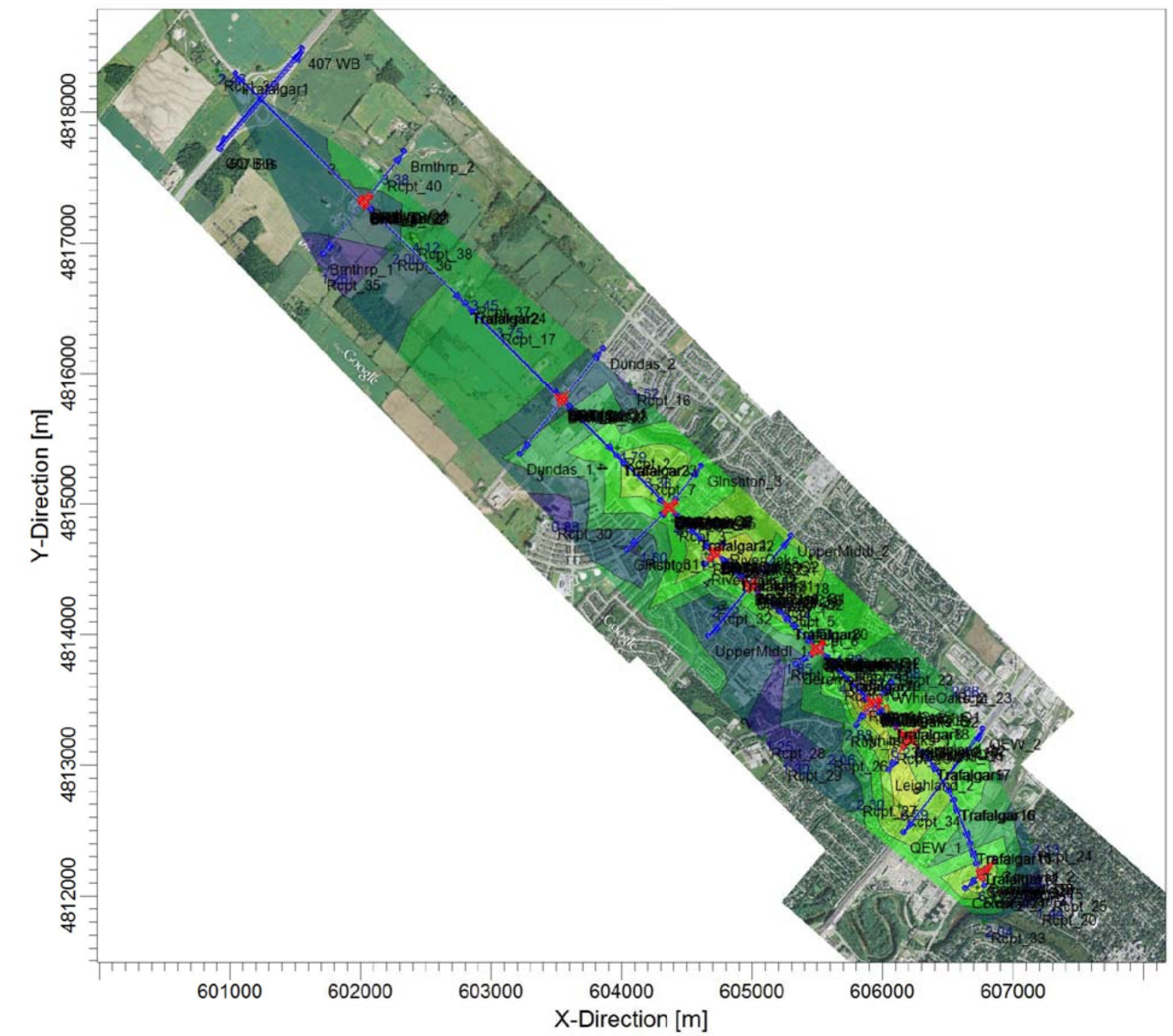
0.31	0.40	0.50	0.60	0.70	0.80	0.90	1.00	2.00	2.82

COMMENTS: Future Center BRT - North of Dundas (PM2.5)	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME:	
	MAX: **2.82**	UNITS: **ug/m**3**	MODELER:	
	LINKS: **111**	RECEPTORS: **42**		
	SCALE: 1:51,850 (0 — 1 m)		DATE: **4/13/2015**	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software C:\Lakes\CALRoads View\Trafalgar Rd EA\Appendix D. CAL3QHCR InputOutput\TrafalgarFB1PM25.clv

PROJECT TITLE:

Future Center BRT - North of Dundas (PM10)



Contours ug/m**3

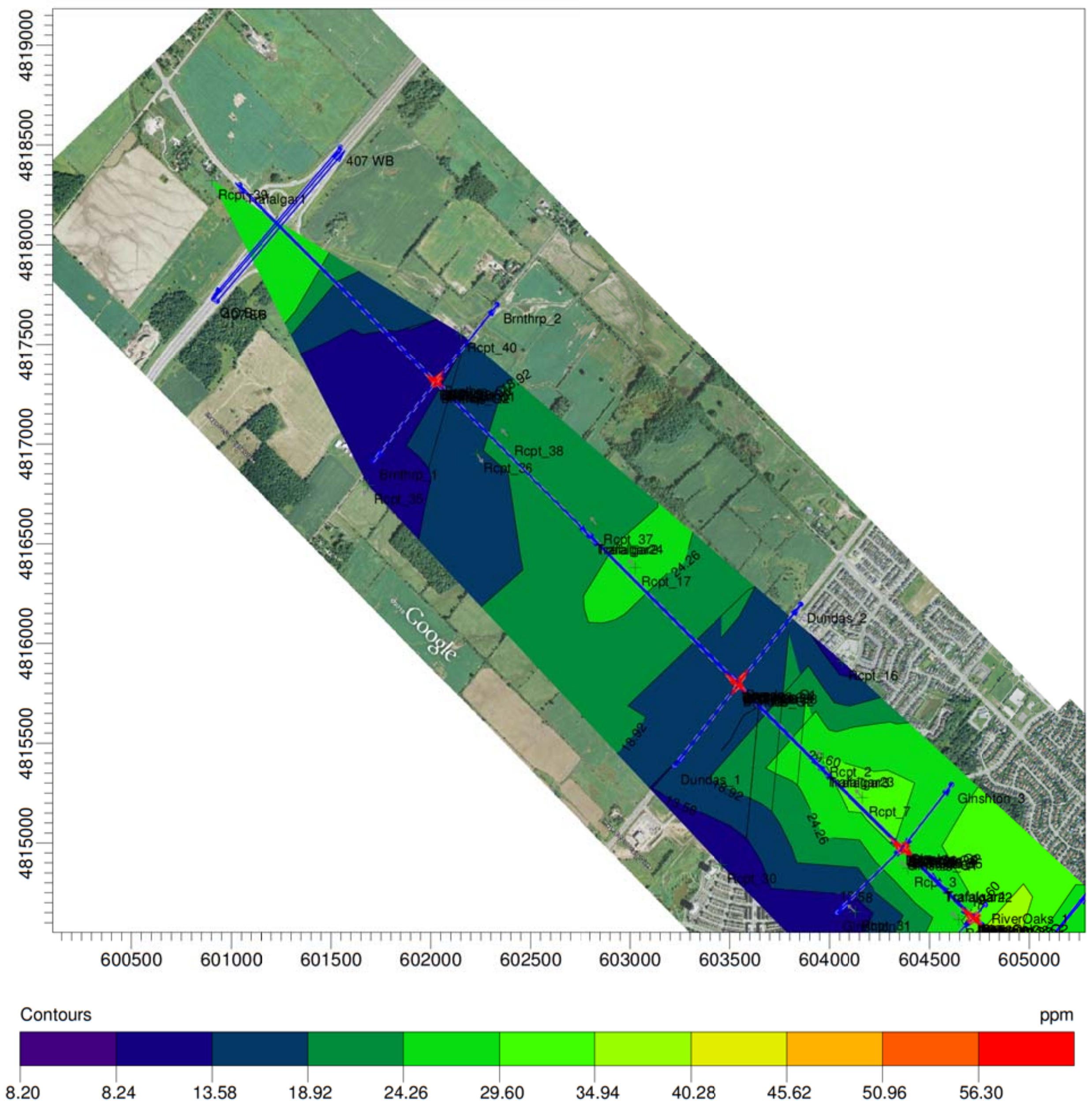
0.877	1.000	2.000	3.000	4.000	5.000	6.000	7.000	8.000	8.003

COMMENTS: Future Center BRT - North of Dundas (PM10)	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME:	
	MAX: **8.00**	UNITS: **ug/m**3**	MODELER:	
	LINKS: **111**	RECEPTORS: **42**		
	SCALE: 1:51,454 (0 — 1 m)		DATE: **4/13/2015**	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software C:\Lakes\CALRoads View\Trafalgar Rd EA\Appendix D. CAL3QHCR InputOutput\TrafalgarFB1PM10.clv

PROJECT TITLE:

Future RHL BRT - North of Dundas (CO)



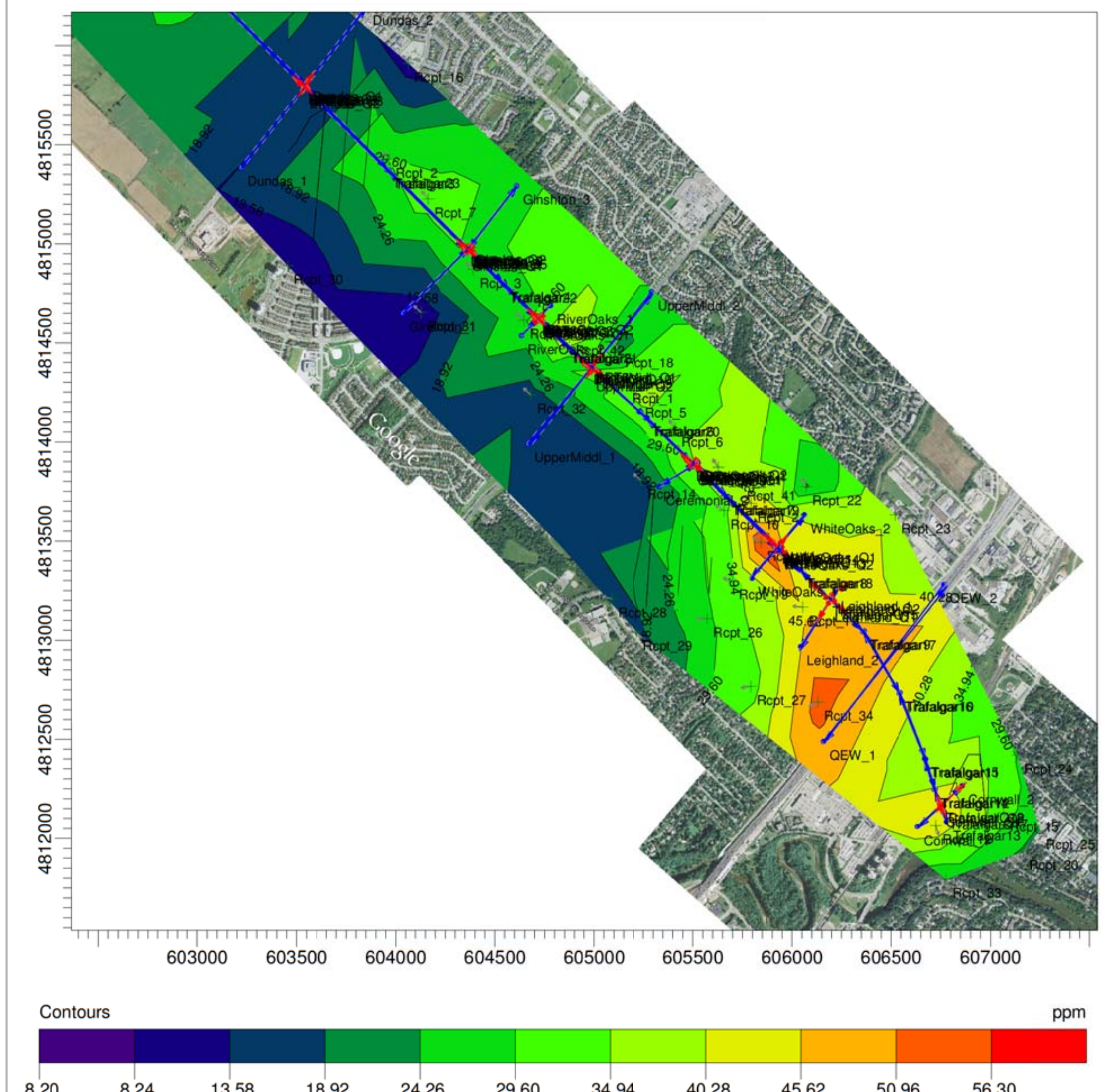
COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Future RHL BRT - North of Dundas (CO)	**CAL3QHCR**	**CO**	**AECOM**	
			MODELER: **MS/TB/TW**	
	LINKS: **111**	RECEPTORS: **42**		
	SCALE: 1:31,571 (0 — 1 m)		DATE: **9/29/2011**	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software

C:\Trafalgar NO GO Train\FB2\CO\TrafalgarFB2CO.clv

PROJECT TITLE:

Future RHL BRT - South of Dundas (CO)



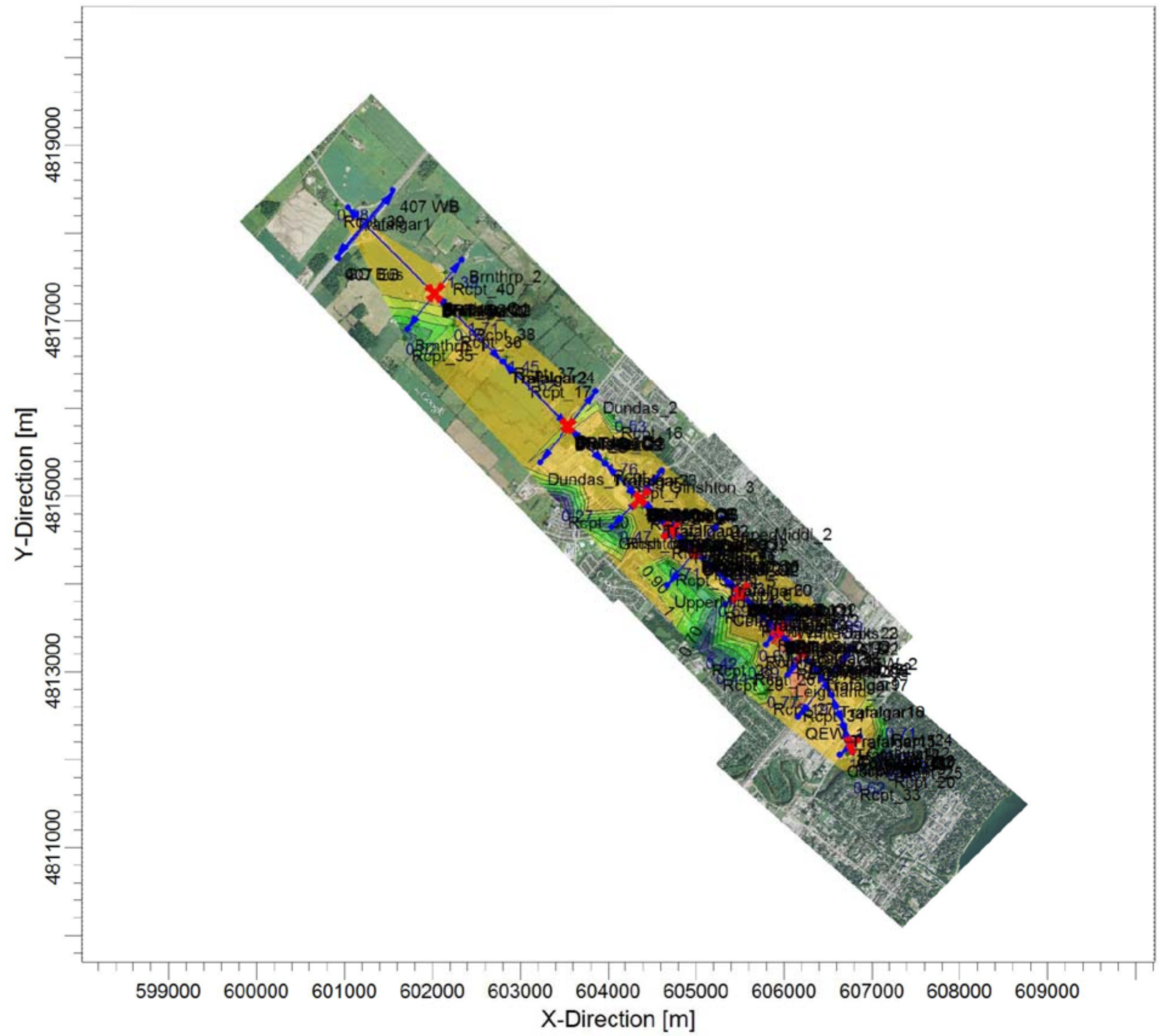
COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Future RHL BRT - South of Dundas (CO)	**CAL3QHCR**	**CO**	**AECOM**	
			MODELER: **MS/TB/TW**	
	LINKS: **111**	RECEPTORS: **42**		
	SCALE: 1:31,571 (0 — 1 m)		DATE: **9/29/2011**	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software

C:\Trafalgar NO GO Train\FB2\CO\TrafalgarFB2CO.clv

PROJECT TITLE:

Future RHL BRT -PM2.5



Contours ug/m**3

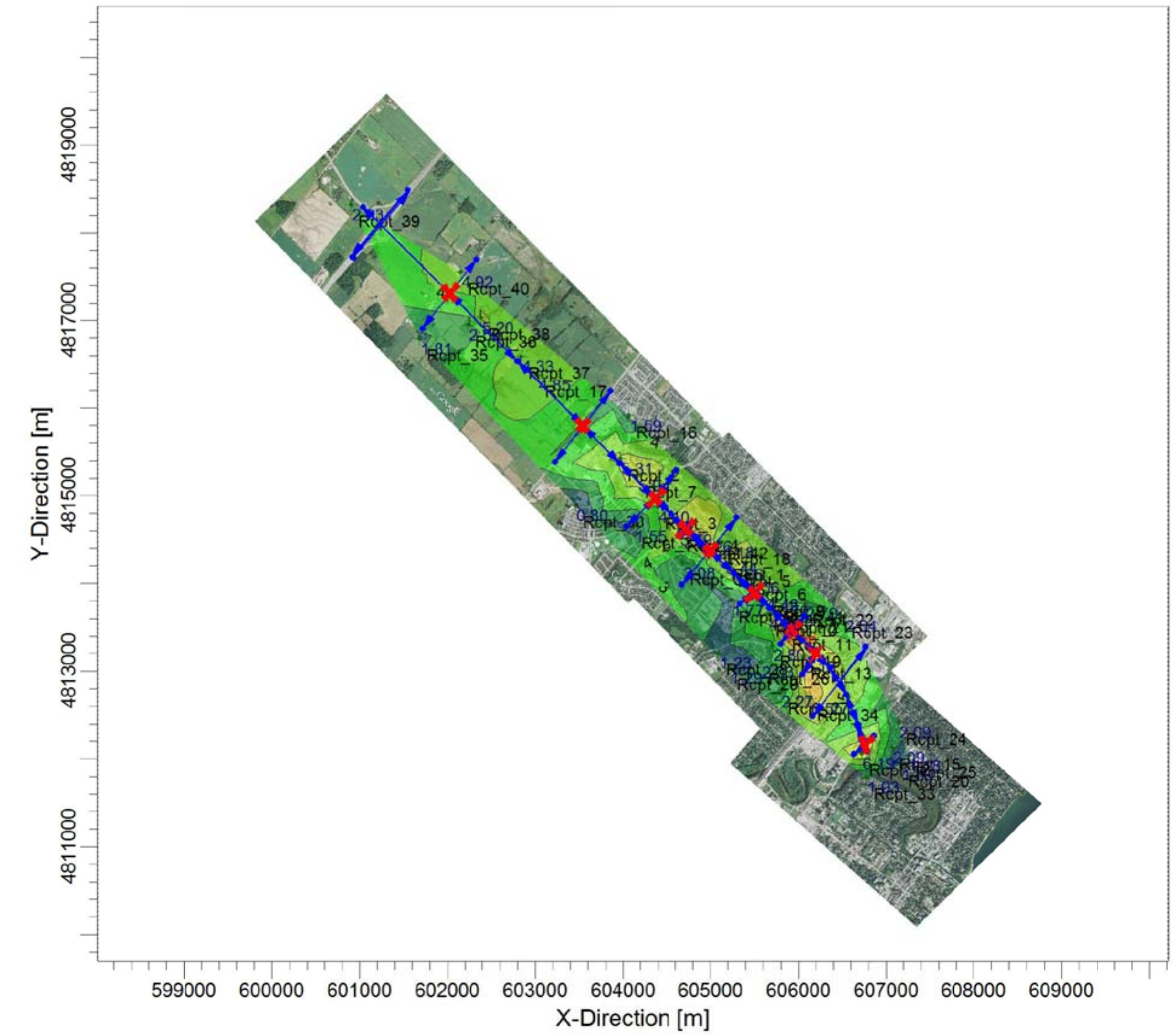
0.27	0.40	0.50	0.60	0.70	0.80	0.90	1.00	2.00	2.51	

COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Future RHL BRT - PM2.5	**CAL3QHCR**	**Particulate**		
	MAX: **2.51**	UNITS: **ug/m**3**	MODELER:	
	LINKS: **111**	RECEPTORS: **42**		
	SCALE: 1:76,729 (0 — 2 m)		DATE: **4/9/2015**	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software C:\Lakes\CALRoads View\Trafalgar Rd EA\Appendix D. CAL3QHCR InputOutput\TrafalgarFB2PM25.clv

PROJECT TITLE:

Future RHL BRT -PM10



Contours ug/m**3

0.80	0.90	1.00	2.00	3.00	4.00	5.00	6.00	7.00	7.56	

COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
Future RHL BRT - (PM10)	**CAL3QHCR**	**Particulate**		
	MAX: **7.56**	UNITS: **ug/m**3**	MODELER:	
	LINKS: **111**	RECEPTORS: **42**		
	SCALE: 1:76,729 (0 — 2 m)		DATE: **4/9/2015**	PROJECT / PLOT NO.: **60119993**

CALRoads View - Lakes Environmental Software C:\Lakes\CALRoads View\Trafalgar Rd EA\Appendix D. CAL3QHCR InputOutput\TrafalgarFB2PM10.clv