February 2015

PHASES 1 TO 3
TORONTO PEARSON INTERNATIONAL AIRPORT EMISSIONS INVENTORY

Air Quality Study at Toronto Pearson International Airport

Submitted to:
Greater Toronto Airport Authority
Environmental Management
Toronto Pearson International Airport
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REPORT

Report Number: 13-1151-0169

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Executive Summary

The Greater Toronto Airports Authority (GTAA) retained Golder Associates Ltd. (Golder) to complete an air quality study of operations at the Lester B. Pearson International Airport (Toronto Pearson) located to the north of Toronto. The study included an updated air emissions inventory for Toronto Pearson and an assessment of the Airport's current and likely future contributions to air quality in the Greater Toronto and Hamilton Area (GTHA). The contributions of regional emissions around Pearson Airport to air quality were also included to allow for a thorough assessment of local air quality levels.

The current work is an update of previous studies completed in 1991 and 2003, respectively. Since the previous studies were completed, there have been many changes at the airport as well as in the surrounding area. In addition, there have been improvements in emissions estimation methods and the air quality modelling techniques. This work was undertaken in four phases:

- Phase 1 – Toronto Pearson Emissions Inventory;
- Phase 2 – Regional Emissions Inventory;
- Phase 3 – Dispersion Modelling;
- Phase 4 – Human Health Risk Assessment (Carried out by Intrinsik Environmental as a separate report).

Seven main critical air contaminants have been assessed in this study, namely nitrogen oxides (NOx), sulphur dioxide (SO2), carbon monoxide (CO), particulates under 10 and 2.5 microns (PM10 and PM2.5 respectively), and volatile organic compounds (VOC). Dispersion modelling has been carried out with the aid of the U.S. Federal Aviation Authority's (FAA) Emissions and Dispersion Modelling System (EDMS). Dispersion modelling simulates the transport and diffusion of emissions released into the atmosphere by processing local meteorological data with terrain data to calculate ground level concentrations over a study area. The study area for the current project extends roughly 7.5 km from the Toronto Pearson site boundary.

This report is not intended to determine the compliance status of Toronto Pearson with respect to provincial and federal air quality criteria. Instead, this report should be viewed as an assessment of the impacts of the airport in the region surrounding the airport, the contribution of the airport to the regional air quality, and how the impacts of the airport will changed based on future predictions of growth in the region.

<u>Phase 1 – Toronto Pearson Emissions Inventory:</u>

A current air emissions inventory for the airport was created, using 2011 airport operations records and source information, such as aircraft traffic and schedules, vehicle counts and fuel use. Two future scenarios were also considered; 2022 and 2032, based on anticipated aircraft traffic, passenger numbers and aircraft fleets. Emissions for these three years were compared to the emissions from the previous 2003 studies.

Current aircraft emissions were calculated based on the actual Pearson Airport 2011 aircraft schedule. The schedule included the time of aircraft landed, which runway was used, which gate the aircraft taxied to and how long an auxiliary power unit was in use at the gate. Similarly, for departures, the schedule included the departure gate, taxiing to the runway, which runway was used for takeoff, the takeoff time and auxiliary power unit usage. These data were used in the FAA EDMS modelling system to estimate emissions from the various aircraft and airport activities.

Other mobile source emissions were also included in the airport emissions inventory such as Ground Support Equipment (aircraft tugs, catering services, baggage tugs, tow equipment, etc.), passenger vehicles used on the airside (support vehicles, staff vehicles, etc.), vehicles using the roads on airport property (e.g., personal vehicles and taxis used by arriving and departure passengers, deliveries, workers' personal vehicles, etc.). Ground Support Equipment emissions were estimated based on usage times and fuel use. Emissions from vehicles using public roadways and parking facilities were based on U.S. Environmental Protection Agency (USEPA) emission factors, and the traffic count records for the airport.

Emissions from stationary sources at the airport, such as the Cogeneration Facility, fossil-fueled boilers, snow melters, training fires, etc. were based on USEPA emission factors, and fuel use records.

For the future scenarios (2022, 2032), the anticipated aircraft and passenger numbers were provided by the GTAA. These estimates were used in EDMS to estimate future emissions based on the projected aircraft fleets and passenger traffic.

The following table summarizes the estimated 2011, 2022 and 2032 Emissions for Toronto Pearson Airport for each of the key critical air contaminants.

Critical Air Contaminant	**Emissions (tonnes/yr)**		
	2011	**2022**	**2032**
Carbon Monoxide (CO)	2,611	2,525	2,987
Nitrogen Oxides (NO_x) †	1,554	2,026	2,455
Sulphur Oxides (SO_x)	113	169	206
Volatile Organic Compounds (VOCs)	207	274	330
Particulate Matter under 10 µm in diameter (PM_{10})	24	30	36
Particulate Matter under 2.5 µm in diameter ($PM_{2.5}$)	23	28	34
GHG	351,162	493,070	586,611

† Nitrogen oxides (NO_x) are the sum of nitric oxide (NO) and nitrogen dioxide.

A full description of the methods used to estimate emissions for the Toronto Pearson Airport is detailed in Section 2 of this report.

Phase 2 – Regional Emissions Inventory:

The regional emissions inventory includes the off-site, non-GTAA related sources and activities, for an area extending in a 7.5 km radius outside the airport property. These regional emissions were based on the most recent emissions data available from Environment Canada for 2006. Emissions sources were assigned geographically based on land use from the Region of Peel (e.g., for sources like road and railway emissions, residential emissions, and commercial sources). Larger industries were assigned locations based on the data provided under the National Pollutant Release Inventory (NPRI) program for 2006.

Future emissions from off-airport sources were estimated based on published data from Environment Canada, regarding trends in Canadian air emissions. Overall, it is expected that regional emissions will decrease or stay constant between 2011 and 2022, based on current trends. As it is unlikely that emissions reduction trends will continue indefinitely, 2032 emissions have conservatively been assumed to remain at the projected 2022 levels. Regional emissions are considerably higher than those from the airport.

The following table summarizes the 2011, 2022 and 2032 regional emissions for the area extending 7.5 km beyond the airport boundary for each of the key critical air contaminants.

Critical Air Contaminants	**Emissions (tonnes/yr)**	
	2011	**2022 and 2032**
Carbon Monoxide (CO)	98,457	98,457
Nitrogen Oxides (NO_x) [1]	16,945	15,528
Sulphur Oxides (SO_2)	2,049	2,049
Volatile Organic Compounds (VOCs)	21,303	18,797
Particulate Matter under 10 µm in diameter (PM_{10})	10,959	8,351
Particulate Matter under 2.5 µm in diameter ($PM_{2.5}$)	4,296	3,321
GHG [2]	N/A	N/A

[1] Nitrogen oxides (NO_x) is the sum of nitric oxide (NO) and nitrogen dioxide (NO_2).
[2] GHG emissions for the study area were not available (N/A)

Section 3 of this report provides more details regarding the emissions data provided by Environment Canada, and how it was used to determine emissions from off-airport sources within the study area.

Phase 3 – Dispersion Modelling:

Dispersion modelling was carried out for the airport and regional sources to predict the airport's contributions to local air quality, the contributions from off-airport sources, and finally the overall air quality in the area within 7.5 km of the airport property boundary. The modelling was carried out using the EDMS system which includes and emission inventory processor and the AERMOD dispersion model, a standard dispersion model provided by the U.S. Environmental Protection Agency. The dispersion modelling uses real terrain information and hourly weather data to transport and disperse the emissions and subsequently calculate hourly airborne concentrations of the substances of interest at specified locations (i.e., receptors).

The model was run for three separate scenarios, namely the airport alone, the region alone, and the sum of the airport and regional contributions. A detailed discussion of the dispersion modelling methodology is provided in Section 4 of this report, while the results are presented in detail in Section 5. The modelling results showed that the airport operations had maximum impact at the airport property boundary line. Contributions to local air quality beyond the airport decrease rapidly with increasing distance from the airport, and at distances of a kilometre or more from the airport itself local air quality is almost entirely a result of regional emissions, especially major highways. In general, Toronto Pearson Airport contributed about 0.2 to 8% to local air quality within 7.5 km of the airport property.

The predicted modelled air quality from the airport and regional sources has been compared to local air quality monitoring data, with the results presented in more detail in Section 6. Overall, this comparison of modelling results to measurements made at air monitoring stations in the area found that the model was doing a good job predicting air concentrations inside the study area for most substances of interest.

A further analysis was carried out between the results of the current study to those of previous studies. The differences in the tools available and the approaches used for the 1991, 2003 and current study are discussed in detail in Section 7 of the report. Of note are the significant differences in the regional emissions between the current and previous studies, along with a reduction in the emissions attributed to the airport.

Overall the predicted airborne concentrations have decreased since the previous studies were completed, through a combination of:

- improvements made to airport operations;
- more efficient vehicles, with lower emissions;
- changing aircraft fleets;
- improvements made to tools for estimating emissions; and
- updated and improved models for calculating airborne concentrations.

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ABBREVIATIONS

AAQC	Ambient air quality criteria
ACERT	Airport Carbon and Emissions Reporting Tool
APUs	Auxiliary Power Units
CACs	Critical Air Contaminants
CCME	Canadian Council of Ministers of the Environment
CO	Carbon monoxide
CWS	Canada-Wide Standards
EC	Environment Canada
EDMS	Emissions and Dispersion Modelling System
FAA	U.S. Federal Aviation Authority
GHG	Greenhouse gas
GIS	Geographic Information System
GSE	Ground Support Equipment
GTA	Greater Toronto Area
GTAA	Greater Toronto Airports Authority
GTHA	Greater Toronto and Hamilton Area
MOE	Ontario Ministry of Environment
MOECC	Ontario Ministry of the Environment and Climate Change
N	North
NAAQOs	National Ambient Air Quality Objectives
NE	North East
NMHC	Non-methane hydrocarbons
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides
NPRI	National Pollutant Release Inventory
NW	North West
O_2	Oxygen
O_3	Ozone
OLM	Ozone limiting method
PM	Particulate matter
PM_{10}	Particulate matter with aerodynamic diameters less than 10 microns
$PM_{2.5}$	Fine particulate matter; particulate matter with aerodynamic diameters less than 2.5 microns
PMNV	Non-volatile particulate matter
PMVO	Volatile organics particulate matter
PMVS	Volatile particulate matter
POI	Point-of-impingement
RFP	Request for proposal
SE	South East

SID	Standard Instrument Departures
SO_2	Sulphur dioxide
SPM	Suspended particulate matter; also known as TSP
SW	South West
THC	Total hydrocarbons
TOG	Total organic gases
Toronto Pearson	Lester B. Pearson International Airport
TRB	Transportation Research Board
TSP	Total Suspended Particulate; also known as SPM
U.S.	United States
U.S. EPA	United States Environmental Protection Agency
VOCs	Volatile organic compounds

UNITS

km	kilometre
km/h	kilometres per hour
kW	kilowatt
m	metre
tonnes/yr	tonnes per year
µg/m³	micrograms per cubic metre
µm	micrometre; microns

1.0 INTRODUCTION

Lester B. Pearson International Airport (Toronto Pearson) is located approximately 27 km northwest of the City of Toronto, in the City of Mississauga and is operated by the Greater Toronto Airports Authority (GTAA). The airport property borders on the City of Toronto, the City of Vaughan, the City of Brampton and the Region of Peel. Toronto Pearson covers approximately 1,800 hectares and currently includes 5 runways, 2 main terminals (and several smaller satellite terminals), parking facilities, on-site public roads, a de-icing facility, a bus depot, emergency services (fire and ambulance), a cogeneration facility, and over 200 buildings including administration, hangers and garages, airline offices and other supporting operations. The airport handles approximately 35 million passengers and 450,000 aircraft movements annually. The facility operates primarily in the day (06:30 to 00:30 hours) with reduced operations during nighttime (00:30 to 06:30 hours) periods. Almost one quarter of Canada's population lives within 160 km of the airport.

Toronto Pearson has previously completed air quality emissions estimation and dispersion modelling (RWDI, 1991; RWDI, 2003) and human health risk assessment (Cantox, 2004 with minor internal updates in 2010/2011). The Airport also completes annual greenhouse gas (GHG) emission inventories, under the Federal GHG Reporting Program, and pollutant release estimates under the National Pollutant Release Inventory (NPRI) program.

While noise issues remain a predominant public concern with respect to airports, Toronto Pearson is undertaking an update to its emissions inventory, dispersion modelling and human health risk assessment to better quantify and assess the current and projected future air quality associated with airport operations. Many aspects of Toronto Pearson operations have changed since the last assessment, including new estimates of demand for air travel (commercial and personal), a constantly-changing aircraft fleet, newer and more efficient Ground Support Equipment (GSE), modified operational guidelines and new Standard Instrument Departures (SIDs, also known as departure procedures) among other things. The GTAA has also embarked on a plan for improving sustainability, which has involved reducing their airside vehicle fleet, decreasing fuel use (or replacing older equipment with newer) among others initiatives. All of these changes at Toronto Pearson demonstrate why now is the time to proceed with an update of the emissions inventory, dispersion modelling and human health risk assessment.

Figure 1 shows the Toronto Pearson Airport boundary and surrounding area.

LEGEND

Approximate Site Boundary

REFERENCE

Base Data - MNR LIO, obtained 2009
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Imagery - ESRI World Imagery WMS, 2014
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

600 300 0 600 1,200 1,800
SCALE 1:50,000 METRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

SITE LOCATION PLAN

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	27 Feb. 2014	FIGURE: 1	
GIS	ME	27 Feb. 2014		
CHECK	EH	27 Feb. 2014		
REVIEW	AB	27 Feb. 2014		

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudy\Phase2_ReportJanuary2015\Figure1_SiteLocationPlan.mxd

1.1 Objective of the Study

This study was undertaken to provide an updated air emissions inventory for Toronto Pearson Airport and an assessment of the Airport's current (2011) and likely future (2022 and 2032) contributions to air quality in the Greater Toronto and Hamilton Area (GTHA). The study was completed in three phases, each with their own study program and objectives.

1.1.1 Phase 1

In the first phase of this study, the objective was to create a current air emission inventory for the airport property, including aircraft, vehicular traffic and other ancillary equipment, using the U.S. Federal Aviation Authority's (FAA) Emissions and Dispersion Modelling System (EDMS). Three years were considered in this study - 2011, 2022 and 2032.

Emissions for 2011 were calculated from the actual 2011 aircraft schedule, aircraft auxiliary power unit use as reported by Air Canada, which was also used for other aircraft traffic lacking more specific information, estimated ground support equipment assignments, an on-site traffic count (for public roadways and parking garages), and actual or estimated fuel use by stationary equipment with the aid of the EDMS model. The 2011 schedule was used to develop operational profiles for month of year, day of week, and quarter-hour of day, in effect determining peak and off-peak aircraft movement times.

Emissions for 2022 and 2032 were also calculated using the EDMS model, based on the GTAA's projected aircraft movements and anticipated aircraft types in each year were provided. The anticipated 2022 and 2032 aircraft movements and types were then distributed through the year based on the 2011 schedule of aircraft operations. Projected road traffic was estimated based on the 2011 traffic count and passenger numbers, scaled up for the future years using the estimated future passenger numbers. The stationary equipment was assumed to have the same fuel consumption as 2011.

1.1.2 Phase 2

Phase 2 was focused on obtaining relevant regional emission data from off-site, non-GTAA related, sources and activities for an area extending in a 7.5 km radius around the airport property.

Regional emissions, excluding GTAA, within the 7.5 km radius were quantified using Environment Canada's 2006 SMOKE emissions inventory (Environment Canada, 2006). Additional land use data were obtained from the Region of Peel, which were defined by the Region for their own modelling program (underway as of the time of writing this report).

Environment Canada provided country-wide data, with additional data (such as transportation-related emissions) sourced from the Ontario Ministry of the Environment and Climate Change (MOECC) which were processed by Environment Canada with the aid of the SMOKE model for 2006.

For these off-site sources, the area within 7.5 km of Toronto Pearson was be divided into 1 km by 1 km grid cells and emissions were apportioned to each cell according to the facilities, operations or land use in each cell using Geographic Information System (GIS). Each grid cell was treated as a separate area source and assigned emissions parameters consistent with the land use within the cell, based on current United States Environmental Protection Agency (U.S. EPA) modelling guidance (USEPA 1995 and USEPA 2014). Emissions for residential, commercial and industrial operations were assigned to the appropriate grid cells defined within the 7.5 km radius of the airport property based on the land use from the Region of Peel. Facilities which report their emissions under the NPRI program were assigned to the appropriate grid cell based on location. The allocation of area emissions (such as road networks, residential emissions or commercial/industrial enterprises too small to report individually) was based on the percentage of roads, rail lines, residential or commercial area, etc. located within the study area, relative to the entire area over which the emissions were calculated. Point sources outside the 7.5 km radius surrounding the airport property were not modelled.

1.1.3 Phase 3

For phase 3, dispersion modelling was carried out using the U.S. EPA AERMOD dispersion model (version 12345) which is included in the EDMS system (version 5.1.4 dated April 2013). On-site (airport) and off-site (regional) sources were modelled to determine the combined impact (or cumulative effects) around the airport and compared to nearby Federal and Provincial ambient air monitoring stations.

On-site airport sources were modelled as either point (most stationary sources) or volume sources. Volume sources were typically building ventilation or other identified stationary source emissions not associated with specific stacks or airport-specific sources (runways, taxiways, apron areas, parking garages, etc.) as determined by EDMS. Modelling for off-site sources was undertaken using the current version of the same version of AERMOD.

Modelling results for the airport sources, off-site sources and the cumulative effects (airport + off-site sources) are compared to ambient monitoring data available at the Centennial Park (Station 60413) and Brampton (Station 60428) monitoring stations. Criteria Air Contaminants (CACs) including Nitrogen Dioxide (NO_2), Sulphur Dioxide (SO_2), Carbon Monoxide (CO) and Particulate Matter (PM) are available at the Brampton Station but not at Centennial Park and so comparisons for CACs will include the 125 Resources Rd (Station 60430) location for the period of interest. Speciated Volatile Organic Compounds (VOCs) are available at the stations at Centennial Park and Brampton (Table 1). Two additional stations, outside the modelling domain, were considered to provide additional regional context, these are located in downtown Toronto (Bay and Wellesley) and in the north of Toronto (Yonge St. and Hendon) which report CACs levels.

Table 1: Ambient Air Quality Stations in the City of Toronto and the City of Mississauga

Station Location	Station ID	Substances Available (2011/2012)
Centennial Park/Elmcrest Rd.	60413/35003	Speciated VOCs
Brampton	60428/46089	Speciated VOCs, CACs
125 Resources Rd.	60430/34020	CACs
Toronto Downtown (Bay/Wellesley)	60424/31103	CACs
Toronto North (Yonge/Hendon)	34020	CACs

Figure 2 presents the identified ambient air quality stations as well as other stations which measure and report recent CAC and/or speciated VOC data.

1.2 Study Domain

The study domain requested in the Request For Proposal (GTAA, 2013) extends in a 7.5 km radius around the perimeter of Toronto Pearson Airport. For the sake of simplicity in the modelling, this was extended to a rectangle which incorporates this perimeter. The modelling domain is provided in Figure 3.

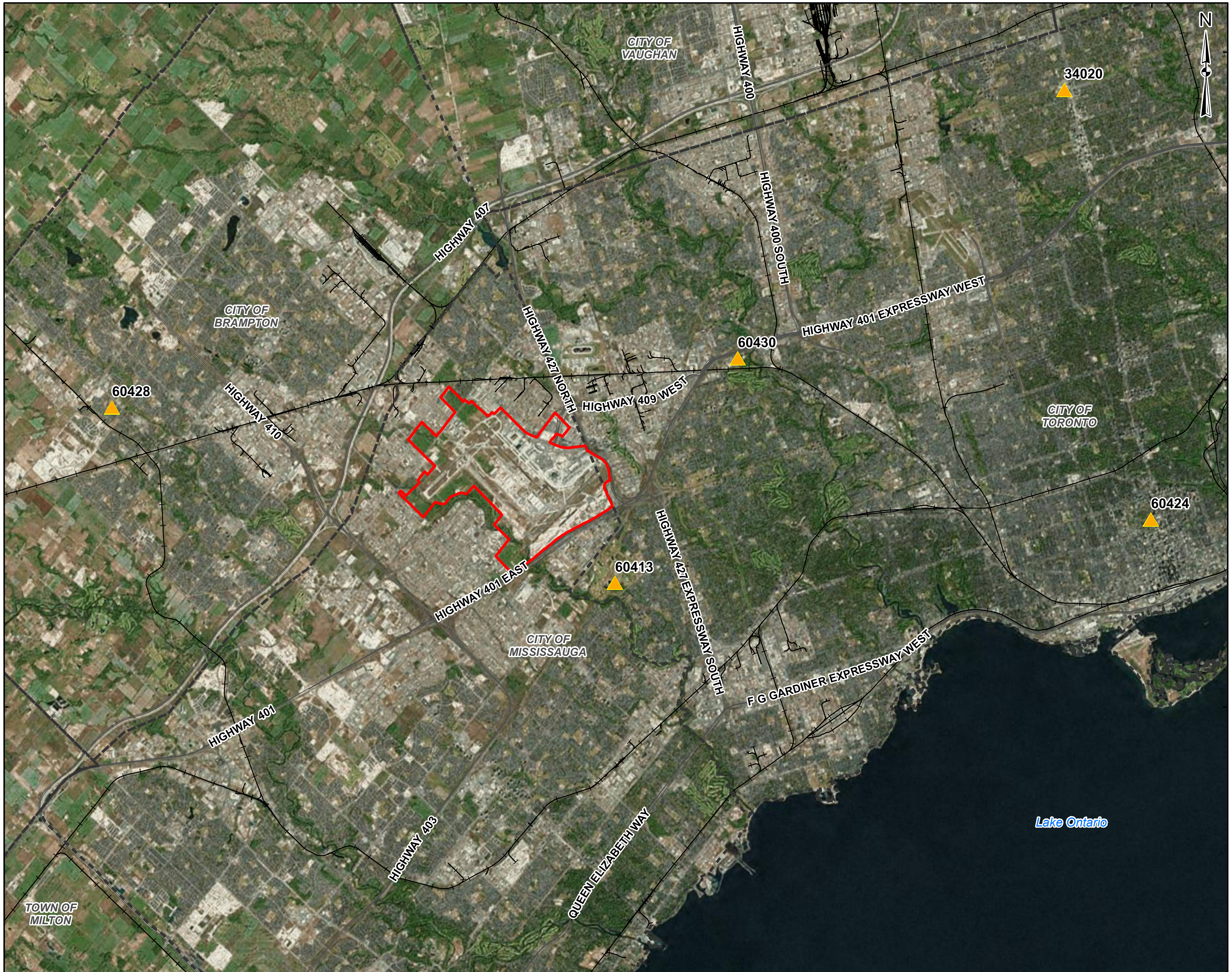
1.3 Selection of Air Emissions Compounds

The modelling was completed and output generated for the Criteria Air Contaminants (CACs), namely;

- carbon monoxide (CO);
- nitrogen oxides (NO_x), nitrogen dioxide (NO_2);
- sulphur dioxide (SO_2).
- speciated volatile organic compounds (VOCs);
- particulates (PM); and
- greenhouse gases.

VOC speciation was determined based on data in the EDMS databased for on-airport emissions and using the latest recommendations from the U.S. Transportation Research Board (TRB 2008, 2012) and the MOVES emissions model for on-road transportation sources.

Ozone, while a species of considerable interest in Canada and the U.S. is not an emitted species but one that forms through chemical reactions in the atmosphere. For this reason, ozone has not been included in this study.



LEGEND

- Regional Air Quality Monitoring Station
- Highway
- Railways
- Waterbody
- Municipality
- Approximate Site Boundary

REFERENCE

Base Data - MNR LIO, obtained 2013
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

0 1 2 4 6
SCALE 1:120,000 KILOMETERS

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
REGIONAL AIR QUALITY MONITORING STATIONS COMPARISON AGAINST MODELLING RESULTS

Golder Associates
Mississauga, Ontario

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GIS	ME/PR	2014-11-26		
CHECK	AB	2014-11-26		
REVIEW				

FIGURE: 2

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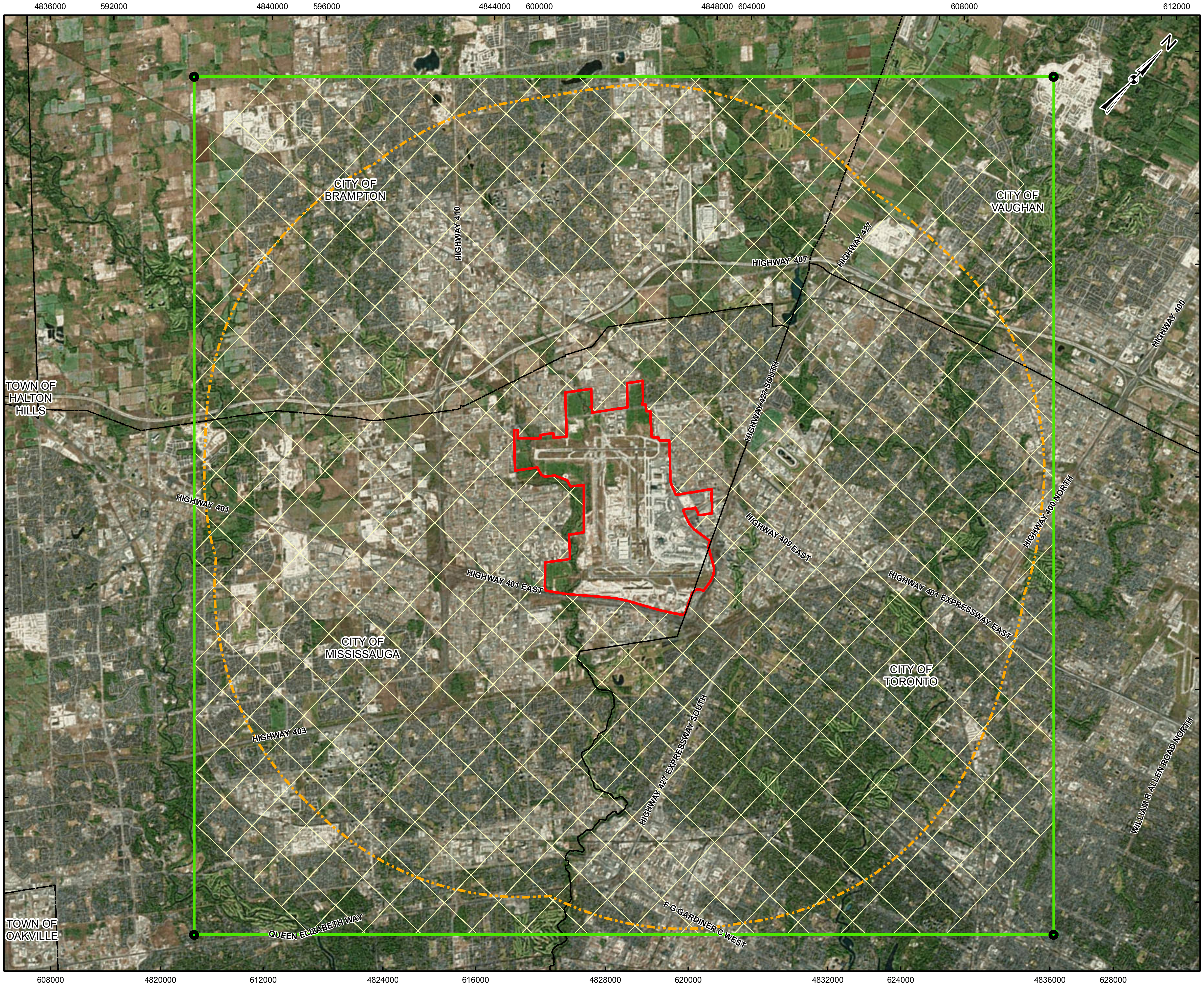

LEGEND

- Approximate Regional Extent Nodes
- Buffer 7.5km
- Approximate Regional Extent
- Municipal Boundary, Lower Tier
- Approximate Site Boundary
- Grid (Supplied by Peel Region)

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Imagery - ESRI World Imagery WMS, 2014
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:100,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

MODELLING DOMAIN FOR THE TORONTO PEARSON AIR QUALITY STUDY

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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CHECK	EH	2014-09-12		
REVIEW	AB	2014-09-12		

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1.4 Air Quality Criteria

In Ontario, limits and guidelines for regulating air quality are established under Ontario Regulation 419/05 (*Air Pollution – Local Air Quality*). These include standards, point-of-impingement (POI) guidelines and ambient air quality criteria (AAQC) for various compounds. The AAQC are commonly used in assessments of general air quality in a community, and the potential for causing an adverse effect, whereas the standards and POI guidelines are used to assess specific impacts of an individual facility for compliance and permitting requirements.

In addition, there are two sets of federal objectives and criteria; namely, the National Ambient Air Quality Objectives (NAAQOs) and the Canada-Wide Standards (CWS). The NAAQOs are a benchmark which is used to facilitate air quality management on a regional scale, and provide national goals for outdoor air quality that protects public health, the environment, or aesthetic properties of the environment (CCME, 1999). In this, the federal government has established three levels of NAAQOs. The levels are described as follows:

- The Maximum Desirable Level defines the long-term goal for air quality and provides a basis for an anti-degradation policy for unpolluted parts of the country and for the continuing development of control technology.
- The Maximum Acceptable Level is intended to provide adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being.
- The Maximum Tolerable Level denotes an air contaminant concentration that requires abatement (mitigation without delay to avoid further air quality deterioration that could endanger the prevailing Canadian lifestyle or ultimately, that poses a substantial risk to public health).

The CWS are standards that have been developed under the Canada-wide Accord on Environmental Harmonization that provides common environmental standards across the country that are agreed upon by the individual Provinces and Territories.

The CWS process has been progressing for a limited set of compounds, including ozone and fine particulate matter ($PM_{2.5}$). The first set of CWS for air pollutants was ratified by the Canadian Council of Ministers of the Environment (CCME) in June 2000. The compounds for which the CWS have been adopted include $PM_{2.5}$, Ozone (O_3), benzene and mercury. The CCME has not yet established an acceptable ambient air quality criterion for benzene, but has set targets for reducing the emissions of benzene by about 40% from 1995 levels by the end of 2010.

The purpose of this study is not to determine the compliance status of Toronto Pearson with respect to published provincial criteria, however for the purposes of comparison and to further understanding of the modelling and published monitoring results, a summary of the applicable Ontario and Canadian objectives and criteria are listed in Table 2.

Table 2: Ontario and Canadian Regulatory Air Quality Objectives and Criteria

Substance	Averaging Period	Ontario Criteria ($\mu g/m^3$)		Canada-Wide Standards ($\mu g/m^3$) [c]	National Ambient Air Quality Objectives ($\mu g/m^3$) [d]		
		Schedule 3 [a]	Ambient [b]		Desirable	Acceptable	Tolerable
CO	1-Hour	36,200	36,200	—	15,000	35,000	—
	8-Hour	15,700	15,700	—	6,000	15,000	20,000
NO_x	1-Hour	400[e]	—	—	—	—	—
	24-Hour	200[e]	—	—	—	—	—
NO_2	1-Hour	—	400	—	—	400	1,000
	24-Hour	—	200	—	—	200	300
	Annual	—	—	—	60	100	—
SO_2	1-hour	690	—	—	450	900	—
	24-hour	275	—	—	150	300	800
	Annual	—	—	—	30	60	—
SPM	24-Hour	120	120	—	—	120	400
	Annual	—	60	—	60	70	—
PM_{10}	24-Hour	—	50[f]	—	—	—	—
$PM_{2.5}$	24-Hour	—	25[g]	30[h]	—	—	—
	Annual	—	—	8.8[i]	—	—	—

Notes:

[a] MOECC (2012a)
[b] MOECC (2012b)
[c] CCME (2000)
[d] CCME (1999)
[e] The Ontario limit for NOx is based on Nitrogen Oxides, which are defined to be the sum of nitrogen dioxide (NO_2) and nitric oxide (NO).
[f] Interim standard.
[g] MOECC guideline for $PM_{2.5}$ is 25 $\mu g/m^3$ for a single source
[h] Compliance with the Canada Wide Standard is based on the 98th percentile of the annual monitored data averaged over three years of measurements. Canadian Ambient Air Quality Standards (CAAQS) for $PM_{2.5}$ will replace CWS. The current 24-hour CWS of 30 $\mu g/m^3$ will change to the $PM_{2.5}$ CAAQS of 28 $\mu g/m^3$ which is set to be implemented in 2015, and is further reduced to 27 $\mu g/m^3$ in 2020 CCME(2012).
[i] Annual $PM_{2.5}$ CAAQS of 10 $\mu g/m^3$ is set to be implemented in 2015, and is further reduced to 8.8 $\mu g/m^3$ in 2020 CCME(2012).

— = No guideline available;

$\mu g/m^3$ = micrograms per cubic metre; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; SPM = suspended particulate matter <0.44 µm; PM = particular matter.

1.5 Dispersion Meteorology

A five year hourly dispersion meteorology data set based on Toronto Pearson Airport recorded data was provided by the MOECC for this project. The data set was model-ready (for EDMS/AERMOD) and includes hourly wind speed, wind direction, temperature, precipitation, relative humidity and other parameters required by the dispersion model. A complete summary of the dispersion meteorology, compared to long-term climate normals for the area, is provided in APPENDIX A. A wind rose showing the wind speeds and directions over the 2008-2012 period included in the data set is shown in Figure 4. The figure shows that the dominant winds are primarily from the northwest and westerly directions with reciprocating winds from the southeastern sector. High speed winds primarily originate from the west and northwest, respectively.

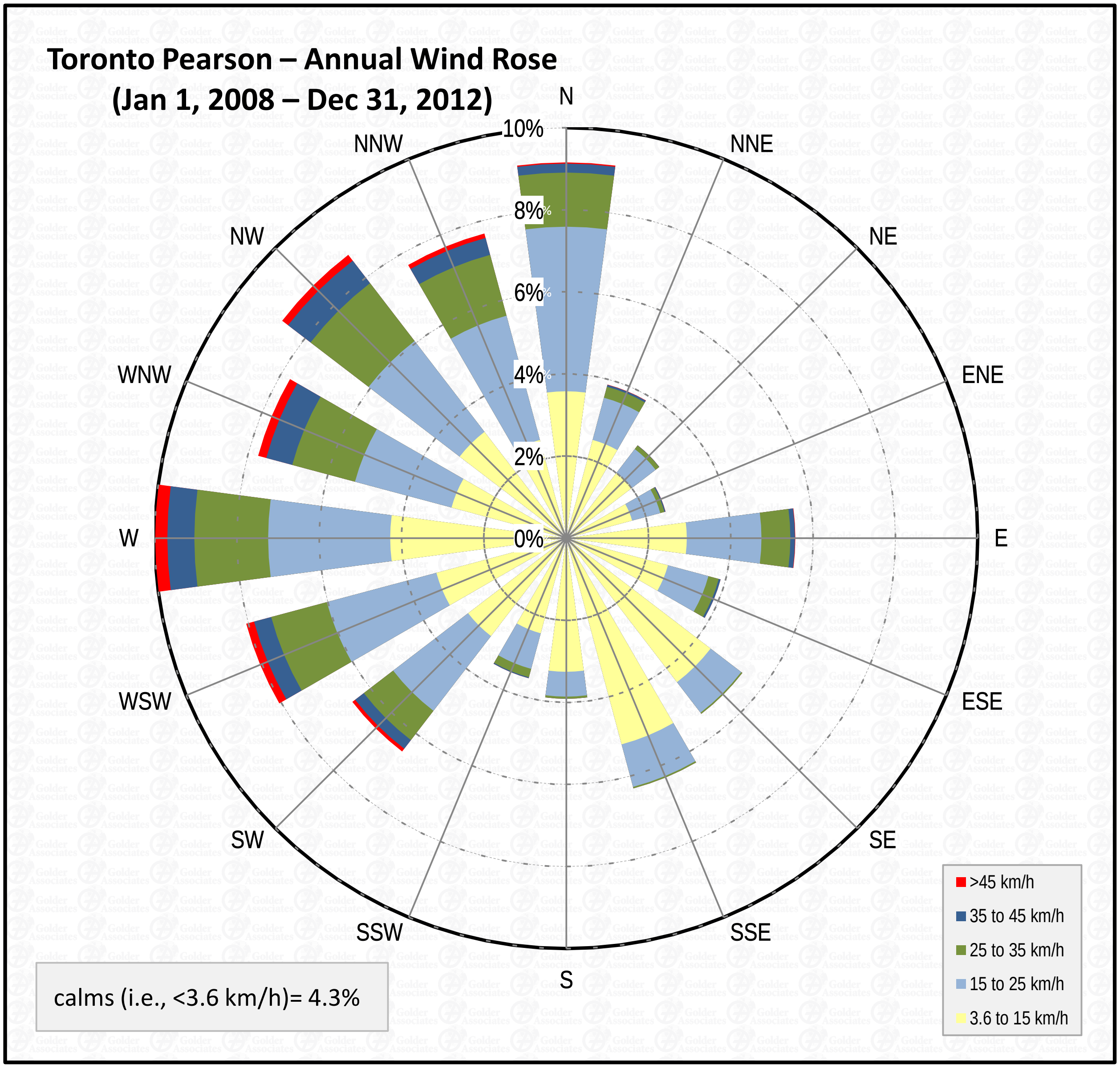


Figure 4: Wind Rose for the 2008-2012 Period for Toronto Pearson Airport

1.6 Receptors

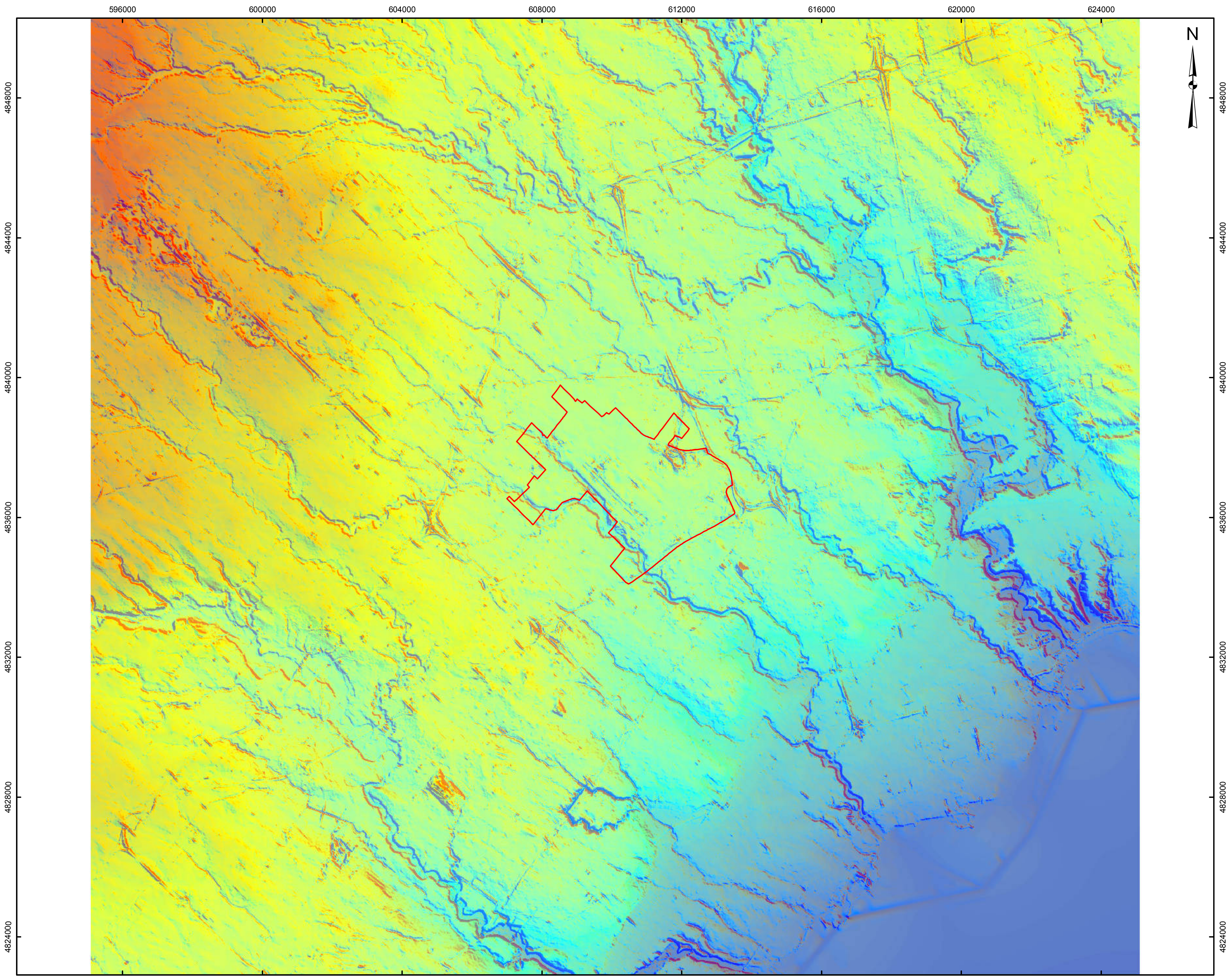
Within the study domain, gridded receptors were selected following the MOECC selection process outlined in the document "Air Dispersion Modelling Guideline for Ontario" (MOE, 2009). Based on this document, nested grids were generated with the following parameters:

- 50 m spacing from the centre of the airport to 500 m;
- 100 m spacing from 500 m to 1,000 m;
- 200 m spacing from 1,000 m to 2,000 m;
- 500 m spacing from 2,000 m to 5,000 m; and
- 1,000 m spacing from 5,000 m to 15,000 m.

All receptors were modelled with local terrain elevations, based on terrain data provided by the MOECC. A map showing the terrain elevations within the modelling domain is provided in Figure 5**.**

In addition, receptor locations were placed approximately every 50 metres along the fenceline of the airport property. Note that receptors within the property line were removed as a standard practice. Figure 6 shows the gridded and fenceline receptors selected for the study.

As this study provides modelling results for a human health risk assessment, a number of individual receptors were incorporated into the modelling. These receptors were identified in the previous study as being of interest and so are discussed here to provide continuity and the ability to accurately compare the results of the previous assessment to the current study. Four (4) new individual receptors have also been included in this study. In all cases, these individual receptors have been identified at locations of particular interest, such as residential areas closest to Toronto Pearson Airport, neighbourhoods containing schools, etc. Figure 7 shows the locations and descriptions of the individual receptors identified for this study.



LEGEND

Approximate Site Boundary

Digital Elevation Model

High : 287 (m)

Low : 67 (m)

REFERENCE

Base Data - MNR LIO, obtained 2009
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4 6

SCALE 1:110,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

MODELLING TERRAIN

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	27 Feb. 2014	**FIGURE: 5**	
GIS	ME	5 Mar. 2014		
CHECK	EH	5 Mar. 2014		
REVIEW	AB	5 Mar. 2014		

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LEGEND

- Individual Receptors
- Approximate Site Boundary

REFERENCE

Base Data - MNR LIO, obtained 2009
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Imagery - ESRI World Imagery WMS, 2014
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

1 0.5 0 1 2 3

SCALE 1:50,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

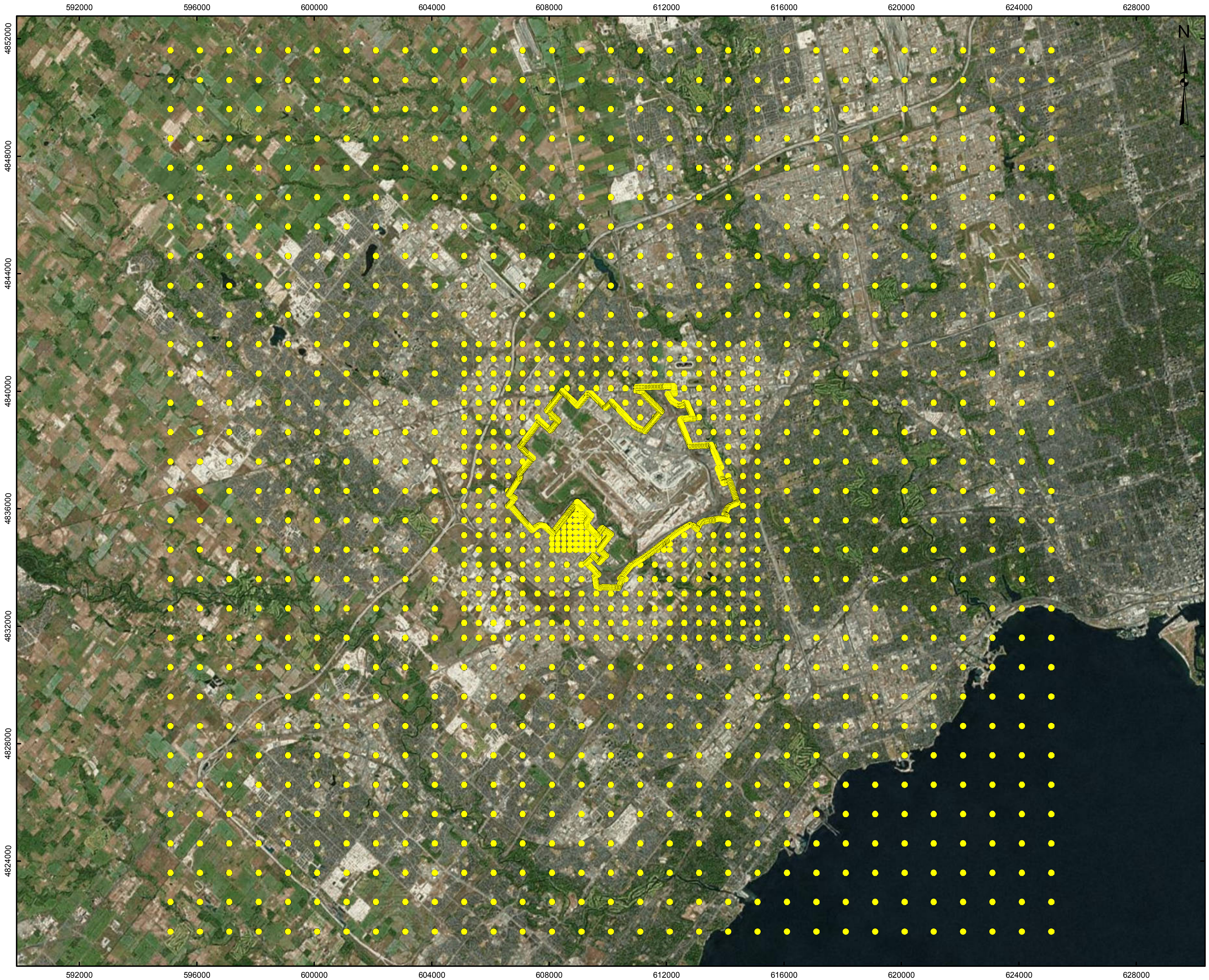
TITLE

INDIVIDUAL RECEPTORS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-09-15	**FIGURE: 6**	
GIS	ME	2014-09-15		
CHECK	AB	2014-09-15		
REVIEW				

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudyPhase2_Report\January2015\Figure6_IndividualReceptors.mxd



LEGEND

- Gridded Receptors

REFERENCE

Base Data - MNR LIO, obtained 2009
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Imagery - ESRI World Imagery WMS, 2014
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4 6

SCALE 1:130,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

GRIDDED RECEPTORS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	27 Feb. 2014	FIGURE: 7	
GIS	ME	5 Mar. 2014		
CHECK	EH	5 Mar. 2014		
REVIEW	AB	5 Mar. 2014		

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2.0 PHASE 1: TORONTO PEARSON AIRPORT

A summary of the complete 2011, 2022 and 2032 emissions inventories are provided in APPENDIX B. The following provides a summary of the emission estimation methods and techniques.

2.1 2011 Emissions Inventory

Sources at Toronto Pearson were categorized based on source type, which includes aircraft, ground support equipment (GSE), parking facilities, roadways, stationary sources (such as generators, boilers, heaters, and cooling towers), and training fires. When possible, actual time-varying data were used for developing the emissions inventory. For example, aircraft emissions for 2011 were calculated based on the actual aircraft arrival and departure schedule for that year. Emissions from roadways and parking facilities were calculated based on daily traffic counts, and varied using EDMS default schedules. Due to the lack of data, emissions associated with some of the aircraft auxiliary power units (APUs) and stationary equipment were estimated based on default values.

The most recent version of EDMS (Version 5.1.4) was used to develop the 2011 emission inventory, with the exception of greenhouse gases. For all other substances, EDMS calculated total annual 2011 emissions for carbon monoxide (CO), total hydrocarbons (THC), non-methane hydrocarbons (NMHC), total volatile organic compounds (VOCs), total organic gases (TOG), nitrogen oxides (NO_X), sulphur dioxides (SO_X), particulate matter with aerodynamic diameters less than 10 microns (PM_{10}) and less than 2.5 microns ($PM_{2.5}$), non-volatile particulate matter (PMNV), volatile sulphates particulate matter (PMVS), and volatile organics particulate matter (PMVO). Fugitive dust from sources other than roadways, such as construction activities, was not included in the emissions inventory. EDMS does not calculate emissions from brake and tire wear for aircraft. Brake and tire wear for vehicles results in particulate emissions, so this limitation of EDMS may partially underrepresent particulate emissions from aircraft operations. However, as the percentage of time is short when brake and tire wear may occur, it is likely that this source would be negligible (ACRP, 2013).

Greenhouse gases were calculated using several combined methods. EDMS was used to generate aircraft GHG emissions, in keeping with the rest of the airport emissions inventory. The 2011 Airport Carbon and Emissions Reporting Tool (ACERT) v.1.0, was provided by the GTAA, and the data were used to estimate emissions from airside vehicles. The 2011 GHG emissions, as calculated by the GTAA for reporting under the Canadian Greenhouse Gas Reporting Program, provided total GHGs from stationary sources. Finally, GHGs from roads and parking lots were estimated based on the ratio of CO to CO_2 emissions for vehicles (where CO was calculated for vehicles per the description below).

The following subsections discuss these source types, and the method of emissions estimation used to develop the inventory.

2.1.1 Aircraft

Several additions were made to the GTAA's facility layout, in the current study, in order to better incorporate all aircraft operations. These are:

- Gates were defined for Vista Cargo, General Aviation (North), FedEx Cargo, General Aviation (Infield) and Cargo (Infield).
- Appropriate taxipaths for all runways to these gates were defined.
- Taxiway J was extended to its current full length parallel to Runway 05/23.
- Taxiway K was added to the database.

GTAA provided the 2011 aircraft schedule which included information on aircraft type, arrival and departure times, gate numbers associated with each aircraft's arrival and departure, and runways and taxiways used by the aircraft (i.e., generating time-varying emissions based on actual aircraft movement times). In the 2011 emissions inventory, 406,774 of the 408,879 entries provided in the 2011 schedule were included in the analysis (a 99.5% capture of aircraft activities). Initially, 37,722 flights had missing data but were incorporated into the activity log by following these criteria:

- Where the aircraft in question was associated with a known airline (e.g., Air Canada, Westjet, etc.), the movement was assigned to a gate at the appropriate Terminal (1 or 3).
- FedEx flights were all assigned to a newly-defined FedEx gate.
- Vista Cargo flights were all assigned to a newly-defined Vista Cargo gate.
- Infield Cargo flights were all assigned to a newly-defined Infield Cargo gate.
- General Aviation flights were randomly divided between a newly-defined General Aviation Infield gate and a newly-defined General Aviation North gate.

Aircraft/engine combinations were obtained from "World Airline Fleet Directory 46th edition" (Flightglobal, 2012). The current list of 2011 aircraft was matched with engines based on aircraft type. Once this list of aircraft/engine combinations was created for Toronto Pearson, the most common engine type for an aircraft type was determined and selected in EDMS. If no engine information was available for a specific aircraft, the default values from EDMS were used. Engine emissions were calculated using the emission factors built into the EDMS model. EDMS default taxi times, "push-back" times, and queue times were used.

Emissions were calculated for on-site aircraft idling as well as takeoff, climb out and approach up to an elevation of 915 m (3000 ft), as is standard for assessing airports worldwide.

2.1.2 Ground Support Equipment (GSE)

Ground Support Equipment (GSE), consist of vehicles and mobile equipment that service the aircraft when it is at the gate. GSE includes aircraft tugs, cabin service vehicles, catering services trucks, water trucks, fuel trucks, lavatory services trucks, baggage tugs and external auxiliary power units (used for aircraft not equipped with auxiliary power units). EDMS provides default GSE assignments based on aircraft type, and these were applied in the current assessment unless more specific information for the aircraft type was available from the GTAA. Emissions were calculated by EDMS using default emission factors for each type of vehicle.

2.1.3 Auxiliary Power Units (APUs)

Auxiliary Power Units, or APUs, are smaller tail-mounted turbines on jet aircraft to generate power for the aircraft while parked at the gate. The version of the EDMS model used in the previous 2003/2004 assessment did not have the capacity to assess APU emissions but the current version incorporates default emission factors for these units. APU usage was provided under a confidentiality agreement for some aircraft types (by Air Canada) and their use times were included in the current dispersion modelling. For those aircraft for which actual APU use was not available, EDMS defaults were used. As APU use is based on aircraft gate times, these emissions were estimated for each hour of 2011 (time-varying emissions).

2.1.4 Roadways

The GTAA provided peak hourly traffic volumes for on-site roads, including those extending between (but not including) Airport Road, Highway 409, Highway 427, and the terminal buildings, along with those between Highway 401 and the infield area. Data were provided for the 2011 base case year, based on actual vehicle counts. These traffic volumes were input into the EDMS model and assigned to the appropriate road. EDMS includes the MOBILE6 model which calculates tailpipe emissions for vehicle fleets using a default vehicle fleet. Modelling was completed using the default MOBILE6 emissions estimated for the roadways. Daily vehicle counts were converted to time-varying emissions within EDMS using default hourly profiles.

Emissions were also estimated outside the EDMS model using the more-current MOVES model (CCSI, 2014) but best practices on how to incorporate these emissions into the modelling were not available until after model run completion and so default EDMS emissions estimates for roadways, using the U.S. EPA's MOBILE6 on-road model were used. Internal comparison of the EDMS calculated emissions and those calculated using MOVES showed that estimated emissions for this particular scenario did not change significantly and so it is unlikely that the use of MOBILE6 emissions estimates adversely affected the quality of the emissions estimates or the resulting predicted concentrations.

2.1.5 Parking Lots

GTAA provided total monthly volumes for 2011 for the Terminal 1 and 3 parking facilities, and the Value Park garage and outdoor parking lot. The number of parking levels and spacing between levels was estimated based on aerial photos and site maps. Assumptions were made regarding the average vehicle speed within the lots, average distance travelled per vehicle, and vehicle idling time. Default EDMS emission factors (MOBILE6) were used for calculating emissions and hourly emissions were calculated using the default EDMS profiles. Off-site parking lots are not included in the assessment.

2.1.6 Stationary Sources

An inventory of the stationary emission sources at Toronto Pearson was provided by GTAA. Such sources included natural gas fired boilers, heaters and turbines, diesel generators, and cooling towers. Emissions of particulate matter from the cooling towers were estimated using Environment Canada's "Emissions Calculator for Particulate Matter Emissions from Cooling Towers" (EC, 2012). In the 2003 assessment (RWDI, 2003), the only significant stationary source assessed was the Power Plant, which was decommissioned and replaced in 2005 by the Cogeneration Facility. Additional stationary sources have also been included in the current assessment which did not previously appear, including the Terminal 3 boilers, snowmelters, small heating units located at other buildings, and the large (>1500 kW) emergency diesel generators. In all cases, actual 2011 fuel use was input into EDMS for the purposes of emissions estimation, using default emission factors. Fuel use by stationary sources were allocated over 24 hours per day, 7 days per week, and 52 weeks per year with the exception of the emergency diesel generators and snowmelters. Diesel generators were assumed to operate for several consecutive hours each month (standard testing) and snowmelters were assumed to only operate in winter months (December to February).

2.1.7 Training Fires

Due to the lack of information, the fire training facility was assumed to operate 24 hours per day, 7 days per week, 52 weeks per year assuming the fuel use provided by the GTAA. The total volume of propane fuel used in fire training in 2011 was provided by GTAA. A default release height, diameter, gas velocity, and temperature for the emissions due to propane combustion in fire training was provided in EDMS, and used in conjunction with the fuel volume to estimate contaminant emissions. Training fires are a small source of emissions at Toronto Pearson (<1% of total emissions). Given the assumption that the emissions were spread over an entire year, training fires likely have little impact on the predicted results.

2.1.8 Comparison of 2011 Emission Inventory to Previous Predictions

The new 2011 emission inventory has been prepared based on actual 2011 operations data. The previous emissions inventory and modelling report for Toronto Pearson Airport (RWDI, 2003) estimated total emissions for the forecast years of 2005, 2010 and 2015 based on predictions of aircraft and vehicle traffic, ground-based traffic types, transportation patterns and anticipated number of travellers through the airport.

The previously forecasted 2010 emissions are compared to the 2011 actuals to provide some context regarding changes in operations at the airport as well as updates to emission inventory methods. Table 3 compares the 2011 and the forecast 2010 emissions for the different operations at Toronto Pearson. It was found that 2010 forecasts were generally higher than the actual 2011 emission rates for the species of interest for the air quality and human health risk assessment. Some notable differences between the 2010 predicted emissions and the 2011 inventory include:

- Stationary sources (increased from predicted 2010 to 2011 actuals)
- Aircraft emissions (decreased from predicted 2010 to 2011 actuals)
- Parking lots and roadways (decreased from predicted 2010 to 2011 actuals).

The 2011 stationary sources included a number of sources that were not in the 2010 forecasts, including: several large emergency diesel generators (>1500 kW), Terminal 3 boilers, the Cogeneration Facility, snowmelters, and known small heaters and boilers located in buildings around the airport. When the 2010 emissions estimates were generated, Toronto Pearson was using a Power Plant which was replaced by the Cogeneration Facility and the other stationary sources listed here were not included in the inventory.

The aircraft fleet in 2011 was not the same as that predicted in the 2003 study. Both aircraft numbers and aircraft types changed considerably in that time frame and the reduction in emissions reflects these changes. Toronto Pearson provides pre-conditioned air and ground power to aircraft parked at gates, which reduces the amount of time main or auxiliary engines are operating, which may contribute to the reduced emissions attributed to aircraft.

The largest change in emissions is with respect to parking and roadways. There is over an order of magnitude reduction is particulate and gaseous emissions between those calculated for 2010 (in the previous study) and in the 2011 inventory. Detailed information on parking lot configurations and assumptions were not published in the 2003 report, however the 2003 estimates for travel distances in parking lots and parking garages were approximately five times the current estimates. In this assessment, travel distances (total distance travelled per vehicle in the parking lot) were estimated based on the site plans for the parking facilities. In estimating travel distances, it was assumed that a vehicle on average would park in the middle of the parking lot. For parking facilities with multiple floors, it was assumed that a vehicle on average would park at the middle floor in the middle of the parking lot.

Due to limitations within the EDMS model, estimates of $PM_{2.5}$ emissions were not included in the 2010 emissions inventory. With updates to the model, this substance has been included in the current inventory. Fine particulate matter (i.e., $PM_{2.5}$) is a subset of the PM_{10}, and PM_{10} is a subset of Suspended Particulate Matter (SPM, also called Total Suspended Particulate or TSP). Most of the estimated particulate from Toronto Pearson is $PM_{2.5}$ (and therefore the PM_{10} and $PM_{2.5}$ numbers are very similar), as is typical of combustion sources.

Table 3: Comparison of Forecast (2010) and Actual (2011) Emissions Inventory for Toronto Pearson.

Contaminant	Source Category	Total Emissions (tonnes)		% Difference of Inventory Compared to Forecast (over-[+], or under-forecast[-])
		2011 Inventory	2010 Forecast	
CO	Aircraft	974	1,410	-31%
	GSE	1,177	3,022	-61%
	APUs	38	—	N/A
	Parking	33	487	-93%
	Roadways	350	1835	-81%
	Stationary Sources	40	6	567%
	Training Fires	0.6	1	-40%
	Total	**2,611**	**6,761**	-61%
NO_X	Aircraft	1,238	2,265	-45%
	GSE	123	266	-54%
	APUs	63	—	N/A
	Parking	3	26	-88%
	Roadways	35	263	-87%
	Stationary Sources	93	26	258%
	Training Fires	0.1	0.0	N/A
	Total	**1,554**	**2,846**	-45%
SO_X	Aircraft	102	144	-29%
	GSE	3	11	-73%
	APUs	8	—	N/A
	Parking	0.02	1	-98%
	Roadways	0.3	13	-98%
	Stationary Sources	0.4	0	N/A
	Training Fires	0.0003	0	N/A
	Total	**113**	**169**	-33%
VOC	Aircraft	138	222	-38%
	GSE	40	91	-56%
	APUs	3.4	—	N/A
	Parking	2.6	44	-94%
	Roadways	20	210	-90%
	Stationary Sources	2.6	11	-76%
	Training Fires	0.5	1	-50%
	Total	**207**	**579**	-64%

Contaminant	Source Category	Total Emissions (tonnes)		% Difference of Inventory Compared to Forecast (over-[+], or under-forecast[-])
		2011 Inventory	2010 Forecast	
PM_{10}	Aircraft	6.5	—	N/A
	GSE	3.9	12	-68%
	APUs	6.0	—	N/A
	Parking	0.09	1	-91%
	Roadways	1.3	11	-88%
	Stationary Sources	4.4	1	340%
	Training Fires	2.0	4	-50%
	Total	**24**	**29**	-17%
$PM_{2.5}$	Aircraft	6.5	—	N/A
	GSE	3.7	—	N/A
	APUs	6.0	—	N/A
	Parking	0.05	—	N/A
	Roadways	0.7	—	N/A
	Stationary Sources	3.7	—	N/A
	Training Fires	2.0	—	N/A
	Total	**23**	—	N/A
GHG	Aircraft	273,538	1,435,475	-81%
	GSE	—	—	N/A
	APUs	—	—	N/A
	Parking	1,056	5,535	-81%
	Roadways	11,199	64,354	-83%
	Stationary Sources	65,369	22†	297,031%
	Training Fires	—	—	N/A
	Total	**351,162**	**1,505,386**	-77%

Note: Values may not appear to add due to rounding, totals have been obtained by adding un-rounded numbers; $PM_{2.5}$ was not forecast for 2010. † This value contains only the power plant, and does not include a number of sources included in the 2011 inventory.

2.2 2022 and 2032 Emissions Inventories

Emissions for 2022 and 2032 were also calculated using the EDMS model, based on the internal database of emissions for each aircraft type and operational mode. For these cases, the GTAA's projected aircraft movements and anticipated aircraft types in each year were provided. The 2011 schedule was used to develop operational profiles for month of year, day of week, and quarter-hour of day, in effect determining peak and off-peak aircraft movement times. The anticipated 2022 and 2032 aircraft movements and types were then distributed through the year based on this schedule of aircraft operations. As for 2011, stationary equipment was entered into EDMS. Projected traffic was estimated based on the 2011 traffic count and passenger numbers, scaled up for the future years using the estimated future passenger numbers. This is discussed further in Section 4.1.

Emissions associated with parking facilities, roadways, stationary sources and training fires were scaled up based on total forecasted aircraft movements in the future years relative to the 2011 inventory. A summary of the complete 2022 and 2032 emission inventories is provided in Table 4 and APPENDIX B.

Table 4: Summary of 2022 and 2032 Emission Inventories.

Contaminant	Total Emissions (tonnes)	
	2022 Inventory	2032 Inventory
CO	2,525	2,987
NO_x	2,026	2,455
SO_x	169	206
VOC	274	330
PM_{10}	30	36
$PM_{2.5}$	28	34
GHG	493,070	586,611

3.0 PHASE 2: REGIONAL AIR QUALITY

Regional emissions for 2006 within the 7.5 km radius of the airport were quantified using Environment Canada's 2006 SMOKE emissions inventory (Environment Canada, 2006) and geo-referenced with land use data provided by the Region of Peel. The land use data were used as surrogates as defined by the Region of Peel for their own modelling program (underway as of the time of writing this report).

Environment Canada provided country-wide data but some data (such as transportation-related emissions) were provided based on data from the MOECC which were processed by Environment Canada using the SMOKE model for 2006.

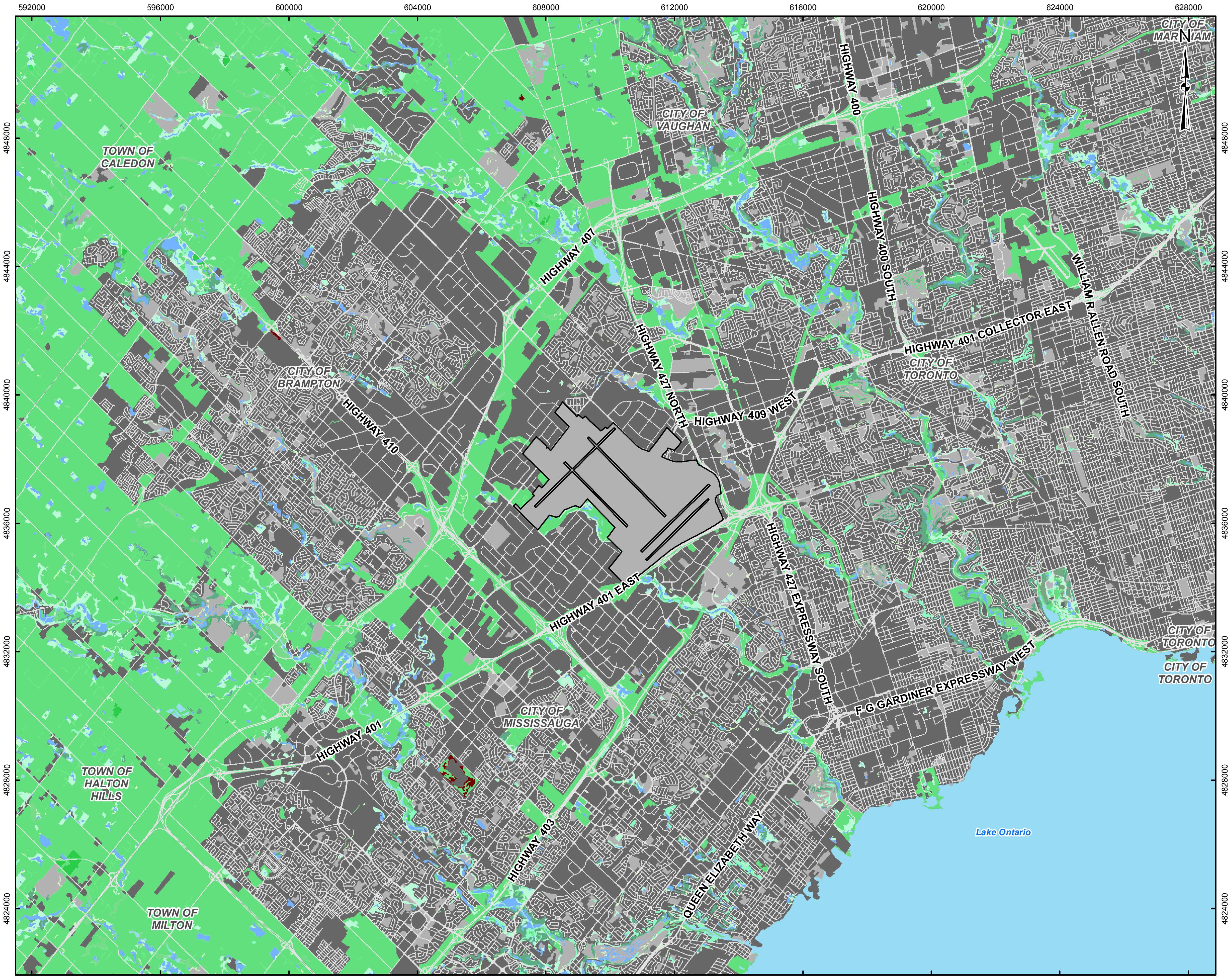
3.1 Data Processing

Environment Canada's (EC) 2006 emissions inventory is a Canada-wide inventory of emissions, grouped by sector (e.g., industrial, commercial, residential, agricultural, etc.), provincial data were provided for transportation-related sources (e.g., roads, rail, marine). The contaminants of interest included in the regional emissions inventory include NO_x, SO_2, CO, PM_{10}, $PM_{2.5}$ and VOCs. This data set is the most up-to-date, comprehensive and complete emissions data for Canada available as of the date of this study. The data have been used by Environment Canada for their own internal dispersion modelling, and have been shared with the U.S. EPA for the purposes of long-range modelling across North America.

Emissions data for the regional domain were extracted from the SMOKE data set and allocated to the 516 individual grid cells over the modelling domain based on land use parameters for each grid cell with the aid of a Geographic Information System (GIS). Land use over the modelling domain is show in Figure 8 by the Region of Peel, as per a data-sharing agreement between the GTAA and the Region of Peel. Environment Canada's data provided geographically-allocated emissions for "industrial sources" on a tonnes per year basis. The Region of Peel's data allowed for the geo-referencing and portioning of emissions to modelling grid cells. For example, if the EC data provided a value of 2,000 tonnes/yr emissions from a geographic area spread equally across four grid cells in the dispersion modelling domain, then each grid cell was allocated 500 tonnes/yr of emissions (i.e. 25% of the emissions in each).

The geo-referencing of emissions is a multi-step process, as shown in Figure 9.

Limited point source information was also provided with the EC emissions inventory. Emissions for approximately 1,100 industrial or commercial facilities known to be within the regional modelling domain were included. No stack parameter information was available, either from the EC data set or through the National Pollutant Release Inventory (NPRI) database, thus all stacks included in this regional emissions inventory are either less than 50 m tall or have emissions too low to be reportable under NPRI (stacks greater than 50 m, associated with facilities required to report under NPRI must have stack information provided). As these stacks are relatively low, and do not have stack parameters available, these sources have been included in the emissions for the grid cell in which each facility is located.



LEGEND

- Municipality
- Toronto/Lester B. Pearson International
- Bog
- Built-up Area Impervious
- Built-up Area Pervious
- Coniferous Forest
- Deciduous Forest
- Extraction
- Forest
- Hedge Rows
- Marsh
- Mixed Forest
- Open Water
- Plantations - Tree Cultivated
- Swamp
- Tallgrass Woodland
- Transportation
- Undifferentiated

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:120,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

LAND USE OVER THE MODELLING DOMAIN FOR THE TORONTO PEARSON AIR QUALITY STUDY

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	13 Jun. 2014	**FIGURE: 8**	
GIS	ME	13 Jun. 2014		
CHECK	EH	13 Jun. 2014		
REVIEW	AB	13 Jun. 2014		

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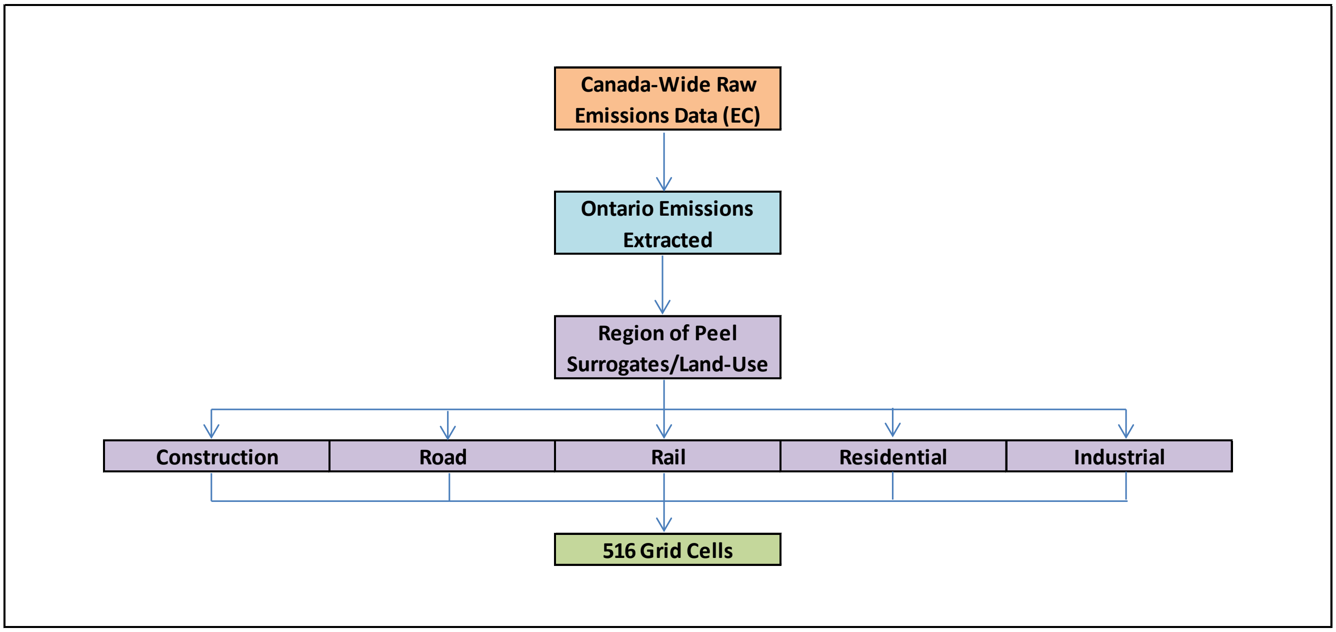


Figure 9: Geographic Allocation of Emissions Stepwise Process

3.2 Regional Emissions Inventory

A summary of the annual emissions for the regional modelling (within 7.5 km of Toronto Pearson) is provided in Table 5. Individual contributions from the available source groups and the total annual emissions, in metric tonnes per year over the entire domain are shown.

Special consideration was given to the EC surrogates provided with the SMOKE emissions data. For example, airport emissions (from Toronto Pearson and Billy Bishop) were allocated by Environment Canada based on the postal code in which airport workers reside. As Billy Bishop is outside the modelling domain, and detailed emissions for Toronto Pearson are the subject of the Phase 1 modelling, all airport emissions were removed from the data set.

It was also found that EC used population as a surrogate for off-road vehicle emissions (e.g., dirt bikes, ATVs, snowmobiles and jet-skis, etc.). Golder re-assigned these emissions to Federal and Provincial Parks. As there are no areas where the use of off-road vehicles is legal within 7.5 km of the Toronto Pearson property boundary, emissions from these sources are not included within the regional modelling.

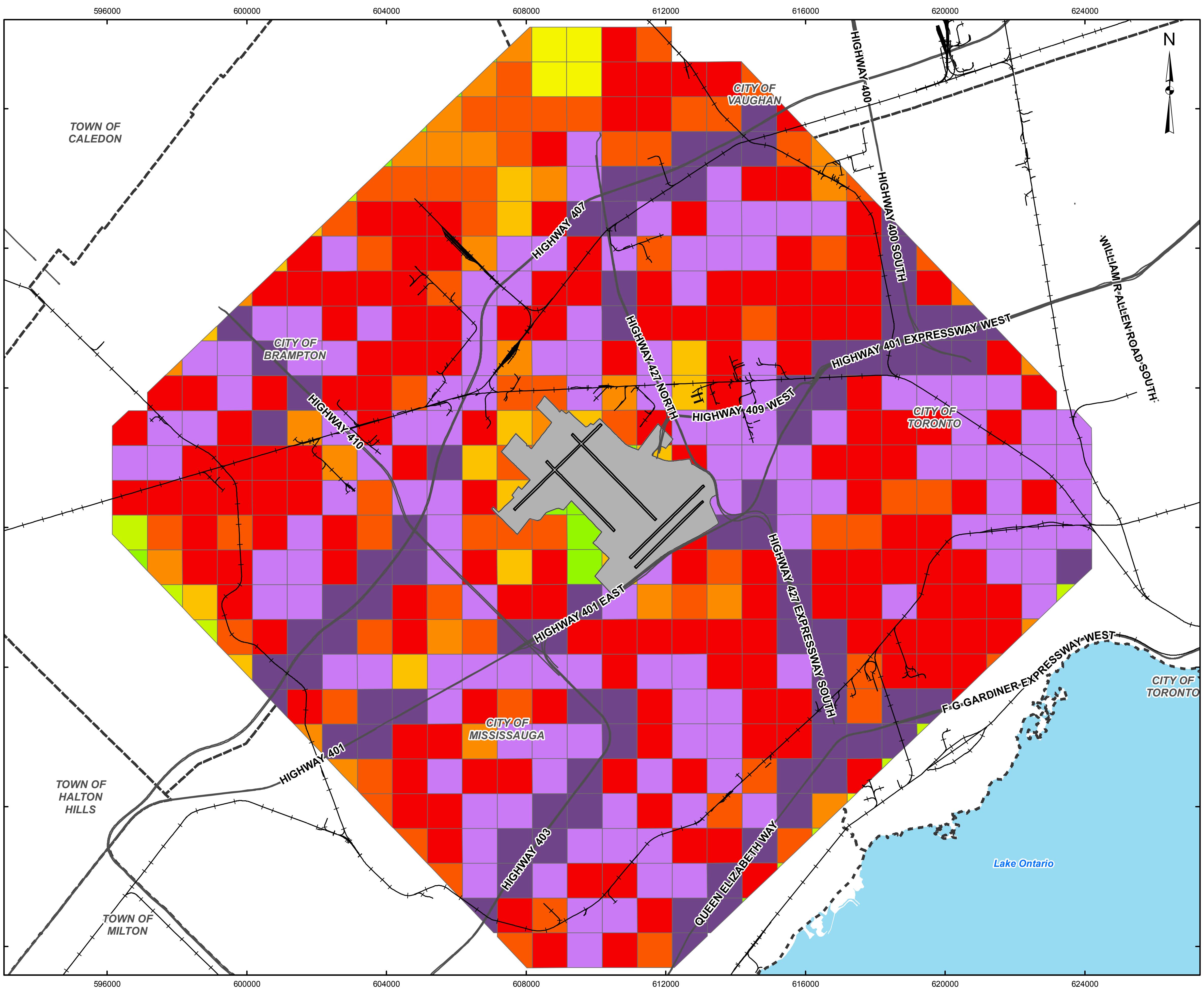
EC rail emissions were not found to align with known rail lines and were subsequently corrected in the gridded emissions. Similarly, land use data from the Region of Peel was found to be out-of-date, with numerous areas identified as “agricultural”, which other sources identify as residential, commercial or industrial. The land use was updated with the aid of the GIS to ensure that agricultural emissions were not mistakenly associated with different land uses.

Table 5: Summary of Annual Regional Emissions by Source Group

Contaminant	Emissions (tonnes/year)					
	Construction	Road	Rail	Residential	Industrial	TOTAL
CO	—	88,495	102	7,073	2,787	98,457
NO_X	—	11,109	671	1,326	3,839	16,945
SO_2	—	44	29	267	1,709	2,049
VOC	—	5,535	17	1,457	14,294	21,303
PM_{10}	2,288	5,770	22	1,344	1,535	10,959
$PM_{2.5}$	429	1,496	20	1,337	1,013	4,296

The emissions shown above were gridded through the process described in Section 3.1 and are shown graphically in Figure 10 to Figure 15. In each case, summed emissions in each grid cell are presented, in tonnes/year, representing the total mobile and stationary emissions originating from sources within that grid cell. Grid cells are 1 x 1 km, with the exception of those immediately around the airport property or along the modelling domain boundary. Cells in these areas have irregular shapes and sizes and are smaller than 1 km by 1 km. A brief discussion of the emissions for each contaminant follows.

Regional GHG emissions are not available for the area bounded by this study.



LEGEND

- Road
- Railways

Total Annual Emissions (t/yr)

- > 250
- 100 - 250
- 50 - 100
- 25 - 50
- 10 - 25
- 5 - 10
- 2.5 - 5
- 1 - 2.5
- < 1
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

REFERENCE

Base Data - MNR LIO, obtained 2013
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:110,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

ANNUAL REGIONAL CO EMISSIONS (TONNES/YR)

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	13 Jun. 2014		
GIS	ME	13 Jun. 2014		
CHECK	EH	13 Jun. 2014		
REVIEW	AB	13 Jun. 2014		

FIGURE: 10

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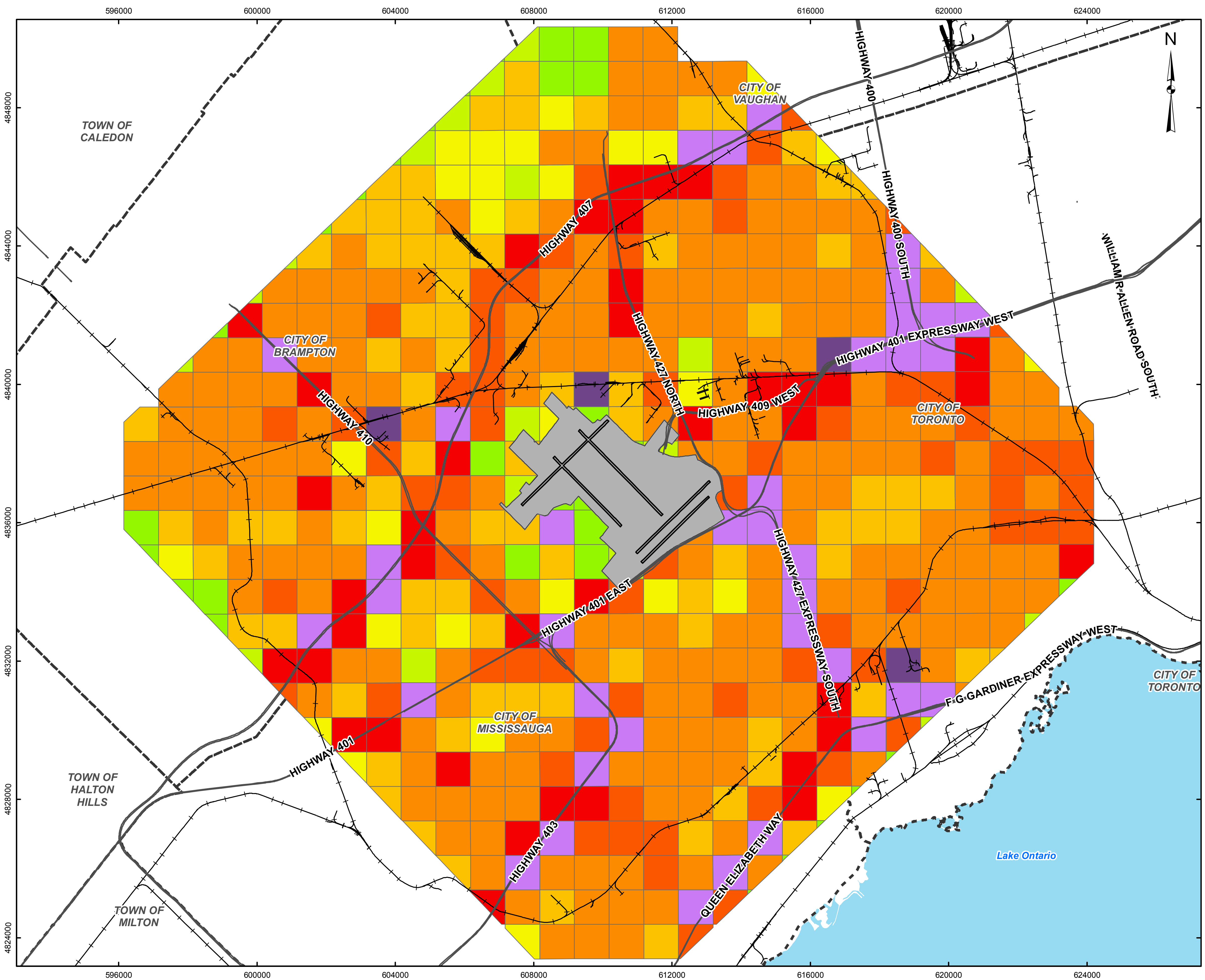

LEGEND

- Road
- Railways

Total Annual Emissions (t/yr)

- > 250
- 100 - 250
- 50 - 100
- 25 - 50
- 10 - 25
- 5 - 10
- 2.5 - 5
- 1 - 2.5
- < 1
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

REFERENCE

Base Data - MNR LIO, obtained 2013
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PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
ANNUAL REGIONAL NOX EMISSIONS (TONNES/YR)

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	13 Jun. 2014		
GIS	ME	13 Jun. 2014		
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REVIEW	AB	13 Jun. 2014		

Golder Associates
Mississauga, Ontario

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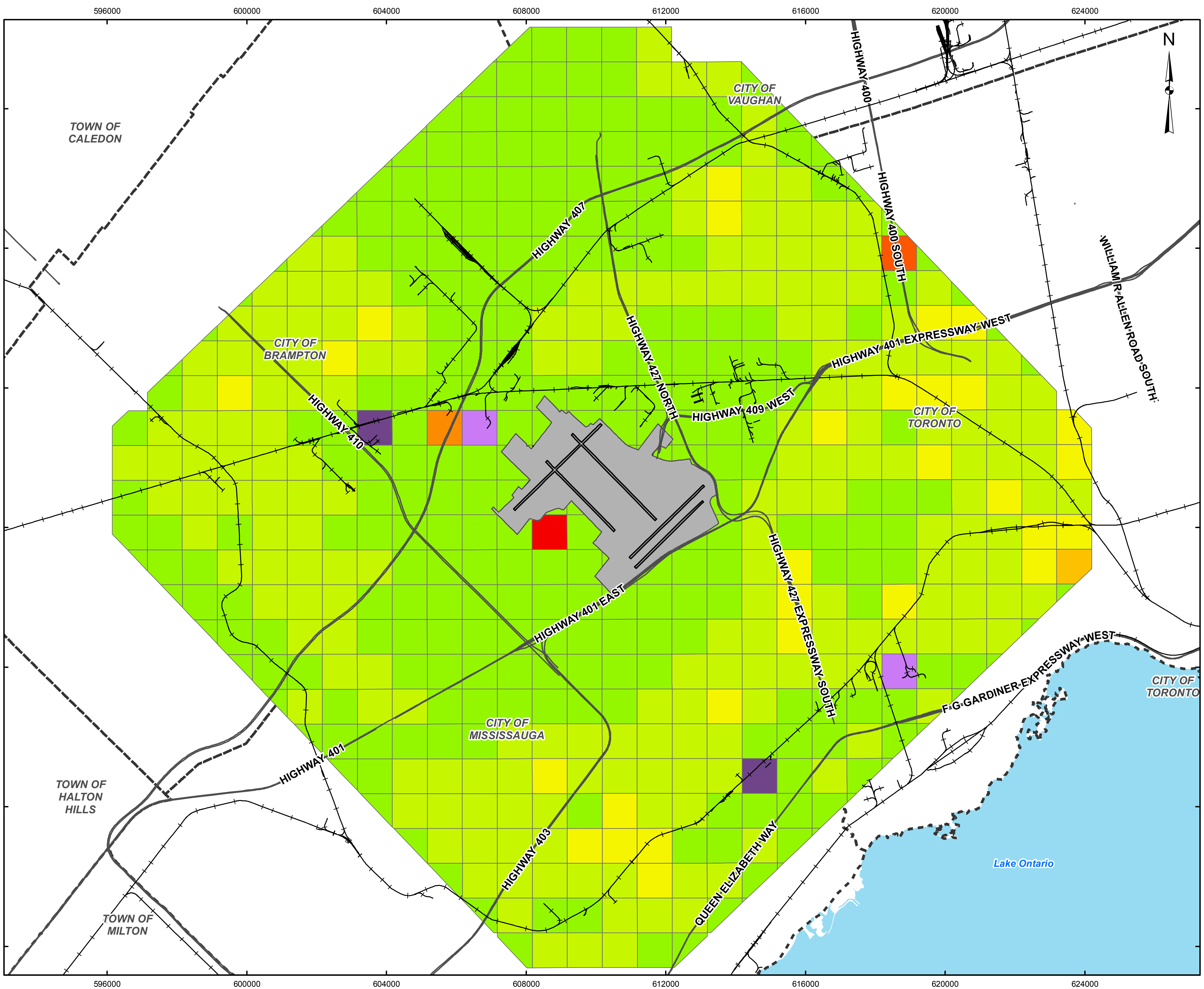

LEGEND

- Road
- Railways

Total Annual Emissions (t/yr)

- > 250
- 100 - 250
- 50 - 100
- 25 - 50
- 10 -25
- 5 - 10
- 2.5 - 5
- 1 - 2.5
- < 1
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

REFERENCE

Base Data - MNR LIO, obtained 2013
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PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

ANNUAL REGIONAL SO2 EMISSIONS (TONNES/YR)

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	13 Jun. 2014	FIGURE: 12	
GIS	ME	13 Jun. 2014		
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REVIEW	AB	13 Jun. 2014		

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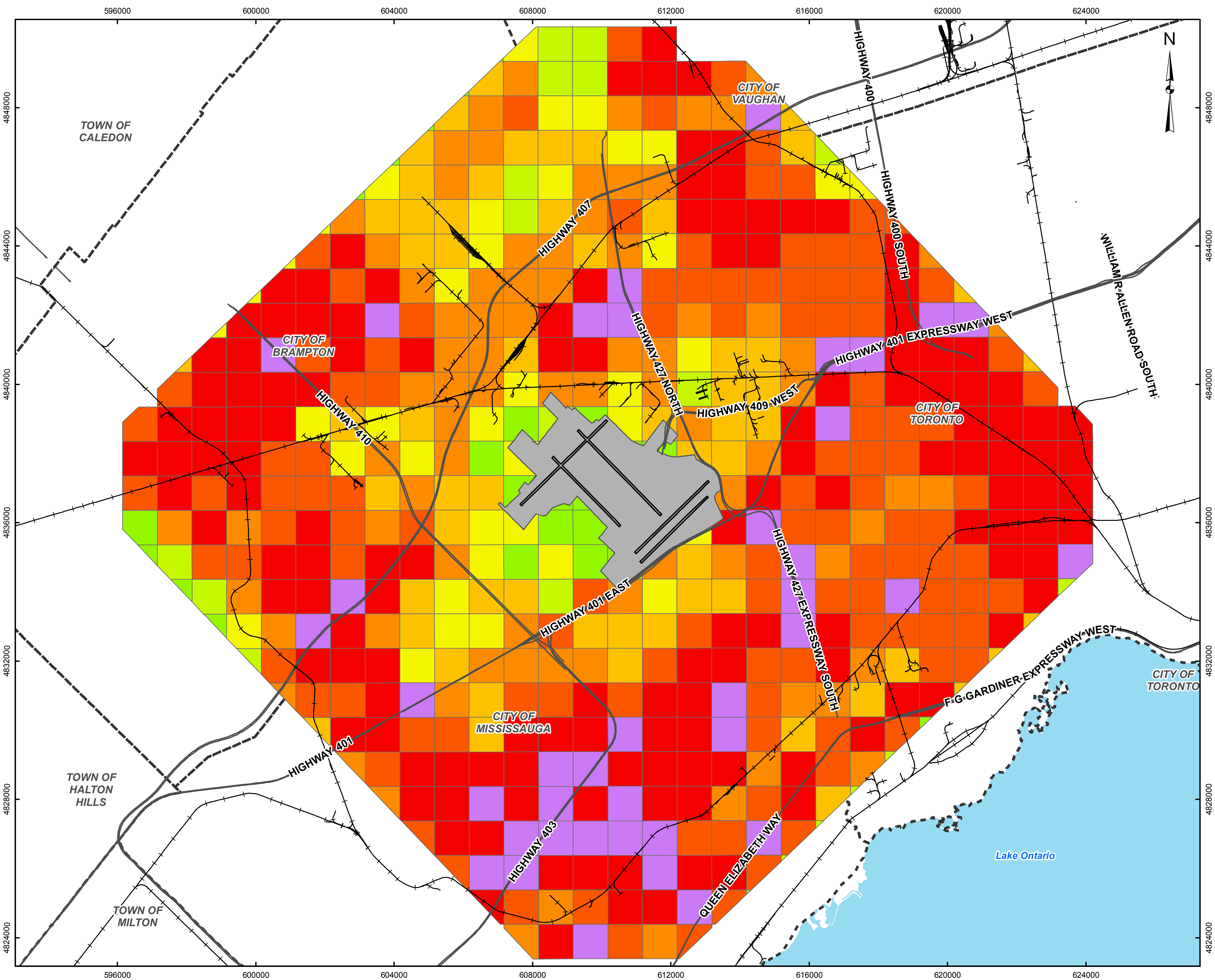

LEGEND

- Road
- Railways

Total Annual Emissions (t/yr)

- > 250
- 100 - 250
- 50 - 100
- 25 - 50
- 10 - 25
- 5 - 10
- 2.5 - 5
- 1 - 2.5
- > 1
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

REFERENCE

Base Data - MNR LIO, obtained 2013
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

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SCALE 1:110,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

ANNUAL REGIONAL VOC EMISSIONS (TONNES/YR)

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	13 Jun. 2014		
GIS	ME	13 Jun. 2014		
CHECK	EH	13 Jun. 2014		
REVIEW	AB	13 Jun. 2014		

FIGURE: 13

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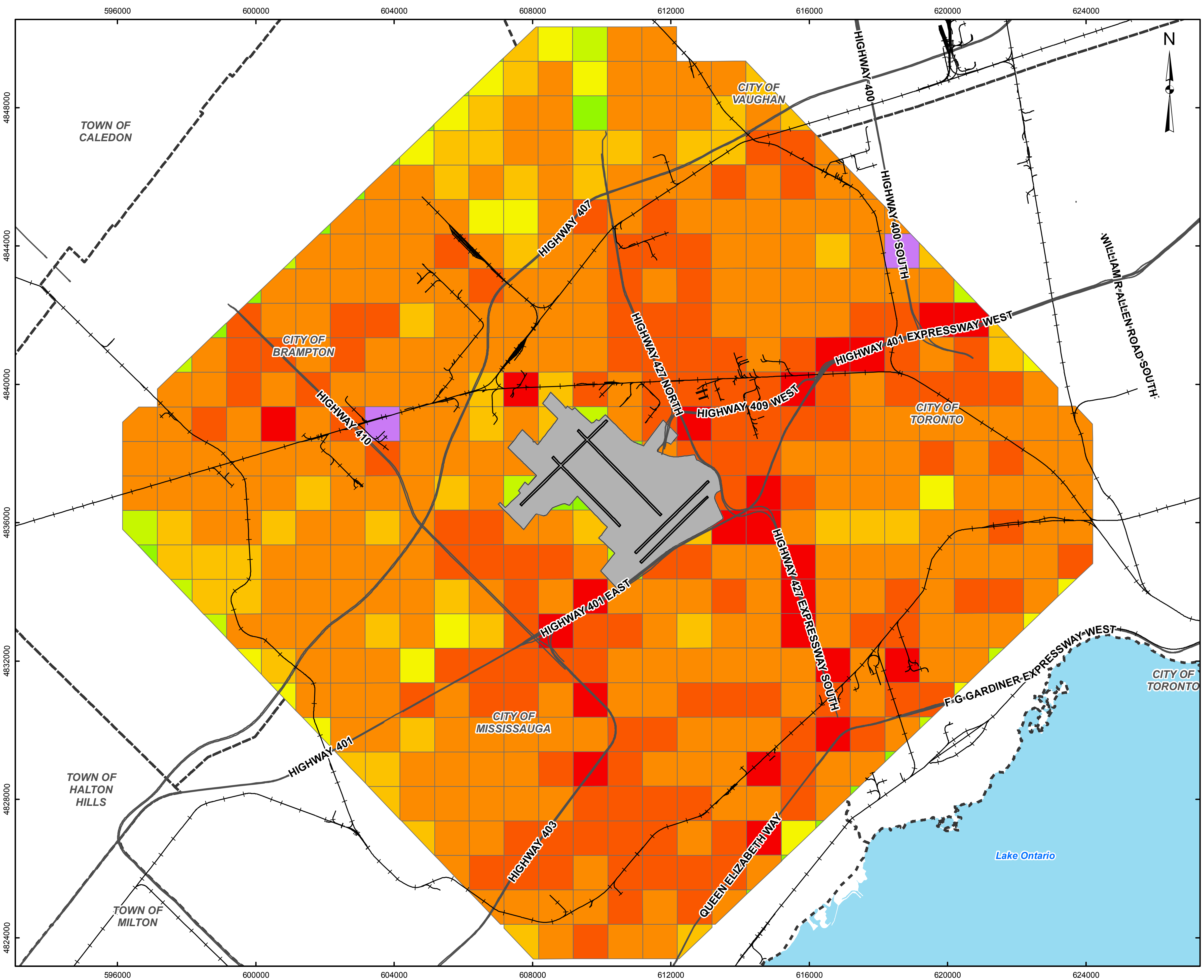

LEGEND

- Road
- Railways

Total Annual Emissions (t/yr)

- > 250
- 100 - 250
- 50 - 100
- 25 - 50
- 10 - 25
- 5 - 10
- 2.5 - 5
- 1 - 2.5
- > 1
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

REFERENCE

Base Data - MNR LIO, obtained 2013
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2 1 0 2 4
SCALE 1:110,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

ANNUAL REGIONAL PM10 EMISSIONS (TONNES/YR)

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	13 Jun. 2014		
GIS	ME	13 Jun. 2014		
CHECK	EH	13 Jun. 2014		
REVIEW	AB	13 Jun. 2014		

FIGURE: 14

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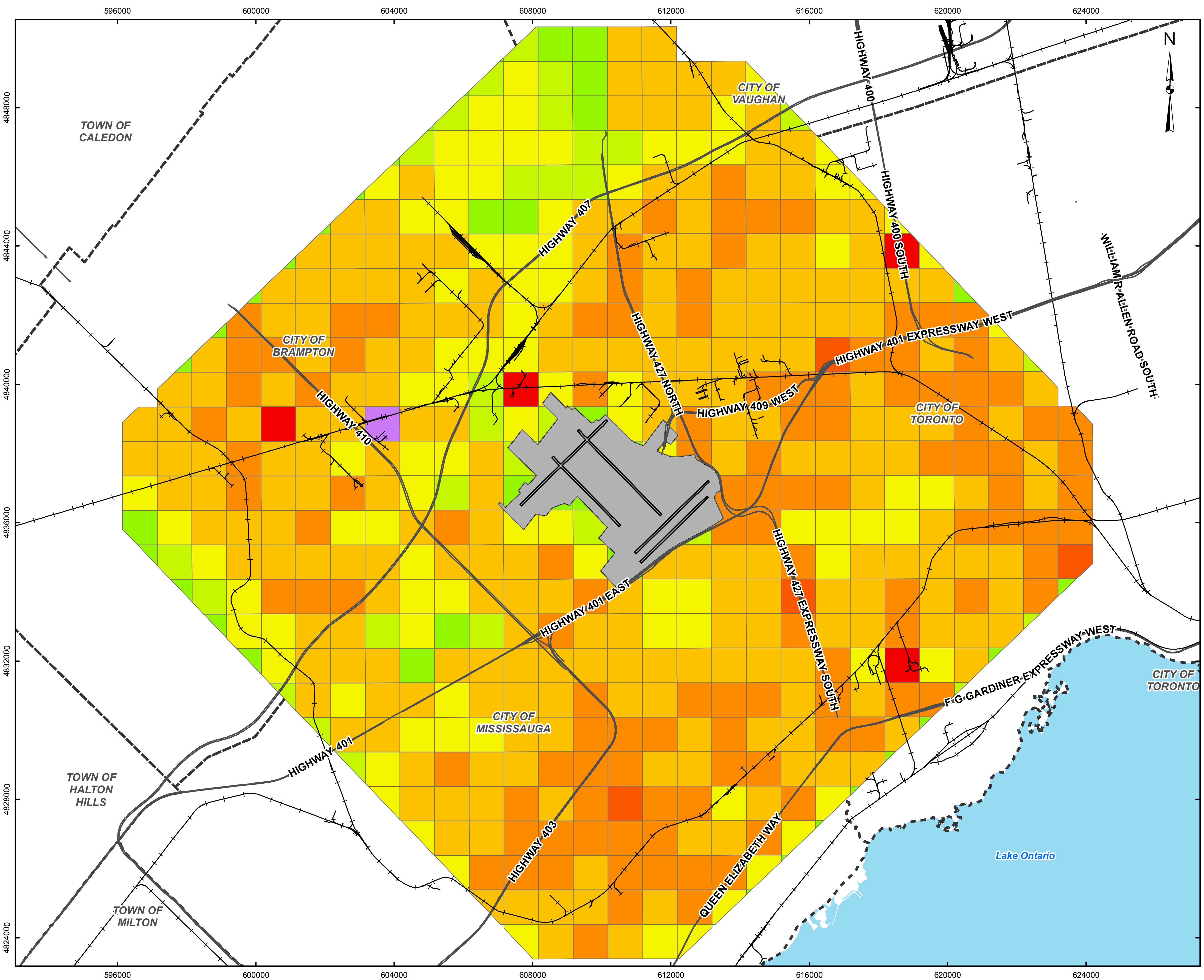

LEGEND

- Road
- Railways

Total Annual Emissions (t/yr)

- > 250
- 100 - 250
- 50 - 100
- 25 - 50
- 10 - 25
- 5 - 10
- 2.5 - 5
- 1 - 2.5
- > 1
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

REFERENCE

Base Data - MNR LIO, obtained 2013
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:110,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

ANNUAL REGIONAL $PM_{2.5}$ EMISSIONS (TONNES/YR)

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	13 Jun. 2014		
GIS	ME	13 Jun. 2014		
CHECK	EH	13 Jun. 2014		
REVIEW	AB	13 Jun. 2014		

FIGURE: 15

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3.2.1 Regional CO Emissions

The greatest contribution to regional CO emissions in the vicinity of the airport is from the roadways and the highest emissions are generally found where two or more major highways cross (e.g., Highway 401 and Highway 403, Highway 401 and Highway 400, Highway 427 and the Queen Elizabeth Way/Gardiner, etc.). Figure 12 shows that CO emissions are highest along the major highways through the study area.

3.2.2 Regional NO_x Emissions

The greatest contribution to regional NO_x emissions in the vicinity of the airport is from the roadways. Figure 10 shows that the cells with the largest annual NO_x emissions follow the major highways, such as Highway 401, the 407, the 427 and 400. Four cells show annual NO_x emissions greater than 250 tonnes per year. These cells, and their significant contributors to NO_x emissions, are:

- NW of airport at Highway 410: Several industrial facilities (chemical and manufacturing) in this grid cell contributes the highest emissions of NO_x. In addition, there are some other smaller industrial facilities. These point sources were included in the gridded emissions.
- N-central: The primary contributor to NO_x emissions in this grid cell is a power generation facility not associated with Toronto Pearson. This is one of the point sources which have been included in the gridded emissions.
- NE at 401: There are four significant point sources located in close proximity to each other in this grid cell. All were identified in the point source database provided by Environment Canada and were included in the gridded emissions.
- SE: A manufacturing facility in this grid cell has high emissions of NO_x, SO_2, PM_{10} and $PM_{2.5}$. This is one of the point sources which have been included in the gridded emissions.

3.2.3 Regional SO_2 Emissions

The greatest contribution to regional SO_2 emissions in the vicinity of the airport is from industrial sources. Figure 11 shows three cells with annual SO_2 emissions greater than 250 tonnes per year. These cells, and their significant contributors to SO_2 emissions, are:

- NW near Highway 410: A chemical facility in this grid cell contributes the highest emissions of SO_2. There are other, smaller, industrial facilities located in this grid cell which also contribute to the summed SO_2 emissions. A second cell, nearer the airport, includes several small manufacturing facilities which add up to elevated SO_2 emissions also. These are the point sources which have been included in the gridded emissions.
- W of Airport: Three heavy manufacturing facilities are located in this grid cell. These are point sources which have been included in the gridded emissions.

- SW north of Queen Elizabeth Way: There is a manufacturing facility here which is the single largest point source contributor to SO_2 emissions in the regional modelling domain. There are several other industrial facilities which were identified as point sources in this grid cell which also contribute to total SO_2 emissions. These facilities were all point sources which have been included in the gridded emissions.

3.2.4 Regional VOC Emissions

The greatest overall contribution to regional VOC emissions in the vicinity of the airport is from industrial sources, most of which were not specifically identified in Environment Canada's database, but were rather derived Environment Canada's industrial emissions mapped to "built up" land uses around the modelling domain. Figure 15 shows the distribution of VOC emissions, with larger contributions found in built-up areas near the major highways and in Toronto, Mississauga, Brampton, Etobicoke, and Rexdale.

3.2.5 Regional PM_{10} Emissions

The greatest overall contribution to regional PM_{10} emissions in the vicinity of the airport is also from roadways, and would include both tailpipe emissions and re-suspended road dust. Figure 13 shows two cells with emissions greater than 100 tonnes per year. These cells, and their significant contributors to PM_{10} emissions, are:

- NW at Highway 410: A chemical facility in the grid cell with high emissions of PM_{10}. This is one of the point sources which have been included in the gridded emissions.
- NE at Highway 400: There are two point sources located in close proximity to each other in this grid cell, the larger of which is a manufacturing facility. Both were identified in the point source database provided by Environment Canada and were included in the gridded emissions.

3.2.6 Regional $PM_{2.5}$ Emissions

The greatest overall contribution to regional $PM_{2.5}$ emissions in the vicinity of the airport is also from roadways, and would include both tailpipe emissions and re-suspended road dust. Figure 14 shows that the pattern of $PM_{2.5}$ emissions is the same as for PM_{10}, and the same cells show above-average emissions. The sources of $PM_{2.5}$ contributing to these cells would be the same as for PM_{10}.

3.3 Comparison of Current and Previous Regional Emission Inventory

The previous emissions inventory and modelling report (RWDI, 2003), estimated regional emissions using the 1995 Environment Canada Canadian Criteria Air Contaminants emission inventory (the most up-to-date national inventory available at the time). These emissions can be compared to the 2006 regional emissions used for the current report.

Regional $PM_{2.5}$ emissions were not available for the baseline year used in the previous study. It is only since the publication of the 2003 study that $PM_{2.5}$ has been identified as a contaminant of concern, resulting in a national effort to monitor and estimate emissions of this substance.

The estimated regional baseline emissions from the previous Air Quality Report are presented with the current baseline regional emissions to provide some context regarding changes in the local area emissions. Table 6 provides the current and previously-estimated emissions for the same geographic region around Toronto Pearson.

Emissions patterns in the region around the airport have changed since the previous study was completed. All compounds being considered, with the exception of carbon monoxide, have decreased in the study area. Comparing the previous emissions inventory to current data, it was found that while industrial/commercial, and residential emissions have all decreased, emissions from mobile sources, specifically roads, have increased, nearly tripling since the previous inventory was completed. The differences between the two inventories are likely explained by changes to commercial and industrial facilities in the region and improvements in technologies for emissions controls and changing traffic patterns. In particular, traffic counts throughout the study area, particularly on the highly-travelled 400-series highways have increased significantly, nearly doubling in some areas. Highway 407 was also not included in the previous report as it opened after the base year inventory, further contributing to the large increase in traffic-related emissions.

Table 6: Comparison of Previous and Current Regional Emissions Inventories

Contaminant	Emissions (tonnes/year)	
	2011 Inventory[1]	2010 Forecast Inventory[2]
CO	98,457	47,925
NO_x	16,945	25,189
SO_2	2,049	22,225
VOC	21,303	29,747
PM_{10}	10,959	14,134
$PM_{2.5}$	4,296	N/A

Notes:
1 Based on 2006 Environment Canada SMOKE data
2 Based on 1995 Environment Canada Criteria Air Contaminants National Inventory

3.4 2022 and 2032 Regional Emissions Inventories

There is a great deal of uncertainty associated with estimating regional emissions for the future scenarios and care must be used in interpreting results based on assumed trends. Environment Canada has extensive historic data for a number of the contaminants of interest which can permit some assumptions regarding future trends in regional emissions, however these are country-wide trends and do not always correlate with the observed emissions trends in the modelling domain. The following discussions are provided as a starting point for how the future regional emissions inventory might be derived from current values.

3.4.1 Carbon Monoxide

Emissions of carbon monoxide have been steadily declining in Canada since the 1990's (EC, 2014c). This is primarily attributed to a reduction in emissions from transportation (e.g., on-road vehicles, rail, air, and marine). Based on published data from 1990 to 2012, national CO emissions have been declining by an average of 2.5% per year. Emissions of CO in the modelling domain have increased approximately 9.4% per year since the previous air quality study, primarily due to increased traffic along 400-series highways, in particular Highway 407 which was not open when the previous emissions inventory was generated. The highways were found to be the largest source of regional CO emissions. Given the discrepancy between the national trend and the local trend in emissions, and especially since highways are the most significant source of CO emissions locally, as a conservative approach the regional CO emissions remain at the 2011 baseline rate for the 2022 and 2032 modelling (Table 7).

Table 7: Estimated Regional Emissions for Future Scenarios.

Contaminant	2011 Baseline (tonnes/year)	2022 and 2032 (tonnes/year)
CO	98,457	98,457
NOx	16,945	15,528
SO_2	2,049	2,049
VOC	21,303	18,797
PM_{10}	10,959	8,351
$PM_{2.5}$	4,296	3,321

3.4.2 Nitrogen Oxides

Emissions of nitrogen oxides were relatively stable in Canada from 1990 to 2003, but have been declining since then (EC, 2014a). This reduction has been primarily attributed to reduction in emissions from transportation and power generation. Some decreases were also found among some industry sectors. Based on published data from 1990 to 2012, national NO_x emissions have been declining by an average of 1.4% per year. Emissions of NO_x in the regional modelling domain have also decreased since the previous air quality study (RWDI, 2003); by a greater amount than the national trend (regional emissions have shown a 4.8% decrease on an annual basis). It therefore seems reasonable to assume that future emissions of NO_x will be lower than current emissions. As a conservative approach, the national per cent decrease has been used rather than the local decrease. In light of this, future NO_x emissions have been estimated in Table 7. It has been assumed that 2011 emissions were the same as those reported for Environment Canada's 2006 emissions inventory (i.e. no change in emissions between the date of the most recent regional inventory and the baseline year was assumed).The 1.4% federal annual NO_x reduction was applied only going forward to 2022. As reduction trends are unlikely to continue indefinitely, it is recommended that 2032 be modelled using the same emissions as 2022.

3.4.3 Sulphur Dioxide

Emissions of sulphur dioxide have been steadily declining in Canada since the 1990's (EC, 2014b). This decline is due in large part to government actions to fight acid rain, and associated federal-provincial and United States agreements on capping SO_x emissions by 1994. Further reductions are attributable to upgrades and air pollution controls for smelting operations and the reduction in reliance on coal for power generation and reductions from the petroleum refining sector. Mobile emissions of SO_2 have dropped through the implementation of low-sulphur fuels. Based on published data from 1990 to 2012, national SO_2 emissions have been declining by an average of 3.9% per year. Locally, the decrease appears to have been even greater, over 20% annually. Given the primary sectors in which reductions have been occurring (smelting, power generation, petroleum refining - none of which are represented in the study area) and in view of the fact that the existing fleet of mobile vehicles in Ontario already primarily relies on low-sulphur fuel, it seems unlikely that regional SO_2 emissions will continue to drop at the historic rate (either the Federal rate or that observed locally in the last decade). For the purposes of the current assessment, the SO_2 emissions remain unchanged at the 2011 baseline rate for the 2022 and 2032 modelling (Table 7).

3.4.4 VOC

Emissions of volatile organic compounds have been generally declining in Canada since the 1990's (EC, 2014e), with a slight increase in emissions from 2011 to 2012. This increase was attributed to industrial sources, primarily in the oil and gas, and wood industry sectors. The long-term decline in VOC emissions is mainly attributed to a reduction in emissions from transportation and off-road vehicles, reductions from the petroleum refining sector, chemical industries and the wood industry and a reduction in emissions due to decreased use of VOCs in paints, solvents and cleaners. Based on the published data from 1990 to 2012, national VOC emissions have been declining an average of 1.4% per year. Regionally, emissions of VOCs have been found to be decreasing 4.1% per year from 2003 to 2011. Future VOC emissions have been estimated in Table 7, with future regional emissions being calculated based on the national rate of decline (1.4% per year) to be conservative. In order to take a conservative approach, it has been assumed that 2011 emissions were the same as those reported in Environment Canada's 2006 emissions inventory (i.e. no decline between the date of the most recent regional inventory and the baseline year was assumed), and the 1.4% per year reduction was applied only to 2022. As reduction trends are unlikely to continue indefinitely, 2032 will be modelled using the same regional emissions as 2022.

EMDS provides a breakdown of the speciation of volatile organic compounds attributable to airport operations. This breakdown, which is provided as a percentage of the Total Organic Gases (TOG) category of emissions, was applied to the modelling results to determine the concentrations of those compounds of interest for the Human Health Risk Assessment. As most of these emissions are not regulated provincially or federally, they have not been summarized in this report, but are addressed in the Human Health Risk Assessment.

3.4.5 PM_{10}

Emissions of particulate matter (for all size fractions) have been declining in Canada since the 1990's (EC, 2014d). Reductions have been attributed to reduced emissions from power generation, transportation and some industrial sectors. Based on published data from 1990 to 2012, national PM_{10} emissions have been declining by an average of 2.5% per year. Regionally, PM_{10} emissions have been found to be decreasing by nearly the same amount (3.1% reduction per year). It therefore seems reasonable to assume that future emissions of PM_{10} will be lower than current emissions, however, as a conservative approach, the national percent decrease has been used instead of the local decrease. The future PM_{10} emissions have been estimated in Table 7. It has been assumed that 2011 regional emissions were the same as those reported in Environment Canada's 2006 emissions inventory (i.e. no change in emissions between the date of the most recent regional inventory and the baseline year was assumed). The regional emissions for 2022 are based on the 2.5% federal annual reduction. As reduction trends are unlikely to continue indefinitely, the 2032 regional emissions are assumed to be the same as for 2022.

3.4.6 $PM_{2.5}$

Emissions of particulate matter (for all size fractions) have been declining in Canada since the 1990's (EC, 2014d). Reductions have been attributed to reduced emissions from power generation, transportation and some industrial sectors. Based on published data from 1990 to 2012, national $PM_{2.5}$ emissions have been declining by an average of 2.4% per year. No regional comparison is possible as $PM_{2.5}$ was not directly assessed in the previous study, and was only considered as a fraction of PM_{10}. It is therefore recommended that $PM_{2.5}$ regional emissions for the future scenarios be reduced at the federally-observed rate, to maintain consistency with PM_{10} emissions, as shown in Table 7. As with the PM_{10} emissions, the 2032 regional emissions are modelled at the same amount as the 2022 regional emissions.

4.0 PHASE 3: DISPERSION MODELLING SETUP

The set-up for the dispersion modelling sources and scenarios are discussed below for the airport alone, regional alone, and the summed results for airport plus regional modelling.

4.1 Toronto Pearson Airport

For the 2011 base case, the 2011 airport emissions inventory was modelled using the 2011 hourly meteorological data. This ensured that the runways in use in the 2011 schedule correspond with the actual meteorological conditions during each hour. If the 2011 schedule was used with meteorological data from other years, the runways in use during any particular hour might not correspond with the wind direction during that hour, introducing a potential source of error into the modelling results. The 2011 hourly emissions, based on the actual 2011 schedule of operations was distributed across nearly 7000 point, volume, and area sources across the airport property, representing stationary sources, gates, runways, taxiways, on-site roads, apron areas, parking garages, etc. Parking lots were modelled as areas; parking garages, aircraft gates and other ancillary equipment were modelled as volume sources; taxiways, runways, and on-site roads were parameterized as a series of volume sources tracing the route of the aircraft or vehicles; and stationary combustions sources such as boilers, heaters, diesel generators and fire training were treated as point sources. The building and airport physical sizes and locations where parameterized with the aid of EDMS and reviewed to ensure the parameterization was acceptable. A screenshot of EDMS's representation of the airport is provided in Figure 16. Convair Drive, Highway 409 and other public roadways are not represented in this figure so they are not double-counted when combining airport and regional modelling.

The future cases (2022 and 2032) were modelled using five years of meteorological data (2008-2012) to capture a wider range of possible meteorological conditions. The estimated emissions were distributed throughout the year based on an activity profile generated within EDMS. The activity profiles, based on the 2011 data, distributed the aircraft and other activities throughout the year.

An example of the quarter-hour, weekly and monthly operational profile for 2022 arrivals is shown in Figure 17. The operational profiles show the percent of the maximum number of flights for each period (monthly, daily or quarter-hourly) that occur during each period. The Y-axis shows the fraction (0 – 1) of the maximum operations for that period. For example, July has an operational profile of "1" in the monthly figure while August is a close second with a value of 0.991. These are the busiest months of operations and therefore have 100% and 99.1% of the maximum monthly operations respectively. February is the least busy month, according to current schedules, with only 0.8155 of the maximum monthly operations occurring in that month. Operations at night are significantly lower than during daytime hours, and this is reflected in the quarter-hourly profile which shows nighttime operations are a fraction of the maximum possible levels, whereas there is an increase in the number of hourly operations during the daytime.

As future years were modelled using quarter-hourly, daily and monthly scheduling, rather than an actual log of activities, the model internally assigned emissions to runways, taxiways, gates, etc. based on the aircraft schedule derived from the 2011 data. Emissions sources for 2022 and 2032 are the same as for the base year.

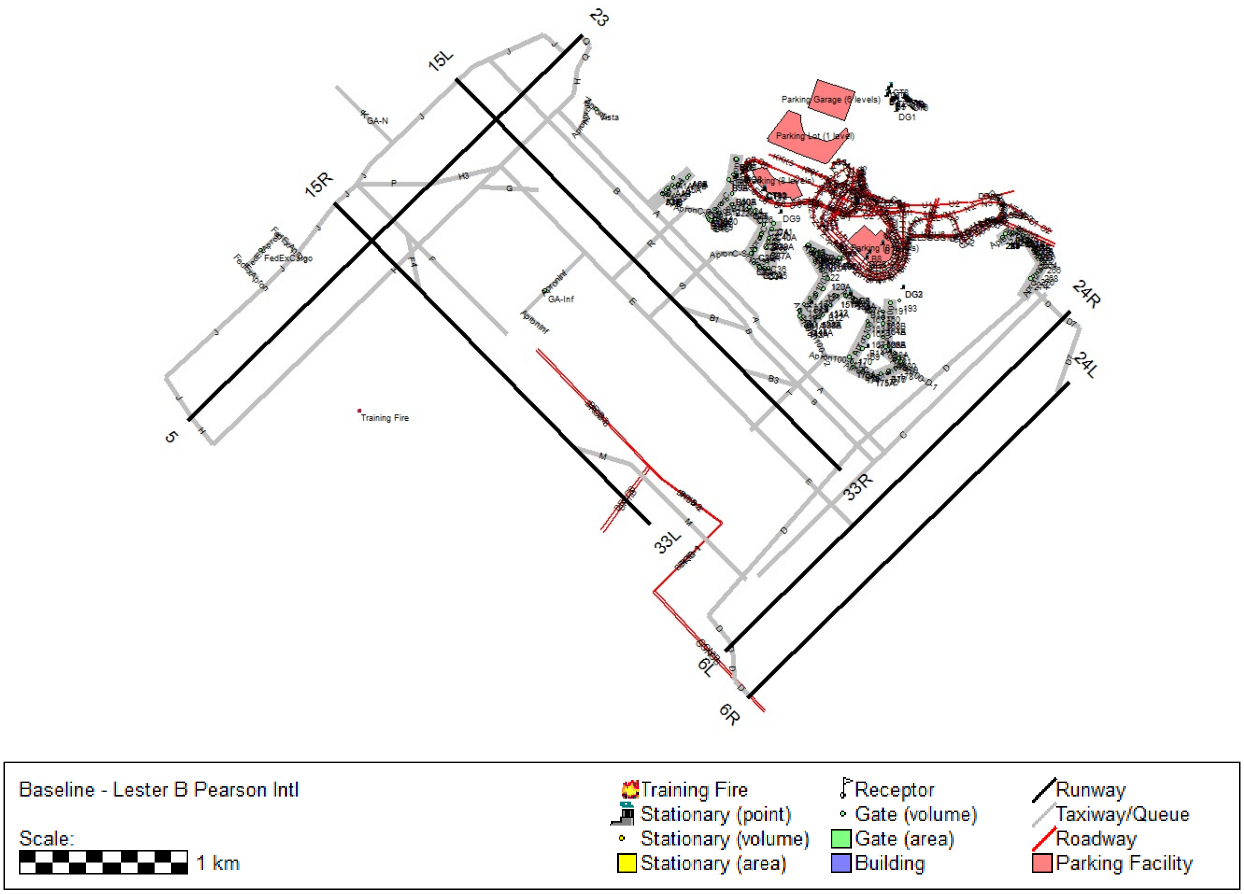

Figure 16: EDMS Representation of Toronto Pearson Airport

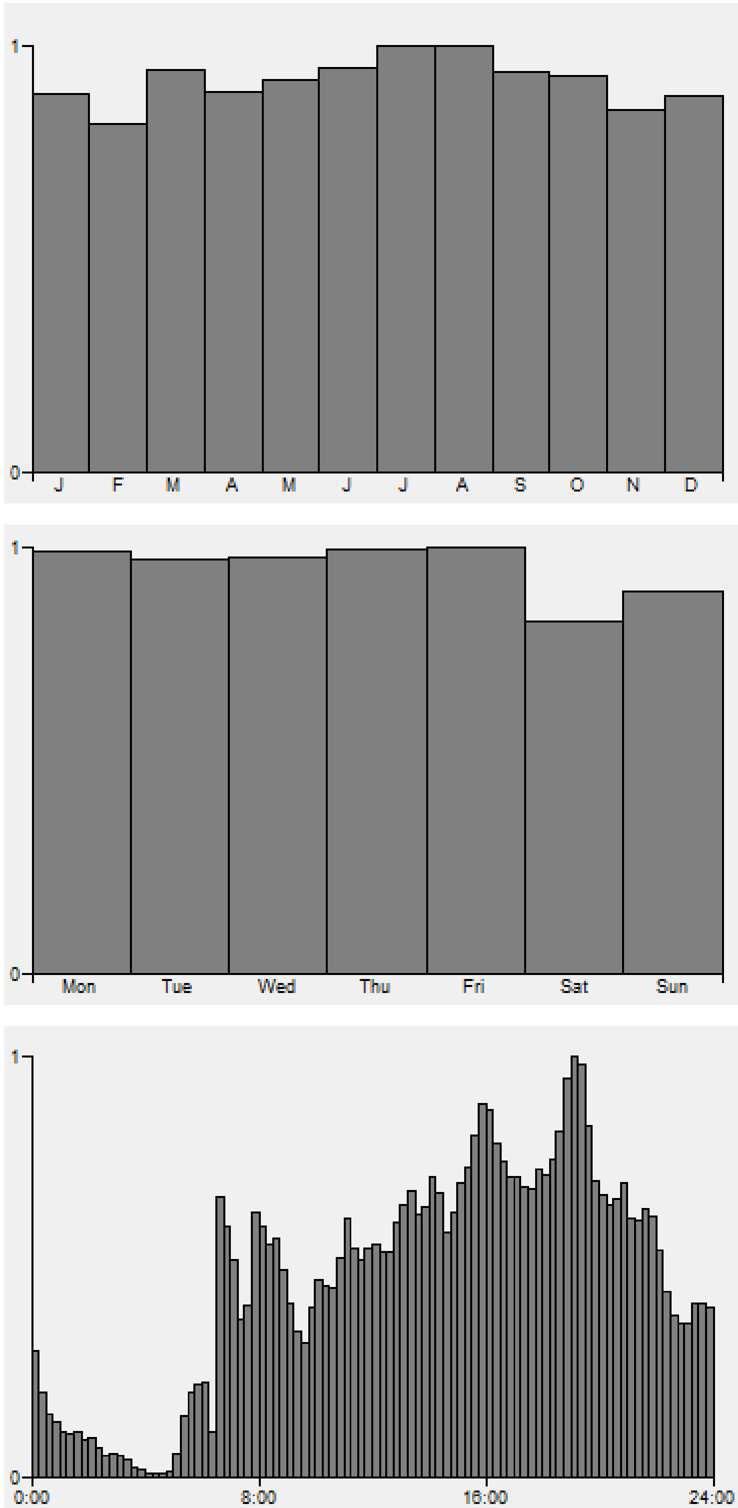

Figure 17: Monthly, Daily and Quarter-Hourly Operations Profiles for 2022 Arrivals

4.2 Regional Modelling

Regional dispersion modelling was undertaken separately for the on-road mobile sources and all other sources. Previous modelling studies for the City of Toronto have provided a description of the diurnal variability of on-road mobile sources (capturing morning and afternoon rush-hours on the major highways for example) and it was desirable to ensure that this was captured in the regional modelling. As volatile emissions were not speciated in the Environment Canada database, speciation of volatiles for regional emissions was also undertaken after modelling was completed. The VOC speciation from the MOVES onroad emissions model was applied to the predicted VOC concentrations to determine the percentage contribution to the total VOCs attributable to each particular species. The MOVES speciation was used as mobile emissions constitute a significant portion of the total regional emissions and MOVES has been updated recently, providing the latest information on VOC speciation for combustion sources.

The same individual and gridded receptors were modelled using the regional emissions as were used in the Airport-Alone modelling.

Regional modelling was set up to run mobile and non-mobile emissions separately with the aid of AERMOD (version 12345) and the results were combined with the airport as part of the post-processing. The baseline year, 2011, was modelled using 2011 meteorological data. The two future scenarios, 2022 and 2032, were modelled using all five years (2008 to 2012) of meteorological data, to ensure that all likely meteorological conditions are assessed.

4.3 Combined Airport and Regional Modelling Approach

Modelling results for the regional modelling were first summed (mobiles plus all other sources) to provide the total regional predicted concentrations for each species being considered. These results have been presented as Regional Modelling results alone. The summing was applied to each hour of the dispersion modelling (8,760 hours for the 2011 baseline; 43,848 hours in the combined 5-year meteorological dataset used for the future scenarios) for each receptor, such that the predicted 1-hour maximum concentration at any given receptor is the sum of the modelling results for that hour and that location for the airport alone and for the regional emissions alone.

The total emissions modelled for this study are summarized in Table 8.

Table 8: Summary of Airport and Regional Emissions for Modelling Scenarios (tonnes/yr)

Substance	2011		2022		2032	
	Airport	Region	Airport	Region	Airport	Region
CO	2,611	98,457	2,525	98,457	2,987	98,457
NO_x	1,554	16,945	2,026	15,528	2,455	15,528
SO_2	113	2,049	169	2,049	206	2,049
VOC	207	21,303	274	18,797	330	18,797
PM_{10}	24	10,959	30	8,351	36	8,351
$PM_{2.5}$	23	4,296	28	3,321	34	3,321

5.0 DISPERSION MODELLING RESULTS AND ANALYSIS

The dispersion modelling results for airport alone, regional emissions alone and the combined modelling of airport and regional emissions are summarized by compound. All figures showing the predicted modelling results are provided in the appendices. Figures showing the 2011, 2022 and 2032 dispersion modelling results for the airport alone modelling are provided in APPENDIX C. Figures showing the 2011, 2022 and 2032 dispersion modelling results for the Regional modelling are provided in APPENDIX D. Figures showing the 2011, 2022 and 2032 combined (airport + regional) dispersion modelling results are provided in APPENDIX E. The results presented in Sections 5.2 through 0 are presented only for the relevant averaging periods for each substance for the Ambient Air Quality Criteria (as discussed in Section 1.4).

The results shown in the modelling results figures are not representative of a single day of concentration; rather they are the maximum concentration modelled at each receptor over the modelling period. This gives an overview of the maximum concentrations over the whole modelling domain regardless of the wind direction or other meteorological conditions. The maximum modelled concentration over the domain does not necessarily coincide with the direction of the prevailing winds. While receptors located downwind of the airport during a prevailing wind will experience more frequent impacts from the airport, they are not necessarily going to experience the maximum modelled concentrations.

This air quality study is not intended to demonstrate Toronto Pearson's compliance with Provincial air quality criteria, however for the purposes of the airport understanding its impact, current and future, on the local environment.

5.1 Carbon Monoxide (CO)

The maximum predicted concentrations of CO are presented in Table 9 for the airport alone, regional emissions alone, and airport plus regional emissions. Between 2011 and future years, the regional emissions are not expected to change significantly, while the airport emissions are anticipated to increase. Predicted CO concentrations due to airport operations alone are anticipated to increase in both 2022 and 2032, due to increased future emissions. Unlike SO_2, as discussed above, the predicted concentrations of CO due to airport emissions are anticipated to be greater in 2032 than 2022. This difference is attributable to the manner in which EDMS has calculated the emissions distribution due to the aircraft types assumed for these two years. In all modelled years, CO from the airport alone is predicted to meet the Ontario 1-hour and 8-hour guidelines, as do the predicted concentrations due to emissions from the region alone. This is discussed further in Section 6.3.

Table 9: Maximum Predicted Concentrations for CO for all Scenarios

Source [(1)]	Averaging Period	Criteria	Predicted Concentration (µg/m^3)		
			2011	2022	2032
Airport Alone	1-hour 8-hour	36,200 15,700	5,080 1,850	8,750 2,250	9,440 2,870
Regional Alone	1-hour 8-hour	36,200 15,700	13,543 6,479	13,648 7,609	13,648 7,609
Airport + Regional	1-hour 8-hour	36,200 15,700	13,549 6,480	13,651 7,611	13,650 7,611

Note: (1) Location of maximum may not be the same for sources.

The maximum predicted concentrations for all three study years are dominated by regional emissions. The airport plus region maximum concentration is not located in the vicinity of the airport but is nearer the major highways passing through the modelling domain, which are the primary sources of the regional CO emissions. Figures showing the predicted concentrations resulting from airport alone operation, regional alone emissions and airport plus regional emissions are provided in APPENDIX C, APPENDIX D and APPENDIX E, respectively. CO emissions from Toronto Pearson represent 2.6% of the total (airport plus regional) emissions for 2011, and are predicted to represent 2.6% of the total emissions in 2022 and 2.9% of the total emissions in 2032.

5.2 Nitrogen Oxides (NO_x) and Nitrogen Dioxide (NO_2)

Dispersion modelling was carried out for both the airport and regional sources using emissions of nitrogen oxides (NO_x). NO_x refers to the sum of nitric oxide (NO) and nitrogen dioxide (NO_2). Initial discharges are composed primarily of NO, with a small portion of NO_2. Some of the emitted NO will convert to NO_2 over time if there is sufficient ozone (O_3) available. Typically, dispersion modelling is based on NO_x emissions, while air quality criteria are presented only for NO_2. Therefore, in most cases it is it is most appropriate, when possible, to convert modelled NO_x predictions to NO_2. The preferred method of converting NO_x to NO_2 is the use of the Ozone Limiting Method (OLM) (Cole and Summerhays, 1979), which uses the ambient concentration of ozone to determine the amount of NO_2 formed through the reaction:

$$NO + O_3 \rightarrow NO_2 + O_2$$

For the purposes of this assessment, hourly ozone data measured at the 125 Resources Road monitoring station were used in the OLM calculation. For the 2011 dispersion modelling, hourly ozone for 2011 were used for this calculation. For the future modelling (2022 and 2032), ozone data for 2008 to 2012, corresponding with the meteorological data set, were used. In doing this, it ensured that the hourly ozone being used to generate NO_2 corresponded with the appropriate meteorological conditions for the modelling period. This represents a significant improvement in the modelling approach which has greatly improved the accuracy of the modelling results.

For the purposes of comparison, the predicted NO_x concentrations for airport operations, regional emissions and airport plus regional emissions for the three scenarios considered are presented in Table 10.

Table 10: Maximum Predicted Concentrations for NO_x for all Scenarios

Source (1)	Averaging Period	Predicted Concentration (µg/m³)		
		2011	2022	2032
Airport Alone	1-hour 24-hour	3,640 267	2,760 186	2,670 236
Regional Alone	1-hour 24-hour	2,250 643	2,060 860	2,060 860
Airport + Regional	1-hour 24-hour	3,765 751	3,208 970	3,482 987

(1) Location of maximum may not be the same for sources.

The projected increase in NO_x emissions for 2022 and 2032 from the airport does not result in a higher predicted concentration due to several factors. The change from an hourly profile (as used in 2011) to a more generic operational profile (such as was required for the 2022 and 2032 assessments) as well as differences in the aircraft fleet in the future scenarios, results is somewhat lower predicted future maximum concentrations for NO_x from airport emissions. As the aircraft are the largest contributor to airport emissions, these changes between the different assessed years have a large impact on the resultant predicted concentrations attributed to Toronto Pearson.

Regional emissions of NO_x were predicted to decrease in future years, which has resulted in a decrease in the predicted regional concentrations. Predicted regional concentrations in 2022 and 2032 are the same as the emissions have been assumed to be the same.

NO_x emissions from Toronto Pearson represent 8.4% of the total (airport plus regional) emissions for 2011, but are predicted to represent 11.5% of the total emissions in 2022 and 13.7% of the total emissions in 2032.

The use of the OLM to generate NO_2 means that the maximum predicted NO_2 concentration does not necessarily correspond with the date and time of the maximum predicted NO_x concentration (since it is the availability of ozone which permits the NO_2 to be generated). Increasing emissions of NOx do not necessarily correlate easily with the predicted NO_2 concentrations. The maximum predicted concentrations of NO_2 are presented in Table 11 for the airport alone, regional emissions alone, and airport plus regional emissions.

Table 11: Maximum Predicted Concentrations for NO_2 for all Scenarios

Source (1)	Averaging Period	Criteria	Predicted Concentration (µg/m^3)		
			2011	2022	2032
Airport Alone	1-hour 24-hour	400 µg/m^3 200 µg/m^3	378 37	304 44	342 46
Regional Alone	1-hour 24-hour	400 µg/m^3 200 µg/m^3	294 101	344 122	344 122
Airport + Regional	1-hour 24-hour	400 µg/m^3 200 µg/m^3	**424** 104	329 145	365 122

Note: (1) Location of maximum may not be the same for sources.
Values in **BOLD** exceed the NO_2 1-hour average Ambient Air Quality Criteria of 400 µg/m^3

Near the fenceline, the Airport is the primary contributor to predicted NO_2 concentrations, however further away the regional emission are the primary contributor. The relative contributions of the Airport's emissions and regional emissions to predicted concentrations are discussed further in Section 6.3 and Figure 18.

5.3 Sulphur Dioxide (SO_2)

The maximum predicted concentrations of SO_2 are presented in Table 12 for the airport alone, regional emissions alone, and airport plus regional emissions. Between 2011 and future years, the regional emissions are not expected to change significantly, while the airport emissions are anticipated to increase. Due to the different aircraft fleets anticipated in 2022 and 2032, however, the effects of airport SO_2 emissions are actually predicted to decrease slightly between 2022 and 2032, though both years are predicted to be higher than the 2011 base year. In all modelled years, SO_2 from the airport alone is predicted to meet the Ontario 1-hour and 24-hour guidelines, while predicted concentrations due to emissions from the region alone would appear to exceed Ontario guideline values for all years. This is discussed further in Section 6.3.

Table 12: Maximum Predicted Concentrations for SO_2 for all Scenarios

Source (1)	Averaging Period	Criteria	Predicted Concentration (µg/m^3)		
			2011	2022	2032
Airport Alone	1-hour 24-hour	690 275	168 16	423 34	395 50
Regional Alone	1-hour 24-hour	690 275	**1,738** **579**	**1,738** **607**	**1,738** **607**
Airport + Regional	1-hour 24-hour	690 275	**1,738** **580**	**1,738** **608**	**1,738** **608**

Note: (1) Location of maximum may not be the same for sources. Values in **BOLD** exceed the SO_2 Ambient Air Quality Criteria of 690 µg/m³ for the 1-hour average and 275 µg/m³ for the 24-hour average.

The maximum predicted concentrations for all three study years are dominated by emissions from the region, and the overall airport plus regional emissions maximum concentration is not located in the vicinity of the airport but is nearer the major highways passing through the modelling domain, which are significant sources of the regional emissions. The apparent increase in predicted SO_2 due to regional emissions is not due to increased emissions of SO_2 in future years (SO_2 emissions were held at 2011 values for 2022 and 2032) but because of the use of five years of meteorological data for the modelling of future years, rather than only 2011 meteorological data for the 2011 scenario. Figures showing the predicted concentrations resulting from airport alone operation, regional alone emissions and airport plus regional emissions are provided in APPENDIX C APPENDIX D and APPENDIX E, respectively. SO_2 emissions from Toronto Pearson represent 5.2% of the total (airport plus regional) emissions for 2011, but are predicted to represent 7.6% of the total emissions in 2022 and 9.1% of the total emissions in 2032.

5.4 Volatile Organic Compounds (VOCs)

The maximum predicted concentrations of VOCs are presented in Table 13 for the airport alone, regional emissions alone and airport plus regional emissions. Between 2011 and the future years, airport VOC emissions from are anticipated to increase by approximately 50% (Table 4), predicted concentrations of VOCs are predicted to increase by a greater amount. The additional increase is due to the use of five years of meteorological data for modelling the future scenarios, while compared to the use of 2011 meteorological data to model the 2011 emissions. Between 2011 and the future years, emissions from regional sources are anticipated to decrease. The increase in airport VOC emissions is reflected in the increasing predictions for VOC 1-hour, 24-hour, and annual concentrations for airport alone. The significant reductions assumed for regional VOC emissions are reflected in the decreased predicted VOC concentrations from regional emissions for the future scenarios. There are no Ontario or Canadian ambient air quality guidelines for grouped VOCs. The assessment of speciated VOCs will be carried out through a human health risk assessment based on the modelling results.

Table 13: Maximum Predicted Concentrations for VOCs for all Scenarios

Source (1)	Averaging Period	Criteria	Predicted Concentration (µg/m^3)		
			2011	2022	2032
Airport Alone	1-hour	—	360	981	1,120
	24-hour	—	41.6	90.9	131
	Annual	—	5.5	7.6	9.0
Regional Alone	1-hour	—	1,674	1,564	1,564
	24-hour	—	352	434	434
	Annual	—	98	103	103
Airport + Regional	1-hour	—	1,674	1,564	1,564
	24-hour	—	354	434	434
	Annual	—	98	103	103

Note: (1) Location of maximum may not be the same for sources.

The maximum predicted concentrations for all three study years are dominated by regional emissions. The airport plus region maximum concentration is not located in the vicinity of the airport but is nearer the major highways, which are significant sources of the regional emissions. Figures showing the predicted concentrations resulting from airport alone operation, regional alone emissions and airport plus regional emissions are provided in APPENDIX C, APPENDIX D and APPENDIX E, respectively. VOC emissions from Toronto Pearson represent 1.0% of the total (airport plus regional) emissions for 2011, and are predicted to represent 1.4% of the total emissions in 2022 and 1.7% of the total emissions in 2032.

5.5 Particulates

5.5.1 PM_{10}

The maximum predicted concentrations of PM_{10} are presented in Table 14 for the airport alone, regional emissions alone and airport plus regional emissions. Between 2011 and the future years, airport emissions are anticipated to increase, while emissions from regional sources are predicted to decrease. This is reflected in the increasing predictions for PM_{10} 24-hour concentrations for airport alone. As future scenarios include five years of meteorological data, it was found that future predictions of PM_{10} concentrations due to regional sources also increased slightly, and this is the result of using five years of meteorological data rather than a single year. While emissions from the regional sources decreased, different meteorological conditions contributed to increasing predicted concentrations slightly. Predicted concentrations of PM_{10} due to airport operations are predicted to meet the Ontario guideline for all three scenarios, while predicted concentrations due to regional sources are predicted to exceed the guideline in each year studied.

Table 14: Maximum Predicted Concentrations for PM_{10} for all Scenarios

Source [(1)]	Averaging Period	Criteria	Predicted Concentration (µg/m^3)		
			2011	2022	2032
Airport Alone	24-hour	50 µg/m³.	5.0	8.6	11.3
Regional Alone	24-hour	50 µg/m³.	**193**	**207**	**207**
Airport + Regional	24-hour	50 µg/m³.	**193**	**207**	**207**

Note: (1) Location of maximum may not be the same for sources.
Values in **BOLD** exceed the PM_{10} 24-hour Ambient Air Quality Criteria of 50 µg/m³.

The maximum predicted concentrations for all three study years are dominated by regional emissions. The overall airport plus region maximum concentration is not located in the vicinity of the airport but is nearer the major highways passing through the modelling domain, which are a significant source of the regional emissions. Figures showing the predicted concentrations resulting from airport alone operation, regional alone emissions and airport plus regional emissions are provided in APPENDIX C, APPENDIX D and APPENDIX E respectively. PM_{10} emissions from Toronto Pearson represent 0.2% of the total (airport plus regional) emissions for 2011, and are predicted to represent 0.4% of the total emissions in 2022 and 2032.

5.5.2 $PM_{2.5}$

The maximum predicted concentrations of $PM_{2.5}$ are presented in Table 15 for the airport alone, regional emissions alone and airport plus regional emissions. Between 2011 and the future years, airport emissions are anticipated to increase, while emissions from regional sources are predicted to decrease. This is reflected in the increasing predictions for $PM_{2.5}$ 24-hour and annual concentrations for airport alone. As future scenarios include five years of meteorological data, it was found that future predictions of $PM_{2.5}$ concentrations due to regional sources also increased slightly, and this is the result of using five years of meteorological data rather than a single year. While emissions from the regional sources decreased, different meteorological conditions contributed to increasing predicted concentrations slightly. Predicted concentrations of $PM_{2.5}$ due to airport operations are predicted to meet the Ontario guideline for all three scenarios, while predicted concentrations due to regional sources are predicted to exceed the guideline in each year studied.

Table 15: Maximum Predicted Concentrations for $PM_{2.5}$ for all Scenarios

Source (1)	Averaging Period	Criteria	Predicted Concentration (µg/m³)		
			2011	2022	2032
Airport Alone	24-hour	25 (2)	4.7	8.4	10.9
	Annual	8.8 (4)	0.46	0.66	0.70
Regional Alone	24-hour	30 (3)	**143**	**124**	**124**
	Annual	8.8 (4)	**36**	**32**	**32**
Airport + Regional	24-hour	30 (3)	**143**	**126**	**126**
	Annual	8.8 (4)	**36**	**32**	**32**

Notes: (1) Location of maximum may not be the same for sources.
(2) MOECC guideline for $PM_{2.5}$ is 25 µg/m³ for a single source
(3) Compliance with the Canada Wide Standard is based on the 98th percentile of the annual monitored data averaged over three years of measurements. Canadian Ambient Air Quality Standards (CAAQS) for $PM_{2.5}$ will replace CWS. The current 24-hour CWS of 30 µg/m³ will change to the $PM_{2.5}$ CAAQS of 28 µg/m³ which is set to be implemented in 2015, and is further reduced to 27 µg/m³ in 2020 CCME(2012).
(4) Annual $PM_{2.5}$ CAAQS of 10 µg/m³ is set to be implemented in 2015, and is further reduced to 8.8 µg/m³ in 2020 CCME(2012).
Values in **BOLD** exceed the $PM_{2.5}$ Ambient Air Quality Criteria of 25 µg/m³ for the 24-hour average and 8.8 µg/m³ for the annual average.

The maximum predicted concentrations for all three study years are dominated by regional emissions. The airport plus region maximum concentration is not located in the vicinity of the airport but is nearer the major highways passing through the modelling domain, which are significant sources of the regional emissions. Figures showing the predicted concentrations resulting from airport alone operation, regional alone emissions and airport plus regional emissions are provided in APPENDIX C, APPENDIX D and APPENDIX E, respectively. $PM_{2.5}$ emissions from Toronto Pearson represent 0.5% of the total (airport plus regional) emissions for 2011, and are predicted to represent 0.8% of the total emissions in 2022 and 1.0% of the total emissions in 2032.

5.6 Greenhouse Gases

A comparison showing Toronto Pearson's contributions to GHG emissions is provided in Table 16. GHGs were not modelled as part of this study.

Table 16: Contributions of Toronto Pearson Airport Operations to GHG Emissions

Source		**2011**	**2022**	**2032**
Airport	Aircraft	273,538	415,318	506,901
	Roadways	1,056	1,056	1,216
	Parking Lots	11,199	11,327	13,125
	Stationary Sources	65,369	65,369	65,369
TOTAL		**351,162**	**493,070**	**586,611**
Canada Transportation Sector †		165,000,000	—	—
Ontario†		166,700,000	—	—
Canada-Wide†		701,000,000	—	—

† Based on 2012 values (EC, 2014).

6.0 COMPARISON TO LOCAL MONITORING

To better consider how well the AERMOD characterizes emissions and determine if the model is likely to be over-, under-, or accurately predicting concentrations, a comparison between local monitoring data and the modelling results discussed in the previous sections has been undertaken.

6.1 Existing Monitoring Data

Monitoring of particulates and VOCs is either currently or recently been underway at several locations in the Greater Toronto Area (GTA). Table 17 provides a summary of the nearest monitoring stations which were in operation in 2011, and the substances they report.

Table 17: Ambient Air Quality Stations Nearest Toronto Pearson

Station Location	Station ID	Substances Available (2011/2012)
Centennial Park/Elmcrest Rd.	60413/35003	Speciated VOCs
Brampton	60428/46089	Speciated VOCs, CACs
125 Resources Rd.	60430/34020	CACs
Toronto Downtown (Bay/Wellesley)	60424/31103	CACs
Toronto North (Yonge/Hendon)	34020	CACs

These stations are reported by both Environment Canada and the Province of Ontario, with bot station numbers provided in Table 17 (Federal/Provincial). Data have been summarized for the most recent five years for which data have been reported, 2008 to 2012. A summary of the maximum 1-hour, maximum 24-hour and annual averages for the species of interest measured at each station is provided in Table 18. For the purposes of comparison, the relevant Ambient Air Quality Criteria (AAQC) have been provided.

Table 18: Summary of 2011 Regional Monitoring Data

Substance	Averaging Period	Concentration (µg/m³)					
		AAQC	Centennial Park/Elmcrest	Brampton	125 Resources Rd.	Toronto Downtown	Toronto North
CO	1-hour	36,200	1,592	—	1,592	1,741 [a]	—
	8-hour	15,700	873	—	826	1,129 [a]	—
NO_2	1-hour	400	134	115	134	102	115
	24-hour	200	79	73	79	67	82
	Annual	—	36	22	36	29	28
SO_2	1-hour	690	45	—	45	58 [a]	—
	24-hour	275	13	—	13	18 [a]	—
	Annual	—	2.9	—	2.9	2.4 [a]	—
VOC	24-hour	—	—	57	—	128 [b]	—
	Annual	—	—	33	—	39 [b]	—
PM_{10}	24-hour	50	47	48	47	43	**59**
$PM_{2.5}$	24-hour	30	24	24	24	21	**30**
	Annual	8.8	6.9	6.0	6.8	6.2	7.7

Note:
Values in **BOLD** exceed the Ambient Air Quality Criteria of 50 µg/m³ for 24-hour average PM_{10} and 25 µg/m³ for 24-hour average $PM_{2.5}$.
[a] Values are from 2010, the most recent year for which data are available at this station.
[b] Values are from 2008, the most recent year for which data are available at this station.

VOC data have been reported above as the sum of the speciated VOCs measured at the two stations for which there are data. Speciated data will be used for the human health risk assessment but are not further addressed here. Only a single year of VOC data was available for the Toronto Downtown station (2008).

The monitoring data shows that most of the substances of interest typically meet the ambient air quality criteria around the region, with the exception of 24-hour PM_{10} and 24-hour $PM_{2.5}$. Annual average $PM_{2.5}$ has been found to be close to the AAQC at all locations, but has not been measured to exceed it.

6.2 Comparison to Modelling Data

Modelling was not completed for each of the locations for which monitoring data are available, for example the Toronto Downtown and Toronto North locations are both outside the current modelling domain. In order to compare modelling to monitoring data, if the monitoring location was found to be outside the modelling domain, the nearest receptor within the domain was used as a surrogate. Summarized modelling data have been provided for the Airport plus Regional emissions, this being the most appropriate estimate of total air quality being measured at each station. For each station, the 2011 monitoring data have been compared to the 2011 modelling results for airport plus regional sources. A final column shows the percentage over or under prediction of the modelling compared to monitoring (a percentage value greater than 100% indicates the modelling results were higher than monitoring data, while a percentage value less than 100% indicates the modelling results were lower than monitoring data).

6.2.1 Centennial Park/Elmcrest Rd.

Table 19 provides a comparison of the 2011 monitoring data for the substances of interest in this study at the Centennial Park monitoring location and the predicted 2011 concentrations obtained from the dispersion modelling. The modelling results were obtained from an individual receptor placed at this location.

Table 19: Summary of Centennial Park/Elmcrest Rd. Monitoring and Modelling Data

Substance	Averaging Period	AAQC ($\mu g/m^3$)	Monitoring Data ($\mu g/m^3$)	Modelled Results ($\mu g/m^3$)	% Difference of Monitoring Data Compared to Modelled Results (over-[+], or under-actual[-])
CO	1-hour	36,200	1,592	4,809	202%
	8-hour	15,700	873	2,840	225%
NO_2	1-hour	400	134	**942**	603%
	24-hour	200	79	161	104%
	Annual	—	36	38	6%
SO_2	1-hour	690	45	294	553%
	24-hour	275	13	27	108%
	Annual	—	2.9	4	38%
VOC	24-hour	—	—	160	—
	Annual	—	—	41	—
PM_{10}	24-hour	50	47	**124**	164%
$PM_{2.5}$	24-hour	30	24	**37**	54%
	Annual	8.8	6.9	**10**	45%

Note:
Values in **BOLD** exceed the Ambient Air Quality Criteria

At this location, modelling predictions at this location are higher than the measured concentrations for all substances and averaging periods. The Centennial Park/Elmcrest monitoring station is located just south of Highway 401, south of Toronto Pearson Airport, so it is possible some of the difference is a reflection of the way the model is modelling major roadways, which have been allocated to 1 km by 1 km area sources.

While the model has generally over-predicted ambient concentrations, annual predictions appear to be more accurate than short-term predictions; generally falling within a factor of two of the measured values (e.g., modelling results are between 50 and 200% of the measured values). Predicted 1-hour concentrations appear to be approximately generally three or more times the measured values, in spite of the use of the Ozone Limiting Method (OLM) to convert total NO_x to NO_2.

6.2.2 Brampton

Table 20 provides a comparison of the 2008 to 2012 monitoring data for the substances of interest in this study at the Brampton monitoring location and the predicted 2011 concentrations obtained from the dispersion modelling. The modelling results were obtained from an individual receptor placed at this location.

Table 20: Summary of Brampton Monitoring and Modelling Data

Substance	Averaging Period	AAQC ($\mu g/m^3$)	Monitoring Data ($\mu g/m^3$)	Modelled Results ($\mu g/m^3$)	% Difference of Monitoring Data Compared to Modelled Results (over-[+], or under-actual[-])
CO	1-hour	36,200	—	2,641	—
	8-hour	15,700	—	1,254	—
NO_2	1-hour	400	115	147	28%
	24-hour	200	73	29	-60%
	Annual	—	22	7.3	-67%
SO_2	1-hour	690	—	75	—
	24-hour	275	—	7.9	—
	Annual	—	—	1.7	—
VOC	24-hour	—	57	80	40%
	Annual	—	33	36	9%
PM_{10}	24-hour	50	48	36	-25%
$PM_{2.5}$	24-hour	30	24	15	-38%
	Annual	8.8	6.0	1.5	-75%

Note:
Values in **BOLD** exceed the Ambient Air Quality Criteria

At this monitoring station, which is located west of the airport and north of Highways 401 and 407, modelled concentrations are higher for 1-hour NO_2 and 24-hour and Annual VOCs. Predictions were lower than monitoring data for 24-hour and Annual NO_2 and for particulates.

6.2.3 125 Resources Rd.

Table 21 provides a comparison of the 2008 to 2012 monitoring data for the substances of interest in this study at the 125 Resources Road monitoring location and the predicted 2011 concentrations obtained from the dispersion modelling. The modelling results were obtained for the nearest grid receptor to this location, which has been used as a surrogate.

Table 21: Summary of 125 Resources Road Monitoring and Modelling Data

Substance	Averaging Period	AAQC (µg/m^3)	Monitoring Data (µg/m^3)	Modelled Results (µg/m^3)	% Difference of Monitoring Data Compared to Modelled Results (over-[+], or under-actual[-])
CO	1-hour	36,200	1,592	8,852	456%
	8-hour	15,700	826	5,653	584%
NO_2	1-hour	400	134	182	36%
	24-hour	200	79	62	-22%
	Annual	—	36	32	-11%
SO_2	1-hour	690	45	257	471%
	24-hour	275	13	21	62%
	Annual	—	2.9	3.1	7%
VOC	24-hour	—	—	281	—
	Annual	—	—	78	—
PM_{10}	24-hour	50	47	**159**	238%
$PM_{2.5}$	24-hour	30	24	**56**	133%
	Annual	8.8	6.8	**16**	135%

Note:
Values in **BOLD** exceed the Ambient Air Quality Criteria

The location of the monitoring station is east of the airport, north of Highway 401 but south of Highway 407. There is an over-prediction in the model of 1-hour and 8-hour CO, either due to the handling of road sources or to the very high reported CO emissions for the area. At this location, NO_2 was reasonably well-represented by the model, as were 24-hour and annual SO_2 concentrations. Particulates were generally over-predicted likely due to the over-estimate of road emissions.

6.2.4 Toronto Downtown (Bay/Wellesley)

Table 22 provides a comparison of the 2008 to 2012 monitoring data for the substances of interest in this study at the Toronto Downtown monitoring location and the predicted 2011 concentrations obtained from the dispersion modelling. While this station is outside the modelling domain, the comparison provides useful additional regional context. The nearest receptor has been used as a surrogate but is located several kilometers from the monitoring location and may not be representative of conditions in Toronto's downtown core.

Table 22: Summary of Toronto Downtown Monitoring and Modelling Data

Substance	Averaging Period	AAQC (µg/m³)	Monitoring Data (µg/m³)	Modelled Results (µg/m³)	% Difference of Monitoring Data Compared to Modelled Results (over-[+], or under-actual[-])
CO	1-hour	36,200	1,741 [a]	3,242	86%
	8-hour	15,700	1,129 [a]	1,600	42%
	Annual	—	29	5.2	-82%
SO_2	1-hour	690	58 [a]	183	216%
	24-hour	275	18 [a]	16	-11%
	Annual	—	2.4 [a]	1.7	-29%
VOC	24-hour	—	128 [b]	167	30%
	Annual	—	39 [b]	25	-36%
PM_{10}	24-hour	50	43	**75**	74%
$PM_{2.5}$	24-hour	30	21	**33**	57%
	Annual	8.8	6.2	4.9	-21%

Note:
Values in **BOLD** exceed the Ambient Air Quality Criteria
[a] Values are from 2010, the most recent year for which data are available at this station.
[b] Values are from 2008, the most recent year for which data are available at this station.

This monitoring station is located several kilometers east of the modelling grid and has been approximated using a receptor at the easternmost edge of the modelling domain (south of Highway 401). With the exception of 1-hour SO_2, and 24-hour and Annual NO_2 concentrations, predictions were within a factor of two of the monitoring data (e.g., modelling predictions were between 50% and 200% of the monitoring results). Using this location as a surrogate for the downtown monitoring station, the model continues to over-predict for short-term averaging periods (1-hour and most 24-hour concentrations) and generally under-predicts annual values. The 24-hour and annual predictions best approximate the monitoring data and for this location, particulates are generally in agreement between the model and the monitoring data. Given the distance between the actual station location and the selected surrogate, this comparison shows relatively good agreement.

6.2.5 Toronto North (Yonge/Hendon)

Table 23 provides a comparison of the 2008 to 2012 monitoring data for the substances of interest in this study at the Toronto North (Yonge/Hendon) monitoring location and the predicted 2011 concentrations obtained from the dispersion modelling. While this station is outside the modelling domain, this comparison provides useful additional regional context. The nearest receptor has been used as a surrogate but is located several kilometers from the monitoring location and may not be representative of conditions in the north of Toronto.

Table 23: Summary of Toronto North Monitoring and Modelling Data

Substance	Averaging Period	AAQC (µg/m^3)	Monitoring Data (µg/m^3)	Modelled Results (µg/m^3)	% Difference of Monitoring Data Compared to Modelled Results (over-[+], or under-actual[-])
CO	1-hour	36,200	—	2,687	—
	8-hour	15,700	—	815	—
	Annual	—	28	2.6	-91%
SO_2	1-hour	690	—	92	—
	24-hour	275	—	6.8	—
	Annual	—	—	0.5	—
VOC	24-hour	—	—	62	—
	Annual	—	—	7.2	—
PM_{10}	24-hour	50	**59**	36	-39%
$PM_{2.5}$	24-hour	30	**30**	14	-53%
	Annual	8.8	7.7	1.5	-81%

Note:
Values in **BOLD** exceed the Ambient Air Quality Criteria

There was generally poor agreement between the modelling results and the monitoring data for this location, with the model under-predicting for all substances and averaging periods except 1-hour NO_2. Note that only NO_2, PM_{10} and $PM_{2.5}$ are available at this monitoring location. It is likely that the selected surrogate location is not representative of the actual monitoring location.

6.3 Contribution of Airport Emissions to Regional Air Quality

The contribution of the air emissions from Toronto Pearson Airport to air quality in the region was qualitatively assessed by considering the relative concentrations predicted by the AERMOD model for the airport alone scenarios and the regional emissions alone scenarios. To provide some context regarding the contribution of the existing airport emissions' contribution, Figure 18 has been compiled. In this figure, the predicted concentration of each substance that is attributable to the airport emissions has been shown in blue, while the contribution attributable to regional emissions has been shown in red. For example, at the Highway 427/Dixon Road intersection, it can be seen that even at this proximity to the airport, the region is the primary contributor to concentrations of NO_2, PM_{10}, SO_2 and VOC ($PM_{2.5}$ would show a similar pattern to PM_{10} and so has been omitted). Further from the airport, the contribution to local air quality from the regional sources, especially the highways (such as Highway 401, Highway 427, the Queen Elizabeth Way/Gardiner Expressway, Highway 407, etc.) virtually obscures the airport's contribution to local air quality. The receptors shown are not all identified individual receptors, but receptors that have been selected based on proximity to the airport and regional sources of interest (such as major highways).

LEGEND

- Individual Receptors
- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

NOTES:

Airport Sources | Off-Site Sources

1. Relative contributions for each site measured in μg/m³

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

0 1 2 4 6 8
SCALE 1:200,000 KILOMETERS

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
COMPARISON OF AIRPORT AND
REGIONAL CONTRIBUTIONS TO LOCAL AIR QUALITY

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26		
GIS	ME/PR	2015-01-27		
CHECK	AB	2015-01-27		
REVIEW				

FIGURE: 18

7.0 COMPARISON TO PREVIOUS MODELLING STUDIES

Previous studies for Toronto Pearson were carried out for the site in 1991 and 2003. It is not possible to directly compare all results from the current study to the studies completed in 1991 and 2003 as some sources, species, models and methodologies have been changed. The best comparison possible at this time is presented in Table 24 showing the results predicted for 2001 in the 1991 study, the results predicted for 2010 in the 2003 study (RWDI, 2003), and the current baseline results (2011) for the airport sources without the regional sources.

Table 24: Comparison of 1991, 2003 and Current Study Results.

Species	Averaging Period	Predicted Concentration (µg/m³)		
		2001 [a]	2010 [b]	2011 [c]
CO	1-hour 8-hour Annual	3,619 —	23,742 5,633 394	5,080 1,850 87.4
NO_2	1-hour 24-hour Annual	4,780 —	1,441 — 38	378 37 7.9
TSP	1-hour	73	—	—
PM_{10}	24-hour Annual	—	11 2.2	5.0 0.5
$PM_{2.5}$	24-hour Annual	—	—	4.7 0.46
SO_2	1-hour 24-hour Annual	221 — —	191 — 2.8	168 16 1.4
VOC	1-hour 24-hour Annual	1,470 — —	2,479 — 41	360 42 5.5

Notes:
Species not included in study are denoted by a long dash (—)
a Study completed in 1991, forecast data for 2001 recommended case. NOx is presented in place of NO_2. Total Hydrocarbons (THC) were modelled in place of Volatile Organic Compounds (VOC).
b Study completed in 2003, forecast data for 2010.
c Current study, data for 2011 baseline case.

Significant changes across the three studies include:

- The original 1991 study did not account for taxiing, climb out and approach modes of operation as these were not included in the then-available beta version of EDMS. CALINE was used outside of EDMS to model runways (take-off and landing).
- Emission factors have changed significantly since 2003.
- The dispersion model has changed over this period (AERMOD has undergone between one and three updates per year over the last six years alone). The original study used a prototype version of EDMS, which itself has been updated many times even in the last decade.
- TSP is no longer a species of interest in North America. PM_{10} is of some interest, as it was in 2003, but $PM_{2.5}$ is the subject of current focus with respect to both air quality and human health.
- The baseline assumptions for the three studies are different - The 1991 study used 1990 data as a baseline and projected forward to 2000; The 2003 study used 2001 as a baseline and project forward to 2015, though only 2010 projections have been reproduced here; And the current study is based on 2011 baseline data and projects forward to 2022 and 2032.
- Operational changes at Toronto Pearson include the availability (and use) of 400 Hz power at the gates as well as pre-conditioned air, which has reduced the reliance on Auxiliary Power Units.
- The aircraft fleet has changed over the 10 year period since the last study, resulting in more efficient aircraft and reduced emissions.
- Over the last two decades, there have been two significant recessionary periods which have significantly altered the actual activity levels at Toronto Pearson, compared to the assumptions made in the previous studies. The first of these, in 2001, affected the baseline year for the 2003 study (likely lowering actual activity levels compared to those assumed in the previous study); the second of which was in 2007/2008, which cause activity levels at Toronto Pearson so stagnate for several years, significantly lowering actual 2011 activity compared to the assumptions made for 2010 in the previous study.

8.0 DISCUSSION AND CONCLUSIONS

A rigorous air quality assessment of the Toronto Pearson Airport's activities has been carried out with the aid of an approved and appropriate modelling system, namely the U.S. Federal Aviation Authority's (FAA) EDMS modelling system which is a current industry standard for air quality assessment of airports. The assessment addresses the cumulative impact of both the direct emissions from the airport activities as well as the contribution from non-airport activities in the surrounding area. The air quality study has demonstrated the following:

- The estimated emissions attributable to the airport are generally much lower than those found for the regional sources.
- Estimated emissions for the airport are anticipated to increase, based on a changing aircraft fleet and increased air traffic.
- Predicted concentrations of substances of interest are generally below current guidelines when considering the Airport alone, for the 2011 base case and both assessed future cases (2022 and 2032).
- Predicted concentrations of substances of interest over most of the modelling domain are dominated by contributions from the region, rather than by emissions from the Airport.
- The use of the Ozone Limiting Method (OLM) for estimating nitrogen dioxide conversion from nitrogen oxides provided data more comparable to local monitoring.

In general, Toronto Pearson Airport contributed about 0.2 to 8% to local air quality within 7.5 km of the airport property. Contributions to local air quality from the airport decrease rapidly with increasing distance from the airport, and at distances of a kilometre or more from the airport itself local air quality is almost entirely a result of regional emissions, especially major highways.

A brief comparison of the modelling data for 2011 and the last five years of available monitoring data at five local monitoring stations demonstrated that, with the exception of CO, the model was generally providing comparable results to those measured in the area. It is likely that the very high CO emissions provided by Environment Canada for the region (particularly those attributable to the highways) is the primary factor why CO predictions were not comparable to monitoring results. Generally, longer-term predictions (annual) were found to be more comparable to monitoring records, but 1-hour and 24-hour results, with the exception of CO, showed general agreement with the monitoring data.

Comparing the results of the current study to the previous Air Quality Studies undertaken by Toronto Pearson demonstrates that:

- 2011 emissions from the airport are lower than what was previously estimated for 2010.
- Predicted concentrations of substances of interest are lower for 2011 than previously estimated for 2010.
- Regional emissions have changed substantially since the previous studies were published.
- Predicted concentrations attributable to airport operations are significantly lower than previously estimated, which may be due to airport operational changes, improvements made to the emissions model (EDMS), and improvements made to the dispersion model (AERMOD).

- The use of the Ozone Limiting Method with hourly ozone data provides greater detail regarding the conversion of nitrogen oxides to nitrogen dioxide, a method that was attempted previously but for which there was insufficient data to fully incorporate into the modelling and reporting.

A summary of the Toronto Pearson Airport, Regional and Cumulative modelling results at the sensitive receptors identified for the Human Health Risk Assessment is provided in APPENDIX F.

9.0 REFERENCES

ACRP (Airports Cooperative Research Council), 2013. Report 97: Measuring PM Emissions from Aircraft Auxiliary Power Units, Tires, and Brakes.

Cantox (Cantox Environmental Inc), 2004. *Phase 5 Human Health Risk Assessment of Air Emissions from the Toronto Pearson International Airport.*

CCME (Canadian Council of Ministers of the Environment), 1999. *Canadian National Ambient Air Quality Objective: Process and Status* Canadian Council of Ministers of the Environment.

CCME (Canadian Council of Ministers of the Environment), 2000. *Canada-Wide Standards for Particulate Matter (PM) and Ozone*. Canadian Council of Ministers of the Environment. Quebec City, Quebec.

CCME (Canadian Council of Ministers of the Environment), 2012. *Guidance Document on Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone.* Canadian Council of Ministers of the Environment.

Cole, H.S., and J.E. Summerhays, 1979. A Review of Techniquest Available for Estimation of Short-Term NO_2 Concentrations. *Journal of the Air Pollution Control Association*, 29(8): 812-817.

GTAA (Greater Toronto Airports Authority), 2013. *Request for Proposal Package for Air Quality Study*. Number 2038057.

EC (Environment Canada), 2014. *National Inventory Report 1990-2012 – Greenhouse Gas Sources and Sinks in Canada*.

Flightglobal, 2012. *World Airline Fleet Directory.* 46th edition. Buchair UK Ltd.

MOECC (Ontario Ministry of the Environment and Climate Change), 2009a. *Air Dispersion Modelling Guideline for Ontario: Version Two*. PIBS#: 5165E.

MOECC (Ontario Ministry of the Environment and Climate Change), 2009b. *Procedure for Preparing an Emission Summary and Dispersion Modelling Report, Version 3.0*. PIBS#: 3614e03.

MOECC (Ontario Ministry of the Environment and Climate Change), 2012a. *Summary of Standards and Guidelines to Support Ontario Regulation 419: Air Pollution — Local Air Quality*. PIBS#6569e01 April 2012

MOECC (Ontario Ministry of the Environment and Climate Change), 2012b. *Ontario's Ambient Air Quality Criteria*. PIBS#6570e01 April 2012

MOECC (Ontario Ministry of the Environment and Climate Change), 2013. *Ontario Regulation 419/05: Air Pollution – Local Air Quality.* Environmental Protection Act.

RWDI (Rowan Williams Davies and Irwin Inc.), 1991. *Lester B Pearson International Airport Air Quality Study.* Submitted to Public Works Canada, Ontario Region. Reference #90-180F-63.

RWDI (Rowan Williams Davies and Irwin Inc.), 2003. *Phases 1 to 3 – Predicted Impacts Air Quality Study Toronto Pearson International Airport, Toronto, Ontario*. Submitted to Greater Toronto Airports Authority. Project Number 01-630A.

TRB (Transportation Research Board) 2008. *Aircraft and Airport-Related Hazardous Air Pollutants: Research Needs and Analysis.* ACRP (Airport Cooperative Research Program) Report 7. Washington, D.C.

TRB (Transportation Research Board) 2012. *Measurement of Gaseous HAP Emissions from Idling Aircraft as a Function of Engine and Ambient Conditions.* ACRP (Airport Cooperative Research Program) Report 63. Washington, D.C.

USEPA (U.S. Environmental Protection Agency), 1995. *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models. Volume 1 – User Instructions*. September 1995.

USEPA (U.S. Environmental Protection Agency), 2014. *User's Guide for the AMS/EPA Regulatory Model – AERMOD*. EPA-454/B-03-001. May 2014.

Report Signature Page

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APPENDIX A

Dispersion Meteorology Summary

1.0 INTRODUCTION

This document records the methods, data and assumptions that were used to develop the meteorological data set that was used in the dispersion modelling assessment of the Project. The dispersion meteorological data set was developed using the following process:

- obtaining an AERMOD-ready data set for dispersion modelling from the Ontario Ministry of Environment (MOE) for the region in which the Project is located;
- comparing the MOE data set to regional climatological data to demonstrate that the data set is appropriate for use at the Project location;
- comparing the MOE data set to the data used in the previous Air Quality Study; and
- adding the hourly precipitation and relative humidity to the data set to allow for the assessment of dust and gaseous deposition, and to provide additional information to the Human Health Risk Analysis team for their assessment.

These steps are detailed in the following sections.

2.0 METEOROLOGICAL DATA SOURCES

AERMOD-ready data for air dispersion modelling was prepared by the Ontario Ministry of Environment (MOE) specifically for this Project. This dispersion meteorology data set provides recent data from the nearest hourly weather station in the vicinity of the Project and was requested for this project specifically to ensure that data were recent and incorporated those weather parameters that are required in order to carry out wet deposition calculations using AERMOD (e.g., relative humidity and precipitation). For the purposes of this assessment, the climate normals from the nearest climate station were used to confirm that the MOE data set is representative of climatic conditions near the project site, providing assurance that the dispersion modelling will reflect the environment at that location. The five year (2008-2012) dispersion meteorology data set, prepared by the Ontario Ministry of the Environment for the study area, consists of surface and upper air meteorological variables.

In the MOE data set, the surface meteorological data were assembled using data from the Toronto Pearson Airport station (Climate ID: 6158733). The upper air meteorological variables were assembled using upper air soundings from Buffalo, NY, located approximately 110 km southeast of the site.

The assessment of the dispersion meteorology is supposed to address the following questions:

- Is the 5-year MOE data set for the Project representative of long-term climate in the area?
- Is the 5-year MOE data set for the Project comparable to data used in the previous Air Quality Study?
- Can the data set be modified in order to allow for modelling deposition, as required for the Environmental Assessment?

The following sections address these questions.

2.1 Winds Analysis

The predominant wind directions in the MOE data set are representative of much of Ontario, with winds predominantly from the west (west-southwest through west-northwest) with seasonal variability. In winter, there are generally more high-speed winds and winds are generally from the west through northwest. In spring, wind speeds drop slightly and the easterly component of the winds becomes more noticeable. In summer, winds are lowest and there is a strong southwesterly component and in the fall, winds begin to pick up again and develop the more west-northwesterly component.

The data set contains 4.3% calm winds; that is winds less than 3.6 km/h or 1 m/s. The annual average wind speed in the data set is 4.4 m/s (or 15.9 km/h). This is representative of the region, as seen in the long-term records provided in Table 1. Figure A1 illustrates the annual and seasonal surface wind patterns in the dispersion meteorology data set. Figure A2 shows the diurnal (daytime vs. nighttime) wind roses for the same data. Nighttime winds are noticeably lower in speed than those in the day, averaging 14.9 km/h in the night compared to 16.9 km/h in the day. This is expected behaviour.

Table 1: Wind Speed Comparison for Toronto Pearson Airport

Month	MOE Data Set (2008 – 2012)		Toronto Pearson Climate Average Reported by Environment Canada [(a)]	
	Wind Speed (km/h)	Most Frequent Direction	Wind Speed (km/h)	Most Frequent Direction
January	17.6	W	17.6	W
February	18.2	W	17.0	W
March	17.4	N	16.9	N
April	18.3	N	16.8	N
May	15.4	N	14.4	N
June	14.8	NW	13.2	N
July	14.0	W	12.9	W
August	13.4	W	11.9	N
September	13.8	N	12.7	W
October	15.7	W	14.0	W
November	14.7	W	15.7	W
December	18.1	W	16.7	W
Annual	15.9	W	15.0	W

Note:
(a) These data are from the 30-year (1971 – 2000) climate normals for Toronto Pearson International Airport, as reported by Environment Canada.

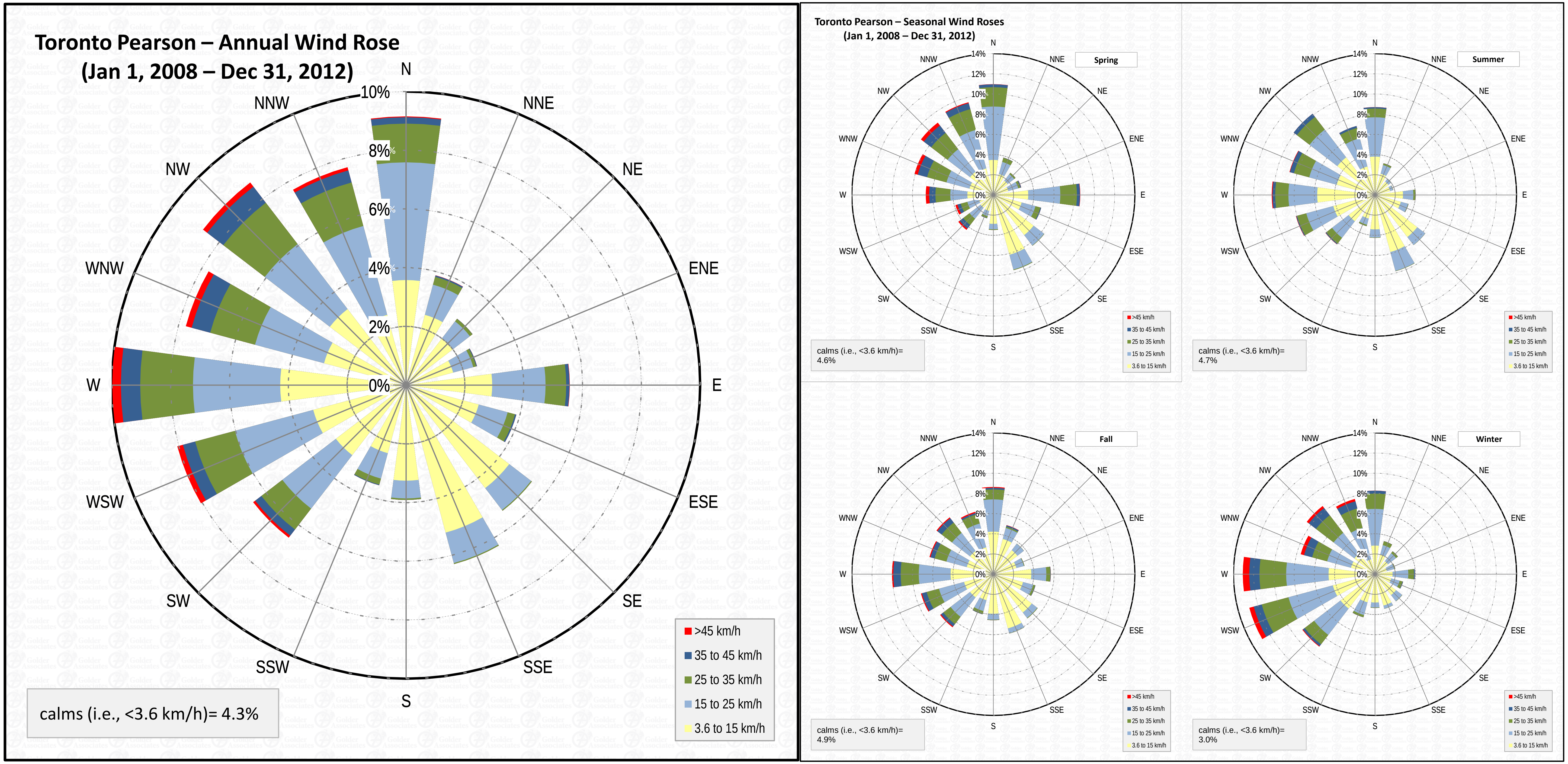

Figure A1: Annual and Seasonal Wind-roses for the MOE Dispersion Meteorology Data

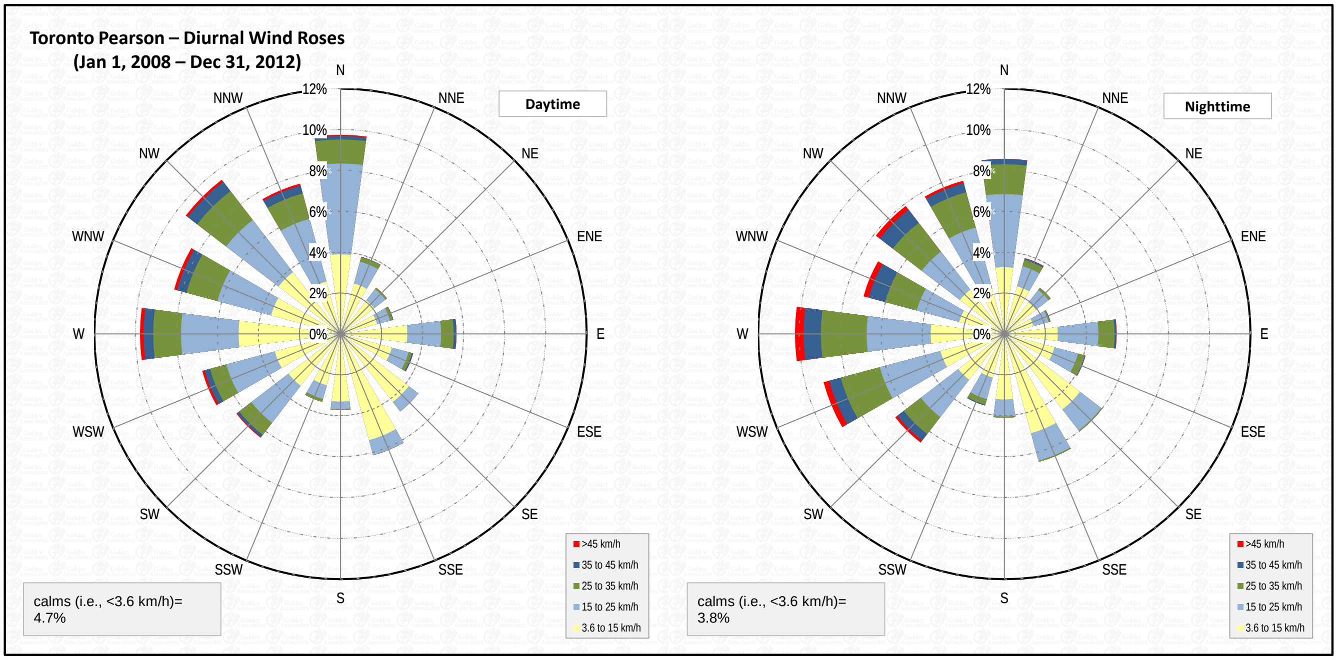

Figure A2: Diurnal Wind-roses for the MOE Dispersion Meteorology Data

An annual wind rose generated from the reported wind data for 1999 in the previous Air Quality Study is provided in Figure A3. This is approximate as hourly data were not available and so the reported wind speed and direction frequencies had to be fitted for comparison. Overall, the 1999 wind rose is similar to that reported for the 2008-2012 period, though there are more hours with reported high winds (>45 km/hr) from the west-northwest through northerly directions.

Based on the information available, the 2008 to 2012 winds were similar to those reported for the previous Air Quality Study. Diurnal and seasonal wind roses could not be generated for the 1999 modelling data, based on the data provided in the report.

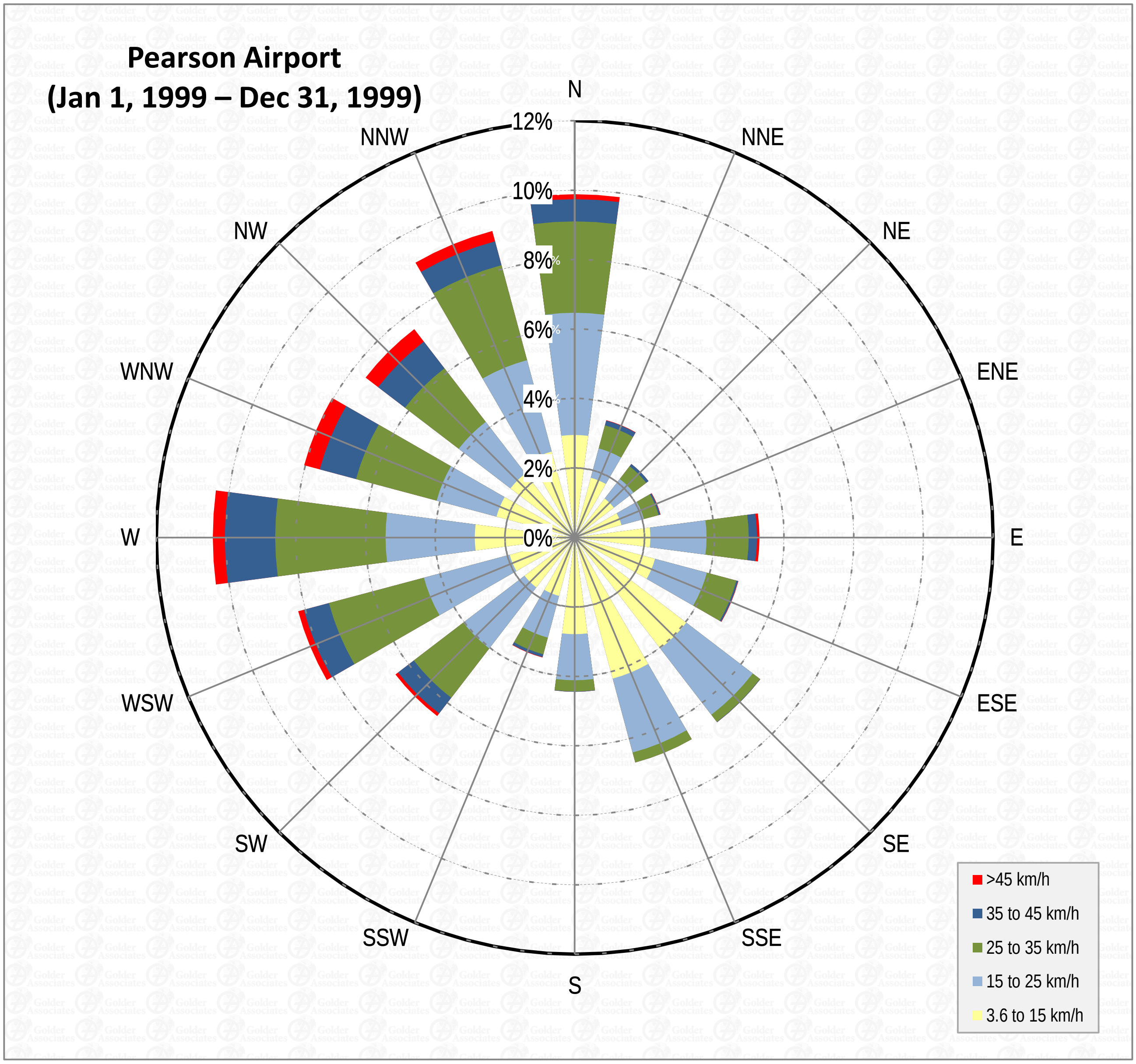

Figure A3: Fitted Wind-rose for the 1999 Toronto Pearson Wind Data (2003 Air Quality Study Data)

2.2 Temperature Analysis

In the MOE dataset, the average temperature in the winter season is approximately 9.2°C, while the extreme minimum temperature in the area may reach as low as -21.2°C. Summer temperatures are warm, with an average of approximately 21.1°C. The extreme daily maximum temperature may reach 27.3°C in the summer.

The expected values of any weather parameters can be expressed in terms of normal values obtained from the long-term averages. Figure A4, below, illustrates that the temperature field obtained from the MOE dataset is within the expected monthly temperature variations. This figure uses a "box-and-whisker" plot to show the range of temperatures obtained from the MOE dataset compared to reported climate normals. The box in the graph represents the middle 50% of the observations (i.e., from the 25th to 75th percentiles). The whiskers extend up to the maximum observation and down to the minimum. The diamond represents the average of the observations in each month. The green lines on the graph represent the climate normals at Toronto Pearson for the extreme maximum (dashed line above the average normal), the daily maximum (dotted line above the average normal), the average (solid line), the daily minimum (dotted line below the average normal), and the extreme minimum temperatures (dashed line below the average normal) for each month. The hourly temperature data in the data set generally falls within the extreme climate normals except in March and July, when the extreme maximum temperatures were above the normal.

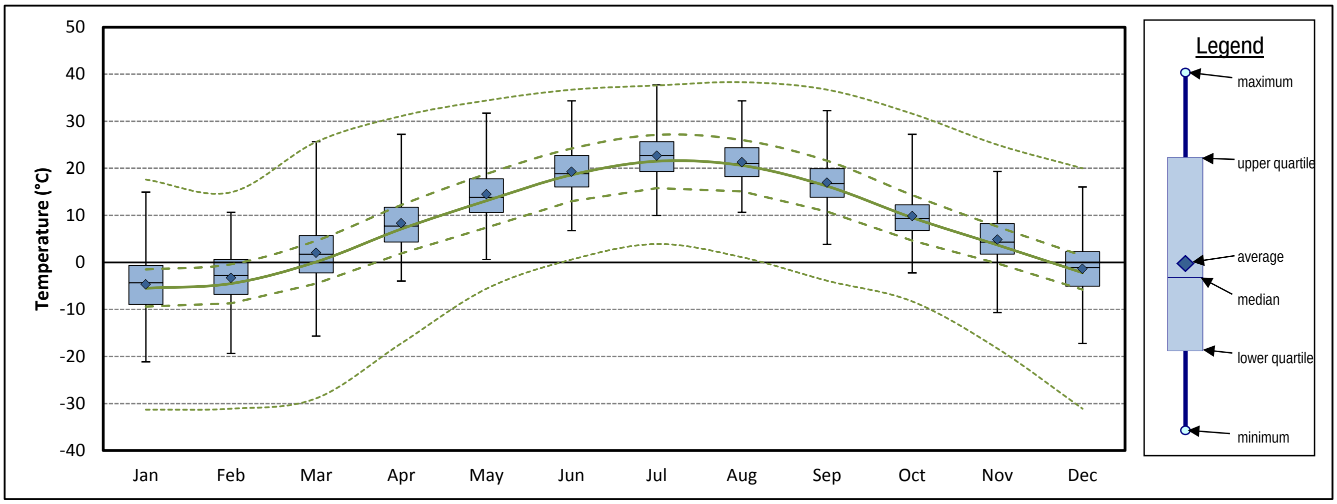

Figure A4: Monthly Temperature Distribution for the MOE Dispersion meteorology Data Compared to Climate Normals

A more detailed breakdown of the monthly temperature distribution in the MOE meteorological dataset is shown in Table 2. Hourly temperatures above 30°C occur regularly from June, through September, while temperatures below -10°C are common in December, January, February and March. A similar table summarizing the reported climate normals is provided in Table 3. Overall, the MOE dataset contained higher daily average temperatures than the reported climate normals. Temperatures in the MOE dataset fell within the range shown in the reported climate normals and are therefore considered representative for the region.

Temperature data were not available from the previous Air Quality Study for comparison to the 2008 to 2012 data set.

Table 2: Monthly Temperature Distribution for the MOE Dispersion Meteorology

MOE Surface Data Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (a)
Daily Average (°C)	-4.7	-3.3	2.0	8.3	14.5	19.3	22.7	21.3	17.0	9.8	4.8	-1.3	9.2
Standard Deviation (°C)	6.1	5.2	6.4	5.5	5.6	4.7	4.4	4.1	4.7	4.6	4.7	5.1	10.7
Daily Maximum (°C)	-1.5	0.0	6.2	13.1	19.1	23.6	27.3	25.7	21.1	13.6	8.4	1.6	13.2
Daily Minimum (°C)	-8.1	-7.0	-2.3	3.5	9.4	14.6	17.7	16.6	12.5	5.8	1.1	-4.6	5.0
Extreme Maximum (°C)	14.9	10.6	25.6	27.2	31.7	34.3	37.7	34.3	32.2	27.2	19.3	16.0	37.7
Extreme Minimum (°C)	-21.2	-19.4	-15.7	-4.0	0.6	6.7	9.9	10.6	3.8	-2.3	-10.7	-17.3	-21.2
Days with Maximum Temperatures Above 30°C	0	0	0	0	1	2	6	2	1	0	0	0	12
Days with Minimum Temperatures Below -10°C	13	8	3	0	0	0	0	0	0	0	0	5	29

Note:
a) Data are annualized and may not appear to add across columns due to rounding.

Table 3: Monthly Temperature Distribution for the Climate Normals for Toronto Pearson Airport

MOE Surface Data Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (a)
Daily Average (°C)	-5.5	-4.5	0.1	7.1	13.1	18.6	21.5	20.6	16.2	9.5	3.7	-2.2	8.2
Standard Deviation (°C)	3.2	2.3	2.0	1.6	1.9	1.6	1.5	1.5	1.6	1.5	1.5	2.6	1.0
Daily Maximum (°C)	-1.5	-0.4	4.6	12.2	18.8	24.2	27.1	26.0	21.6	14.3	7.6	1.4	13.0
Daily Minimum (°C)	-9.4	-8.7	-4.5	1.9	7.4	13.0	15.8	15.1	10.8	4.6	-0.2	-5.8	3.3
Extreme Maximum (°C)	17.6	14.9	25.6	31.1	34.4	36.7	37.6	38.3	36.7	31.6	25.0	20.0	38.3
Extreme Minimum (°C)	-31.3	-31.1	-28.9	-17.2	-5.6	0.6	3.9	1.1	-3.9	-8.3	-18.3	-31.1	-31.3
Days with Maximum Temperatures Above 30°C	0	0	0	0	1	3	7	4	1	0	0	0	16
Days with Minimum Temperatures Below -10°C	14	12	5	0	0	0	0	0	0	0	0	7	39

Note:
a) Data are annualized and may not appear to add across columns due to rounding.

2.3 Mixing Height Summary

Mixing height describes the height above ground of the atmospheric layer in which turbulent flow occurs because of the influence of surface characteristics such as albedo, Bowen Ratio and surface roughness. Mixing height can be described as “convective”, resulting from solar heating (daylight hours only); or mechanical, resulting from wind flow over terrain. Mixing height is not reported in long-term climate normals. For this parameter, an assessment has been made of the MOE dataset to determine if the data appear reasonable for the region.

Convective and mechanical mixing heights are presented below, by hour of day, for each season, and as an annual summary from MOE dispersion meteorology dataset. The convective mixing height is a result of the upward movement of an air mass driven by the temperature lapse rate as a function of surface characteristics. Convective mixing heights increase during the day as the sun rises and decrease after sunset when temperatures drop. Mechanical mixing is mostly driven by winds over the Earth’s surface and the surface roughness. Mixing height greatly influences dispersion by providing a region of turbulent flow through which emissions can mix and disperse, and through the daily growth/collapse cycle of the convective mixing layer, which greatly affects ground concentrations of emissions.

The annual and seasonal summary of mixing heights by hour of day is shown in Figure A5. Mechanical mixing heights are significantly lower at night, compared to those in the day, due to lower wind speeds at night. Convective mixing heights are effectively zero from sunset until just after sunrise.

The day- and nighttime mixing heights for both convective and mechanical mixing are compared in Figure A6. The mixing heights from the MOE dataset show the expected seasonal variability. For example, the mixing layer begins to build at 7:00 am in the summer, but not until 10:00 am in the winter. This is consistent with the fact that sunrise is later during the winter than in the summer. Overall, the mixing layer data appears to be representative of what would be expected in the Project area.

Mixing height data were not available from the previous Air Quality Study for comparison to the 2008 to 2012 data set.

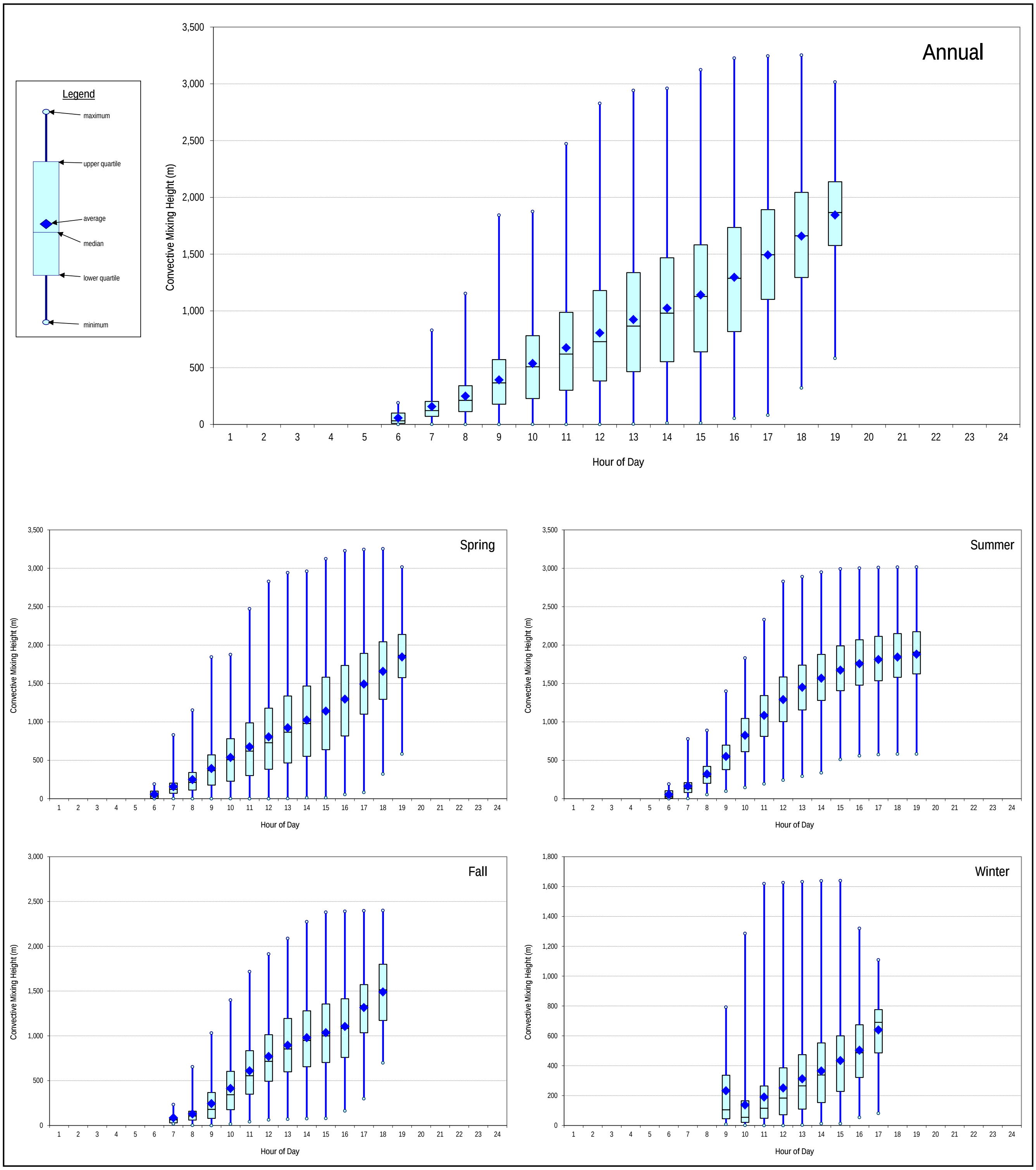

Figure A5: Annual and Seasonal Mixing Height Summary for the MOE Dispersion Meteorology

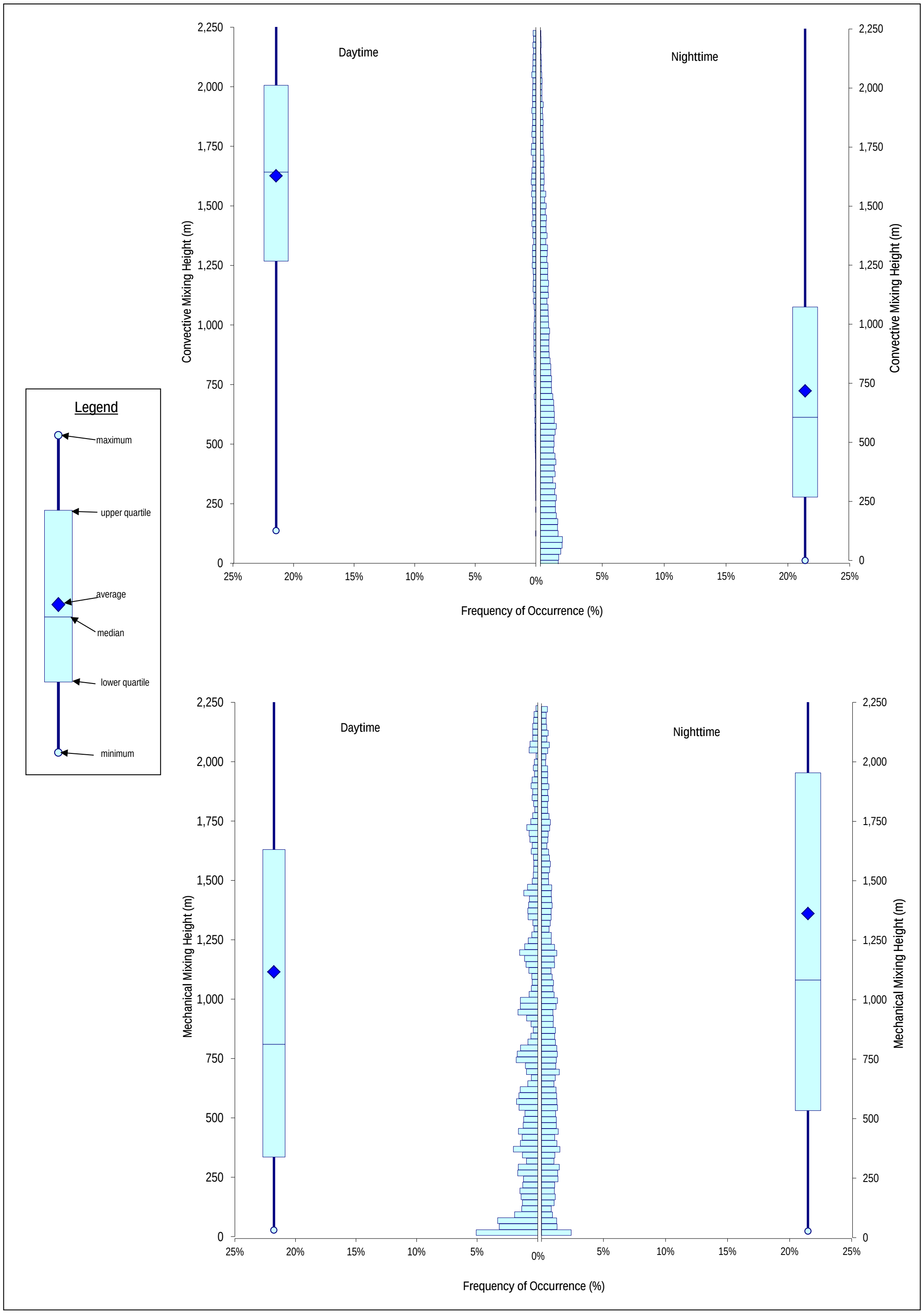

Figure A6: Convective and Mechanical Mixing Height Summary for Toronto

2.4 Added Variables

In order to model deposition, additional weather variables such as relative humidity, hourly precipitation rate and precipitation code must be added into the surface meteorological data. Toronto Pearson weather station precipitation and relative humidity records were used to fill in the additional weather parameters. The additional parameters from the Toronto Pearson station were reviewed by Golder. No out-of-range values were found. Additionally, any hourly precipitation rates above 10 mm/h were checked against ambient temperature, relative humidity and dew point temperature for that hour and a determination was made as to whether such precipitation was possible given the atmospheric condition for that particular hour.

Precipitation data is flagged as liquid precipitation when the temperature is equal to or above 0°C and as solid precipitation when the temperature is below 0°C.

Annual total precipitation varies slightly from year to year, and monthly total precipitation shows even greater variability. For example, 2010 was the driest year in the 5-year data set, and the greatest monthly precipitation occurred in the autumn, while 2006 had the highest annual precipitation with June and July being the wettest months that year. Table 4 illustrates monthly total precipitation and its yearly total, while Figure A7 illustrates the comparison of the 5-year average MOE dataset with the 30-year average climatic normal.

Table 4: Precipitation Summary for Dispersion Meteorology

Month	2006 (mm)	2007 (mm)	2008 (mm)	2009 (mm)	2010 (mm)
January	58.33	41.35	20.52	40.34	54.06
February	105.34	72.75	23.43	44.82	24.06
March	60.32	70.84	65	86.04	14.93
April	55.24	132.04	36.56	95.99	44.44
May	65.69	60.09	50.07	140.41	44.43
June	110.96	68.13	191.23	59.14	73.15
July	190.69	83.24	88.35	32.44	101.07
August	92.71	143.77	58.42	72.33	52.82
September	78.52	40.62	87.6	86.8	120.32
October	37.05	70.29	56.9	112.71	126.91
November	78.2	31.41	64.99	98.04	9.61
December	99.53	76.14	33.96	55.08	57.39
Annual	1032.58	890.67	777.03	924.14	723.19

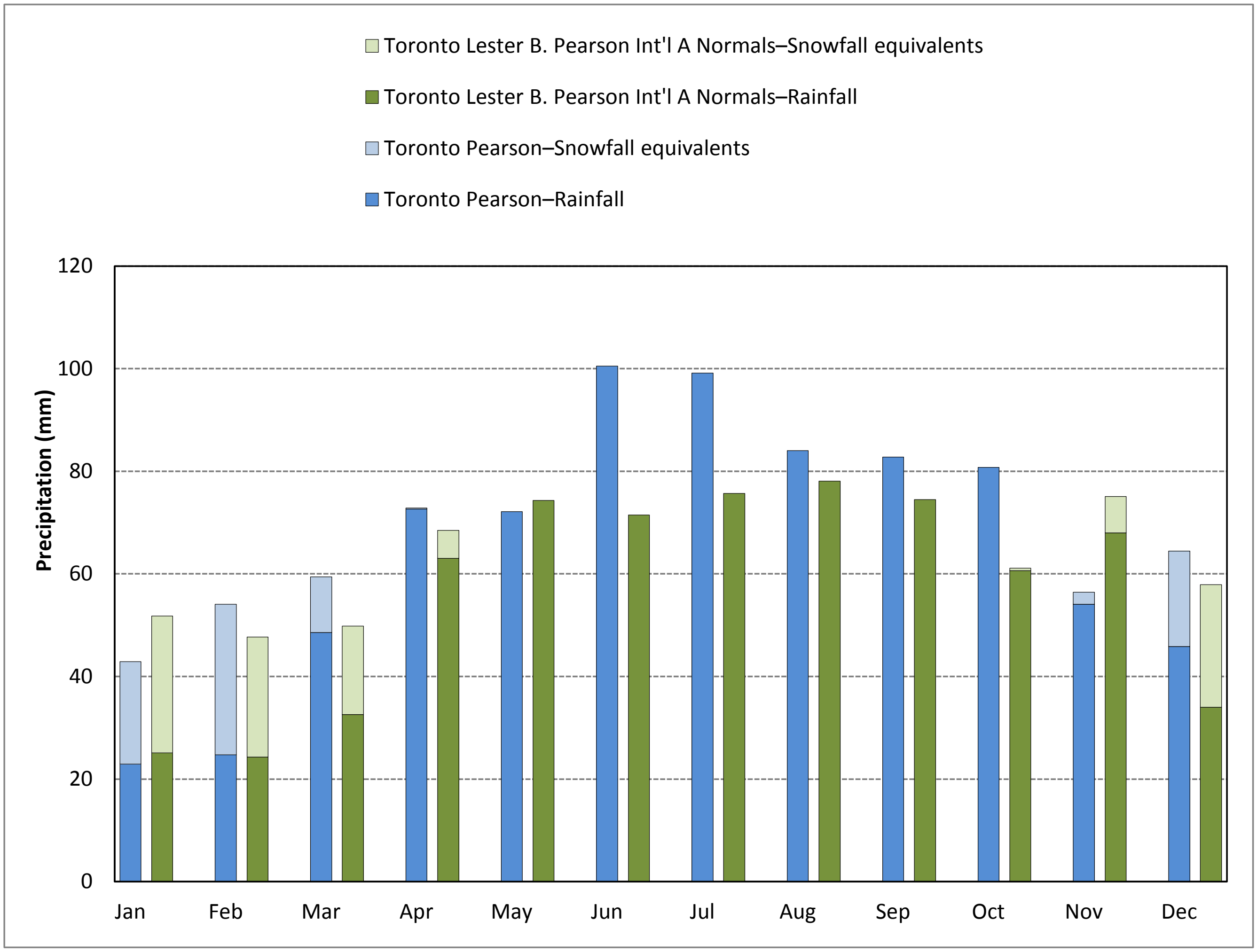

Figure A7: Precipitation Comparison between the MOE Dataset and Precipitation Normals at Toronto

A comparison of the 2008 through 2012 precipitation data shows that the measured rainfall and snowfall amounts for this period are consistent with the long-term climate normals for the area. Precipitation in the June through October period was somewhat higher than the long-term average but overall the precipitation data are representative of the area.

Precipitation data were not available from the previous Air Quality Study for comparison to the 2008 to 2012 data set.

A summary of the Climate Normals precipitation data is provided in Table 5 and describes the amounts of snowfall, rainfall and total precipitation.

Table 5: Precipitation Summary for the Toronto Climate Normals

Month	Rainfall (mm)	Snowfall (cm)	Precipitation (mm)	Extreme Daily Precipitation (mm)	Days with Measurable Precipitation
January	25.1	29.5	51.8	58.7	15.1
February	24.3	24.0	47.7	55.9	11.6
March	32.6	17.7	49.8	41.7	12.4
April	63.0	4.5	68.5	55.8	12.5
May	74.3	0.0	74.3	92.7	12.5
June	71.5	0.0	71.5	53.8	10.8
July	75.7	0.0	75.7	118.5	10.4
August	78.1	0.0	78.1	80.8	10.2
September	74.5	0.0	74.5	108.0	10.5
October	60.6	0.4	61.1	121.4	12.1
November	68.0	7.5	75.1	86.1	13.1
December	34.0	24.9	57.9	40.9	14.8
Annual	681.6	108.5	785.9	—	145.9

Note:
(a) Data are annualized and may not appear to add across columns due to rounding.

3.0 SUMMARY AND CONCLUSIONS

Comparisons between the Ontario Ministry of the Environment (MOE) dispersion meteorology dataset and climate normals for Toronto show that the dispersion meteorology dataset for Toronto Pearson airport is within the expected climatic conditions for the region, represented by long term records at the Toronto climate station, also located at Toronto Pearson Airport.

A statistical summary, such as that found over long term records, tends to smooth out year-to-year or month-to-month variations, while a similar summary over a shorter term appears less smooth. Thus, while there are differences between the 5-year averages of the MOE dataset and the long-term climatic normals, the trend or rate of change which was presented in the figures and tables above provide assurance that the dispersion meteorology dataset is appropriate for use in the modelling for this area.

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APPENDIX B

Toronto Pearson Airport Emissions Inventory

COMPLETE 2011, 2022 AND 2032 EMISSIONS INVENTORIES

Sources at Toronto Pearson were categorized based on source type, which includes aircraft, ground support equipment (GSE), parking facilities, roadways, stationary sources (such as generators, boilers, heaters, and cooling towers), and training fires. When possible, actual data were used for developing the emissions inventory. For example, aircraft emissions for 2011 were calculated based on actual aircraft schedule for that year. Emissions from roadways and parking facilities were calculated based on traffic count. Due to the lack of data, emissions associated with some of the aircraft auxiliary power units and stationary equipment were estimated based on default values.

EDMS calculated total annual 2011 emissions for carbon monoxide (CO), total hydrocarbons (THC), non-methane hydrocarbons (NMHC), total volatile organic compounds (VOCs), total organic gases (TOG), nitrogen oxides (NO_X), sulphur dioxides (SO_X), particulate matter with aerodynamic diameters less than 10 microns (PM_{10}) and less than 2.5 microns ($PM_{2.5}$), non-volatile particulate matter (PMNV), volatile sulphates particulate matter (PMVS), and volatile organics particulate matter (PMVO). Fugitive dust from sources other than roadways, such as construction activities, was not included in the emissions inventory.

Emissions for 2022 and 2032 were also calculated using the EDMS model, based on the internal database of emissions for each aircraft type and operational mode. For these cases, the GTAA's projected aircraft movements and anticipated aircraft types in each year were provided. The 2011 schedule was used to develop operational profiles for month of year, day of week, and quarter-hour of day, in effect determining peak and off-peak aircraft movement times. The anticipated 2022 and 2032 aircraft movements and types were then distributed through the year based on this schedule of aircraft operations. As for 2011, stationary equipment was entered into EDMS. Projected traffic was estimated based on the 2011 traffic count and passenger numbers, scaled up for the future years using the estimated future passenger numbers.

Section 2.1 of the report discusses the future scenario estimation methods. Table 1, Table 2, and Table 3 below present the complete emission inventories for the three scenarios.

Table 1: Complete 2011 Emissions Inventory for Toronto Pearson (by Source Category)

Source Category	Total Annual Emissions (tonnes)													
	CO_2	H_2O	CO	THC	NMHC	VOC	TOG	NO_x	SO_x	PM_{10}	$PM_{2.5}$	PMNV	PMVS	PMVO
Aircraft	273,538	107,248	974	120	139	138	139	1,238	102	6.5	6.5	1.4	3.7	1.3
GSE	—	—	1,177	—	38	40	44	123	2.6	3.9	3.7	—	—	—
APUs	—	—	38	3.0	3.4	3.4	3.4	63	7.7	6.0	6.0	—	—	—
Parking Facilities	—	—	33	—	2.6	2.6	2.8	3.1	0.02	0.09	0.1	—	—	—
Roadways	—	—	350	—	20	20	21	35	0.3	1.3	0.7	—	—	—
Stationary Sources	—	—	40	5.5	2.2	2.6	6.0	92	0.4	4.4	3.7	—	—	—
Training Fires	—	—	0.6	3.2	0.6	0.5	3.2	0.1	0.0	2.0	2.0	—	—	—
Total	273,538	107,248	2,611	132	205	207	219	1,554	113	24	23	1.4	3.7	1.3

Table 2: Complete 2022 Emissions Inventory for Toronto Pearson (by Source Category)

Source Category	Total Annual Emissions (tonnes)													
	CO_2	H_2O	CO	THC	NMHC	VOC	TOG	NO_x	SO_x	PM_{10}	$PM_{2.5}$	PMNV	PMVS	PMVO
Aircraft	415,318	162,836	1,672	204	236	234	236	1,764	154	10	10	2.0	5.7	2.1
GSE	N/A	N/A	359	N/A	13	14	15	37	3.1	2.2	2.1	N/A	N/A	N/A
APUs	N/A	N/A	55	4.2	4.9	4.9	4.9	84	10	8.3	8.3	N/A	N/A	N/A
Parking Facilities	N/A	N/A	33	N/A	2.0	2.0	2.1	1.6	0.03	0.09	0.04	N/A	N/A	N/A
Roadways	N/A	N/A	354	N/A	14	15	16	18	0.4	1.2	0.6	N/A	N/A	N/A
Stationary Sources	N/A	N/A	52	7.2	2.8	3.5	7.8	121	0.6	5.7	4.8	N/A	N/A	N/A
Training Fires	N/A	N/A	0.8	4.2	0.8	0.7	4.2	0.1	0.0	2.6	2.6	N/A	N/A	N/A
Total	415,318	162,836	2,525	220	274	274	285	2,026	169	30	28	2.0	5.7	2.1

Table 3: Complete 2032 Emissions Inventory for Toronto Pearson (by Source Category)

Source Category	Total Annual Emissions (tonnes)													
	CO_2	H_2O	CO	THC	NMHC	VOC	TOG	NO_x	SO_x	PM_{10}	$PM_{2.5}$	PMNV	PMVS	PMVO
Aircraft	506,901	198,744	2,038	249	287	286	287	2,154	188	12	12	2.4	6.9	2.5
GSE	—	—	366	—	14	14	15	31	3.8	2.2	2.1	—	—	—
APUs	—	—	67	5.2	6.0	5.9	6.0	103	13	10	10	—	—	—
Parking Facilities	—	—	38	—	2.2	2.3	2.4	1.5	0.03	0.1	0.05	—	—	—
Roadways	—	—	413	—	16	16	17	17	0.5	1.4	0.6	—	—	—
Stationary Sources	—	—	64	8.8	3.4	4.2	10	148	0.7	7.0	5.9	—	—	—
Training Fires	—	—	1.0	5.2	1.0	0.9	5.2	0.2	0.001	3.2	3.2	—	—	—
Total	506,901	198,744	2,987	268	330	330	343	2,455	206	36	34	2.4	6.9	2.5

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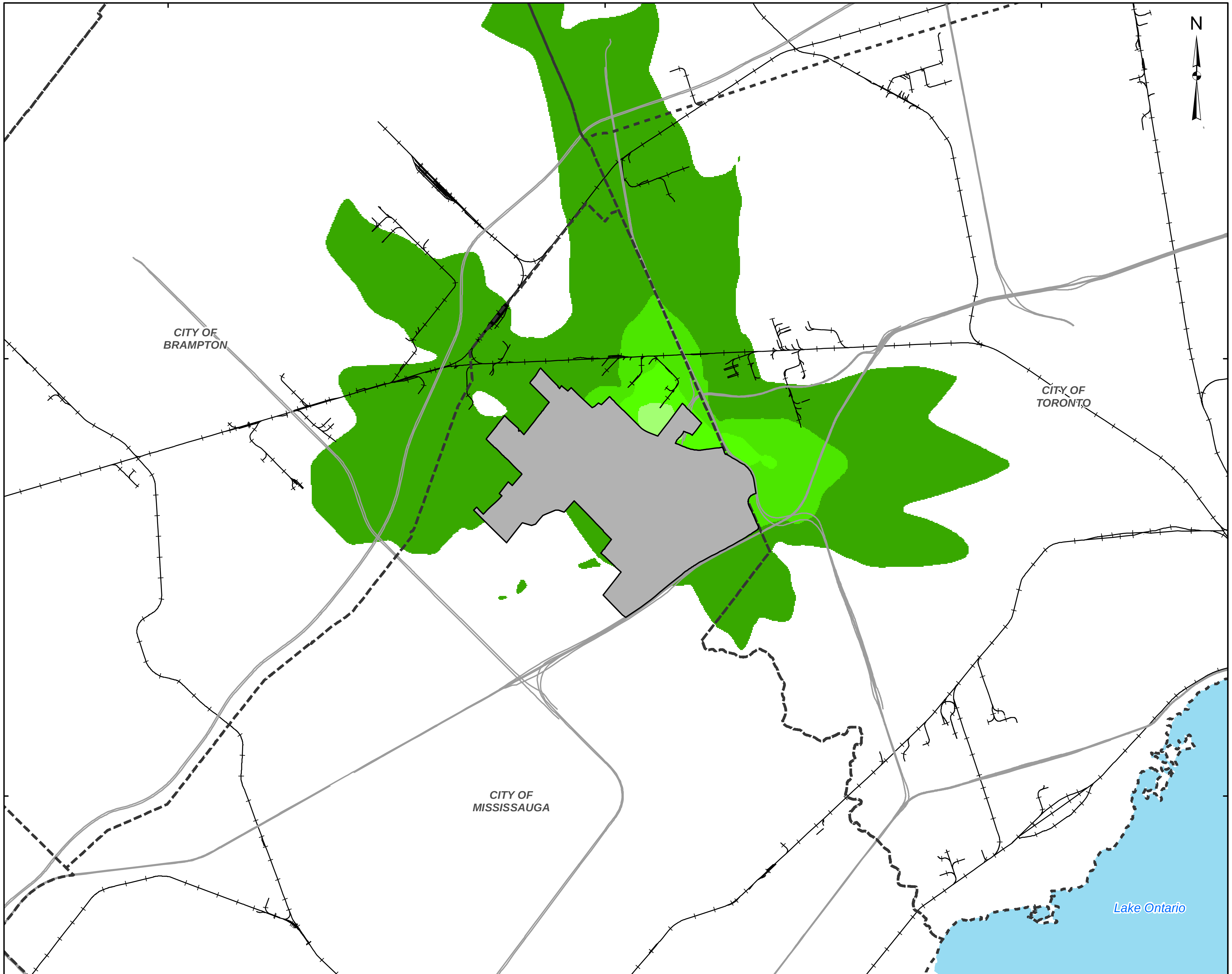
APPENDIX C

Airport Alone Dispersion Modelling Results Figures



LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - CO µg/m³

- < 1,000
- 2,000
- 3,000
- 4,000
- > 4,000

NOTES:

1-Hour CO AAQC standard = 36,000 µg/m3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

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SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2011 1 HOUR CO CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

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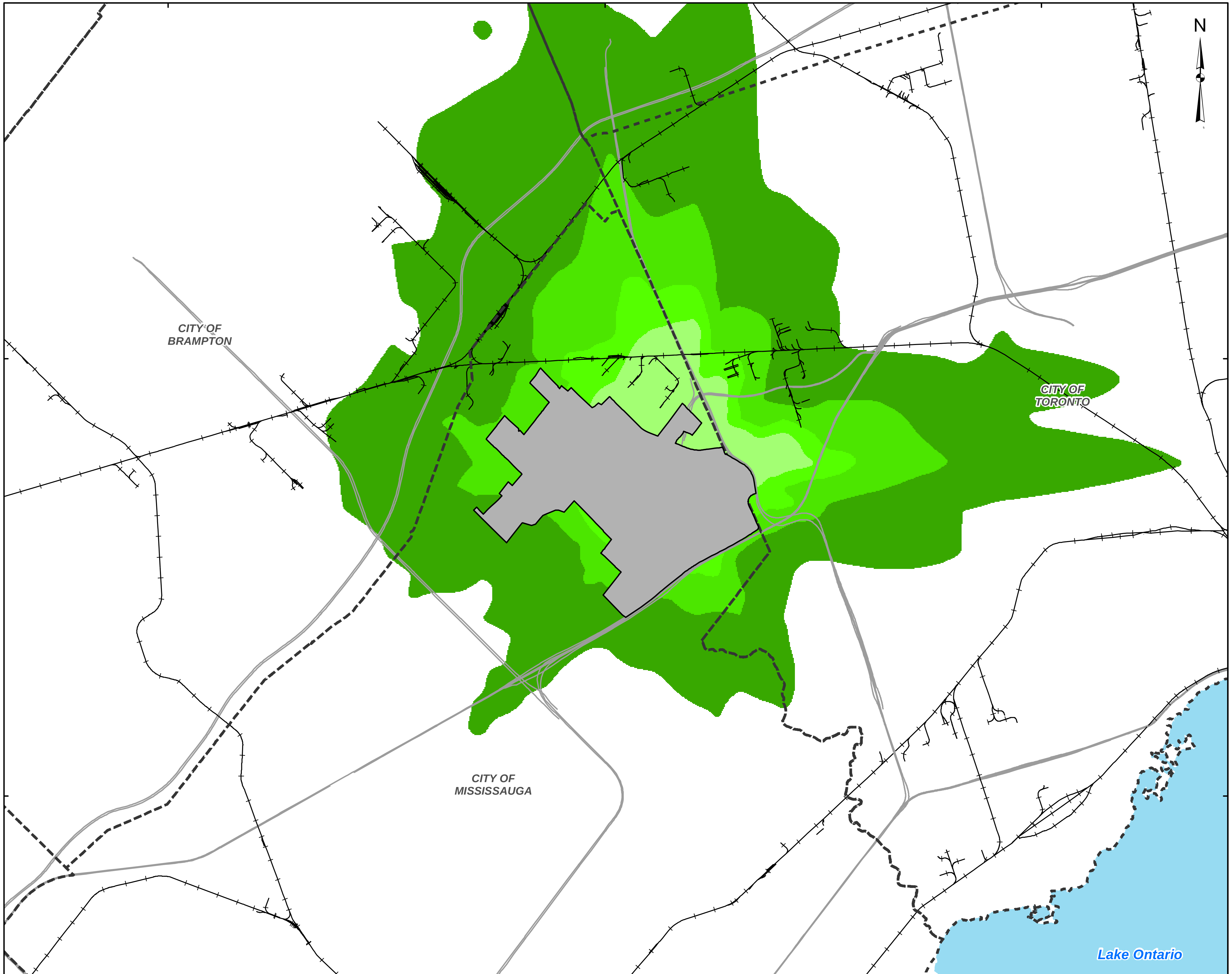

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

8-Hour Predicted Concentration - CO µg/m^3

- < 200
- 200- 400
- 400 - 600
- 600 - 800
- > 1,000

NOTES:

8-Hour CO AAQC Standard = 17,700 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 8 HOUR CO CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN / REV. 0.0
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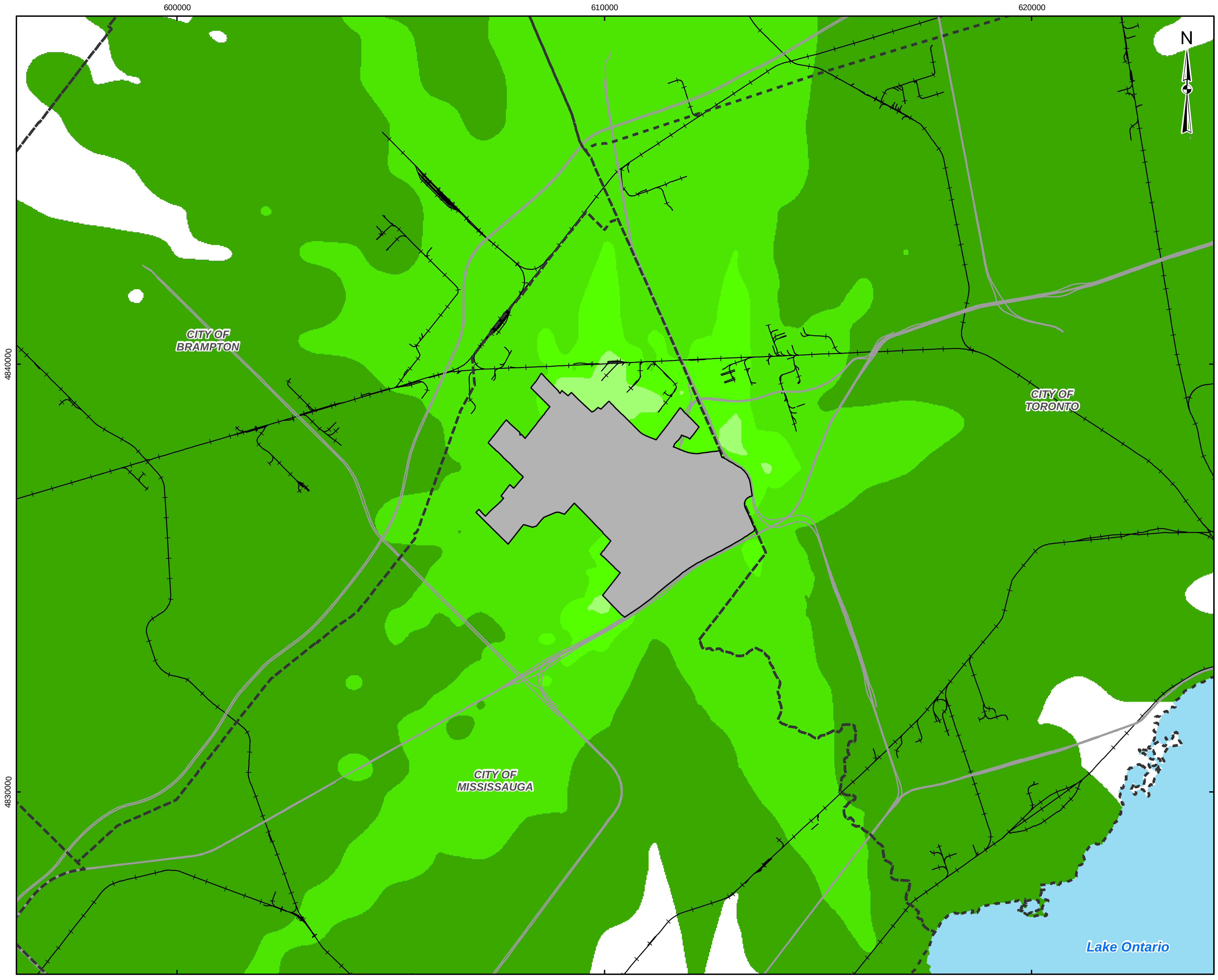

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - NO_2 µg/m^3

- < 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200

NOTES:

1-Hour NO_2 AAQC Standard = 400 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

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SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 1-HOUR NO_2 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

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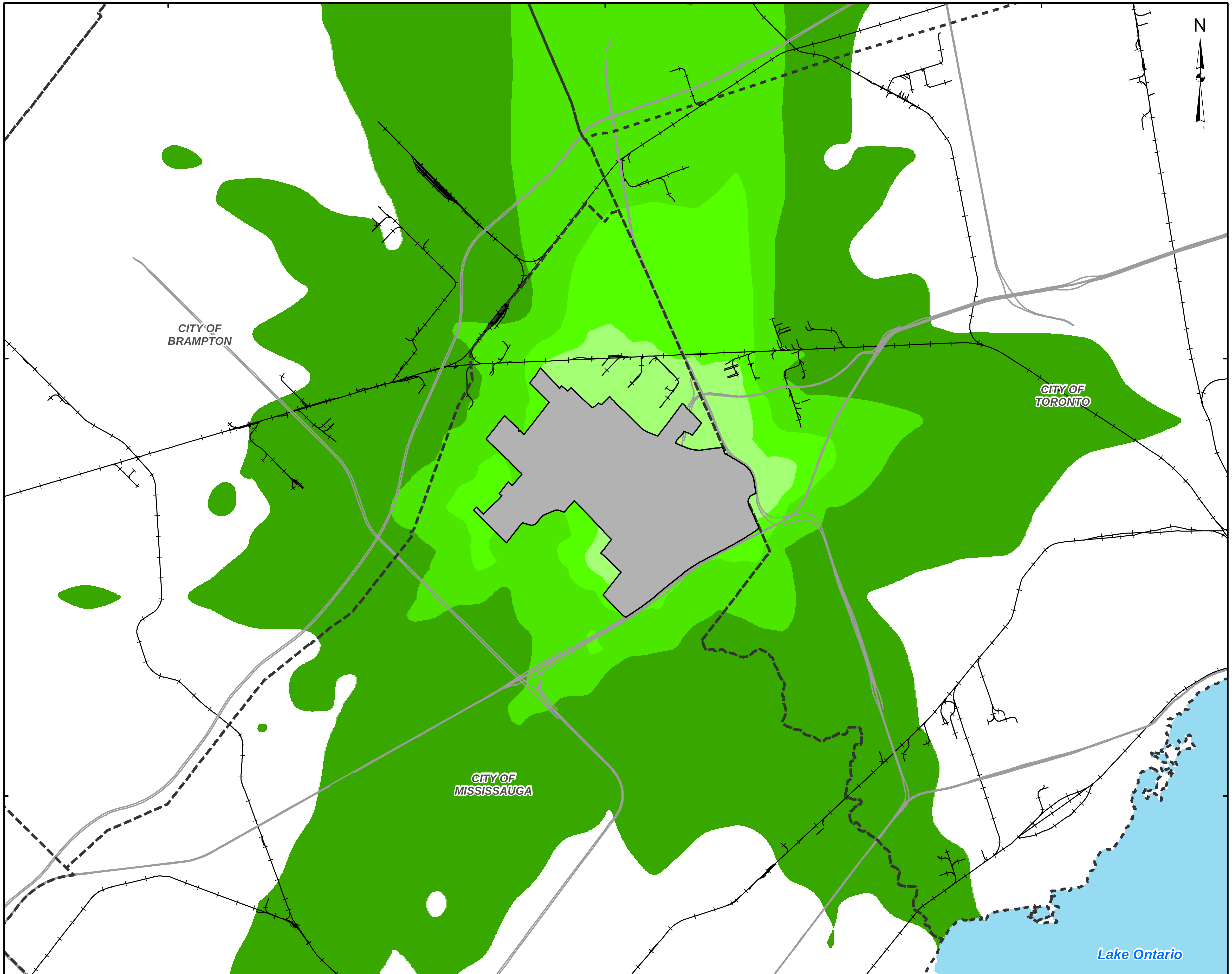

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - NO_2 µg/m^3

- < 5
- 5 - 10
- 10 - 15
- 15 - 20
- > 20

NOTES:

24-hour NO_2 AAQC Standard = 200 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
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SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2011 24-HOUR NO_2 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

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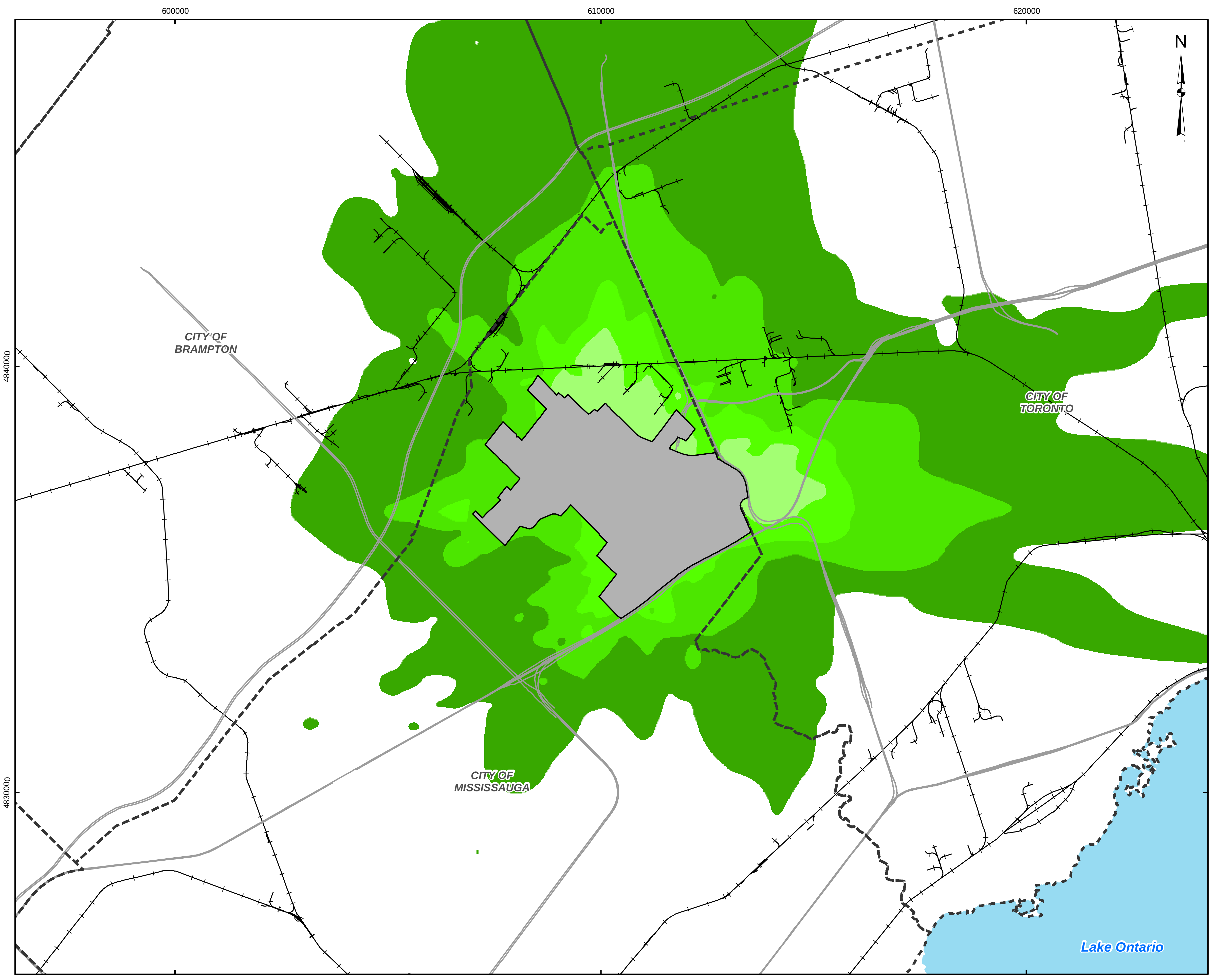

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - SO_2 µg/m^3

- < 20
- 21 - 40
- 41 - 60
- 61 - 80
- > 80

NOTES:

1-Hour SO_2 AAQC Standard = 690 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 1-HOUR SO_2 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

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REVIEW				

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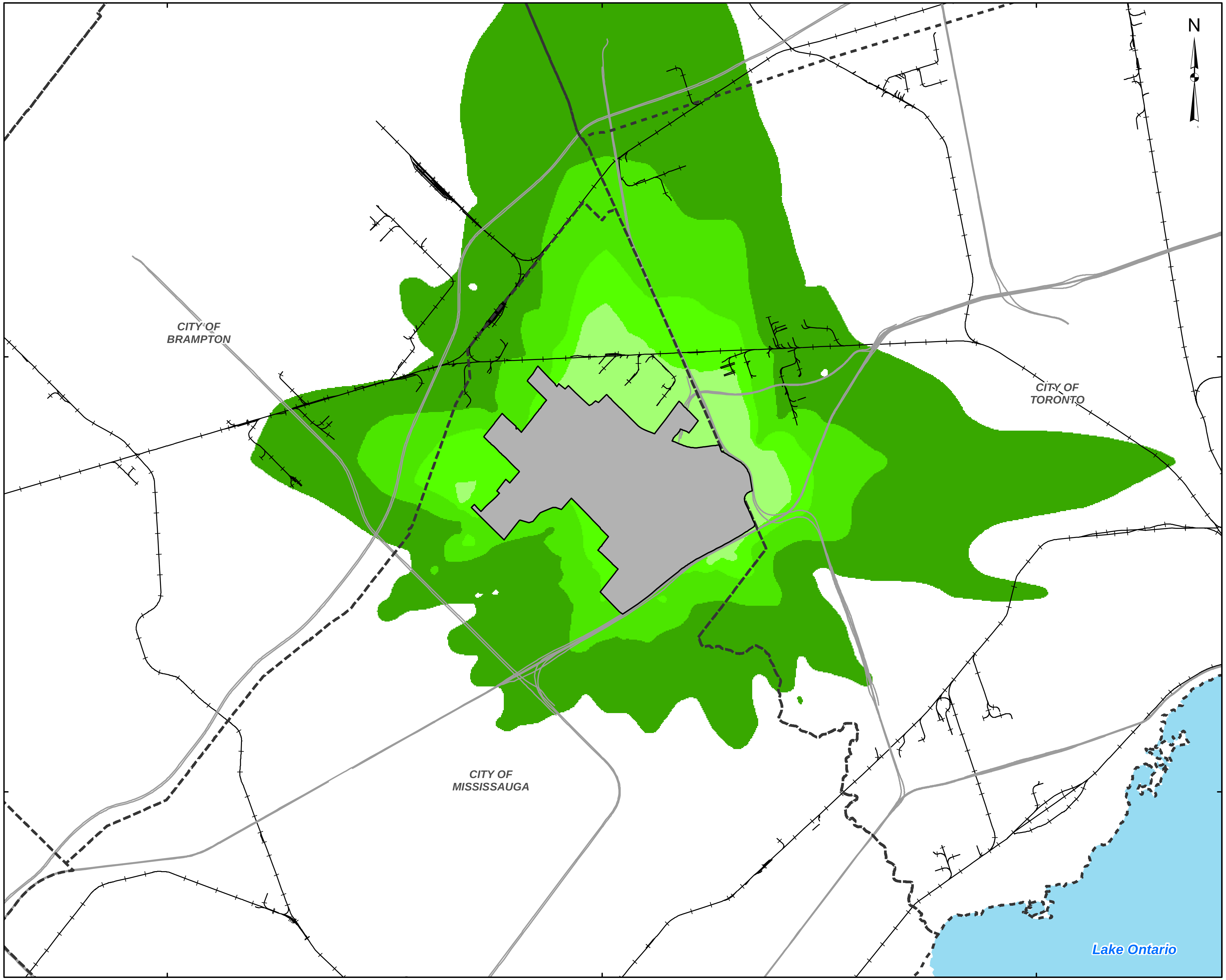

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - SO_2 µg/m^3

- < 1.5
- 1.5 - 3
- 3 - 4.5
- 4.5 - 6
- > 6

NOTES:

24-Hour SO_2 AAQC Standard = 275 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
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SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2011 24-HOUR SO_2 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

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CHECK	AB	2015-01-23		
REVIEW				

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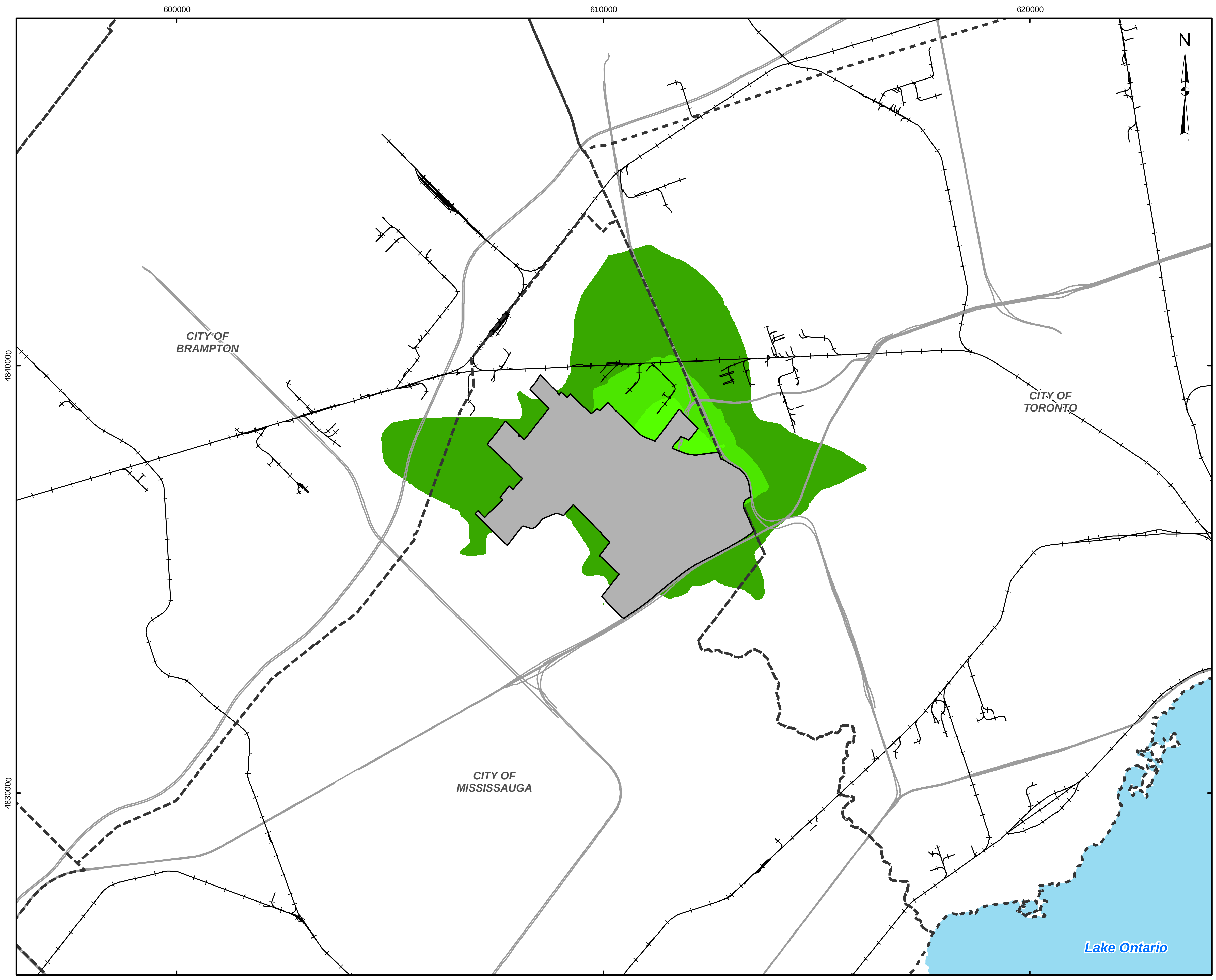

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - VOC µg/m³

- < 10
- 10 - 20
- 20 - 30
- > 40

REFERENCE

Base Data - MNR LIO, obtained 2013
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Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

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SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2011 24-HOUR VOC CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

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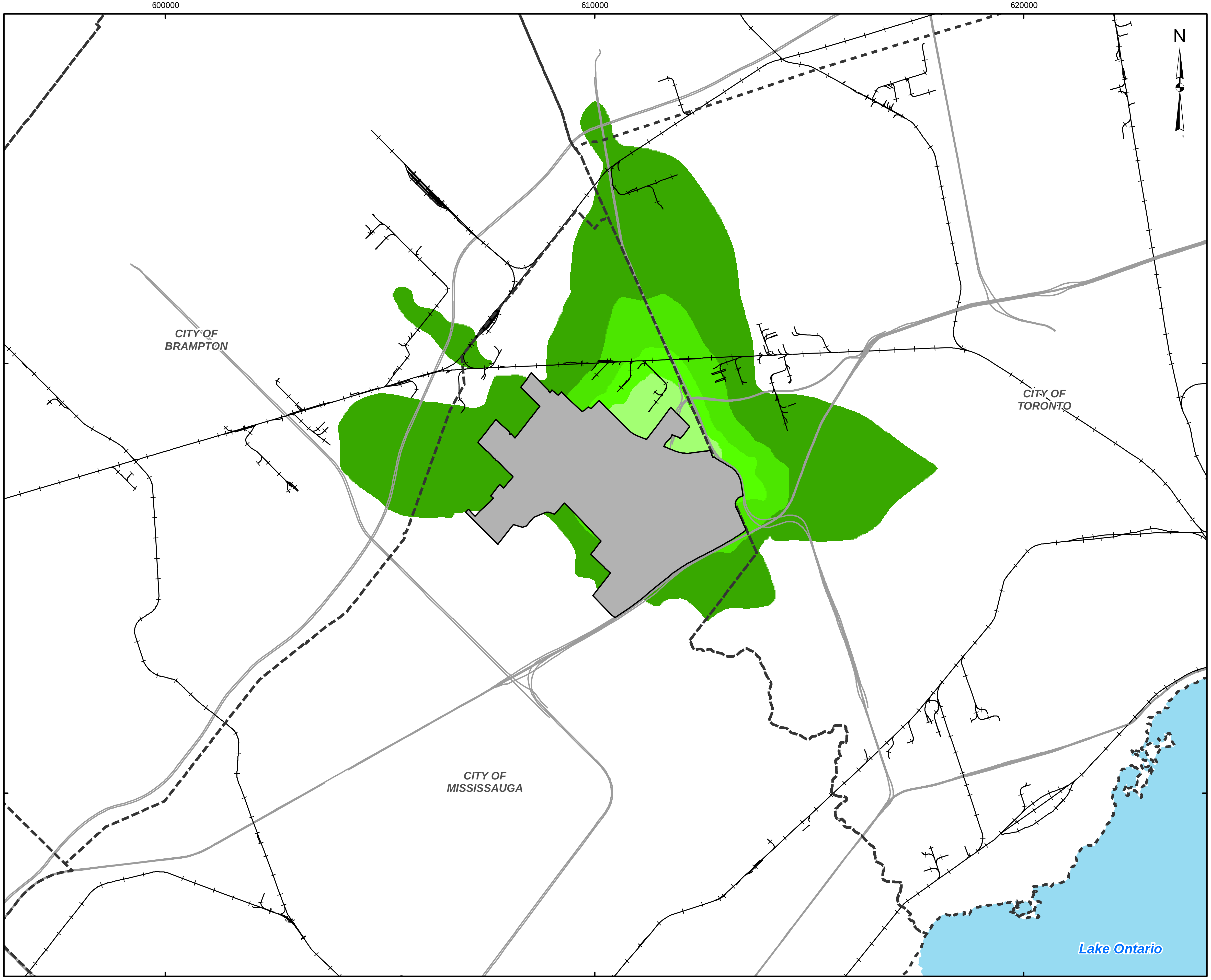

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM10 µg/m³

- < 0.5
- 0.5 - 1
- 1. - 1.5
- 1.5 - 2
- > 2

NOTES:

24-hour PM10 AAQC Standard = 50 µg/m³

REFERENCE

Base Data - MNR LIO, obtained 2013
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 24-HOUR PM10 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

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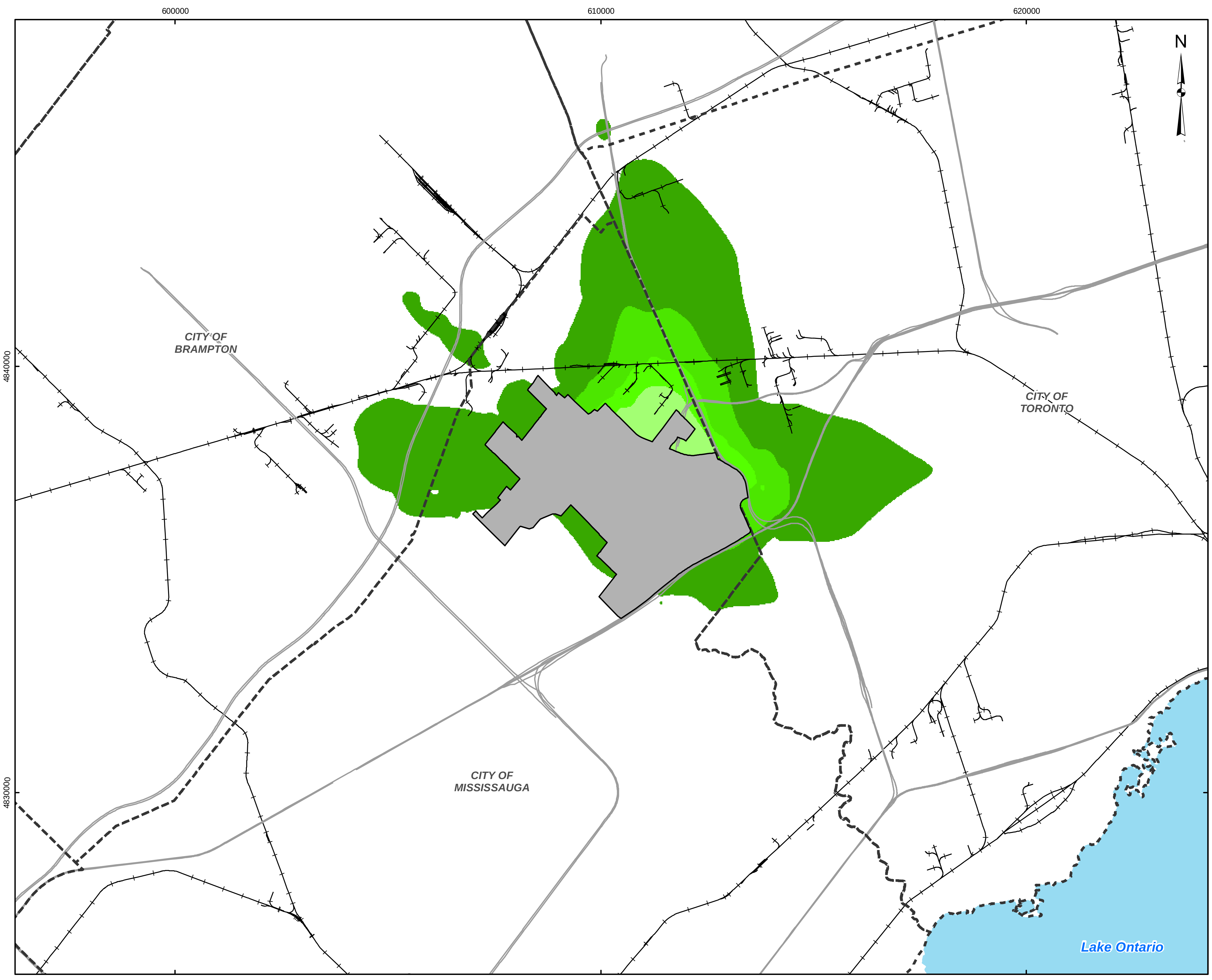

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM2.5 μg/m^3

- < 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

NOTES:

24-hour PM2.5 AAQC Standard = 25 μg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
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Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 24-HOUR PM2.5 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

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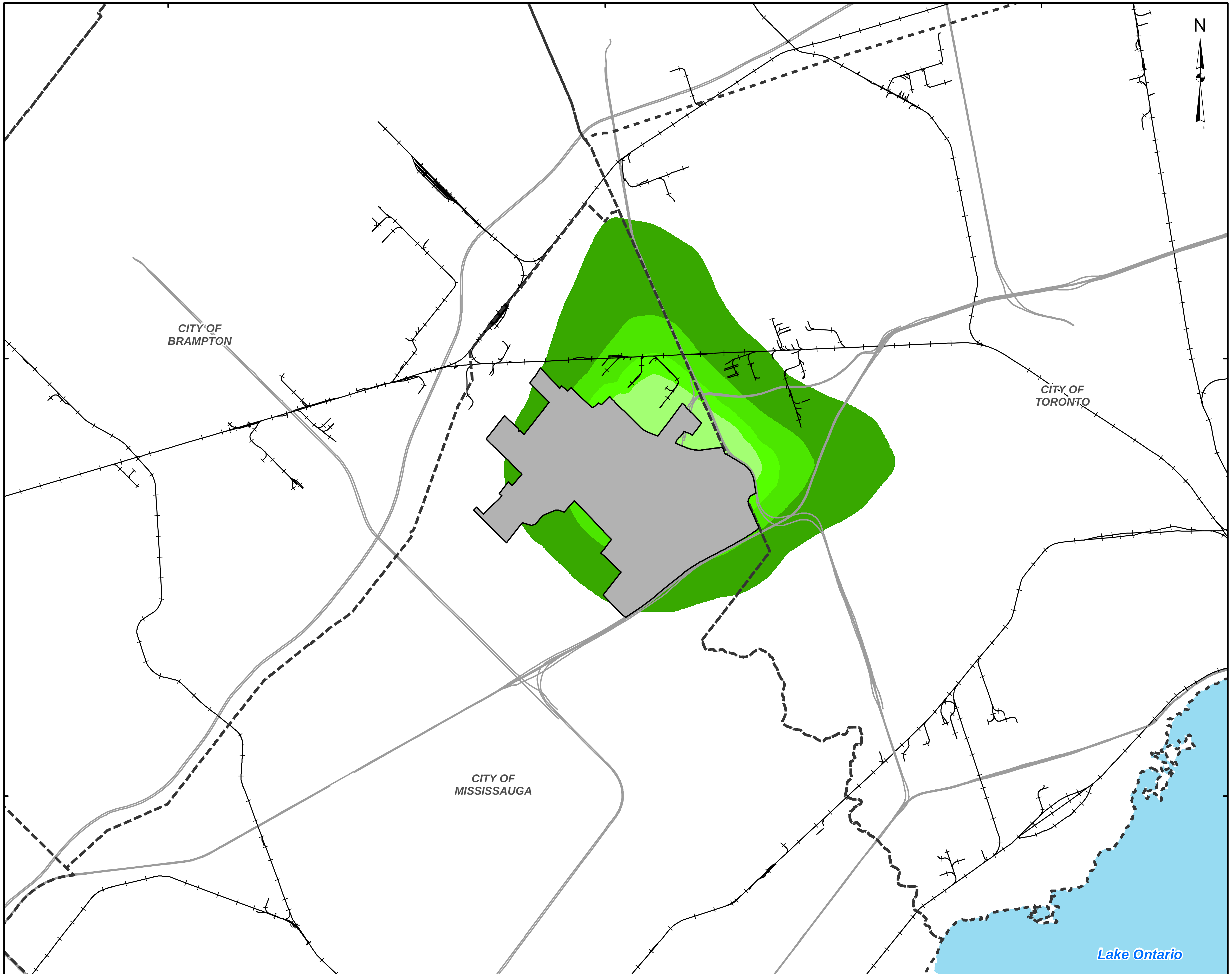

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

Annual Predicted Concentration - PM 2.5 μg/m^3

- < 0.05
- 0.05 - 0.1
- 0.10 - 0.15
- 0.15 - 0.2
- > 0.2

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 ANNUAL PM2.5 CONCENTRATIONS ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C10	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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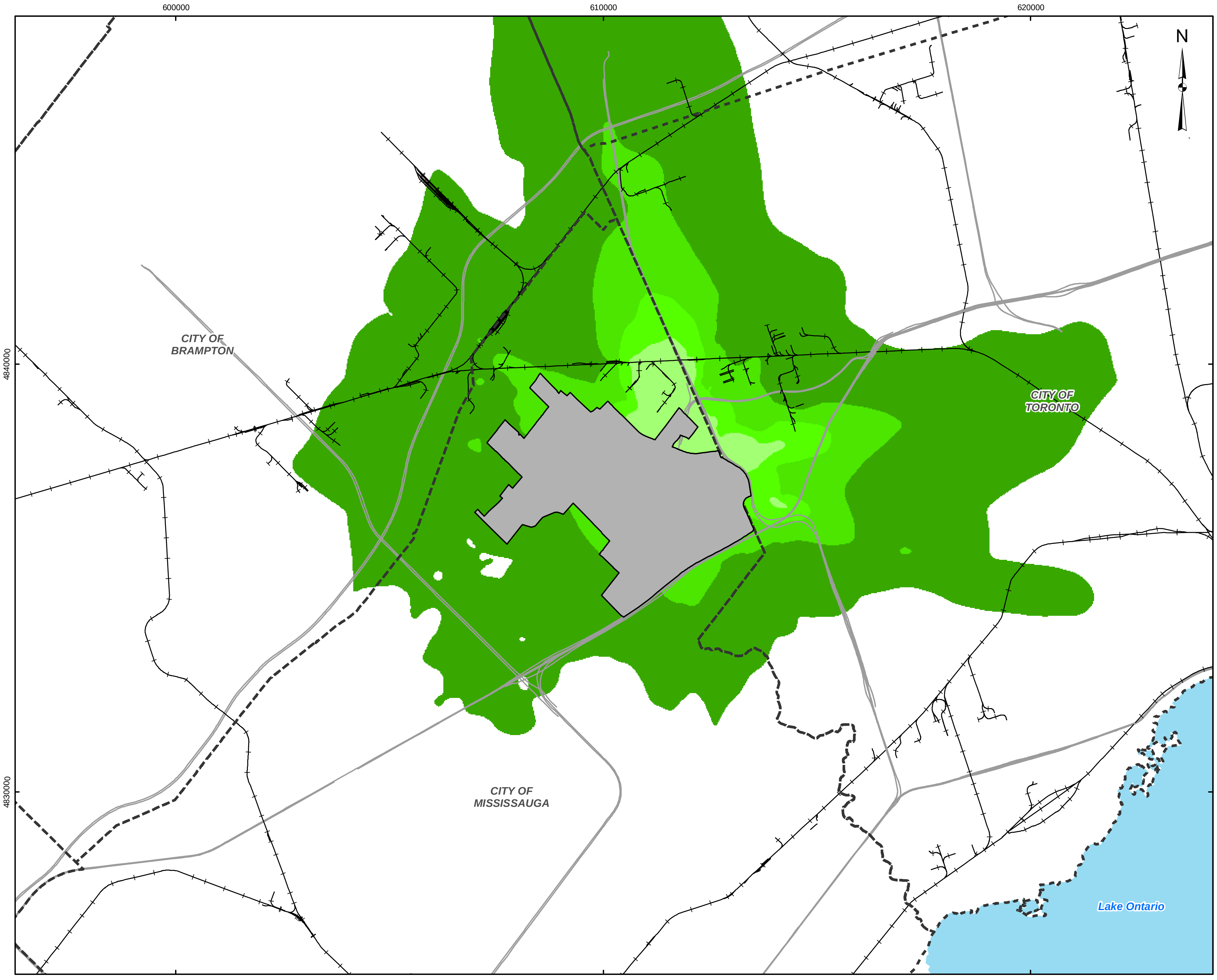

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - CO µg/m^3

- < 1,000
- 1,000 - 2,000
- 2,000 - 3,000
- 3,000 - 4,000
- 4,000 - 5,000

NOTES:

1-Hour CO AAQC Standard = 36,000 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2022 1-HOUR CO CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-09-16	FIGURE: C11	
GIS	ME	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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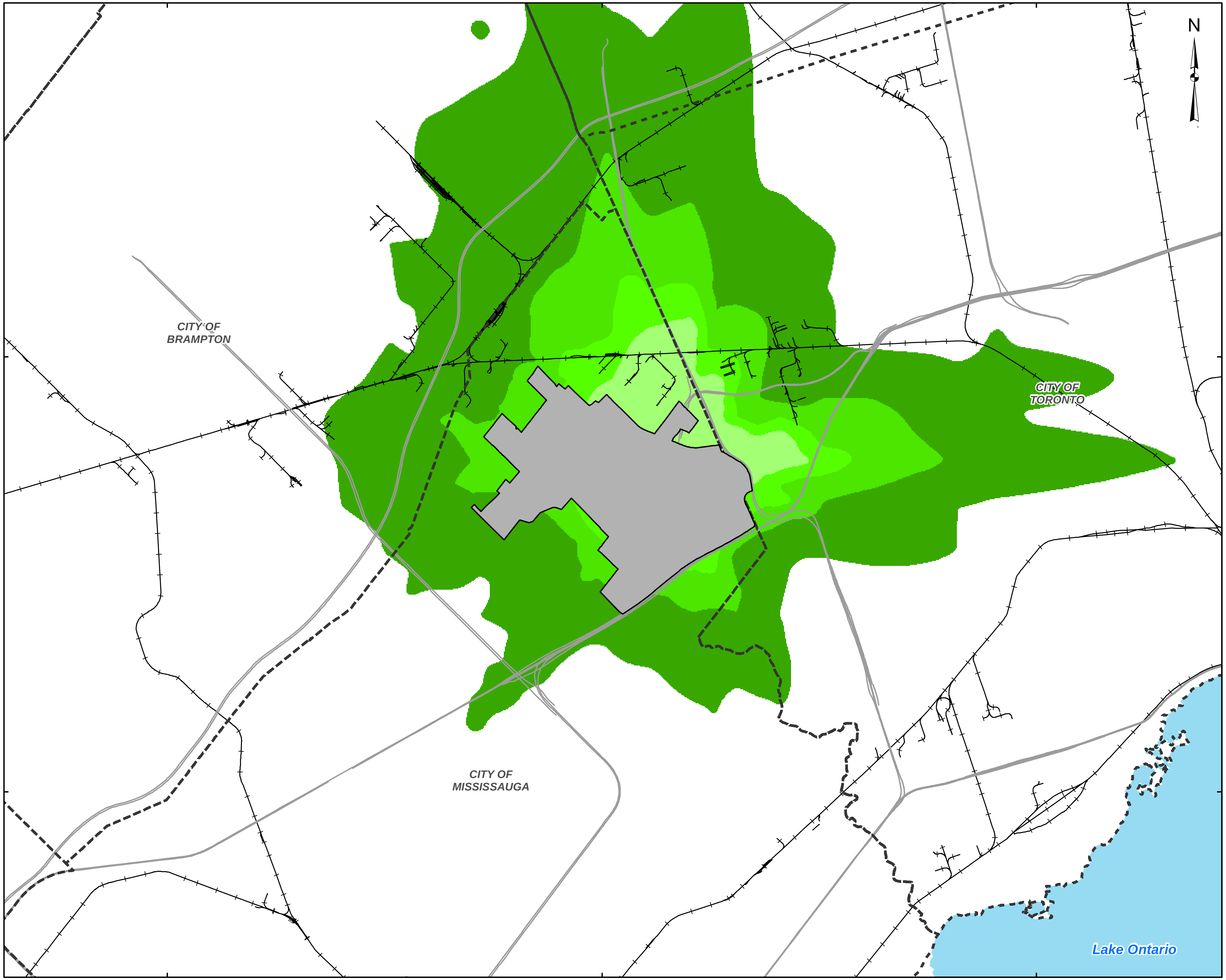


LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

8-Hour Predicted Concentration - CO µg/m^3

- < 200
- 200 - 400
- 400 - 600
- 600 - 800
- > 800

NOTES:

8-hour CO AAQC Standard = 15,700 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

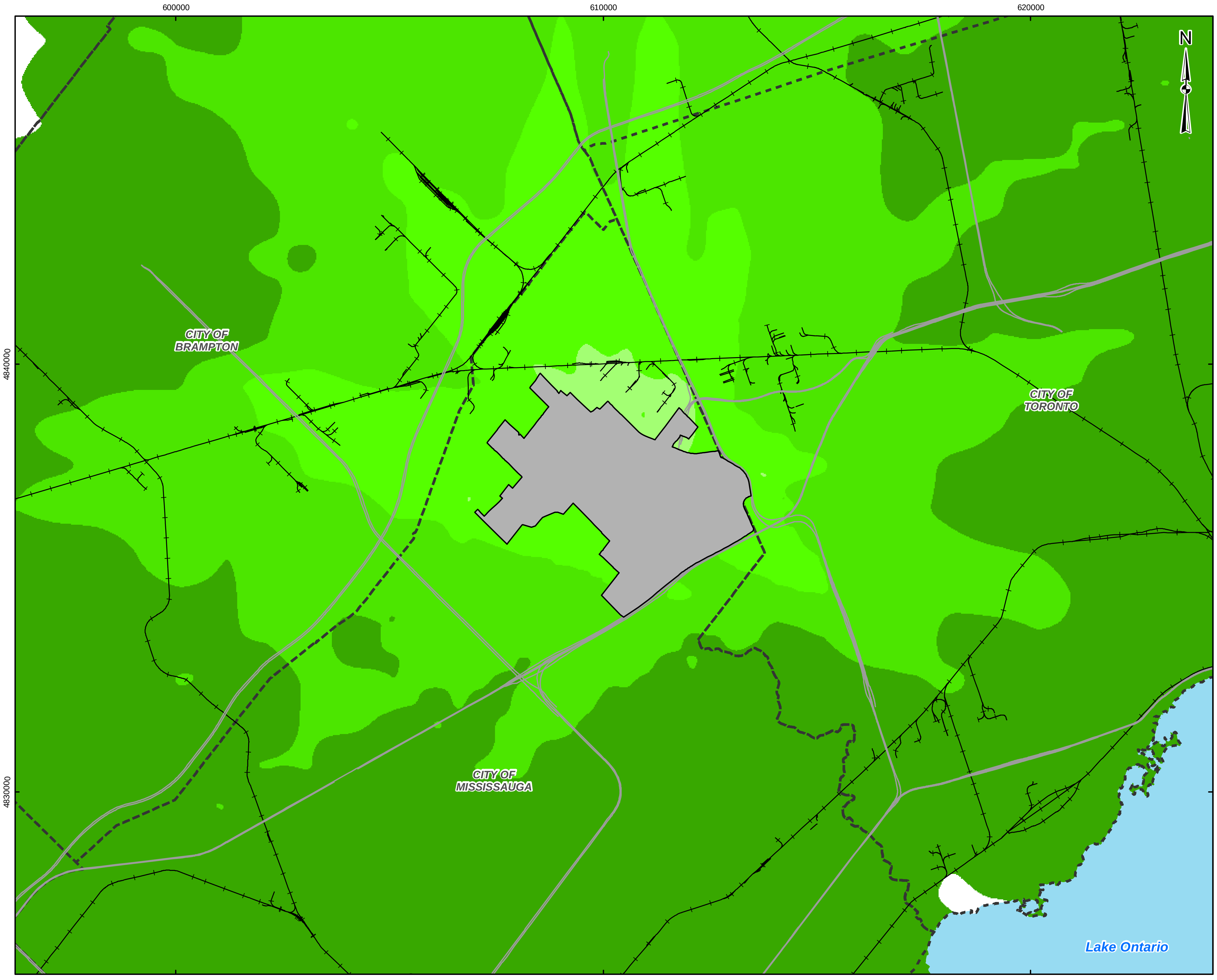
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2022 8-HOUR CO CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C12	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

Golder Associates
Mississauga, Ontario



LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - NO_2 µg/m^3

- < 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200

NOTES:

1-Hour NO_2 AAQC Standard = 400 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2022 1-HOUR NO_2 CONCENTRATIONS ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C13	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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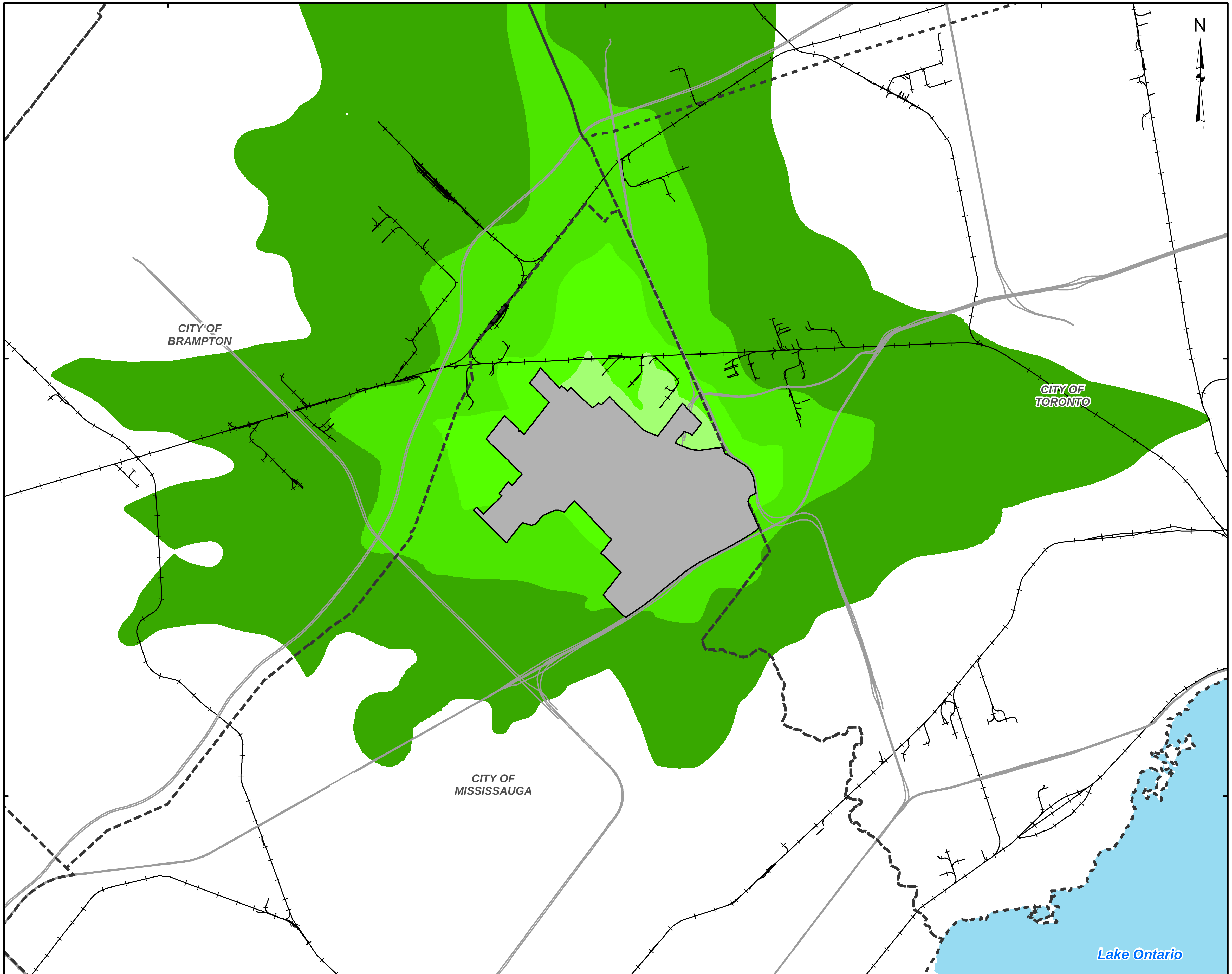

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - NO_2 µg/m^3

- < 8
- 8 - 16
- 16- 24
- 24- 32
- > 32

NOTES:

24-Hour NO_2 AAQC Standard = 200 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2022 24-HOUR NO_2 CONCENTRATIONS ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C14	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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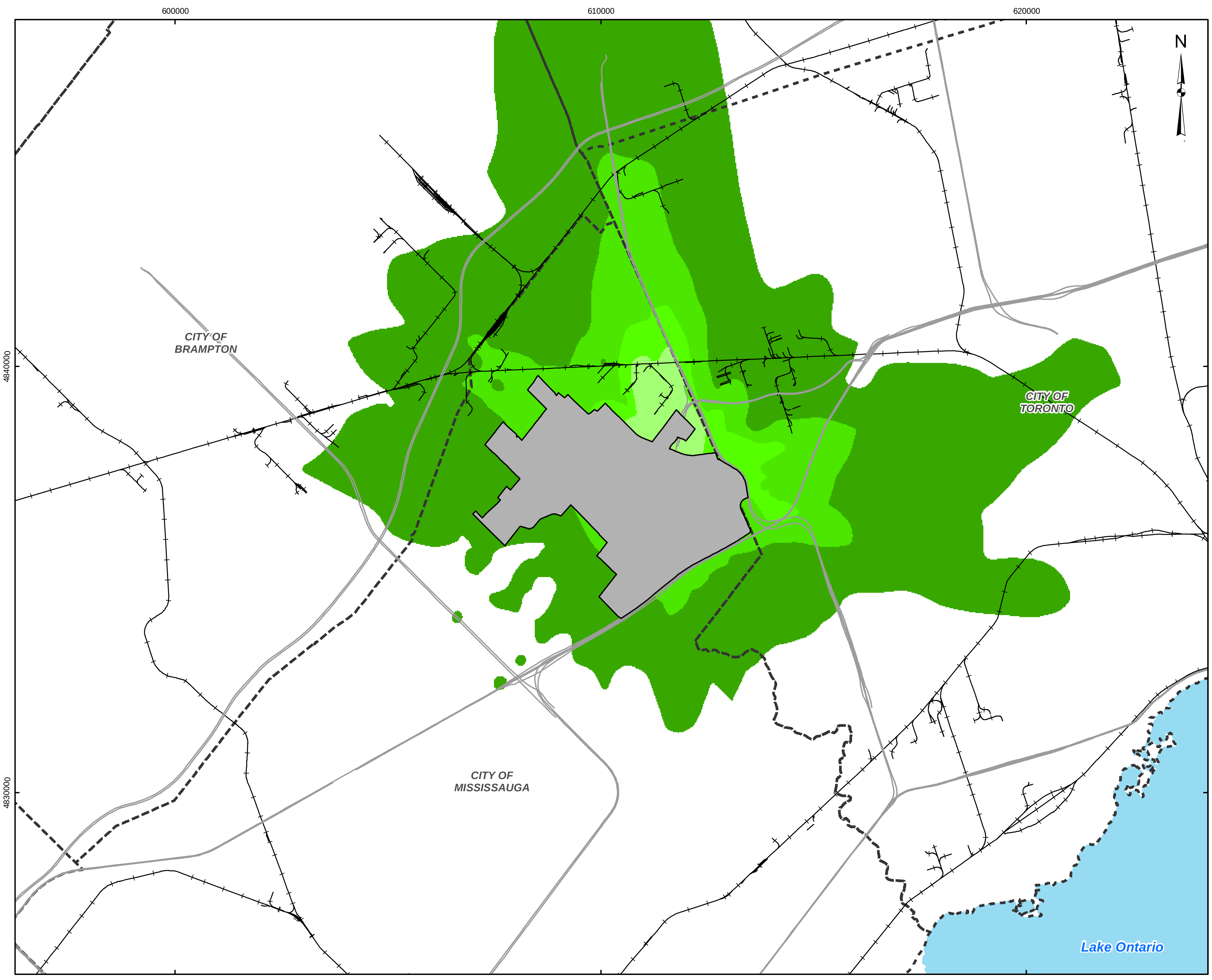

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - SO_2 µg/m^3

- < 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200

NOTES:

1-hour SO_2 AAQC Standard = 690 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2022 1-HOUR SO_2 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C15	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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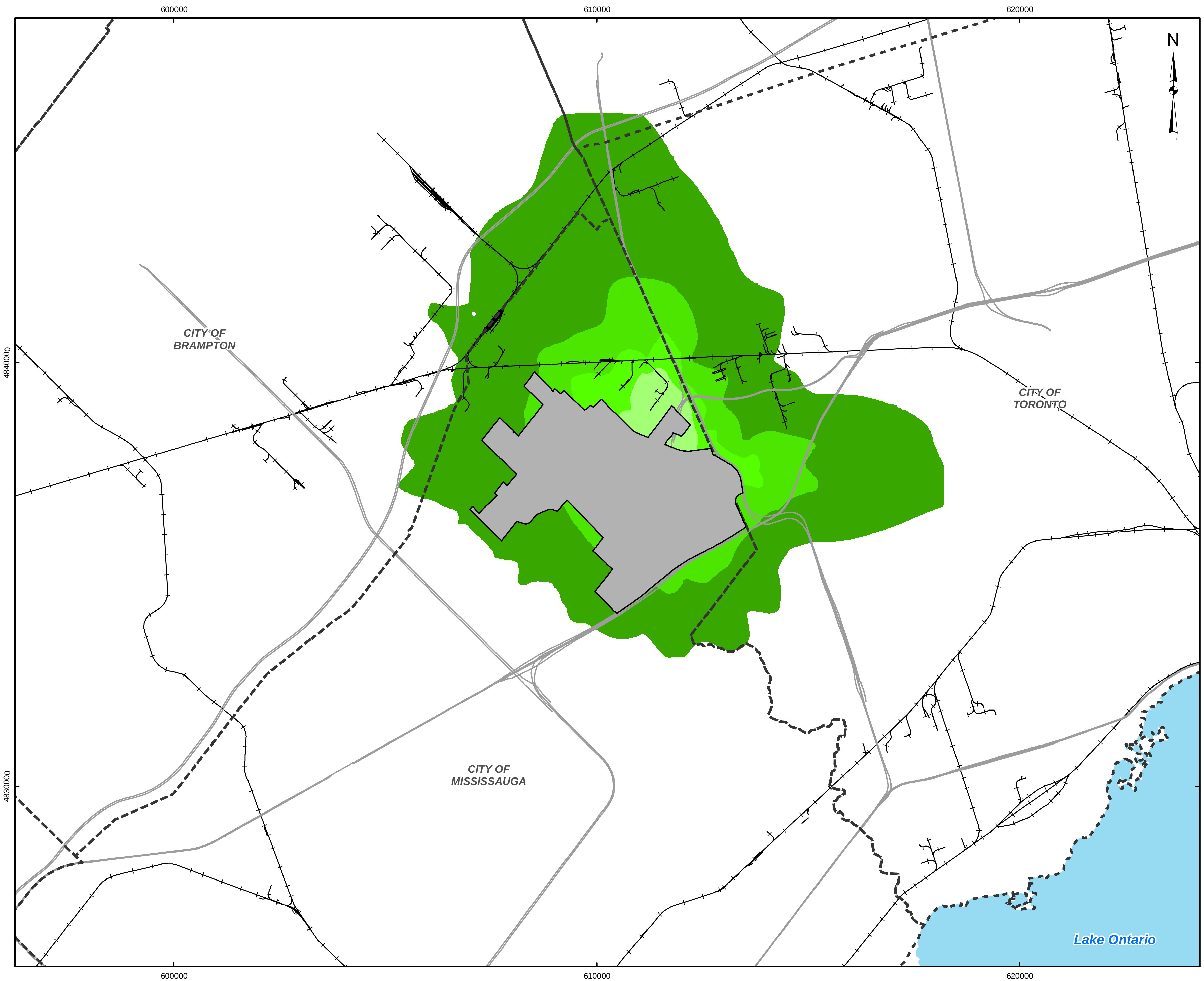


LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - SO_2 µg/m^3

- < 5
- 5 - 10
- 10 - 15
- 15 - 20
- > 20

NOTES:

24-Hour SO_2 AAQC Standard = 275 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

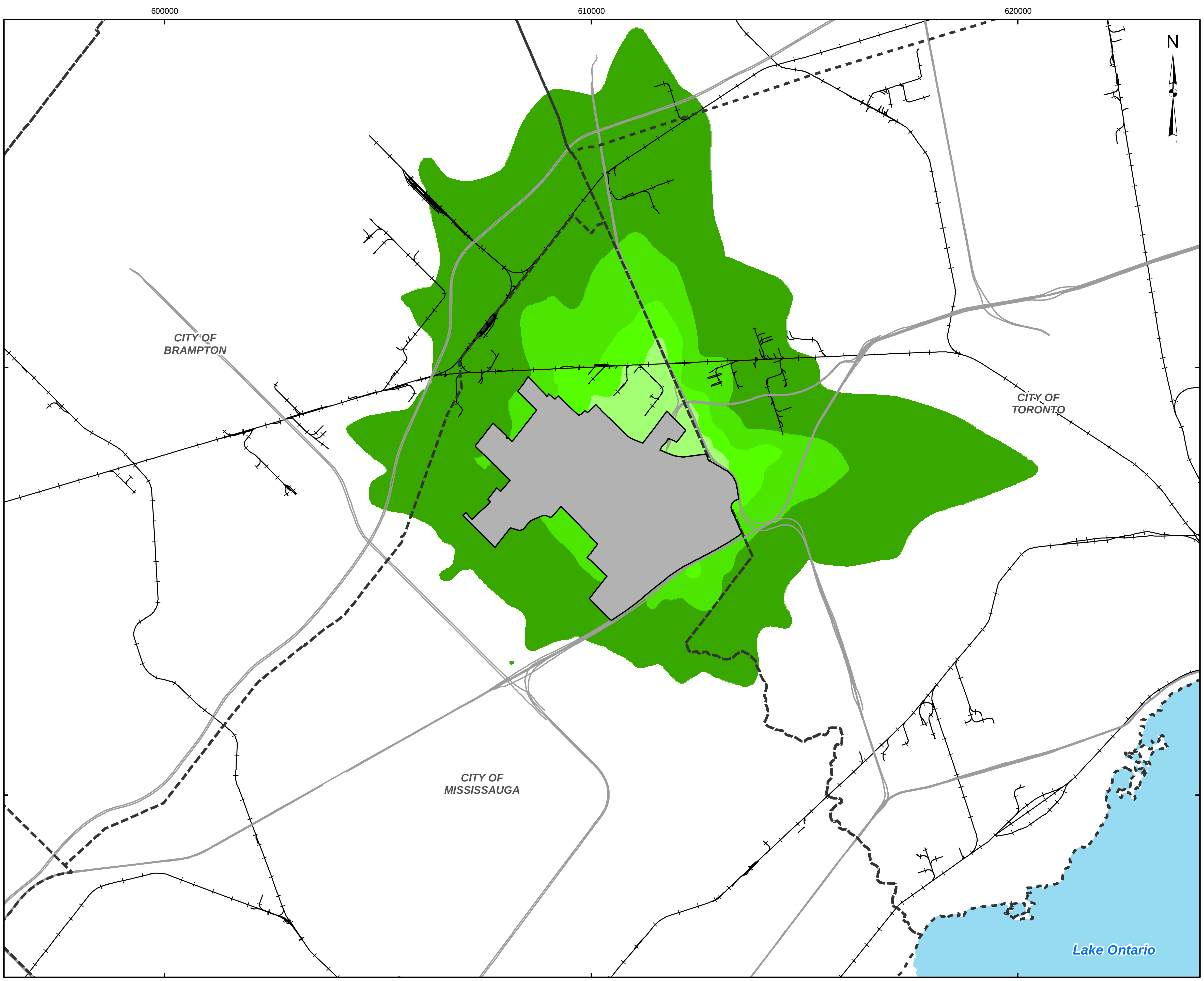
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2022 24-HOUR SO_2 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C16	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				



LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - VOC µg/m³

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- > 40

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

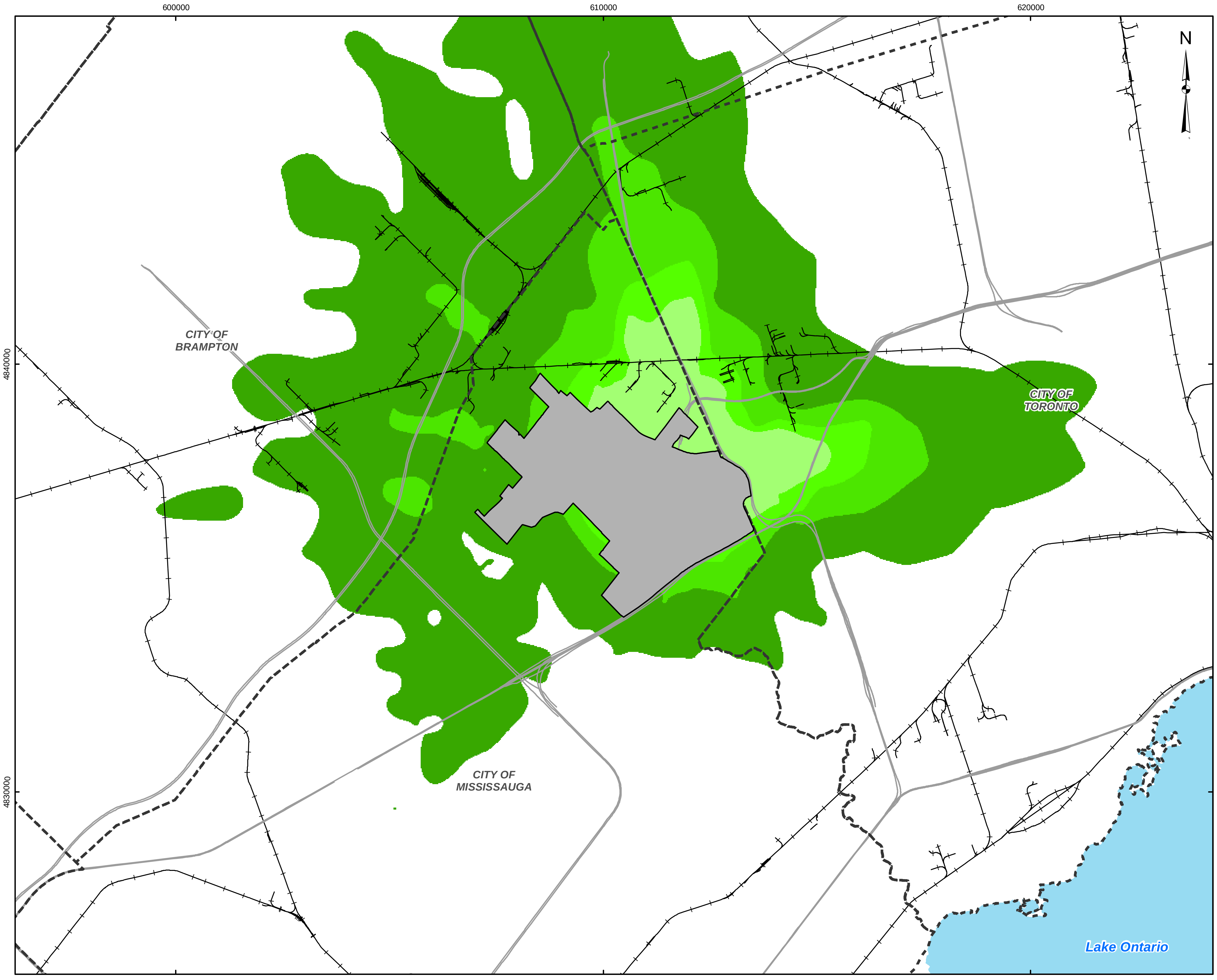
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2022 24-HOUR VOC CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C17	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				



LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM10 $\mu g/m^3$

- < 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

NOTES:

24-Hour PM10 AAQC Standard = 50 $\mu g/m^3$

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

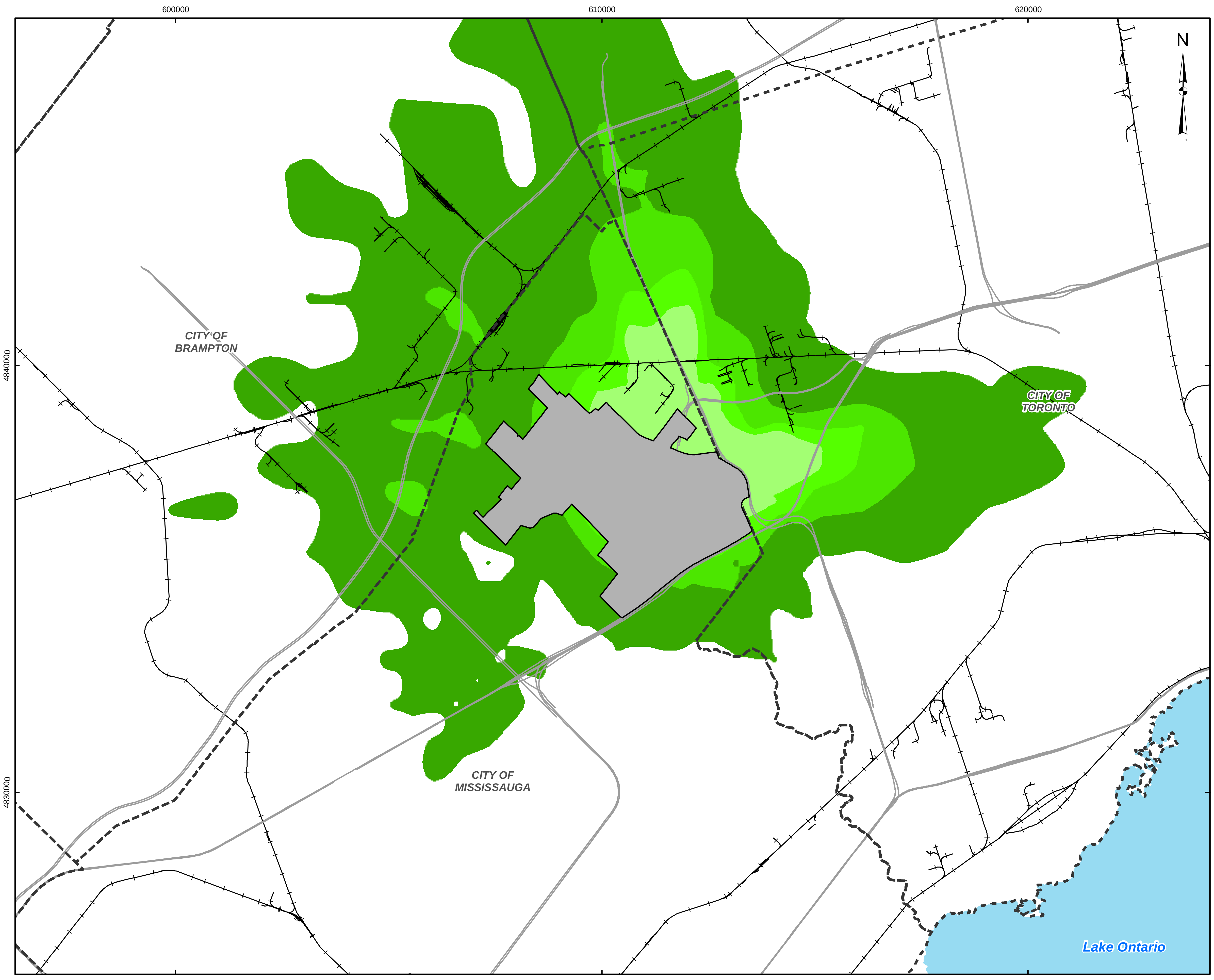
PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2022 24-HOUR PM10 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C18	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudy\Phase2_Report\Appendix_C\Updates_Jan2015\FigureC18_2022_24_Hr_PM10.mxd



LEGEND

- Highway
- Railways
- Waterbody
- Municipality

24-Hour Predicted Concentration - PM2.5 µg/m³

- < 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- > 2.5

NOTES:

24-Hour PM2.5 AAQC Standard = 25 µg/m³

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

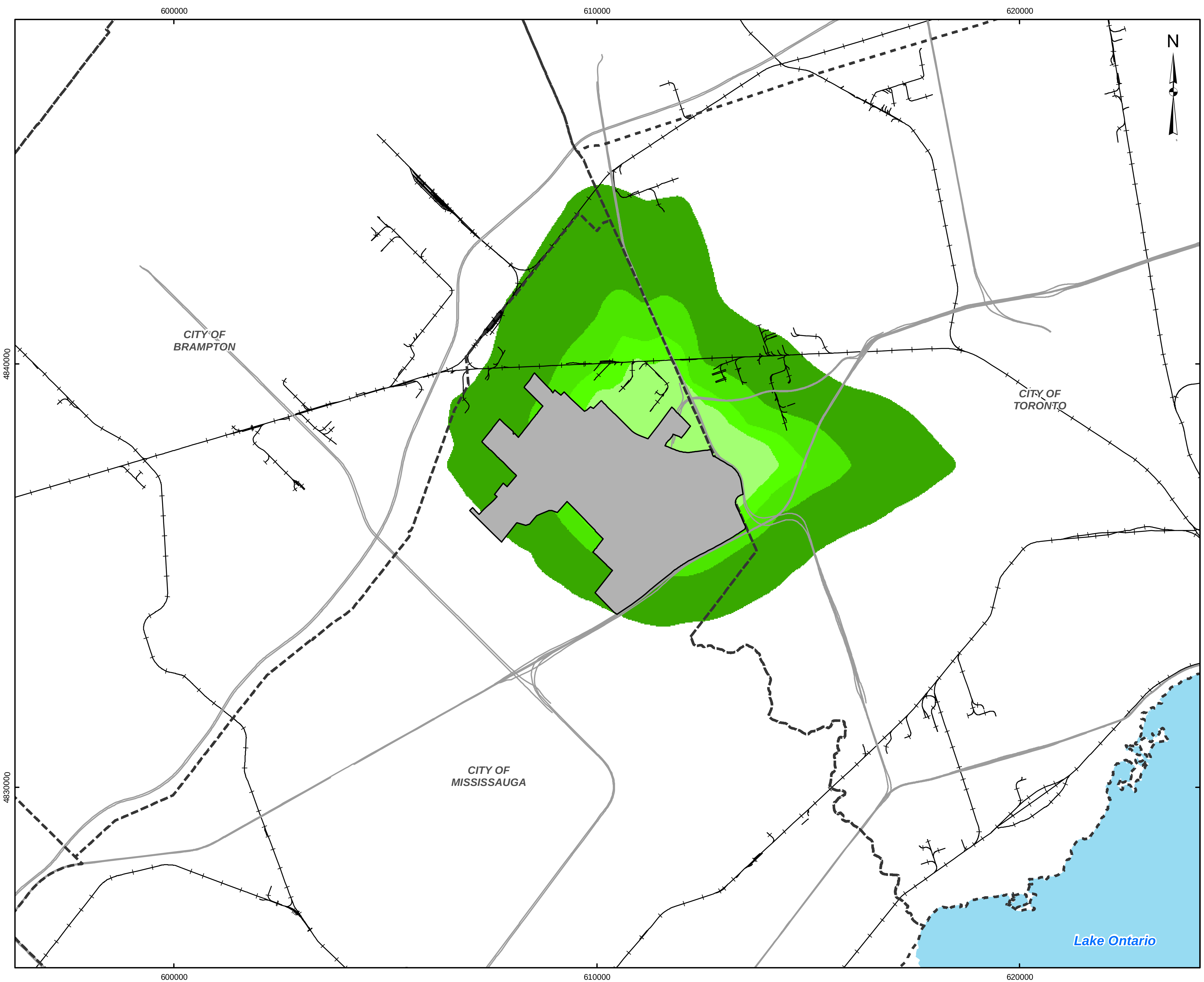
PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2022 24-HOUR PM2.5 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C19	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudy\Phase2_Report\Appendix_C\Updates_Jan2015\FigureC19_2022_24_Hr_PM25.mxd



LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

Annual Predicted Concentration - PM2.5 µg/m^3

- < 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.1 - 0.2
- > 0.25

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

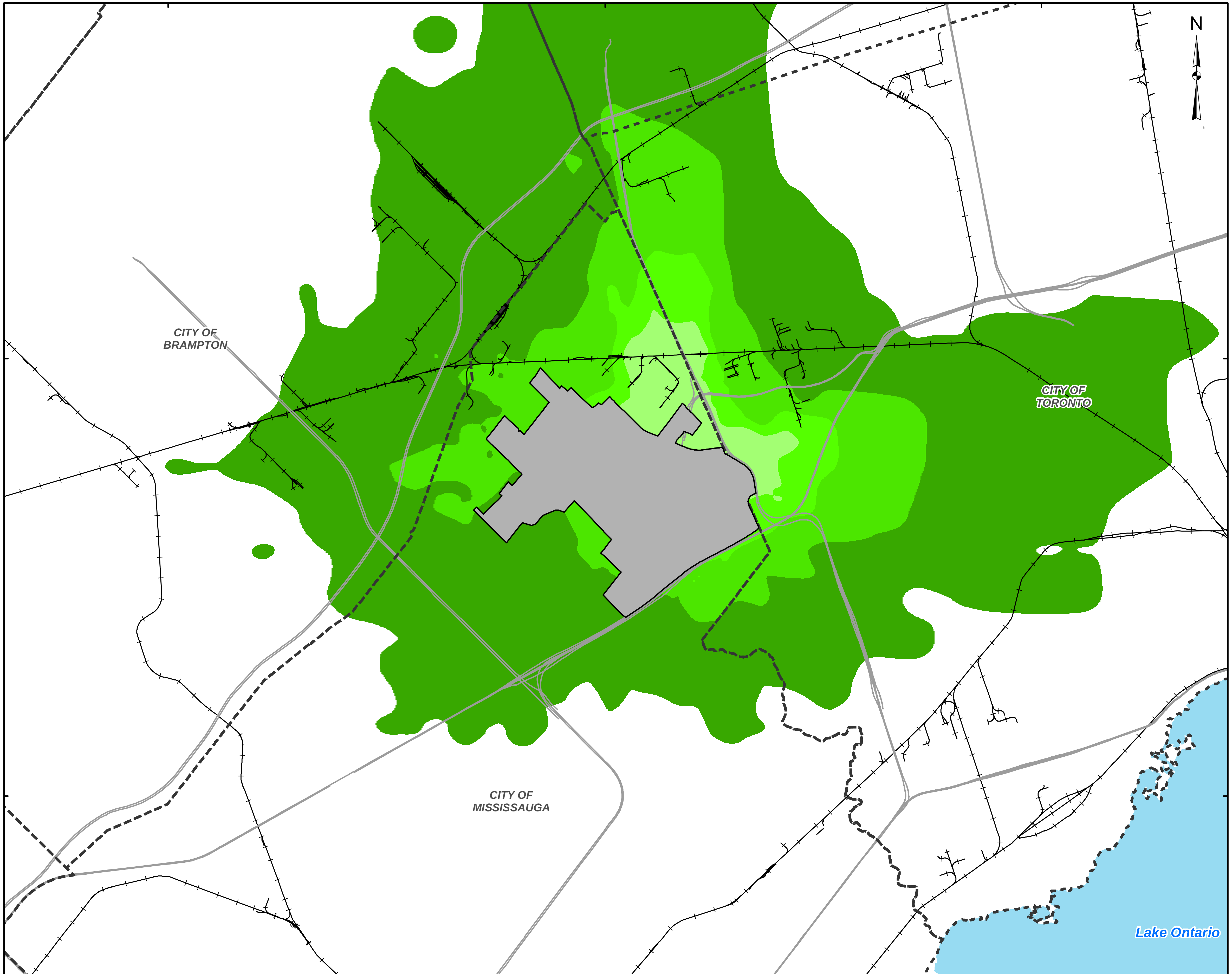
2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2022 ANNUAL PM2.5 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11		
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23	FIGURE: C20	
REVIEW				



LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - CO µg/m^3

- < 1,000
- 1,000 - 2,000
- 2,000 - 3,000
- 3,000 - 4,000
- > 4,000

NOTES:

1-Hour CO AAQC Standard = 36,000 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2032 1-HOUR CO CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-09-16	FIGURE: C21	
GIS	ME	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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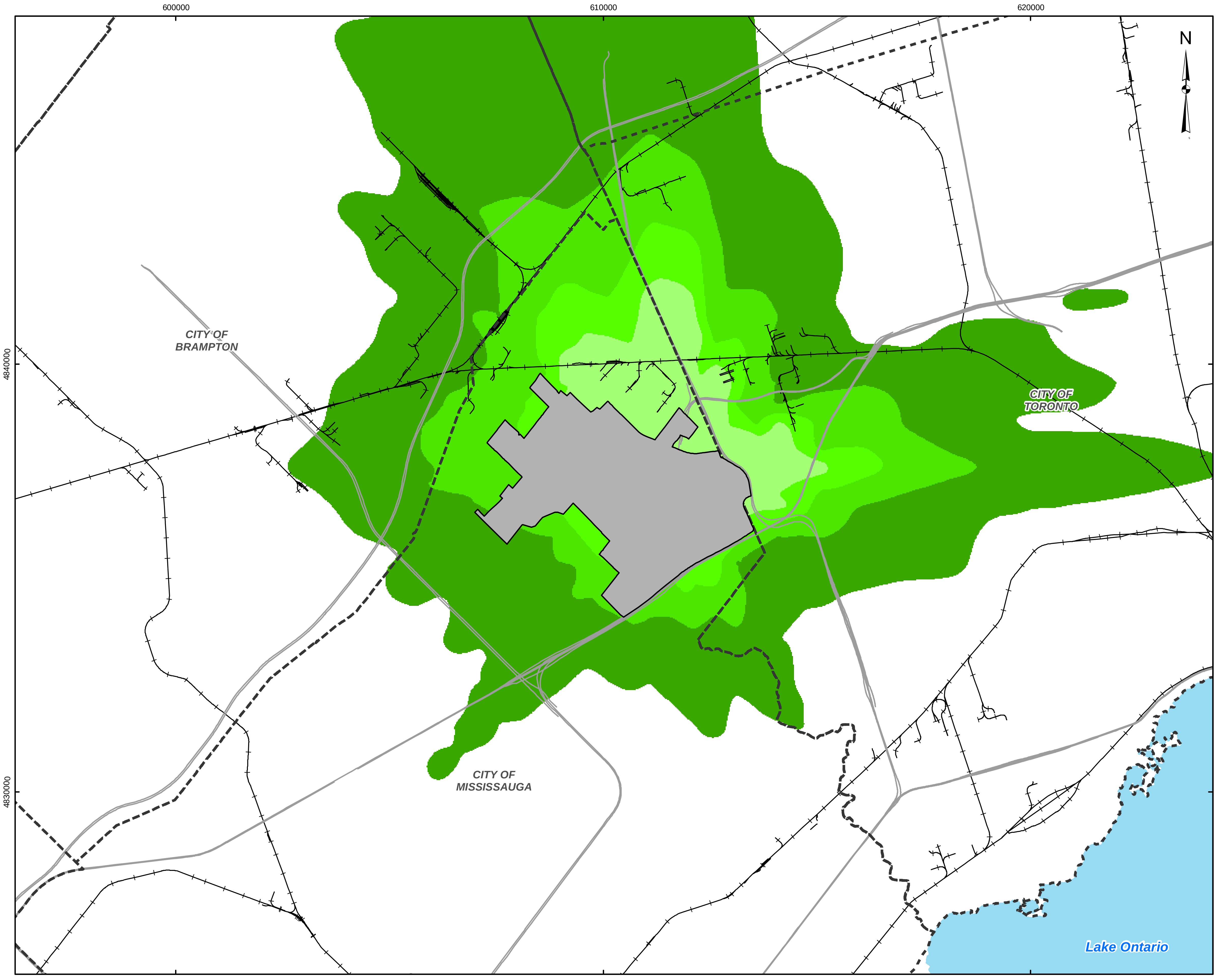

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

8-Hour Predicted Concentration - CO µg/m^3

- < 200
- 200 - 400
- 400 - 600
- 600 - 800
- > 800

NOTES:

8-Hour CO AAQC Standard = 15,700 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2032 8-HOUR CO CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C22	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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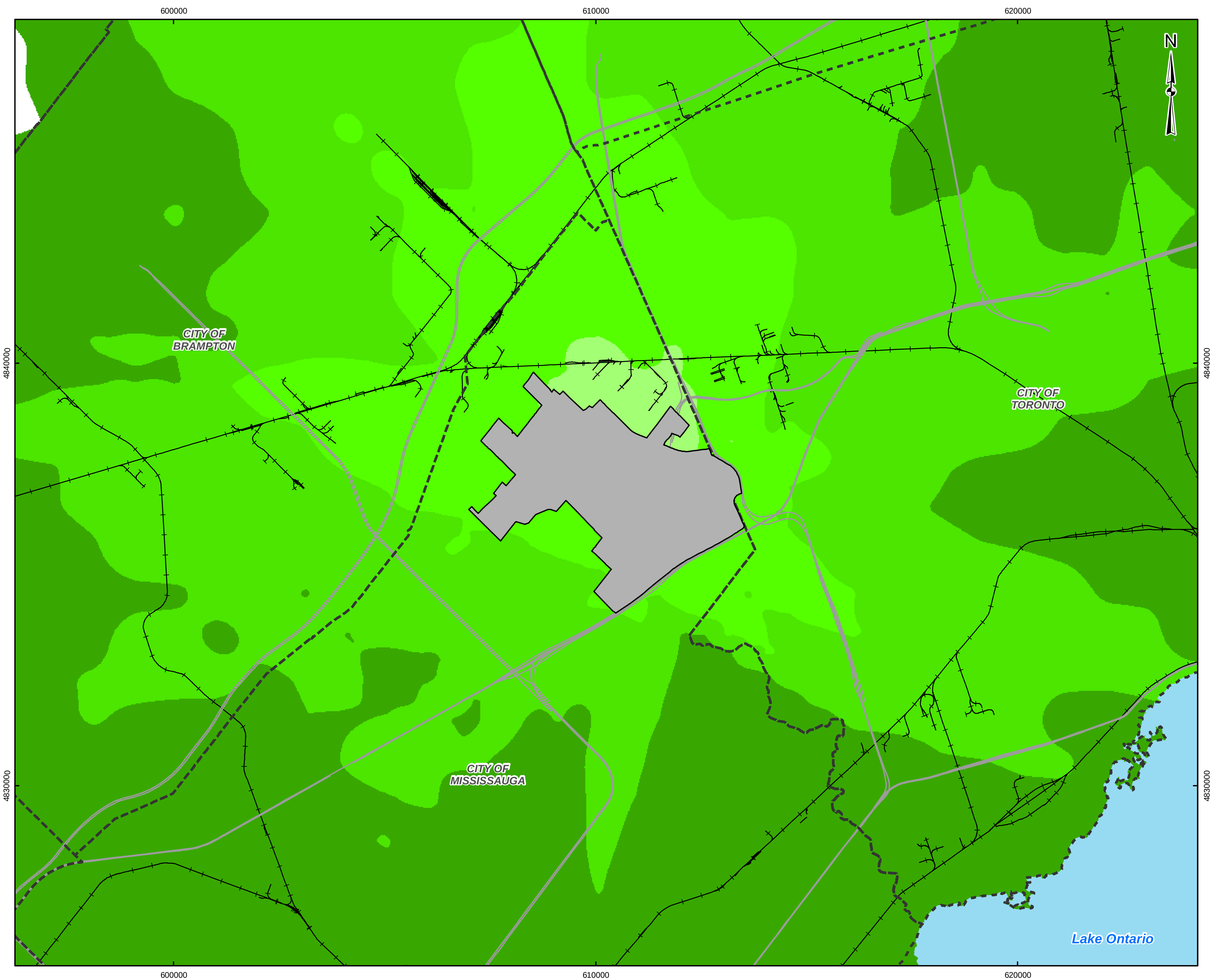

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - NO_2 µg/m^3

- < 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200

NOTES:

1-Hour NO_2 AAQC Standard = 400 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2032 1-HOUR NO_2 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C23	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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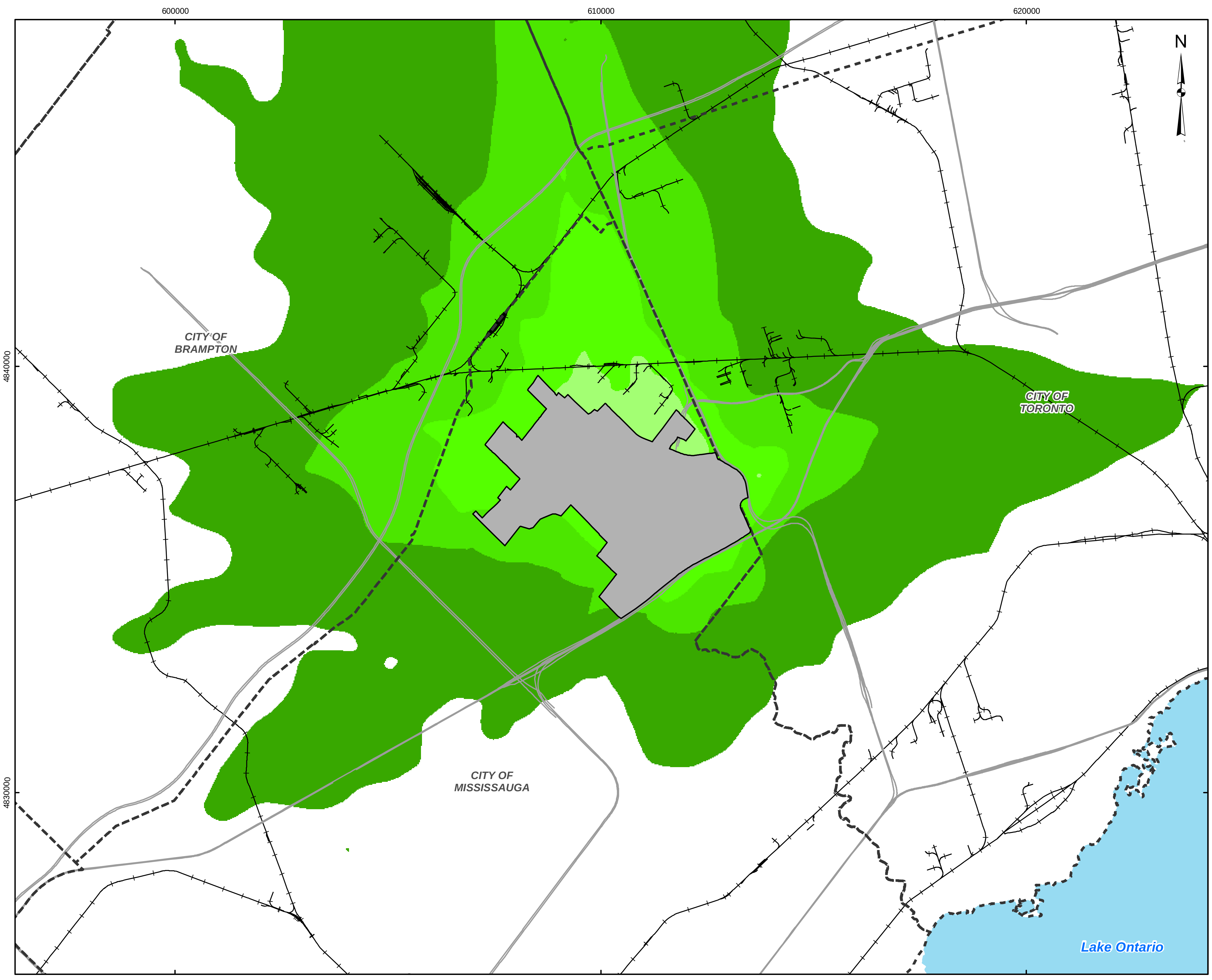

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - NO_2 µg/m^3

- < 8
- 8 - 16
- 16 - 24
- 24 - 32
- > 32

NOTES:

24-Hour NO_2 AAQC Standard = 200 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2032 24-HOUR NO_2 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C24	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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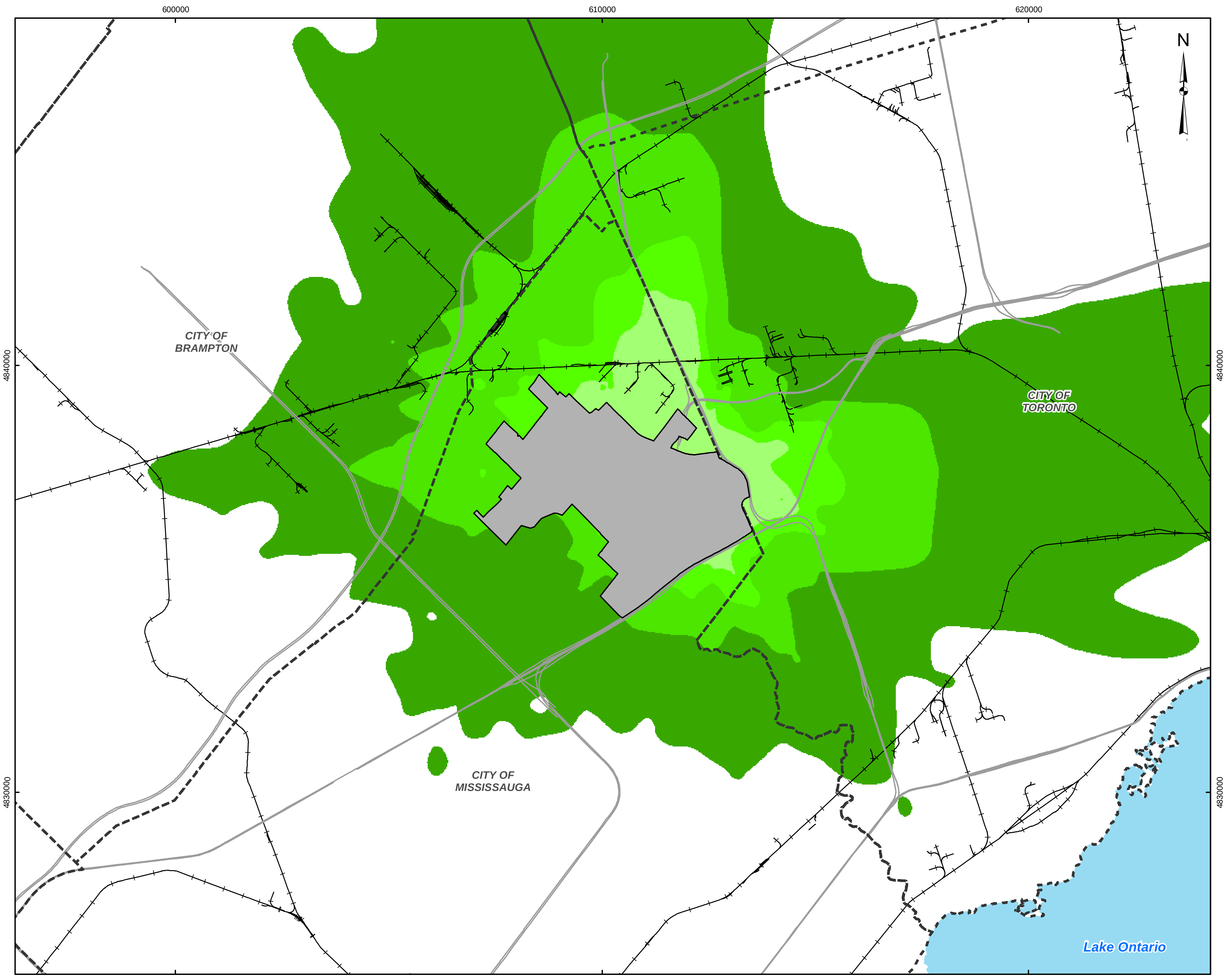

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - SO_2 µg/m^3

- < 40
- 40 - 80
- 80 - 120
- 120 - 160
- > 160

NOTES:

1-Hour SO_2 AAQC Standard = 690 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2032 1-HOUR SO_2 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C25	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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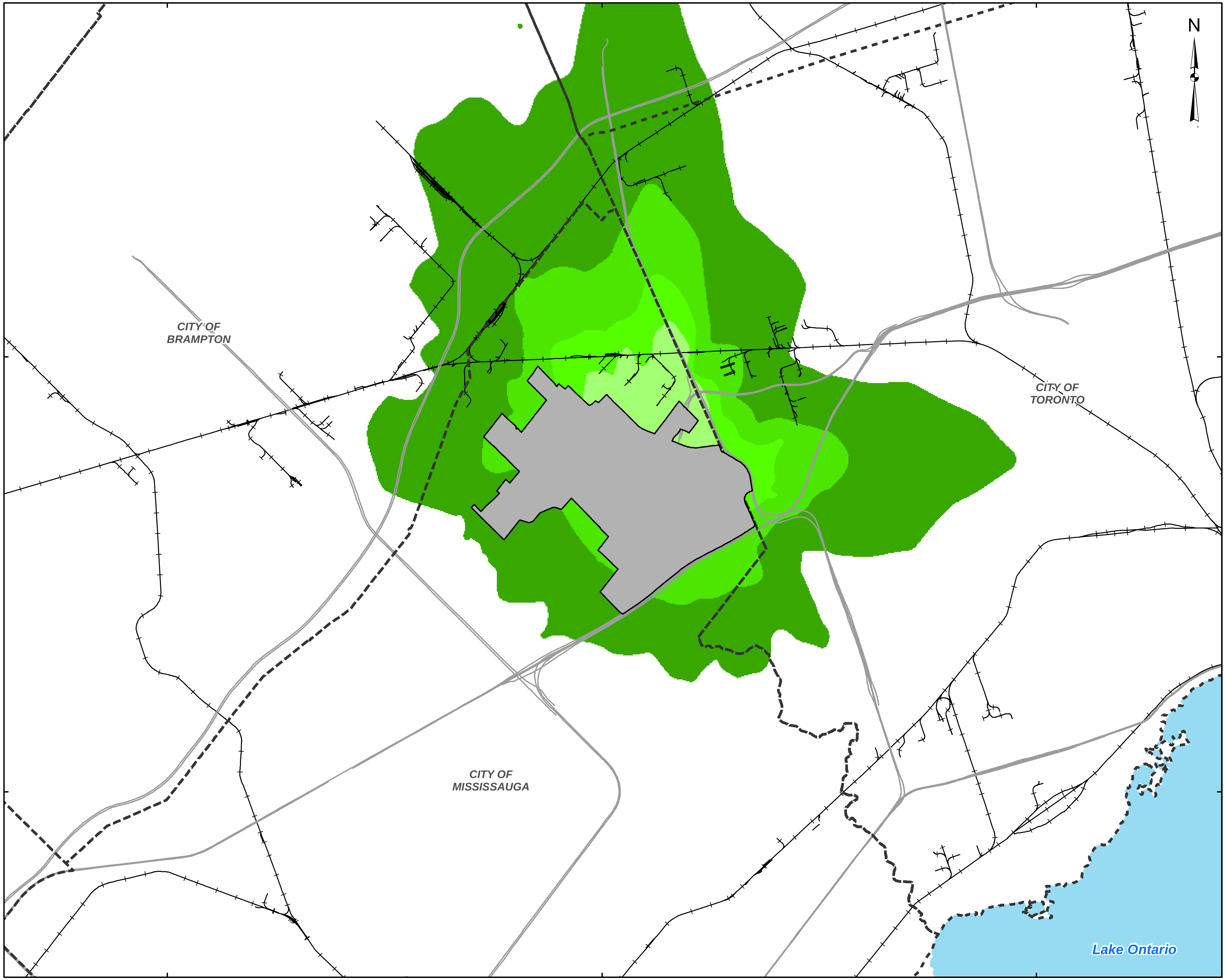

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - SO_2 µg/m^3

- < 5
- 5 - 10
- 10 - 15
- 15 - 20
- > 20

NOTES:

24-Hour SO_2 AAQC Standard = 275 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2032 24-HOUR SO_2 CONCENTRATIONS ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C26	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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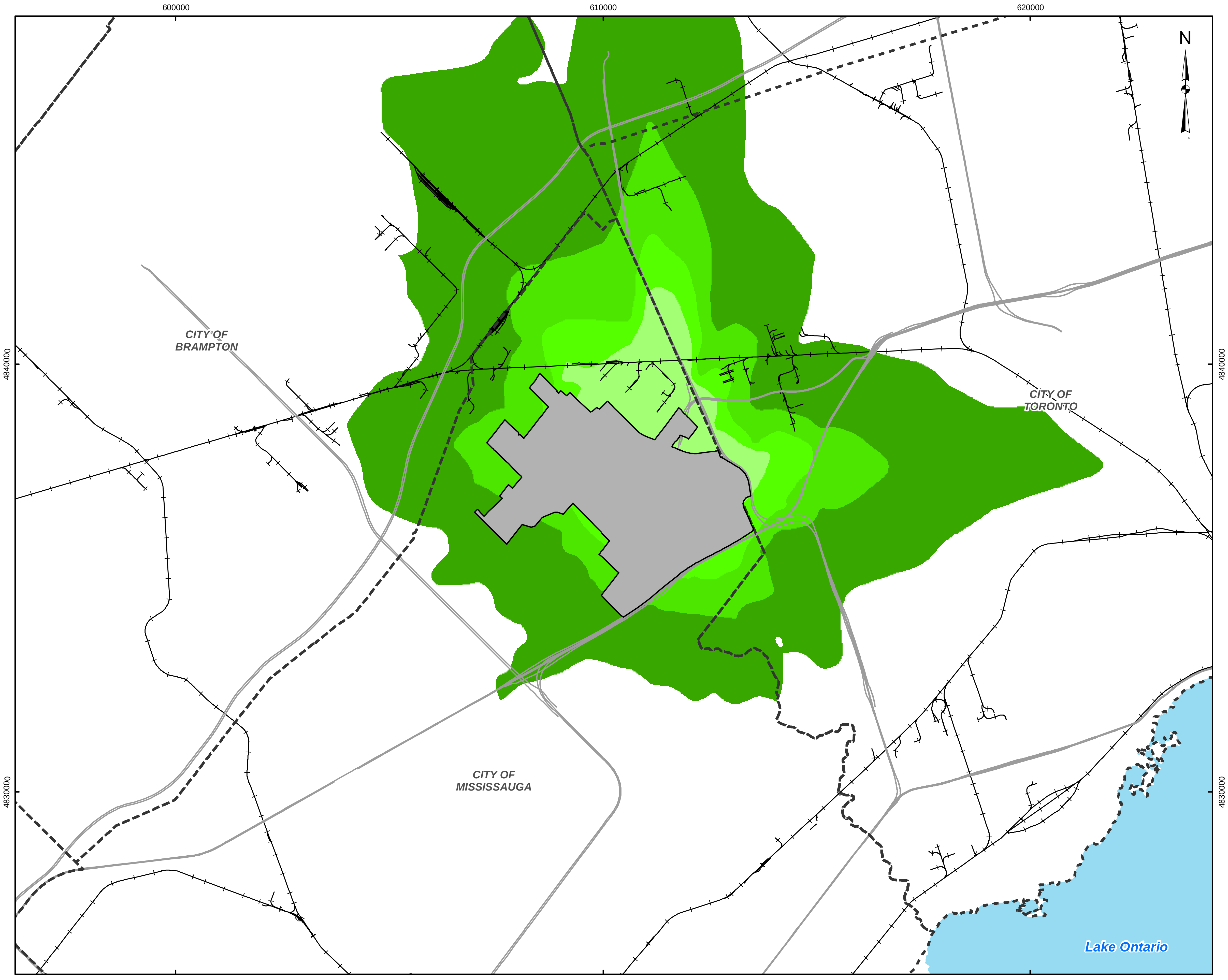

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - VOC µg/m³

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- > 40

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2023 24-HOUR VOC CONCENTRATIONS ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C27	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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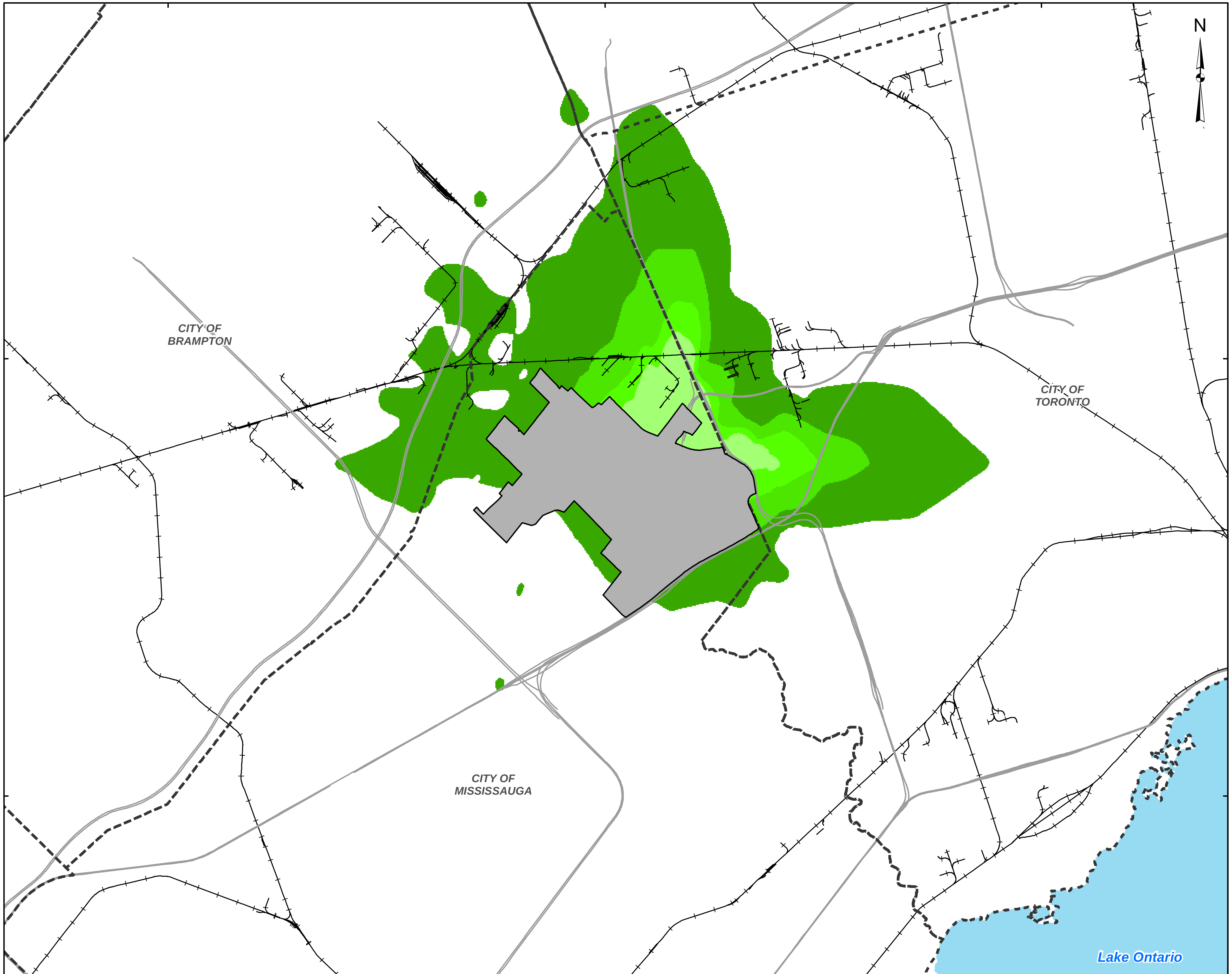

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM10 µg/m³

- < 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4

NOTES:

24-Hour PM10 AAQC Standard = 50 µg/m³

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2032 24-HOUR PM10 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C28	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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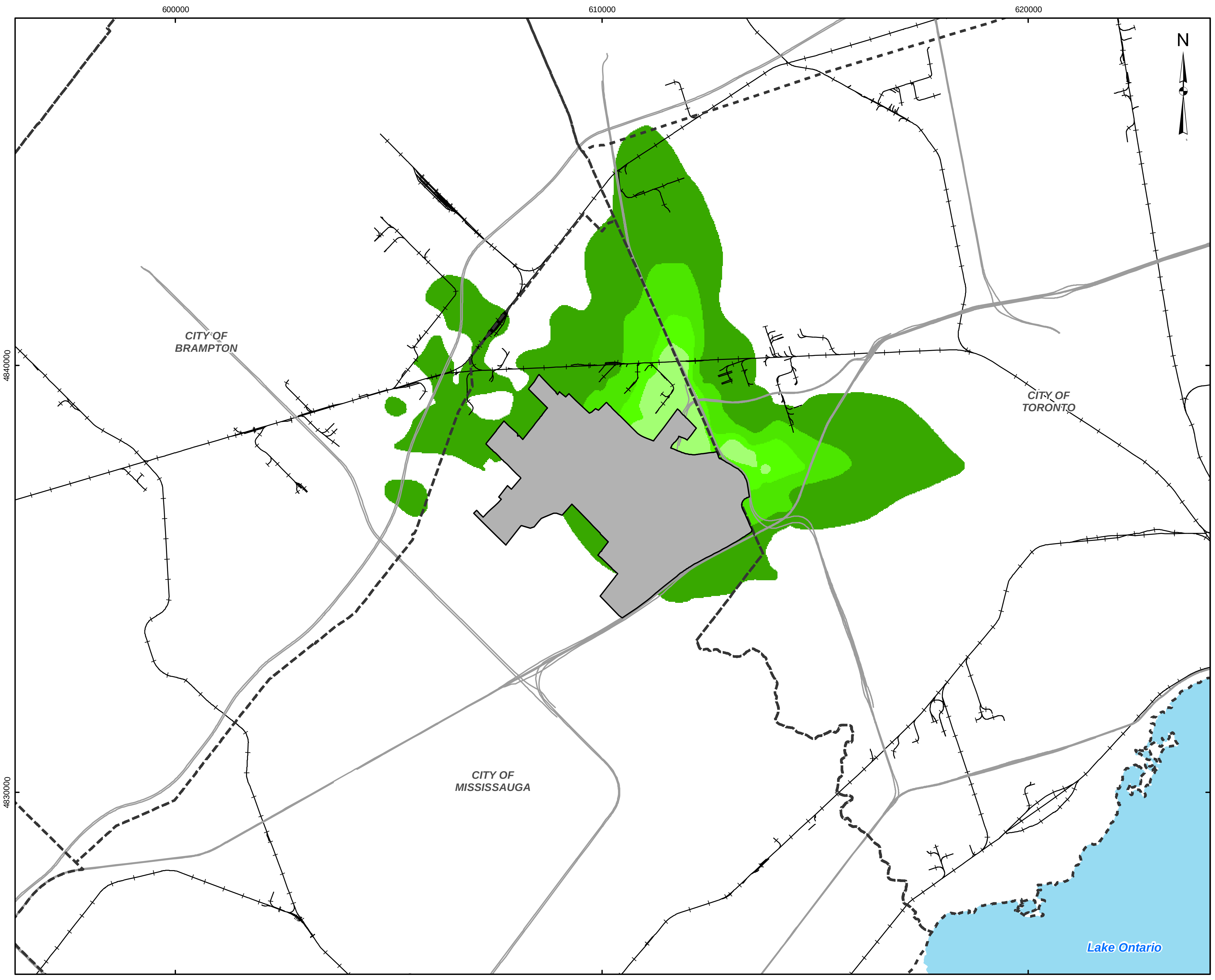

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM2.5 µg/m^3

- < 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4

NOTES:

24-Hour PM2.5 AAQC Standard = 25 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2032 24-HOUR PM2.5 CONCENTRATIONS
ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C29	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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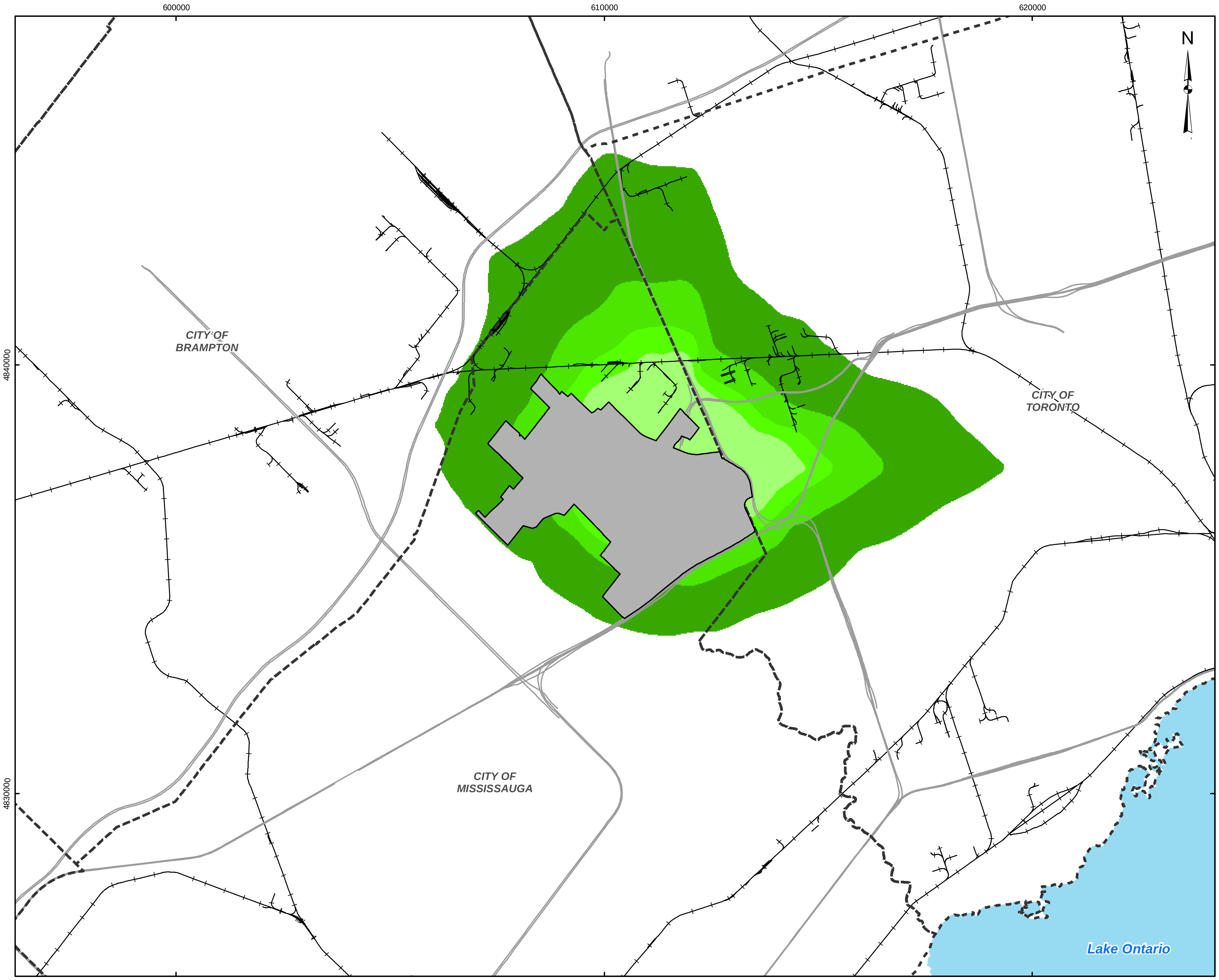

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Annual Predicted Concentration - PM2.5 µg/m^3

- < 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- > 0.2

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2032 24-HOUR PM2.5 CONCENTRATIONS ASSOCIATED WITH AIRPORT EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-10-11	FIGURE: C30	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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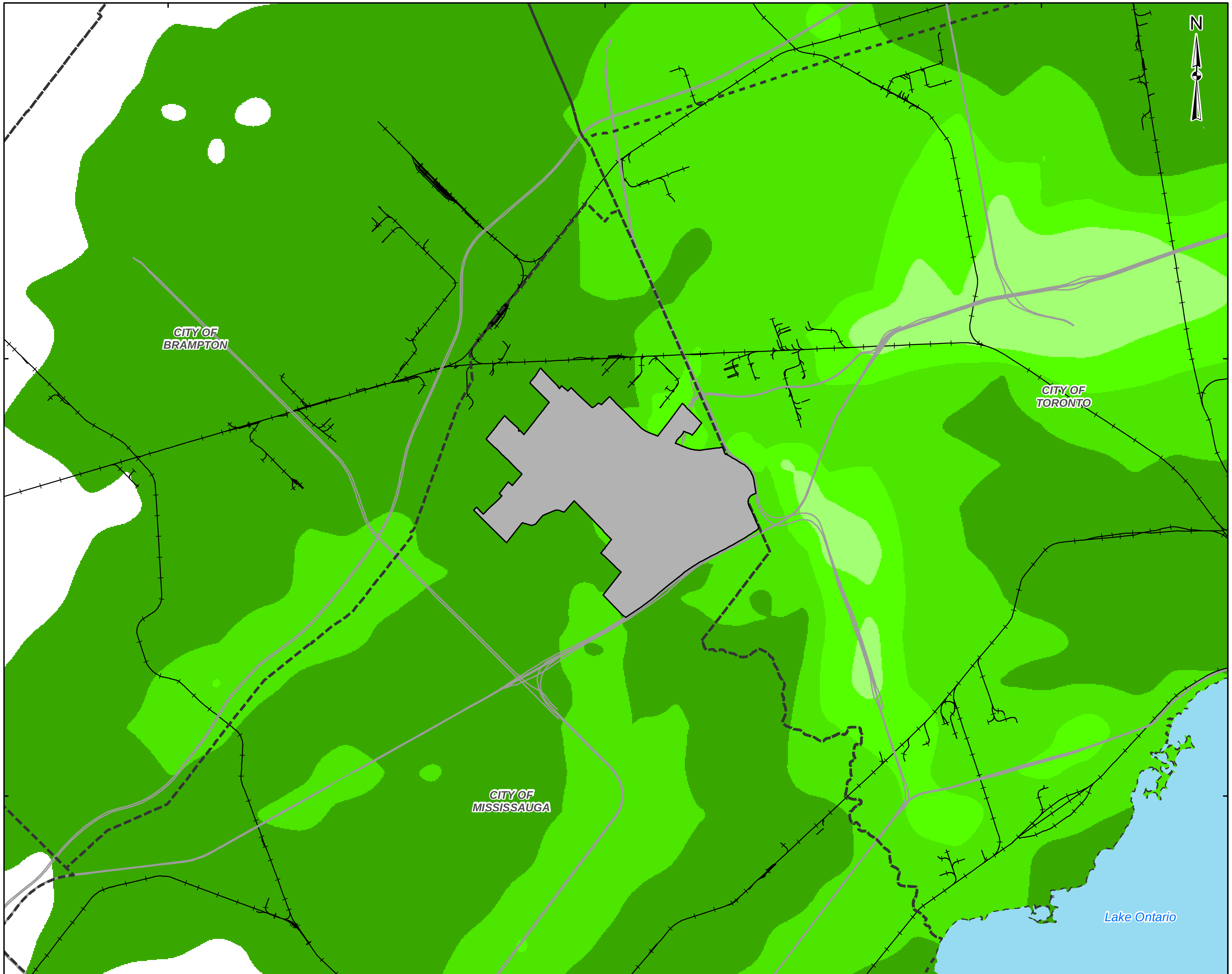
APPENDIX D

Regional Dispersion Modelling Results Figures



LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - CO µg/m³

- < 2,000
- 2,000 - 4,000
- 4,000 - 6,000
- 6,000 - 8,000
- > 8,000

NOTES:

1-Hour CO AAQC standard = 36,000 µg/m3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2011 1-HOUR CO
CONCENTRATIONS ASSOCIATED
WITH REGIONAL EMISSIONS.

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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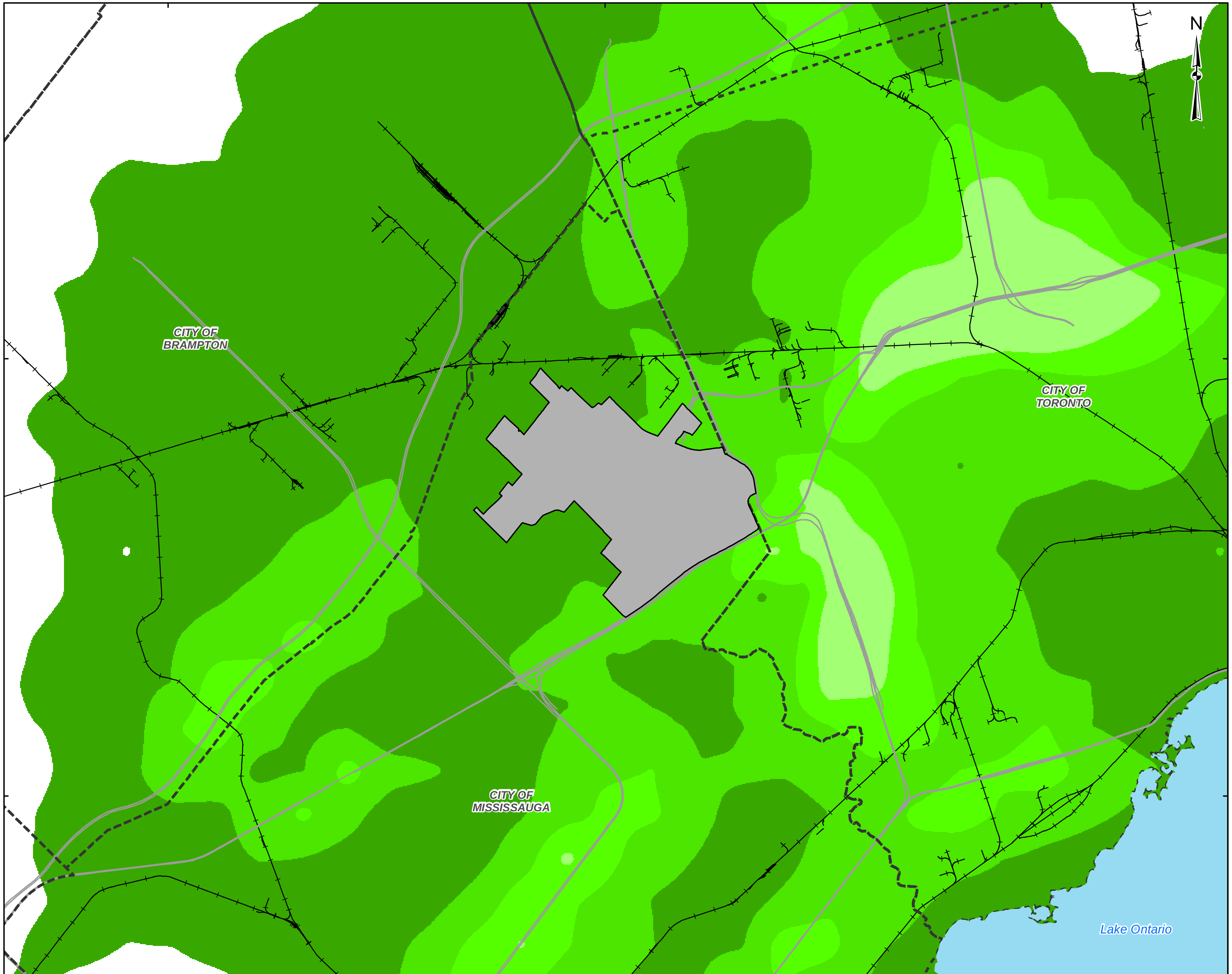

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

8-Hour Predicted Concentration - CO µg/m^3

- < 1,000
- 1,000 - 2,000
- 2,000 - 3,000
- 3,000 - 4,000
- > 4,000

NOTES:

8-Hour CO AAQC Standard = 17,700 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2011 2011 8-HOUR CO
CONCENTRATIONS ASSOCIATED WITH
REGIONAL EMISSIONS

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: D2	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

Golder Associates
Mississauga, Ontario

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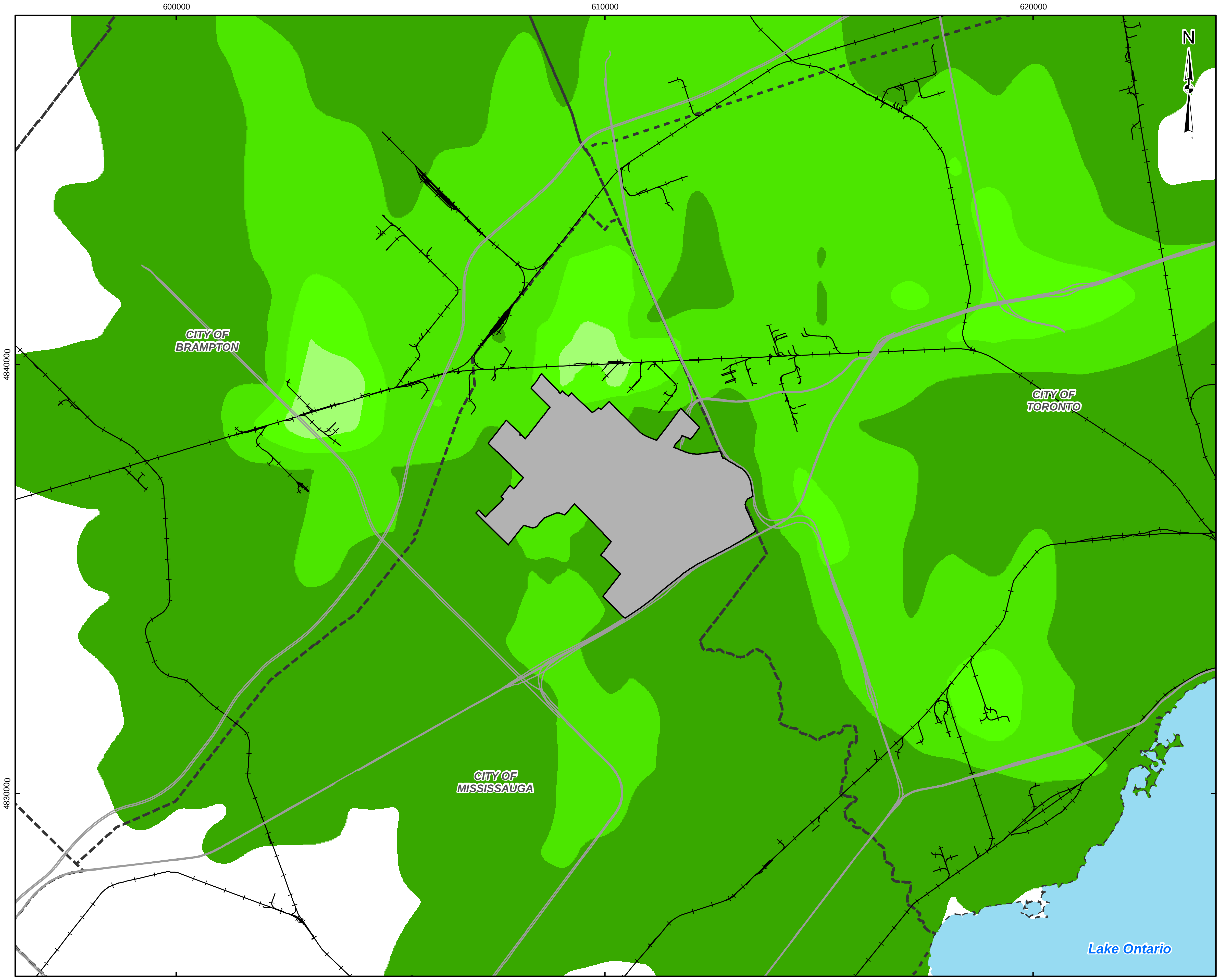

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - NO_2 µg/m^3

- < 125
- 125 - 165
- 165 - 210
- 210 - 250
- > 250

NOTES:

1-Hour NO_2 AAQC Standard = 400 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2011 1-HOUR NO_2
CONCENTRATIONS ASSOCIATED WITH
REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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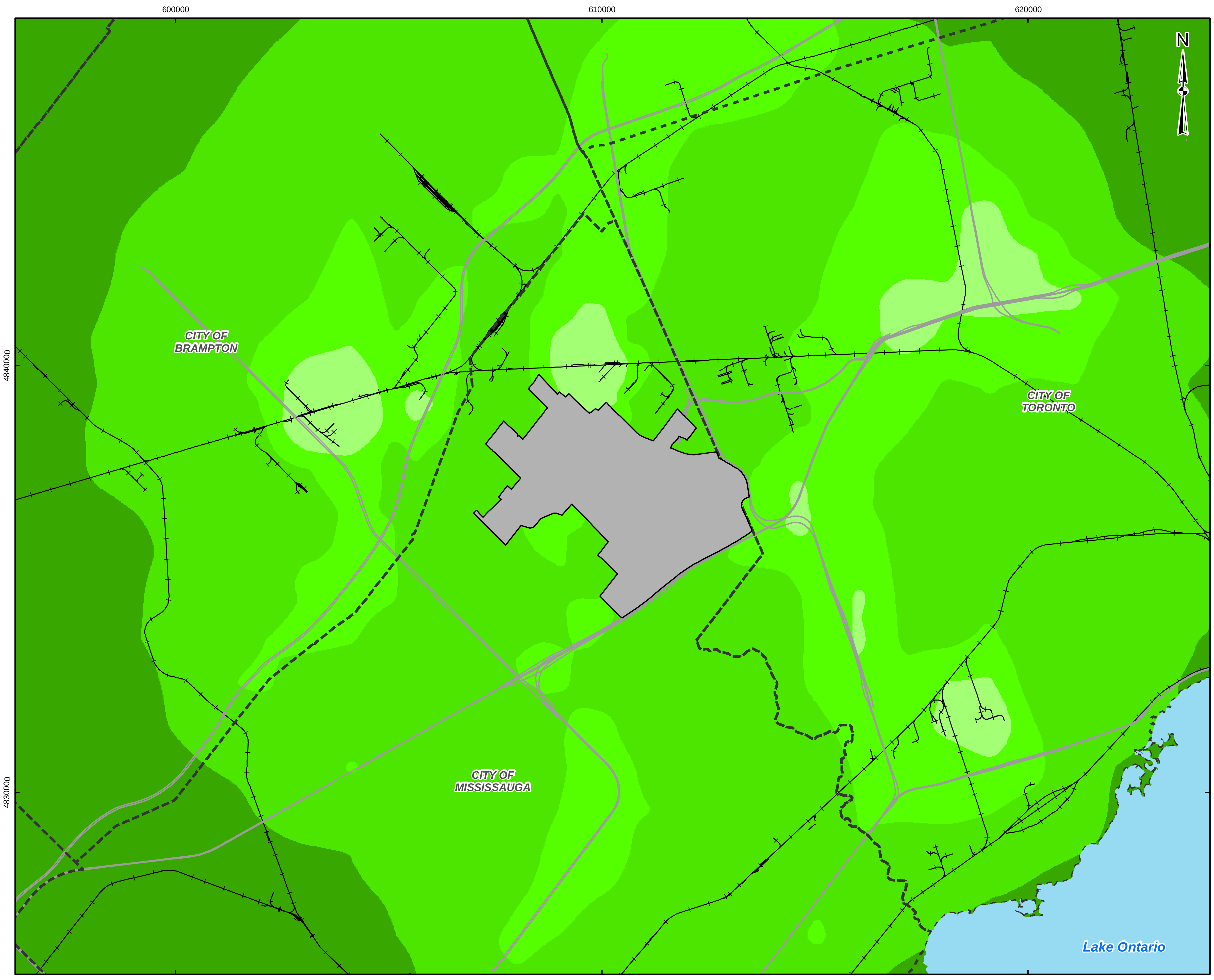

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - NO_2 μg/m^3

- < 15
- 15 - 30
- 30 - 45
- 45 - 60
- > 60

NOTES:

24-hour NO_2 AAQC Standard = 200 μg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 24-HOUR NO_2
CONCENTRATIONS ASSOCIATED WITH
REGIONAL EMISSIONS

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

Golder Associates
Mississauga, Ontario

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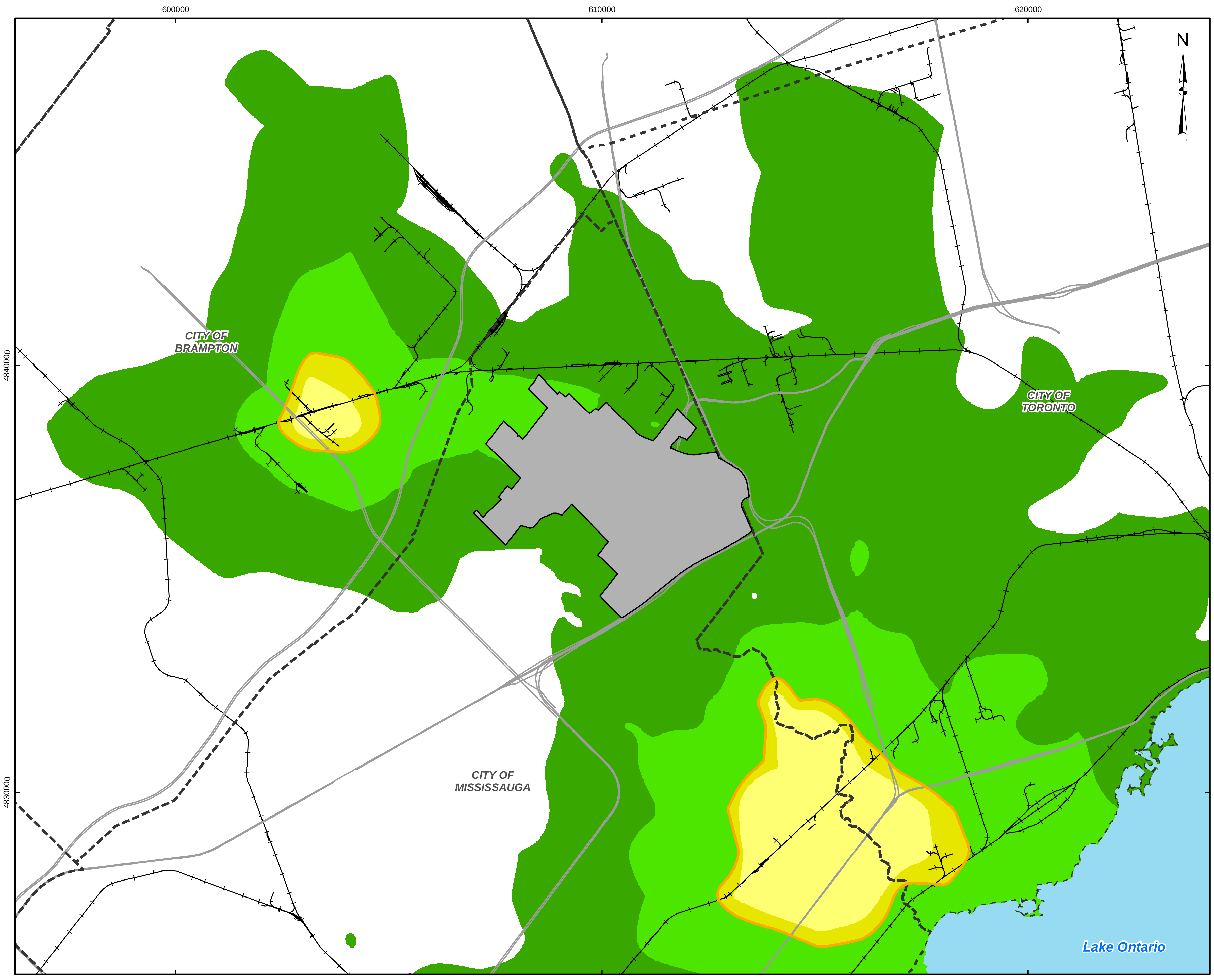

LEGEND

- Highway
- Railways
- 1-hour AAQC Standard (690 µg/m³)
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - SO_2 µg/m³

- < 200
- 200 - 400
- 400 - 690
- 690 - 800
- \> 800

NOTES:

1-Hour SO_2 AAQC Standard = 690 µg/m³

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2011 1-HOUR SO_2
CONCENTRATIONS ASSOCIATED WITH
REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

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REVIEW				

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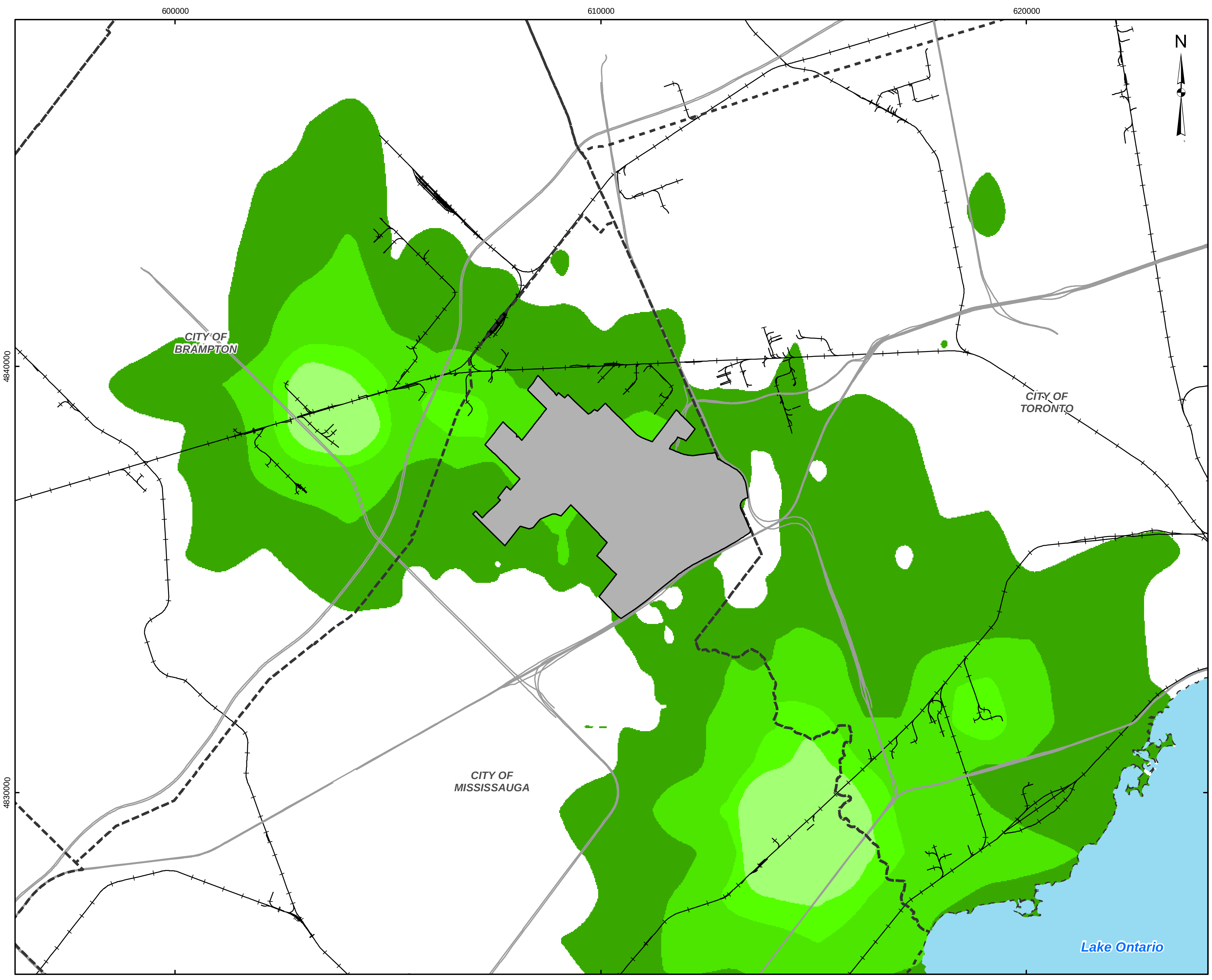

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - SO_2 µg/m^3

- < 25
- 25 - 50
- 50 - 100
- 100 - 150
- > 150

NOTES:

24-Hour SO_2 AAQC Standard = 275 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 24-HOUR SO_2
CONCENTRATIONS ASSOCIATED WITH
REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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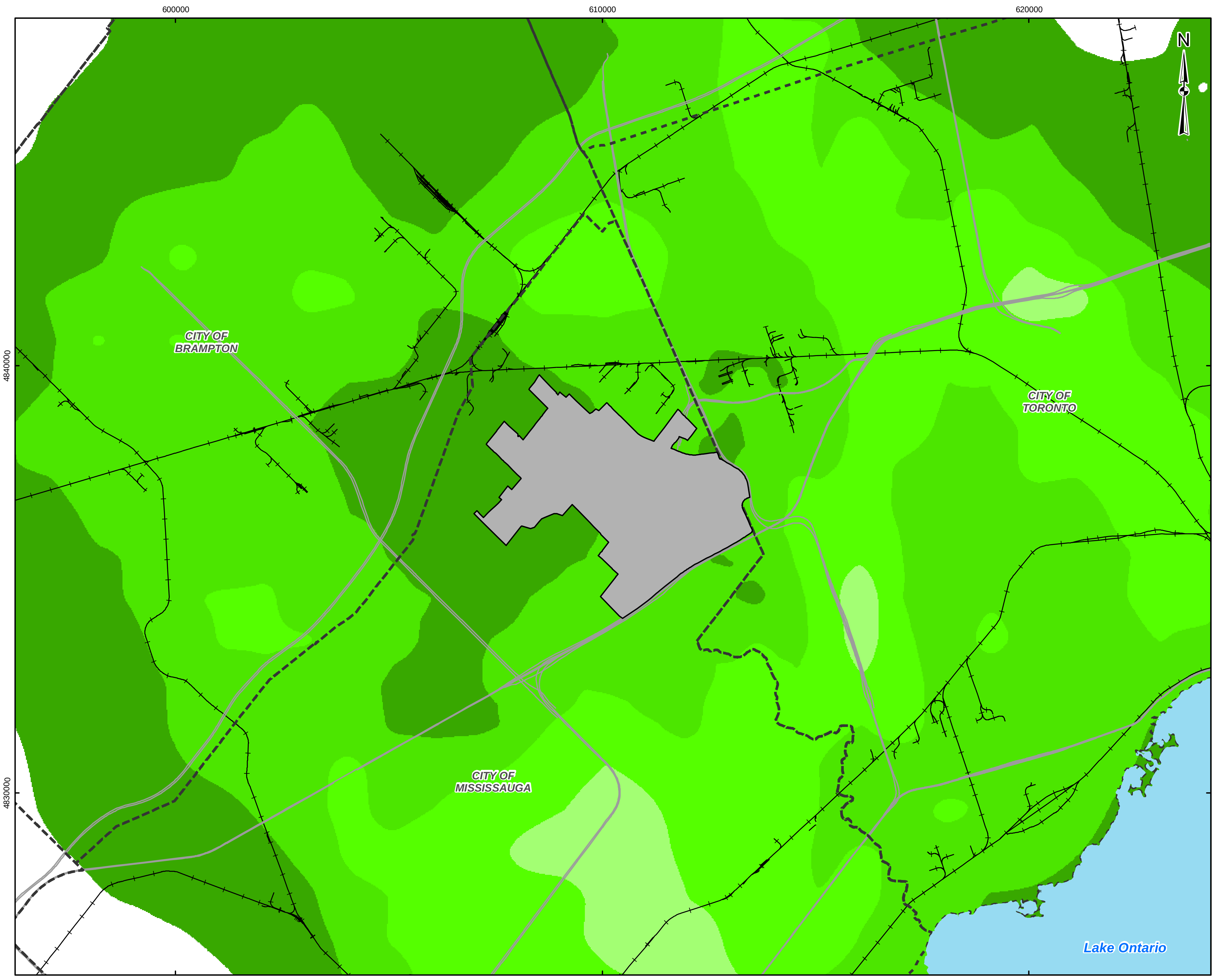

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - VOC µg/m^3

- < 70
- 70 - 140
- 140 - 210
- 210 - 280
- > 280

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 24-HOUR VOC
CONCENTRATIONS ASSOCIATED
REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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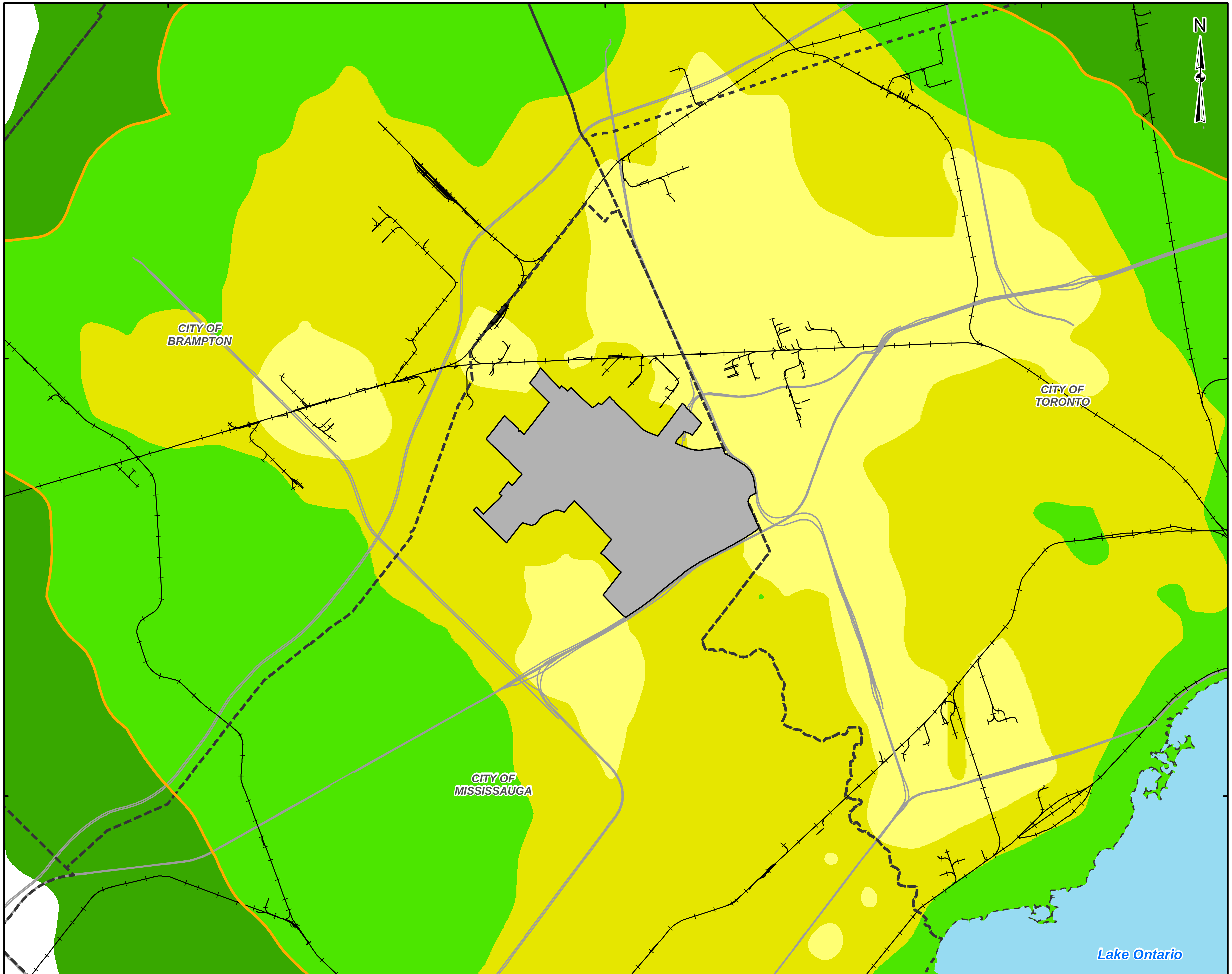

LEGEND

- Highway
- Railways
- 24-hour AAQC Standard (50 µg/m^3)
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM10 µg/m^3

- < 30
- 30 - 50
- 50 - 90
- 90 - 120
- > 120

NOTES:

24-hour PM10 AAQC Standard = 50 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 24-HOUR PM10
CONCENTRATIONS ASSOCIATED WITH
REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
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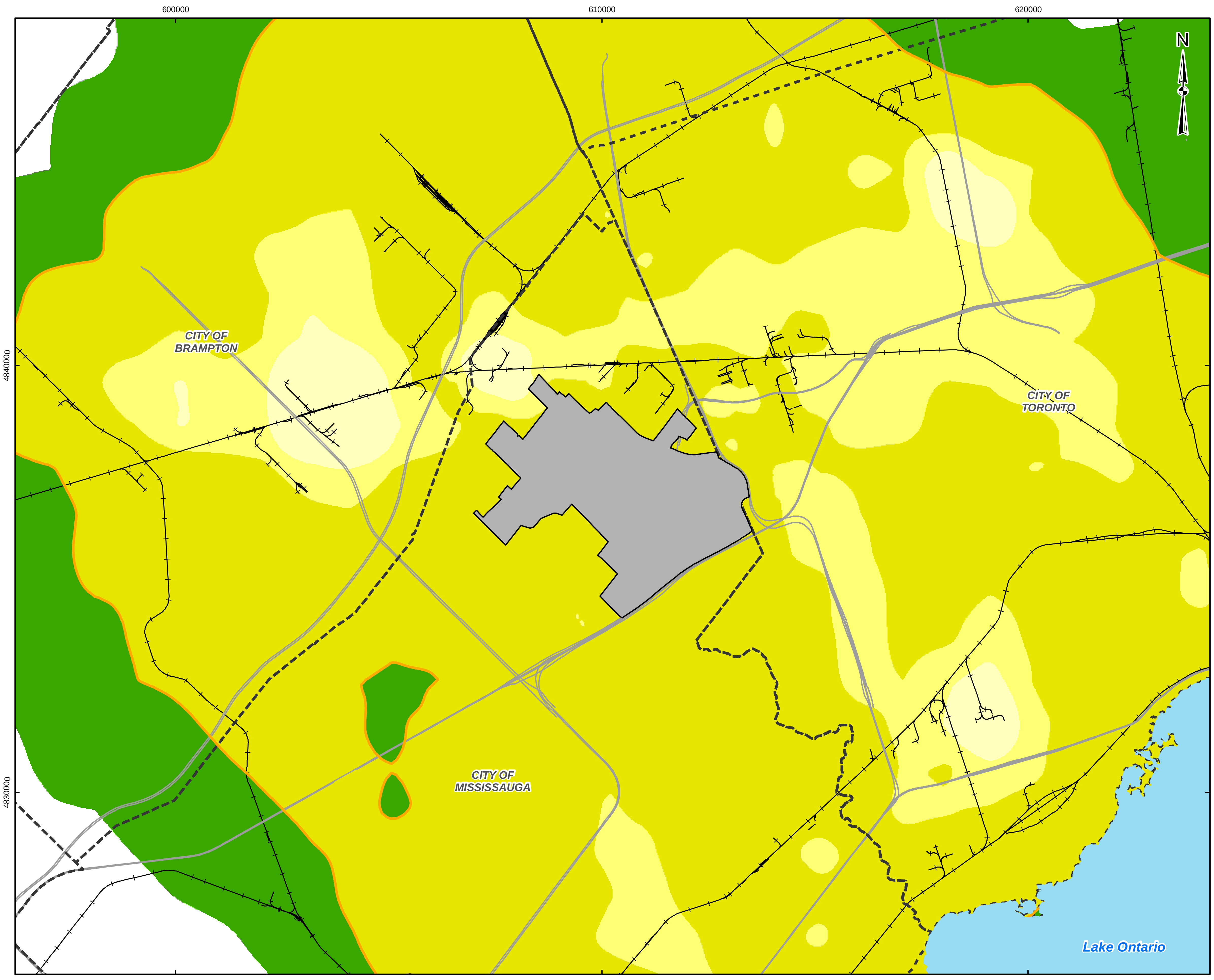

LEGEND

- Highway
- Railways
- 24-hour AAQC Standard (25 µg/m³)
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM2.5 µg/m³

- < 15
- 15 - 25
- 25 - 45
- 45 - 60
- > 60

NOTES:

24-hour PM2.5 AAQC Standard = 25 µg/m³

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2011 24-HOUR PM2.5
CONCENTRATIONS ASSOCIATED WITH
REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: D9	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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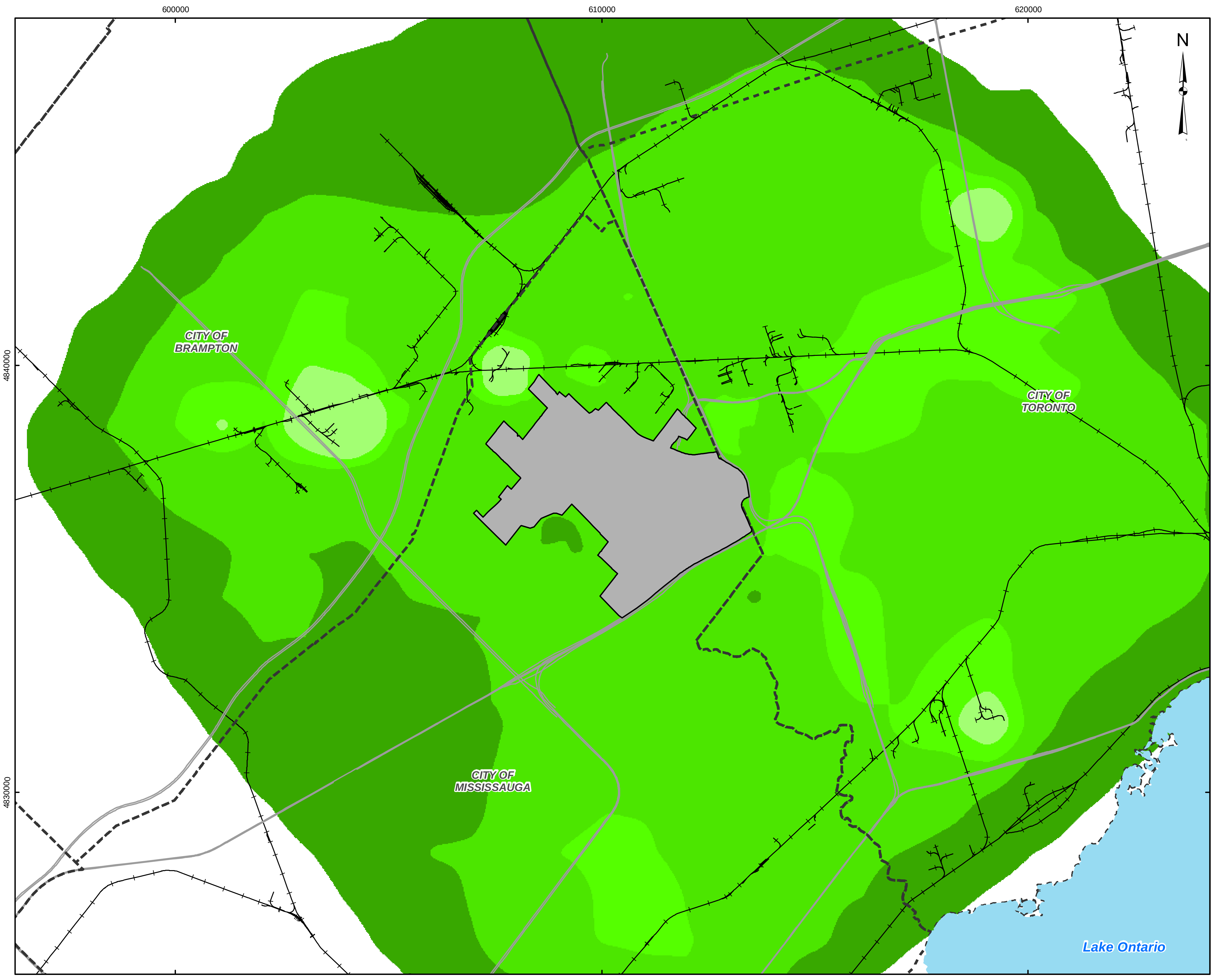

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

Annual Predicted Concentration - PM 2.5 µg/m³

- < 4
- 4 - 8
- 8 - 12
- 12 - 16
- > 16

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 ANNUAL PM2.5
CONCENTRATIONS ASSOCIATED WITH
REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: D10	
GIS	ME/PR	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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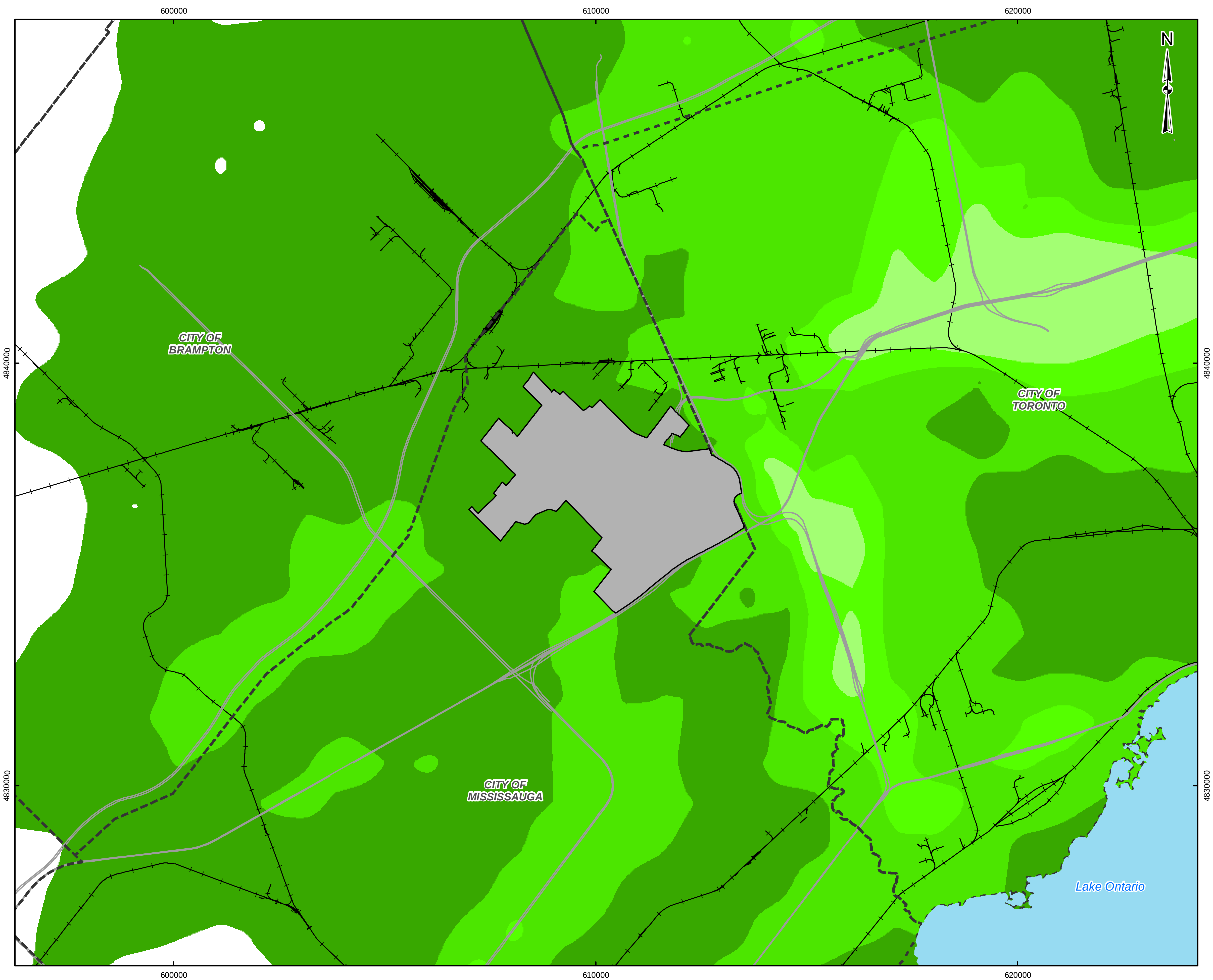

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - CO µg/m³

- < 2,000
- 2,000 - 4,000
- 4,000 - 6,000
- 6,000 - 8,000
- > 8,000

NOTES:

1-Hour CO AAQC standard = 36,000 µg/m3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
FUTURE PREDICTED 1-HOUR CO CONCENTRATIONS
ASSOCIATED WITH REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-27	FIGURE: D11	
GIS	ME	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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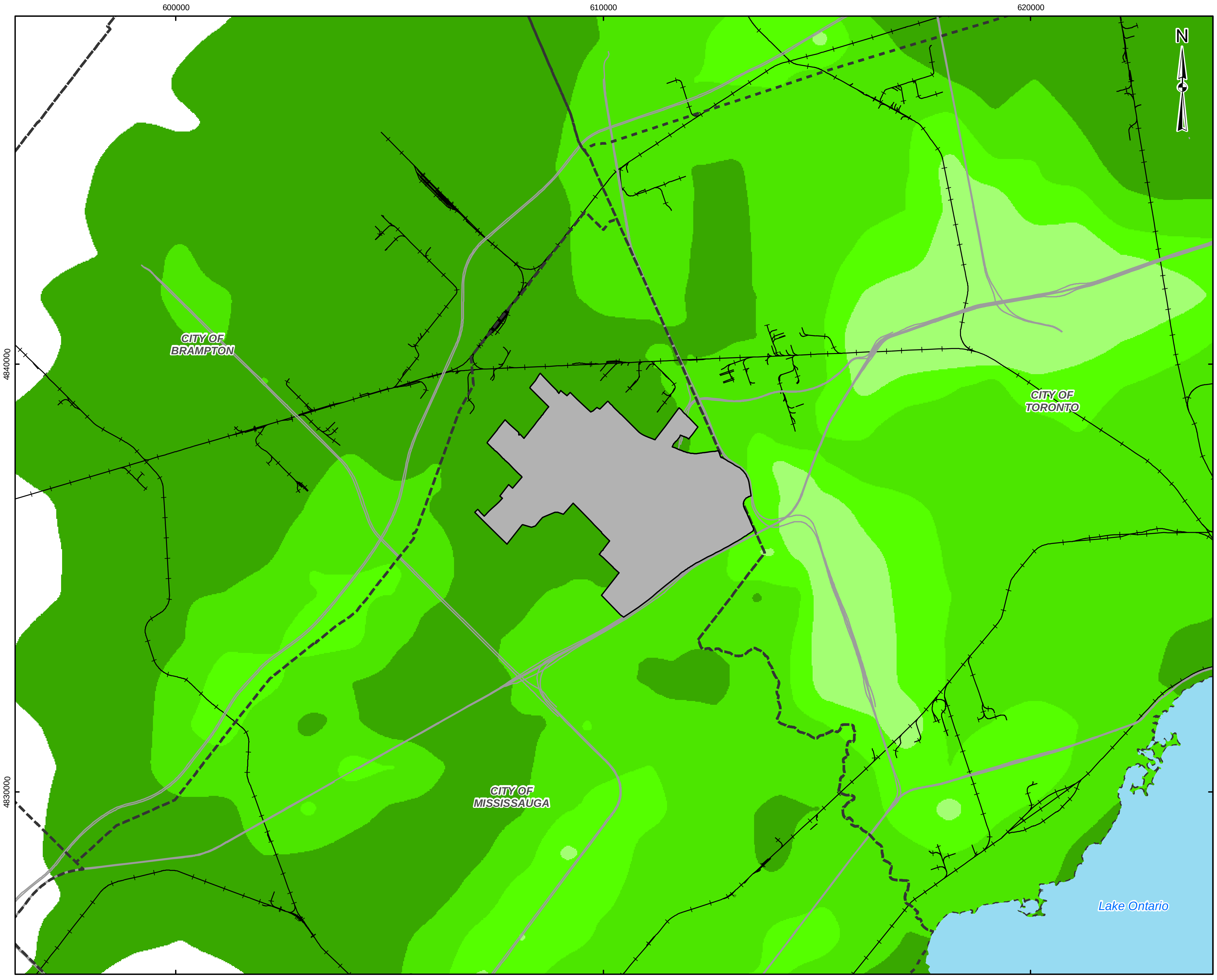

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

8-Hour Predicted Concentration - CO µg/m³

- < 1,000
- 1,000 - 2,000
- 2,000 - 3,000
- 3,000 - 4,000
- > 4,000

NOTES:

8-Hour CO AAQC Standard = 17,700 µg/m³

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
FUTURE PREDICTED 8-HOUR CO CONCENTRATIONS
ASSOCIATED WITH REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-27	FIGURE: D12	
GIS	ME	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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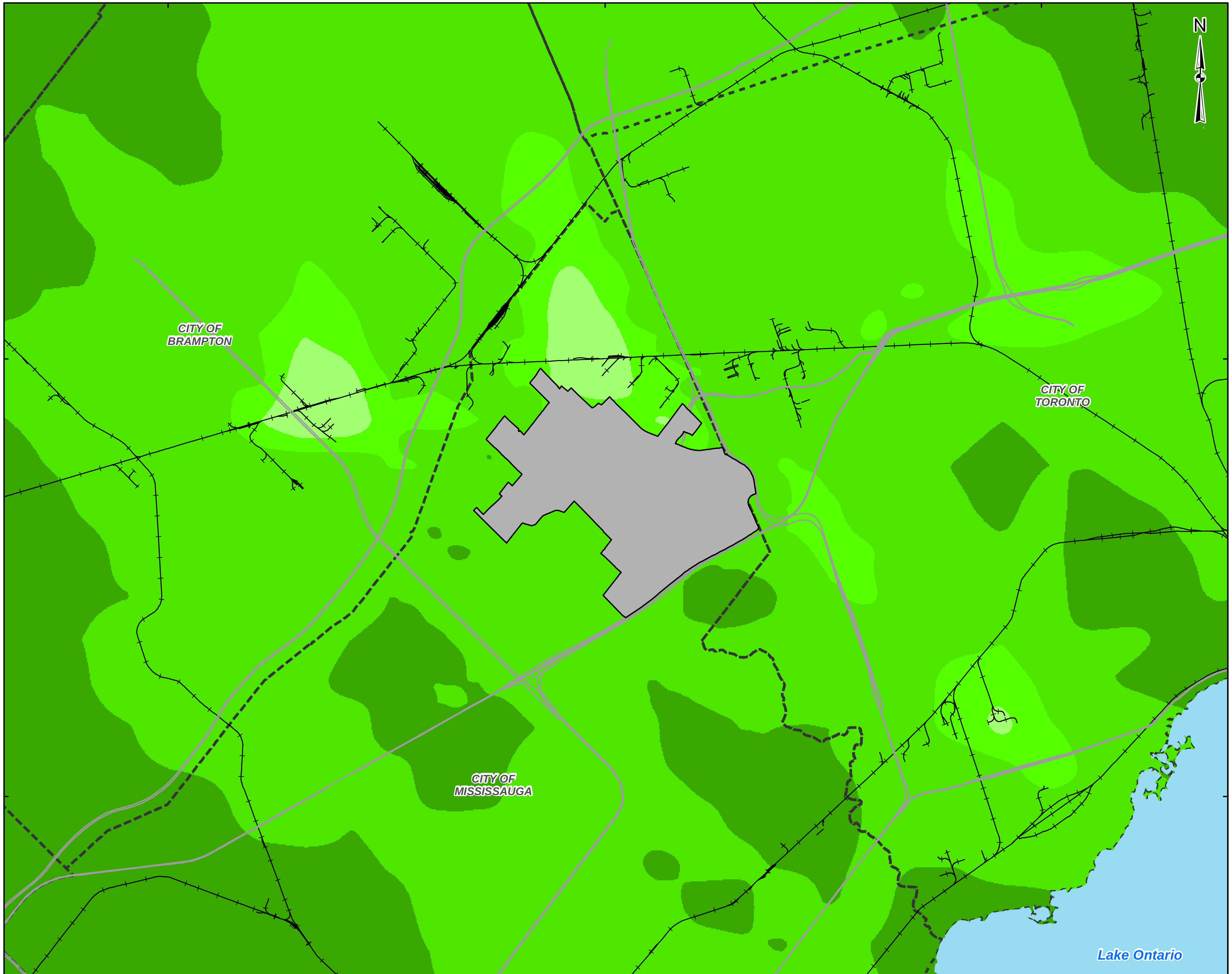

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - NO_2 µg/m^3

- < 125
- 125 - 165
- 165 - 210
- 210 - 250
- > 250

NOTES:

1-Hour NO_2 AAQC Standard = 400 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

FUTURE PREDICTED NO_2 CONCENTRATIONS
ASSOCIATED WITH REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-27	FIGURE: D13	
GIS	ME	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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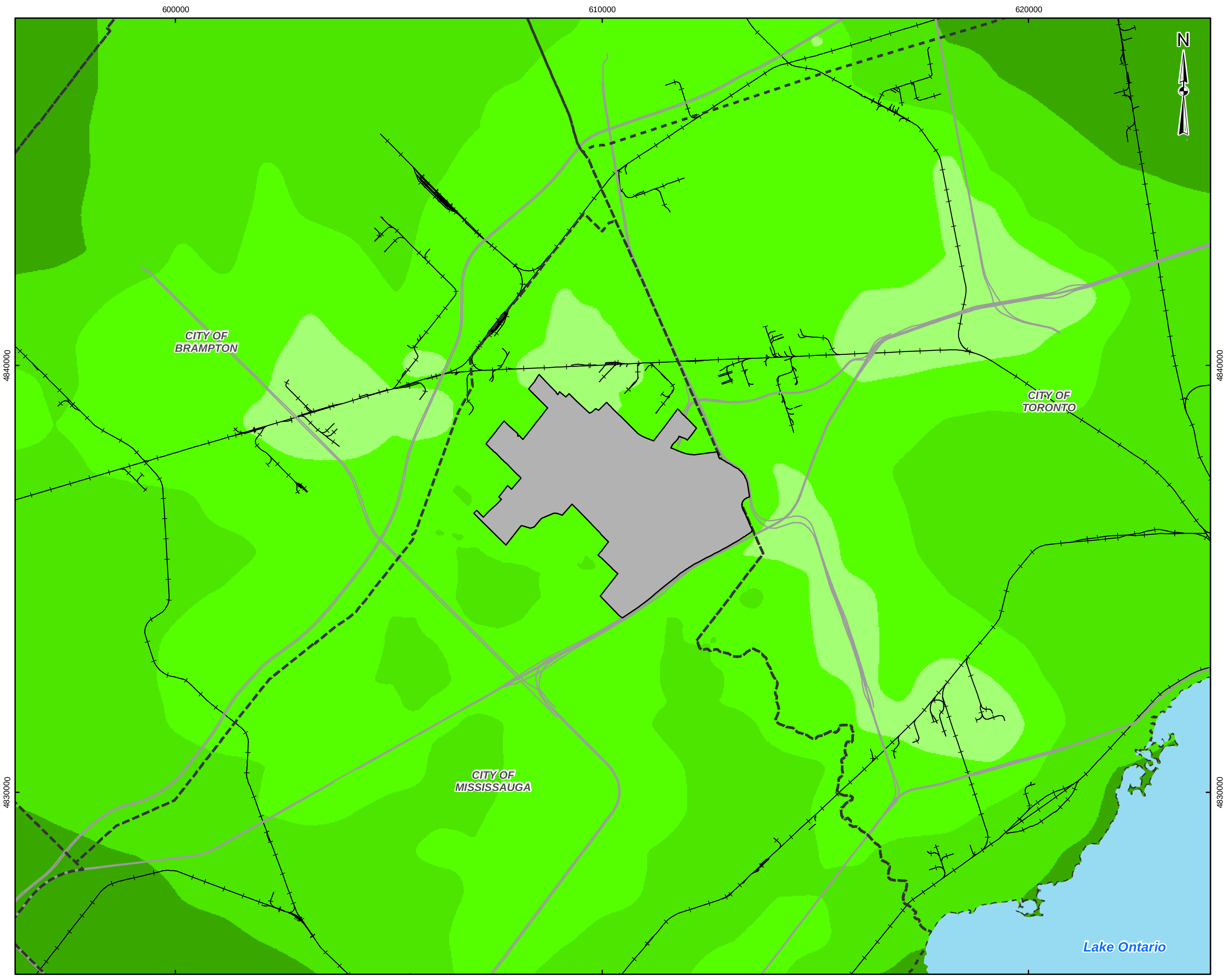

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - NO_2 µg/m^3

- < 15
- 15 - 30
- 30 - 45
- 45 - 60
- > 60

NOTES:

24-hour NO_2 AAQC Standard = 200 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

FUTURE PREDICTED 24-HOUR NO_2 CONCENTRATIONS ASSOCIATED WITH REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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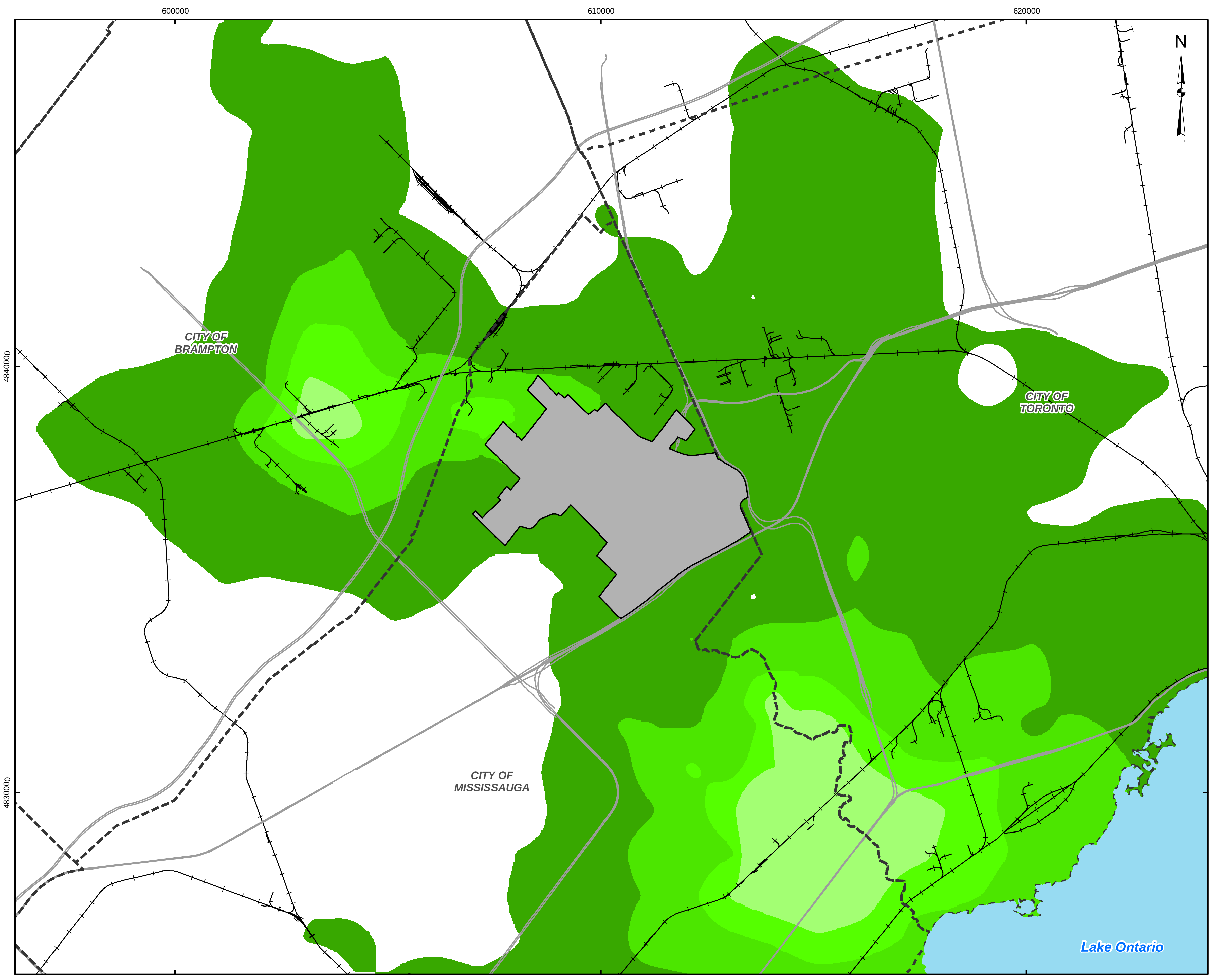

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - SO_2 µg/m^3

- < 200
- 200 - 400
- 400 - 600
- 600 - 800
- > 800

NOTES:

1-Hour SO_2 AAQC Standard = 690 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
FUTURE PREDICTED 1-HOUR SO_2 CONCENTRATIONS
ASSOCIATED WITH REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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CHECK	AB	2015-01-23		
REVIEW				

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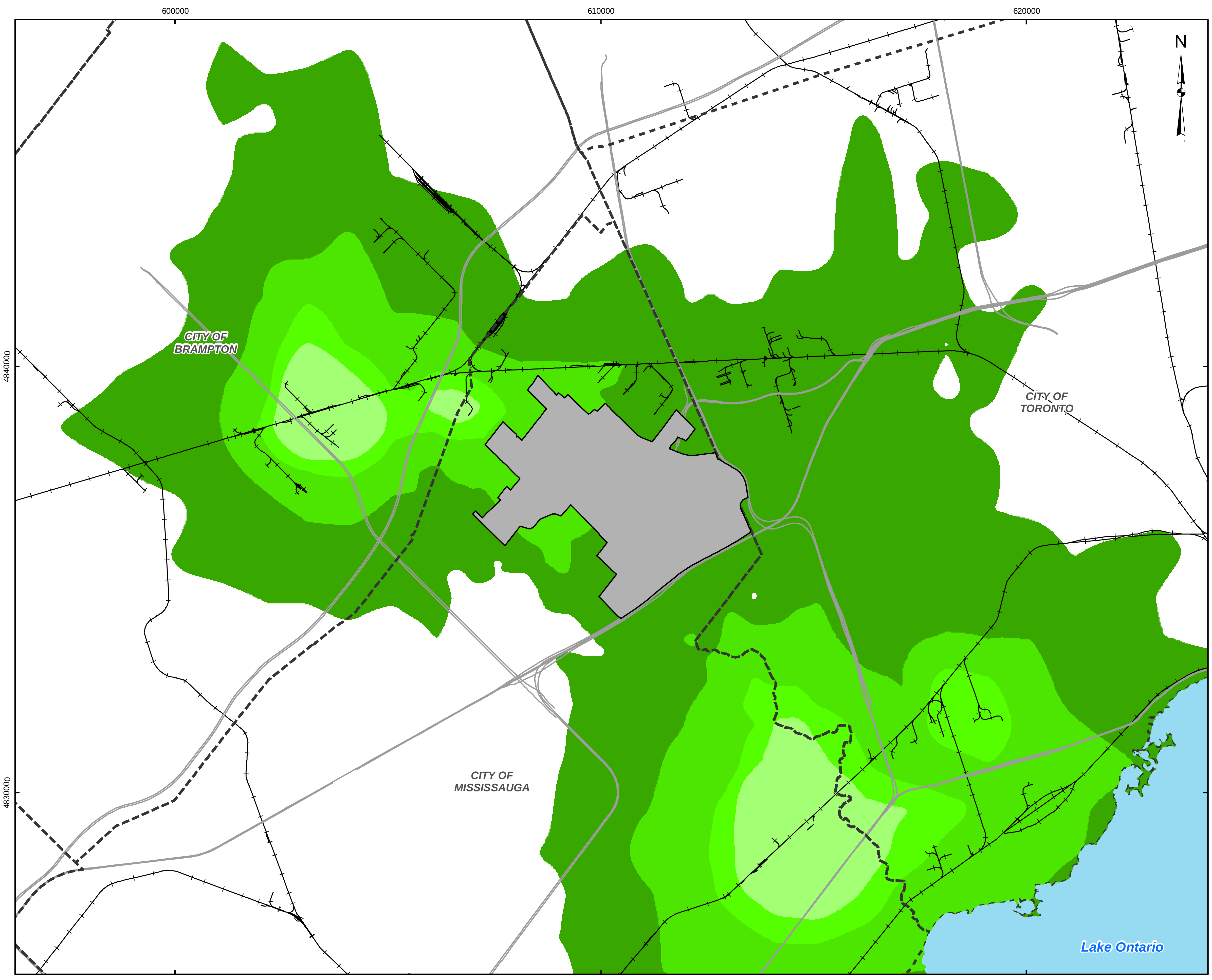

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - SO_2 µg/m^3

- < 25
- 25 - 50
- 50 - 100
- 100 - 150
- > 150

NOTES:

24-Hour SO_2 AAQC Standard = 275 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

FUTURE PREDICTED 24-HOUR SO_2 CONCENTRATIONS
ASSOCIATED REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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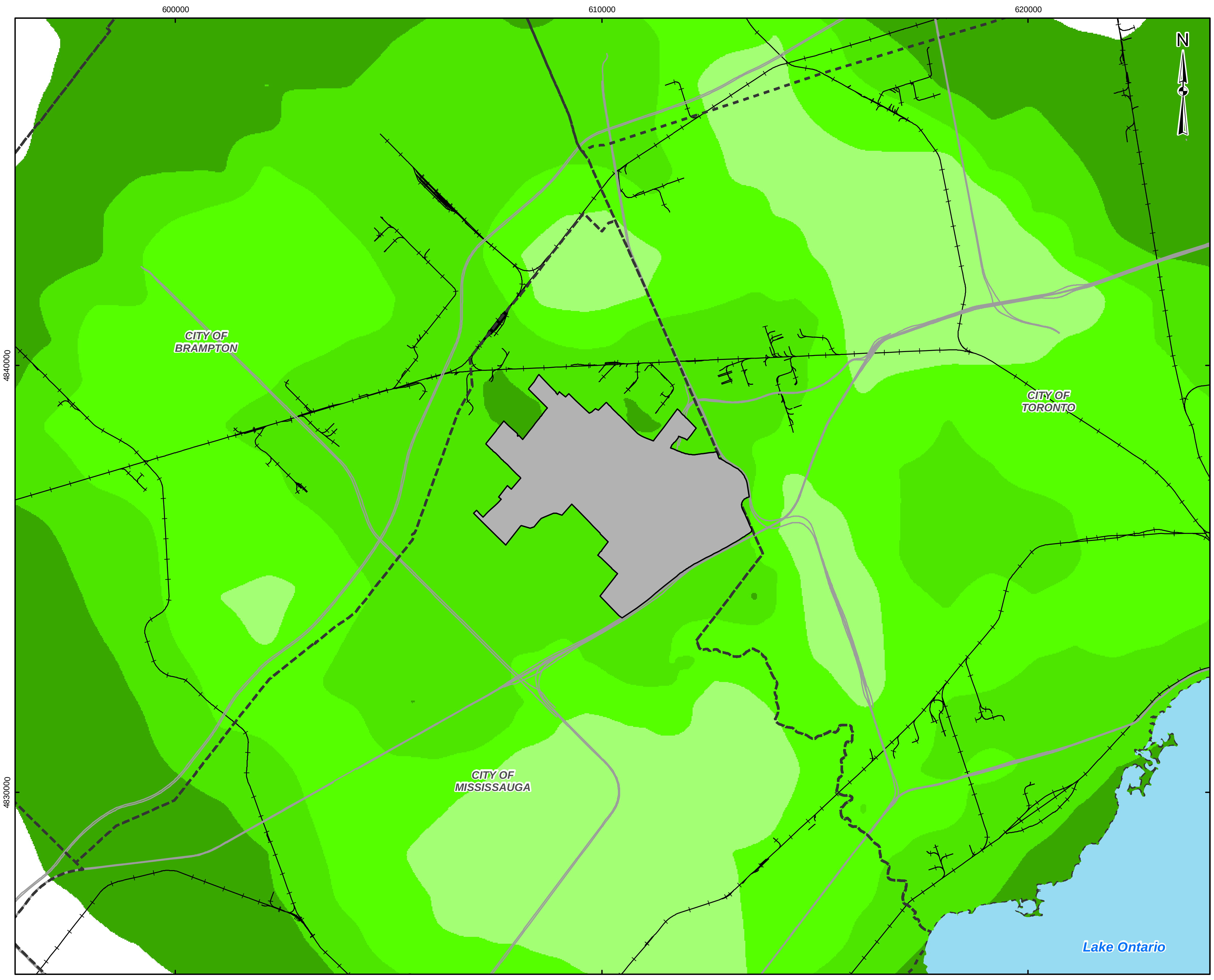

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - VOC µg/m^3

- < 70
- 70 - 140
- 140 - 210
- 210 - 280
- > 280

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

FUTURE PREDICTED 24-HOUR VOC CONCENTRATIONS
ASSOCIATED WITH REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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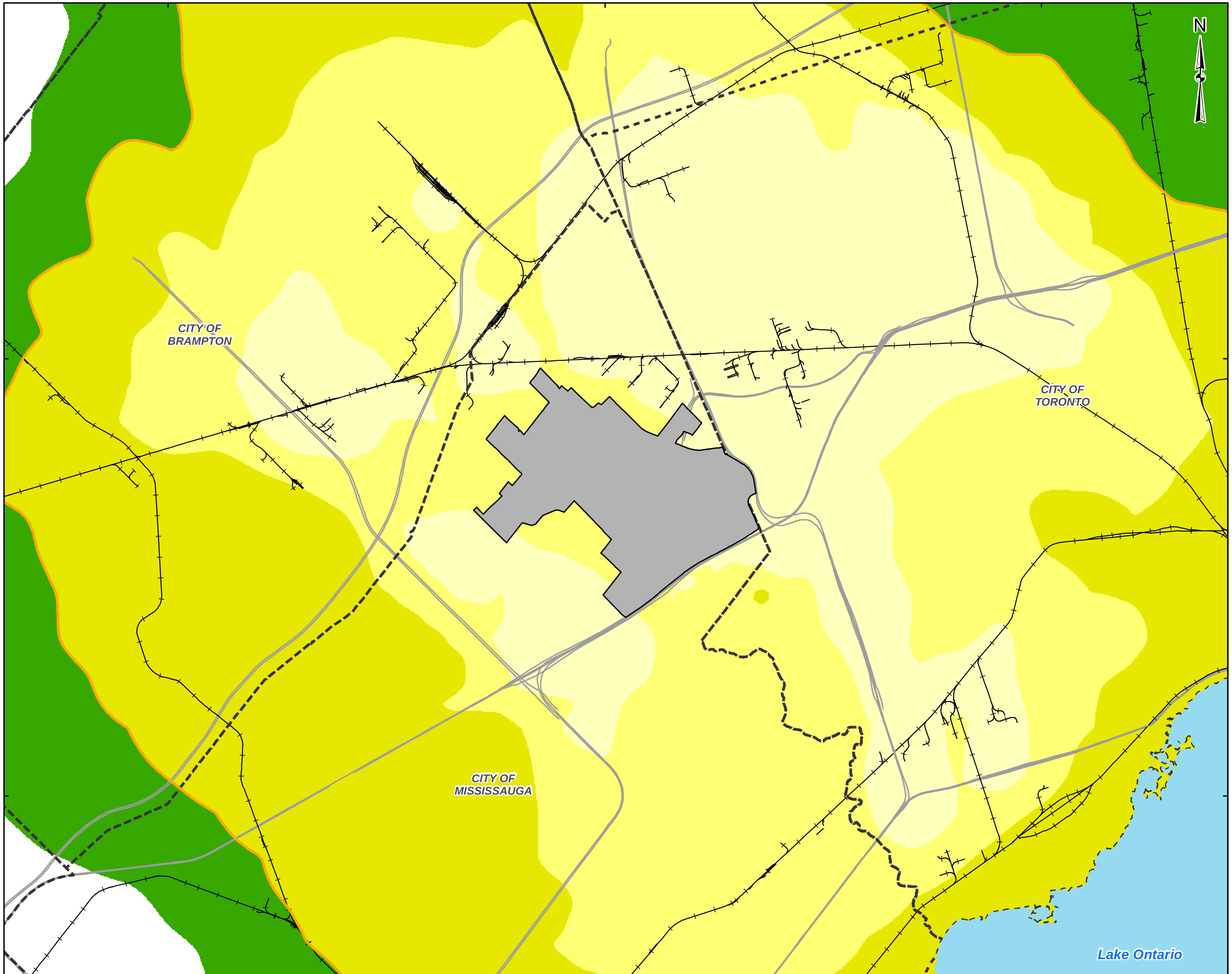

LEGEND

- Highway
- Railways
- 24-hour AAQC Standard (50 µg/m³)
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM10 µg/m³

- < 30
- 30 - 50
- 50 - 90
- 90 - 120
- > 120

NOTES:

24-hour PM10 AAQC Standard = 50 µg/m³

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
FUTURE PREDICTED 24-HOUR PM10 CONCENTRATIONS
ASSOCIATED WITH REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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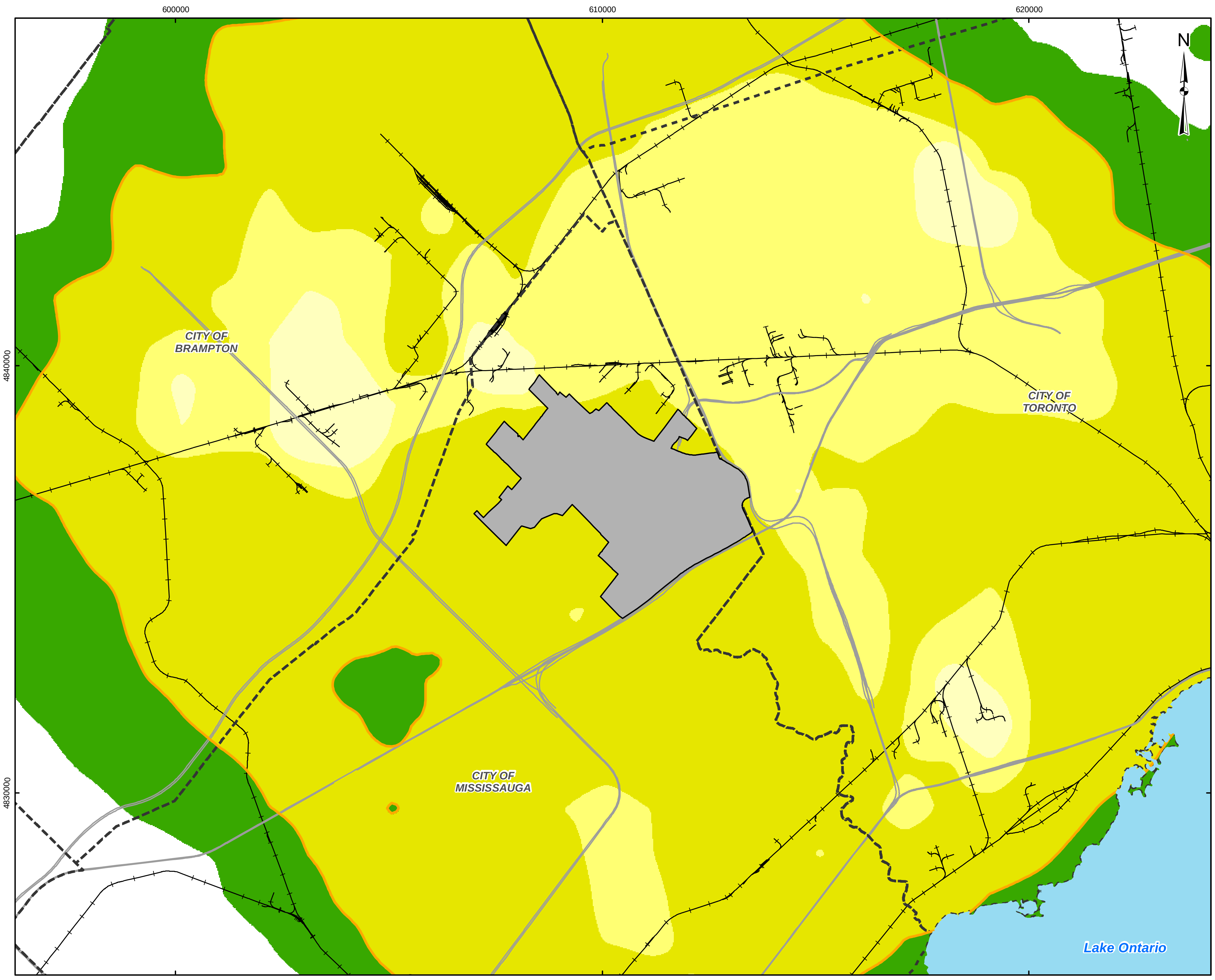

LEGEND

- Highway
- Railways
- 24-hour AAQC Standard (25 µg/m³)
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM2.5 µg/m³

- < 15
- 15 - 25
- 25 - 45
- 45 - 60
- >60

NOTES:

24-hour PM2.5 AAQC Standard = 25 µg/m³

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

FUTURE PREDICTED 24-HOUR PM2.5 CONCENTRATIONS ASSOCIATED WITH REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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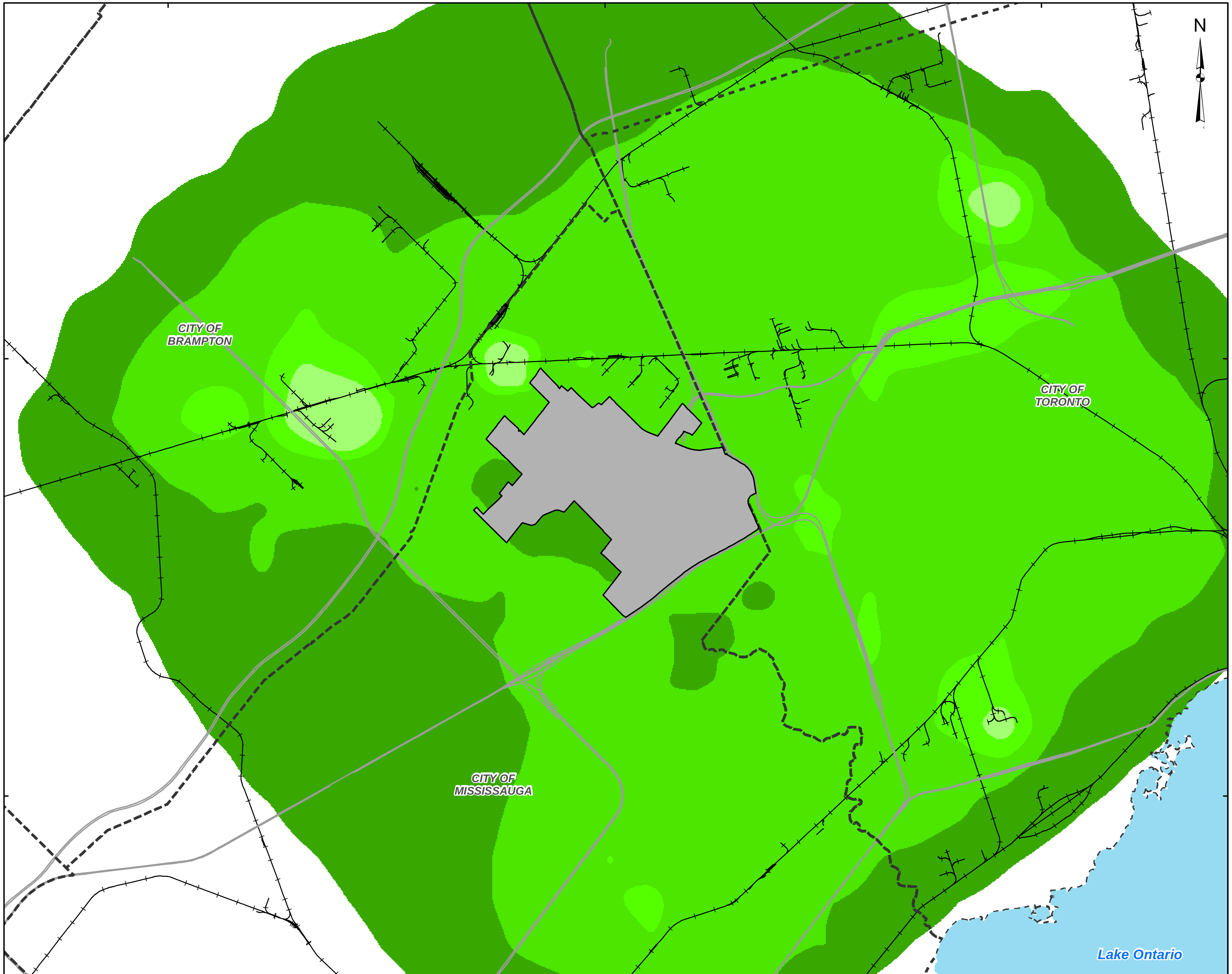

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

Annual Predicted Concentration - PM 2.5 μg/m³

- < 4
- 4 - 8
- 8 - 12
- 12 - 16
- > 16

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
FUTURE PREDICTED ANNUAL PM2.5 CONCENTRATIONS
ASSOCIATED WITH REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-27	FIGURE: D20	
GIS	ME	2015-01-23		
CHECK	AB	2015-01-23		
REVIEW				

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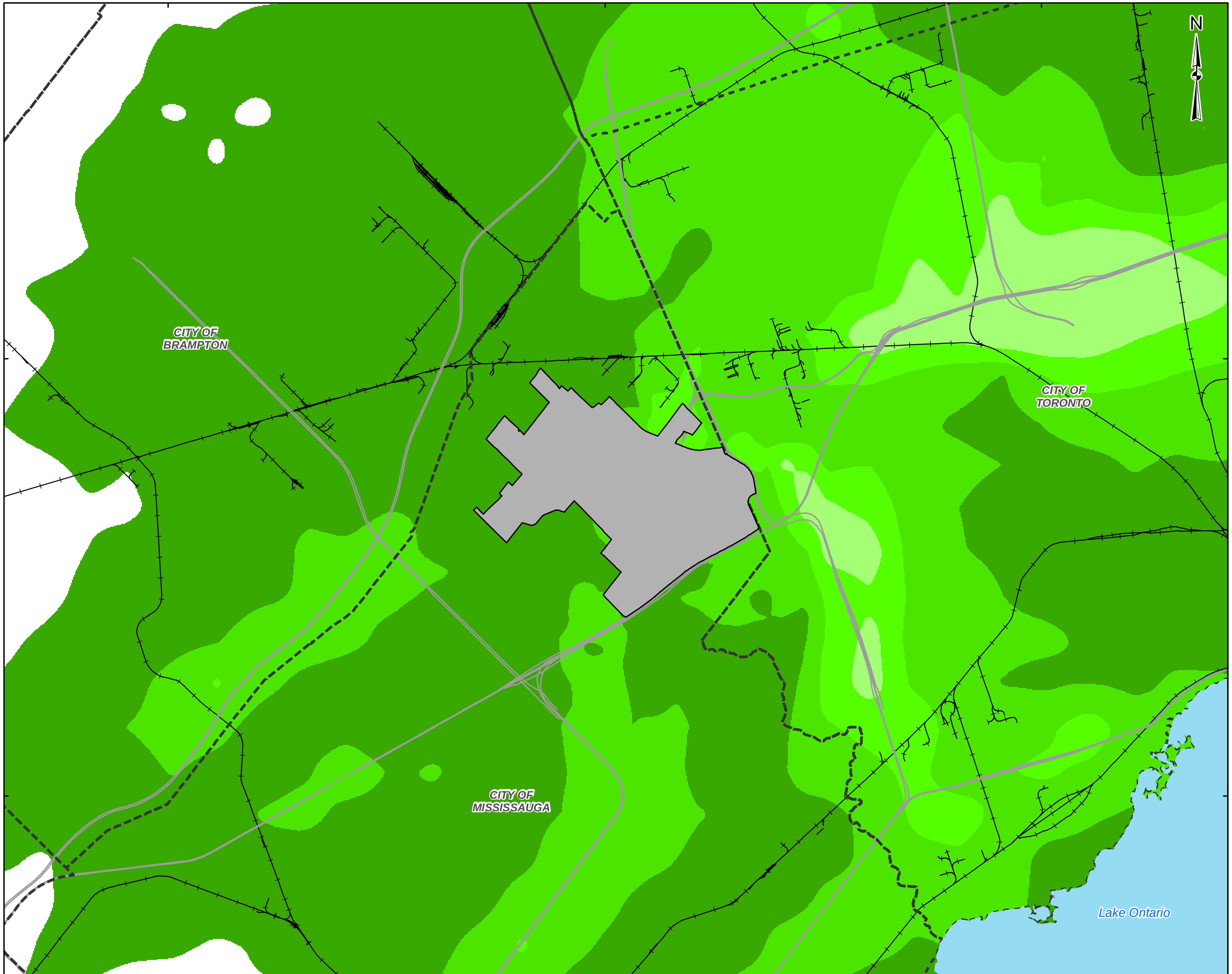
APPENDIX E

Combined Airport + Regional Dispersion Modelling Results Figures



LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - CO μg/m³

- < 2,000
- 2,000 - 4,000
- 4,000 - 6,000
- 6,000 - 8,000
- > 8,000

NOTES:

1-Hour CO AAQC standard = 36,000 μg/m3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 1-HOUR CO
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS.

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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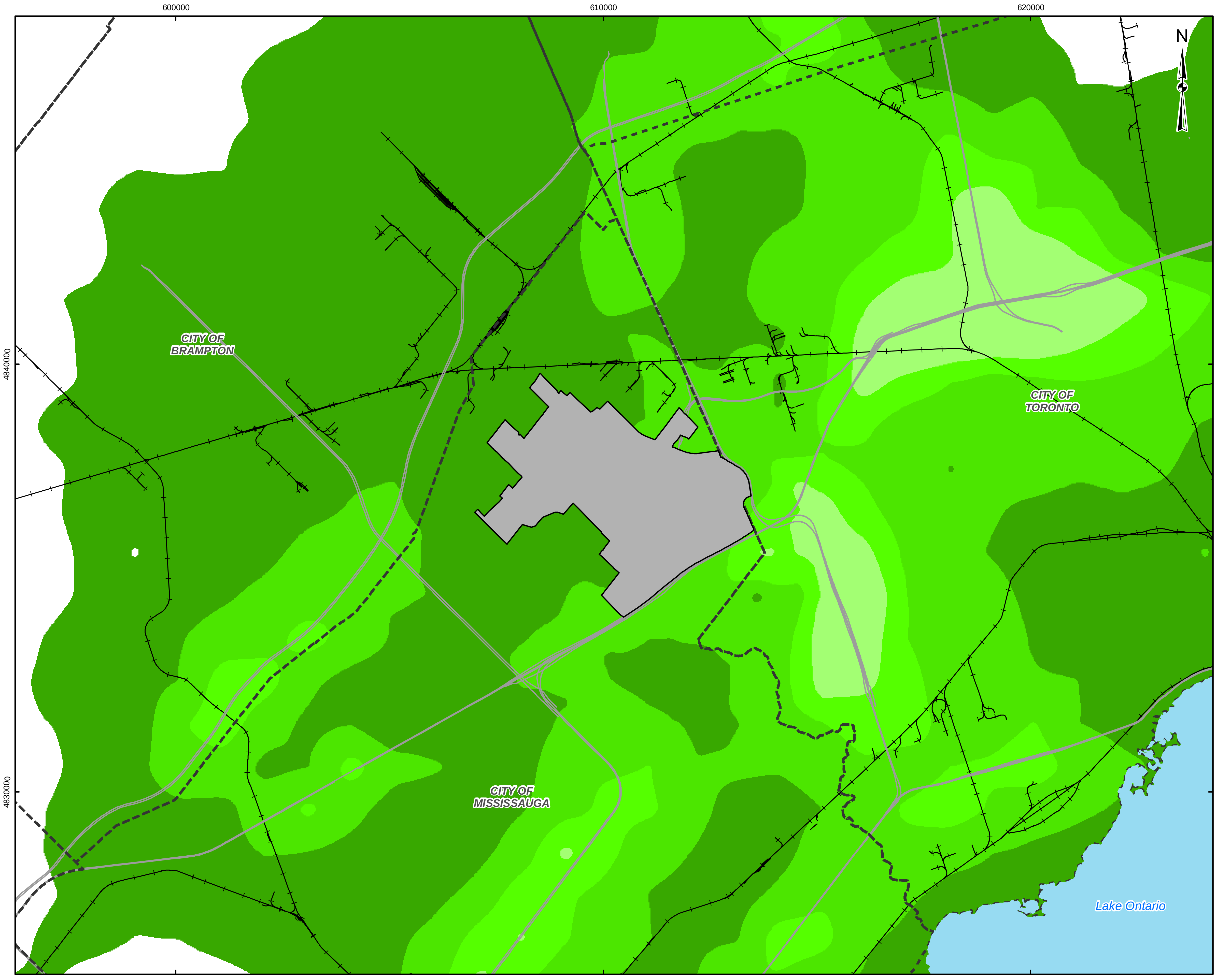

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

8-Hour Predicted Concentration - CO µg/m^3

- < 1,000
- 1,000 - 2,000
- 2,000 - 3,000
- 3,000 - 4,000
- > 4,000

NOTES:

8-Hour CO AAQC Standard = 17,700 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2011 8-HOUR CO
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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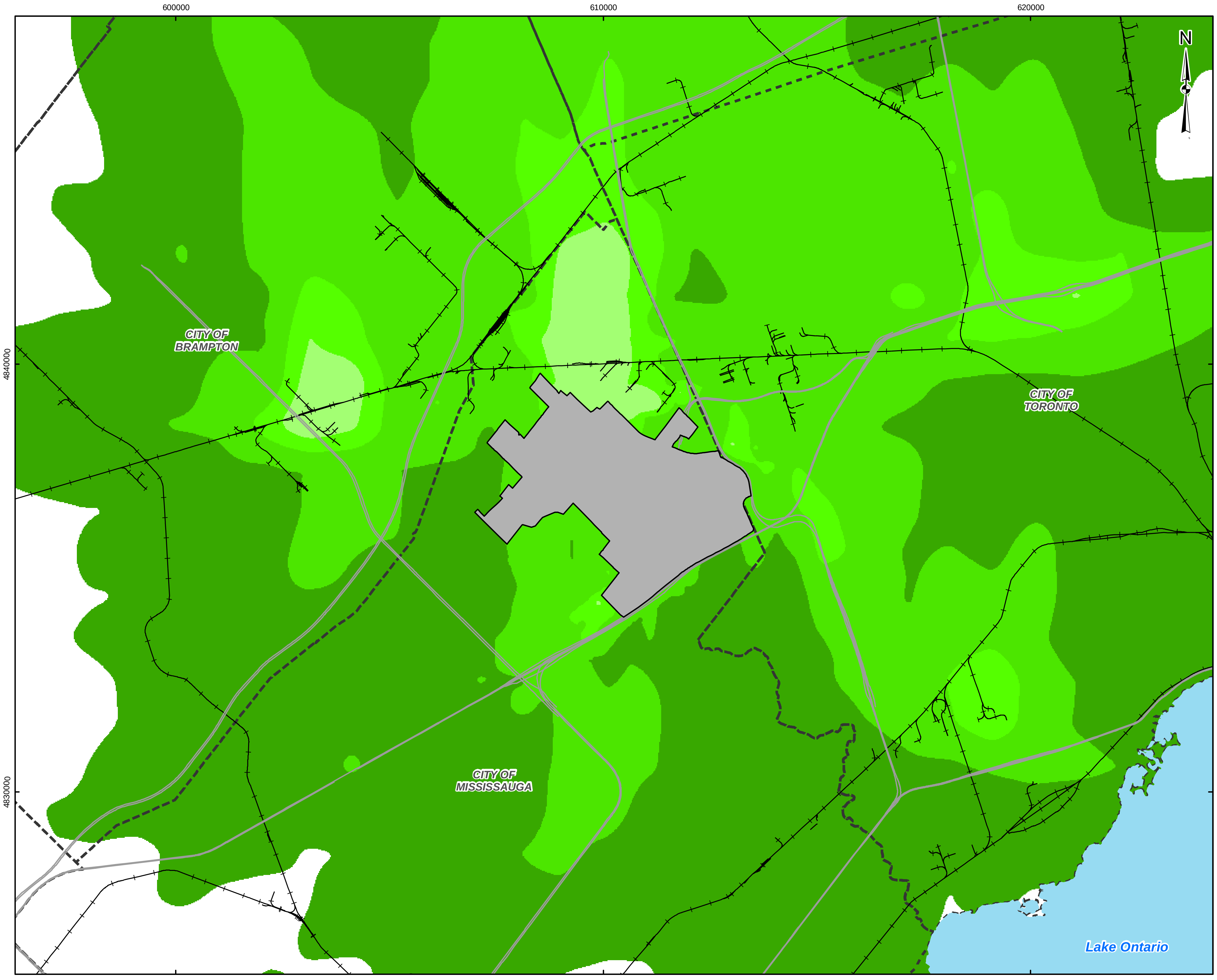

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - NO_2 µg/m^3

- < 125
- 125 - 165
- 165 - 210
- 210 - 250
- > 250

NOTES:

1-Hour NO_2 AAQC Standard = 400 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

2011 1-HOUR NO_2
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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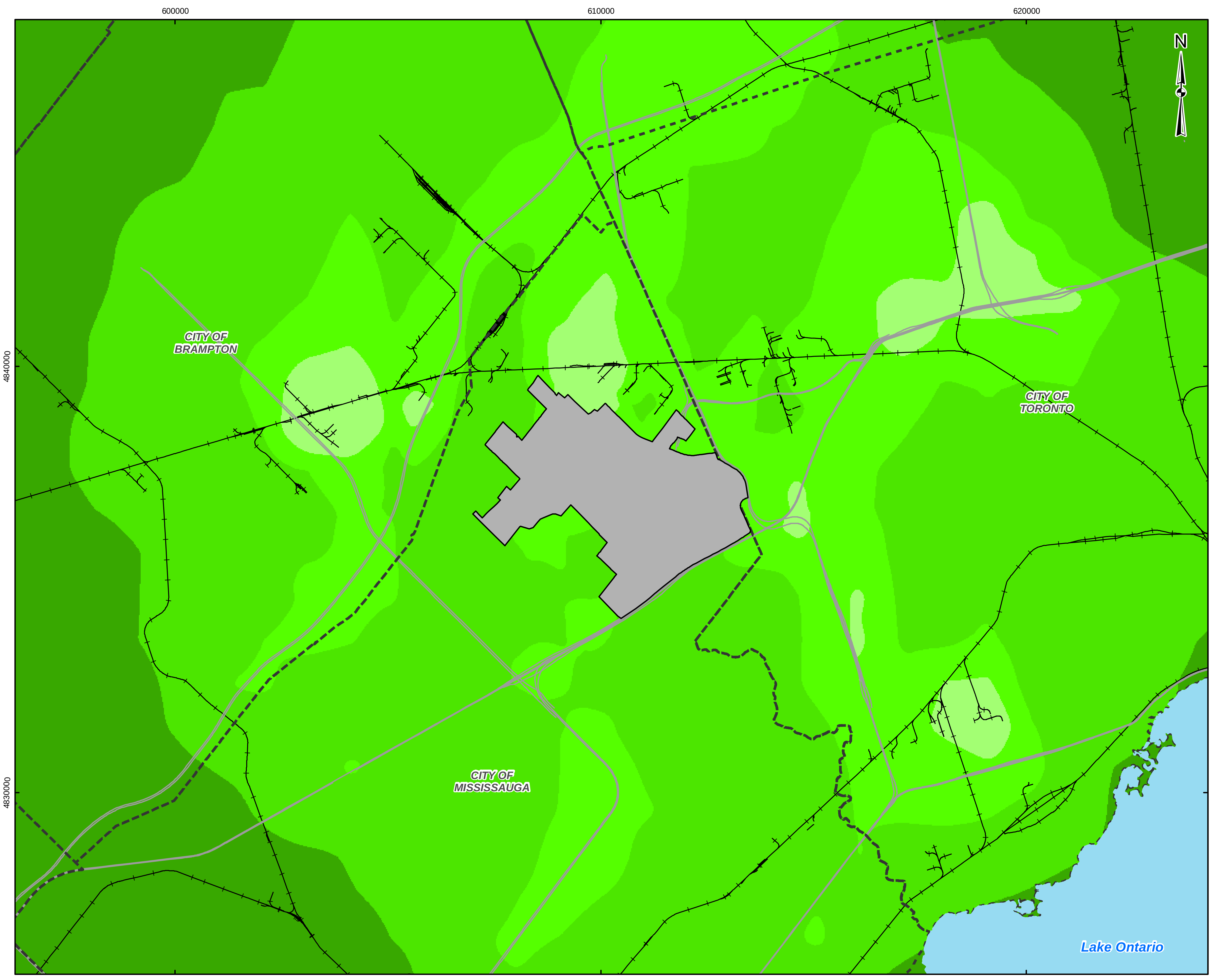

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - NO_2 µg/m^3

- < 15
- 15 - 30
- 30 - 45
- 45 - 60
- > 60

NOTES:

24-hour NO_2 AAQC Standard = 200 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 24-HOUR NO_2
CONCENTRATIONS ASSOCIATED WITH
AIRPORT PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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CHECK	AB	2015-01-22		
REVIEW				

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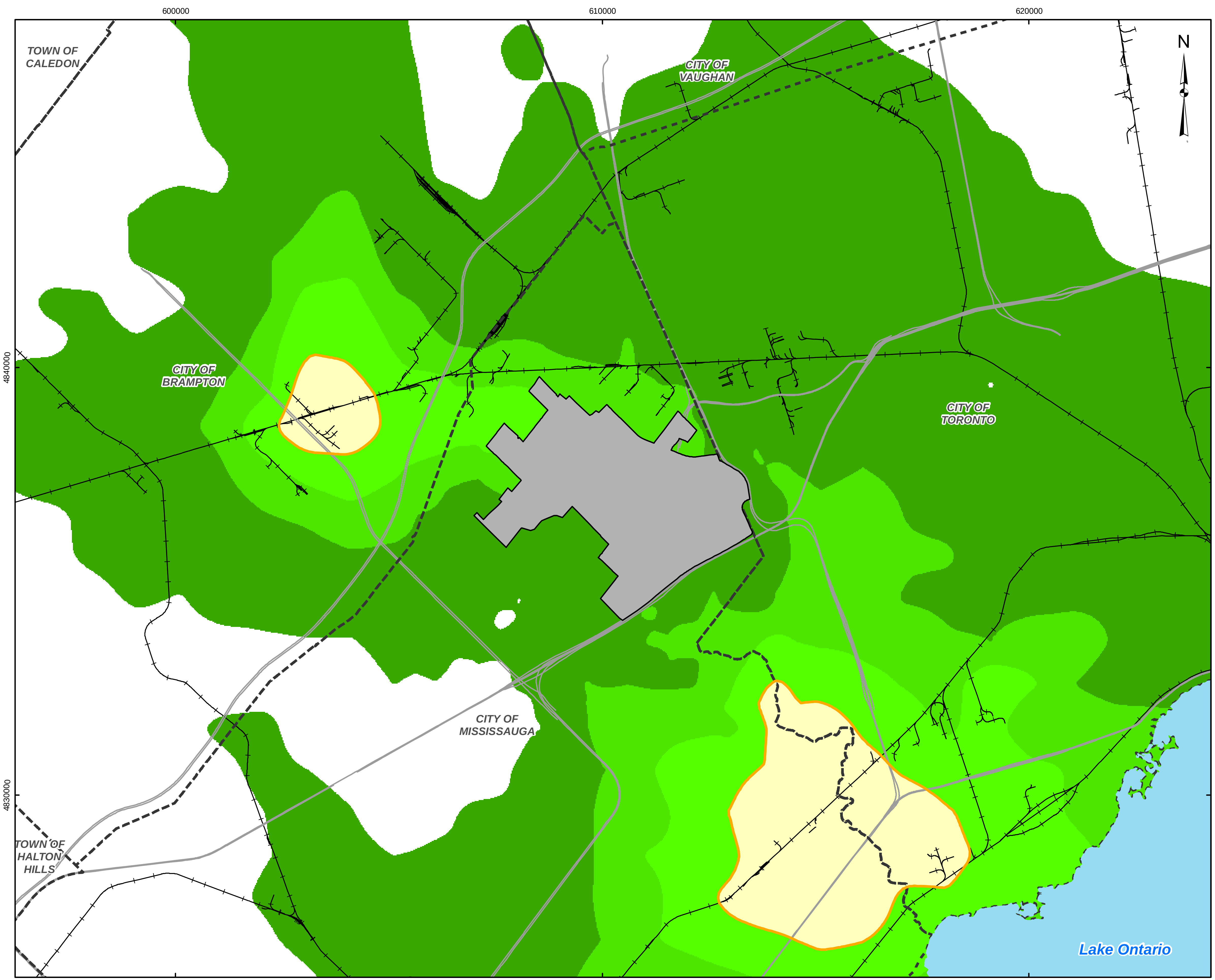

LEGEND

- Highway
- Railways
- 1-Hour AAQC Standard = 690 µg/m^3
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - SO_2 µg/m^3

- < 150
- 150 - 300
- 300 - 450
- 450 - 690
- > 690

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2011 1-HOUR SO_2
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME/PR	2015-01-15		
CHECK	AB	2015-01-15		
REVIEW				

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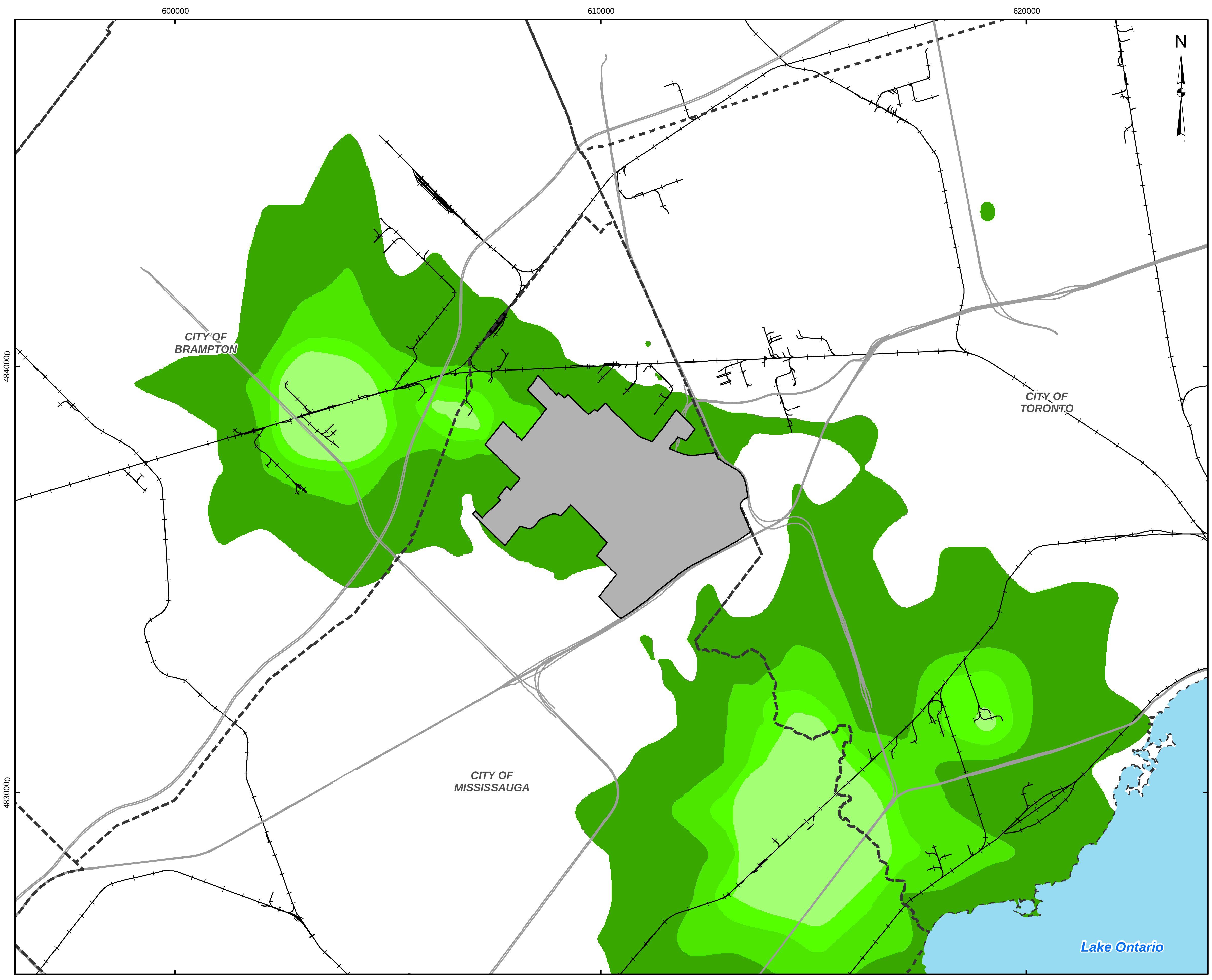

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - SO_2 µg/m^3

- < 30
- 30 - 60
- 60 - 90
- 90 - 120
- > 120

NOTES:

24-Hour SO_2 AAQC Standard = 275 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 24-HOUR SO_2
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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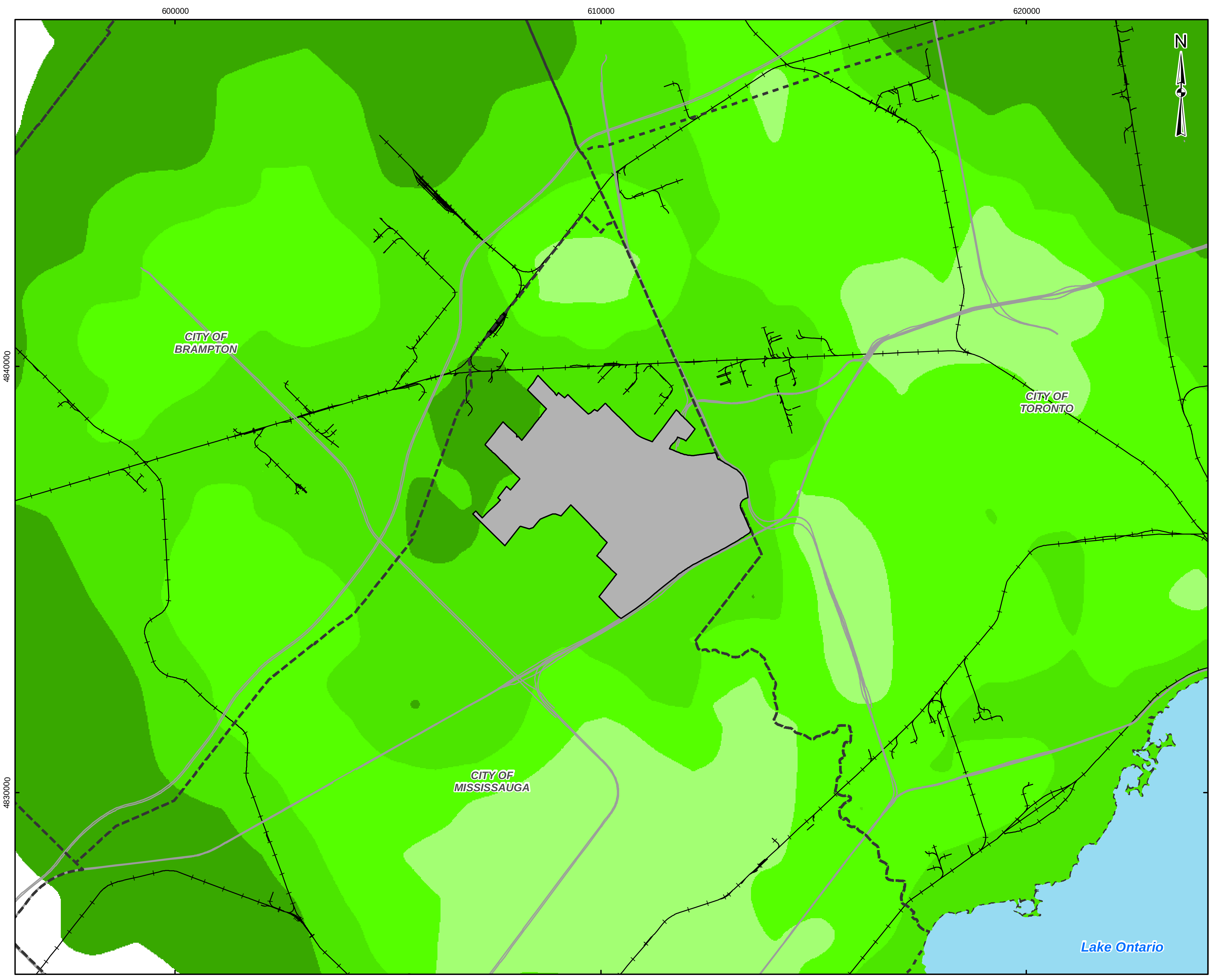

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - VOC µg/m³

- < 60
- 60 - 120
- 120 - 180
- 180 - 240
- > 240

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 24-HOUR VOC
CONCENTRATIONS ASSOCIATED WITH
AIRPORT PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
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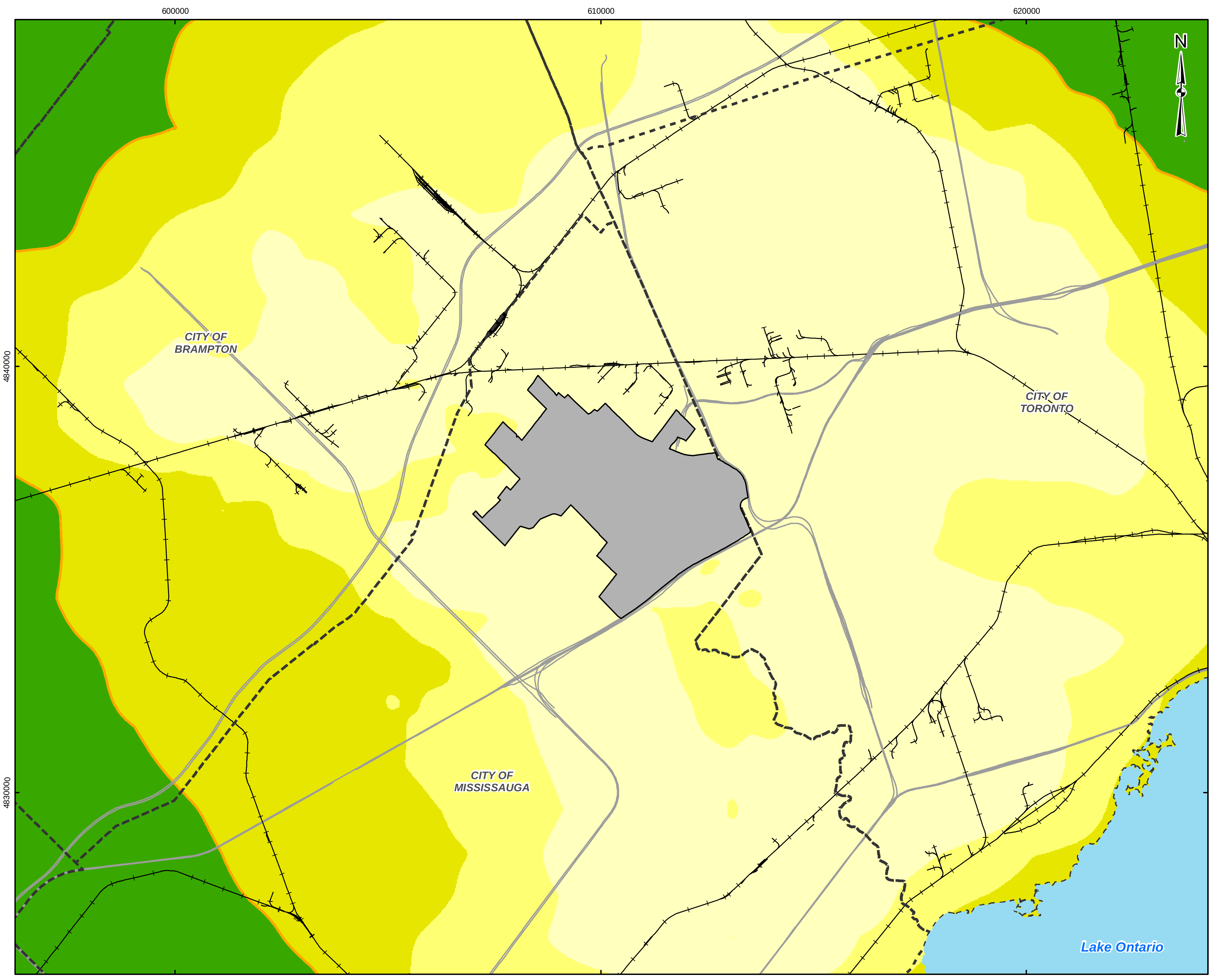
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				



LEGEND

- Highway
- Railways
- 24-hour AAQC Standard (50 µg/m³)
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM10 µg/m³

- < 25
- 25 - 50
- 50 - 75
- 75 - 100
- > 100

NOTES:

24-hour PM10 AAQC Standard = 50 µg/m³

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2011 24-HOUR PM10
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E8	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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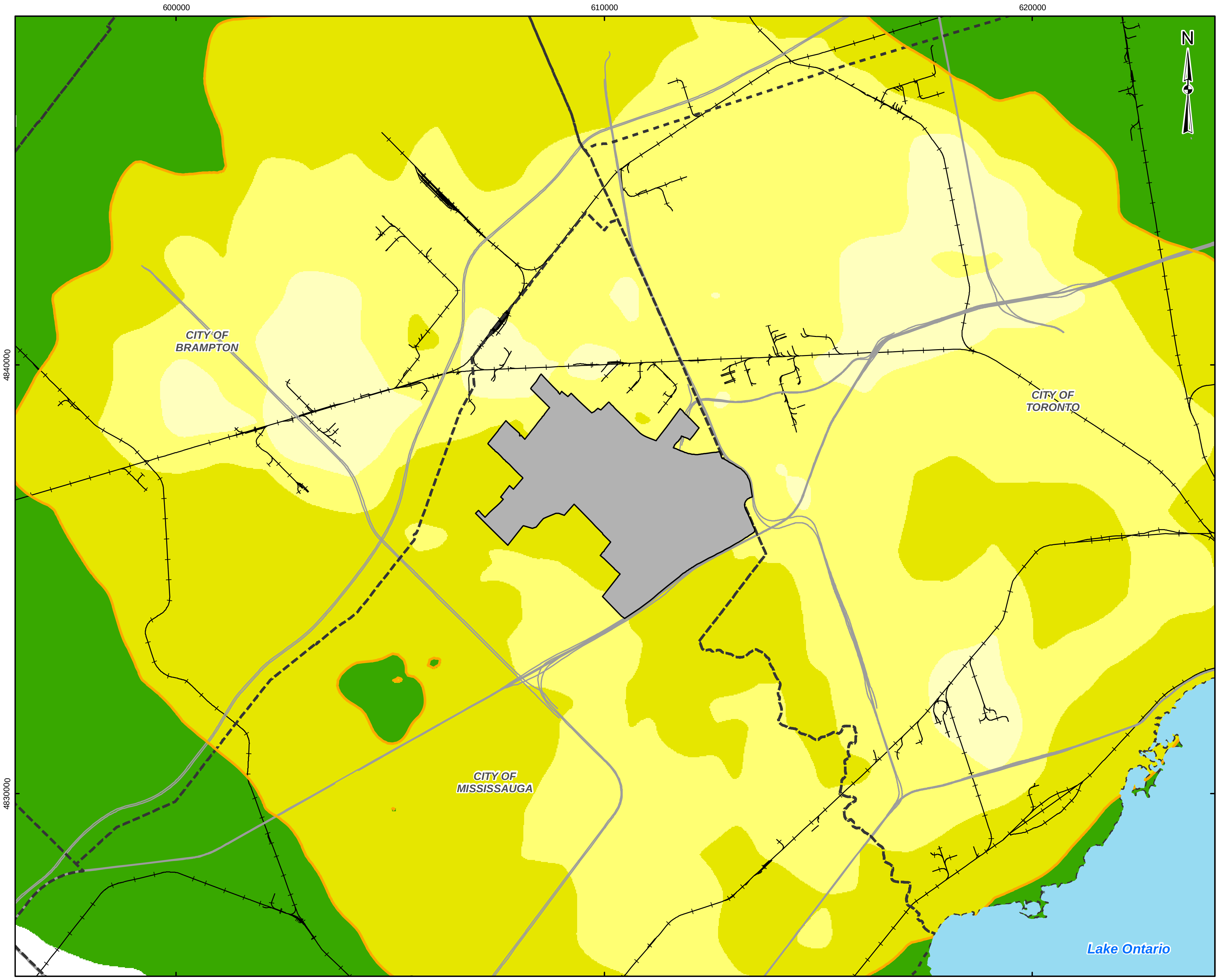

LEGEND

- Highway
- Railways
- 24-hour AAQC Standard (25 µg/m³)
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM2.5 µg/m³

- < 10
- 10 - 25
- 25 - 40
- 40 - 55
- > 55

NOTES:

24-hour PM2.5 AAQC Standard = 25 µg/m³

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 24-HOUR PM2.5
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E9	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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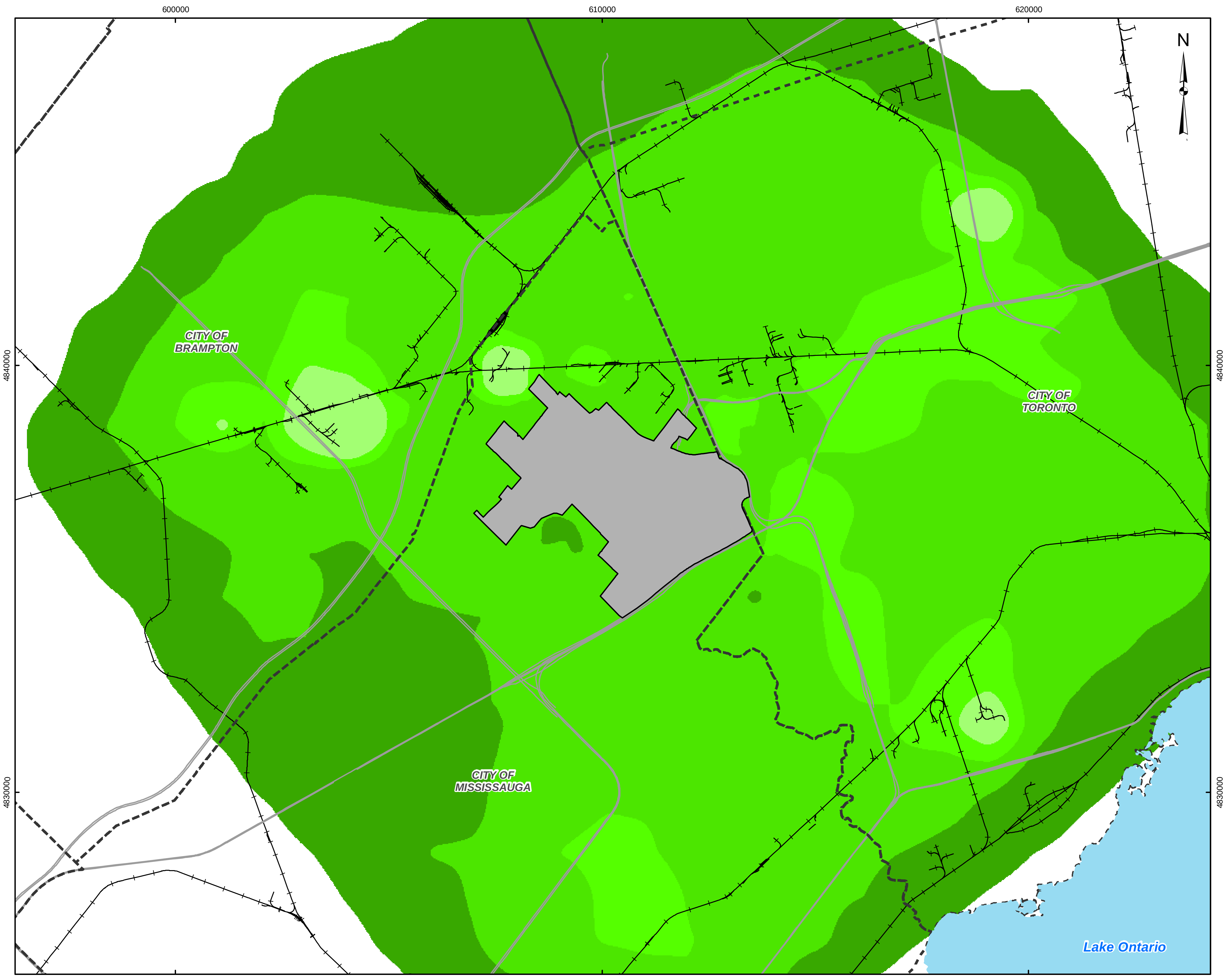

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

Annual Predicted Concentration - PM 2.5 μg/m^3

- < 4
- 4 - 8
- 8 - 12
- 12 - 16
- > 16

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2011 ANNUAL PM2.5
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E10	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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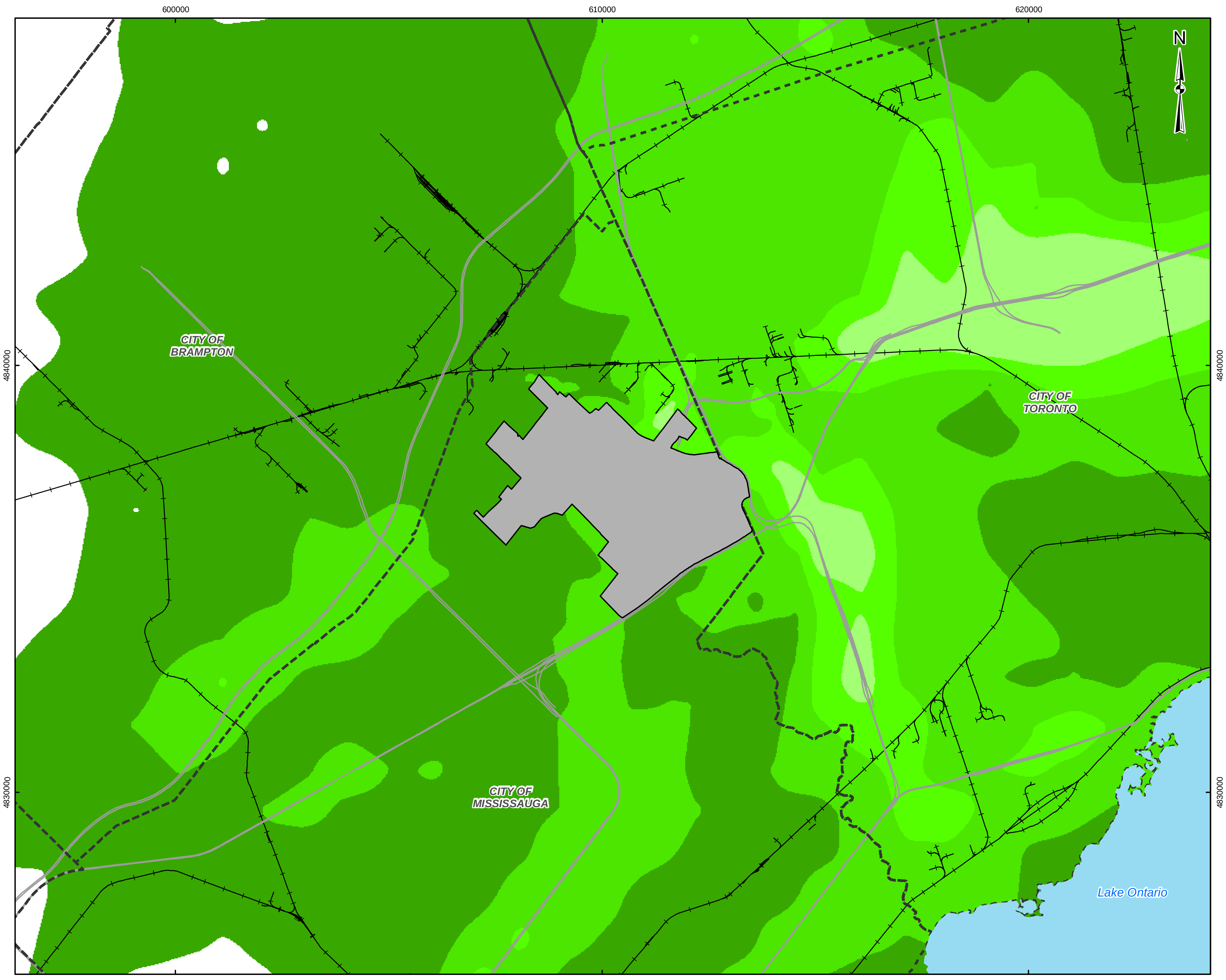


LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - CO µg/m^3

- < 2,000
- 2,000 - 4,000
- 4,000 - 6,000
- 6,000 - 8,000
- > 8,000

NOTES:

1-Hour CO AAQC standard = 36,000 µg/m3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

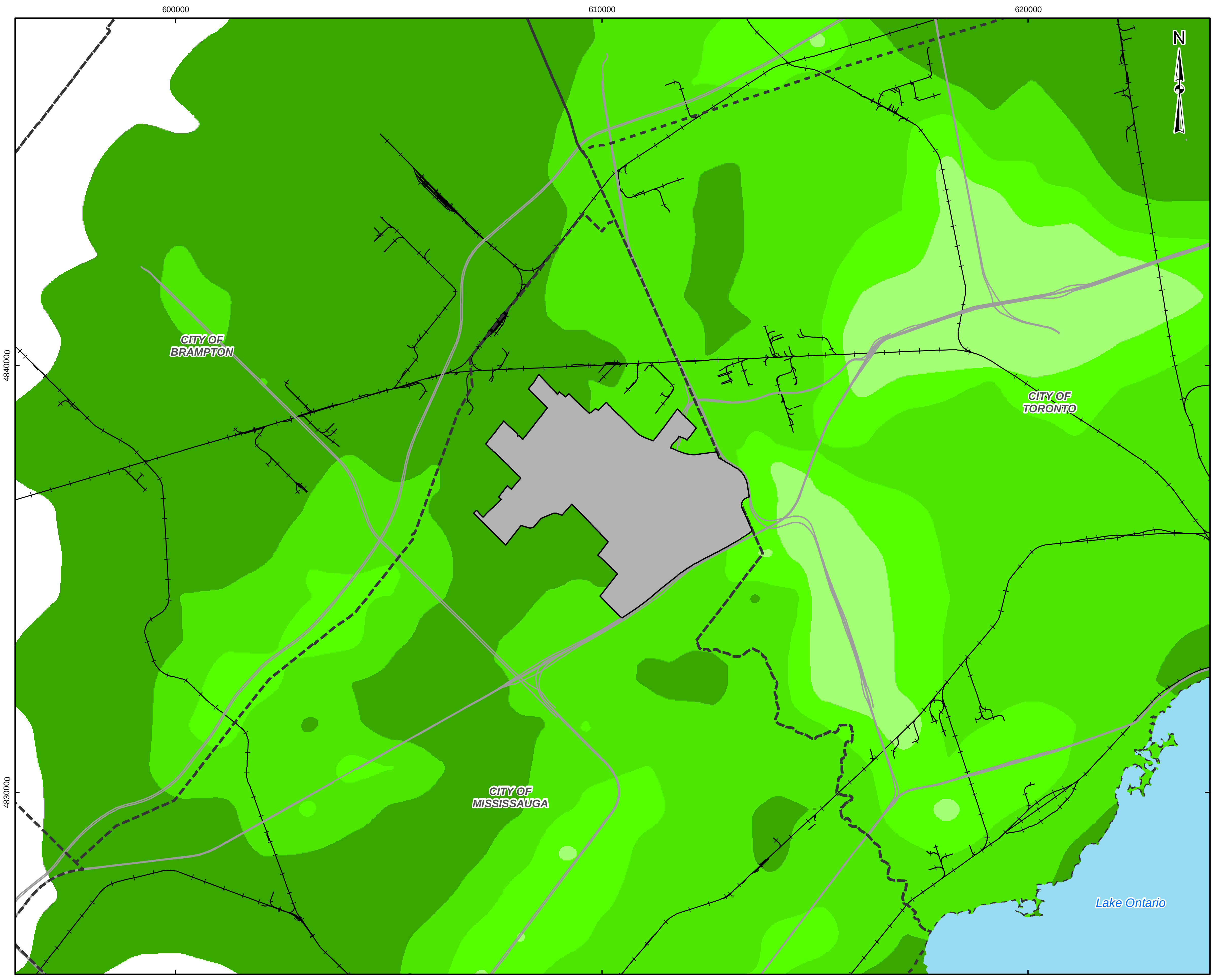
PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
FUTURE 2022 1-HOUR CO
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS.

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E11	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudy\Phase2_Report\Appendix_E\Updates_Jan2015\FigureE11_Predicted_2022_1_hour_CO.mxd



LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

8-Hour Predicted Concentration - CO µg/m^3

- < 1,000
- 1,000 - 2,000
- 2,000 - 3,000
- 3,000 - 4,000
- > 4,000

NOTES:

8-Hour CO AAQC Standard = 17,700 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

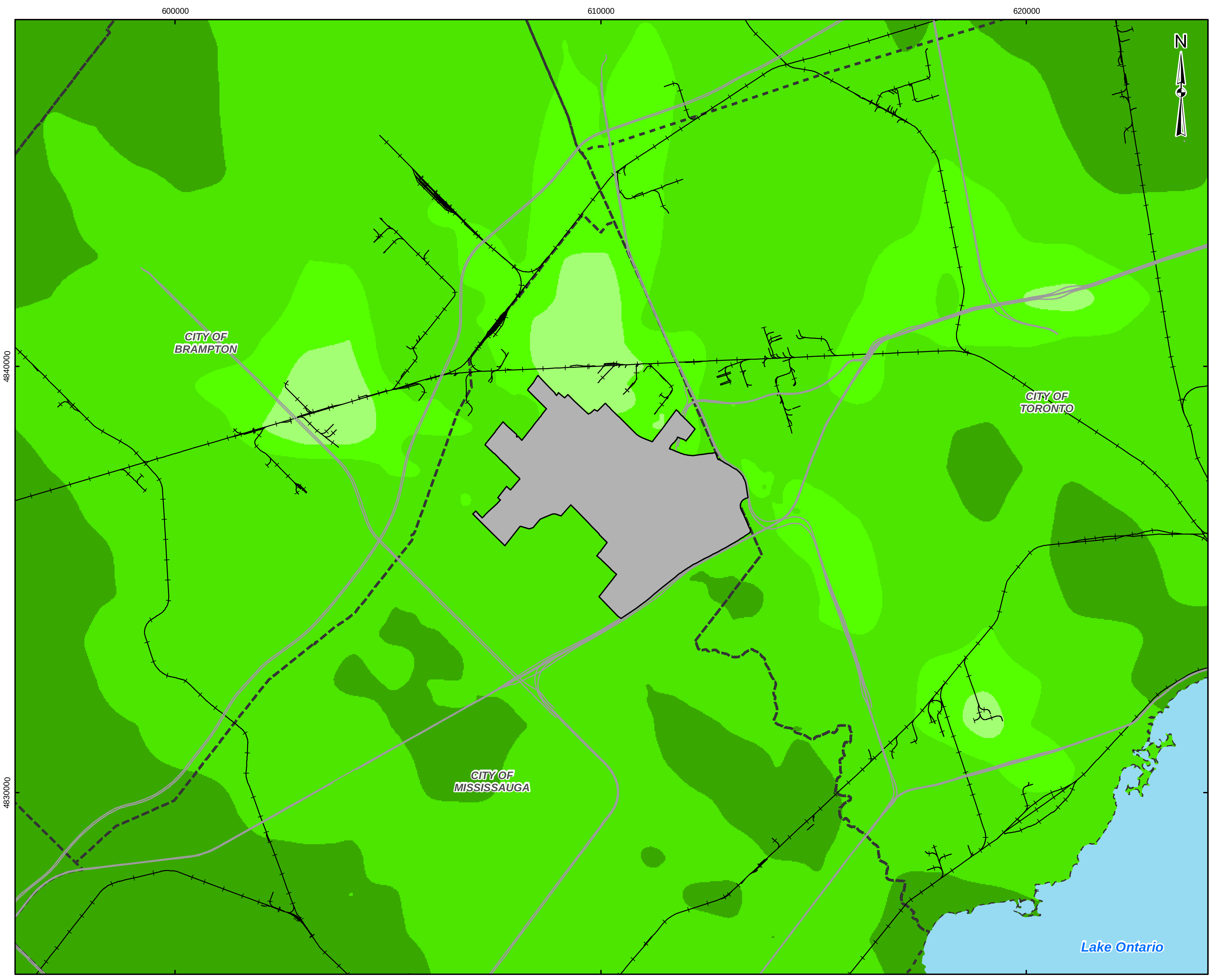
2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2022 8-HOUR CO
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E12	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				



LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - NO_2 µg/m^3

- < 125
- 125 - 165
- 165 - 210
- 210 - 250
- > 250

NOTES:

1-Hour NO_2 AAQC Standard = 400 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
2022 1-HOUR NO_2
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E13	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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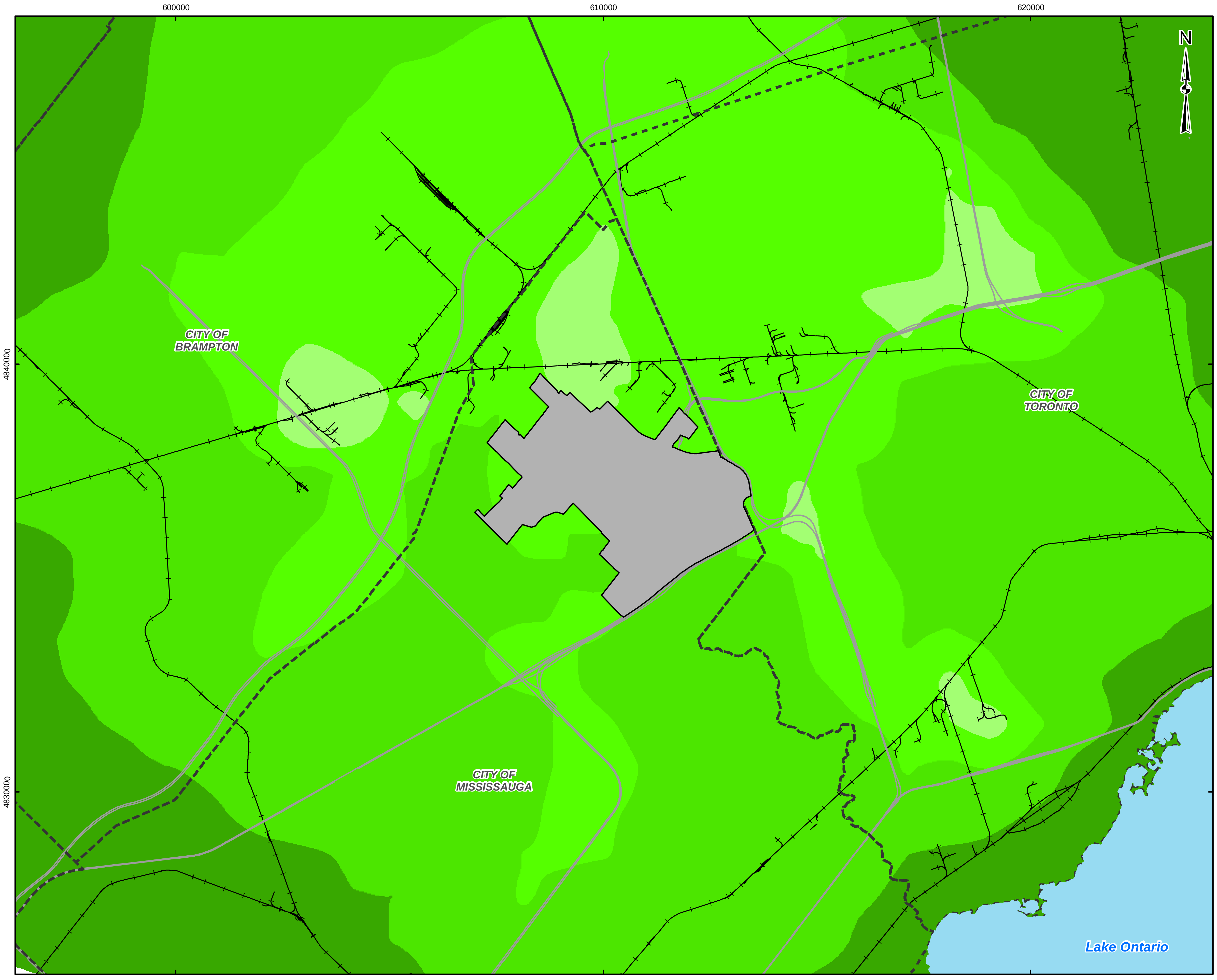

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - NO_2 µg/m^3

- < 20
- 20 - 40
- 40 - 60
- 60 - 80
- > 80

NOTES:

24-hour NO_2 AAQC Standard = 200 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2022 24-HOUR NO_2
CONCENTRATIONS ASSOCIATED WITH
AIRPORT PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26		
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

FIGURE: E14

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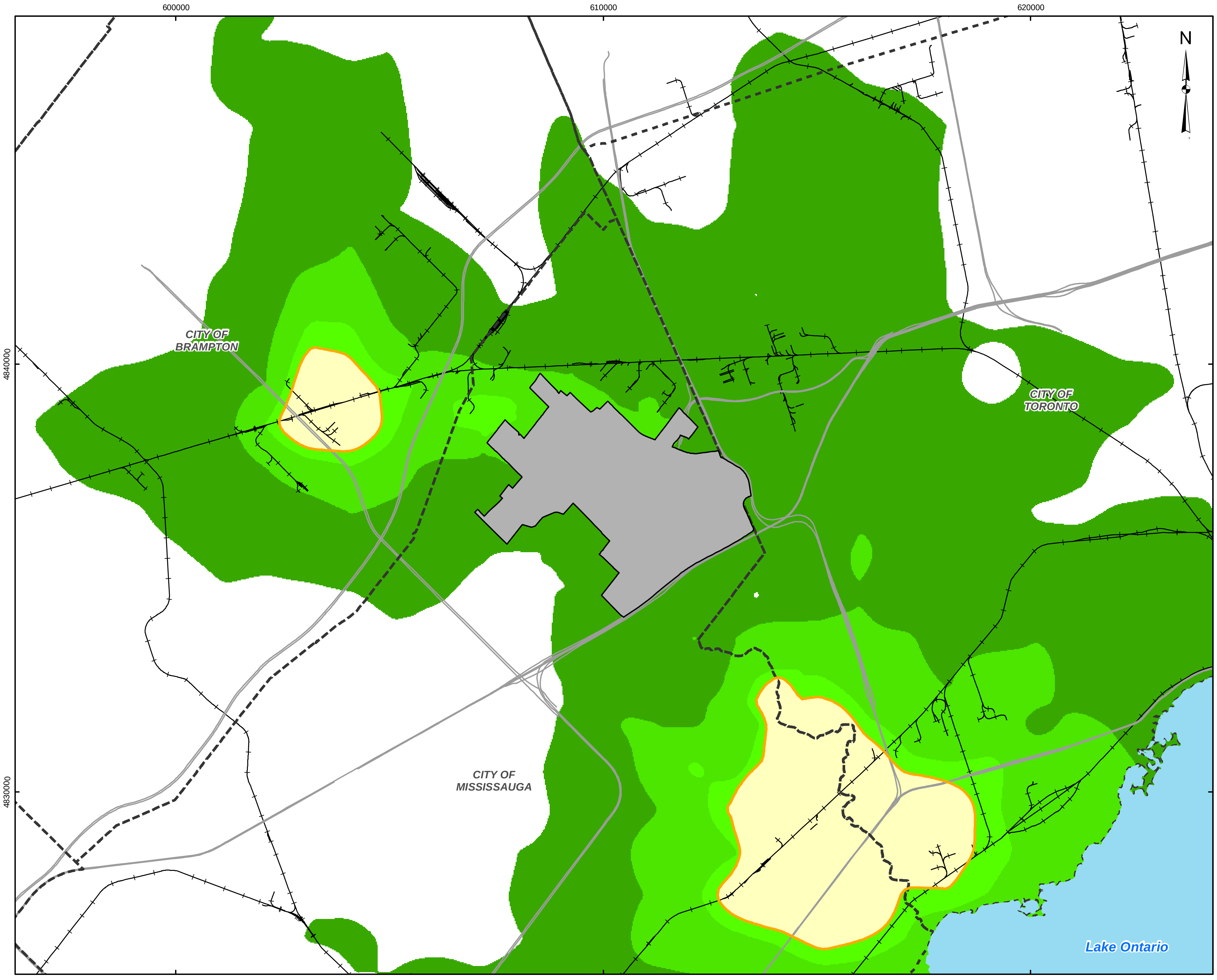

LEGEND

- Highway
- Railways
- 1-Hour AAQC Standard = 690 µg/m^3
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - SO_2 µg/m^3

- < 200
- 200 - 400
- 400 - 600
- 600 - 690
- > 690

NOTES:

1-Hour SO_2 AAQC Standard = 690 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2022 1-HOUR SO_2
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E15	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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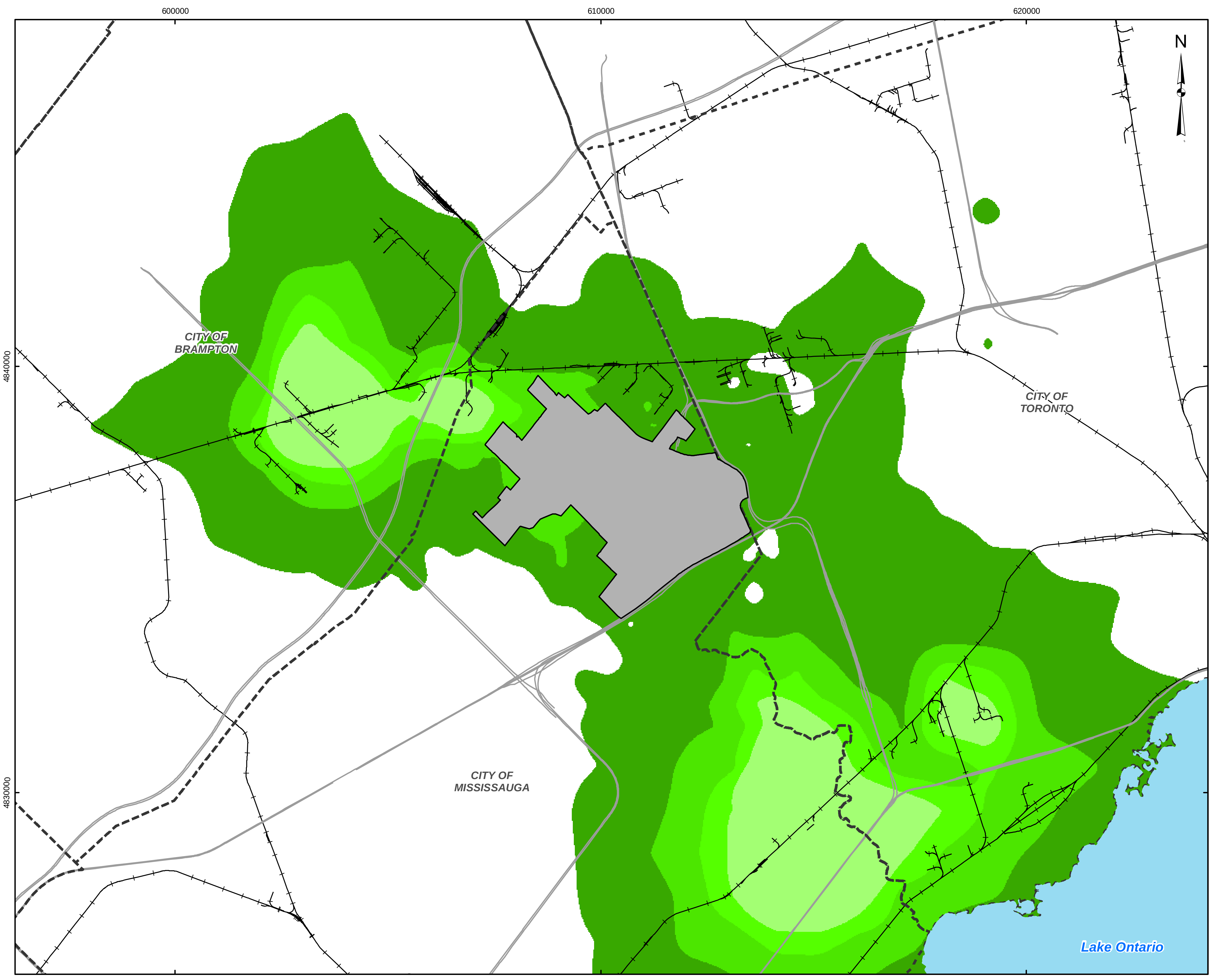


LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - SO_2 µg/m^3

- < 30
- 30 - 60
- 60 - 90
- 90 - 120
- > 120

NOTES:

24-Hour SO_2 AAQC Standard = 275 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

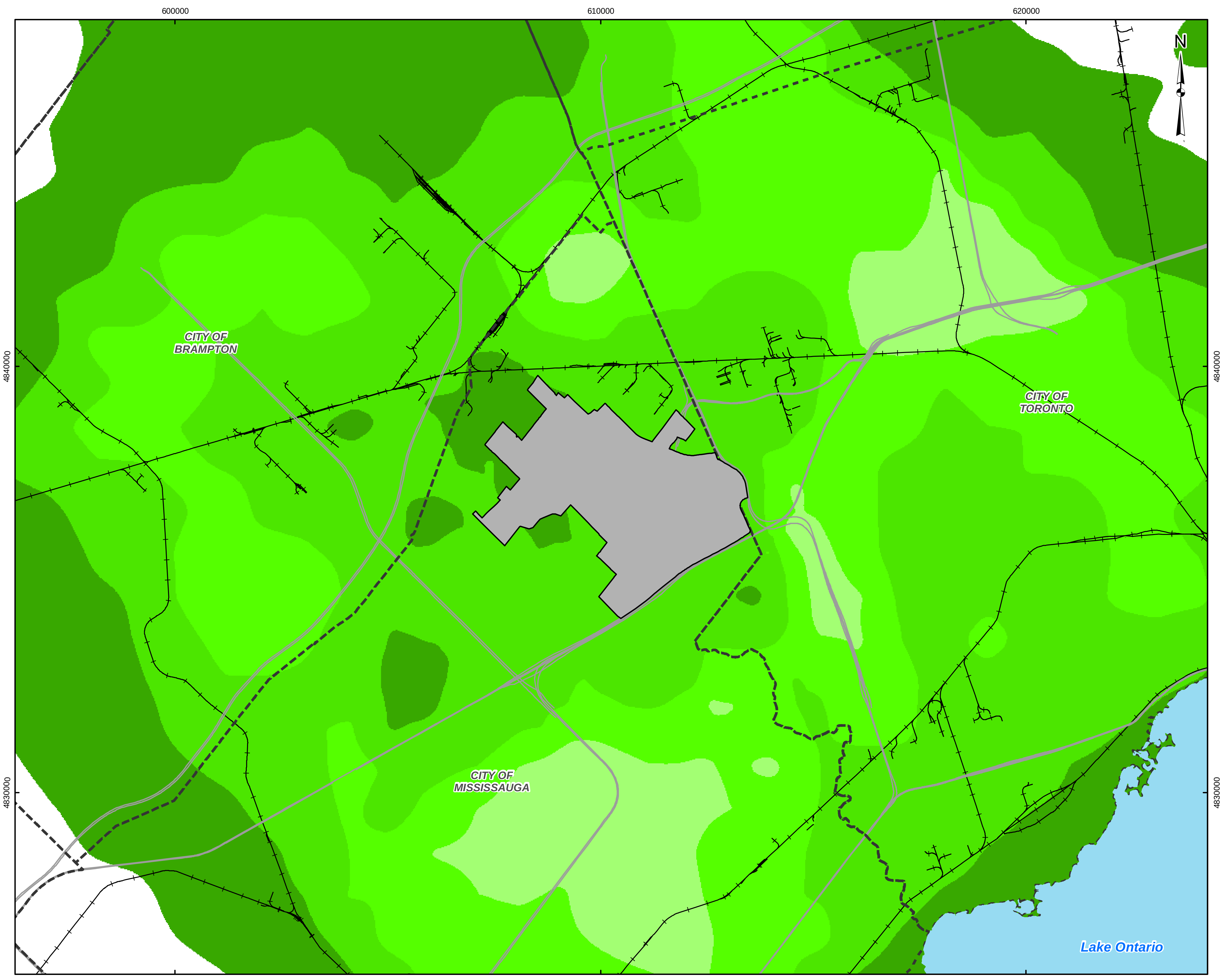
TITLE

PREDICTED 2022 24-HOUR SO_2
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN / REV. 0.0
DESIGN	ME	2014-11-26	
GIS	ME/PR	2015-01-22	FIGURE: E16
CHECK	AB	2015-01-22	
REVIEW			

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudy\Phase2_Report\Appendix_E\Updates_Jan2015\FigureE16_Predicted_2022_24_Hr_SOx.mxd



LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - VOC µg/m³

- < 80
- 80 - 160
- 160 - 240
- 240 - 320
- > 320

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

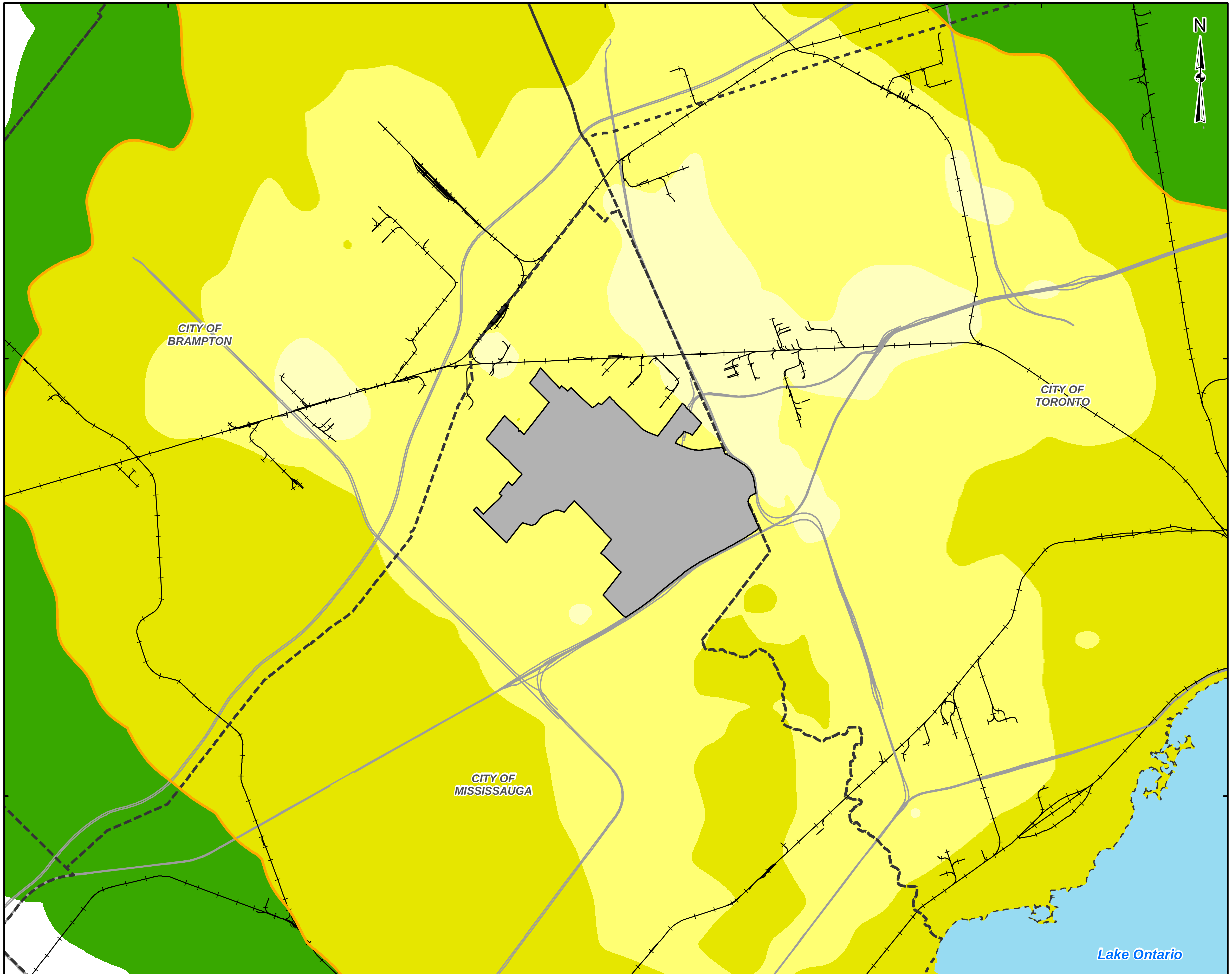
PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2022 24-HOUR VOC
CONCENTRATIONS ASSOCIATED WITH
AIRPORT PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E17	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudy\Phase2_Report\Appendix_E\Updates_Jan2015\FigureE17_Predicted_2022_24Hr_VOC.mxd



LEGEND

- Highway
- Railways
- 24-hour AAQC Standard (50 µg/m^3)
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM10 µg/m^3

- < 25
- 25 - 50
- 50 - 100
- 100 - 150
- > 150

NOTES:

24-hour PM10 AAQC Standard = 50 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2022 24-HOUR PM10
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E18	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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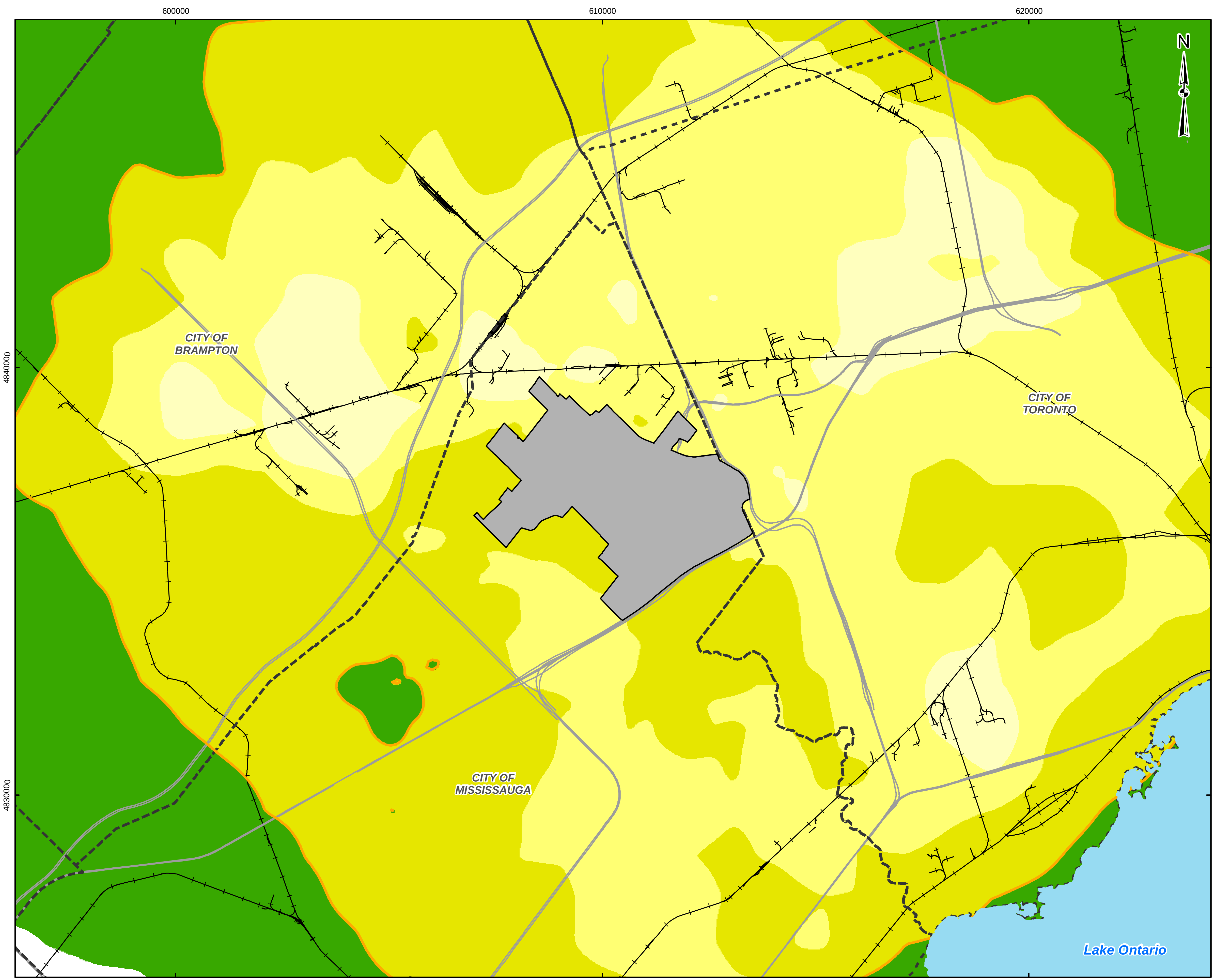

LEGEND

- Highway
- Railways
- 24-hour AAQC Standard (25 µg/m³)
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM2.5 µg/m³

- < 10
- 10 - 25
- 25 - 40
- 40 - 55
- > 55

NOTES:

24-hour PM2.5 AAQC Standard = 25 µg/m³

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2022 24-HOUR PM2.5
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E19	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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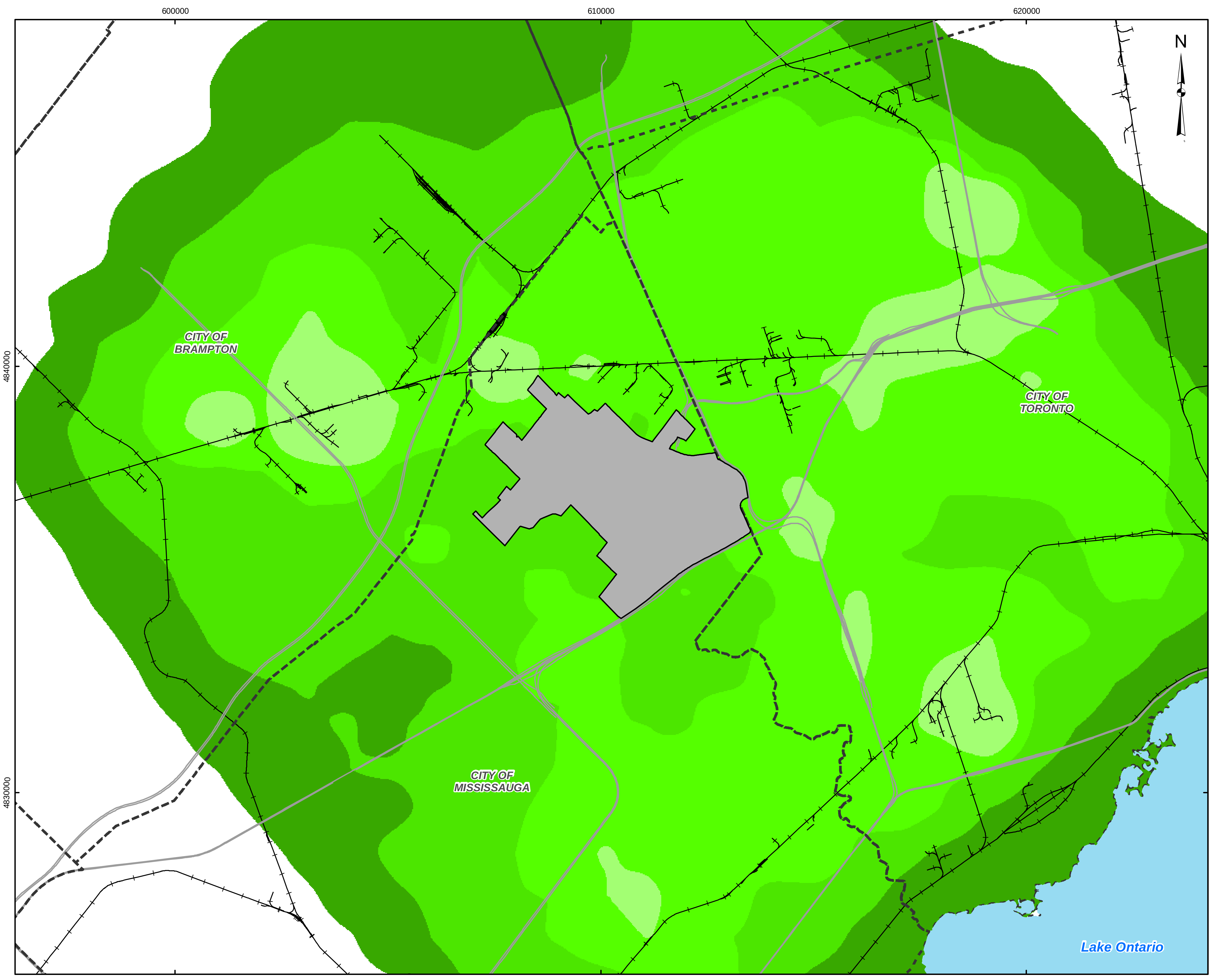

LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

Annual Predicted Concentration - PM 2.5 μg/m³

- < 3
- 3 - 6
- 6 - 9
- 9 - 12
- > 12

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2022 ANNUAL PM2.5
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E20	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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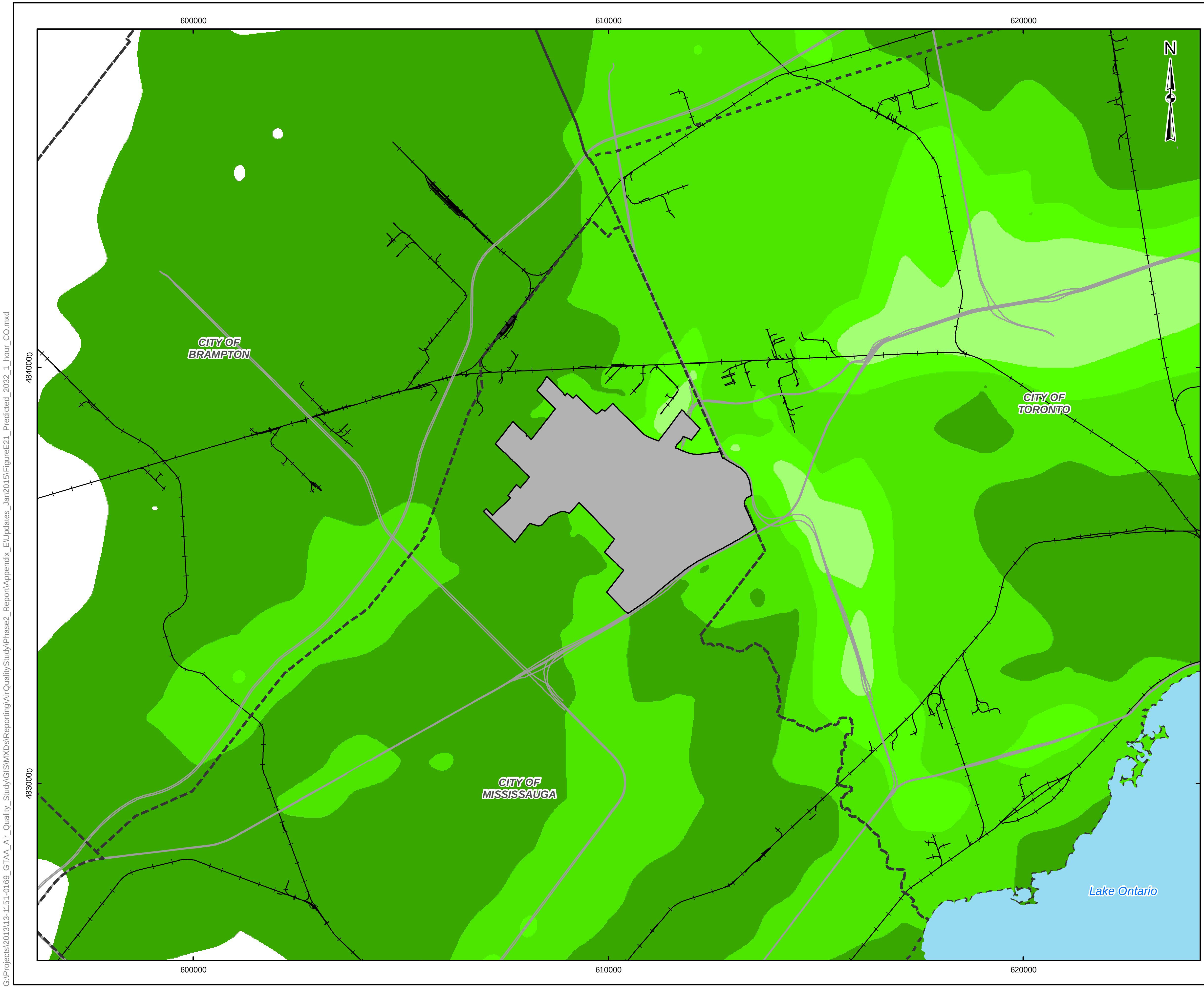


LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - CO µg/m^3

- < 2,000
- 2,000 - 4,000
- 4,000 - 6,000
- 6,000 - 8,000
- > 8,000

NOTES:

1-Hour CO AAQC standard = 36,000 µg/m3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

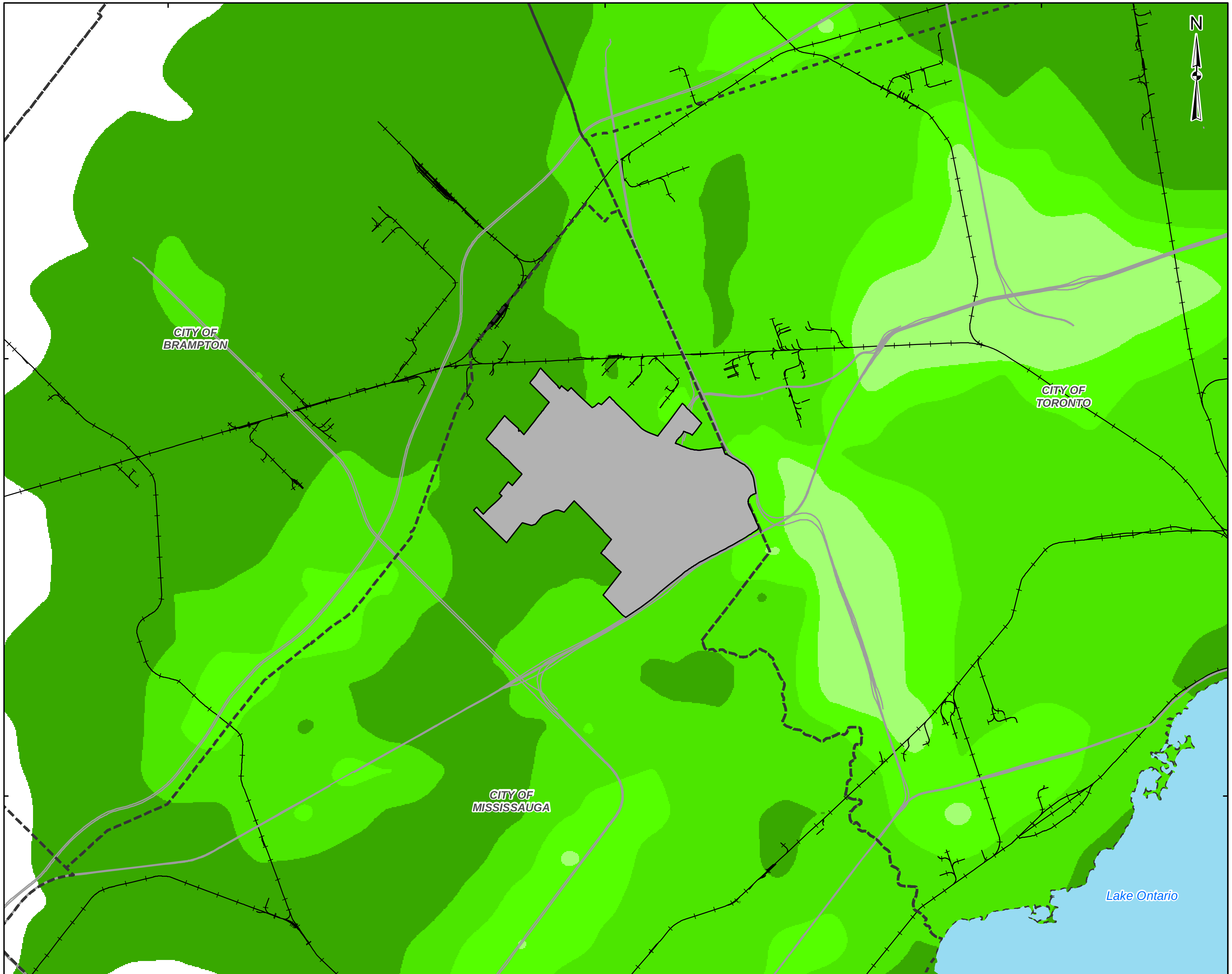
PREDICTED 2032 1-HOUR CO
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS.

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN / REV. 0.0
DESIGN	ME	2014-11-26	
GIS	ME/PR	2015-01-22	
CHECK	AB	2015-01-22	
REVIEW			

FIGURE: E21

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudy\Phase2_Report\Appendix_E\Updates_Jan2015\FigureE21_Predicted_2032_1_hour_CO.mxd



LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

8-Hour Predicted Concentration - CO µg/m^3

- < 1,000
- 1,000 - 2,000
- 2,000 - 3,000
- 3,000 - 4,000
- > 4,000

NOTES:

8-Hour CO AAQC Standard = 17,700 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2032 8-HOUR CO
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E22	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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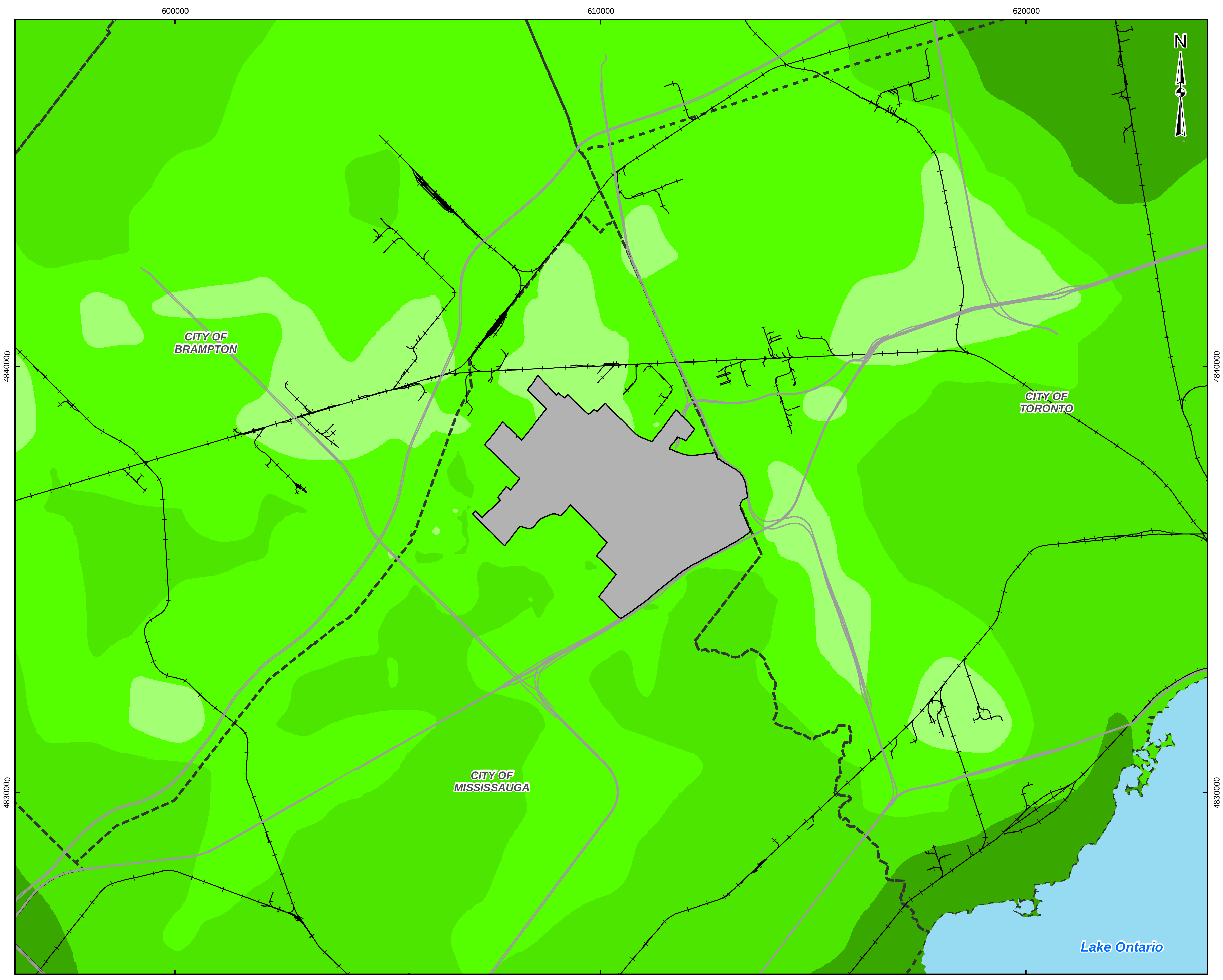

LEGEND

Highway
Railways
Waterbody
Municipality
Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - NO_2 µg/m^3

< 15
15 - 30
30 - 45
45 - 60
> 60

NOTES:

1-Hour NO_2 AAQC Standard = 400 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
2032 1-HOUR NO_2
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E23	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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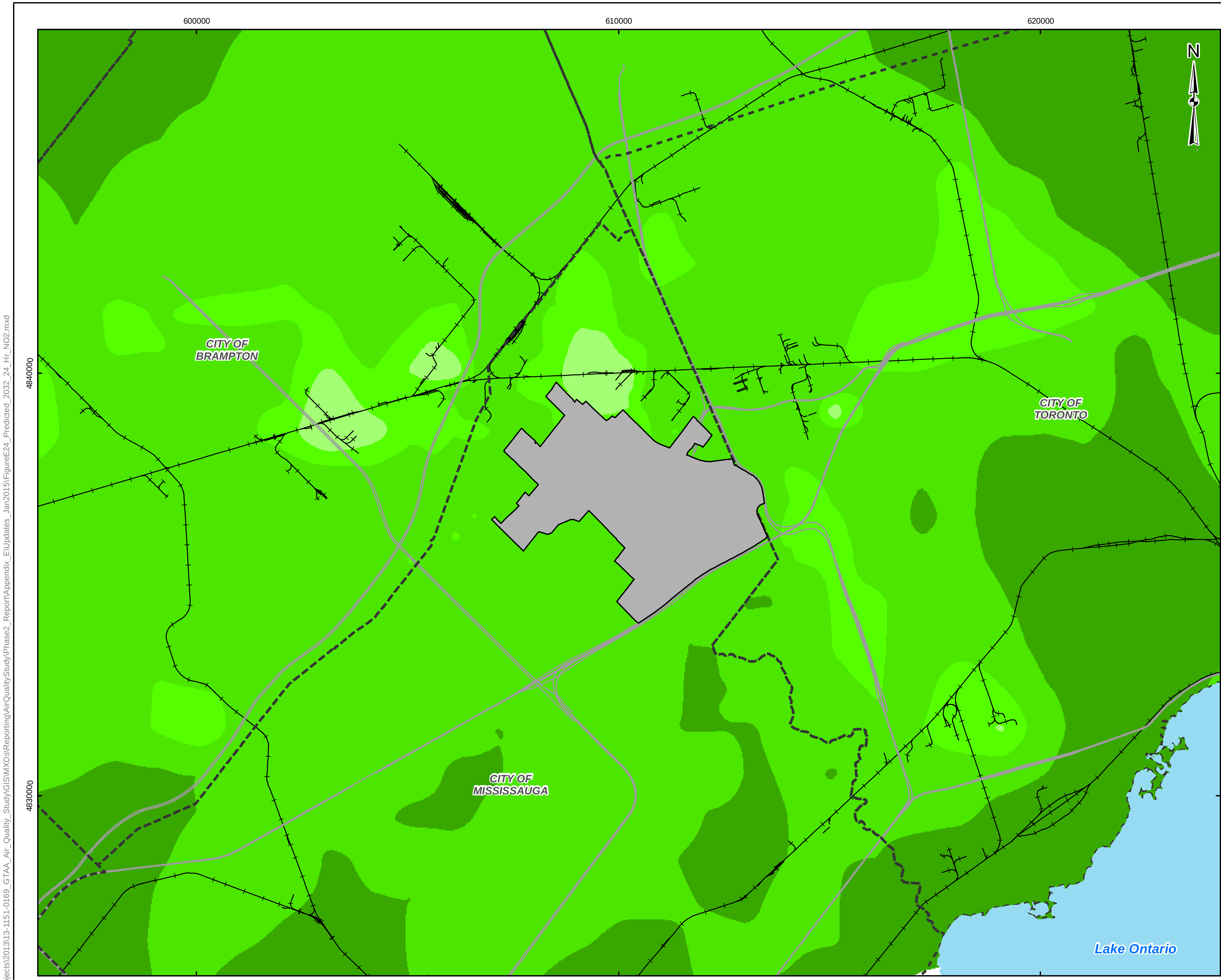


LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - NO_2 µg/m^3

- < 20
- 20 - 40
- 40 - 60
- 60 - 80
- > 80

NOTES:

24-hour NO_2 AAQC Standard = 200 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2032 24-HOUR NO_2
CONCENTRATIONS ASSOCIATED WITH
AIRPORT PLUS REGIONAL EMISSIONS

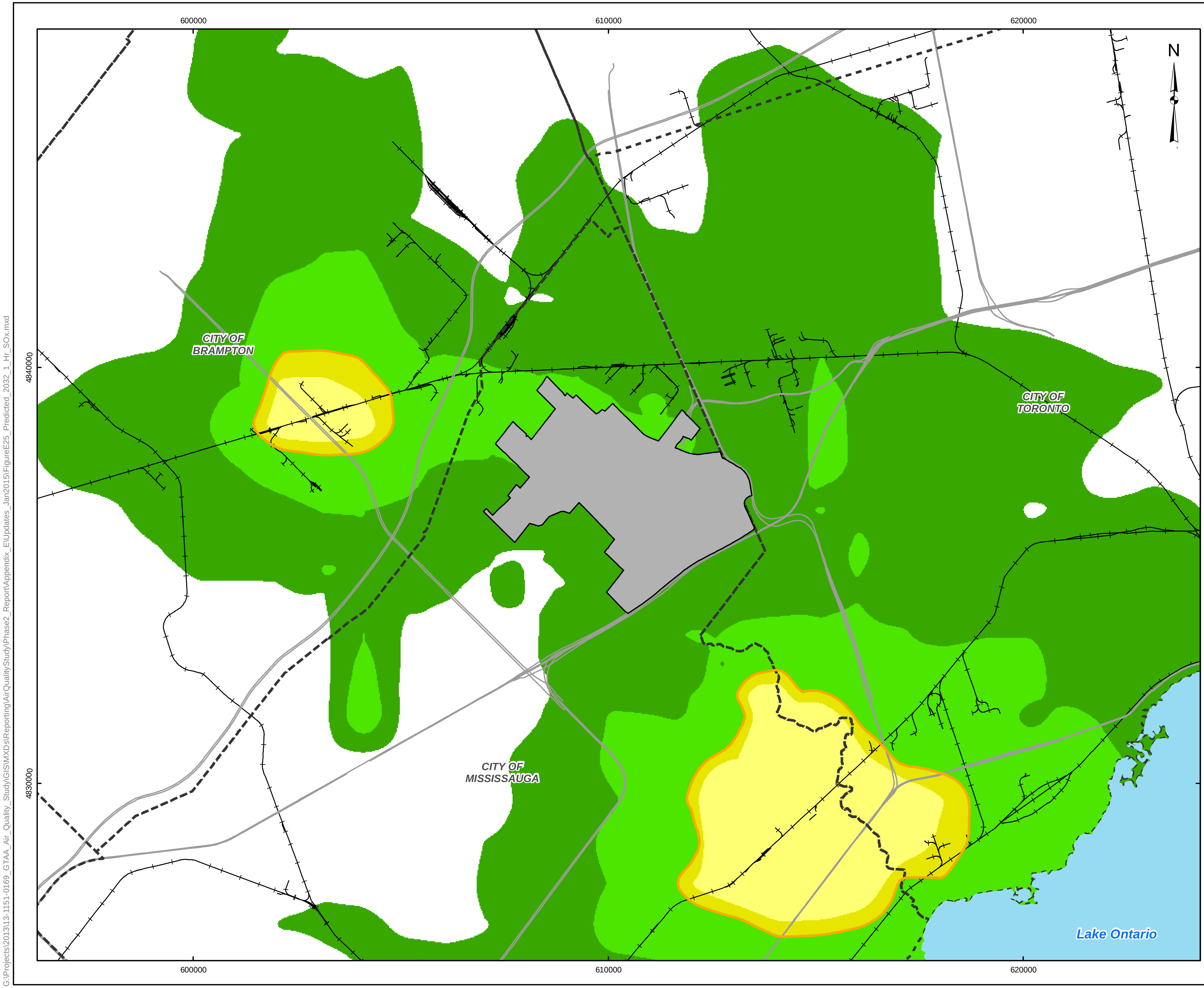
Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169		
DESIGN	ME	2014-11-26
GIS	ME/PR	2015-01-22
CHECK	AB	2015-01-22
REVIEW		

SCALE AS SHOWN REV. 0.0

FIGURE: E24

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudy\Phase2_Report\Appendix_E\Updates_Jan2015\FigureE24_Predicted_2032_24_Hr_NO2.mxd



LEGEND

- Highway
- Railways
- 1-Hour AAQC Standard = 690 µg/m^3
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

1-Hour Predicted Concentration - SO_2 µg/m^3

- < 200
- 200 - 400
- 400 - 690
- 690 - 800
- > 800

NOTES:

1-Hour SO_2 AAQC Standard = 690 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

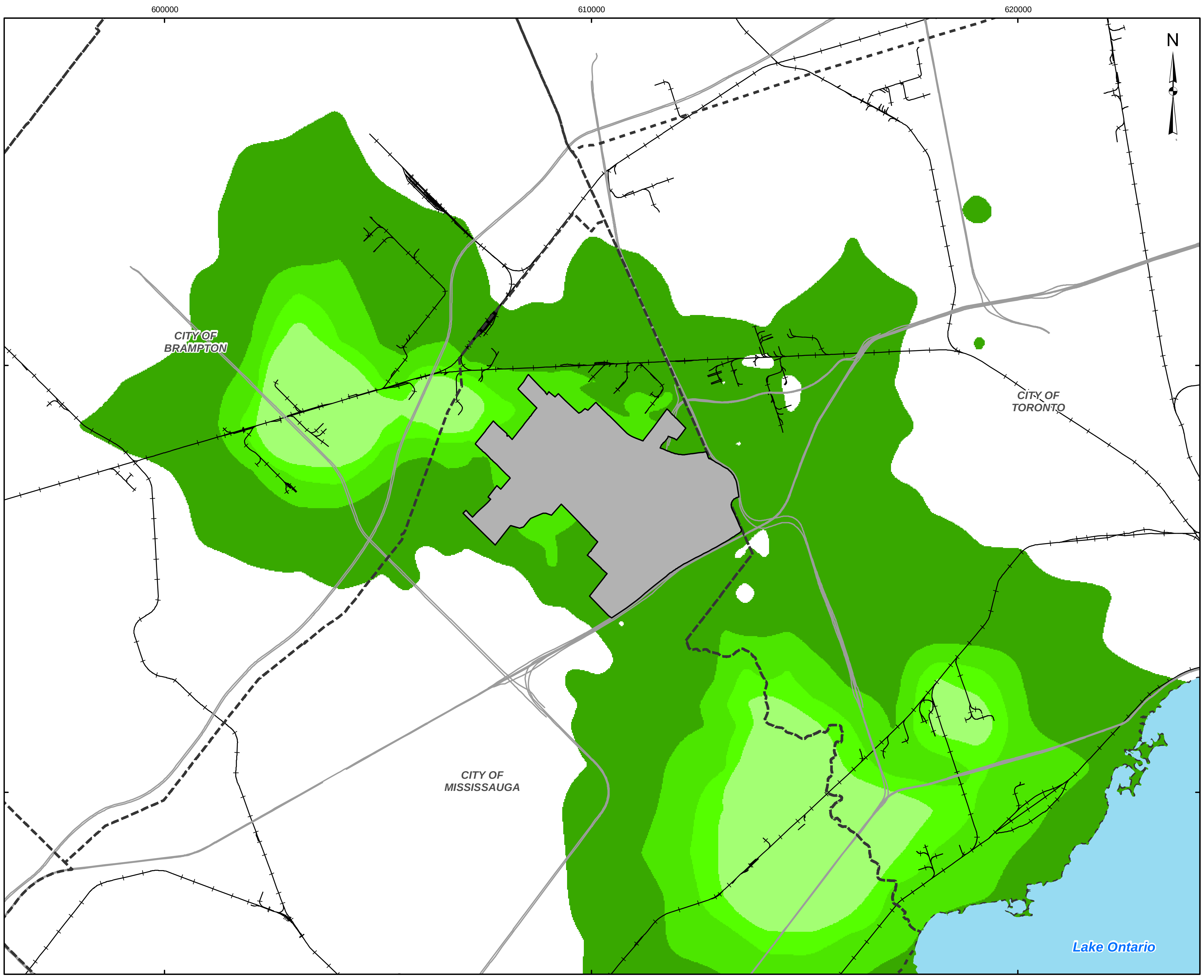
PREDICTED 2032 1-HOUR SO_2
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN
DESIGN	ME	2014-11-26	REV. 0.0
GIS	ME/PR	2015-01-22	
CHECK	AB	2015-01-22	
REVIEW			

FIGURE: E25

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudy\Phase2_Report\Appendix_E\Updates_Jan2015\FigureE25_Predicted_2032_1_Hr_SOx.mxd



LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - SO_2 µg/m^3

- < 30
- 30 - 60
- 60 - 90
- 90 - 120
- > 120

NOTES:

24-Hour SO_2 AAQC Standard = 275 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4

SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

PREDICTED 2032 24-HOUR SO_2
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E26	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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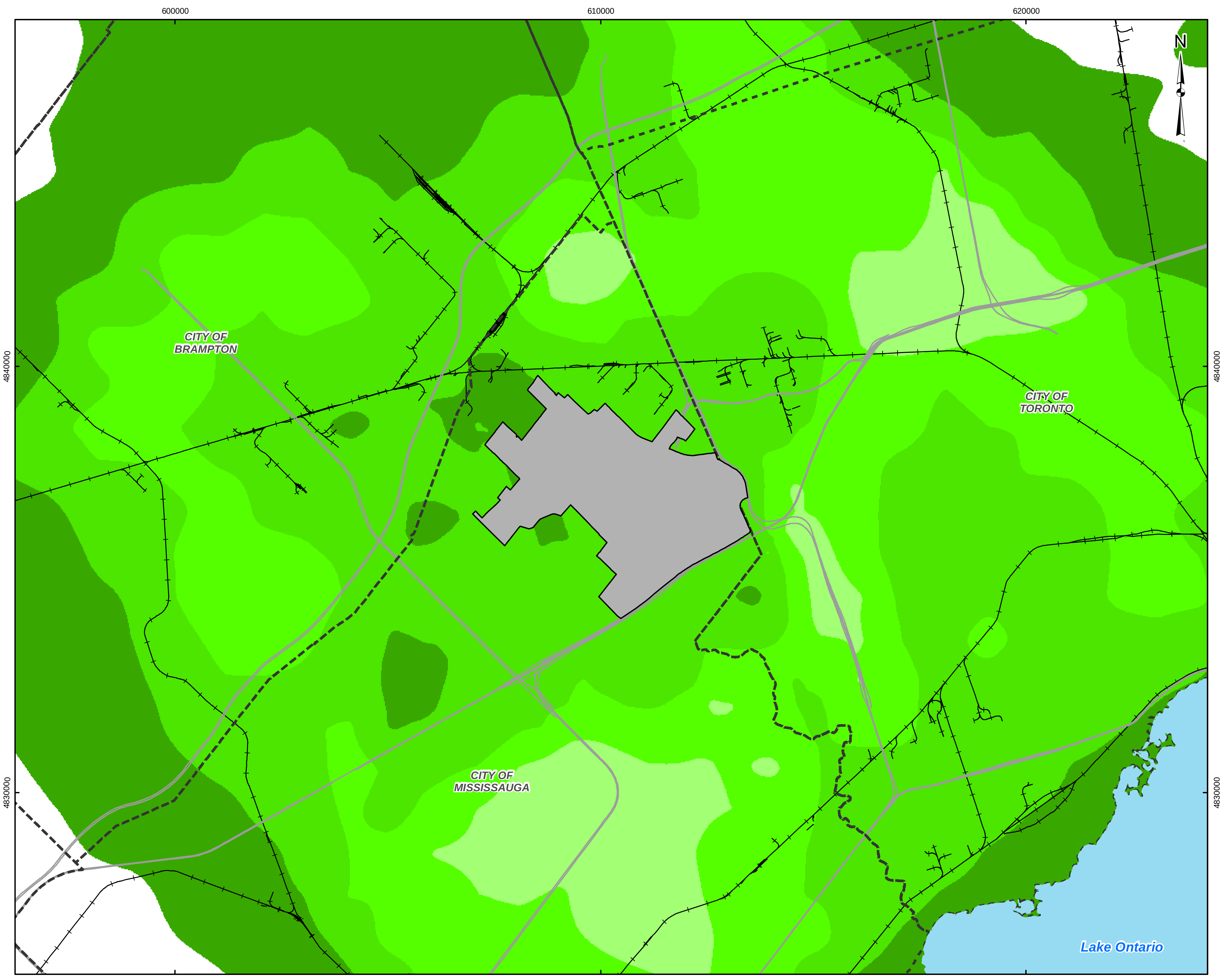


LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - VOC µg/m^3

- < 80
- 80 - 160
- 160 - 240
- 240 - 320
- > 320

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

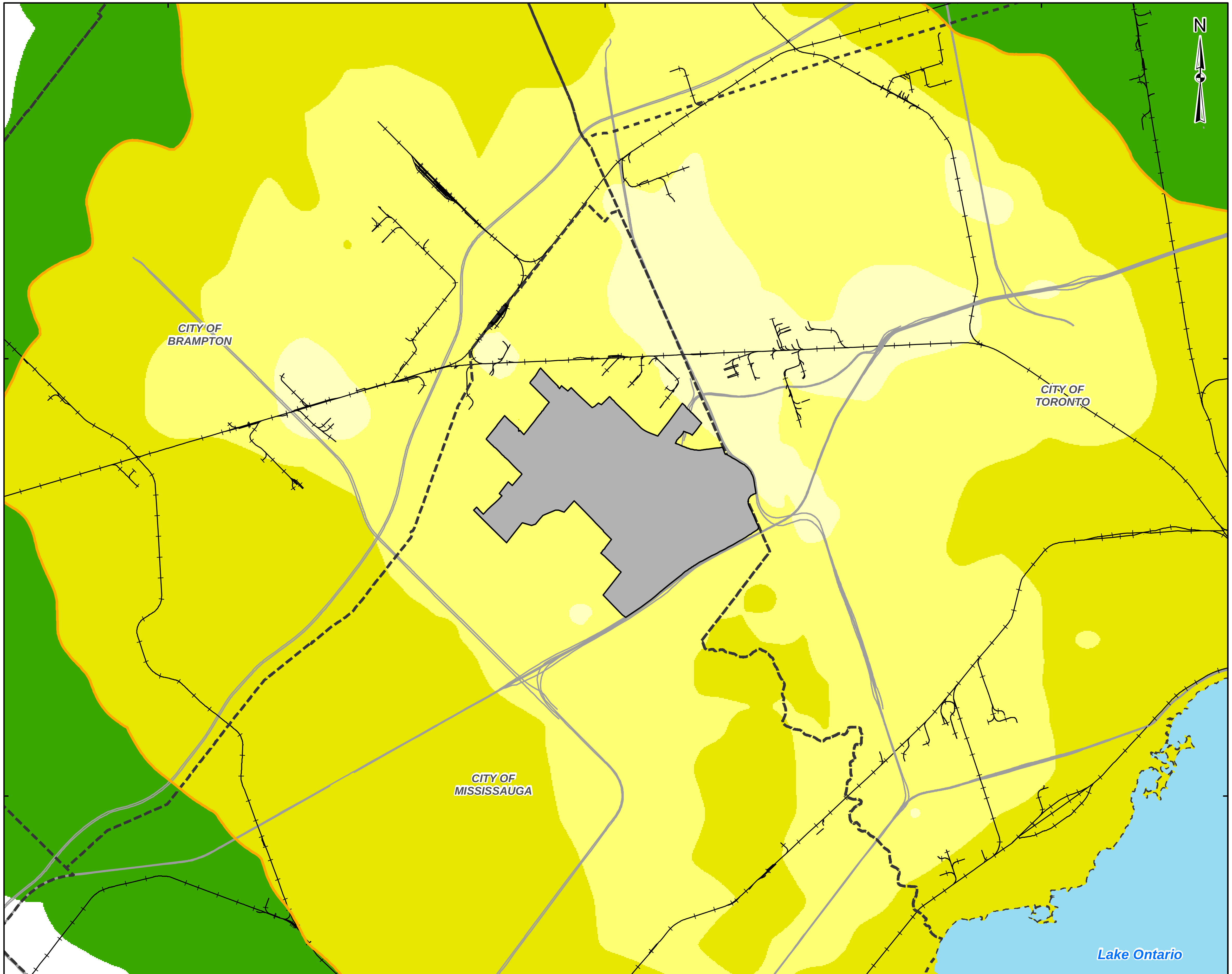
PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2032 24-HOUR VOC
CONCENTRATIONS ASSOCIATED WITH
AIRPORT PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26		
GIS	ME/PR	2015-01-22	FIGURE: E27	
CHECK	AB	2015-01-22		
REVIEW				

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudy\Phase2_Report\Appendix_E\Updates_Jan2015\FigureE27_Predicted_2032_24Hr_VOC.mxd



LEGEND

- Highway
- Railways
- 24-hour AAQC Standard (50 µg/m^3)
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM10 µg/m^3

- < 25
- 25 - 50
- 50 - 100
- 100 - 150
- > 150

NOTES:

24-hour PM10 AAQC Standard = 50 µg/m^3

REFERENCE

Base Data - MNR LIO, obtained 2013
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Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT

TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE

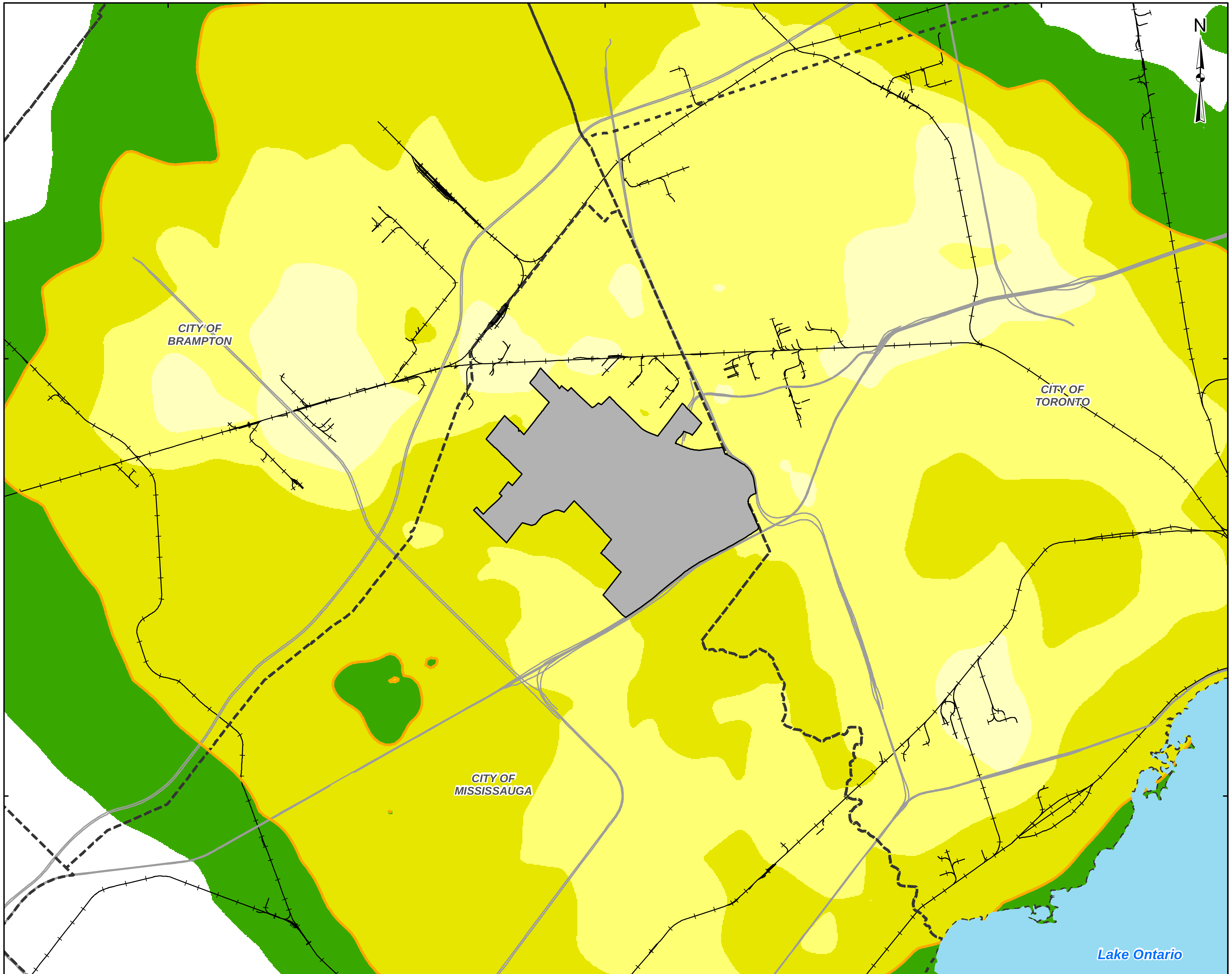
PREDICTED 2032 24-HOUR PM10
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26		
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

FIGURE: E28

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudy\Phase2_Report\Appendix_E\Updates_Jan2015\FigureE28_Predicted_2032_24Hr_PM10.mxd



LEGEND

- Highway
- Railways
- 24-hour AAQC Standard (25 µg/m³)
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

24-Hour Predicted Concentration - PM2.5 µg/m³

- < 15
- 15 - 25
- 25 - 40
- 40 - 55
- > 55

NOTES:

24-hour PM2.5 AAQC Standard = 25 µg/m³

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2032 24-HOUR PM2.5
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E29	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

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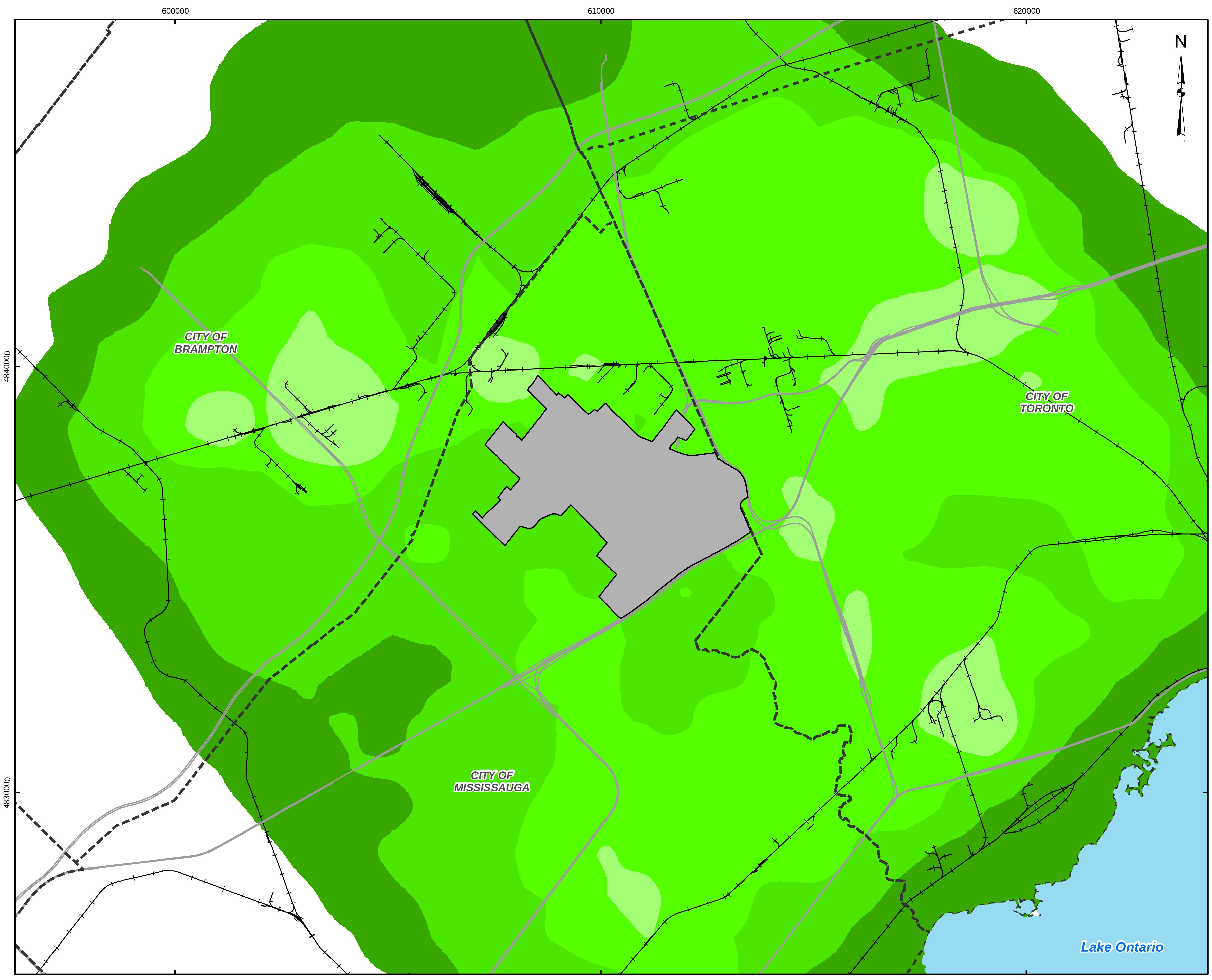

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LEGEND

- Highway
- Railways
- Waterbody
- Municipality
- Toronto/Lester B. Pearson International

Annual Predicted Concentration - PM 2.5 µg/m^3

- < 3
- 3 - 6
- 6 - 9
- 9 - 12
- > 12

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:90,000 KILOMETRES

PROJECT
TORONTO PEARSON AIRPORT - GTAA
AIR QUALITY STUDY

TITLE
PREDICTED 2032 ANNUAL PM2.5
CONCENTRATIONS ASSOCIATED WITH AIRPORT
PLUS REGIONAL EMISSIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-11-26	FIGURE: E30	
GIS	ME/PR	2015-01-22		
CHECK	AB	2015-01-22		
REVIEW				

APPENDIX F

Human Health Risk Results

Substance	Averaging Period	2011 Airport Alone												
		Grid Max	MAX LOC	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
CO	1-hour	5,080	611220.5, 4838659.1	3,452	3,560	2,010	1,090	639	726	1,550	839	790	304	480
	8-hour	1,850	611264.6, 4838642.4	1,163	922	314	171	161	91	211	157	177	65	60
	Annual	87	612639.0, 4838100.0	87	59	13	6.4	3.5	1.1	9.1	2.0	3.9	1.9	1.2
NMHC	1-hour	356	611220.5, 4838659.1	216	221	183	93	71	49	174	50	69	35	33
	24-hour	41	611264.6, 4838642.4	30	29	10	8.3	5.2	2.1	7.5	3.8	4.1	2.5	2.7
	Annual	5.4	612639.0, 4838100.0	5.4	3.8	0.9	0.4	0.2	0.1	0.8	0.2	0.3	0.2	0.1
NO_2	1-hour	378	610614.9, 4839122.8	175	243	137	108	90	81	190	95	92	94	104
	24-hour	37	612639.0, 4838100.0	37	30	13	10	6.4	8.0	22.2	9.4	7.4	4.4	5.3
	Annual	7.9	612639.0, 4838100.0	7.9	6.2	1.9	1.2	0.8	0.4	2.7	0.5	0.8	0.5	0.3
PM10	24-hour	5.0	611264.6, 4838642.4	2.4	1.9	0.72	0.57	0.31	0.23	0.52	0.34	0.36	0.12	0.23
	Annual	0.5	611264.6, 4838642.4	0.5	0.3	0.09	0.04	0.03	0.008	0.06	0.01	0.03	0.01	0.009
PM2.5	24-hour	4.7	611264.6, 4838642.4	2.1	1.8	0.69	0.56	0.28	0.22	0.47	0.33	0.34	0.11	0.22
	Annual	0.5	611264.6, 4838642.4	0.4	0.3	0.08	0.04	0.02	0.007	0.06	0.01	0.03	0.01	0.008
SO_2	1-hour	168	610067.8, 4839568.2	74	92	91	32	33	15	67	17	30	16	17
	24-hour	16	609995.5, 4839499.1	9.5	12	4.2	3.2	2.0	0.78	4.5	1.1	1.7	1.0	0.74
	Annual	1.4	610923.5, 4838797.7	1.1	1.0	0.32	0.15	0.095	0.040	0.37	0.056	0.093	0.059	0.038
THC	1-hour	356	611220.5, 4838659.1	122	112	131	68	55	26	135	41	43	25	26
	24-hour	41	611264.6, 4838642.4	14	17	7.0	5.5	3.4	1.5	5.8	2.2	2.3	1.8	1.5
	Annual	5.4	612639.0, 4838100.0	1.7	1.5	0.5	0.2	0.1	0.1	0.5	0.1	0.1	0.1	0.1
TOG	1-hour	374	611220.5, 4838659.1	229	234	188	95	72	52	177	53	71	36	34
	24-hour	43	611264.6, 4838642.4	31.6	30	10.0	8.5	5.3	2.17	7.6	4.0	4.3	2.5	2.86
	Annual	5.8	612639.0, 4838100.0	5.8	4.0	1.0	0.5	0.3	0.1	0.8	0.2	0.3	0.2	0.1
VOC	1-hour	360	611220.5, 4838659.1	219	224	184	93	71	50	174	51	70	35	33
	24-hour	42	611264.6, 4838642.4	30	29	10	8.3	5.2	2.1	7.5	3.8	4.2	2.5	2.7
	Annual	5.5	612639.0, 4838100.0	5.5	3.8	0.9	0.4	0.2	0.1	0.8	0.2	0.3	0.2	0.1

Substance	Averaging Period	2022 Airport Alone												
		Grid Max	MAX LOC	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
CO	1-hour	8,750	611328.3, 4838719.4	4,644	6,420	2,090	1,210	1,110	807	2,380	1,120	923	622	592
	8-hour	2,250	611328.3, 4838719.4	1,242	1,340	480	217	213	124	485	169	223	89	80
	Annual	89	612639.0, 4838100.0	89	58	15	6.9	4.0	1.2	15	3.2	4.0	1.9	1.1
NMHC	1-hour	984	611296.4, 4838680.9	493	540	241	165	166	71	297	142	123	93	59
	24-hour	94	611455.9, 4838873.4	52	40	22	14	10	4	22	6	8.6	4.9	4.4
	Annual	7.3	611264.6, 4838642.4	6.1	4.4	1.5	0.7	0.4	0.14	1.8	0.34	0.4	0.20	0.12
NO_2	1-hour	304	610546.0, 4839195.3	165	186	133	149	107	110	215	138	90	102	93
	24-hour	44	611296.4, 4838680.9	33	29	17	11	10	11	30	13	9.1	6.0	9.5
	Annual	8.2	611264.6, 4838642.4	7.9	6.3	2.4	1.7	1.1	0.4	3.7	0.9	1.0	0.6	0.4
PM10	24-hour	8.1	611392.1, 4838796.4	3.9	4.2	1.4	0.7	0.4	0.4	1.2	0.7	0.6	0.3	0.3
	Annual	0.7	611296.4, 4838680.9	0.6	0.4	0.1	0.06	0.03	0.01	0.1	0.03	0.04	0.02	0.01
PM2.5	24-hour	7.8	611392.1, 4838796.4	3.3	3.9	1.4	0.7	0.4	0.4	1.1	0.6	0.5	0.2	0.3
	Annual	0.6	611296.4, 4838680.9	0.5	0.4	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
SO_2	1-hour	423	611296.4, 4838680.9	163	200	104	67	59	27	138	66	50	29	21
	24-hour	34	611296.4, 4838680.9	17	14	11	6.3	4.1	1.7	11	3.0	3.4	1.9	1.6
	Annual	2.6	611264.6, 4838642.4	1.8	1.5	0.6	0.3	0.2	0.06	0.8	0.1	0.2	0.09	0.05
THC	1-hour	806	611264.6, 4838642.4	372	360	204	142	140	52	243	119	105	77	43
	24-hour	70	611455.9, 4838873.4	31	27	19	11	8	2.8	19	5.3	7.0	4.0	3.2
	Annual	4.9	611264.6, 4838642.4	3.1	2.6	1.1	0.5	0.3	0.1	1.4	0.3	0.3	0.2	0.1
TOG	1-hour	991	611296.4, 4838680.9	500	556	241	165	167	73	299	142	123	93	61
	24-hour	92	611455.9, 4838873.4	53	41	22	14	10	4.0	22	6.3	8.7	4.9	4.4
	Annual	7.5	611264.6, 4838642.4	6.3	4.6	1.5	0.7	0.4	0.1	1.8	0.4	0.4	0.2	0.1
VOC	1-hour	981	611296.4, 4838680.9	493	543	240	164	166	72	296	141	122	92	59
	24-hour	91	611455.9, 4838873.4	52	40	22	14	10	3.9	22	6.3	8.6	4.9	4.4
	Annual	7.3	611264.6, 4838642.4	6.1	4.5	1.5	0.7	0.4	0.1	1.8	0.3	0.4	0.2	0.1

Substance	Averaging Period	2032 Airport Alone												
		Grid Max	MAX LOC	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
CO	1-hour	9,440	611455.9, 4838873.4	5,214	7,060	2,820	1,690	1,360	840	2,620	1,280	1,410	727	781
	8-hour	2,870	611487.8, 4838911.9	1,419	1,810	595	254	226	115	648	209	246	105	108
	Annual	103	612639.0, 4838100.0	103	67	18	8.1	4.6	1.5	18	3.7	4.7	2.2	1.3
NMHC	1-hour	1,120	611424.0, 4838834.9	542	617	328	218	178	77	360	158	205	84	62
	24-hour	131	611455.9, 4838873.4	58	49	26	20	12	3.7	28	7.3	10	5.1	3.5
	Annual	8.9	611264.6, 4838642.4	7.1	5.2	1.8	0.8	0.5	0.2	2.2	0.3	0.5	0.2	0.1
NO_2	1-hour	342	610442.7, 4839304.0	184	192	142	158	98	121	196	142	87	115	121
	24-hour	46	611264.6, 4838642.4	31	31	18	14	11	10	30	15	10	6.7	10
	Annual	9.2	611264.4, 4838642.4	8.7	7.2	2.8	2.0	1.2	0.5	4.2	0.8	1.2	0.7	0.4
PM10	24-hour	11.3	611551.6, 4838988.9	4.5	6.0	1.9	0.9	0.5	0.4	1.5	0.9	0.7	0.3	0.4
	Annual	0.90	611296.4, 4838680.9	0.7	0.5	0.1	0.07	0.04	0.01	0.1	0.03	0.04	0.02	0.01
PM2.5	24-hour	10.9	611551.6, 4838988.9	3.8	5.6	1.9	0.9	0.4	0.4	1.4	0.9	0.6	0.3	0.3
	Annual	0.70	611296.4, 4838680.9	0.5	0.4	0.1	0.07	0.04	0.01	0.1	0.03	0.04	0.02	0.01
SO_2	1-hour	395	611424.0, 4838834.9	189	229	147	87	73	30	126	72	89	36	30
	24-hour	50	611455.9, 4838873.4	20	18	11	8.4	5.1	1.4	13	3.6	4.3	2.0	1.7
	Annual	3.4	611264.6, 4838642.4	2.1	1.8	0.8	0.4	0.2	0.08	1.0	0.2	0.2	0.1	0.06
THC	1-hour	923	611360.2, 4838757.9	409	407	279	181	150	57	310	138	175	68	55
	24-hour	102	611455.9, 4838873.4	35	31	22	17	10	3.0	24	6.5	7.4	4.0	3.3
	Annual	6.3	611264.6, 4838642.4	3.7	3.2	1.4	0.6	0.4	0.1	1.7	0.3	0.4	0.2	0.1
TOG	1-hour	1,130	611424.0, 4838834.9	550	634	328	219	178	78	360	165	205	85	76
	24-hour	133	611455.9, 4838873.4	60	50	26	20	12	3.7	28	7.8	10.1	5.1	4.2
	Annual	9.2	611264.6, 4838642.4	7.4	5.4	1.9	0.8	0.5	0.2	2.2	0.4	0.5	0.2	0.1
VOC	1-hour	1,120	611424.0, 4838834.9	542	620	326	217	177	77	358	164	204	84	74
	24-hour	131	611455.9, 4838873.4	58	49	26	20	12	3.7	28	7.8	10	5.0	4.1
	Annual	9.0	611264.6, 4838642.4	7.1	5.2	1.8	0.8	0.5	0.2	2.2	0.4	0.5	0.2	0.1

Individual Receptor Locations

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R5	Audubon Blvd, Mississauga	612786, 4832834
R6	County Court Road, Brampton	603172, 4835115
R7	Cattrick St., Malton	608784, 4839600
R8	Bramalae Rd. and Avondale Rd.	604943.1, 4840341.5
R9	Elmcrest Rd.	614039.5, 4833435.8
R10	Kennedy Rd. and Grand Highland Way	608864.24, 4830816.4
R11	Mavis Rd. and 401	604060.15, 4830900.25

Substance	Averaging	2011 Regional Emissions Alone												
	Period	Grid Max	MAX LOC	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
CO	1-hour	13,543	621100.0, 4841600.0	3,735	4,067	7,102	4,809	3,261	4,379	3,717	2,780	3,352	3,128	4,630
	8-hour	6,479	621100.0, 4841600.0	1,749	2,049	3,924	2,821	1,932	2,777	1,377	1,362	2,591	2,105	2,663
	Annual	808	621100.0, 4841600.0	183	202	403	228	189	308	144	154	212	242	291
NO_2	1-hour	294	603100.0, 4838600.0	170	176	171	163	139	168	224	163	160	153	168
	24-hour	101	609600.0, 4840100.0	40	42	53	41	35.5	52.4	55.0	45.9	39.3	45.0	46.7
	Annual	50	609576.7, 4839768.8	16	16	23	15	14	18	18	15	14	15	18
PM10	24-hour	193	604100.0, 4838600.0	135.5	150.2	151.07	123.87	90.68	71.13	104.92	100.65	109.70	100.53	69.88
	Annual	55	604100.0, 4838600.0	40	43	38	30	24	19	25	24	28	26	17
PM2.5	24-hour	143	604100.0, 4838600.0	41	45	48	37	34	35	44	50	36	36	27
	Annual	36	604100.0, 4838600.0	11	12	13	10	8.8	8.2	11	10	10	9.3	6.5
SO_2	1-hour	1,738	615100.0, 4828600.0	257	246	307	294	366	210	417	473	471	208	130
	24-hour	579	615100.0, 4828600.0	29	28	26	27	44	27	42	67	44	16	17
	Annual	135.3	615100.0, 4828600.0	3.2	3.2	3.7	3.6	4.4	3.0	5.2	6.5	5.3	2.4	1.8
VOC	1-hour	1,674	621100.0, 4841600.0	447	460	859	578	796	604	473	538	745	848	709
	24-hour	352	611100.0, 4826600.0	107	114	232	158	216	198	128	158	202	242	230
	Annual	98	611100.0, 4827600.0	28	29	53	41	50	53	32	39	48	56	51

Substance	Averaging	2022 and 2032Regional Emissions Alone												
	Period	Grid Max	MAX LOC	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
CO	1-hour	13,648	621100.0, 4841600.0	3,820	4,067	7,245	4,899	3,364	4,640	3,768	2,894	3,359	3,424	4,630
	8-hour	7,609	621100.0, 4841600.0	2,234	2,544	3,934	2,821	1,932	3,061	1,377	1,532	2,591	2,105	3,127
	Annual	954	620100.0, 4841600.0	228	252	465	281	231	376	178	186	263	295	360
NO_2	1-hour	344	609600.0, 4838600.0	190	194	212	177	180	187	258	182	178	178	186
	24-hour	122	610067.8, 4839908.6	48	50	56	43	41.7	57.6	75.7	49.6	45.4	47.2	57.6
	Annual	49	609576.6, 4839768.8	15	15	22	14	13	17	17	14	13	14	17
PM10	24-hour	206	604100.0, 4838600.0	145.2	164.3	138.70	112.12	92.99	72.07	111.68	113.47	98.48	100.84	74.67
	Annual	49	604100.0, 4838600.0	37	40	35	28	22	17	24	23	26	24	15
PM2.5	24-hour	124	604100.0, 4838600.0	43	48	46	36	36	32	52	44	37	39	28
	Annual	32	604100.0, 4838600.0	11	11	12	9	8.2	7.6	10	10	9	8.7	6.2
SO_2	1-hour	1,738	615100.0, 4828600.0	284	270	307	303	381	211	436	479	471	219	130
	24-hour	607	615100.0, 4828600.0	29	28	36	35	57	28	67	67	56	24	19
	Annual	155	615100.0, 4828600.0	3.7	3.6	4.2	4.3	5.6	3.2	6.6	9.0	6.2	2.8	2.0
VOC	1-hour	1,564	621100.0, 4841600.0	413	406	808	542	707	594	443	484	674	790	644
	24-hour	434	611100.0, 4827600.0	149	161	266	201	272	281	150	183	238	328	279
	Annual	103	611100.0, 4827600.0	30	32	55	43	52	57	34	41	51	61	57

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R11	Mavis Rd. and 401	604060.15, 4830900.25

Substance	Averaging Period	2011 Airport + Regional Emissions												
		Grid Max	MAX LOC	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
CO	1-hour	13,549	621100, 841600	5,166	5,630	7,102	4,809	3,369	4,379	3,720	2,783	3,354	3,128	4,631
	8-hour	6,480	621100, 841600	2,084	2,051	3,953	2,840	1,944	2,777	1,378	1,364	2,600	2,110	2,663
	Annual	809	620100, 841600	270	261	416	235	193	309	153	156	216	244	292
NO_2	1-hour	424	610031.7, 4839533.6	176	244	171	163	139	168	224	163	160	153	168
	24-hour	104	609600, 4840100	53	54	53	41	35.6	52.4	55.4	46.4	39.4	45.0	46.7
	Annual	50	609612.4, 4839733.8	21	20	24	16	14	19	19	15	15	16	18
PM10	24-hour	193	604100, 838600	137	151	151	124	91	71	105	101	110	101	70
	Annual	55	604100, 838600	41	44	39	30	24	19	25	24	28	26	17
PM2.5	24-hour	143	604100, 838600	41	46	49	37	34	35	44	50	36	36	27
	Annual	36	604100, 838600	12	13	13	10	8.8	8.2	11	10	10	9.3	6.5
SO_2	1-hour	1,738	615100, 828600	271	262	307	294	367	210	417	473	471	208	130
	24-hour	580	615100, 828600	35	32	27	27	44	27	42	67	44	16	17
	Annual	135	615100, 828600	4.3	4.2	4.0	3.8	4.5	3.0	5.5	6.5	5.4	2.4	1.9
VOC	1-hour	1,674	621100, 841600	588	600	859	578	797	604	474	538	746	848	709
	24-hour	354	611100, 826600	137	143	232	160	217	198	128	158	203	242	230
	Annual	98	611100, 827600	33	33	54	41	50	53	33	39	48	56	51

Substance	Averaging Period	2022 Airport + Regional Emissions												
		Grid Max	MAX LOC	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
CO	1-hour	13,651	621100, 4841600	5,943	8,303	7,254	4,909	3,371	4,641	4,169	2,894	3,368	3,428	4,630
	8-hour	7,611	621100, 4841600	2,445	2,921	3,936	2,824	1,935	2,979	1,468	1,534	2,593	2,122	2,691
	Annual	956	621100, 4841600	316	309	480	287	234	377	193	189	267	297	361
NO_2	1-hour	329	609600, 4840100	195	214	212	177	181	187	258	183	179	178	186
	24-hour	145	609600, 4840100	53	53	56	43	41.8	59.5	79.7	51.0	45.4	47.2	57.7
	Annual	53	609612.4, 4839734	19	19	23	15	13	17	18	14	14	15	17
PM10	24-hour	207	604100, 4838600	148	167	139	113	93	72	112	114	99	101	75
	Annual	49	604100, 4838600	37	40	35	28	22	17	24	23	26	24	15
PM2.5	24-hour	126	604100, 4838600	45	51	46	36	36	32	53	45	37	39	29
	Annual	32	604100, 4838600	11	12	12	9	8.3	7.6	10	10	9	8.7	6.2
SO_2	1-hour	1,738	615100, 4828600	311	294	308	304	381	211	436	479	471	219	130
	24-hour	603	615100, 4828600	36	35	36	35	57	29	69	67	57	24	19
	Annual	155	615100, 4828600	5.4	5.1	4.7	4.5	5.8	3.3	7.4	9.2	6.3	2.9	2.0
VOC	1-hour	1,564	621100, 4841600	598	737	808	542	708	594	472	484	674	790	644
	24-hour	434	611100, 4827600	182	190	271	202	272	283	161	183	238	328	280
	Annual	103	611100, 4827600	36	36	57	44	53	57	35	41	52	61	57

Substance	Averaging Period	2032 Airport + Regional Emissions												
		Grid Max	MAX LOC	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
CO	1-hour	13,650	621100, 4841600	6,647	8,945	7,253	4,909	3,370	4,641	3,994	2,894	3,366	3,429	4,631
	8-hour	7,611	621100, 4841600	2,825	3,388	3,937	2,824	1,934	2,979	1,587	1,534	2,593	2,123	2,701
	Annual	957	621100, 4841600	331	319	482	289	235	378	196	189	267	297	361
NO_2	1-hour	365	606100, 4840100	199	219	212	177	181	187	258	183	179	178	186
	24-hour	122	609291.6, 4839884.9	55	54	56	43	41.8	59.5	80.1	51.2	45.4	47.2	57.7
	Annual	53	609612.4, 4839733.8	20	20	23	16	13	18	19	14	14	15	17
PM10	24-hour	207	604100, 4838600	149	168	139	113	93	72	112	114	99	101	75
	Annual	49	604100, 4838600	37	40	35	28	22	17	24	23	26	24	15
PM2.5	24-hour	126	604100, 4838600	45	51	46	36	36	32	53	45	37	39	29
	Annual	32	604100, 4838600	11	12	12	9	8.3	7.6	10	10	9	8.7	6.2
SO_2	1-hour	1,738	615100, 4828600	328	311	308	304	381	211	436	479	471	219	130
	24-hour	608	615100, 4828600	37	36	36	36	57	29	69	67	58	24	19
	Annual	155	615100, 4828600	5.7	5.5	4.9	4.6	5.8	3.3	7.6	9.2	6.3	2.9	2.1
VOC	1-hour	1,564	621100, 4841600	673	814	808	542	707	594	498	484	674	790	644
	24-hour	434	611100, 4827600	189	190	271	202	272	284	162	183	238	328	280
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