REGION OF WATERLOO LIGHT RAIL TRANSIT AIR QUALITY IMPACT ASSESSMENT

REGION OF WATERLOO

FINAL

PROJECT NO.: 161-07859-01
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Glossary of Acronyms and Abbreviations

AADT	Annual Average Daily Traffic
AAQC	Ontario's Ambient Air Quality Criteria
AQIA	Air Quality Impact Assessment
AQMP	Air Quality Management Plan
BRT	Bus Rapid Transit
CAAQS	Canadian Ambient Air Quality Standards
CACs	Criteria Air Contaminants
CAQMP	Construction Air Quality Management Plan
CCME	Canadian National Ambient Air Quality Objectives
CO	Carbon Monoxide
COC	Contaminants of Concern
ECCC	Environment and Climate Change Canada
EPR	Environmental Project Report
GHG	Greenhouse Gas
GWP	Global Warming Potential
LRT	Light Rail Transit
MECP	Ministry of the Environment, Conservation and Parks
MOVES	Motor Vehicle Emission Simulator
MTO	Ontario Ministry of Transportation
NAPS	National Air Pollution Surveillance
NO_2	Nitrogen Oxides expressed as Nitrogen Dioxide
NPRI	National Pollutant Release Inventory
$PM_{2.5}$	Fine Particulate Matter
QA/QC	Quality Assurance and Quality Control
SO_2l	Sulphur Dioxide
TPA	Transit Project Assessment
TSP	Total Suspended Particulates
US EPA	United States Environmental Protection Agency
VKT	Vehicle Kilometres Travelled
VOCS	Volatile Organic Compounds
WR	Waterloo Region

1 Introduction

The Region of Waterloo is currently undertaking a Transit Project Assessment (TPA), as per Ontario Regulation 231/08, for Stage 2 of the ION Light Rapid Transit system. Stage 2 ION consists of replacing the existing Bus Rapid Transit (BRT) between Fairway Station and Downtown Cambridge with Light Rail Transit (LRT) along an alignment selected through a comprehensive examination of alternatives. Once completed, the ION system will be comprised of a continuous route that will connect the urban centres of Waterloo, Kitchener, and Cambridge. The Stage 2 ION Study Area is divided into four sections: Kitchener, North Cambridge, Central Cambridge, and South Cambridge.

An Air Quality Assessment was originally completed in 2016 which evaluated the existing air quality conditions within the Study Area, as a basis for more detailed assessment of the preferred route. WSP revised the existing conditions presented in the 2016 report to reflect newer data available and completed an Air Quality Impact Assessment (AQIA) for Stage 2 ION.

The location of the Study Area and the proposed route and stations for Stage 2 ION is shown in **Figure 1-1**.

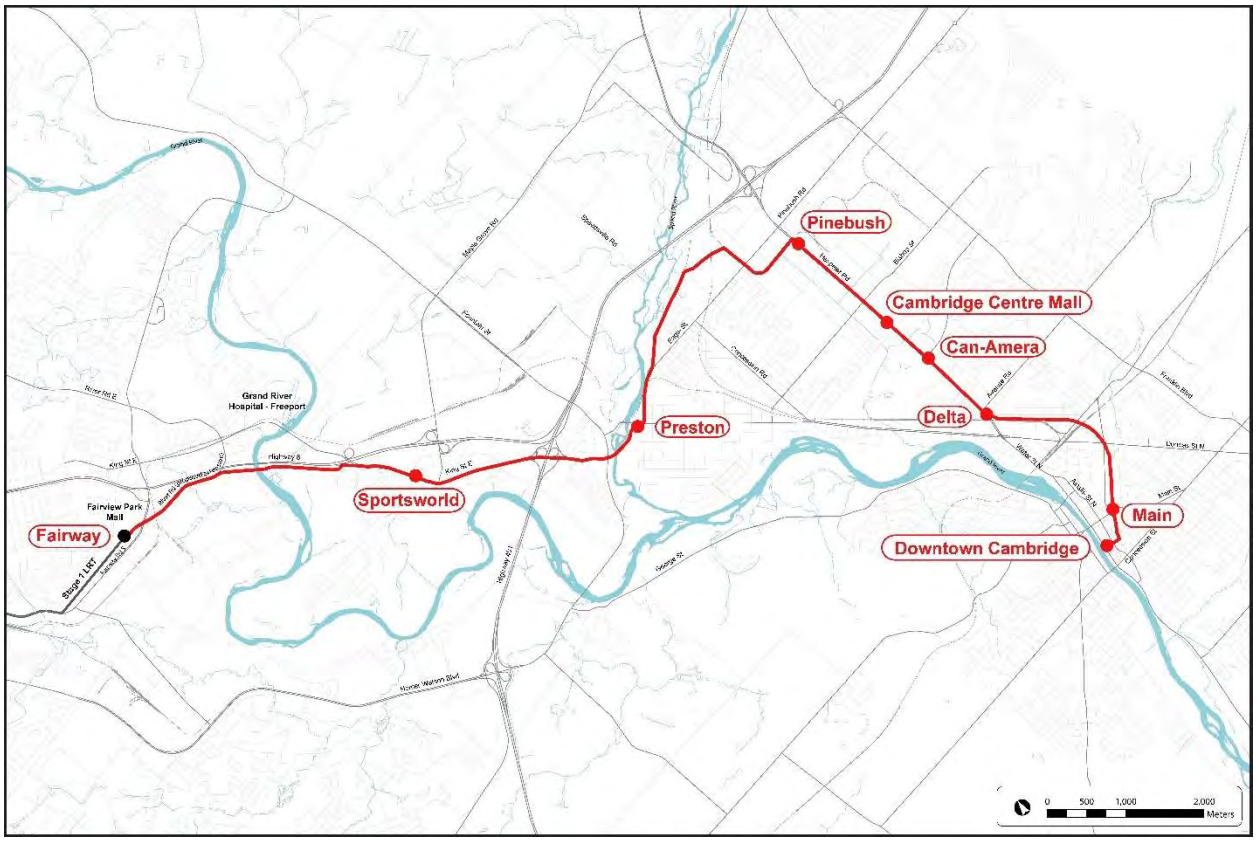


Figure 1-1 Study Area and Proposed Stage 2 ION Route and Stations

1.1 Project Description

To move from planning to implementation, the Region of Waterloo is following the Transit Project Assessment Process, as documented in Ontario Regulation 231/08. This document is a component of the Environmental Project Report (EPR) in support of the TPA, specifically addressing air quality. Potential air quality impacts of the proposed Project are assessed, and appropriate mitigation measures and monitoring requirements are recommended.

1.2 Study Objectives

The purpose of this AQIA is to assess the effect on local air quality of the proposed Project operations once implementation is complete. The objective of the AQIA is to document existing air quality in the Study Area along with the current operational scenario and quantify the impacts from traffic of the project by evaluating the future conditions if the project is built (build scenario) and if the project is not implemented (no-build scenario). To assess the impact on the local air quality, the impact of the existing conditions with each scenario is compared to selected ambient provincial and federal air quality standards and criteria. This AQIA study also addresses the greenhouse gas (GHG) emissions due to the Project and the construction emissions, reviewing mitigation, and potential monitoring programs. This report documents the AQIA assumptions, methodologies, analysis, and impact of the proposed Project on local air quality.

To satisfy the study objectives, existing and planned sensitive receptors within the Study Area of the Project have been confirmed and documented. The air quality impacts of the development of the Project at these receptors have been assessed and compared to air quality indicator limits. A sensitive receptor for air quality is defined by the Ministry of the Environment, Conservation and Parks (MECP) in Ontario Regulation 419/05 – Air Pollution – Local Air Quality (O. Reg. 419/05), Section 30(8) as a:

- place of residence;
- child care facility;
- health care facility;
- senior citizen's residence;
- long-term care facility; or,
- school.

1.3 Study Areas

To evaluate the air quality impacts, the Study Area presented in **Figure 1-1** was divided into smaller areas to conduct more targeted and detailed air quality impact assessments. These identified sub-Study Areas represent where the worst-case air quality impacts are expected for the entire Study Area. These refined areas are presented in **Table 1-1** and were selected based on analysis of traffic data and proposed future road works. Areas not included in the assessment are also outlined in **Table 1-1** along with rationale for not including these areas. A summary of the traffic

data can be found in **Appendix A**. Transit buses and LRT trains were not included in the annual traffic data obtained as part of the Build and No Build future scenarios as they comprised a small portion of overall traffic volume; however, the air quality impacts from transit buses have been included in the air quality background. The selection of the Study Areas was defined based on the following criteria:

- The intersections with the largest expected changes in traffic (Full-Build vs Current);
- The areas with the closest proximity to residential areas and sensitive receptors as defined in Section 1.2 which represent where the worst-case air quality impacts are expected; and,
- The areas with changes in infrastructure (i.e., road widening).

With the above outlined criteria, the following four sub-Study Areas were ultimately selected to complete “hot spot” modelling:

- King Street East between Sportsworld Crossing and Gateway Park Drive (Figure 1-2);
- Shantz Hill Road between north of Preston Parkway to Fountain Street South (Figure 1-3);
- Eagle Street North between Hedley Street and Industrial Road (Figure 1-4); and,
- Hespeler Road between Isherwood Avenue/Munch Avenue and Coronation Boulevard/Dundas Street North (Figure 1-5).

Further discussion of the selection of these sub-Study Areas for this analysis is provided following **Table 1-1**.

Table 1-1 Summary of Sub-Study Areas

Sub-Study Area	Location	Nearest Sensitive Receptor (m)	Expected Traffic Increase/Decrease (Annual Average Daily Traffic)	Included In Assessment	Rationale
1	King Street East from Sportsworld Crossing to Gateway Park Drive	3 m south (adjacent to King St E)	Decrease of approximately 12,260 (AADT) from 2018 - 2031 (LRT - PH2)	Y	Significant decrease in traffic volume in the area is expected, modelling required to quantify expected air quality improvements from the current to full-build future scenarios.
2	Shantz Hill Rd from north of Preston Parkway to Fountain Street South	3 m south and north (adjacent to Shantz Hill Rd)	Increase of approximately 1,600 (AADT) from 2018 - 2031 (LRT - PH2)	Y	Dense residential areas north and south of Shantz Hill Road, additional residential developments to the west, proximity to Highway 401 off-ramp, expected increase in traffic volume.

Sub-Study Area	Location	Nearest Sensitive Receptor (m)	Expected Traffic Increase/Decrease (Annual Average Daily Traffic)	Included In Assessment	Rationale
3	Eagle Street North from Hedley Street to Industrial Road	3 m south and north (adjacent to Eagle St N)	Increase of approximately 18,768 (AADT) from 2018 - 2031 (LRT - PH2)	Y	Significant increase in traffic volume in the area is expected along with road widening. Dense residential areas and other sensitive receptors are located north and south of Eagle Street North and along Concession Road. Modelling required to quantify expected impacts to air quality.
4	Hespeler Road from Isherwood Avenue/Munch Avenue to Dundas Street North	7 m east (adjacent to Hespeler Rd)	Increase of approximately 12,279 (AADT) from 2018 - 2031 (LRT - PH2)	Y	Significant increase in traffic volume in the area is expected. Dense residential areas and other sensitive receptors are located to the east and west along Hespeler Road. Modelling required to quantify expected impacts to air quality.

Sub-Study Area	Location	Nearest Sensitive Receptor (m)	Expected Traffic Increase/Decrease (Annual Average Daily Traffic)	Included In Assessment	Rationale
N/A	Residential area adjacent to the Highway 8 exit ramp to King Street (Grand Hill Drive area) to Sportsworld	34 m east of Highway 8 off ramp	Deer Ridge Rd and King St E is expected to have a decrease of approximately 2472 (AADT) from 2018 - 2031 (LRT - PH2)	N	Nearest sensitive receptors are further away from the roadway. A decrease in traffic is expected in the area, therefore a reduction of air quality impacts leading to a slight improvement on air quality is expected.
N/A	Preston from the Speed River crossing (adjacent to Chopin), through the King/Eagle/Queenston/Chopin block, along Eagle to the CP Rail crossing, and along the CP Rail spur behind the nursing home and the residences in that area	3 m east of Eagle St N	A significant increase in traffic is not expected at King St and Eagle St S (approximately 241 AADT) from 2018 - 2031 (LRT - PH2)	N	Passenger vehicle traffic not expected along the LRT route at Speed River crossing or north of Eagle Street North at the time of the study, only LRT trains. Fewer sensitive receptors are located in close proximity to the route compared to other Study Areas and the increase of volume will not alter the existing air quality.

Sub-Study Area	Location	Nearest Sensitive Receptor (m)	Expected Traffic Increase/Decrease (Annual Average Daily Traffic)	Included In Assessment	Rationale
N/A	Hespeler/Avenue to Downtown Cambridge	5 m southeast of Wellington and Main	A decrease of approximately 1304 (AADT) is expected in the area by 2031 (PH2)	N	A decrease in traffic volume from no build and full-build future scenarios is expected in the area - therefore the air quality in the area would be improved if Phase 2 is implemented.

Notes: N/A – Sub-area not included in air quality impact assessment

Sub-Study Area 1 was selected as a large decrease in traffic volume is expected along the route from current to future full-build scenarios. Annual Average Daily Traffic (AADT) values for the intersections of concern are expected to decrease by approximately 12,260 vehicles between the two scenarios. Several residential receptors are also located immediately south of the proposed route. Sub-Study Area 2 was selected as an increase of approximately 1,600 vehicles are expected from current to future full-build scenarios. The area surrounding the proposed route in sub-Study Area 2 is also densely populated by residential receptors. Sub-Study Area 3 was selected as it met all three criteria outlined. This sub-Study Area was selected as an increase of approximately 18,768 vehicles are expected from current to future full-build scenarios. Proposed road widening is also expected to be implemented before 2031 along Eagle Street North and Speedsville Road, as outlined in Exhibit 5.1: 2019 – 2031 Waterloo Regional Road Projects of the 2018 Transportation Master Plan (Region of Waterloo, June 2019). The area surrounding the proposed route in sub-Study Area 3 is also densely populated with residential receptors, places of worship, retirement homes, and schools. Sub-Study Area 4 was selected as a large increase in traffic volume is expected along the route from current to future full-build scenarios. AADT values for the intersection of concern is expected to increase by approximately 12,279 vehicles. The area surrounding the proposed route in sub-Study Area 4 is also densely populated by residential receptors.

Several areas within the Project area were not selected as part of the AQIA study as they did not best represent the criteria outlined in **Section 1.3**. The Residential area adjacent to the Highway 8 exit ramp to King Street (Grand Hill Drive area) to Sportsworld was not included in the AQIA study as the nearest sensitive receptors are located further away from the roadway compared to other residential areas. A decrease in traffic volume is also expected in the area from the current to Full-Build future scenario. As a result, it is expected that a reduction of air quality impacts will lead to a slight improvement in air quality.

The neighbourhood of Preston, located in North Cambridge, was also not included in the AQIA study as it did not best represent the criteria outlined in **Section 1.3**. Based on the proposed route, passenger vehicle traffic is not expected along the LRT route at Speed River crossing or north of Eagle Street North. Fewer sensitive receptors are located along the proposed route compared to other residential areas and a decrease in traffic volume is expected between the No-Build and Full-Build future scenarios. As a result, the existing air quality is not expected to be altered.

Several main intersections exist along the proposed route between the intersection of Hespeler Road and Avenue Road, and downtown Cambridge. These intersections include Dundas Street North and Beverly Street, Hespeler Road and Brooklyne Road, Main Street and Wellington Street South, and Ainslie Street South and Bruce Street. Traffic volumes at the above listed intersections are expected to decrease or remain unchanged between the No-Build and Full-Build future scenarios. As a result, these intersections were not included in the AQIA study because an overall decrease in traffic volume is expected to improve air quality.

Predicted local air quality impacts associated with roadways tend to drop off significantly at downwind distances greater than 300 m; therefore, the sensitive receptors included in this assessment are limited to within 300 m to either side of the LRT corridor within the sub-Study Areas.

2 Methodology

Local air quality impacts were assessed by estimating contaminant concentrations resulting from the transit operations in three scenarios:

- Current Scenario: existing conditions in the Study Area (2018);
- No-Build Scenario: 2031 horizon (future scenario) with no LRT; and,
- Full-Build Scenario: 2031 horizon (future scenario) with LRT.

In 2031, the LRT project is anticipated to be completed and fully operational. The comparison of the contaminant concentrations between the 2031 Full-Build and No-Build scenarios determines the impact of the Project on local air quality.

The methodology for this AQIA is outlined in the Ontario Ministry of Transportation (MTO) Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects (the 'MTO Guideline', MTO 2019) and following the guidance of the Ministry of the Environment, Conservation and Parks Central Region Draft Document "Traffic Related Air Pollution: Mitigation Strategies and Municipal Class Environmental Assessment Air Quality Impact Assessment Protocol" (MECP Protocol). The MECP Protocol provides guidance on assessment methodologies that can be applied to AQIA for transportation-related projects. The assessment will be completed by conducting emission and dispersion modelling of contaminants.

2.1 Approach

For the three scenarios, roadway traffic in the current and future scenarios have been utilized to determine the local impacts of the Project on sensitive receptors within the identified Study Areas. The impacts have been compared to applicable air quality indicators. The air quality indicators represent target levels set by federal and provincial authorities and are not specifically enforceable. Operations considered in the Study Areas for the current scenario include traffic movement on roads including passenger cars and passenger trucks. Operations considered in the Study Areas for the Full-Build future scenario include expected passenger car and passenger truck changes with LRT operations. The No-Build future scenario includes expected passenger car and passenger truck changes without LRT operations. The traffic volume data was obtained from the Region of Waterloo's traffic model for all scenarios.

Transit buses were not included in the study as they were not expected to significantly impact traffic volumes. In addition, fewer transit buses are expected to be on the roads in the Full-Build future scenario, therefore the air quality impacts from transit buses are not expected. LRT vehicles were also not included as part of the AQIA study due to expected air contaminant emissions being minimal. LRT vehicles will be electric and will not operate using a fuel combustion system. Without a fuel combustion system, most of the criteria air contaminants outlined in **Section 2.2** will not be emitted. LRT trains can emit particulate matter from tire wear and brake dust, however emissions of these contaminants will be minimal.

The assessment was conducted using an emission rate calculation model. The local impacts of all emissions were predicted using an air dispersion model. The United States Environmental Protection Agency's (US EPA) Motor Vehicle Emission Simulator (MOVES) model version 2014b was used to determine vehicle emission rates for passenger vehicles (cars and trucks). Given the routes evaluated, medium and heavy trucks were not modelled as they do not represent a notable proportion of the vehicles on the selected roads compared to passenger vehicles. Note that the total volume of vehicles provided in the traffic data was modelled, however specific emission rates for heavy and medium truck were not applied. The approximate traffic volume breakdown of heavy trucks, medium trucks, and cars within the sub-Study Areas is presented in **Table 2-1**. Based on the traffic data presented in **Table 2-1**, the volume of heavy and medium trucks is expected to have a minimal impact on air quality. MOVES emission factors can be found in **Appendix B**. The US EPA CAL3QHCR model was used to evaluate the dispersion of the emissions associated with the current, full-build and no-build scenarios. CAL3QHCR is a US EPA preferred dispersion model for predicting pollutants near roadway intersections and a more refined version based on CAL3QHC that requires local meteorological data.

Table 2-1 Approximate Heavy Truck, Medium Truck, and Car Traffic Volume in Study Areas

	Heavy Truck	Medium Truck	Light Duty Vehicles (Cars and Trucks)
Total Count	14,666	5,796	403,580
% Total	3.5%	1.4%	95.2%

For the purpose of determining the cumulative impact, the modelled concentrations from the three scenarios have been independently added to ambient background concentrations and the resulting sums compared to the most stringent air quality indicators in order to evaluate the potential for adverse effects. The potential for an adverse effect is considered to exist when the cumulative impact for a contaminant exceeds the air quality indicator at a sensitive receptor. If the ambient background concentration of a contaminant already exceeds the air quality indicator, then the potential for an adverse effect already exists without considering the Project. The impacts to local air quality due to the Project specifically are also examined to determine if the Project itself has any adverse effect on the Study Areas. Air quality indicators are discussed in Section 2.3.

2.2 Criteria Air Contaminants

The assessment of air quality in the Study Areas focused on criteria air contaminants (CACs), compounds that are expected to be released from mobile sources, and contaminants which are generally accepted as indicators of changing air quality (MTO Guide). These compounds are emitted from fuel combustion and particulate

resuspension, tire wear and brake dust from vehicles travelling on roadways, and tire wear and brake dust from LRT vehicles. The criteria air contaminants (CACs) for this project include:

- total suspended particulates (TSP);
- particulate matter less than 10 microns in diameter (PM_{10});
- particulate matter less than 2.5 microns in diameter ($PM_{2.5}$);
- nitrogen oxides, expressed as nitrogen dioxide (NO_2);
- sulphur dioxide (SO_2);
- carbon monoxide (CO); and,
- selected volatile organic compounds (VOCs), including benzene, 1-3 butadiene, formaldehyde, benzo(a)pyrene, acetaldehyde, and acrolein.

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

2.3 Air Quality Indicators

The MECP has issued guidelines related to ambient air concentrations, which are summarized in **Ontario's Ambient Air Quality Criteria** (AAQC) (MECP, 2020). The federal objectives and criteria are presented in the Canadian Ambient Air Quality Standards (CAAQS).

The Ontario AAQC lists desirable concentrations of contaminants in air, based on protection against adverse effects on health and/or the environment. AAQCs are developed by the MECP and have varying time weighted averaging periods (e.g., annual, 24 h, one hour, and 10 minutes) appropriate for the adverse effect that they are intended to protect against (i.e., acute or chronic). The adverse effects considered may be related to health, odour, vegetation, soiling, visibility, and/or corrosion. AAQCs may be changed from time to time based on the state-of-the-science for a contaminant (MECP, 2012).

The CAAQS are specifically health-based air quality objectives for pollutant concentrations in outdoor air. Under the Air Quality Management System, Environment and Climate Change Canada (ECCC) and Health Canada established air quality standards for fine particulate matter. The CAAQS were established by the Federal government in 2013. The CAAQS include a long-term (annual) target for fine particulate matter (Environment Canada, 2013). Applicable standards include the 2020 CAAQS standards for $PM_{2.5}$. Additional CAAQS for NO_2 and SO_2 are to be implemented by 2020 and 2025.

The AAQC and CAAQS are collectively referred to as "air quality indicators" in this AQIA. **Table 2-2** summarizes the air quality indicators related to the contaminants of

concern used in this AQIA. A value above an air quality indicator does not indicate a concern but is used to describe the air quality qualitatively.

Table 2-2 Applicable Air Quality Indicators

Contaminant of Concern	Averaging Time	Ontario Ambient Air Quality Criteria (µg/m^3) [A]	Canadian Ambient Air Quality Standards (µg/m^3)	Project Criteria
PM_{10}	24 h	50	-	50
$PM_{2.5}$	24 h	27	27 [B]	27
	Annual	8.8	8.8	8.8
TSP	24 h	120	-	120
	Annual	60	-	60
NO_2	1 h	400	79.0 [C]	79.0 [C]
	24 h	200	-	200
	Annual	-	22.6	22.6 [C]

Contaminant of Concern	Averaging Time	Ontario Ambient Air Quality Criteria (µg/m^3) [A]	Canadian Ambient Air Quality Standards (µg/m^3)	Project Criteria
SO_2 [D]	10 min	180	-	180
	1 h	100	170 [E]	100
	Annual	10	10 [E]	10
CO	1 h	36,200	-	36,200
	8 h	15,700	-	15,700
Acrolein	1 h	4.5	-	4.5
	24 h	0.4	-	0.4
Benzene	24 h	2.3	-	2.3
	Annual	0.45	-	0.45
1,3-Butadiene	24 h	10	-	10
	Annual	2	-	2

Contaminant of Concern	Averaging Time	Ontario Ambient Air Quality Criteria (µg/m^3) [A]	Canadian Ambient Air Quality Standards (µg/m^3)	Project Criteria
Acetaldehyde	30 min	500	-	500
	24 h	500	-	500
Formaldehyde	24 h	65	-	65
Benzo(a)pyrene	24 h	0.00005	-	0.00005
	Annual	0.00001	-	0.00001

Notes: [A] MECP 2020 Ontario's Ambient Air Quality Criteria

[B] CAAQS published in Canada Gazette Volume 147, No. 21 – May 25, 2013. Final standard phase of 2020 used.

[C] CAAQS published by CCME. Final standard phase of 2025 used.

[D] Ontario Ambient Air Quality Criteria for Sulphur Dioxide (SO_2) May 1, 2020.

[E] CAAQS published by CCME. Final standard phase of 2025 used.

The air quality indicators represent desirable levels of contaminants in ambient air and are not enforceable within any jurisdiction; they represent indicators of ambient air quality provincially and nationally. The air quality indicator value for each contaminant and its applicable averaging period are used to assess air quality.

The applicable averaging periods for the contaminants are based on 30-minute, 1-hour, 8-hour, 24-hour, and annual exposure periods. The averaging periods for each contaminant are based on adverse impacts to human health, flora, or fauna. The limiting effects are indicated within the AAQC (MECP, 2018). As previously mentioned, CAAQS indicator values are based on adverse impacts to human health only.

2.4 Background Air Quality

The concentrations of the selected contaminants for this assessment resulting from background sources were estimated by analyzing historical monitoring data from ECCC National Air Pollution Surveillance (NAPS) stations and the MECP air monitoring stations in the vicinity of the Project. Consideration was given to assess the representativeness of the data for the station selected for use in this assessment. Publicly available data was obtained from these stations for the latest available years. For most of the ambient stations, 2016 is the most recent year of data that has been through rigorous quality assurance and quality control (QA/QC).

Ambient data from the Kitchener, Mississauga, Windsor, and Egbert stations was retained for this assessment. The location of the selected stations is presented in **Figure 2-1**. Prevailing wind direction for the Project area is shown in **Figure 2-2**, based on meteorological data from ECCC Station #48569 located in Kitchener, Ontario. To

assess meteorological conditions at the Project Area, a meteorological data file was developed using five (5) years of data from ECCC Station #48569.

Figure 2-1: Location of Ambient Monitoring Stations

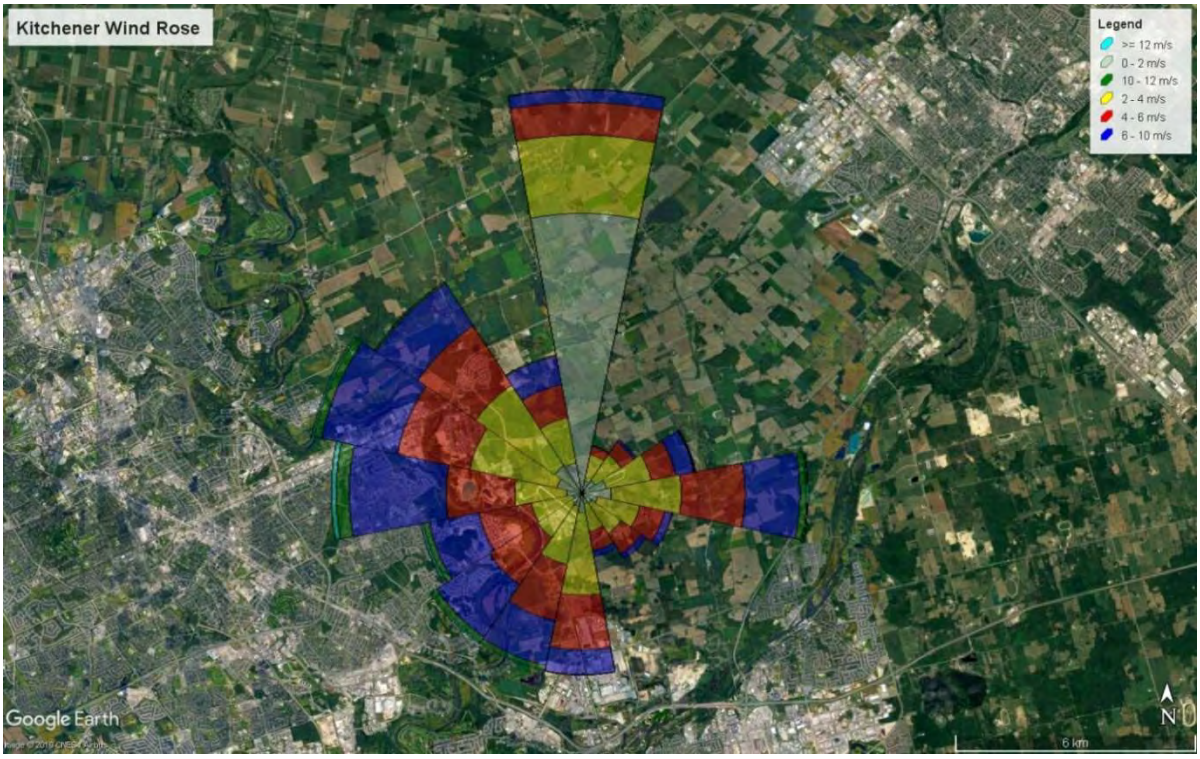


Figure 2-2: Kitchener Wind Rose

Nearby industrial and commercial facilities have the potential to impact existing air quality conditions surrounding the Study Area. Twenty-six (26) facilities have been identified within 5 km of the Study Area which may contribute to existing air quality conditions. These facilities have been identified based on National Pollutant Release Inventory (NPRI) data from 2016 which corresponds to the latest available year with data that has been quality assured by Environment and Climate Change Canada and are shown in **Table 2-3**.

Table 2-3 Summary of Surrounding Industrial Releases

Facility	Description	NOX [A]	CO [A]	VOC [A]	TSP [A]	PM_{10} [A]	$PM_{2.5}$ [A]
Ultra Manufacturing Ltd., Mitchell Plastics	Manufacturing (Plastics)	-	-	97	-	-	-
PWO Canada Inc, Kitchener Plant	Manufacturing	-	0.242	-	-	-	-
Custom Foam Systems Ltd.	Foam Rubber Supplier	-	-	12	-	-	-
Boehmer Box LP	Printing Service	-	-	43	-	3.1	2
Krug Furniture Inc.	Furniture Manufacturing	-	-	53	-	-	-
Inossman North American Corp., Canada Alloy Castings	Foundry	-	-	-	-	0.931	0.927
Triple M Metal LP Kitchener	Recyclable Material Wholesaler-Distributor	-	-	-	1.5	0.437	0.0320
Tri City Ready Mix Limited	Cement and Concrete Product Manufacturing	-	-	-	-	0.605	0.6050
P&H Milling Group (Parrish & Hembecker Limited)	Grain and Oilseed Milling	-	-	-	-	8.7	6.5
Toyota Motor Manufacturing Canada Inc	Motor Vehicle Manufacturing	64	42	971	-	9.2	7.5

Facility	Description	NOX [A]	CO [A]	VOC [A]	TSP [A]	PM_{10} [A]	$PM_{2.5}$ [A]
Arriscraft Canada Inc.	Non-Metallic Mineral Product Manufacturing	-	-	-	-	1.3	1.0
PepsiCo Canada ULC	Food Manufacturing	-	-	-	-	9.8	9.8
Tigercat Industries Inc.	Fabricated Metal Product Manufacturing	-	-	25	-	1.1	1.1
Tenneco Canada	Motor Parts Vehicle Manufacturing	-	-	-	-	2.4	2.3
Plastico Industries Ltd.	Coating, Engraving, Heat Treating and Allied Activities	-	-	0	-	-	-
G&K Services Canada Inc.	Dry Cleaning and Laundry Services	-	-	-	-	1.2	0.690
MacDonald Steel Ltd.	Fabricated Metal Product Manufacturing	-	-	11	-	0.579	0.579
Gerdau Ameristeel Corporation	Iron and Steel Mills and Ferro-Alloy Manufacturing	-	-	-	-	1.1	1.1
Region of Waterloo Waste Management Division Cambridge Landfill Site	Waste Treatment and Disposal	-	-	-	3.3	2.5	0.435
Tigercat Industries Inc. (Plant #5)	Fabricated Metal Product Manufacturing	-	-	32	-	0.615	0.615

Facility	Description	NOX [A]	CO [A]	VOC [A]	TSP [A]	PM_{10} [A]	$PM_{2.5}$ [A]
Barrday Inc.	Textile and Fabric Finishing and Fabric Coating	-	-	18	-	-	-
Grand Valley Fortifiers Ltd.	Animal Food Manufacturing	-	-	-	-	1.6	1.6
Nelson Aggregate Waynco Pit	No-Metallic Mineral Mining and Quarrying	-	-	-	32	10	1.9
Canadian General-Tower Ltd	Plastic Product Manufacturing	-	-	169	-	14	14
Heidelberg Cement Group Cambridge Pit	Non-Metallic Mineral Product Manufacturing	-	-	-	-	6.1	4.2
Dufferin Aggregates Butler Pit	Non-Metallic Mineral Product Manufacturing	34	-	-	20	8.6	3.3
Krug Furniture Inc, Seating	Furniture Manufacturing	-	-	16	-	-	-
Hogg Fuel & Supply Ltd., Kitchener Plant	HVAC Contractor	-	-	-	-	3.2	1.9
Weston Bakeries Ltd., Kitchener	Bakery	-	-	141	-	-	-
Plasti-Fab Ltd., Kitchener	Manufacturer	-	-	84	0.408	-	-
Woodbridge Foam Corp., Morval	Manufacturer	-	-	36	-	-	-

Facility	Description	NOX [A]	CO [A]	VOC [A]	TSP [A]	PM_{10} [A]	$PM_{2.5}$ [A]
Total Emissions		**98**	**42**	**1708**	**57**	**87**	**62**
Ontario Total Emissions		**589 729**	**928 670**	**195 881**	**403 710**	**164 819**	**52 590**
% of Study Area Emissions to Ontario Total		**0.02%**	**0.005%**	**0.87%**	**0.01%**	**0.05%**	**0.12%**

Notes: [A] Measured in tonnes per year

The availability of data varies for each contaminant based on accessibility to quality assured data from ECCC and the MECP. The station information and period of analysis are listed in **Table 2-4**. For $PM_{2.5}$, NO_2,1,3-butadiene, and benzene the MECP station in Kitchener was used. Data from the Windsor West station was used for acrolein. Data from the Mississauga station was used for SO_2. For formaldehyde and acetaldehyde, data from the Egbert station was used. Data for CO was obtained from the Hamilton station. The Kitchener station was selected for $PM_{2.5}$, NO_2, 1,3-butadiene, and benzene as a result of the station proximity to the Project site, as well as the station being located in a similar geographic region with similar local land use. For formaldehyde and acetaldehyde, the MECP Egbert station was selected for use as a result of data availability, similar population size, and similar local land use. For acrolein the MECP Windsor West station was used since only a few stations have data for this contaminant. The MECP Mississauga station was selected for SO_2 due to data availability and similar land use. The MECP Hamilton station was selected for CO as the Kitchener station stopped monitoring for CO in 2012.

Table 2-4 Air Monitoring Stations and Data Available for Selected Contaminants

Station Name	Naps Station ID	$PM_{2.5}$	PM_{10}	TSP	CO	SO_2	NO_2	VOC	Years of Data Available	Distance From Project (km)	Direction From Project
Kitchener	61502	Y	-	-	Y*	Y	Y	Y	2012 - 2016	6	NW
Mississauga	60104	-	-	-	Y	Y	-	-	2012 - 2016	56	E
Egbert	64401	-	-	-	-	Y	-	Y	2006 - 2010	105	NNE
Windsor West	60211	-	-	-	-	Y	-	Y	2006 - 2010	260	SSW
Hamilton	60512	Y	-	-	Y	Y	Y	Y	2012 - 2016	38	SW

Notes: * Kitchener MECP station stopped monitoring for CO in 2012.

Background concentrations for each contaminant were obtained from the stations listed in **Table 2-3.** For contaminants with 1-hour and 24-hour averaging periods, the average 90th percentile over 5 years was recorded. The 90th percentile over the five-year data set is considered to be representative of ambient background conditions for averaging periods of 30 minutes, one hour, 24 hours. The 90th percentile of the available monitoring data is typically considered a conservative estimate of background air quality (CEA Agency and CNSC, 2009). For contaminants with an 8-hour averaging period, the average maximum 8-hour concentration over 5 years was used. For contaminants with an annual averaging period, the average annual mean concentration over 5 years was recorded. **Table 2-5** summarizes background concentrations in the area of the Project.

Note that ambient $PM_{2.5}$ and PM_{10} will include emissions from passenger vehicle, transit bus, and LRT Phase One vehicle brake dust and tire wear. Ambient air monitoring data can also be found in **Appendix C**.

Table 2-5 Summary of Ambient Background Concentrations Within Study Areas

Contaminant	Averaging Period	Background Concentration (µg/m³)	Air Quality Indicator (µg/m³)	% of Indicator
PM_{10}	24 h	27	50	55%
$PM_{2.5}$	24 h	15	27	55%
	Annual	8	8.8	91%
TSP	24 h	49	120	41%
	Annual	27	60	44%
NO_x (expressed as NO_2)	1 h	22	79.0 [A]	27%
	24 h	23	200	12%
	Annual	12	22.6 [A]	51%
SO_2	10 min	9	180	5%
	1 h	5	100	5%
	Annual	2	10	20%
CO	1 h	458	36,200	1%
	8 h	256	15,700	2%
Acrolein	1 h	0.20	4.5	4%
	24 h	0.08	0.4	21%

Contaminant	Averaging Period	Background Concentration (µg/m³)	Air Quality Indicator (µg/m³)	% of Indicator
Benzene	24 h	0.75	2.3	33%
	Annual	0.14	0.45	32%
1,3-Butadiene	24 h	0.06	10	1%
	Annual	0.01	2	1%
Acetaldehyde	30 min	4.8	500	1%
	24 h	1.6	500	0%
Formaldehyde	24 h	4.4	65	7%
Benzo(a)pyrene	24 h	—	0.00005	—
	Annual	—	0.00001	—

Notes:[A] CAAQS published in the Canada Gazette Volume 15, No. 49 — December 9, 2017. Final standard phase of 2025 used.

As shown in **Table 2-5**, all ambient concentrations of CACs were below applicable air quality indicators.

2.5 Sensitive Receptors

Predicted local air quality impacts associated with transportation projects tend to drop off significantly at distances greater than 300 m; therefore, the receptors included in this assessment have been restricted to within 300 m of the selected Study Areas. This also recognizes that as the distance of the receptor from the corridor increases the predicted modelled air quality concentration decrease, therefore the maximum predicted concentration is captured using this distance. The area surrounding the Project is comprised of residential, commercial, and industrial land use types. Various sensitive receptors have been identified within the Study Areas of the Project including residential developments, places of worship, schools, child care centres, and retirement homes. The location of surrounding sensitive receptors can be found in **Appendix D**.

3 Results

3.1 Local Air Quality Impacts

The air dispersion modelling results for the selected CACs for the most impacted sensitive receptor for each scenario are reported in this section. A comparison between future Full-Build and No-Build scenarios is used to determine the impact of the Project on local air quality.

This section includes predicted results for the following three scenarios:

» Current Scenario: conditions currently in the sub-Study Areas (2018);

» No-Build Scenario: 2031 horizon (future scenario) with no LRT; and,

» Full-Build Scenario: 2031 horizon (future scenario) with LRT.

The results for each scenario were evaluated at all sensitive receptors in the selected sub-Study Areas, but only the most impacted receptors are presented. Due to the averaging period, the most impacted sensitive receptor may vary; the 1 h worst-case receptor may not necessarily be the 24 h worst-case receptor. Only the worst-case receptors are identified within this AQIA, so long as either:

» the worst-case receptor is below the air quality indicators; or,

» the background concentration of a COC already exceeds the air quality indicators at the worst-case receptor.

Hourly concentrations were output from the dispersion model in each scenario. Where the air quality indicator was on an hourly basis, the maximum hourly result was reported. If the indicator was on a daily (24 h) basis, the maximum 24 h concentration was reported. The annual results were the average of the hourly values for the year.

The cumulative impacts due to the proposed Project were calculated by aggregating the Project specific modelling results with the 90th percentile background ambient concentrations. The cumulative impacts were compared to air quality indicators for each of the Study Areas and are listed in **Table 3-1** to **Table 3-4**. Where applicable, any resulting concentration that was determined to be in exceedance of the air quality indicator has been bolded. Modelling contour figures can be found in **Appendix E**.

3.1.1 Results for Sub-Study Area 1

Table 3-1 King Street East Between Sportsworld Crossing and Gateway Parkway Cumulative Impacts – Sub-Study Area 1

COC	Averaging Period	2018 Current Scenario (µg/m³) [A]	2031 No-Build (µg/m³) [A]	2031 Full-Build (µg/m³) [A]	Air Quality Indicator	Percent of Indicator Current	Percent of Indicator No-Build	Percent of Indicator Full-Build
NO_2	1 h	33	27	26	79.0 [B]	8.2%	33.9%	33.3%
	24 h	28	26	25	200	14.0%	12.8%	12.7%
	Annual	13	12	12	22.6 [B]	55.4%	53.3%	53.1%
CO	1 h	720	571	561	36200	2.0%	1.6%	1.5%
	8 h	383	308	308	15700	2.4%	2.0%	2.0%
PM_{10}	24 h	30	30	30	50	60.9%	60.9%	60.3%
$PM_{2.5}$	24 h	17	17	16	27	61.4%	61.2%	60.6%
	Annual	8.57	8.56	8.50	8.8	97.4%	97.3%	96.6%
TSP	24 h	55	55	54	120	45.6%	45.6%	45.2%
	Annual	28	28	28	60	46.2%	46.2%	46.0%

COC	Averaging Period	2018 Current Scenario (µg/m³) [A]	2031 No-Build (µg/m³) [A]	2031 Full-Build (µg/m³) [A]	Air Quality Indicator	Percent of Indicator Current	Percent of Indicator No-Build	Percent of Indicator Full-Build
Acetaldehyde	30 min	4.8	0.4	0.1	500	1.0%	0.1%	<0.1%
	24 h	1.765	1.676	1.673	500	0.4%	0.3%	0.3%
Acrolein	1 h	0.1392	0.0965	0.0949	4.5	3.1%	2.1%	2.1%
	24 h	0.1443	0.1268	0.1261	0.4	36.1%	31.7%	31.5%
Benzene	24 h	0.9562	0.8015	0.7971	2.3	41.6%	34.8%	34.7%
	Annual	0.1839	0.1538	0.1529	0.45	40.9%	34.2%	34.0%
1,3-Butadiene	24 h	0.0807	0.0603	0.0602	10	0.8%	0.6%	0.6%
	Annual	0.0155	0.0116	0.0115	2	0.8%	0.6%	0.6%
Benzo (a)pyrene	Annual	0.0000005	0.0000001	0.0000001	0.00001	4.8%	1.0%	0.9%
Formaldehyde	24 h	4.6	4.5	4.5	65	7.1%	6.9%	6.9%

COC	Averaging Period	2018 Current Scenario (µg/m³) [A]	2031 No-Build (µg/m³) [A]	2031 Full-Build (µg/m³) [A]	Air Quality Indicator	Percent of Indicator Current	Percent of Indicator No-Build	Percent of Indicator Full-Build
SO_2	10 min	10.4	10.0	9.9	180	5.8%	5.6%	5.5%
	1 h	5.8	5.6	5.6	100	5.8%	5.6%	5.6%
	Annual	3.1	3.0	3.0	10	30.7%	30.5%	30.4%

Notes: [A] Reported concentration includes ambient background concentrations

[B] CAAQS published in the Canada Gazette Volume 15, No. 49 — December 9, 2017. Final standard phase of 2025 used.

3.1.2 Results for Sub-Study Area 2

Table 3-2 Shantz Hill Road Between North of Preston Parkway to Fountain Street South Cumulative Impacts – Sub-Study Area 2

COC	Averaging Period	2018 Current Scenario (µg/m³) [A]	2031 No-Build (µg/m³) [A]	2031 Full-Build (µg/m³) [A]	Air Quality Indicator	Percent of Indicator Current	Percent of Indicator No-Build	Percent of Indicator Full-Build
NO_2	1 h	39	29	29	79.0 [B]	9.8%	36.3%	36.1%
	24 h	31	26	26	200	15.3%	13.2%	13.1%
	Annual	13	12	12	22.6 [B]	57.6%	53.9%	53.9%
CO	1 h	870	612	610	36200	2.4%	1.7%	1.7%
	8 h	425	326	326	15700	2.7%	2.1%	2.1%
PM_{10}	24 h	33	31	31	50	66.8%	61.8%	61.7%
$PM_{2.5}$	24 h	18	17	17	27	65.3%	62.2%	62.1%
	Annual	**9.15**	**8.81**	8.79	8.8	**104.0%**	**100.1%**	99.9%
TSP	24 h	60	56	56	120	50.0%	46.3%	46.3%
	Annual	29	28	28	60	47.9%	46.5%	46.5%

COC	Averaging Period	2018 Current Scenario (µg/m³) [A]	2031 No-Build (µg/m³) [A]	2031 Full-Build (µg/m³) [A]	Air Quality Indicator	Percent of Indicator Current	Percent of Indicator No-Build	Percent of Indicator Full-Build
Acetaldehyde	30 min	4.85	0.58	0.15	500	1.0%	0.1%	<0.1%
	24 h	1.836	1.690	1.689	500	0.4%	0.3%	0.3%
Acrolein	1 h	0.173	0.102	0.102	4.5	3.8%	2.3%	2.3%
	24 h	0.158	0.129	0.129	0.4	39.6%	32.3%	32.3%
Benzene	24 h	1.072	0.819	0.818	2.3	46.6%	35.6%	35.6%
	Annual	0.206	0.157	0.157	0.45	45.9%	34.9%	34.9%
1,3-Butadiene	24 h	0.0929	0.0606	0.0606	10	0.9%	0.6%	0.6%
	Annual	0.0179	0.0116	0.0116	2	0.9%	0.6%	0.6%
Benzo (a)pyrene	Annual	0.000001	0.0000001	0.0000001	0.00001	7.5%	1.4%	1.4%
Formaldehyde	24 h	4.7	4.5	4.5	65	7.2%	6.9%	6.9%

COC	Averaging Period	2018 Current Scenario (µg/m³) [A]	2031 No-Build (µg/m³) [A]	2031 Full-Build (µg/m³) [A]	Air Quality Indicator	Percent of Indicator Current	Percent of Indicator No-Build	Percent of Indicator Full-Build
SO_2	10 min	11.2	10.4	10.4	180	6.2%	5.8%	5.8%
	1 h	6.3	5.8	5.8	100	6.3%	5.8%	5.8%
	Annual	3.1	3.1	3.1	10	31.1%	30.7%	30.7%

Notes: [A] Reported concentration includes ambient background concentrations

[B] CAAQS published in the Canada Gazette Volume 15, No. 49 — December 9, 2017. Final standard phase of 2025 used.
Bold values are above the air quality indicators

3.1.3 Results for Sub-Study Area 3

Table 3-3 Eagle Street North Between Hedley Street and Industrial Road Cumulative Impacts – Sub-Study Area 3

COC	Averaging Period	2018 Current Scenario (µg/m³) [A]	2031 No-Build (µg/m³) [A]	2031 Full-Build (µg/m³) [A]	Air Quality Indicator	Percent of Indicator Current	Percent of Indicator No-Build	Percent of Indicator Full-Build
NO_2	1 h	34	31	31	79.0 [B]	8.4%	39.1%	39.0%
	24 h	28	27	27	200	14.2%	13.6%	13.6%
	Annual	13	12	12	22.6 [B]	55.7%	54.7%	54.7%
CO	1 h	739	661	659	15000	4.9%	4.4%	4.4%
	8 h	340	326	326	6000	5.7%	5.4%	5.4%
PM_{10}	24 h	30	31	31	50	59.6%	62.7%	62.6%
$PM_{2.5}$	24 h	16	17	17	25	64.7%	68.1%	68.0%
	Annual	8.50	**8.83**	**8.82**	8.8	96.6%	**100.3%**	**100.2%**
TSP	24 h	54	56	56	120	44.6%	47.0%	46.9%
	Annual	27	28	28	60	45.8%	46.7%	46.7%

COC	Averaging Period	2018 Current Scenario (µg/m³) [A]	2031 No-Build (µg/m³) [A]	2031 Full-Build (µg/m³) [A]	Air Quality Indicator	Percent of Indicator Current	Percent of Indicator No-Build	Percent of Indicator Full-Build
Acetaldehyde	30 min	4.85	0.40	0.19	500	1.0%	0.1%	<0.1%
	24 h	1.77	1.71	1.70	500	0.4%	0.3%	0.3%
Acrolein	1 h	0.144	0.109	0.109	4.5	3.2%	2.4%	2.4%
	24 h	0.146	0.132	0.132	0.4	36.5%	33.0%	33.0%
Benzene	24 h	0.97	0.84	0.84	2.3	42.2%	36.5%	36.4%
	Annual	0.19	0.16	0.16	0.45	41.5%	35.8%	35.8%
1,3-Butadiene	24 h	0.43	0.30	0.30	10	4.3%	3.0%	3.0%
	Annual	0.02	0.01	0.01	2	0.8%	0.6%	0.6%
Benzo (a)pyrene	Annual	0.0000005	0.0000002	0.0000002	0.00001	5.1%	1.8%	1.8%
Formaldehyde	24 h	4.6	4.5	4.5	65	7.1%	7.0%	7.0%

COC	Averaging Period	2018 Current Scenario (µg/m³) [A]	2031 No-Build (µg/m³) [A]	2031 Full-Build (µg/m³) [A]	Air Quality Indicator	Percent of Indicator Current	Percent of Indicator No-Build	Percent of Indicator Full-Build
SO_2	10 min	10.5	10.8	10.8	180	5.8%	6.0%	6.0%
	1 h	5.9	6.1	6.1	100	5.9%	6.1%	6.1%
	Annual	3.1	3.1	3.1	10	30.7%	30.9%	30.9%

Notes: [A] Reported concentration includes ambient background concentrations

[B] CAAQS published in the Canada Gazette Volume 15, No. 49 — December 9, 2017. Final standard phase of 2025 used.
Bold values are above the air quality indicators

3.1.4 Results for Sub-Study Area 4

Table 3-4 Hespeler Road Between Isherwood Avenue/Munch Avenue and Coronation Boulevard/Dundas Street North Cumulative Impacts – Study Area 4

COC	Averaging Period	2018 Current Scenario (µg/m³) [A]	2031 No-Build (µg/m³) [A]	2031 Full-Build (µg/m³) [A]	Air Quality Indicator	Percent of Indicator Current	Percent of Indicator No-Build	Percent of Indicator Full-Build
NO_2	1 h	46	35	35	79.0 [B]	11.6%	44.7%	43.7%
	24 h	34	29	29	200	16.8%	14.5%	14.4%
	Annual	14	13	13	22.6 [B]	60.2%	56.3%	56.0%
CO	1 h	1039	756	740	15000	6.9%	5.0%	4.9%
	8 h	467	361	343	6000	7.8%	6.0%	5.7%
PM_{10}	24 h	32	33	33	50	64.8%	66.7%	66.1%
$PM_{2.5}$	24 h	18	18	18	25	70.9%	72.7%	71.9%
	Annual	**9.04**	**9.20**	**9.14**	8.8	**102.7%**	**104.5%**	**103.9%**
TSP	24 h	58	60	59	120	48.5%	50.0%	49.5%
	Annual	28	29	29	60	47.3%	47.9%	47.7%

COC	Averaging Period	2018 Current Scenario (µg/m³) [A]	2031 No-Build (µg/m³) [A]	2031 Full-Build (µg/m³) [A]	Air Quality Indicator	Percent of Indicator Current	Percent of Indicator No-Build	Percent of Indicator Full-Build
Acetaldehyde	30 min	4.85	0.82	0.28	500	1.0%	0.2%	0.1%
	24 h	1.92	1.74	1.73	500	0.4%	0.3%	0.3%
Acrolein	1 h	0.21	0.12	0.12	4.5	4.7%	2.7%	2.7%
	24 h	0.17	0.14	0.14	0.4	43.5%	34.5%	34.2%
Benzene	24 h	1.20	0.88	0.87	2.3	52.3%	38.2%	37.9%
	Annual	0.232	0.169	0.168	0.45	51.5%	37.5%	37.2%
1,3-Butadiene	24 h	0.815	0.410	0.391	10	8.1%	4.1%	3.9%
	Annual	0.021	0.012	0.012	2	1.0%	0.6%	0.6%
Benzo (a)pyrene	Annual	0.0000011	0.0000003	0.0000003	0.00001	10.6%	2.7%	2.5%
Formaldehyde	24 h	4.8	4.6	4.6	65	7.4%	7.1%	7.1%

COC	Averaging Period	2018 Current Scenario (µg/m³) [A]	2031 No-Build (µg/m³) [A]	2031 Full-Build (µg/m³) [A]	Air Quality Indicator	Percent of Indicator Current	Percent of Indicator No-Build	Percent of Indicator Full-Build
SO_2	10 min	12.1	11.7	11.5	180	6.7%	6.5%	6.4%
	1 h	6.9	6.6	6.5	100	6.9%	6.6%	6.5%
	Annual	3.1	3.1	3.1	10	31.5%	31.3%	31.2%

Notes: [A] Reported concentration includes ambient background concentrations

[B] CAAQS published in the Canada Gazette Volume 15, No. 49 — December 9, 2017. Final standard phase of 2025 used.
Bold values are above the air quality indicators

3.2 Impacts From LRT Phase 2 Trains

The proposed LRT vehicles will operate using electric power and not fuel combustion. As a result, the expected contaminants from LRT vehicle operations include particulates from tire wear and brake dust. Compared to tire wear and brake dust emissions from passenger vehicles, brake dust emissions from LRT vehicles is expected to be minimal and would not significantly impact local air quality. The majority of deceleration for LRT vehicles is done using electromagnetic regenerative braking sending current back into the overhead catenary system (OCS). If the OCS is overloaded and cannot take the current, it is released through thermal energy and the OCS brake dust is negligible. While, physical braking systems are a component of LRT vehicles; these are typically only employed during emergency braking or when stopped for operator changeover or servicing and therefore physical braking system dust from the LRT is infrequent due to the infrequent nature of the activity. The tire wear and brake dust emission from the LRT vehicles are also limited by the number of vehicles travelling on the rail at any given time, this volume is significantly smaller than the volume of vehicles travelling on the neighbouring road networks. In addition, tire wear and brake dust emissions from passenger-vehicles represent approximately 10% of the particulate emissions, therefore, it is expected that the tire wear and brake dust from the limited number of LRT vehicles travelling and OCS system (or physical breaking system) at any given time will be negligible when compared to total particulate emissions from the passenger vehicles travelling on the neighbouring road networks.

3.3 Greenhouse Gas Impacts

Greenhouse gases (GHGs) are contributors to the radiative warming effect of the environment that results in global climate change. To investigate the impact of the Project on GHG emissions, the GHG emissions from the Full-Build Scenario (2031) were compared with those of the No-Build Scenario (2031).

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

On a local geographical scale, the warming effects of black carbon may be more prominent than GHGs, especially on a shorter time scale. Black carbon is present in particulate matter generated by fuel combustion processes and absorbs solar radiation at all wavelengths. Given its shorter residence time in the atmosphere than GHGs, the use of the 100-year global warming potential (GWP) factors to determine CO_2 equivalency (CO_{2eq}) may not be appropriate. Other components of diesel combustion such as sulphates, nitrates, and organic carbon (OC) present in particulate matter generally reflect light and have a cooling effect that may partially offset the warming effect of black carbon but are not fully understood. The potential for black carbon and other constituents to impact GHG emissions have not been examined as part of this

assessment. The 100-year GWP values for major GHGs were utilized in this assessment.

To assess GHGs the potential global warming of each chemical is taken into account to express the GHGs in a single parameter called CO_2 equivalent (CO_{2eq}). The 100-year GWP factors from MOVES were used and a single parameter, CO_{2eq}, formed the output. The 100-year GWP factors in MOVES for CO_2, CH_4, and N_2O, are representative of the global warming potential compared to CO_2, and include a factor of 1 for CO_2, 21 for CH_4, and 310 for N_2O.

3.3.1 GHG Emissions Estimates

To assess the impact of the Project on local GHG emissions, the CO_{2eq} emissions for passenger vehicles for all three scenarios in each sub-Study Area were estimated using MOVES. The results of the GHG emissions estimates for the sub-Study areas are consistent with the GHG emissions results for the entire Project area.

The GHG emissions were calculated using the emission factors generated by the US EPA's MOVES2014b model for 2018 and 2031 for passenger vehicles. The distance travelled within a Study Area was calculated as the length of each Study Area multiplied by the number of vehicles within the Study Area to yield the vehicle kilometres travelled (VKT). The average annual VKT estimates for each Study Area and scenario are listed in **Table 3-5**.

Table 3-5 Annualized VKT per Study Area

Study Area	Current (2018) Avg VKT/year	Future No Build (2031) Avg VKT/year	Future Full Build (2031) Avg VKT/year
1	**16,687,070**	15,225,975	14,938,355
2	4,507,020	**4,603,015**	4,548,630
3	14,942,370	**24,279,070**	23,906,405
4	16,712,985	**19,915,130**	18,935,105

Notes: The largest values for each Study Area are **bolded**

The CO_{2eq} emission rates for each scenario were multiplied by the annual VKT estimates to calculate the total GHG emissions for each Study Area. The results for the Current, future No-Build, and future Full-Build scenarios are listed in **Table 3-6**. For each Study Area, a comparison of the percent change in GHG emission estimates between the Current and Future scenarios was performed. Note that the increase in GHG emissions in Study Area 3 for both future scenarios is attributed to a significant increase in the 2031 projected VKT in the area compared to the current scenario VKT (as shown in **Table 3-5**).

Table 3-6 Total GHG Emissions (as CO2eq) per Study Area

Study Area	Current (2018) CO_{2eq} (tonnes/year)	Future No Build (2031) CO_{2eq} (tonnes/year)	2018-2031 No Build (% Change)	Future Full Build (2031) CO_{2eq} (tonnes/year)	2018-2031 Full Build (% Change)
1	**4,925**	3,167	-36%	3,107	-37%
2	**1,330**	958	-28%	946	-29%
3	4,410	**5,051**	15%	4,973	13%
4	**4,933**	4,143	-16%	3,939	-20%

Notes: The largest values for each Study Area are **bolded**

The results of the GHG emissions are compared to the provincial and regional GHG emission estimates in **Table 3-7**. The provincial and regional estimates presented include the latest publicly available data for the same that has been through rigorous quality assurance and quality control. Provincial GHG emission estimates were extracted from Canada's National Inventory Report (2019) for the year 2015 to correspond to the latest regional GHG emission data available for the Region of Waterloo. The Region of Waterloo data was obtained from the Climate Action WR An Update on Waterloo Region's Community Carbon Footprint, released in 2017.

Table 3-7 Annual GHG Emissions Per Study Area

Study Area	Current (2018) CO_{2eq} (tonnes)	Future No Build (2031) CO_{2eq} (tonnes)	Future Full Build (2031) CO_{2eq} (tonnes)	2015 Provincial Emissions [A]	2018-2031 (% of Provincial Total)	2015 Regional Emissions [B]	2018-2031 (% of Regional Total)
1	**4,925**	3,167	3,107	165,000 kt	<0.01%	4,300 kt	0.1%
2	**1,330**	958	946		<0.01%		<0.1%
3	4,410	**5,051**	4,973		<0.01%		0.1%
4	**4,933**	4,143	3,939		<0.01%		0.1%

Notes: [A] National Inventory Report 1990-2017: Greenhouse Gas Sources and Sinks in Canada: Executive Summary (ECCC, 2019)

[B] Climate Action WR An Update on Waterloo Region's Community Carbon Footprint, 2017

The largest values for each Study Area are in **bold**

The reduction in total CO_{2eq} emissions from the No-Build to Full-Build scenarios is an indication of an improvement in total GHG emissions within all Study Areas due to the Project. Vehicle kilometres travelled by passenger vehicles decrease in the 2031 Full-Build Scenario when compared to the 2031 No-Build Scenario. To show that the Project emissions can be considered insignificant when compared to Provincial and Regional 2015 emission totals, and the provincial 2030 GHG targets, the expected emissions for each scenario and Study Area are discussed below.

For all scenarios considered (Current, Future No-Build, and Future Full-Build) in Study Area 1, 3, and 4 the CO_{2eq} emissions were less than 0.01% of the total 2015 Provincial emissions and approximately 0.1% of the 2015 Regional emissions. Therefore, it can be concluded from the results that the proposed Project does not significantly impact the Regional and Provincial GHG inventories.

For all scenarios considered (Current, Future No-Build, and Future Full-Build) in Study Area 2, the CO2eq emissions were less than 0.01% of the total 2015 Provincial emissions and less than 0.1% of the 2015 Regional emissions. Therefore, it can be concluded from the results that the proposed Project does not significantly impact the Regional and Provincial GHG inventories.

The potential Project was also compared to the future Ontario Provincial target for 2030. As there were no 2030 target emissions established for the Region of Waterloo no comparison could be performed at the time of this Study, for the Future emissions to a 2030 regional target. The total estimated CO2eq from the sum of the four Study Area is approximately 0.02% for Future No Build and 0.01% for Full-Build respectively, of the Ontario Provincial Target for 2030 of 111 Mt/year. Therefore, the emissions for both Future scenarios are negligible compared to the 2030 Provincial target.

4 Climate Change Adaptation

Climate change is defined as a significant change in long-term weather patterns including temperature, precipitation, and wind. Increased GHG emissions have played a major role in climate change, mainly from the burning of fossil fuels for energy production. If current GHG emissions trends continue, the Region of Waterloo is expected to experience increased temperatures, precipitation, and extreme weather events.[1]These changes to climate will impact health, infrastructure and buildings, natural environment, energy supply and distribution, and the economy.[2]

As outlined in the Region of Waterloo Asset Management Plan (2020), focus areas and strategic objectives for the Region include improving resilience to climate change and severe weather. In order to reach these objectives, the Region is committed to reducing GHG emissions through minimizing the impact of infrastructure on the environment.

The design and implementation of the Stage 2 ION LRT Project will result in decreased GHG emissions, as the project prioritizes an alternative low carbon transportation option. The Project will be designed to operate using electricity, resulting in a significant decrease in demand for energy from fossil fuel combustion which will result in reduced GHG emissions. As shown in **Table 3-6**, GHG emissions are expected to decrease in the future full build scenario when compared to the future no build scenario. By reducing the demand for fossil fuels and providing a low carbon transportation option to residents, the Project will allow the Region of Waterloo to minimize climate change impacts to health, infrastructure and buildings, natural environment, energy supply and distribution, and the economy.

[1] University of Waterloo, Localized Climate Projections for Waterloo Region, 2015.
[2] Region of Waterloo, A Community Climate Adaptation Plan, 2019.

5 Mitigation of Air Quality Impacts

The impact of the Project components on local air quality and GHGs were investigated in the previous sections. This section documents a qualitative assessment of the potential effects that may occur and proposed mitigation measures and monitoring activities (as applicable) identified to minimize the predicted effects on air quality.

The results presented in Section 3 show a decrease in the maximum predicted concentrations during operations from the Current scenario to both the future No-Build and future Full-Build scenarios for all four Study Areas. This overall decrease in concentrations is attributed to the expected decrease in roadway traffic from the No-Build future scenario to the Full-Build future scenario, increased efficiency of vehicles, more stringent emission standards, and emission control devices on future vehicles included within the MOVES model. A comparison of the Full-Build and No-Build future scenarios indicates that the Project will decrease GHG emissions, therefore improving local air quality within the general Study Area. The future Full-Build has a positive impact from a GHG (climate change) perspective. As a result, there is no proposed mitigation required during the operations with the exception of the continued regular road maintenance along the route.

5.1 Construction Emissions and Mitigation

The construction activities associated with the Project consist of the construction of new structures, platforms, transit lanes, walkways and landscaped areas. Air emissions associated with construction typically include:

1. TSP, PM_{10}, and $PM_{2.5}$ resulting from:
    - » Stockpiling of soils and other friable material;
    - » Granular material loading and unloading activities;
    - » Transportation of soils and other friable materials via dump trucks;
    - » Soil excavation and filling activities required to facilitate the modified site layout for the new station;
    - » Movement of heavy and light vehicles on paved and unpaved roads;
    - » Demolition of structures necessary to accommodate the transit stops; and,
    - » Cutting of existing concrete.
2. Emissions resulting from the combustion engines of construction equipment

Construction activities are exempt from air regulatory requirements in Ontario due to their temporary nature. Nuisance fugitive dust (coarse particulate such as TSP and PM_{10}) will be the primary air quality impact during the construction phase of the project. Nuisance fugitive dust can be managed through a Construction Air Quality Management Plan (CAQMP) for fugitive dust following the recommendations outlined in the existing “Region of Waterloo Rapid Transit Project Environmental Project Report”, dated March 2012, and the ECCC guidance document “Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities”, dated March 2005. Air Quality

Management Plans should ensure that dust from construction and demolition activities do not impact surrounding environmentally sensitive areas such as aquatic habitats and fisheries, terrestrial vegetation, and faunal communities, as well as residential properties in proximity to work areas.

To mitigate construction activities a CAQMP must be developed to address construction equipment vehicle exhaust, potential traffic disruptions and congestion, fugitive dust, and odour. The CAQMP must be submitted to the Region of Waterloo and MECP for review to ensure it is adequate to control fugitive releases caused by construction. Potential mitigation measures that may be included in the CAQMP include:

- Dust suppression measures (e.g., application of water wherever appropriate, or the use of approved non-chloride chemical dust suppressants, where the application of water is not suitable);
- Use of dump trucks with retractable covers for the transport of soils and other friable materials;
- Minimize the number of loadings and unloading of soils and other friable materials;
- Minimize drop heights, use enclosed chutes, and cover bins for debris associated with deconstruction of affected structures;
- Washing of equipment and/use of mud mats where practical at construction site exits to limit the migration of soil and dust off-site;
- Stockpiling of soil and other friable materials in locations that are less exposed to wind (e.g., protected from the wind by suitable barriers or wind fences/screens, or covered when long-term storage is required) and away from sensitive receptors to the extent possible;
- Reduction of unnecessary traffic and implementation of speed limits;
- Permanent stabilization of exposed soil areas with non-erodible material (e.g., stone or vegetation) as soon as practicably possible after construction in the affected area is completed;
- Ensuring that all construction vehicles, machinery, and equipment are equipped with current emission controls, which are in a state of good repair; and,
- Dust-generating activities should be minimized during conditions of high wind.

In addition to the CAQMP, construction activities will be monitored by a qualified Environmental Inspector who will frequently review the efficacy of the mitigation measures and construction best management practices to confirm they are functioning as intended. In the event that mitigation is found to not be effective, revised mitigation measures designed to improve effectiveness will be implemented. Dust levels will be monitored daily by the Contractor and frequently by the Environmental Inspector to assess the effectiveness of dust suppression measures and adjust as required. Monitoring will continue throughout the construction phase until activities are complete, all exposed soils have been stabilized, and all construction waste has been removed from site. A complaint response protocol will be established for nuisance effects, such as dust, for local residents to provide feedback. Regular inspections of dust emissions

will be carried out by the Contractor (frequency to be defined prior to project construction) to confirm dust control watering frequency and rates are adequate for control. Competent Site Supervisors should monitor the site for wind direction and weather conditions to ensure that high-risk dust generating activities are reduced when the wind is blowing consistently towards nearby sensitive receptors. The Site Supervisor should also monitor for visible fugitive dust and take action to determine and correct the cause. Specific details regarding monitoring should be included in the CAQMP.

5.2 Operations Emissions and Mitigation

As outlined in Section 2.1, criteria air contaminant emissions from LRT vehicles will be negligible. LRT vehicles will be electric and will not operate using a fuel combustion system, eliminating emissions of most of the criteria air contaminants. Operations of LRT vehicles have the potential to emit particulates only from tire wear, however these emissions are minimal given the number of trains that will be travelling compared to the emission from much higher number vehicles travelling on neighbouring road networks. Tire wear emissions can be mitigated through regular vehicle maintenance. Maintenance and storage facilities associated with LRT operations also have the potential to emit some particulates. Nuisance fugitive dust can be managed through an Air Quality Management Plan (AQMP) for fugitive dust following the recommendations outlined in the “Region of Waterloo Rapid Transit Project Environmental Project Report”, dated March 2012.

6 Discussion

Contaminant emission rates for vehicles within the four Study Areas were predicted using the US EPA's MOVES2014b model and can be found in **Appendix B**. These rates were supplied to the US EPA's approved dispersion model for predicting contaminant concentrations near roadway intersections, CAL3QHCR, to predict ambient air concentrations of each contaminant. The CAL3QHCR model was run for three scenarios (existing "Current" conditions, future Full-Build, and future No-Build) for the four sub-Study Areas that were identified to be the sectors with the highest potential impact from the proposed Project.

The results presented show a decrease in the maximum predicted concentrations from the current scenario to both the future No-Build and future Full-Build scenarios for the four sub-Study Areas included in this AQIA. This overall decrease in concentrations for the future scenarios is attributed to the expected decrease is roadway traffic between the No-Build and Full-Build future scenarios which is partially attributed to the implementation of Stage 2 ION. Other contributors to decrease concentrations are increased efficiency of vehicles, more stringent emission standards, and emission control devices on future vehicles included within the MOVES model.

A comparison of the future Full-Build and the future No-Build results presented in **Section 3** indicate that local air quality will be improved compared to the Current conditions under both scenarios. The implementation of the Stage 2 ION Project will result in better air quality than the No-Build scenario and is expected to result in decrease GHG emissions.

The results presented in **Table 3-1** to **Table 3-4** show a comparison of the predicted contaminant concentrations for each Study Area and the respective air quality indicator for each averaging period. For Study Areas 2, 3, and 4, the average annual concentrations of $PM_{2.5}$ were predicted to exceed the air quality indicators; however, the results presented are conservative as the modelling conducted included the maximum emissions on a daily basis and were conservatively assumed to remain constant for the full year. Therefore, it is expected that the air quality in the overall Study Area and in the spot check Study Areas will remain good for both future scenarios and for all contaminants assessed.

The results also showed increased concentrations of PM_{10} and TSP in all four Study Areas between current to future scenarios; however, the concentrations of these contaminants remained below the air quality indicators. It is expected that the increase in PM_{10} and TSP concentrations is due to an overall increase in traffic volume within the entire Project area. All of the remaining CACs were also found to be below the air quality indicators and generally showed decreased expected concentrations between the Current and Full-Build scenarios, likely due to more stringent fuel standards and combustion efficiencies that are reflected in the modelling of future year fleets.

The GHG emission estimates for all four Study Areas are considered to be insignificant when compared to the 2015 Provincial CO_{2eq} emission levels as well as the Provincial Target set for 2030. In general, the GHG emission estimates were lower for the future Full-Build scenario than for the future No-Build scenario. As such, the total GHG emissions within the general area are expected to improve with the implementation of the proposed Project.

7 Conclusion

A comparative study of the concentration of twelve pollutants released by vehicles travelling in the general area of the proposed Project was conducted. The MOVES model was used to predict contaminant emission rates and these rates were input to the CAL3QHCR dispersion model for three scenarios (Current, No-Build, and Full-Build) and for each of the four sub-Study Areas. The results of this assessment allow for the following conclusions:

- With the exception of TSP, PM_{10}, and $PM_{2.5}$, the maximum predicted concentrations of all contaminants are expected to decrease from the current to both future No-Build and Full-Build scenarios, regardless of the increase in traffic expected in the current to future No-Build scenarios. The results shown in **Table 3-2** to **Table 3-4** also indicate that criteria air contaminants will be marginally lower for the Full-Build compared to the No-Build scenario;
- The results of the dispersion modelling did not show a significant increase of PM_{10} and TSP concentrations in all four Study Areas between the current and future scenarios; however, the results remained below the air quality indicators;
- The results shown in **Table 3-2** to **Table 3-4** indicate that there is a potential for the annual average concentration of $PM_{2.5}$ to be slightly above the air quality indicators in Study Areas 2, 3, and 4 for the future scenarios. However, given that the assessment is conservative with maximum emission rates presented and applied to a full hour, day or year, this is unlikely to occur. In addition, for all Study Areas there is a decrease in $PM_{2.5}$ emissions from the future No-Build to future Full-Build scenario; and
- The GHG emissions for the Full-Build and No-Build future scenarios will decrease by 37% and 36% in Study Area 1, 29% and 28% in Study Area 2, and 20% and 16% in Study Area 4, respectively compared to the Current scenario. The GHG emissions for the Full-Build and No-Build future scenarios are expected to increase by 13% and 15% in Study Area 3, respectively compared to the Current scenario. The increase in CO2eq emissions for Study Area 3 is attributed to a future increase in traffic volume within the region compared to the current scenario (as shown in **Table 3-5**) as future road widening is planned for the area. Overall, GHG emissions are expected to decrease from the future No-Build to future Full-Build scenario. Therefore, from a climate change perspective this project will assist the Region of Waterloo to achieve their GHG reduction targets.

Overall, the results of the future No-Build and future Full-Build scenarios indicate that the proposed Project, if implemented, is expected to result in a decrease in criteria air contaminants and GHG emissions. From a climate change perspective this project will assist the Region of Waterloo to achieve their GHG reduction targets.

APPENDIX

A TRAFFIC DATA

Study Area 1 (2018)																								
24-hr count location:																								
Links in CALRoads		SBKG1	SBKGTQ1	SBKGLQ1	NBKG1	NBKGTQ1	NBKGLQ1	NBKG2	EBSPW1	EBSPWTQ1	EBSPWLQ1	EBSPW2	WBSPW1	WBSPWTQ1	WBSPWLQ1	WBSPW2	SBKG2	SBKGTQ2	SBKGLQ2	NBKG3	NBKGTQ2	SBKG3	EBTL1	WBTLLQ1
Total values are the addition of all leaving traffic (AADT)		20,783	18,939	1845	13,776	13,546	230	15,340	1,589	1,301	288	5,201	7,674	3,577	4097	1,894	21,709	21,355	354	14,634	13,776	25,055	1,137	4,692
Hour	*Hourly Ratio*																							
0:00	0.65%	135	123	12	90	88	1	100	10	8	2	34	50	23	26.7	12	141	139	2	95	90	163	7	31
1:00	0.39%	80	73	7	53	52	1	59	6	5	1	20	30	14	15.8	7	84	82	1	56	53	96	4	18
2:00	0.33%	70	63	6	46	45	1	51	5	4	1	17	26	12	13.7	6	73	71	1	49	46	84	4	16
3:00	0.37%	77	70	7	51	50	1	57	6	5	1	19	28	13	15.2	7	80	79	1	54	51	93	4	17
4:00	0.44%	91	83	8	60	59	1	67	7	6	1	23	34	16	17.9	8	95	93	2	64	60	110	5	21
5:00	1.25%	259	236	23	172	169	3	191	20	16	4	65	96	45	51.1	24	271	267	4	183	172	313	14	59
6:00	3.31%	687	626	61	455	448	8	507	53	43	10	172	254	118	135.4	63	718	706	12	484	455	828	38	155
7:00	5.63%	1170	1066	104	775	762	13	863	89	73	16	293	432	201	230.6	107	1222	1202	20	824	775	1410	64	264
8:00	7.01%	1456	1327	129	965	949	16	1075	111	91	20	364	538	251	287.1	133	1521	1496	25	1025	965	1756	80	329
9:00	5.32%	1106	1008	98	733	721	12	816	85	69	15	277	408	190	218.0	101	1155	1136	19	779	733	1333	61	250
10:00	4.91%	1020	929	91	676	665	11	753	78	64	14	255	377	176	201.1	93	1065	1048	17	718	676	1230	56	230
11:00	5.48%	1139	1038	101	755	743	13	841	87	71	16	285	421	196	224.6	104	1190	1171	19	802	755	1374	62	257
12:00	5.97%	1240	1130	110	822	808	14	915	95	78	17	310	458	213	244.4	113	1295	1274	21	873	822	1495	68	280
13:00	5.82%	1209	1102	107	801	788	13	892	92	76	17	303	446	208	238.3	110	1263	1242	21	851	801	1457	66	273
14:00	6.15%	1277	1164	113	847	832	14	943	98	80	18	320	472	220	251.8	116	1334	1312	22	899	847	1540	70	288
15:00	7.27%	1510	1376	134	1001	984	17	1115	115	95	21	378	558	260	297.6	138	1577	1552	26	1063	1001	1820	83	341
16:00	8.53%	1772	1615	157	1175	1155	20	1308	135	111	25	443	654	305	349.3	162	1851	1821	30	1248	1175	2136	97	400
17:00	8.63%	1793	1634	159	1188	1168	20	1323	137	112	25	449	662	309	353.4	163	1873	1842	31	1262	1188	2161	98	405
18:00	6.52%	1355	1235	120	898	883	15	1000	104	85	19	339	500	233	267.1	123	1415	1392	23	954	898	1633	74	306
19:00	5.11%	1061	967	94	704	692	12	783	81	66	15	266	392	183	209.2	97	1109	1091	18	747	704	1280	58	240
20:00	4.05%	841	766	75	557	548	9	621	64	53	12	210	311	145	165.8	77	878	864	14	592	557	1014	46	190
21:00	3.29%	684	623	61	453	446	8	505	52	43	9	171	253	118	134.8	62	714	703	12	482	453	825	37	154
22:00	2.15%	447	408	40	296	292	5	330	34	28	6	112	165	77	88.2	41	467	460	8	315	296	539	24	101
23:00	1.46%	303	276	27	201	198	3	224	23	19	4	76	112	52	59.8	28	317	312	5	214	201	366	17	68

		Study Area 2 (2018)										
24-hr count location:												
Links in CALRoads		SBSH1	SBSHLQ1	NBSH1	NBSHTQ1	NBSHLQ1	SBSH2	SBSHTQ1	NBSH2	EBPRES1	EBPRESLQ1	WBPRES1
Total values are the addition of all leaving traffic (AADT)		10,847	5424	11,287	10,549	737	13,647	13,647	11,290	2,299	1313	2,900
Hour	*Hourly Ratio*											
0:00	0.65%	71	35	73	69	5	89	89	74	15	9	19
1:00	0.39%	42	21	43	41	3	53	53	43	9	5	11
2:00	0.33%	36	18	38	35	2	46	46	38	8	4	10
3:00	0.37%	40	20	42	39	3	50	50	42	9	5	11
4:00	0.44%	47	24	49	46	3	60	60	49	10	6	13
5:00	1.25%	135	68	141	132	9	170	170	141	29	16	36
6:00	3.31%	359	179	373	349	24	451	451	373	76	43	96
7:00	5.63%	611	305	635	594	41	768	768	636	129	74	163
8:00	7.01%	760	380	791	739	52	956	956	791	161	92	203
9:00	5.32%	577	289	601	561	39	726	726	601	122	70	154
10:00	4.91%	532	266	554	518	36	670	670	554	113	64	142
11:00	5.48%	595	297	619	578	40	748	748	619	126	72	159
12:00	5.97%	647	324	673	629	44	814	814	674	137	78	173
13:00	5.82%	631	315	656	614	43	794	794	657	134	76	169
14:00	6.15%	667	333	694	648	45	839	839	694	141	81	178
15:00	7.27%	788	394	820	766	54	992	992	820	167	95	211
16:00	8.53%	925	462	962	899	63	1164	1164	963	196	112	247
17:00	8.63%	936	468	974	910	64	1177	1177	974	198	113	250
18:00	6.52%	707	354	736	688	48	890	890	736	150	86	189
19:00	5.11%	554	277	576	539	38	697	697	577	117	67	148
20:00	4.05%	439	219	457	427	30	552	552	457	93	53	117
21:00	3.29%	357	178	371	347	24	449	449	372	76	43	95
22:00	2.15%	233	117	243	227	16	294	294	243	49	28	62
23:00	1.46%	158	79	165	154	11	199	199	165	34	19	42

		Study Area 3 (2018)															
24-hr count location:																	
Links in CALRoads		SBCON1	NBCON1	NBCONTQ1	NBCONLQ1	NBSPDV1	SBSPDV1	SBSPDVTQ1	SBSPDVLQ1	EBEAG1	WBEAG1	WBEAGTQ1	WBEAGLQ1	EBEAG2	EBEAGTQ1	EBEAGLQ1	WBEAG2
Total values are the addition of all leaving traffic (AADT)		6,049	5,849	5,083	766	5,406	6,499	5,360	1139	5,343	5,639	5,233	406	4,513	4,310	203	4,327
Hour	*Hourly Ratio*																
0:00	0.65%	39	38	33	5	35	42	35	7	35	37	34	3	29	28	1	28
1:00	0.39%	23	23	20	3	21	25	21	4	21	22	20	2	17	17	1	17
2:00	0.33%	20	20	17	3	18	22	18	4	18	19	18	1	15	14	1	14
3:00	0.37%	22	22	19	3	20	24	20	4	20	21	19	2	17	16	1	16
4:00	0.44%	26	26	22	3	24	28	23	5	23	25	23	2	20	19	1	19
5:00	1.25%	76	73	63	10	67	81	67	14	67	70	65	5	56	54	3	54
6:00	3.31%	200	193	168	25	179	215	177	38	177	186	173	13	149	142	7	143
7:00	5.63%	340	329	286	43	304	366	302	64	301	317	295	23	254	243	11	244
8:00	7.01%	424	410	356	54	379	455	376	80	374	395	367	28	316	302	14	303
9:00	5.32%	322	311	270	41	288	346	285	61	284	300	278	22	240	229	11	230
10:00	4.91%	297	287	249	38	265	319	263	56	262	277	257	20	222	212	10	212
11:00	5.48%	332	321	279	42	296	356	294	62	293	309	287	22	247	236	11	237
12:00	5.97%	361	349	303	46	323	388	320	68	319	336	312	24	269	257	12	258
13:00	5.82%	352	340	296	45	314	378	312	66	311	328	304	24	263	251	12	252
14:00	6.15%	372	359	312	47	332	399	329	70	328	347	322	25	277	265	12	266
15:00	7.27%	439	425	369	56	393	472	389	83	388	410	380	30	328	313	15	314
16:00	8.53%	516	499	433	65	461	554	457	97	456	481	446	35	385	368	17	369
17:00	8.63%	522	505	438	66	466	561	462	98	461	486	451	35	389	372	18	373
18:00	6.52%	394	381	331	50	352	424	349	74	348	368	341	26	294	281	13	282
19:00	5.11%	309	299	260	39	276	332	274	58	273	288	267	21	230	220	10	221
20:00	4.05%	245	237	206	31	219	263	217	46	216	228	212	16	183	174	8	175
21:00	3.29%	199	192	167	25	178	214	176	37	176	186	172	13	149	142	7	142
22:00	2.15%	130	126	109	16	116	140	115	25	115	121	113	9	97	93	4	93
23:00	1.46%	88	85	74	11	79	95	78	17	78	82	76	6	66	63	3	63

		Study Area 4 (2018)															
24-hr count location:																	
Links in CALRoads		SBHSP1	NBHSP1	NBHSPTQ1	NBHSPLQ1	SBHSP2	SBHSPTQ1	SBHSPLQ1	NBHSP2	WBJAF1	EBJAF1	EBJAFTQ1	EBJAFLQ1	EBAVE1	WBAVE1	WBAVETQ1	WBAVELQ1
Total values are the addition of all leaving traffic (AADT)		28,197	19,678	19,617	61	28,068	27,358	710	19,438	409	220	162	58	3,400	3,511	1,868	1643
Hour	*Hourly Ratio*																
0:00	0.65%	184	128	128	0	183	178	5	127	3	1	1	0	22	23	12	11
1:00	0.39%	109	76	76	0	108	105	3	75	2	1	1	0	13	14	7	6
2:00	0.33%	94	66	66	0	94	92	2	65	1	1	1	0	11	12	6	5
3:00	0.37%	104	73	73	0	104	101	3	72	2	1	1	0	13	13	7	6
4:00	0.44%	123	86	86	0	123	120	3	85	2	1	1	0	15	15	8	7
5:00	1.25%	352	246	245	1	350	341	9	243	5	3	2	1	42	44	23	21
6:00	3.31%	932	650	648	2	928	904	23	643	14	7	5	2	112	116	62	54
7:00	5.63%	1587	1108	1104	3	1580	1540	40	1094	23	12	9	3	191	198	105	92
8:00	7.01%	1976	1379	1375	4	1967	1917	50	1362	29	15	11	4	238	246	131	115
9:00	5.32%	1501	1047	1044	3	1494	1456	38	1034	22	12	9	3	181	187	99	87
10:00	4.91%	1384	966	963	3	1378	1343	35	954	20	11	8	3	167	172	92	81
11:00	5.48%	1546	1079	1075	3	1539	1500	39	1066	22	12	9	3	186	192	102	90
12:00	5.97%	1682	1174	1170	4	1675	1632	42	1160	24	13	10	3	203	209	111	98
13:00	5.82%	1640	1145	1141	4	1633	1591	41	1131	24	13	9	3	198	204	109	96
14:00	6.15%	1733	1209	1206	4	1725	1681	44	1195	25	14	10	4	209	216	115	101
15:00	7.27%	2049	1430	1425	4	2039	1988	52	1412	30	16	12	4	247	255	136	119
16:00	8.53%	2404	1678	1673	5	2393	2333	61	1657	35	19	14	5	290	299	159	140
17:00	8.63%	2432	1697	1692	5	2421	2360	61	1677	35	19	14	5	293	303	161	142
18:00	6.52%	1838	1283	1279	4	1830	1784	46	1267	27	14	11	4	222	229	122	107
19:00	5.11%	1440	1005	1002	3	1433	1397	36	993	21	11	8	3	174	179	95	84
20:00	4.05%	1141	796	794	2	1136	1107	29	787	17	9	7	2	138	142	76	66
21:00	3.29%	928	648	646	2	924	900	23	640	13	7	5	2	112	116	61	54
22:00	2.15%	607	424	422	1	604	589	15	418	9	5	3	1	73	76	40	35
23:00	1.46%	411	287	286	1	410	399	10	284	6	3	2	1	50	51	27	24

		Study Area 1 (2031 FNB)																						
24-hr count location:																								
Links in CALRoads		SBKG1	SBKGTQ1	SBKGLQ1	NBKG1	NBKGTQ1	NBKGLQ1	NBKG2	EBSPW1	EBSPWTQ1	EBSPWLQ1	EBSPW2	WBSPW1	WBSPWTQ1	WBSPWLQ1	WBSPW2	SBKG2	SBKGTQ2	SBKGLQ2	NBKG3	NBKGTQ2	SBKG3	EBTL1	WBTLLQ1
Total values are the addition of all leaving traffic (AADT)		16,918	15,417	1502	13,776	13,546	230	15,340	1,589	1,301	288	5,201	7,674	3,577	4097	1,894	23,575	23,191	384	14,634	13,776	25,055	1,137	3,580
Hour	*Hourly Ratio*																							
0:00	0.65%	110	100	10	90	88	1	100	10	8	2	34	50	23	26.7	12	154	151	3	95	90	163	7	23
1:00	0.39%	65	59	6	53	52	1	59	6	5	1	20	30	14	15.8	7	91	89	1	56	53	96	4	14
2:00	0.33%	57	52	5	46	45	1	51	5	4	1	17	26	12	13.7	6	79	78	1	49	46	84	4	12
3:00	0.37%	63	57	6	51	50	1	57	6	5	1	19	28	13	15.2	7	87	86	1	54	51	93	4	13
4:00	0.44%	74	67	7	60	59	1	67	7	6	1	23	34	16	17.9	8	103	101	2	64	60	110	5	16
5:00	1.25%	211	192	19	172	169	3	191	20	16	4	65	96	45	51.1	24	294	289	5	183	172	313	14	45
6:00	3.31%	559	510	50	455	448	8	507	53	43	10	172	254	118	135.4	63	779	767	13	484	455	828	38	118
7:00	5.63%	952	868	85	775	762	13	863	89	73	16	293	432	201	230.6	107	1327	1305	22	824	775	1410	64	201
8:00	7.01%	1185	1080	105	965	949	16	1075	111	91	20	364	538	251	287.1	133	1652	1625	27	1025	965	1756	80	251
9:00	5.32%	900	820	80	733	721	12	816	85	69	15	277	408	190	218.0	101	1255	1234	20	779	733	1333	61	190
10:00	4.91%	830	757	74	676	665	11	753	78	64	14	255	377	176	201.1	93	1157	1138	19	718	676	1230	56	176
11:00	5.48%	928	845	82	755	743	13	841	87	71	16	285	421	196	224.6	104	1293	1271	21	802	755	1374	62	196
12:00	5.97%	1009	920	90	822	808	14	915	95	78	17	310	458	213	244.4	113	1407	1384	23	873	822	1495	68	214
13:00	5.82%	984	897	87	801	788	13	892	92	76	17	303	446	208	238.3	110	1371	1349	22	851	801	1457	66	208
14:00	6.15%	1040	947	92	847	832	14	943	98	80	18	320	472	220	251.8	116	1449	1425	24	899	847	1540	70	220
15:00	7.27%	1229	1120	109	1001	984	17	1115	115	95	21	378	558	260	297.6	138	1713	1685	28	1063	1001	1820	83	260
16:00	8.53%	1442	1314	128	1175	1155	20	1308	135	111	25	443	654	305	349.3	162	2010	1977	33	1248	1175	2136	97	305
17:00	8.63%	1459	1330	130	1188	1168	20	1323	137	112	25	449	662	309	353.4	163	2034	2000	33	1262	1188	2161	98	309
18:00	6.52%	1103	1005	98	898	883	15	1000	104	85	19	339	500	233	267.1	123	1537	1512	25	954	898	1633	74	233
19:00	5.11%	864	787	77	704	692	12	783	81	66	15	266	392	183	209.2	97	1204	1184	20	747	704	1280	58	183
20:00	4.05%	685	624	61	557	548	9	621	64	53	12	210	311	145	165.8	77	954	938	16	592	557	1014	46	145
21:00	3.29%	557	507	49	453	446	8	505	52	43	9	171	253	118	134.8	62	776	763	13	482	453	825	37	118
22:00	2.15%	364	332	32	296	292	5	330	34	28	6	112	165	77	88.2	41	507	499	8	315	296	539	24	77
23:00	1.46%	247	225	22	201	198	3	224	23	19	4	76	112	52	59.8	28	344	338	6	214	201	366	17	52

		Study Area 2 (2031 FNB)										
24-hr count location:												
Links in CALRoads		SBSH1	SBSHLQ1	NBSH1	NBSHTQ1	NBSHLQ1	SBSH2	SBSHTQ1	NBSH2	EBPRES1	EBPRESLQ1	WBPRES1
Total values are the addition of all leaving traffic (AADT)		11,559	5779	9,332	8,723	610	14,992	14,992	10,103	3,095	1768	4,440
Hour	*Hourly Ratio*											
0:00	0.65%	75	38	61	57	4	98	98	66	20	12	29
1:00	0.39%	45	22	36	34	2	58	58	39	12	7	17
2:00	0.33%	39	19	31	29	2	50	50	34	10	6	15
3:00	0.37%	43	21	35	32	2	55	55	37	11	7	16
4:00	0.44%	51	25	41	38	3	66	66	44	14	8	19
5:00	1.25%	144	72	116	109	8	187	187	126	39	22	55
6:00	3.31%	382	191	308	288	20	496	496	334	102	58	147
7:00	5.63%	651	325	525	491	34	844	844	569	174	100	250
8:00	7.01%	810	405	654	611	43	1051	1051	708	217	124	311
9:00	5.32%	615	308	497	464	32	798	798	538	165	94	236
10:00	4.91%	567	284	458	428	30	736	736	496	152	87	218
11:00	5.48%	634	317	512	478	33	822	822	554	170	97	243
12:00	5.97%	690	345	557	520	36	894	894	603	185	105	265
13:00	5.82%	672	336	543	507	35	872	872	588	180	103	258
14:00	6.15%	710	355	574	536	37	921	921	621	190	109	273
15:00	7.27%	840	420	678	634	44	1089	1089	734	225	128	323
16:00	8.53%	986	493	796	744	52	1278	1278	861	264	151	379
17:00	8.63%	997	499	805	752	53	1293	1293	871	267	153	383
18:00	6.52%	754	377	608	569	40	977	977	659	202	115	289
19:00	5.11%	590	295	477	445	31	766	766	516	158	90	227
20:00	4.05%	468	234	378	353	25	607	607	409	125	72	180
21:00	3.29%	380	190	307	287	20	493	493	332	102	58	146
22:00	2.15%	249	124	201	188	13	323	323	217	67	38	96
23:00	1.46%	169	84	136	127	9	219	219	147	45	26	65

		Study Area 3 (2031 FNB)															
24-hr count location:																	
Links in CALRoads		SBCON1	NBCON1	NBCONTQ1	NBCONLQ1	NBSPDV1	SBSPDV1	SBSPDVTQ1	SBSPDVLQ1	EBEAG1	WBEAG1	WBEAGTQ1	WBEAGLQ1	EBEAG2	EBEAGTQ1	EBEAGLQ1	WBEAG2
Total values are the addition of all leaving traffic (AADT)		9,883	12,205	10,606	1599	14,875	13,445	11,089	2356	7,000	7,464	6,926	538	5,148	4,917	232	6,458
Hour	*Hourly Ratio*																
0:00	0.65%	64	79	69	10	97	88	72	15	46	49	45	4	34	32	2	42
1:00	0.39%	38	47	41	6	57	52	43	9	27	29	27	2	20	19	1	25
2:00	0.33%	33	41	35	5	50	45	37	8	23	25	23	2	17	16	1	22
3:00	0.37%	37	45	39	6	55	50	41	9	26	28	26	2	19	18	1	24
4:00	0.44%	43	53	46	7	65	59	48	10	31	33	30	2	23	21	1	28
5:00	1.25%	123	152	132	20	186	168	138	29	87	93	86	7	64	61	3	81
6:00	3.31%	327	403	351	53	492	444	367	78	231	247	229	18	170	163	8	213
7:00	5.63%	556	687	597	90	837	757	624	133	394	420	390	30	290	277	13	364
8:00	7.01%	693	855	743	112	1042	942	777	165	490	523	485	38	361	345	16	453
9:00	5.32%	526	650	564	85	792	715	590	125	373	397	369	29	274	262	12	344
10:00	4.91%	485	599	521	78	730	660	544	116	344	366	340	26	253	241	11	317
11:00	5.48%	542	669	581	88	816	737	608	129	384	409	380	29	282	270	13	354
12:00	5.97%	590	728	633	95	887	802	662	141	418	445	413	32	307	293	14	385
13:00	5.82%	575	710	617	93	865	782	645	137	407	434	403	31	299	286	13	376
14:00	6.15%	607	750	652	98	914	826	681	145	430	459	426	33	316	302	14	397
15:00	7.27%	718	887	771	116	1081	977	806	171	509	542	503	39	374	357	17	469
16:00	8.53%	843	1041	904	136	1268	1146	945	201	597	636	591	46	439	419	20	551
17:00	8.63%	853	1053	915	138	1283	1160	957	203	604	644	597	46	444	424	20	557
18:00	6.52%	644	796	691	104	970	877	723	154	456	487	452	35	336	321	15	421
19:00	5.11%	505	623	542	82	760	687	566	120	357	381	354	27	263	251	12	330
20:00	4.05%	400	494	429	65	602	544	449	95	283	302	280	22	208	199	9	261
21:00	3.29%	325	402	349	53	490	442	365	78	230	246	228	18	169	162	8	213
22:00	2.15%	213	263	228	34	320	289	239	51	151	161	149	12	111	106	5	139
23:00	1.46%	144	178	155	23	217	196	162	34	102	109	101	8	75	72	3	94

		Study Area 4 (2031 FNB)															
24-hr count location:																	
Links in CALRoads		SBHSP1	NBHSP1	NBHSPTQ1	NBHSPLQ1	SBHSP2	SBHSPTQ1	SBHSPLQ1	NBHSP2	WBJAF1	EBJAF1	EBJAFTQ1	EBJAFLQ1	EBAVE1	WBAVE1	WBAVETQ1	WBAVELQ1
Total values are the addition of all leaving traffic (AADT)		33,425	24,553	24,476	77	33,409	32,564	845	24,984	409	220	162	58	3,119	3,766	2,004	1762
Hour	*Hourly Ratio*																
0:00	0.65%	218	160	159	0	218	212	6	163	3	1	1	0	20	25	13	11
1:00	0.39%	129	95	94	0	129	125	3	96	2	1	1	0	12	15	8	7
2:00	0.33%	112	82	82	0	112	109	3	84	1	1	1	0	10	13	7	6
3:00	0.37%	124	91	91	0	124	120	3	92	2	1	1	0	12	14	7	7
4:00	0.44%	146	107	107	0	146	142	4	109	2	1	1	0	14	16	9	8
5:00	1.25%	417	306	306	1	417	406	11	312	5	3	2	1	39	47	25	22
6:00	3.31%	1105	812	809	3	1104	1076	28	826	14	7	5	2	103	124	66	58
7:00	5.63%	1881	1382	1378	4	1881	1833	48	1406	23	12	9	3	176	212	113	99
8:00	7.01%	2342	1720	1715	5	2341	2282	59	1751	29	15	11	4	219	264	140	123
9:00	5.32%	1779	1307	1302	4	1778	1733	45	1330	22	12	9	3	166	200	107	94
10:00	4.91%	1640	1205	1201	4	1640	1598	41	1226	20	11	8	3	153	185	98	86
11:00	5.48%	1833	1346	1342	4	1832	1785	46	1370	22	12	9	3	171	206	110	97
12:00	5.97%	1994	1465	1460	5	1993	1943	50	1491	24	13	10	3	186	225	120	105
13:00	5.82%	1944	1428	1424	4	1943	1894	49	1453	24	13	9	3	181	219	117	102
14:00	6.15%	2054	1509	1504	5	2053	2001	52	1535	25	14	10	4	192	231	123	108
15:00	7.27%	2429	1784	1778	6	2427	2366	61	1815	30	16	12	4	227	274	146	128
16:00	8.53%	2850	2093	2087	7	2849	2776	72	2130	35	19	14	5	266	321	171	150
17:00	8.63%	2883	2118	2111	7	2882	2809	73	2155	35	19	14	5	269	325	173	152
18:00	6.52%	2179	1601	1596	5	2178	2123	55	1629	27	14	11	4	203	246	131	115
19:00	5.11%	1707	1254	1250	4	1706	1663	43	1276	21	11	8	3	159	192	102	90
20:00	4.05%	1353	993	990	3	1352	1318	34	1011	17	9	7	2	126	152	81	71
21:00	3.29%	1100	808	805	3	1099	1072	28	822	13	7	5	2	103	124	66	58
22:00	2.15%	719	528	527	2	719	701	18	538	9	5	3	1	67	81	43	38
23:00	1.46%	488	358	357	1	488	475	12	365	6	3	2	1	46	55	29	26

		Study Area 1 (2031 FB)																						
24-hr count location:																								
Links in CALRoads		SBKG1	SBKGTQ1	SBKGLQ1	NBKG1	NBKGTQ1	NBKGLQ1	NBKG2	EBSPW1	EBSPWTQ1	EBSPWLQ1	EBSPW2	WBSPW1	WBSPWTQ1	WBSPWLQ1	WBSPW2	SBKG2	SBKGTQ2	SBKGLQ2	NBKG3	NBKGTQ2	SBKG3	EBTL1	WBTLLQ1
Average Annual Daily Traffic (AADT)		16,539	15,071	1468	14,559	15,864	270	16,133	3,346	3,290	56	4,437	5,332	2,486	2847	3,500	19,770	18,015	1755	13,536	14,559	21,265	1,137	4,692
Hour	*Hourly Ratio*																							
0:00	0.65%	108	98	10	95	103	2	105	22	21	0	29	35	16	18.5	23	129	117	11	88	95	138	7	31
1:00	0.39%	64	58	6	56	61	1	62	13	13	0	17	21	10	11.0	13	76	69	7	52	56	82	4	18
2:00	0.33%	55	50	5	49	53	1	54	11	11	0	15	18	8	9.5	12	66	60	6	45	49	71	4	16
3:00	0.37%	61	56	5	54	59	1	60	12	12	0	16	20	9	10.5	13	73	67	6	50	54	79	4	17
4:00	0.44%	72	66	6	64	69	1	71	15	14	0	19	23	11	12.4	15	86	79	8	59	64	93	5	21
5:00	1.25%	206	188	18	182	198	3	201	42	41	1	55	67	31	35.5	44	247	225	22	169	182	265	14	59
6:00	3.31%	547	498	49	481	524	9	533	111	109	2	147	176	82	94.1	116	654	596	58	447	481	703	38	155
7:00	5.63%	931	848	83	819	893	15	908	188	185	3	250	300	140	160.2	197	1113	1014	99	762	819	1197	64	264
8:00	7.01%	1159	1056	103	1020	1112	19	1130	234	231	4	311	374	174	199.5	245	1385	1262	123	948	1020	1490	80	329
9:00	5.32%	880	802	78	775	844	14	859	178	175	3	236	284	132	151.5	186	1052	959	93	720	775	1132	61	250
10:00	4.91%	812	740	72	715	779	13	792	164	161	3	218	262	122	139.7	172	970	884	86	664	715	1044	56	230
11:00	5.48%	907	826	80	798	870	15	885	183	180	3	243	292	136	156.1	192	1084	988	96	742	798	1166	62	257
12:00	5.97%	987	899	88	869	946	16	963	200	196	3	265	318	148	169.8	209	1180	1075	105	808	869	1269	68	280
13:00	5.82%	962	877	85	847	923	16	938	195	191	3	258	310	145	165.6	204	1150	1048	102	787	847	1237	66	273
14:00	6.15%	1016	926	90	895	975	17	991	206	202	3	273	328	153	174.9	215	1215	1107	108	832	895	1307	70	288
15:00	7.27%	1202	1095	107	1058	1153	20	1172	243	239	4	322	387	181	206.8	254	1436	1309	128	983	1058	1545	83	341
16:00	8.53%	1410	1285	125	1241	1353	23	1376	285	281	5	378	455	212	242.7	298	1686	1536	150	1154	1241	1813	97	400
17:00	8.63%	1427	1300	127	1256	1368	23	1392	289	284	5	383	460	214	245.5	302	1705	1554	151	1168	1256	1834	98	405
18:00	6.52%	1078	982	96	949	1034	18	1052	218	214	4	289	348	162	185.6	228	1289	1174	114	882	949	1386	74	306
19:00	5.11%	845	770	75	744	810	14	824	171	168	3	227	272	127	145.4	179	1010	920	90	691	744	1086	58	240
20:00	4.05%	669	610	59	589	642	11	653	135	133	2	180	216	101	115.2	142	800	729	71	548	589	860	46	190
21:00	3.29%	544	496	48	479	522	9	531	110	108	2	146	175	82	93.7	115	651	593	58	445	479	700	37	154
22:00	2.15%	356	324	32	313	341	6	347	72	71	1	95	115	53	61.3	75	425	388	38	291	313	458	24	101
23:00	1.46%	241	220	21	212	231	4	235	49	48	1	65	78	36	41.5	51	289	263	26	198	212	310	17	68

		Study Area 2 (2031 FB)										
24-hr count location:												
Links in CALRoads		SBSH1	SBSHLQ1	NBSH1	NBSHTQ1	NBSHLQ1	SBSH2	SBSHTQ1	NBSH2	EBPRES1	EBPRESLQ1	WBPRES1
Average Annual Daily Traffic (AADT)		11,488	5744	9,143	8,546	597	14,880	14,880	9,931	3,084	1761	4,372
Hour	*Hourly Ratio*											
0:00	0.65%	75	37	60	56	4	97	97	65	20	11	28
1:00	0.39%	44	22	35	33	2	57	57	38	12	7	17
2:00	0.33%	38	19	31	29	2	50	50	33	10	6	15
3:00	0.37%	42	21	34	32	2	55	55	37	11	7	16
4:00	0.44%	50	25	40	37	3	65	65	43	13	8	19
5:00	1.25%	143	72	114	107	7	186	186	124	38	22	55
6:00	3.31%	380	190	302	282	20	492	492	328	102	58	145
7:00	5.63%	647	323	515	481	34	838	838	559	174	99	246
8:00	7.01%	805	402	641	599	42	1043	1043	696	216	123	306
9:00	5.32%	611	306	487	455	32	792	792	528	164	94	233
10:00	4.91%	564	282	449	419	29	730	730	487	151	86	215
11:00	5.48%	630	315	501	469	33	816	816	544	169	97	240
12:00	5.97%	685	343	546	510	36	888	888	592	184	105	261
13:00	5.82%	668	334	532	497	35	866	866	578	179	102	254
14:00	6.15%	706	353	562	525	37	914	914	610	190	108	269
15:00	7.27%	835	417	664	621	43	1081	1081	722	224	128	318
16:00	8.53%	980	490	780	729	51	1269	1269	847	263	150	373
17:00	8.63%	991	495	789	737	52	1284	1284	857	266	152	377
18:00	6.52%	749	374	596	557	39	970	970	647	201	115	285
19:00	5.11%	587	293	467	436	31	760	760	507	157	90	223
20:00	4.05%	465	232	370	346	24	602	602	402	125	71	177
21:00	3.29%	378	189	301	281	20	490	490	327	101	58	144
22:00	2.15%	247	124	197	184	13	320	320	214	66	38	94
23:00	1.46%	168	84	133	125	9	217	217	145	45	26	64

		Study Area 3 (2031 FB)															
24-hr count location:																	
Links in CALRoads		SBCON1	NBCON1	NBCONTQ1	NBCONLQ1	NBSPDV1	SBSPDV1	SBSPDVTQ1	SBSPDVLQ1	EBEAG1	WBEAG1	WBEAGTQ1	WBEAGLQ1	EBEAG2	EBEAGTQ1	EBEAGLQ1	WBEAG2
Average Annual Daily Traffic (AADT)		9,761	12,094	10,509	1585	14,706	13,273	10,947	2326	6,843	7,311	3,891	3421	5,037	4,811	227	6,357
Hour	*Hourly Ratio*																
0:00	0.65%	64	79	68	10	96	86	71	15	45	48	25	22	33	31	1	41
1:00	0.39%	38	47	40	6	57	51	42	9	26	28	15	13	19	19	1	24
2:00	0.33%	33	40	35	5	49	44	37	8	23	24	13	11	17	16	1	21
3:00	0.37%	36	45	39	6	54	49	40	9	25	27	14	13	19	18	1	24
4:00	0.44%	43	53	46	7	64	58	48	10	30	32	17	15	22	21	1	28
5:00	1.25%	122	151	131	20	184	166	137	29	85	91	49	43	63	60	3	79
6:00	3.31%	323	400	347	52	486	439	362	77	226	242	129	113	167	159	7	210
7:00	5.63%	549	681	592	89	828	747	616	131	385	412	219	193	284	271	13	358
8:00	7.01%	684	847	736	111	1030	930	767	163	479	512	273	240	353	337	16	445
9:00	5.32%	519	644	559	84	783	706	583	124	364	389	207	182	268	256	12	338
10:00	4.91%	479	594	516	78	722	651	537	114	336	359	191	168	247	236	11	312
11:00	5.48%	535	663	576	87	806	728	600	128	375	401	213	188	276	264	12	349
12:00	5.97%	582	722	627	95	877	792	653	139	408	436	232	204	301	287	14	379
13:00	5.82%	568	703	611	92	855	772	637	135	398	425	226	199	293	280	13	370
14:00	6.15%	600	743	646	97	904	816	673	143	421	449	239	210	310	296	14	391
15:00	7.27%	709	879	764	115	1068	964	795	169	497	531	283	249	366	350	16	462
16:00	8.53%	832	1031	896	135	1254	1132	933	198	583	623	332	292	429	410	19	542
17:00	8.63%	842	1043	907	137	1269	1145	944	201	590	631	336	295	435	415	20	548
18:00	6.52%	636	788	685	103	959	865	714	152	446	477	254	223	328	314	15	414
19:00	5.11%	498	618	537	81	751	678	559	119	349	373	199	175	257	246	12	325
20:00	4.05%	395	489	425	64	595	537	443	94	277	296	157	138	204	195	9	257
21:00	3.29%	321	398	346	52	484	437	360	77	225	241	128	113	166	158	7	209
22:00	2.15%	210	260	226	34	316	286	236	50	147	157	84	74	108	104	5	137
23:00	1.46%	142	176	153	23	215	194	160	34	100	107	57	50	74	70	3	93

		Study Area 4 (2031 FB)															
24-hr count location:																	
Links in CALRoads		SBHSP1	NBHSP1	NBHSPTQ1	NBHSPLQ1	SBHSP2	SBHSPTQ1	SBHSPLQ1	NBHSP2	WBJAF1	EBJAF1	EBJAFTQ1	EBJAFLQ1	EBAVE1	WBAVE1	WBAVETQ1	WBAVELQ1
Average Annual Daily Traffic (AADT)		31,301	23,508	23,434	73	31,198	30,409	789	23,784	409	220	162	58	3,267	3,837	2,042	1795
Hour	*Hourly Ratio*																
0:00	0.65%	204	153	153	0	203	198	5	155	3	1	1	0	21	25	13	12
1:00	0.39%	121	91	90	0	120	117	3	92	2	1	1	0	13	15	8	7
2:00	0.33%	105	79	78	0	104	102	3	80	1	1	1	0	11	13	7	6
3:00	0.37%	116	87	87	0	115	112	3	88	2	1	1	0	12	14	8	7
4:00	0.44%	137	103	102	0	136	133	3	104	2	1	1	0	14	17	9	8
5:00	1.25%	391	293	293	1	389	380	10	297	5	3	2	1	41	48	25	22
6:00	3.31%	1035	777	775	2	1031	1005	26	786	14	7	5	2	108	127	67	59
7:00	5.63%	1762	1323	1319	4	1756	1712	44	1339	23	12	9	3	184	216	115	101
8:00	7.01%	2193	1647	1642	5	2186	2131	55	1667	29	15	11	4	229	269	143	126
9:00	5.32%	1666	1251	1247	4	1660	1618	42	1266	22	12	9	3	174	204	109	96
10:00	4.91%	1536	1154	1150	4	1531	1492	39	1167	20	11	8	3	160	188	100	88
11:00	5.48%	1716	1289	1285	4	1710	1667	43	1304	22	12	9	3	179	210	112	98
12:00	5.97%	1867	1402	1398	4	1861	1814	47	1419	24	13	10	3	195	229	122	107
13:00	5.82%	1821	1367	1363	4	1815	1769	46	1383	24	13	9	3	190	223	119	104
14:00	6.15%	1924	1445	1440	5	1917	1869	49	1462	25	14	10	4	201	236	125	110
15:00	7.27%	2274	1708	1703	5	2267	2209	57	1728	30	16	12	4	237	279	148	130
16:00	8.53%	2669	2004	1998	6	2660	2593	67	2028	35	19	14	5	279	327	174	153
17:00	8.63%	2700	2028	2021	6	2691	2623	68	2052	35	19	14	5	282	331	176	155
18:00	6.52%	2041	1533	1528	5	2034	1982	51	1551	27	14	11	4	213	250	133	117
19:00	5.11%	1599	1201	1197	4	1593	1553	40	1215	21	11	8	3	167	196	104	92
20:00	4.05%	1267	951	948	3	1262	1230	32	962	17	9	7	2	132	155	83	73
21:00	3.29%	1030	774	771	2	1027	1001	26	783	13	7	5	2	108	126	67	59
22:00	2.15%	674	506	504	2	671	654	17	512	9	5	3	1	70	83	44	39
23:00	1.46%	457	343	342	1	455	444	12	347	6	3	2	1	48	56	30	26

APPENDIX

B MOVES EMISSION FACTORS

Emission Rates Table

Contaminant	Existing (2018) Emissions (g/VKT)			Future (2031) Emissions (g/VKT)		Percentage Increase (+/-)		
	Idling (g/VKT)	Driving (g/VKT)		Idling (g/VKT)	Driving (g/VKT)	Idling (g/VKT)	Driving (g/VKT)	
PM_{10}	—	1.15E-01	1.71E-01[A]	—	1.10E-01	—	-4%	-36%[A]
$PM_{2.5}$	—	6.62E-02	8.04E-02[A]	—	6.14E-02	—	-7%	-24%[A]
TSP	—	2.05E-01	3.06E-01[A]	—	1.96E-01	—	-4%	-36%[A]
NOx	1.97E-01	3.87E-02		9.38E-02	1.65E-02	-52%	-58%	
SO_2	1.02E-02	2.15E-03		7.19E-03	1.52E-03	-29%	-29%	
CO	5.83E+00	1.74E+00		2.21E+00	7.47E-01	-62%	-57%	
Acrolein	9.80E-04	1.51E-04		2.55E-04	4.10E-05	-74%	-73%	
Benzene	5.11E-03	1.01E-03		9.91E-04	2.47E-04	-81%	-75%	
1,3-Butadiene	8.49E-04	1.42E-04		3.15E-05	4.69E-06	-96%	-97%	
Acetaldehyde	6.29E-03	1.00E-03		1.72E-03	2.80E-04	-73%	-72%	
Formaldehyde	1.41E-02	2.22E-03		5.21E-03	8.37E-04	-63%	-62%	
CO_2 Equivalent	1.41E+03	2.95E+02		9.91E+02	2.08E+02	-30%	-30%	

[A] Only for Scenario 2 (different resuspension emissions -- dependent on AADT)

C AMBIENT MONITORING DATA

Project Name: WATERLOO ION LRT STAGE 2 TPAP
WSP Project #: 161-07859-01

Table C1: Ambient Air Quality Data - $PM_{2.5}$ (24-hr Average)

Year: 2012

Label*	NAPS ID	MOE ID	City	Location	2012 (µg/m³)					
					Percentiles			Annual	MAX	
					1h 90th	24h-90th	98th	Mean	1-hr	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	13	12	18	6	46	25

Year: 2013

Label*	NAPS ID	MOE ID	City	Location	2013 (µg/m³)					
					Percentiles			Annual	MAX	
					1h 90th	24h-90th	98th	Mean	1-hr	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	17	16	23	9	61	39

Year: 2014

Label*	NAPS ID	MOE ID	City	Location	2014 (µg/m³)					
					Percentiles			Annual	MAX	
					1h 90th	24h-90th	98th	Mean	1-hr	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	18	16	27	9	64	40

Year: 2015

Label*	NAPS ID	MOE ID	City	Location	2015 (µg/m³)					
					Percentiles			Annual	MAX	
					1h 90th	24h-90th	98th	Mean	1-hr	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	19	17	24	9	68	45

Year: 2016

Label*	NAPS ID	MOE ID	City	Location	2016 (µg/m³)					
					Percentiles			Annual	MAX	
					1h 90th	24h-90th	98th	Mean	1-hr	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	14	13	19	7	41	27

Project Name: WATERLOO ION LRT STAGE 2 TPAP
WSP Project #: 161-07859-01

Table C2: Ambient Air Quality Data - NO_2 (1-hr Average)

Year: 2012

Label*	NAPS ID	MOE ID	City	Location	2012 (µg/m³)				
					Percentiles		Annual	MAX	
					24h 90th	1h 90th	Mean	1-hr	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	26	30	13	113	55

Year: 2013

Label*	NAPS ID	MOE ID	City	Location	2013 (µg/m³)				
					Percentiles		Annual	MAX	
					24h 90th	1h 90th	Mean	1-hr	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	23	24	13	107	66

Year: 2014

Label*	NAPS ID	MOE ID	City	Location	2014 (µg/m³)				
					Percentiles		Annual	MAX	
					24h 90th	1h 90th	Mean	1-hr	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	24	26	13	111	74

Year: 2015

Label*	NAPS ID	MOE ID	City	Location	2015 (µg/m³)				
					Percentiles		Annual	MAX	
					24h 90th	1h 90th	Mean	1-hr	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	24	14	13	114	69

Year: 2016

Label*	NAPS ID	MOE ID	City	Location	2016 (µg/m³)				
					Percentiles		Annual	MAX	
					24h 90th	1h 90th	Mean	1-hr	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	21	13	6	51	24

Project Name: WATERLOO ION LRT STAGE 2 TPAP
WSP Project #: 161-07859-01

Table C3: Ambient Air Quality Data - Sulphur Dioxide (1-hr Average)

Year: 2012

Label*	NAPS ID	MOE ID	City	Location	2012 (µg/m³)					
					Percentiles			Annual	MAX	
					24h 90th	1h 90th	1h 98th	Mean	1-hr	24-hr
2	60434	46108	MISSISSAUGA	3359 MISSISSAUGA ROAD NORTH	4	5	13	2	52	11

Year: 2013

Label*	NAPS ID	MOE ID	City	Location	2013 (µg/m³)					
					Percentiles			Annual	MAX	
					24h 90th	1h 90th	1h 98th	Mean	1-hr	24-hr
2	60434	46108	MISSISSAUGA	3359 MISSISSAUGA ROAD NORTH	4	4	12	2	106	15

Year: 2014

Label*	NAPS ID	MOE ID	City	Location	2014 (µg/m³)					
					Percentiles			Annual	MAX	
					24h 90th	1h 90th	1h 98th	Mean	1-hr	24-hr
2	60434	46108	MISSISSAUGA	3359 MISSISSAUGA ROAD NORTH	6	7	12	3	100	15

Year: 2015

Label*	NAPS ID	MOE ID	City	Location	2015 (µg/m³)					
					Percentiles			Annual	MAX	
					24h 90th	1h 90th	1h 98th	Mean	1-hr	24-hr
2	60434	46108	MISSISSAUGA	3359 MISSISSAUGA ROAD NORTH	7	7	14	3	93	13

Year: 2016

Label*	NAPS ID	MOE ID	City	Location	2016 (µg/m³)					
					Percentiles			Annual	MAX	
					24h 90th	1h 90th	1h 98th	Mean	1-hr	24-hr
2	60434	46108	MISSISSAUGA	3359 MISSISSAUGA ROAD NORTH	4	4	11	0	53	13

Project Name: WATERLOO ION LRT STAGE 2 TPAP
WSP Project #: 161-07859-01

Table C5: Ambient Air Quality Data - Acrolein (24-hr Average)

Year: 2006

Label*	NAPS ID	MOE ID	City	Location	2006 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
4	60211	12016	WINDSOR	COLLEGE & SOUTH ST. / 928 SOUTH ST.	0.09	0.04	--	0.12122

Year: 2007

Label*	NAPS ID	MOE ID	City	Location	2007 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
4	60211	12016	WINDSOR	COLLEGE & SOUTH ST. / 928 SOUTH ST.	0.10	0.05	--	0.12311

Year: 2008

Label*	NAPS ID	MOE ID	City	Location	2008 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
4	60211	12016	WINDSOR	COLLEGE & SOUTH ST. / 928 SOUTH ST.	0.07	0.04	--	0.11652

Year: 2009

Label*	NAPS ID	MOE ID	City	Location	2009 (µg/m³)			
					Percentiles	Annual	MAX	
4	60211	12016	WINDSOR	COLLEGE & SOUTH ST. / 928 SOUTH ST.	0.07	0.03	--	0.1239

Year: 2010

Label*	NAPS ID	MOE ID	City	Location	2010 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
4	60211	12016	WINDSOR	COLLEGE & SOUTH ST. / 928 SOUTH ST.	0.08	0.03	--	0.12979

Project Name: WATERLOO ION LRT STAGE 2 TPAP
WSP Project #: 161-07859-01

Table C6: Ambient Air Quality Data - Benzene (24-hr Average)

Year: 2012

Label*	NAPS ID	MOE ID	City	Location	2012 (µg/m³)		
					Percentiles	Annual	MAX
					90th	Mean	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	0.79	0.48	1.67

Year: 2013

Label*	NAPS ID	MOE ID	City	Location	2013 (µg/m³)		
					Percentiles	Annual	MAX
					90th	Mean	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	0.71	0.90	5.88

Year: 2014

Label*	NAPS ID	MOE ID	City	Location	2014 (µg/m³)		
					Percentiles	Annual	MAX
					90th	Mean	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	0.77	0.03	0.08

Year: 2015

Label*	NAPS ID	MOE ID	City	Location	2015 (µg/m³)		
					Percentiles	Annual	MAX
					90th	Mean	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	0.82	0.55	1.18

Year: 2016

Label*	NAPS ID	MOE ID	City	Location	2016 (µg/m³)		
					Percentiles	Annual	MAX
					90th	Mean	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	0.68	0.41	1.42

Project Name: WATERLOO ION LRT STAGE 2 TPAP
WSP Project #: 161-07859-01

Table C7: Ambient Air Quality Data - 1,3-Butadiene (24-hr Average)

Year: 2012

Label*	NAPS ID	MOE ID	City	Location	2012 (µg/m³)		
					Percentiles	Annual	MAX
					90th	Mean	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	0.07	0.03	0.20

Year: 2013

Label*	NAPS ID	MOE ID	City	Location	2013 (µg/m³)		
					Percentiles	Annual	MAX
					90th	Mean	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	0.07	0.03	0.14

Year: 2014

Label*	NAPS ID	MOE ID	City	Location	2014 (µg/m³)		
					Percentiles	Annual	MAX
					90th	Mean	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	0.06	0.03	0.08

Year: 2015

Label*	NAPS ID	MOE ID	City	Location	2015 (µg/m³)		
					Percentiles	Annual	MAX
					90th	Mean	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	0.06	0.03	0.08

Year: 2016

Label*	NAPS ID	MOE ID	City	Location	2016 (µg/m³)		
					Percentiles	Annual	MAX
					90th	Mean	24-hr
1	61502	26030	KITCHENER	WEST AVE. & HOMEWOOD	0.05	0.02	0.14

Project Name: WATERLOO ION LRT STAGE 2 TPAP
WSP Project #: 161-07859-01

Table C8: Ambient Air Quality Data - Acetaldehyde (24-hr Average)

Year: 2006

Label*	NAPS ID	MOE ID	City	Location	2006 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
3	64401	--	EGBERT	EGBERT	2.17	1.28	--	3.08648

Year: 2007

Label*	NAPS ID	MOE ID	City	Location	2007 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
3	64401	--	EGBERT	EGBERT	1.60	1.01	--	2.01722

Year: 2008

Label*	NAPS ID	MOE ID	City	Location	2008 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
3	64401	--	EGBERT	EGBERT	2.01	1.09	--	2.97

Year: 2009

Label*	NAPS ID	MOE ID	City	Location	2009 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
3	64401	--	EGBERT	EGBERT	1.12	0.60	--	1.82936

Year: 2010

Label*	NAPS ID	MOE ID	City	Location	2010 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
3	64401	--	EGBERT	EGBERT	1.30	0.68	--	2.53063

Project Name: WATERLOO ION LRT STAGE 2 TPAP
WSP Project #: 161-07859-01

Table C9: Ambient Air Quality Data - Formaldehyde (24-hr Average)

Year: 2006

Label*	NAPS ID	MOE ID	City	Location	2006 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
3	64401	--	EGBERT	EGBERT	5.25	3.06	--	8.167362

Year: 2007

Label*	NAPS ID	MOE ID	City	Location	2007 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
3	64401	--	EGBERT	EGBERT	3.74	2.08	--	4.644333

Year: 2008

Label*	NAPS ID	MOE ID	City	Location	2008 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
3	64401	--	EGBERT	EGBERT	5.05	2.49	--	6.75

Year: 2009

Label*	NAPS ID	MOE ID	City	Location	2009 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
3	64401	--	EGBERT	EGBERT	2.59	1.12	--	2.985697

Year: 2010

Label*	NAPS ID	MOE ID	City	Location	2010 (µg/m³)			
					Percentiles	Annual	MAX	
					90th	Mean	1-hr	24-hr
3	64401	--	EGBERT	EGBERT	5.25	3.00	--	7.437818

D SENSITIVE RECEPTOR LOCATIONS

Table D-1: Summary of Sensitive Receptors in Study Area 1

Location	Description	UTM E	UTM N
900 Pioneer Grove Ct	Residential	548798	4806146
11 Pioneer Tower Rd	Residential	548923	4806109
4417 King St E	Residential	549133	4806076
4475 King St E	Residential	549346	4806022
135 Gateway Park Dr	Place of Worship	549607	4806015
12 Stanson Close	Residential	549449	4805937
22 Edgehill Dr	Residential	549694	4805876

Project Name: Waterloo ION Stage 2 TPAP
WSP Project #: 161-07859-01

Table D-2: Summary of Sensitive Receptors in Study Area 2

Location	Description	UTM E	UTM N
440 Shantz Hill Rd	Residential	550540	4805443
345 Shantz Hill Rd	Residential	550607	4805335
342 Shantz Hill Rd	Residential	550658	4805336
311 Shantz Hill Rd	Residential	550710	4805283
246 Fountain Street South	Residential	550888	4805215
295 Fountain Street South	Residential	550896	4805132
207 Linden Dr	Residential	550474	4805336
225 Preston Pkwy	Residential	550392	4805281

Project Name: Waterloo ION Stage 2 TPAP
WSP Project #: 161-07859-01

Table D-3: Summary of Sensitive Receptors in Study Area 3

Location	Description	UTM E	UTM N
704 Eagle St N	Retirement Home	552284	4805860
838 Eagle St N	Residential	552396	4805872
945 Eagle St N	Residential	552506	4805886
1110 Eagle St N	Residential	552574	4805915
103 Oakwood Ave	Residential	552664	4805922
1368 Eagle St N	Residential	552714	4805948
115 Whitley St	Residential	552826	4805949
462 Old Newbury Ln	Residential	553103	4806014
440 Old Newbury Ln	Residential	553173	4806032
424 Old Newbury Ln	Residential	553225	4806044
35 Providence Dr	Residential	553319	4806066
43 Newport Dr	Residential	553449	4806098
67 Newport Dr	Residential	553505	4806111
91 Newport Dr	Residential	553564	4806126
115 Newport Dr	Residential	553620	4806139
143 Newport Dr	Residential	553676	4806152
179 Newport Dr	Residential	553776	4806111
1391 Lydia St	Residential	552808	4806053
1400 Wildren Pl	Residential	552807	4806151
1374 Thorman Pl	Residential	552759	4806243
169 Whitley St	Residential	552852	4805863
548 Old Newbury Ln	Residential	552904	4805761
574 Concession Rd	Residential	552905	4805650
190 Durham Ave	Residential	552932	4805537
651 Concession Rd	Daycare	552955	4805550
757 Concession Road	School	552981	4805438
770 Concession Rd	Residential	552975	4805348
799 Concession Rd	Retirement Home	553014	4805300
952 Concession Rd	Residential	553019	4805176
1145 Concession Rd	Health Centre	553054	4805136
530 Langs Drive	School	553150	4805235
1150 Concession Rd	School	553041	4805082
582 Eagle St N	Place of Worship	552137	4805815
791 Concession Rd	Place of Worship	553003	4805359

Project Name: Waterloo ION Stage 2 TPAP
WSP Project #: 161-07859-01

Table D-4: Summary of Sensitive Receptors in Study Area 4

Location	Description	UTM E	UTM N
183 Hespeler Rd	Residential	555088	4803519
175 Hespeler Rd	Residential	555098	4803458
155 Hespeler Rd	Residential	555129	4803306
29 Harmony Ct	Residential	555194	4803204
134 Hespeler Rd	Residential	555132	4803095
127 Hespeler Rd	Place of Worship	555177	4803057
2 Paisley Heights	Residential	555151	4802961
12 Avenue Rd	Residential	555267	4802927
10 Norfolk Ave	Residential	555255	4802782
10 Jaffray St	Residential	555126	4802891
20 Jaffray St	Residential	555072	4802922
26 Avenue Rd	Residential	555349	4802946
38 Avenue Rd	Residential	555436	4802965
50 Avenue Rd	Residential	555515	4802986
64 Avenue Rd	Residential	555592	4803004
28 Jaffray St	Residential	555035	4802950

E MODELLING CONTOUR FIGURES

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 1 Current Scenario (2018) - 1 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.06**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,000 0 0.1 m		DATE: **27-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 1 Current Scenario (2018) - 8 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.03**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,000 0 0.1 m		DATE: **27-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 2 Current Scenario (2018) - 1 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.10**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:4,000 0 0.1 m		DATE: **27-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 2 Current Scenario (2018) - 8 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.04**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:4,000 0 0.1 m		DATE: **27-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 3 Current Scenario (2018) - 1 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.07**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

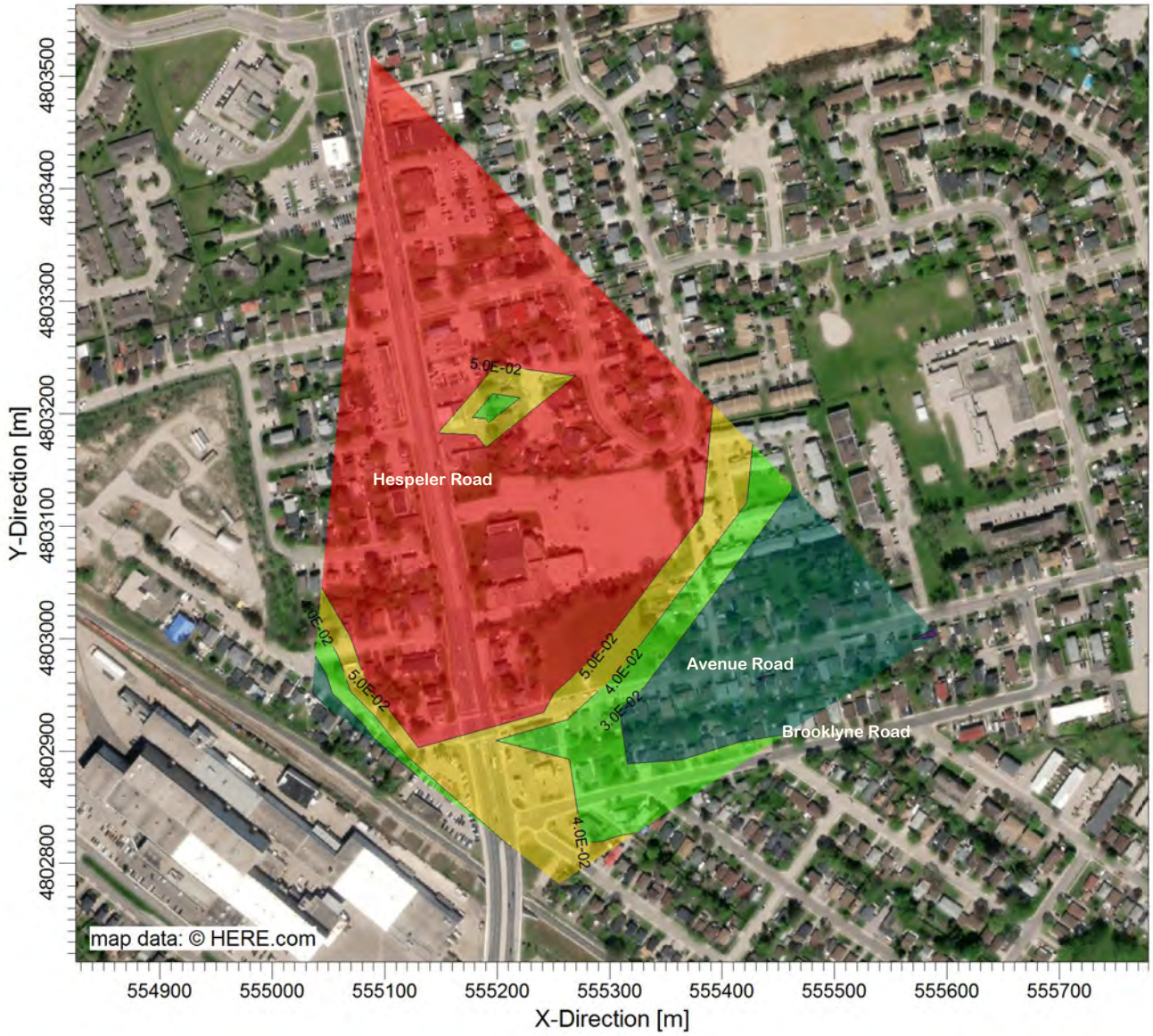
PROJECT TITLE:

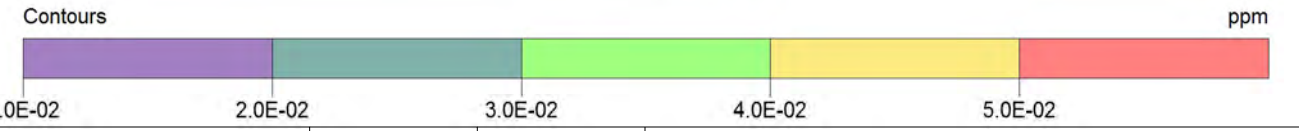
Waterloo Stage 2 ION
Study Area 3 Current Scenario (2018) - 8 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.02**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 4 Current Scenario (2018) - 1 hour

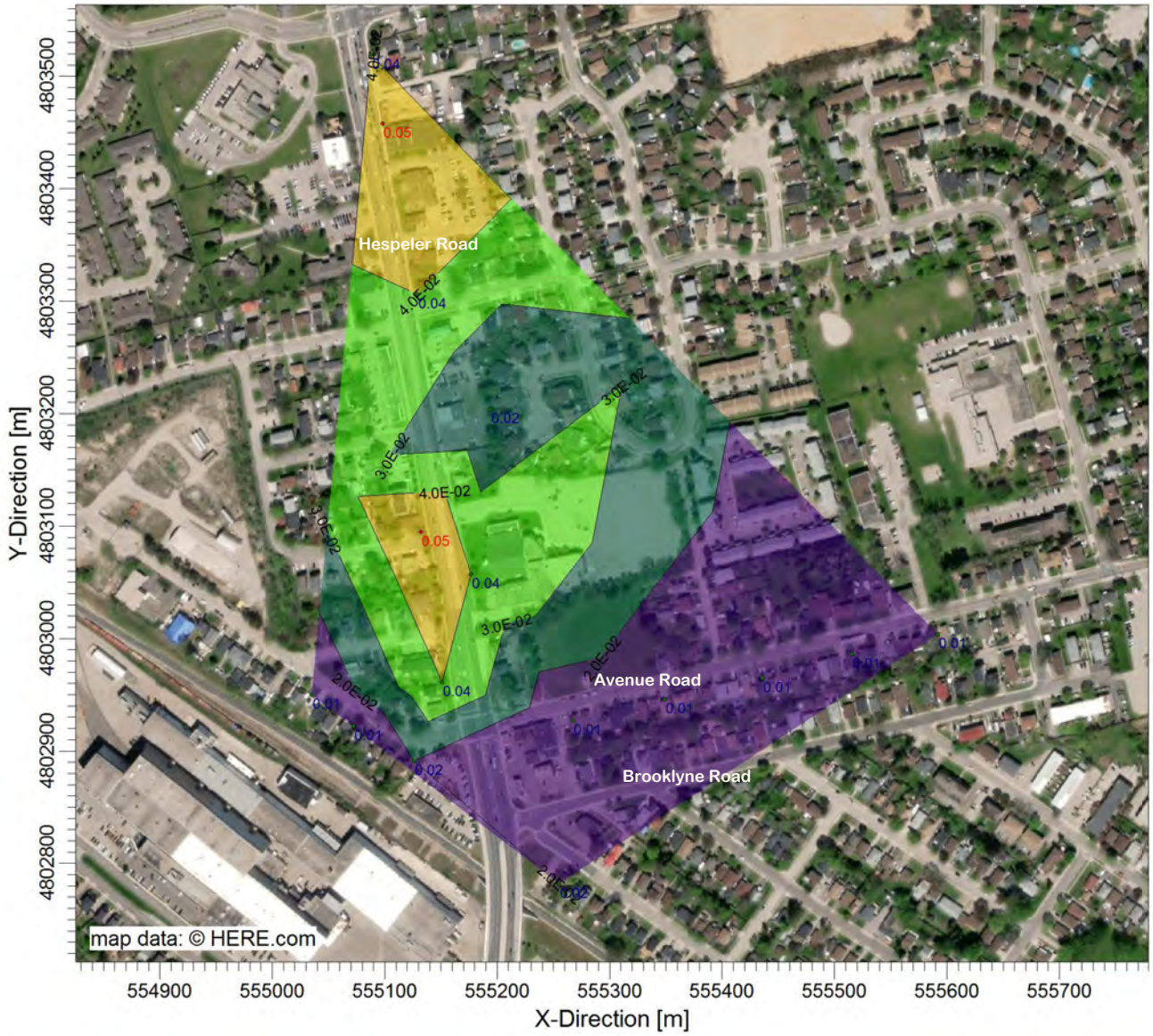


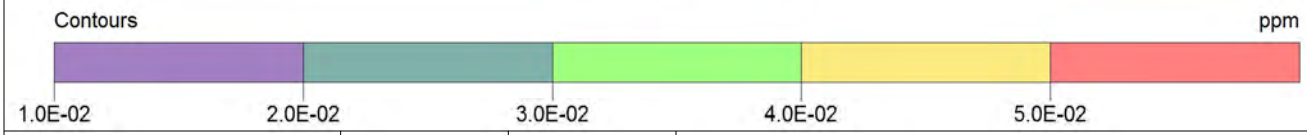


COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.14**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:6,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.:

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 4 Current Scenario (2018) - 8 hour

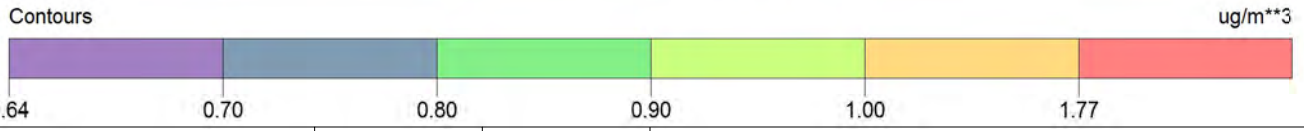




COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.05**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:6,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.:

PROJECT TITLE:

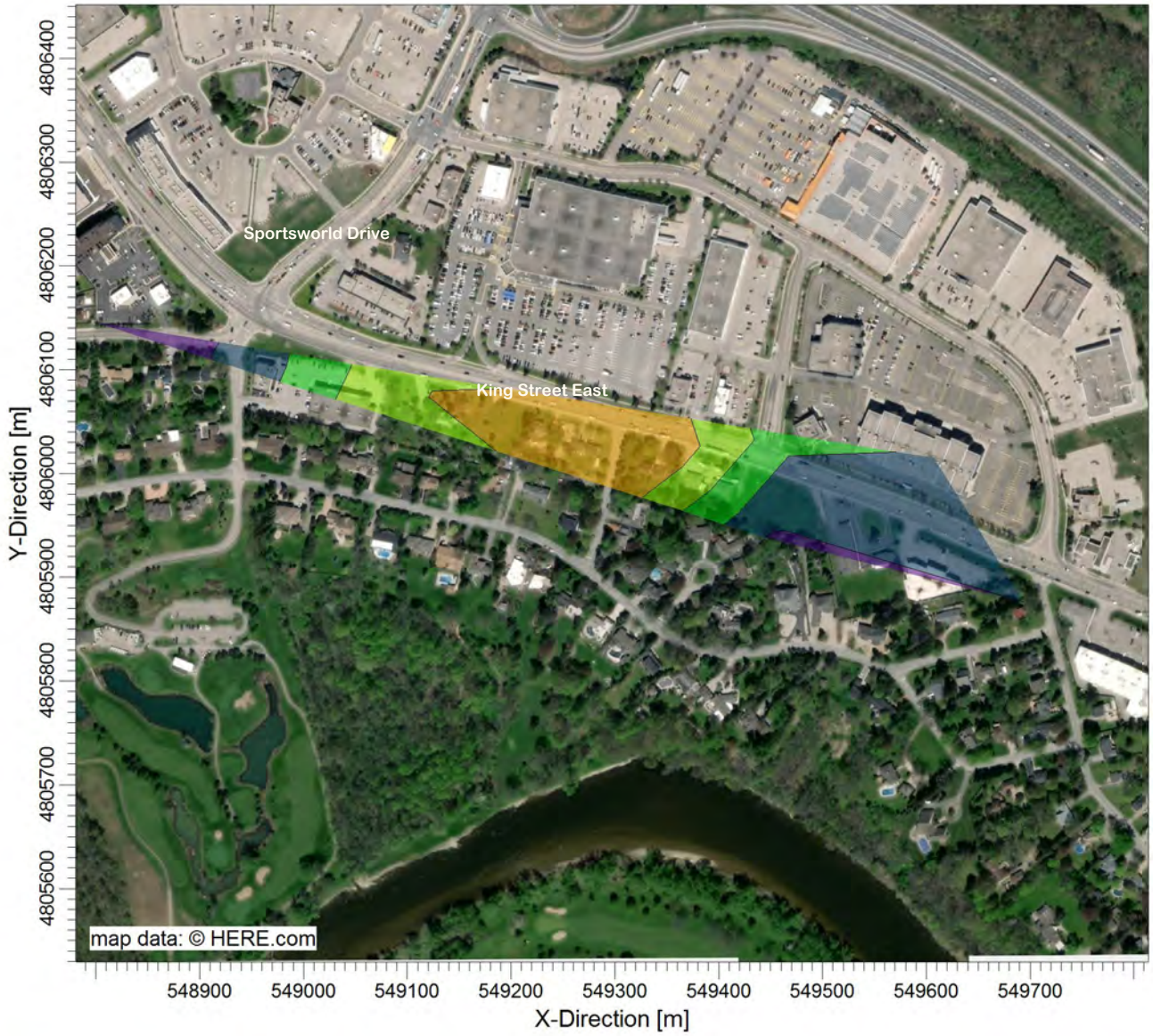
Waterloo Stage 2 ION
Study Area 1 Current Scenario (2018) - 24 hour

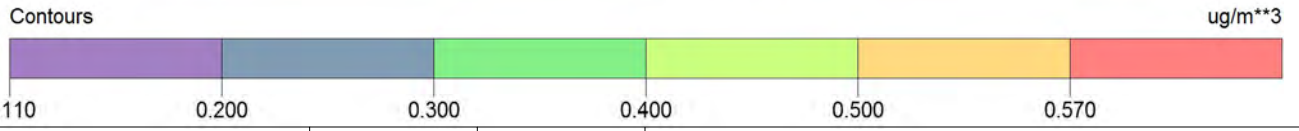


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM2.5	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **1.77**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,500 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 1 Current Scenario (2018) - Annual hour

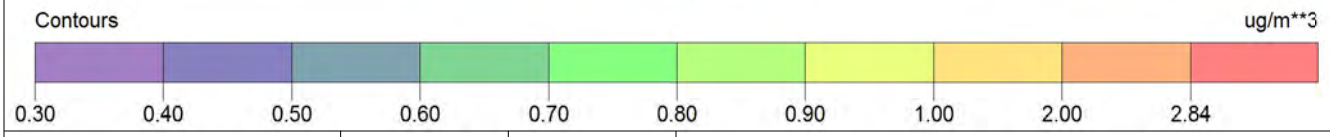




COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM2.5	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **0.57**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,500 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

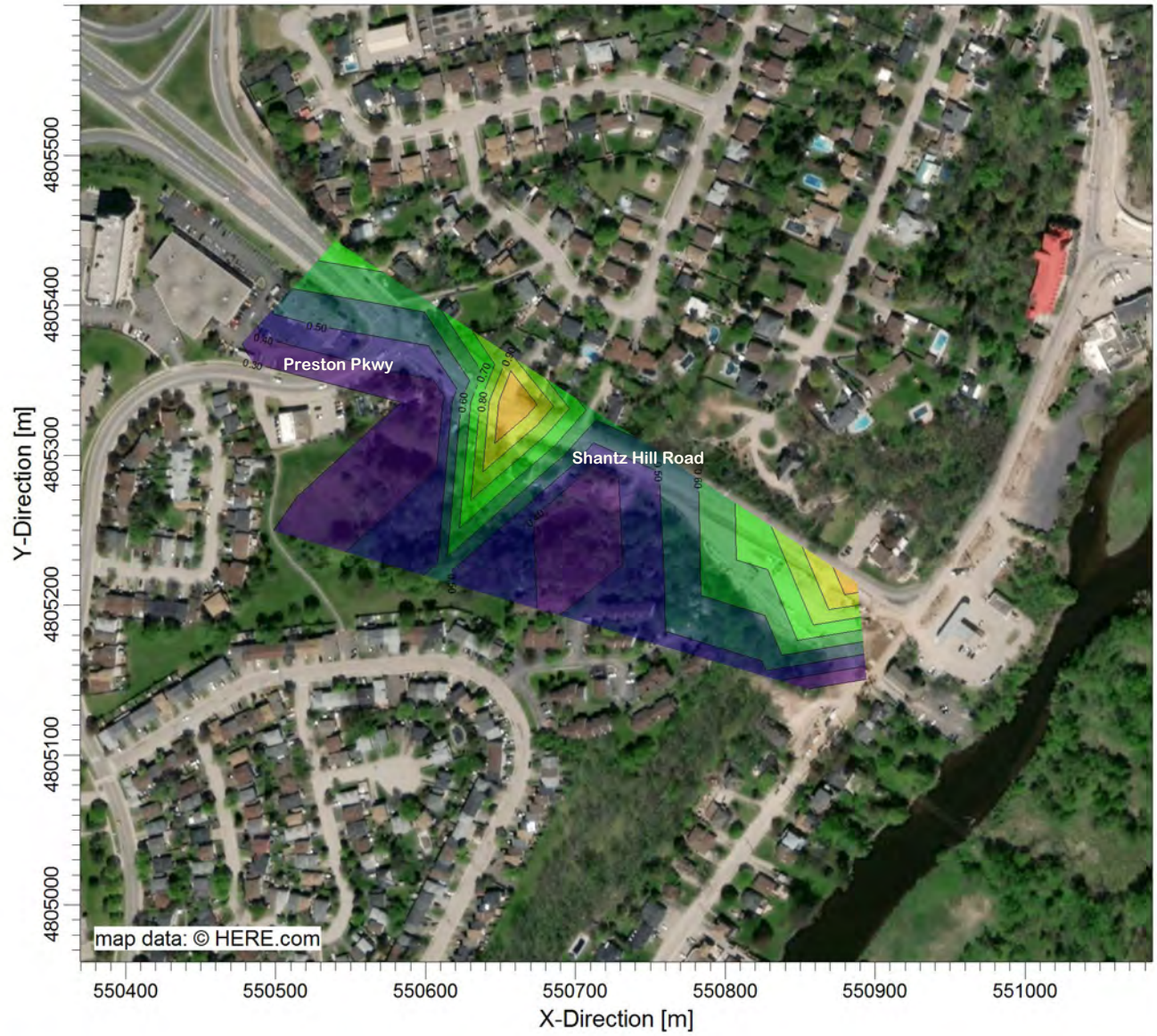
Waterloo Stage 2 ION
Study Area 2 Current Scenario (2018) - 24 hour

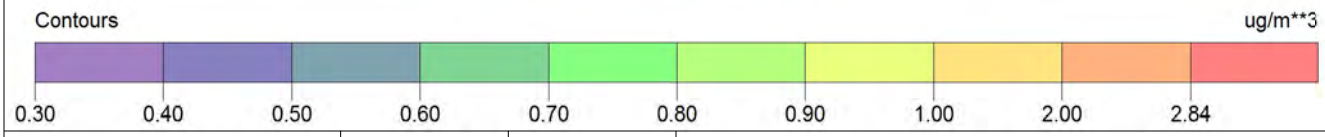


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM2.5	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **2.84**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:5,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 2 Current Scenario (2018) - Annual

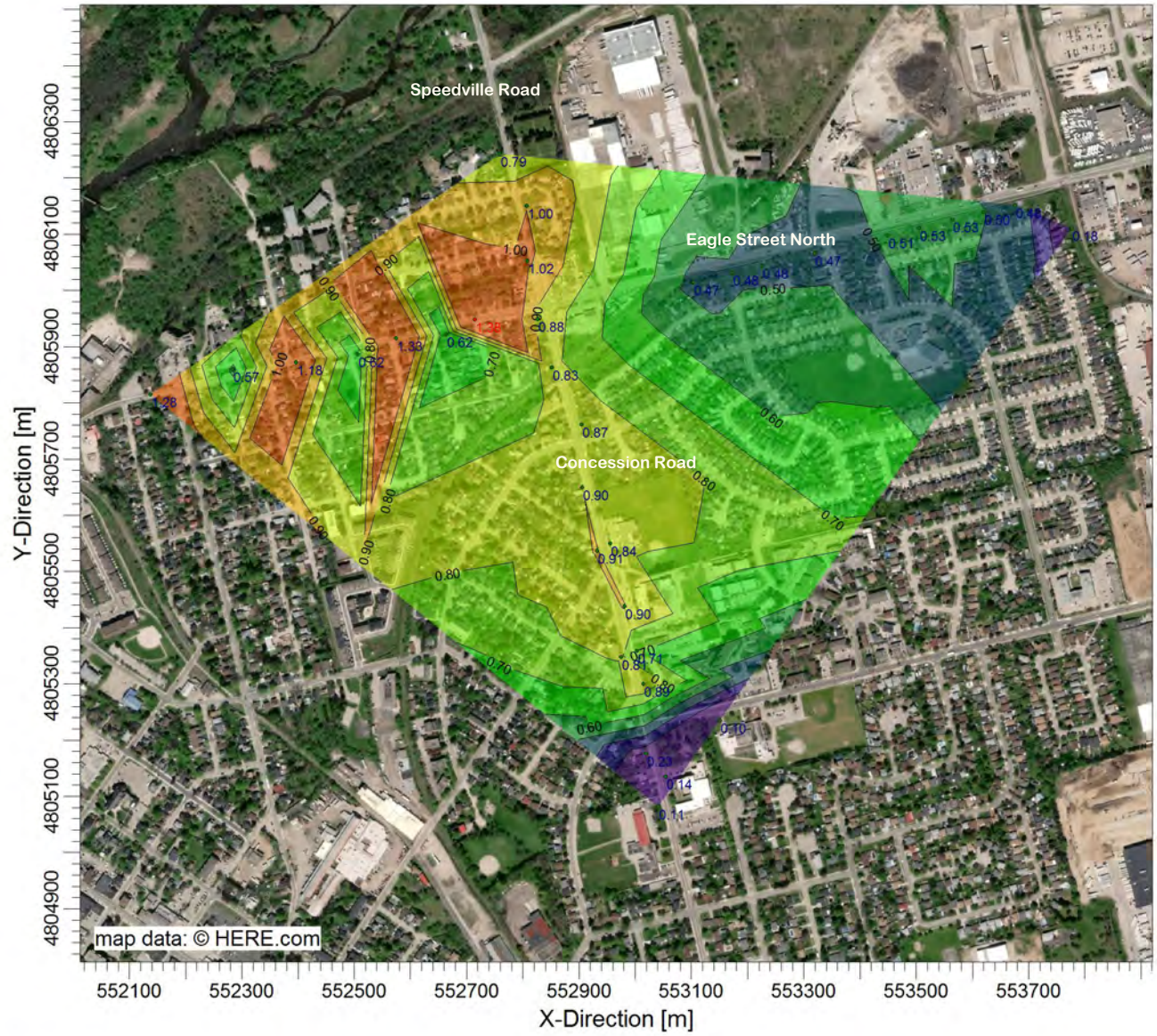


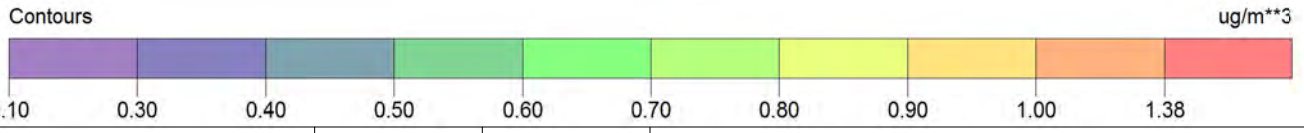


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM2.5	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **1.15**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:4,500 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 3 Current Scenario (2018) - 24 hour

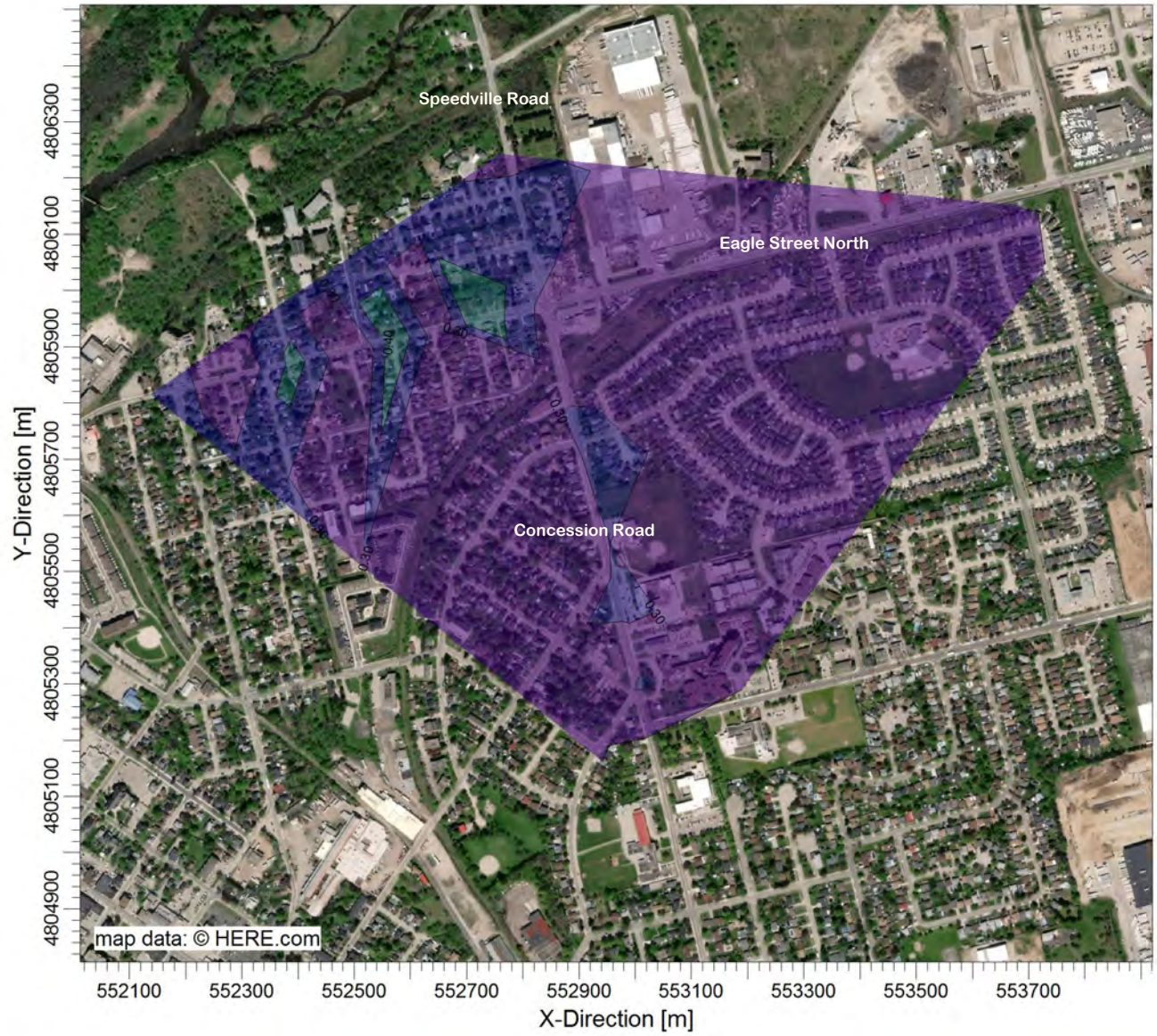


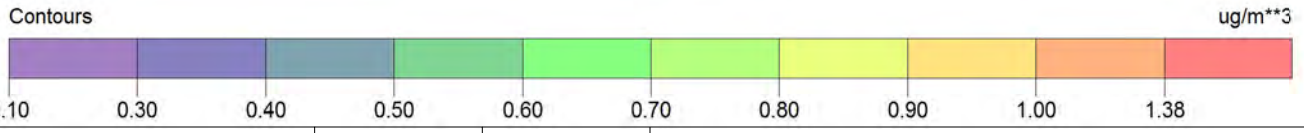


COMMENTS: PM2.5	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **1.38**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 3 Current Scenario (2018) - Annual

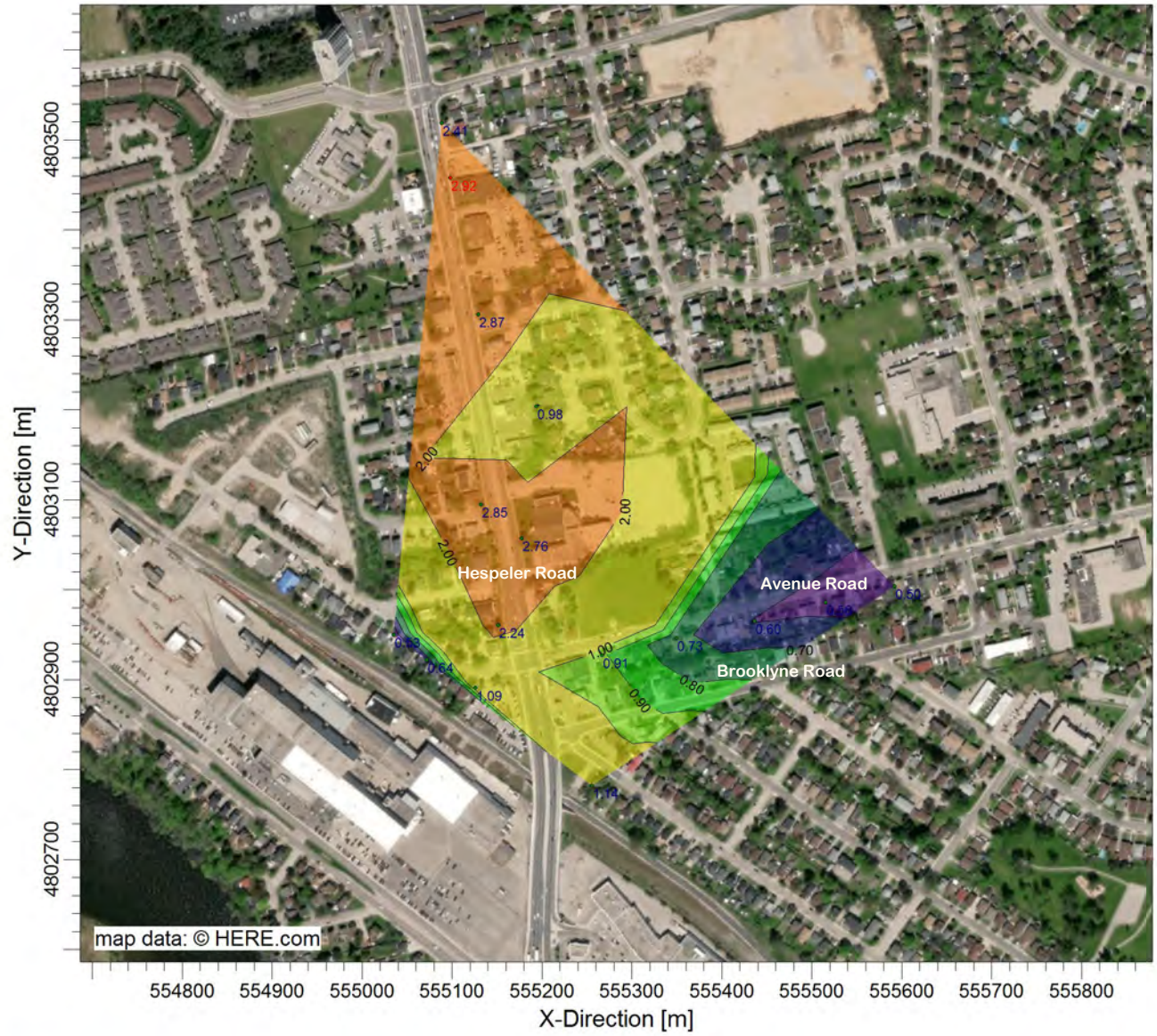


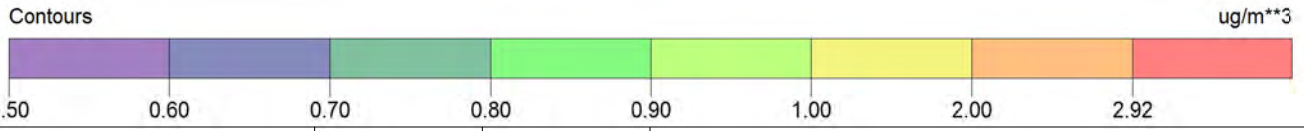


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM2.5	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **0.50**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 4 Current Scenario (2018) - 24 hour

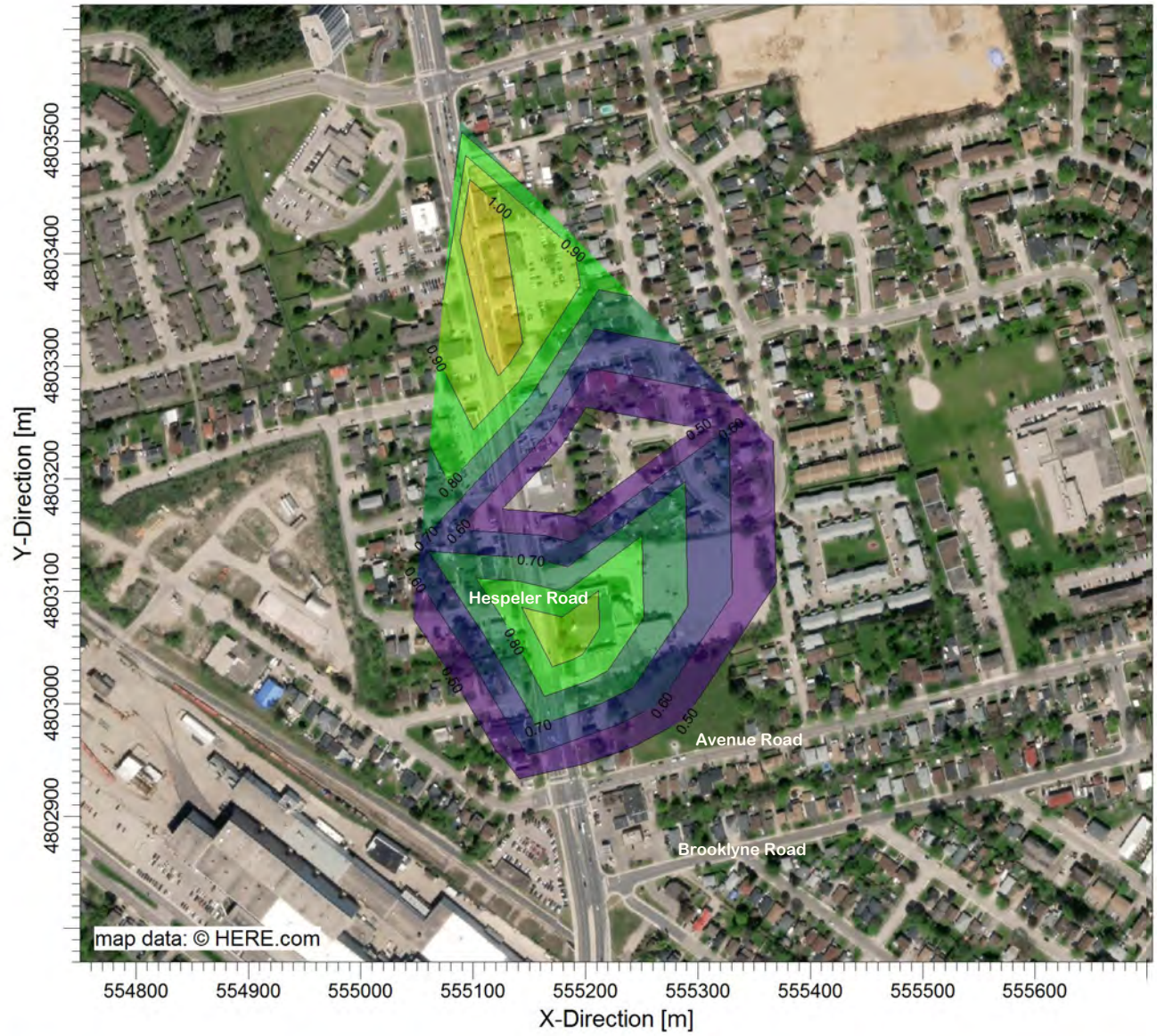


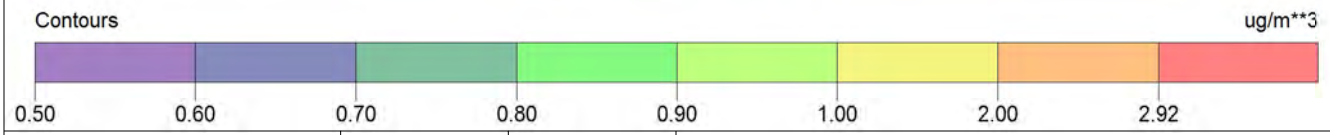


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM2.5	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **2.92**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:7,500 0 0.2 m	DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**	

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 4 Current Scenario (2018) - Annual

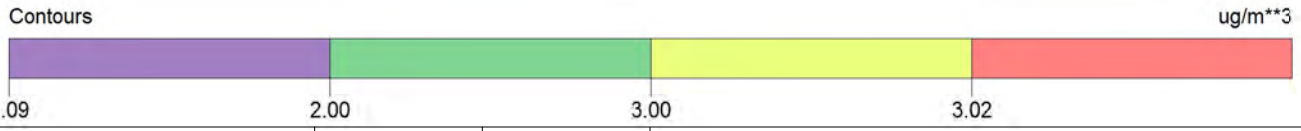




COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM2.5	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **1.04**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:6,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

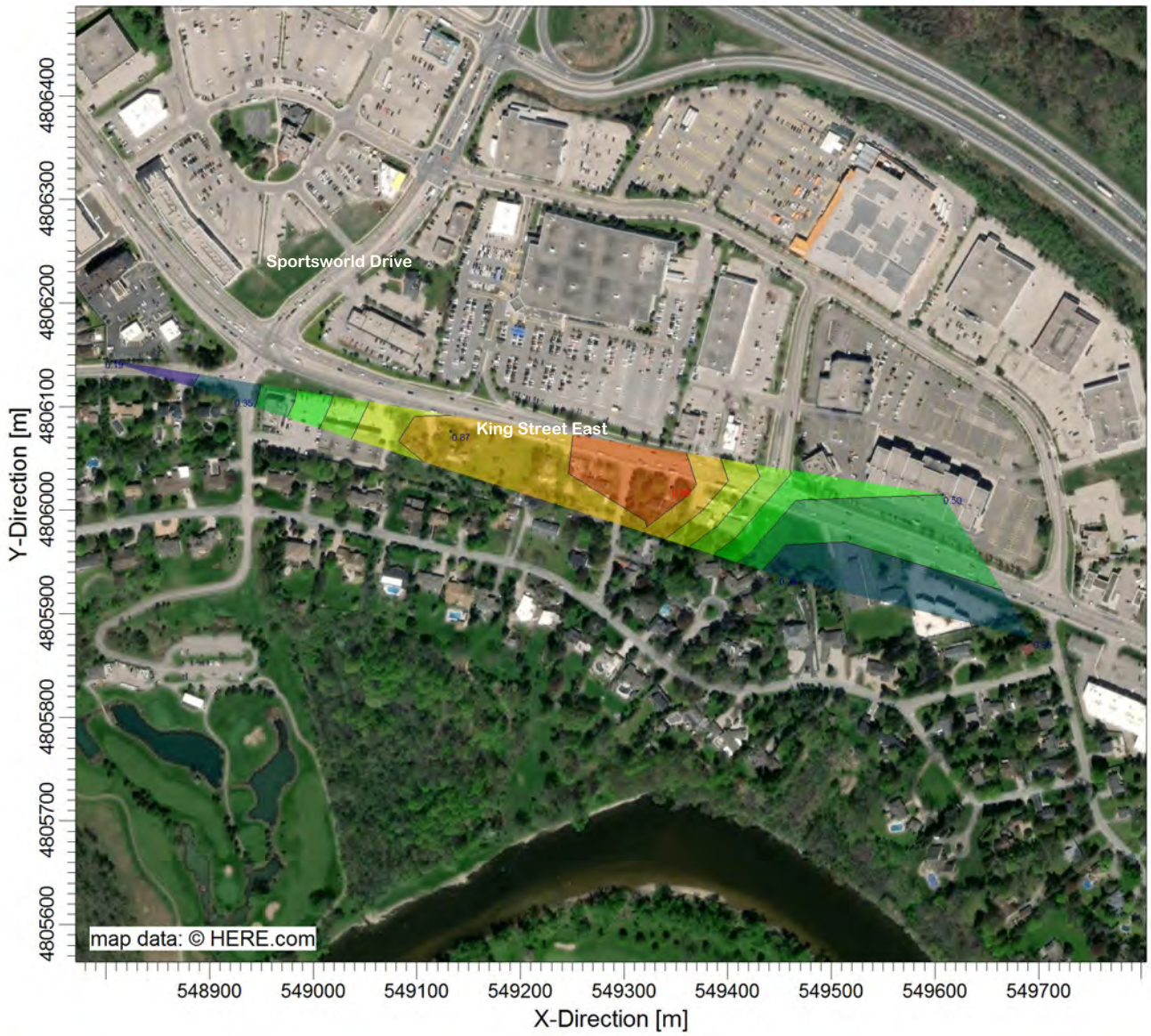
Waterloo Stage 2 ION
Study Area 1 Current Scenario (2018) - 24 hour

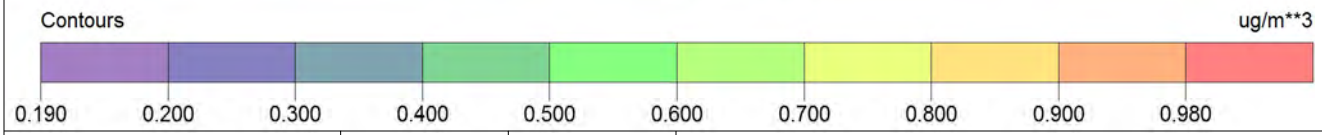


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM10	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **3.02**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,500 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 1 Current Scenario (2018) - Annual

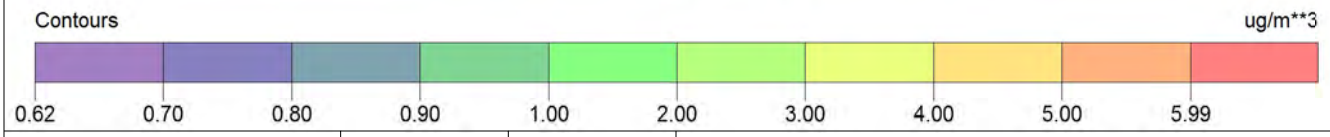




COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM10	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **0.98**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,500 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

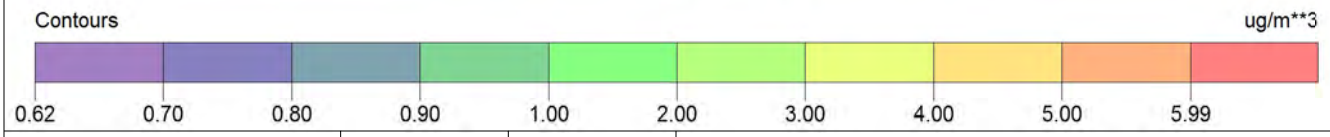
Waterloo Stage 2 ION
Study Area 2 Current Scenario (2018) - 24 hour



COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM10	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **5.99**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:5,500 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

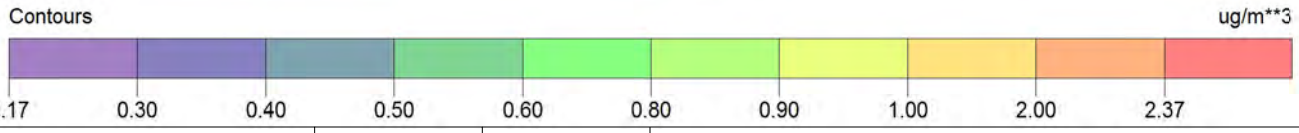
Waterloo Stage 2 ION
Study Area 2 Current Scenario (2018) - Annual



COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM10	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **2.44**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:5,500 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

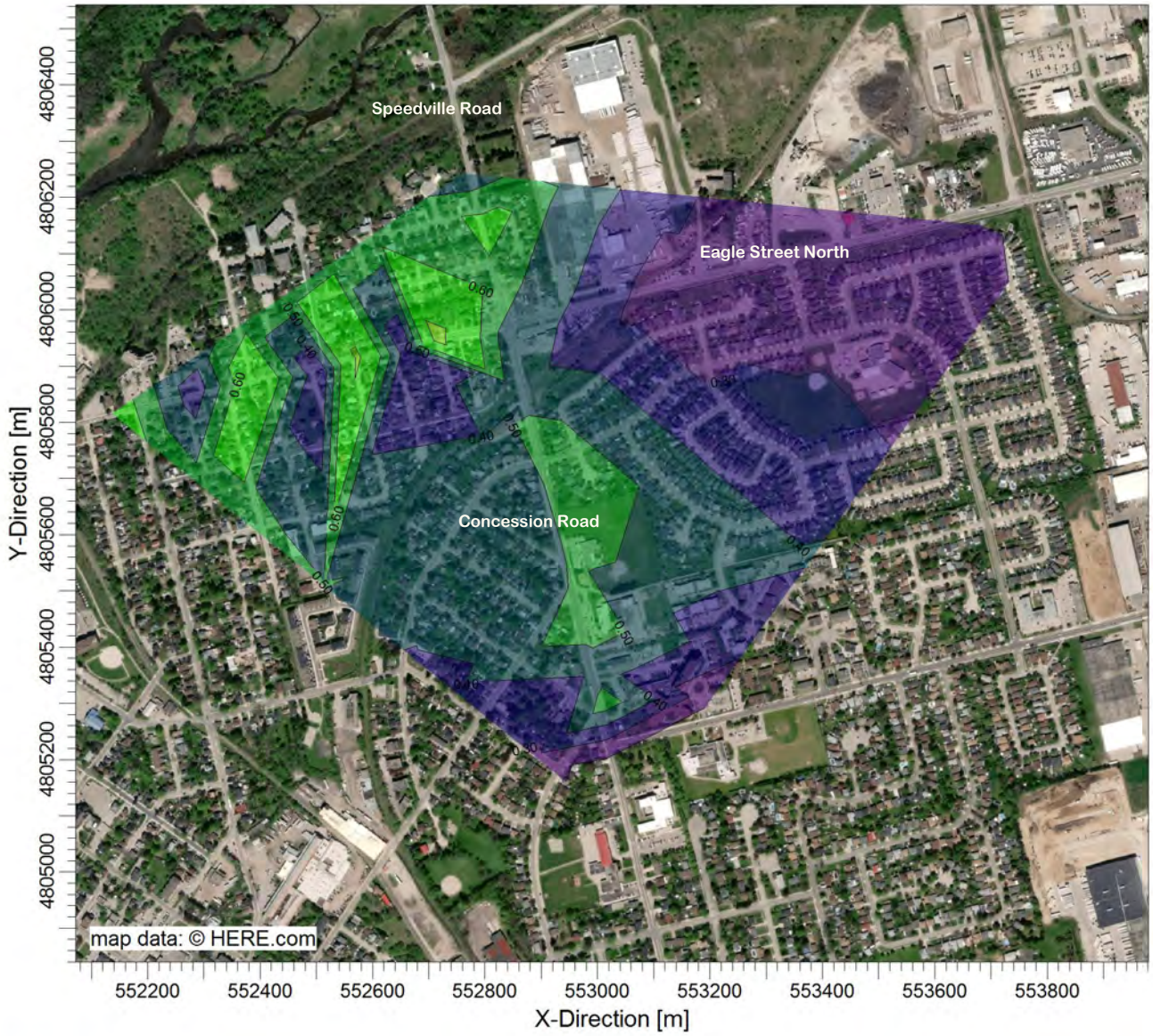
Waterloo Stage 2 ION
Study Area 3 Current Scenario (2018) - 24 hour

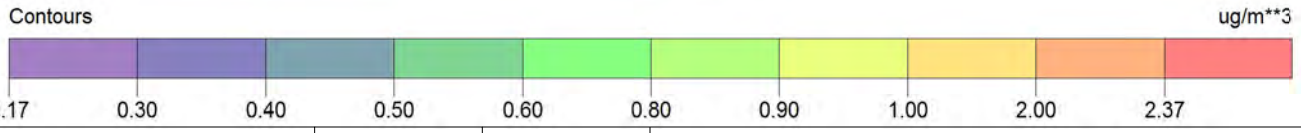


COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **2.37**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 3 Current Scenario (2018) - Annual

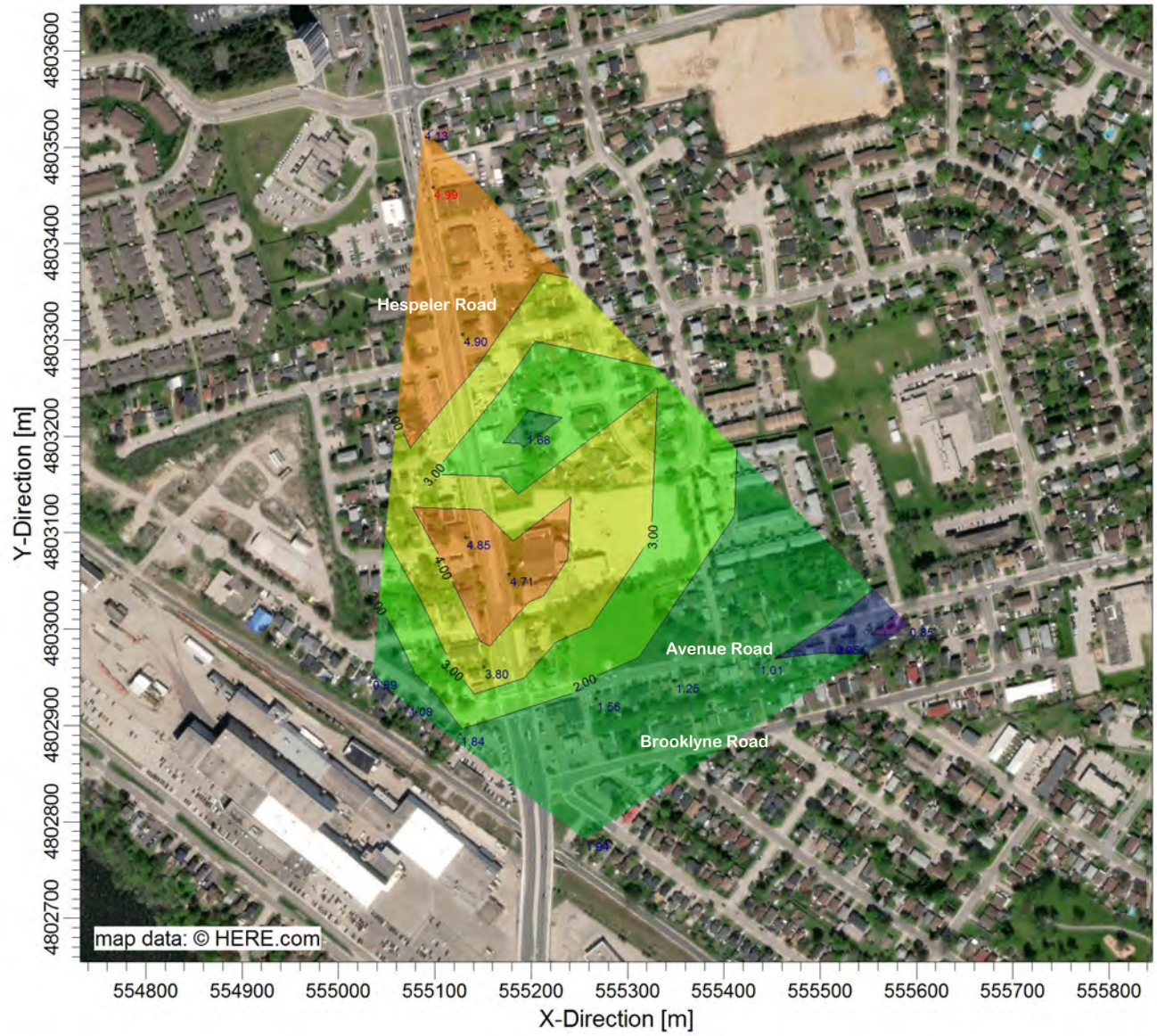


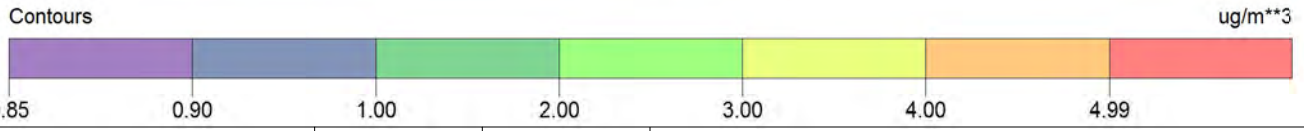


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM10	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **0.85**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 4 Current Scenario (2018) - 24 hour

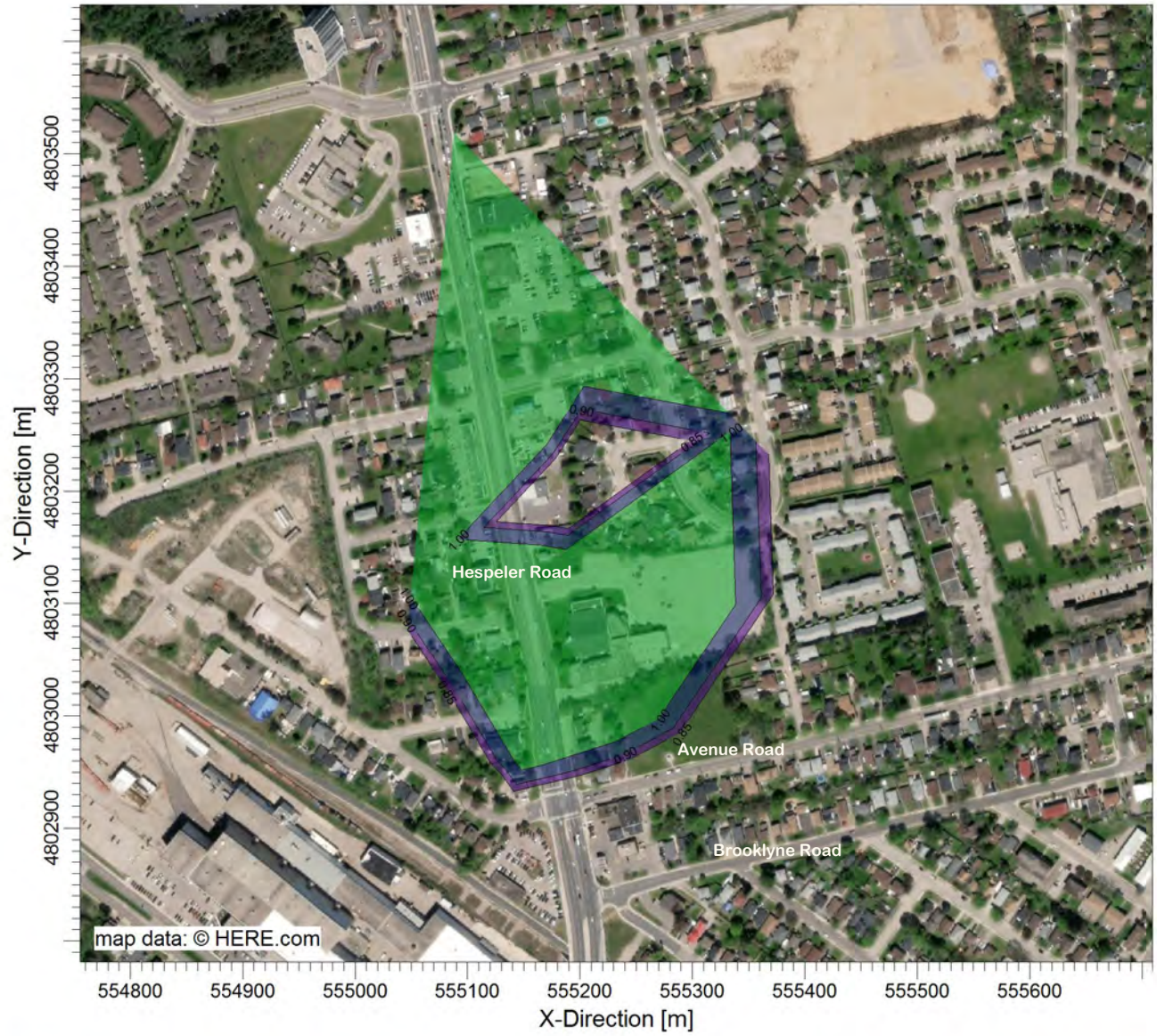


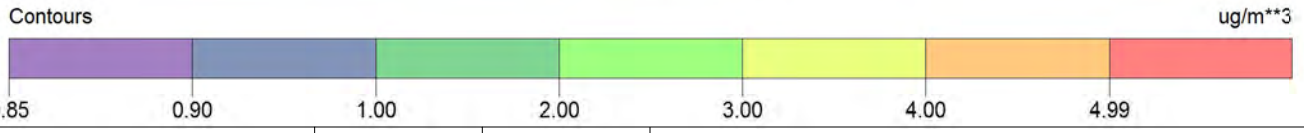


COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **4.99**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:7,000 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 4 Current Scenario (2018) - Annual





COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM10	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **1.79**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:6,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 1 No Build Scenario (2031) - 1 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.06**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

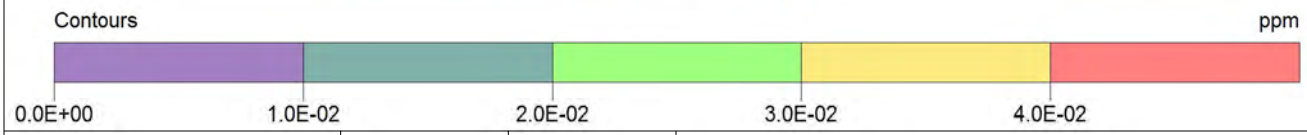
PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 1 No Build Scenario (2031) - 8 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.03**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 2 No Build Scenario (2031) - 1 hour



COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.09**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:4,500 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 2 No Build Scenario (2031) - 8 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.04**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:5,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

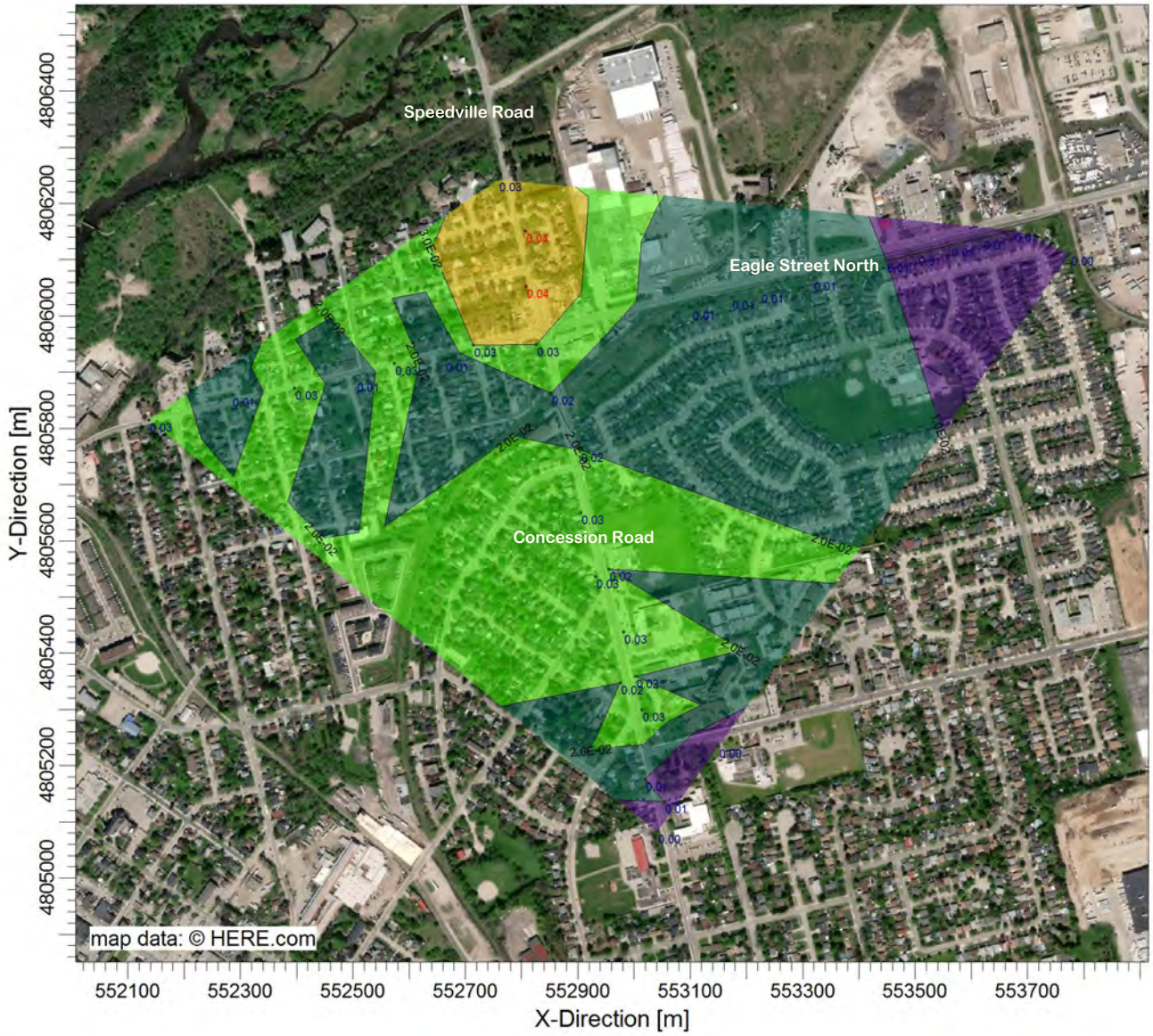
PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 3 No Build Scenario (2031) - 1 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.12**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

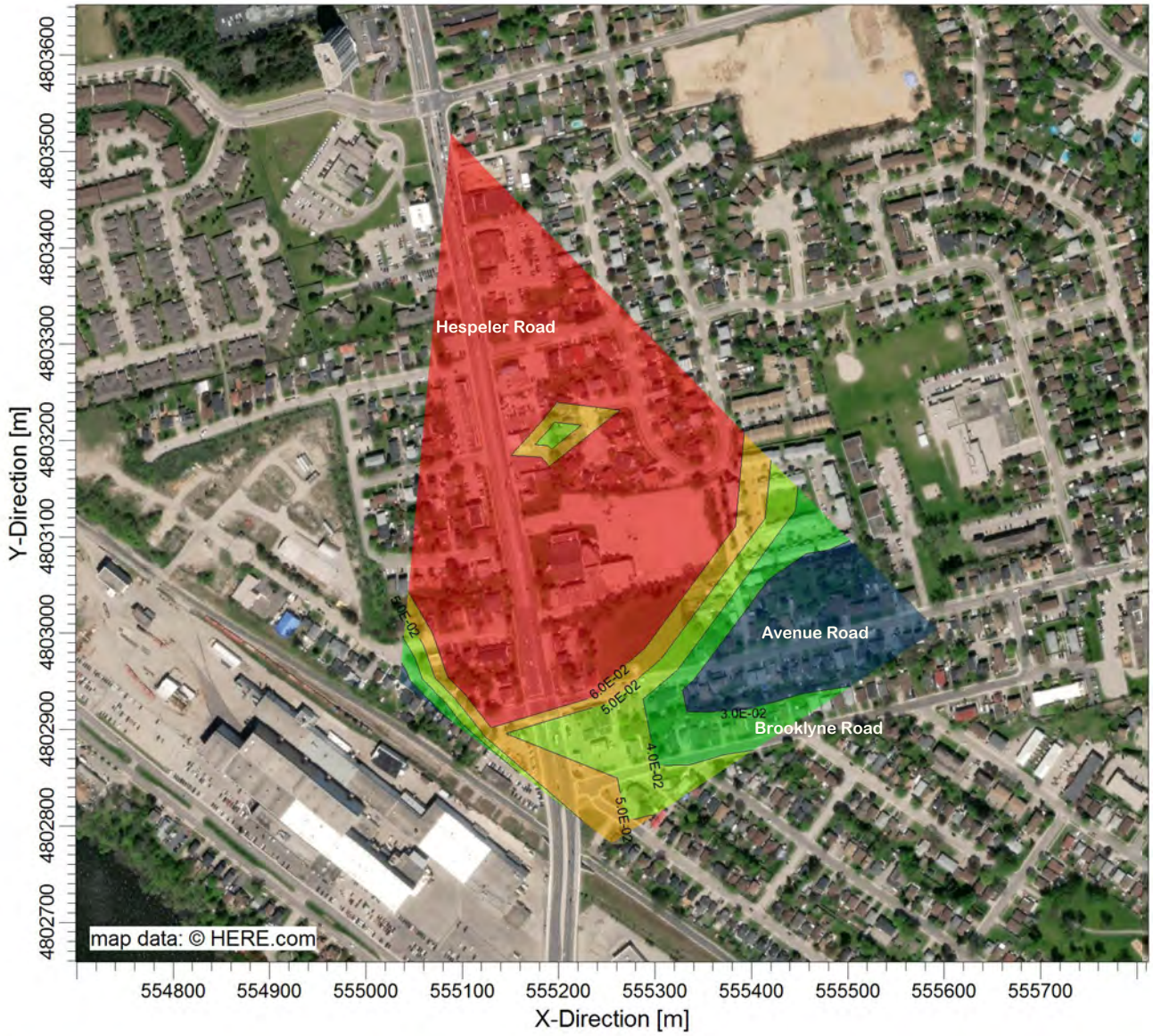
Waterloo Stage 2 ION
Study Area 3 No Build Scenario (2031) - 8 hour

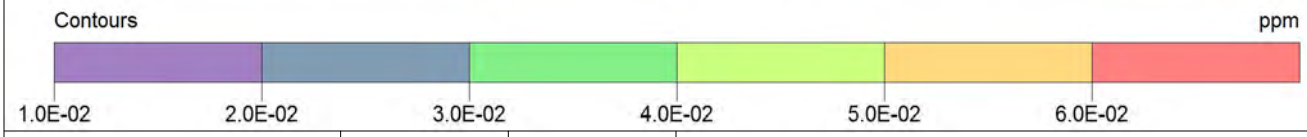


COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.04**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 4 No Build Scenario (2031) - 1 hour

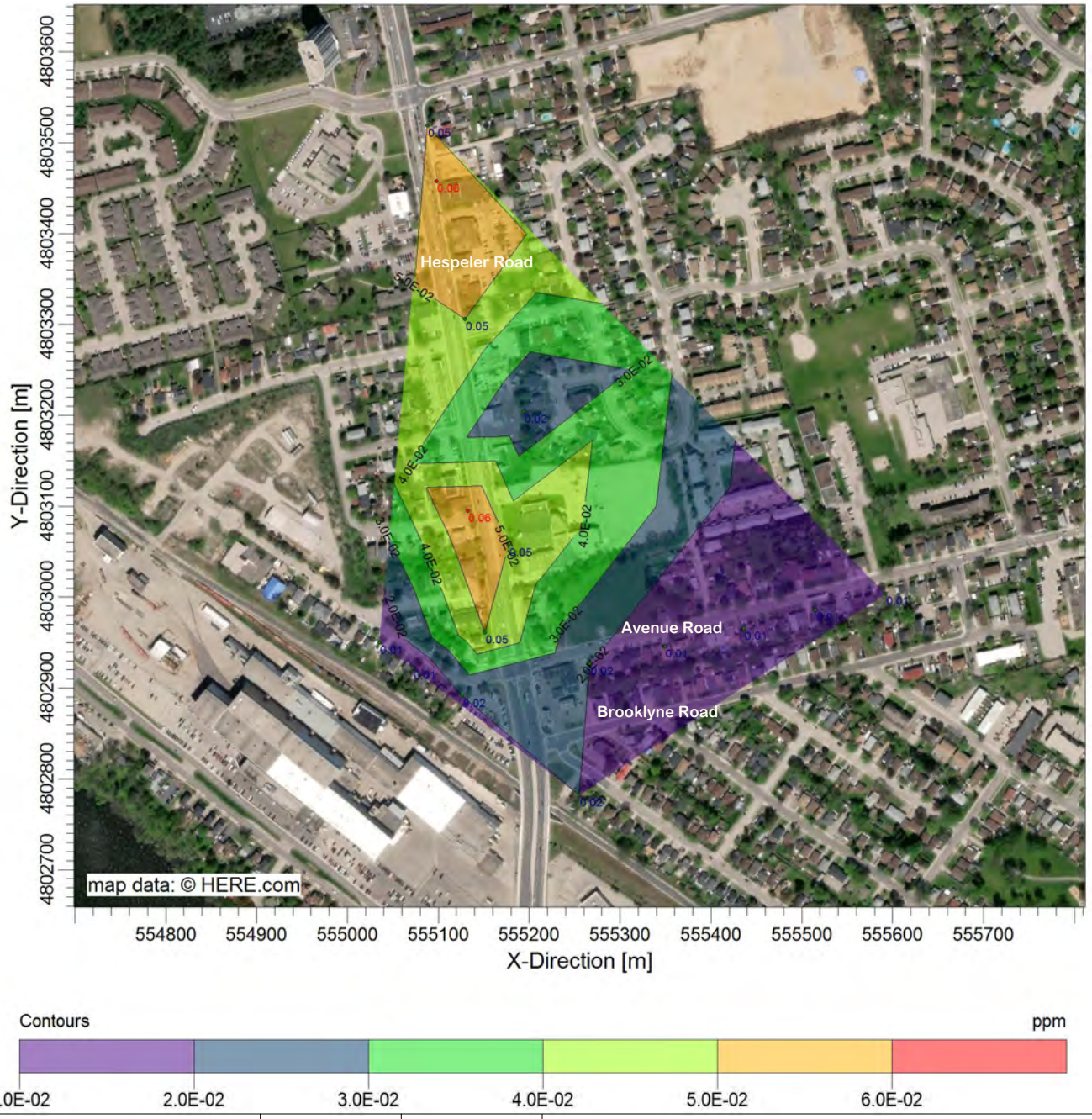




COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.17**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:7,000 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

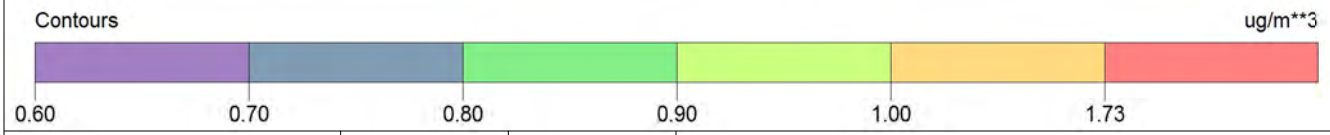
Waterloo Stage 2 ION
Study Area 4 No Build Scenario (2031) - 8 hour



COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.06**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:7,000 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

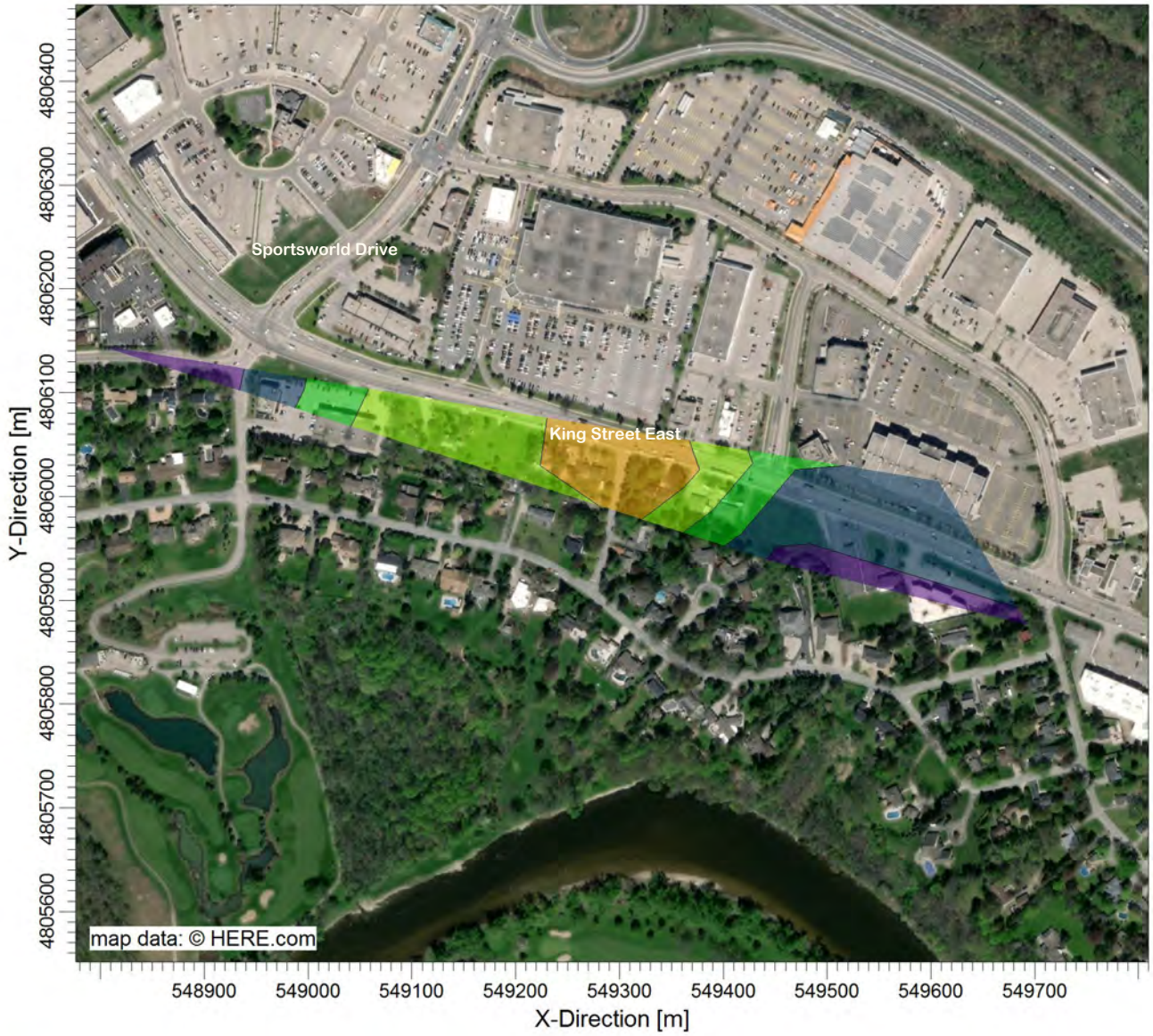
Waterloo Stage 2 ION
Study Area 1 No Build Scenario (2031) - 24 hour

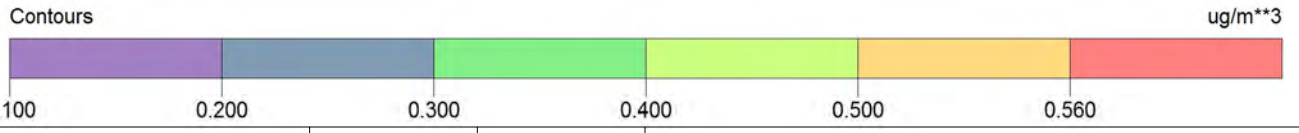


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM2.5	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **1.73**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,500 (0 — 0.2 m)		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 1 No Build Scenario (2031) - Annual

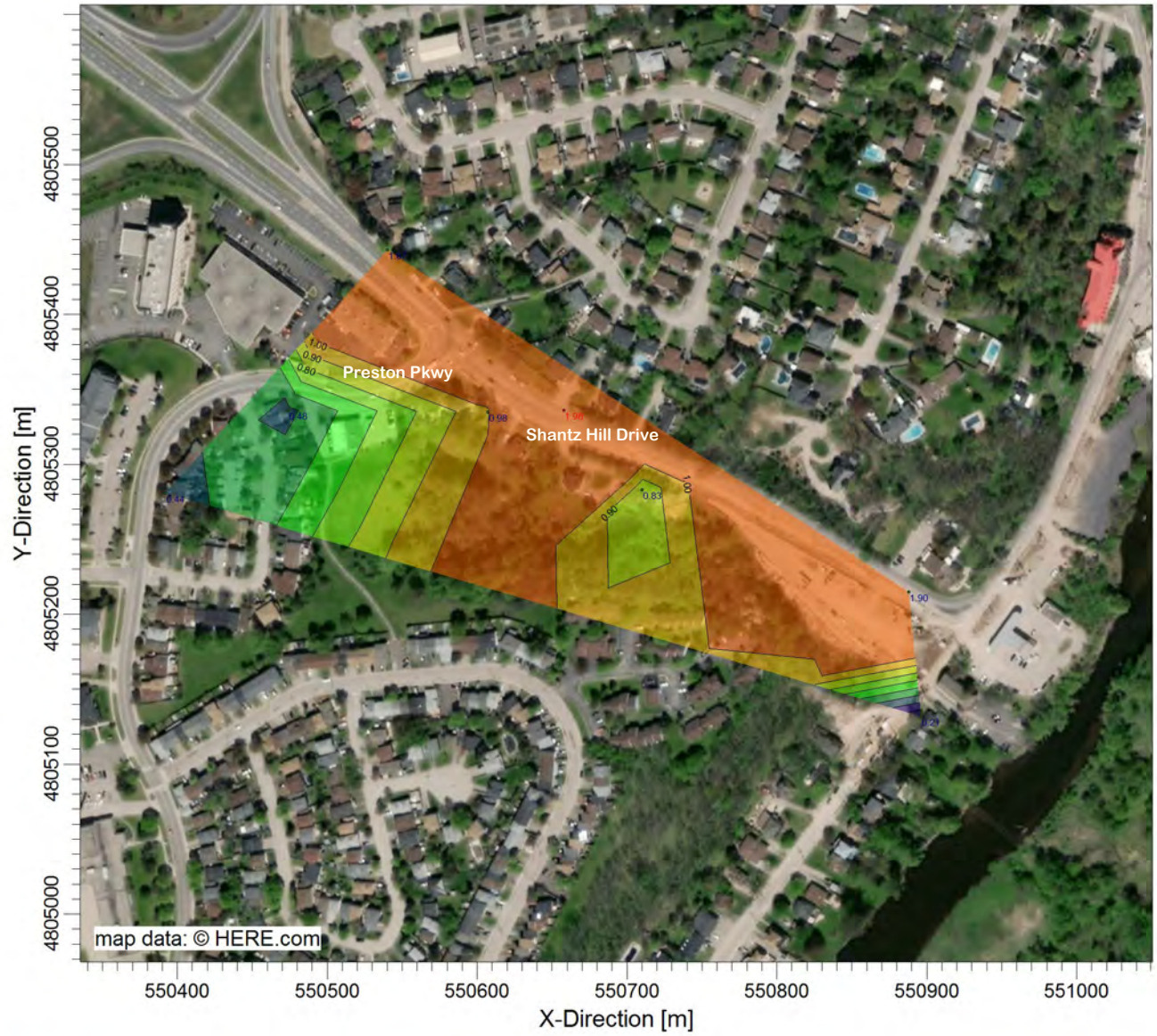


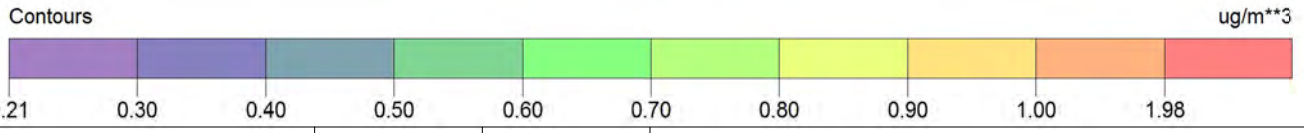


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM2.5	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **0.56**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,500 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 2 No Build Scenario (2031) - 24 hour

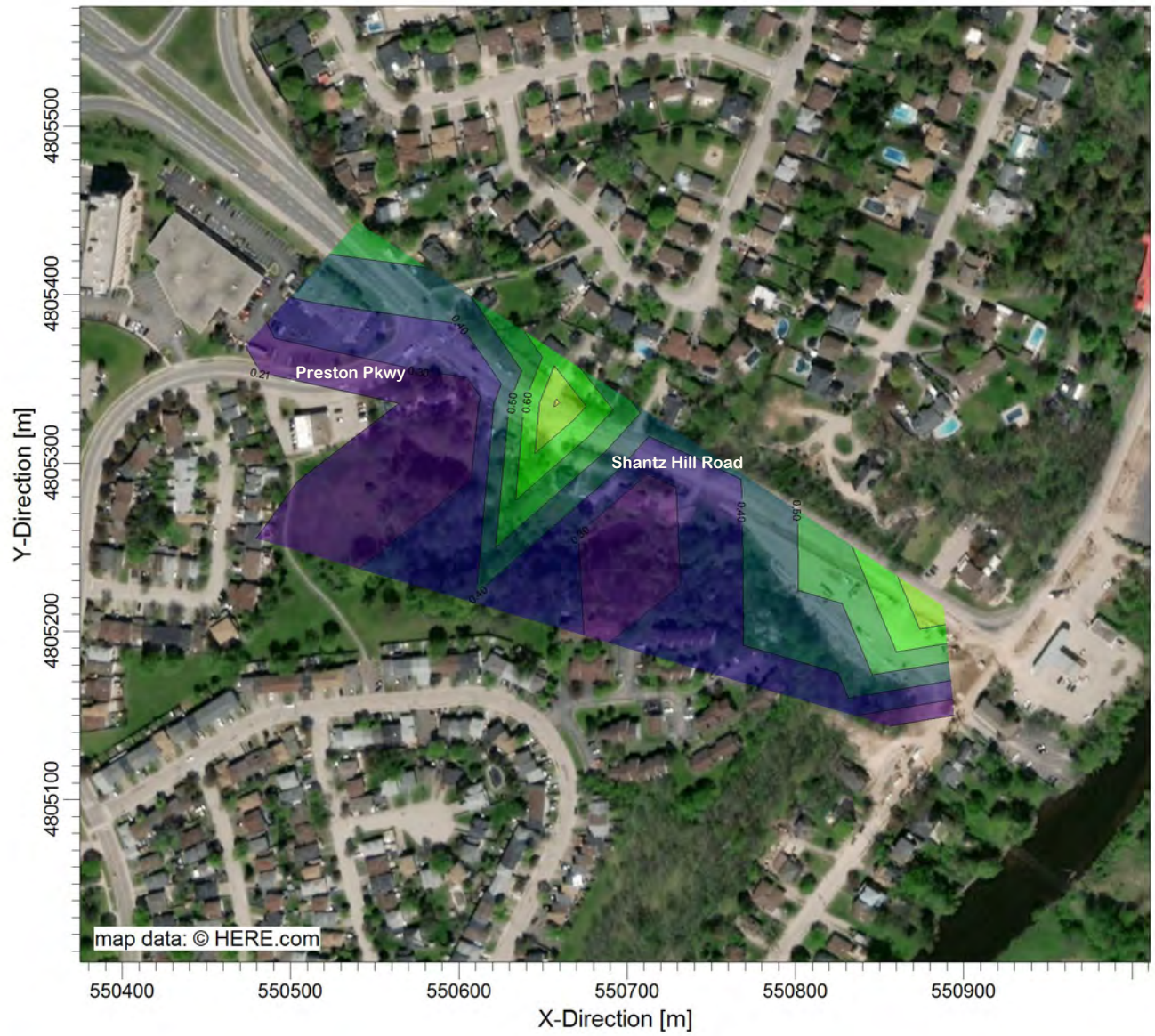


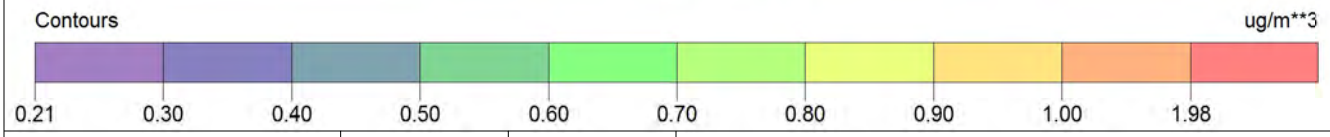


COMMENTS: PM2.5	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **1.98**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:4,500 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 2 No Build Scenario (2031) - Annual

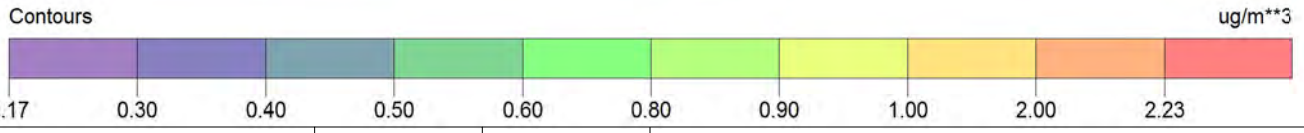




COMMENTS: PM2.5	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.81**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:4,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

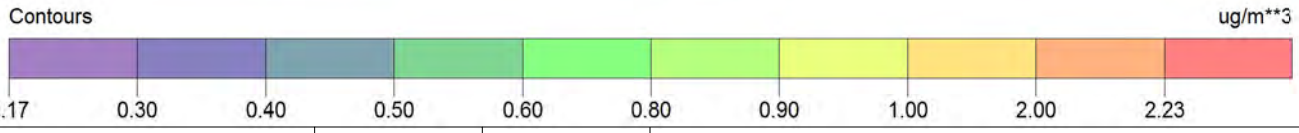
Waterloo Stage 2 ION
Study Area 3 No Build Scenario (2031) - 24 hour



COMMENTS: PM2.5	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **2.23**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

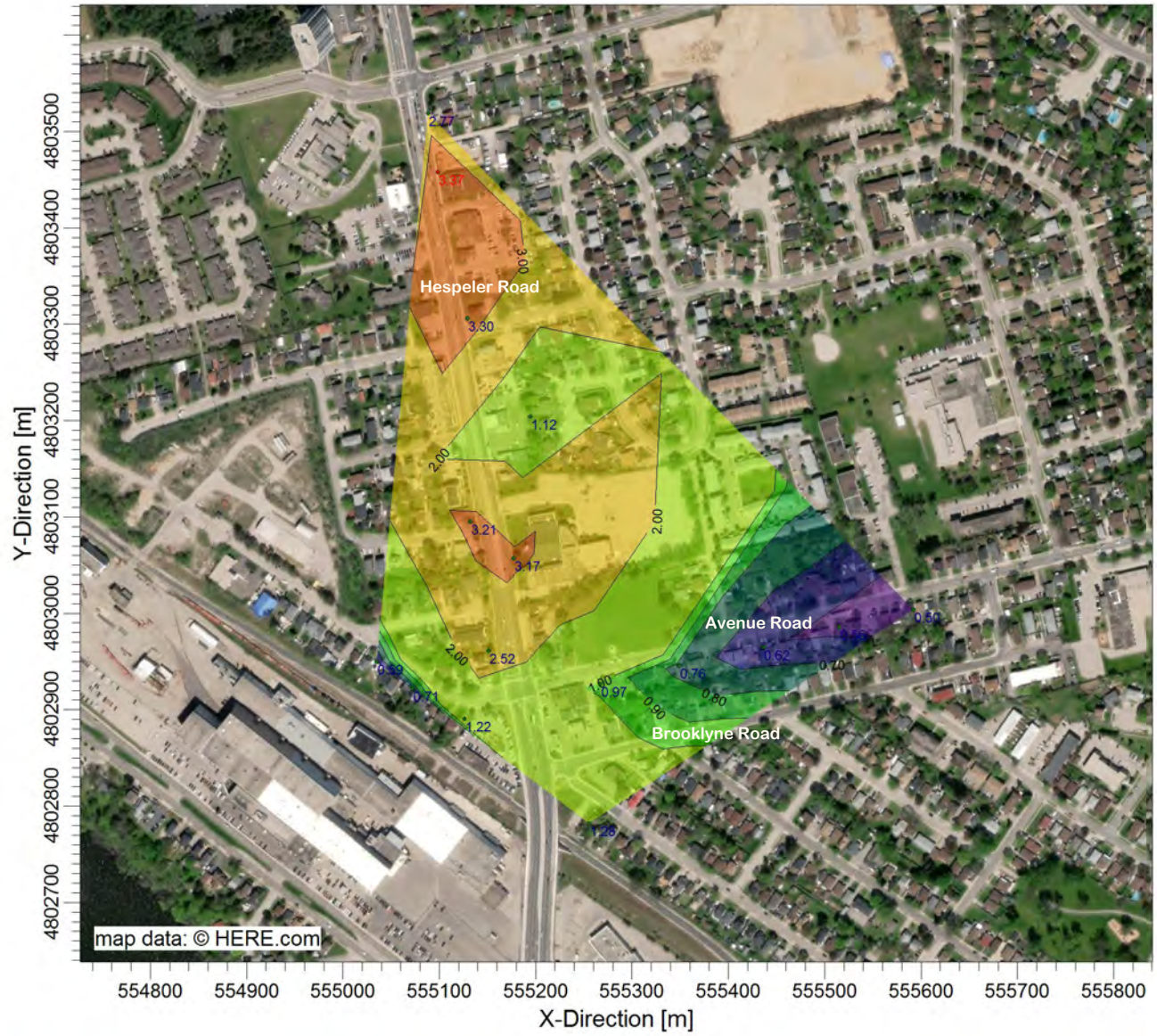
Waterloo Stage 2 ION
Study Area 3 No Build Scenario (2031) - Annual

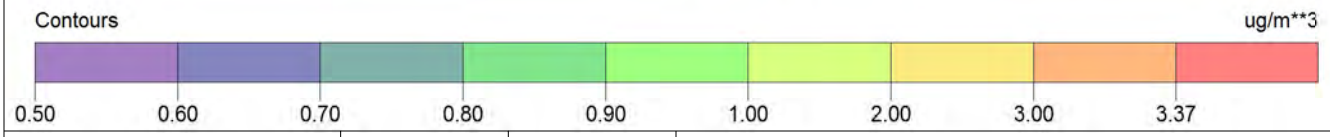


COMMENTS: PM2.5	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.83**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 4 No Build Scenario (2031) - 24 hour

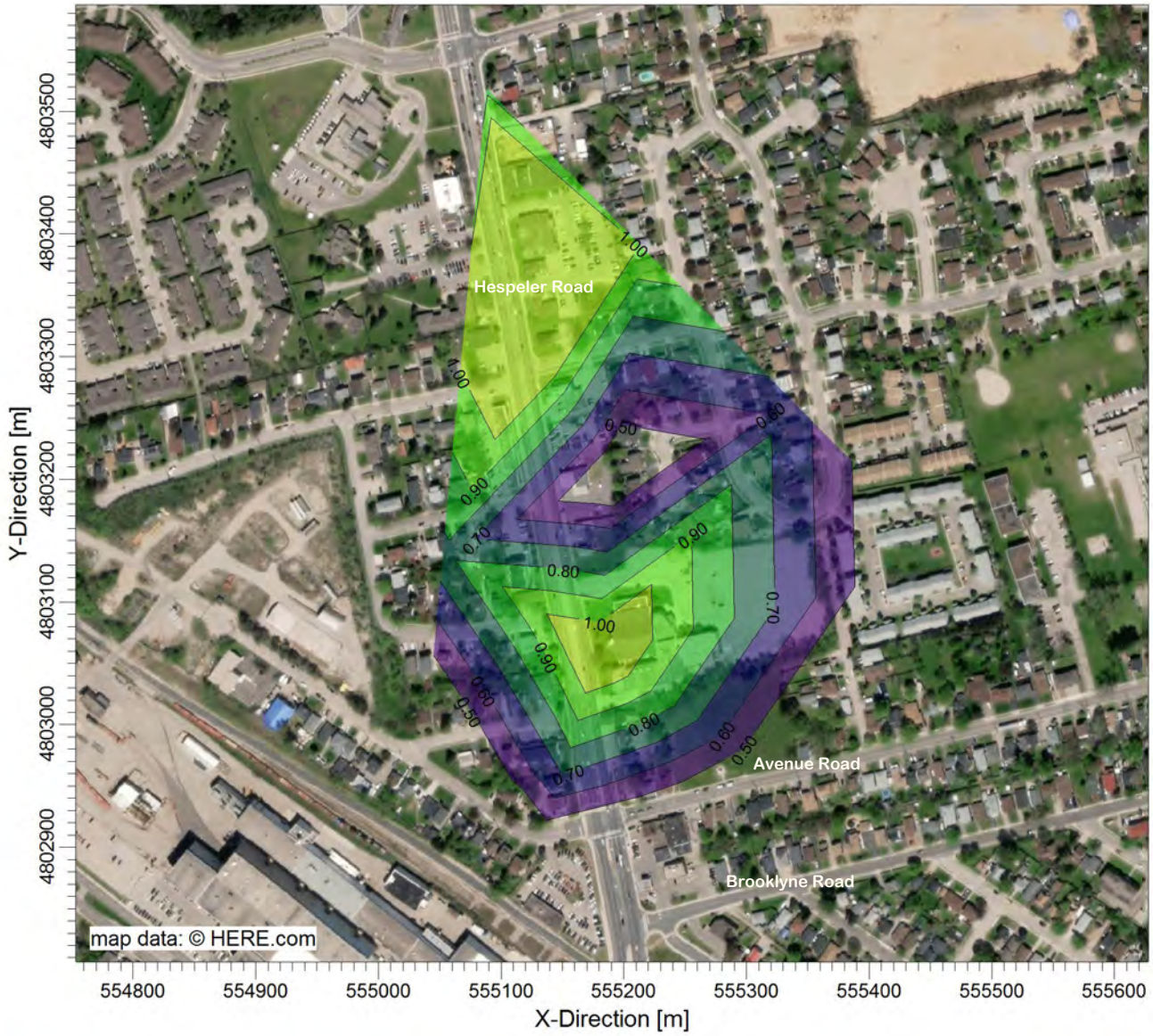


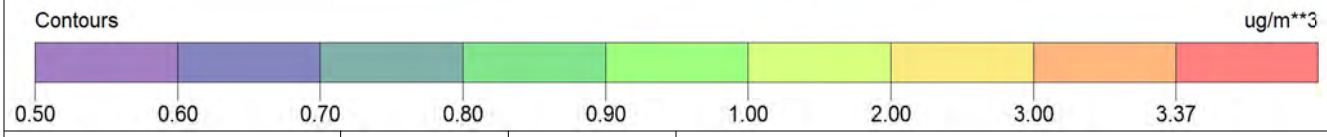


COMMENTS: PM2.5	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **3.37**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:7,000 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 4 No Build Scenario (2031) - Annual

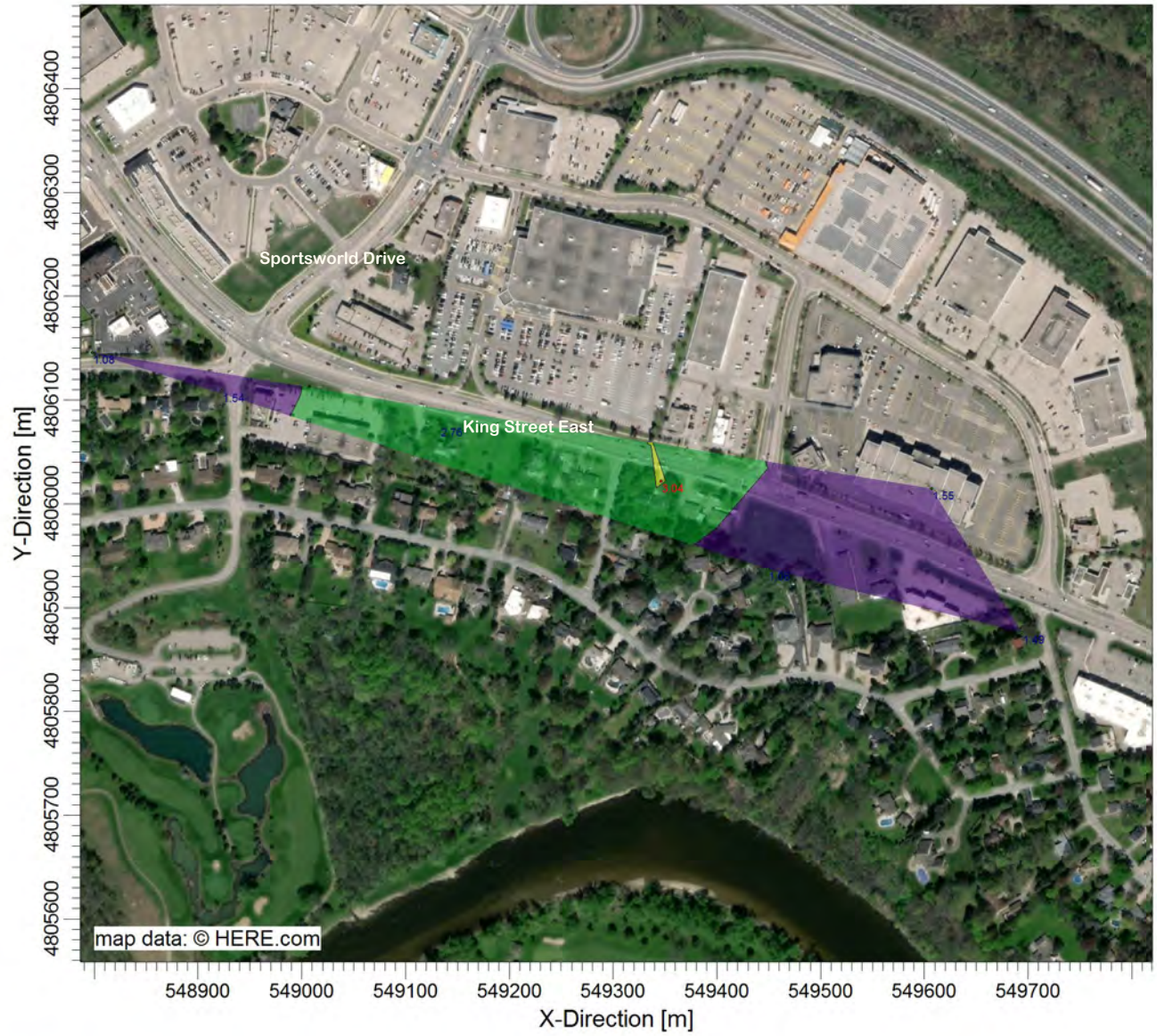


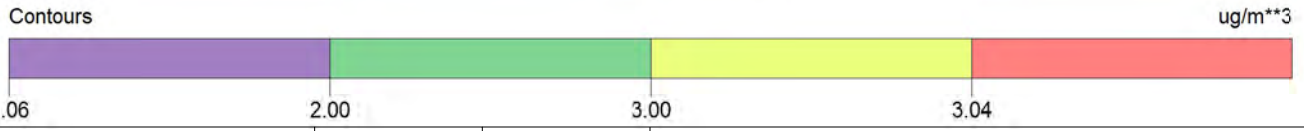


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM2.5	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **1.20**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:5,500 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 1 No Build Scenario (2031) - 24 hour

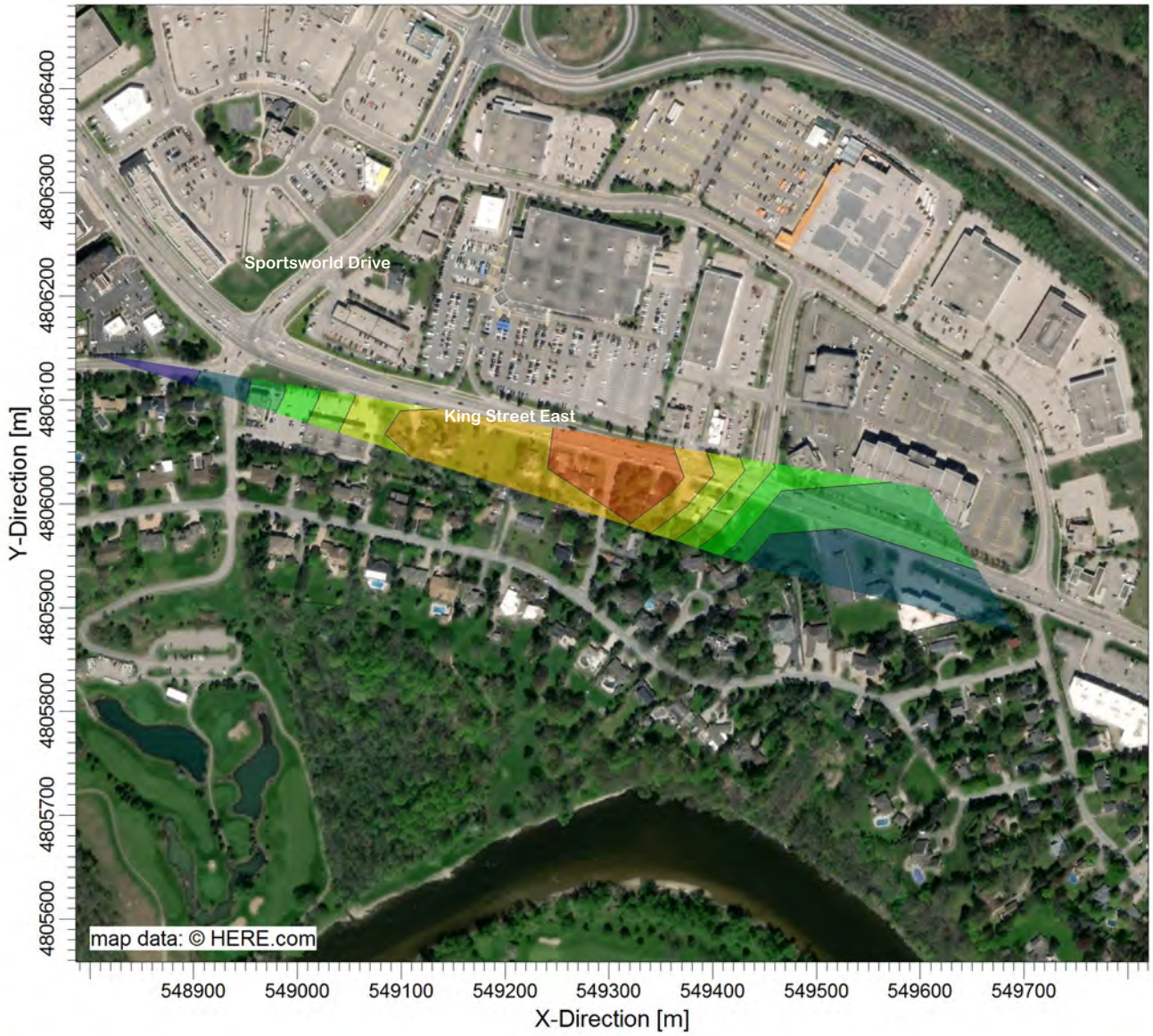


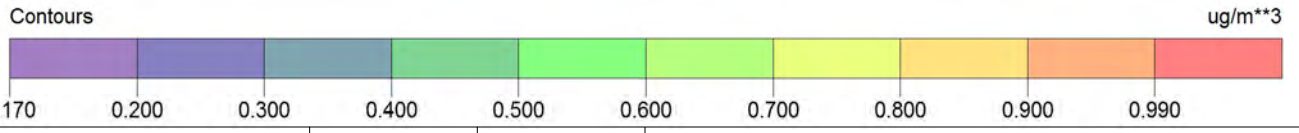


COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **3.04**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,500 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 1 No Build Scenario (2031) - Annual

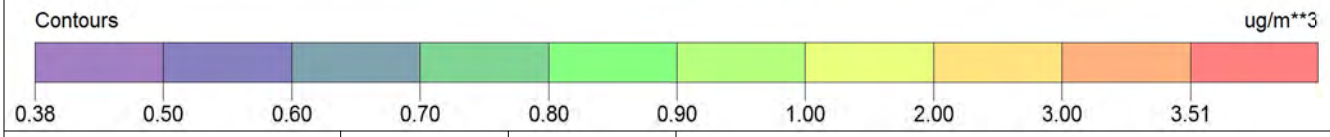




COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM10	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **0.99**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,500 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

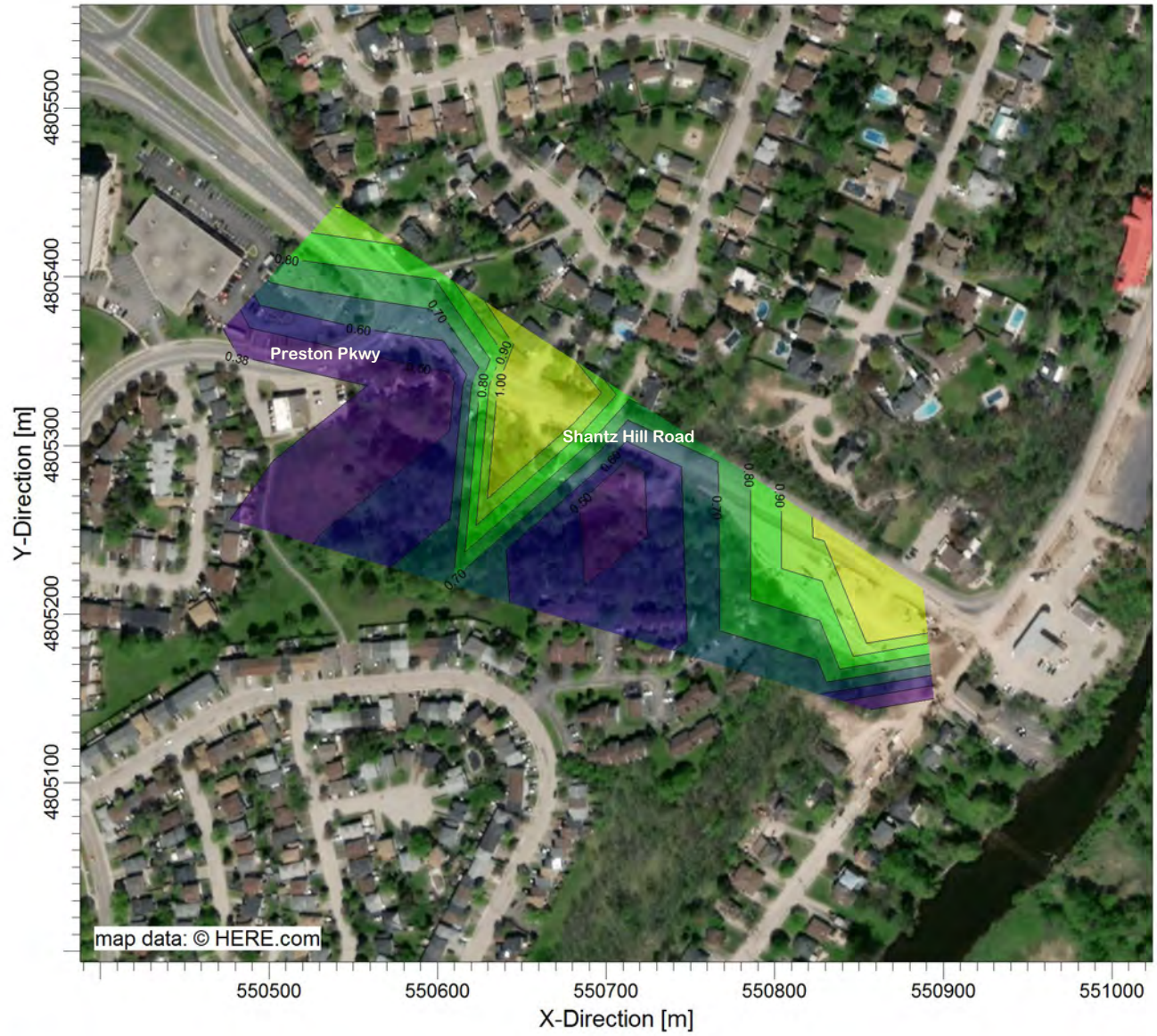
Waterloo Stage 2 ION
Study Area 2 No Build Scenario (2031) - 24 hour

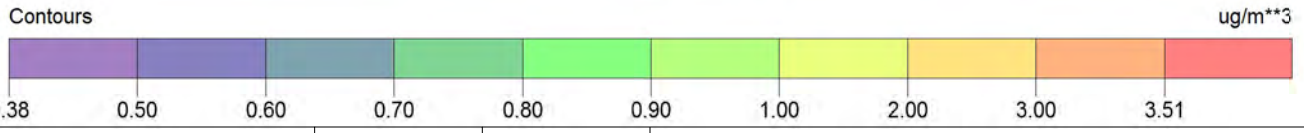


COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **3.51**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:5,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 2 No Build Scenario (2031) - Annual

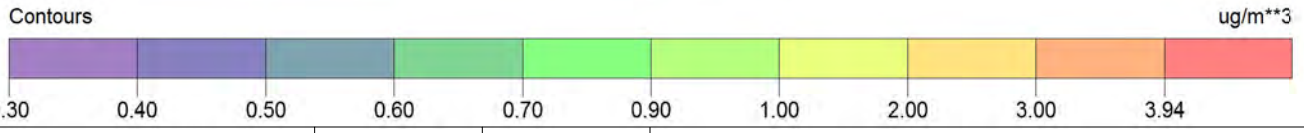




COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **1.43**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:4,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

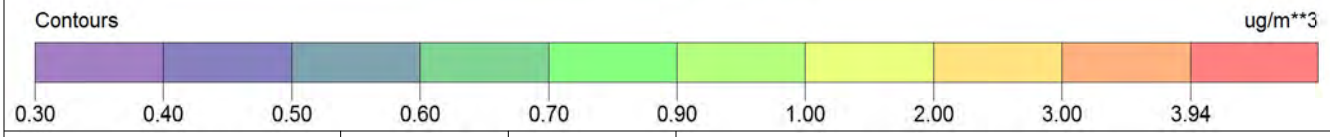
Waterloo Stage 2 ION
Study Area 3 No Build Scenario (2031) - 24 hour



COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **3.94**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

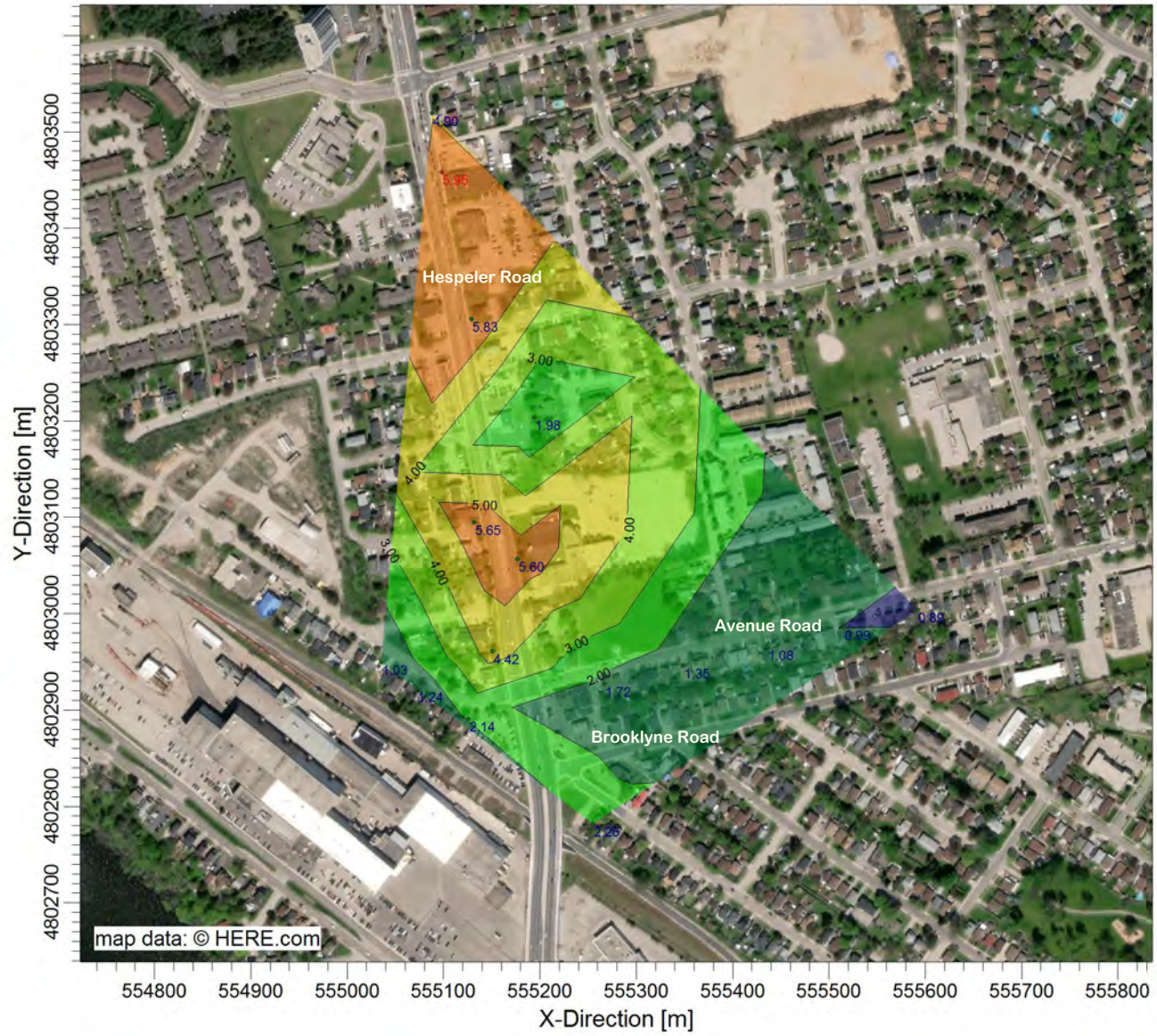
Waterloo Stage 2 ION
Study Area 3 No Build Scenario (2031) - Annual

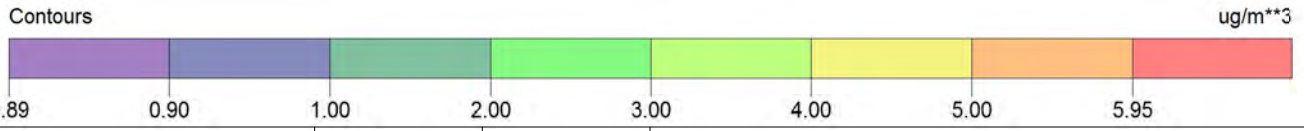


COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **1.47**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 4 No Build Scenario (2031) - 24 hour

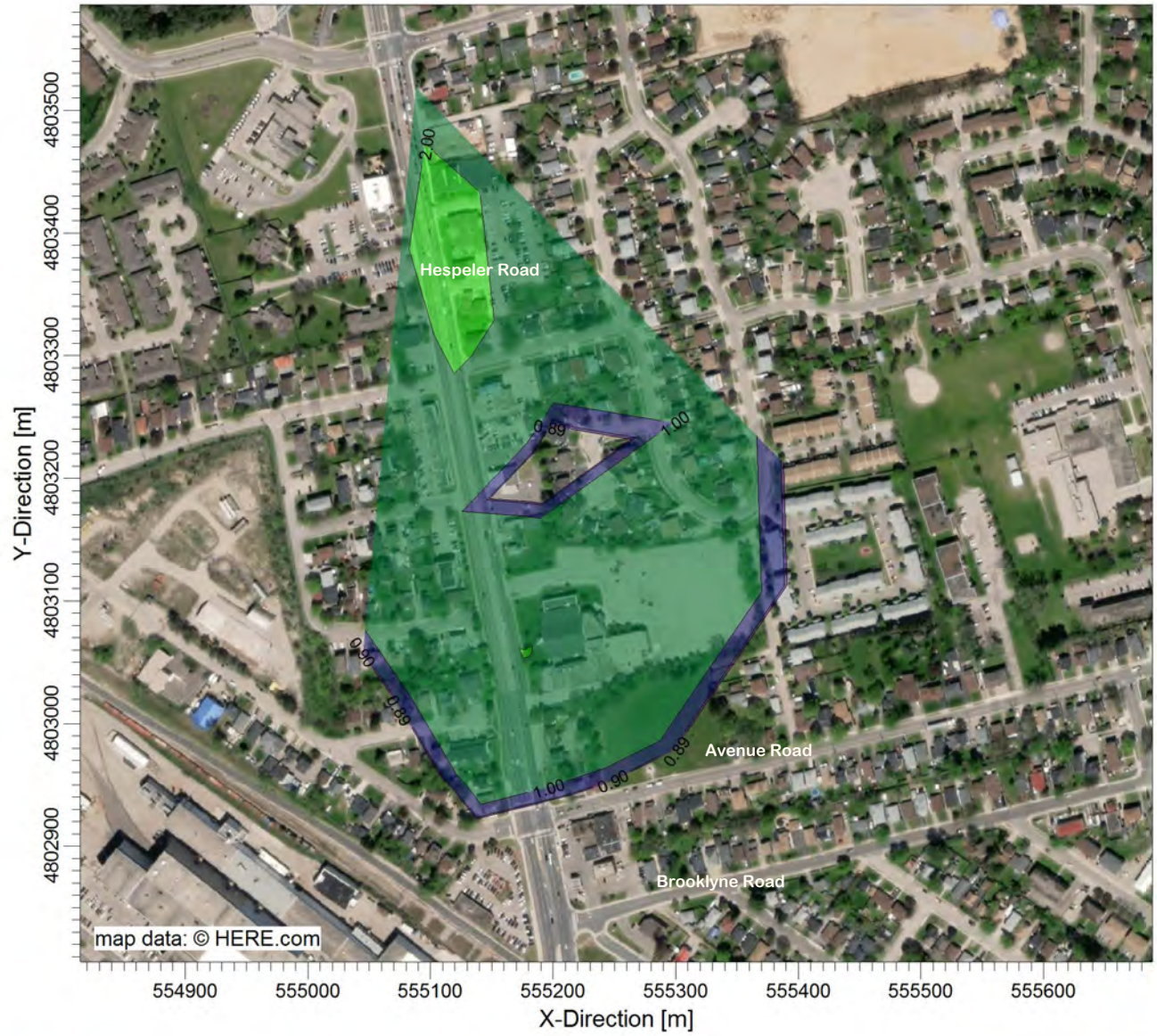


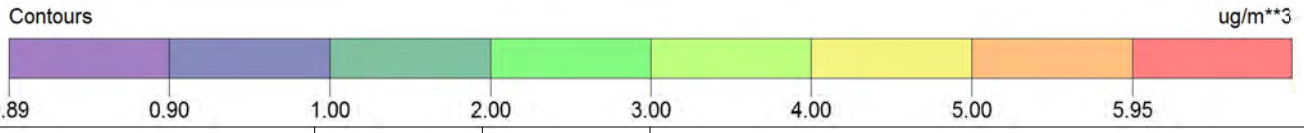


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM10	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **5.95**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:7,000 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 4 No Build Scenario (2031) - Annual





COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **2.14**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:5,500 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 1 Full Build Scenario (2031) - 1 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.06**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,200 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 1 Full Build Scenario (2031) - 8 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.03**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,200 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 2 Full Build Scenario (2031) - 1 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**
	MAX: **0.09**	UNITS: **ppm**	MODELER: **Stephanie Clarke**
	LINKS: **43**	RECEPTORS: **8**	
	SCALE: 1:4,200 (0 — 0.1 m)	DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 2 Full Build Scenario (2031) - 8 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.04**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:4,200 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

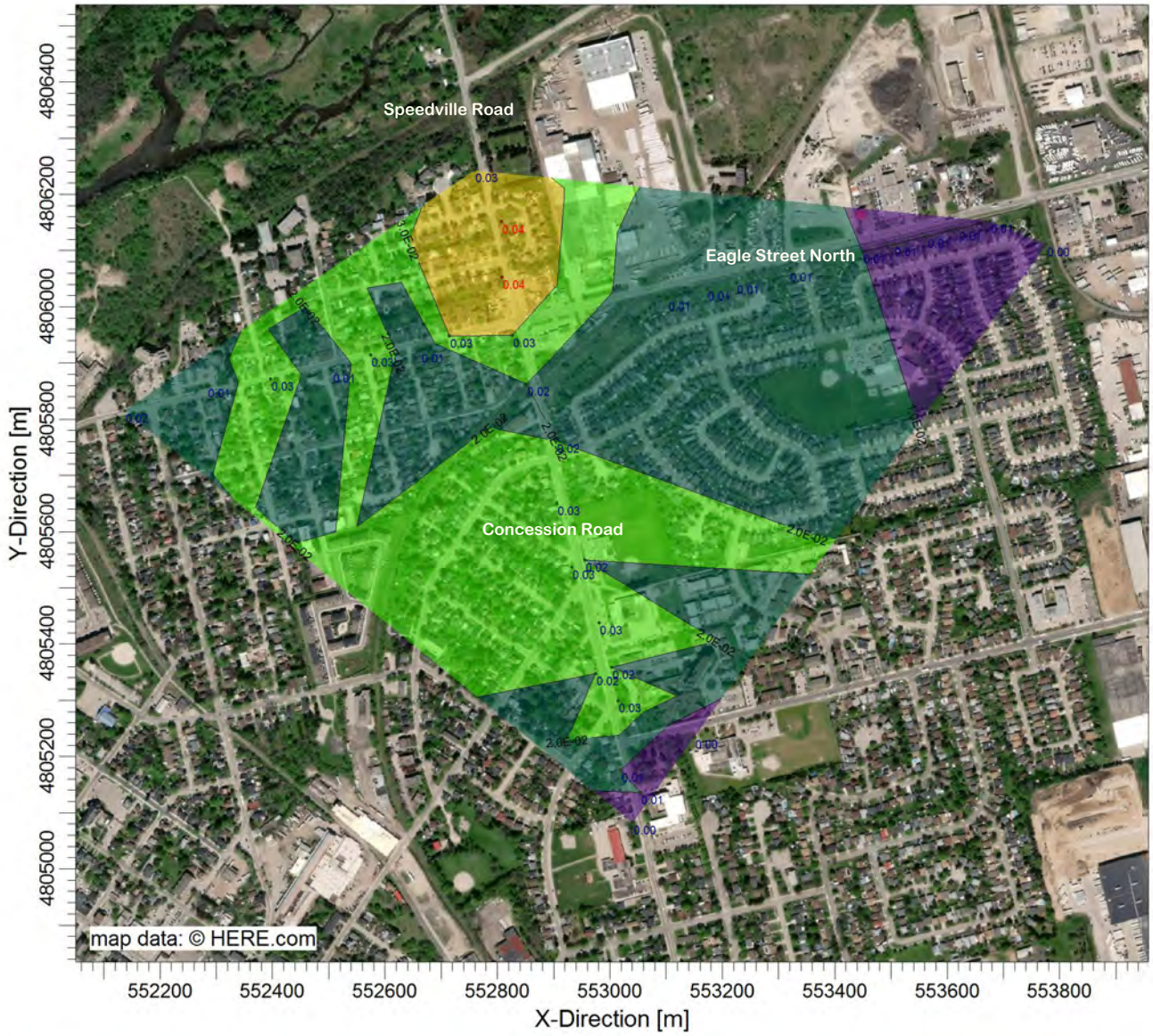
PROJECT TITLE:

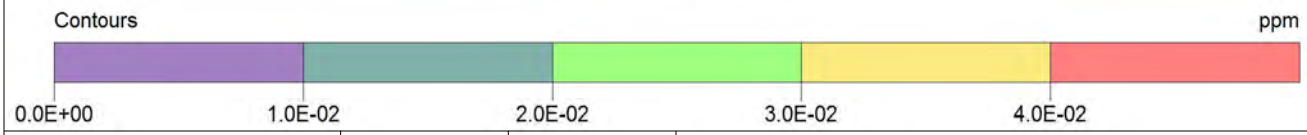
Waterloo Stage 2 ION
Study Area 3 Full Build Scenario (2031) - 1 hour

COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.11**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 3 Full Build Scenario (2031) - 8 hour

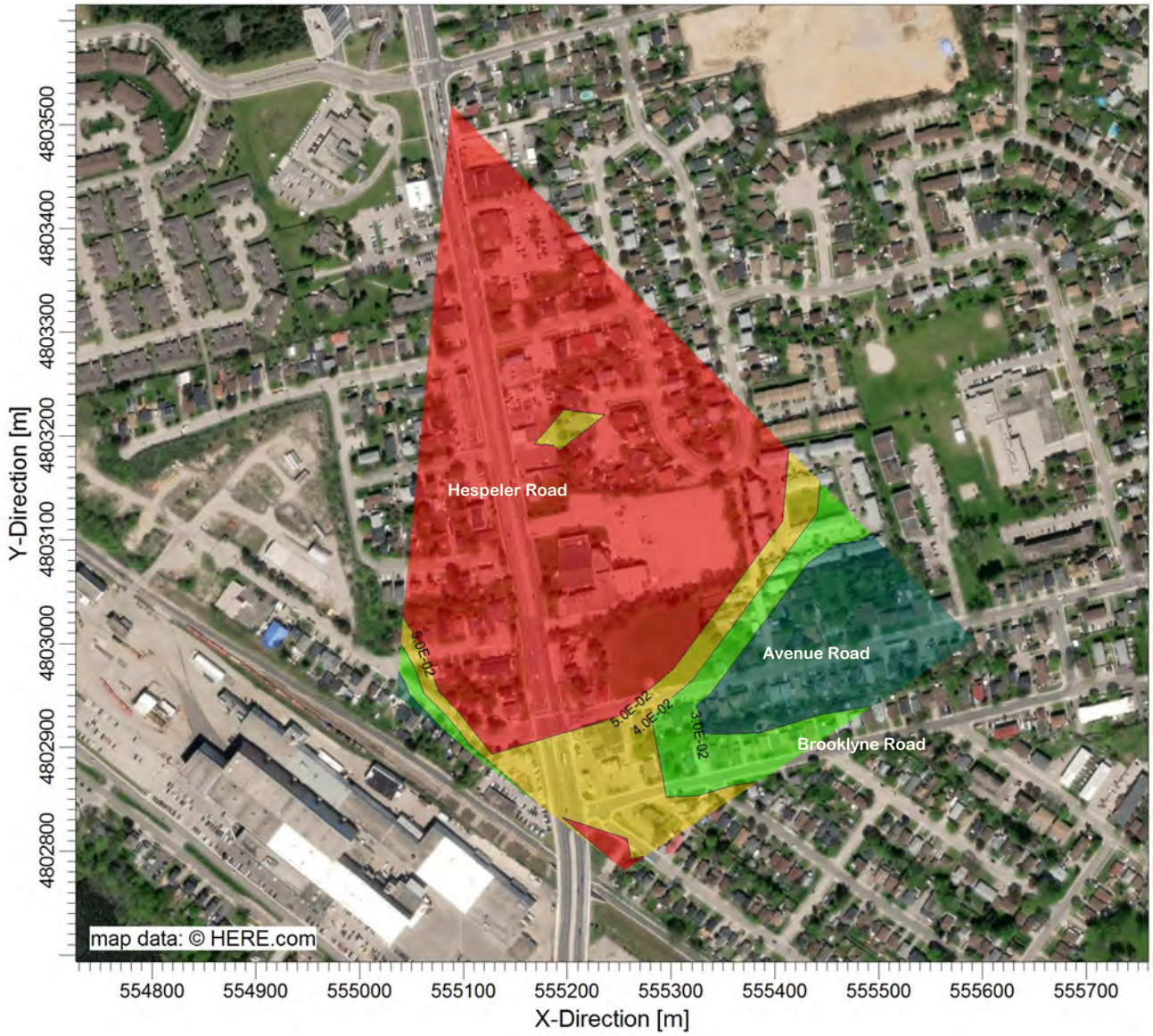




COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.04**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

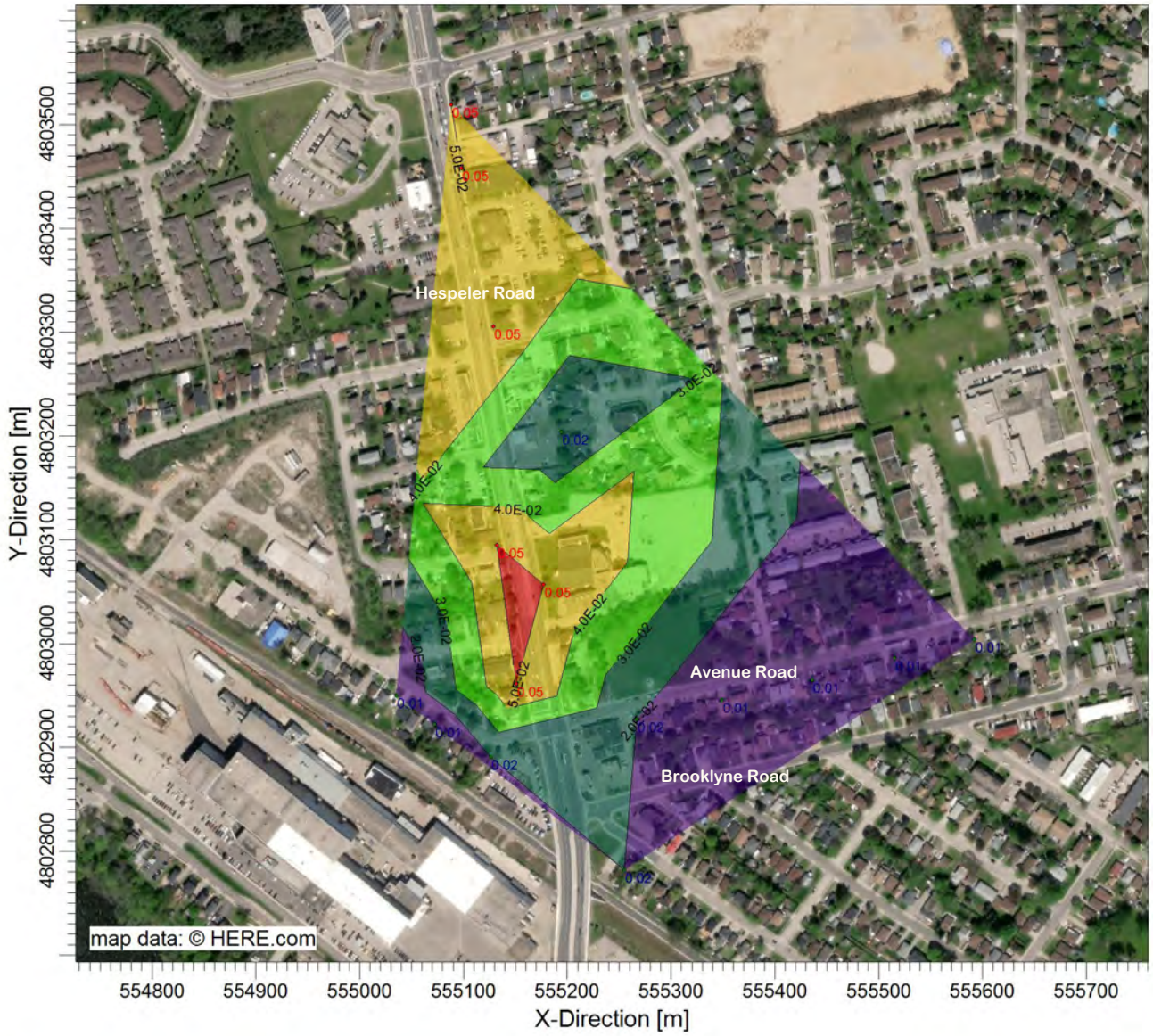
Waterloo Stage 2 ION
Study Area 4 Full Build Scenario (2031) - 1 hour



COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.16**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:6,500 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

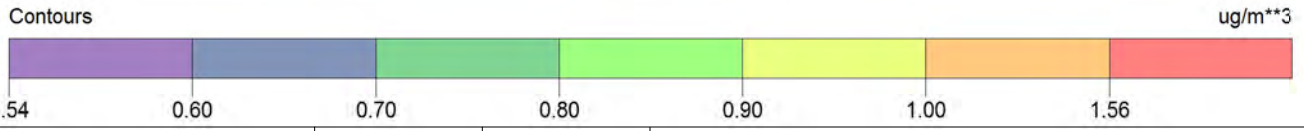
Waterloo Stage 2 ION
Study Area 4 Full Build Scenario (2031) - 8 hour



COMMENTS:	MODEL: **CAL3QHCR**	POLLUTANT: **CO**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.05**	UNITS: **ppm**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:6,500 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

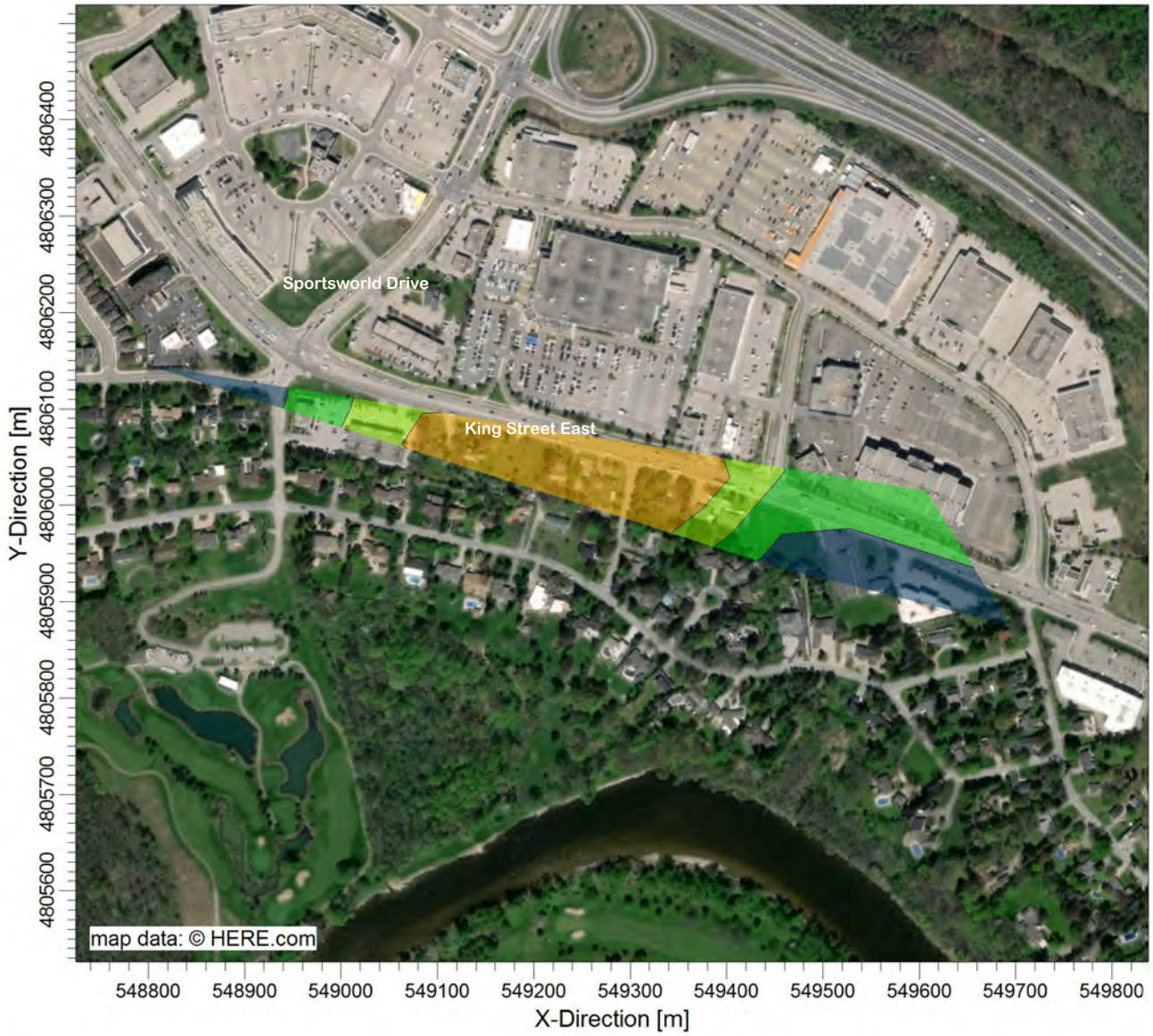
Waterloo Stage 2 ION
Study Area 1 Full Build Scenario (2031) - 24 hour

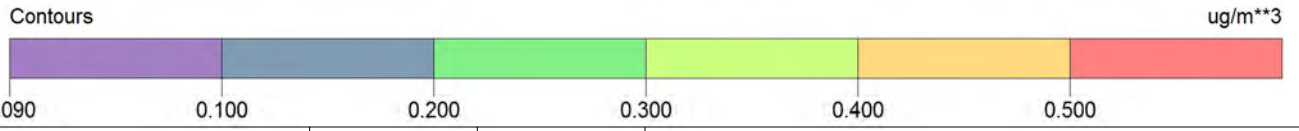


COMMENTS:	MODEL:	POLLUTANT:	COMPANY NAME:	
PM2.5	**CAL3QHCR**	**Particulate**	**WSP Canada Inc.**	
	MAX: **1.56**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:7,000 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 1 Full Build Scenario (2031) - Annual

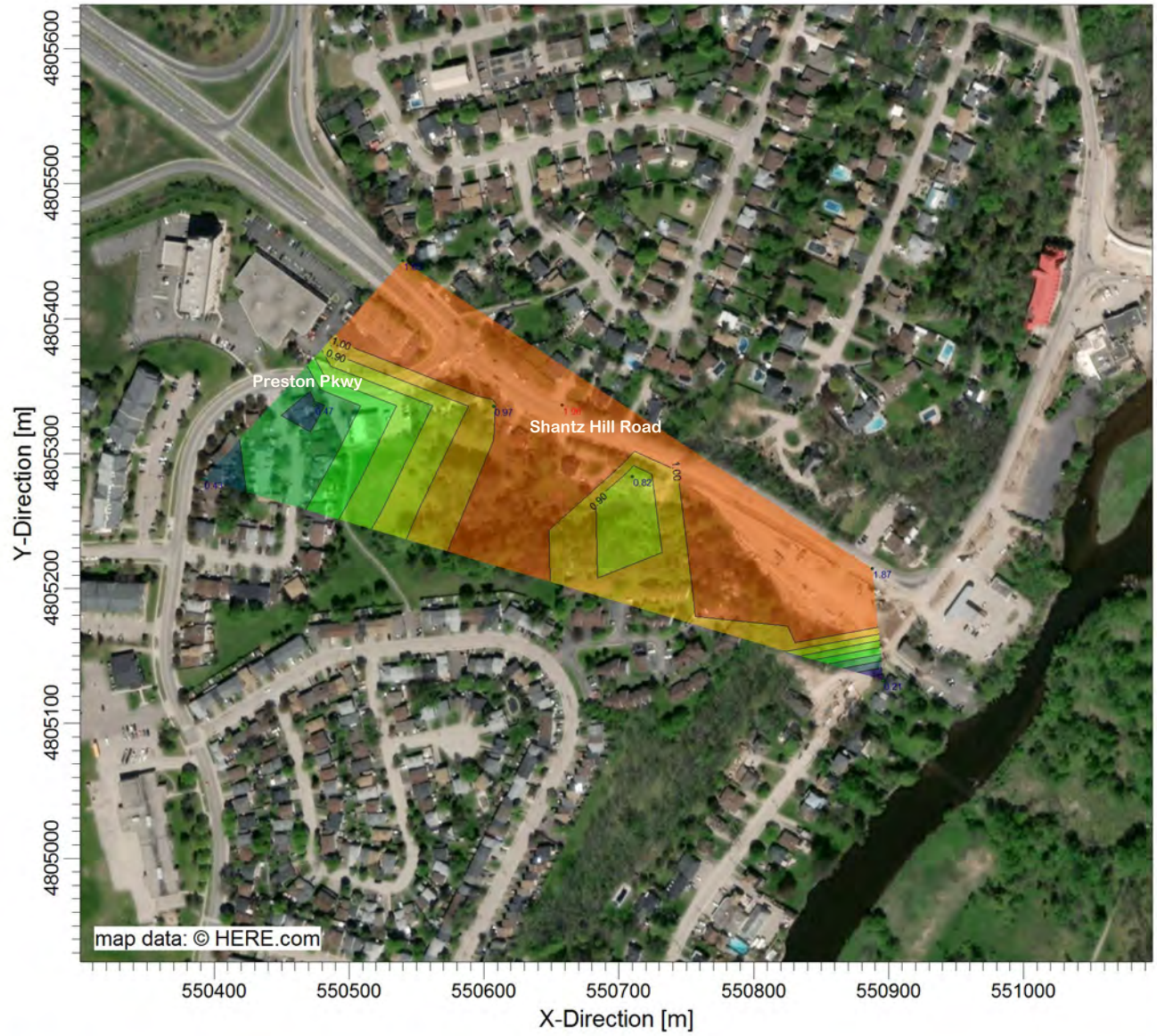


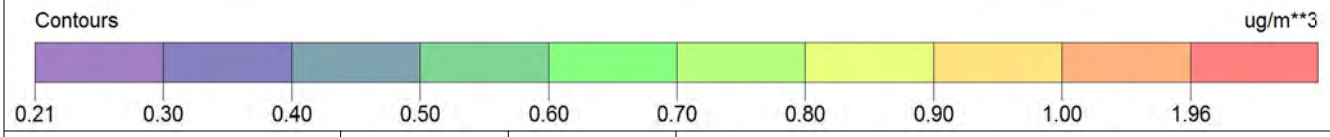


COMMENTS: PM2.5	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.50**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:7,000 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 2 Full Build Scenario (2031) - 24 hour

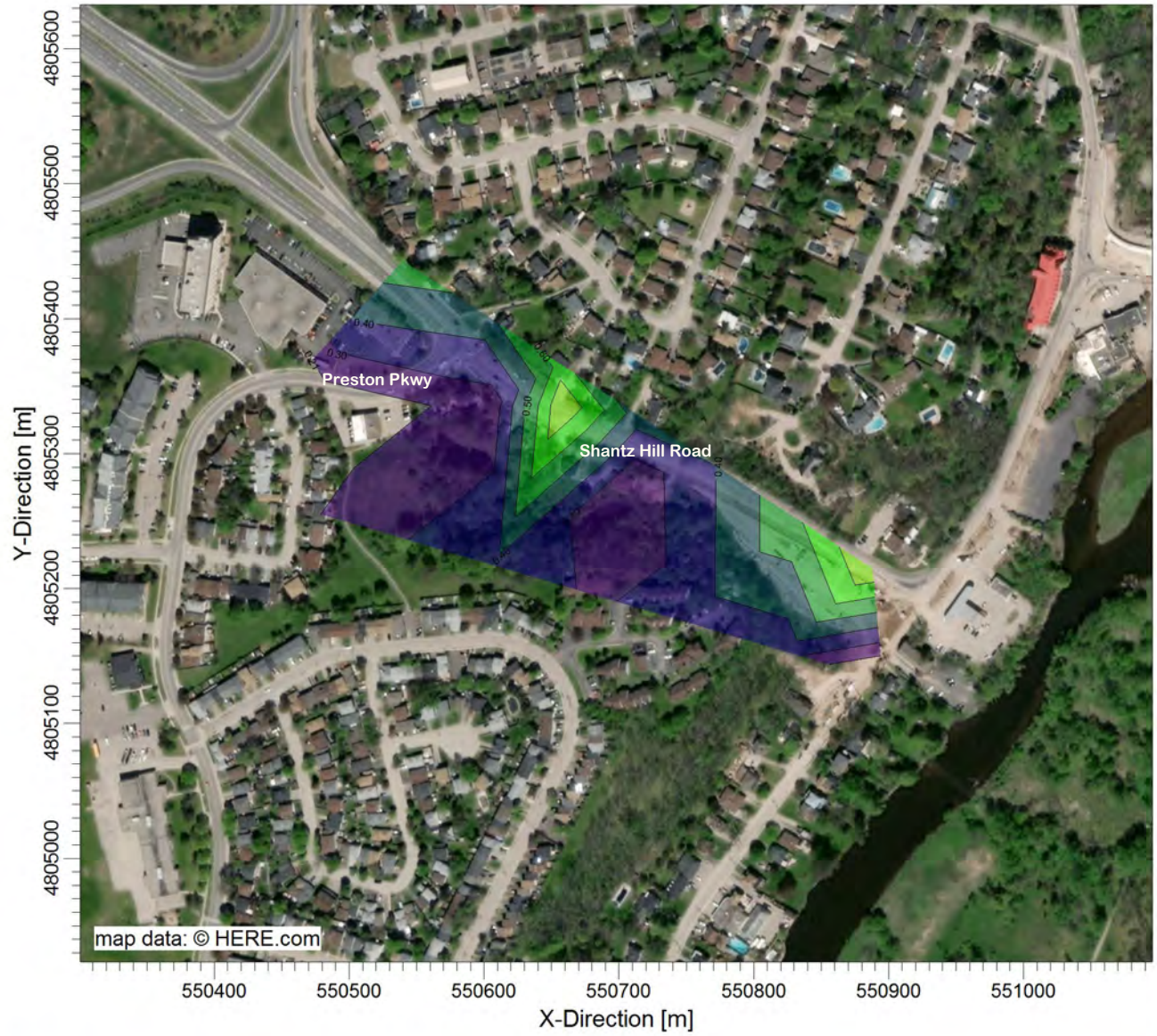


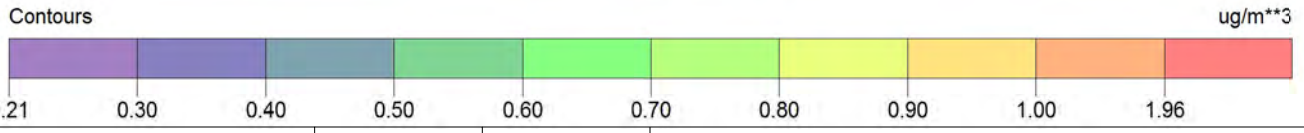


COMMENTS: PM2.5	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **1.96**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:5,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 2 Full Build Scenario (2031) - Annual

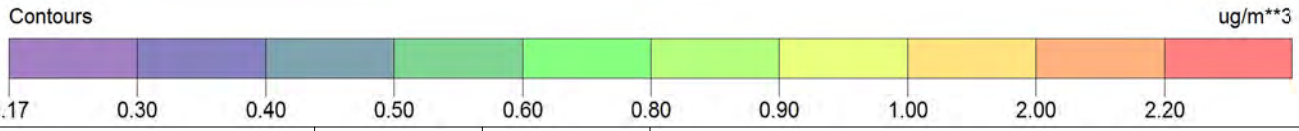




COMMENTS: PM2.5	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.79**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:5,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

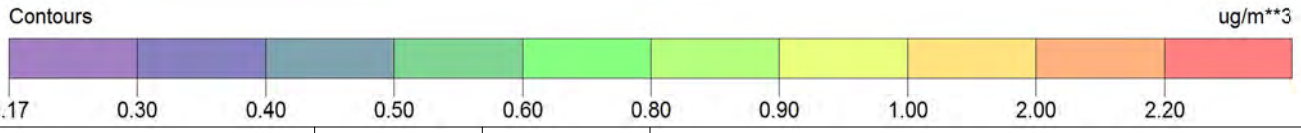
Waterloo Stage 2 ION
Study Area 3 Full Build Scenario (2031) - 24 hour



COMMENTS: PM2.5	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **2.20**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

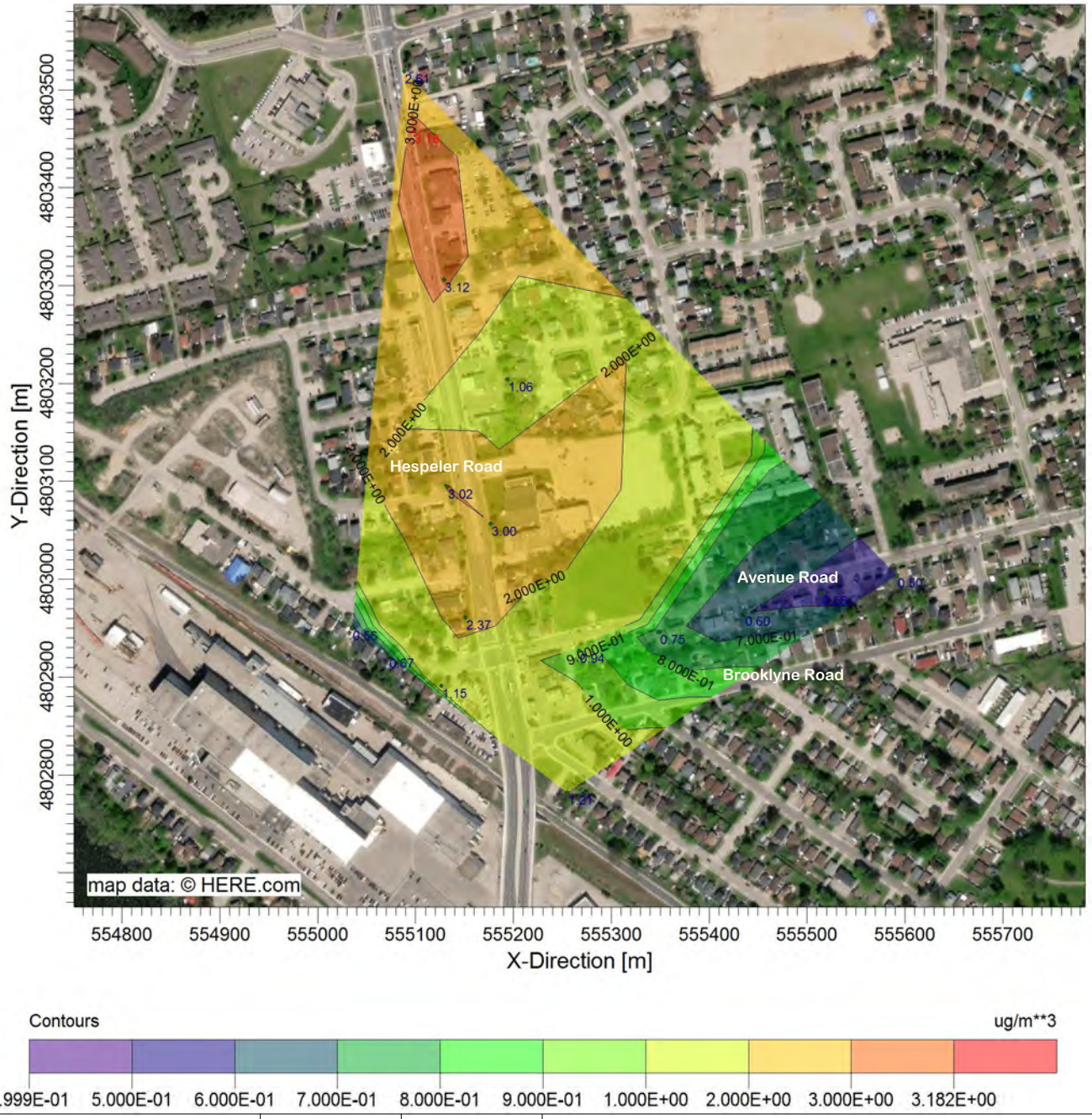
Waterloo Stage 2 ION
Study Area 3 Full Build Scenario (2031) - Annual



COMMENTS: PM2.5	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.82**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:12,000 0 0.3 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

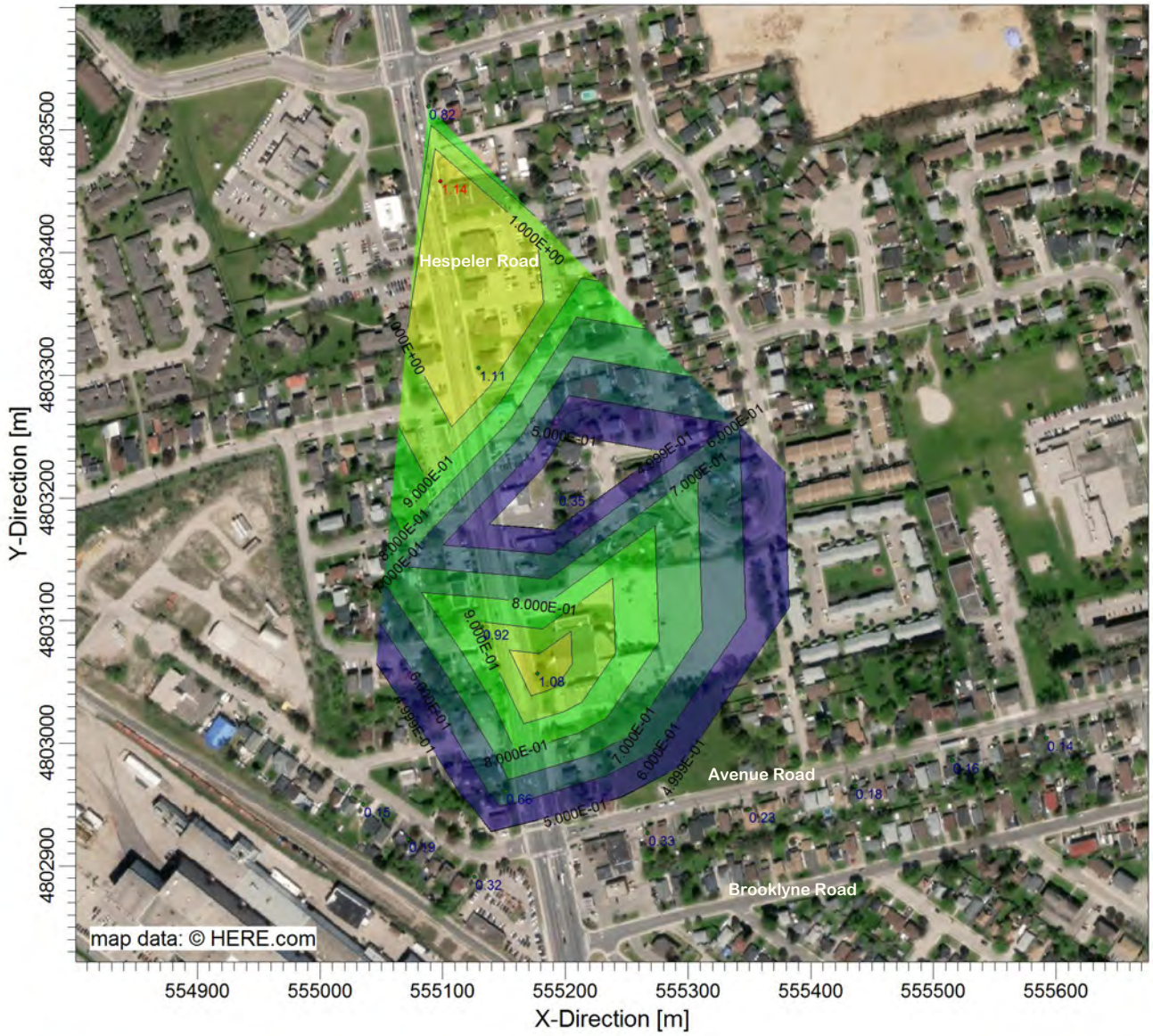
Waterloo Stage 2 ION
Study Area 4 Full Build Scenario (2031) - 24 hour

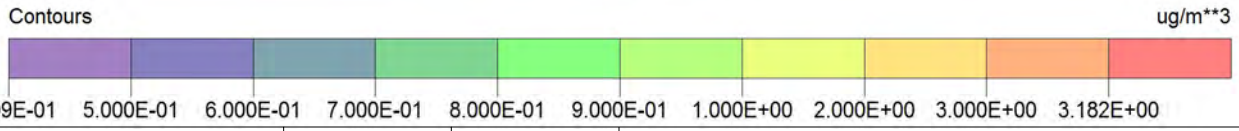


COMMENTS: PM2.5	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**
	MAX: **3.18**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**
	LINKS: **34**	RECEPTORS: **16**	
	SCALE: 1:6,500 (0 — 0.2 m)	DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 4 Full Build Scenario (2031) - Annual

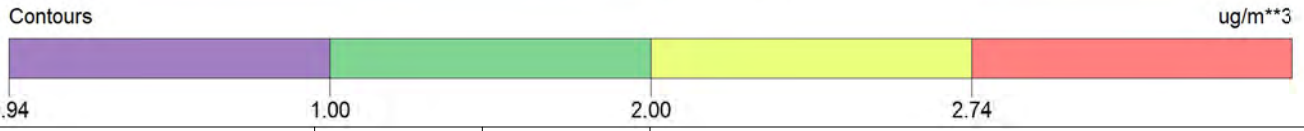




COMMENTS: PM2.5	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**
	MAX: **1.14**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**
	LINKS: **34**	RECEPTORS: **16**	
	SCALE: 1:5,500 (0 — 0.1 m)	DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

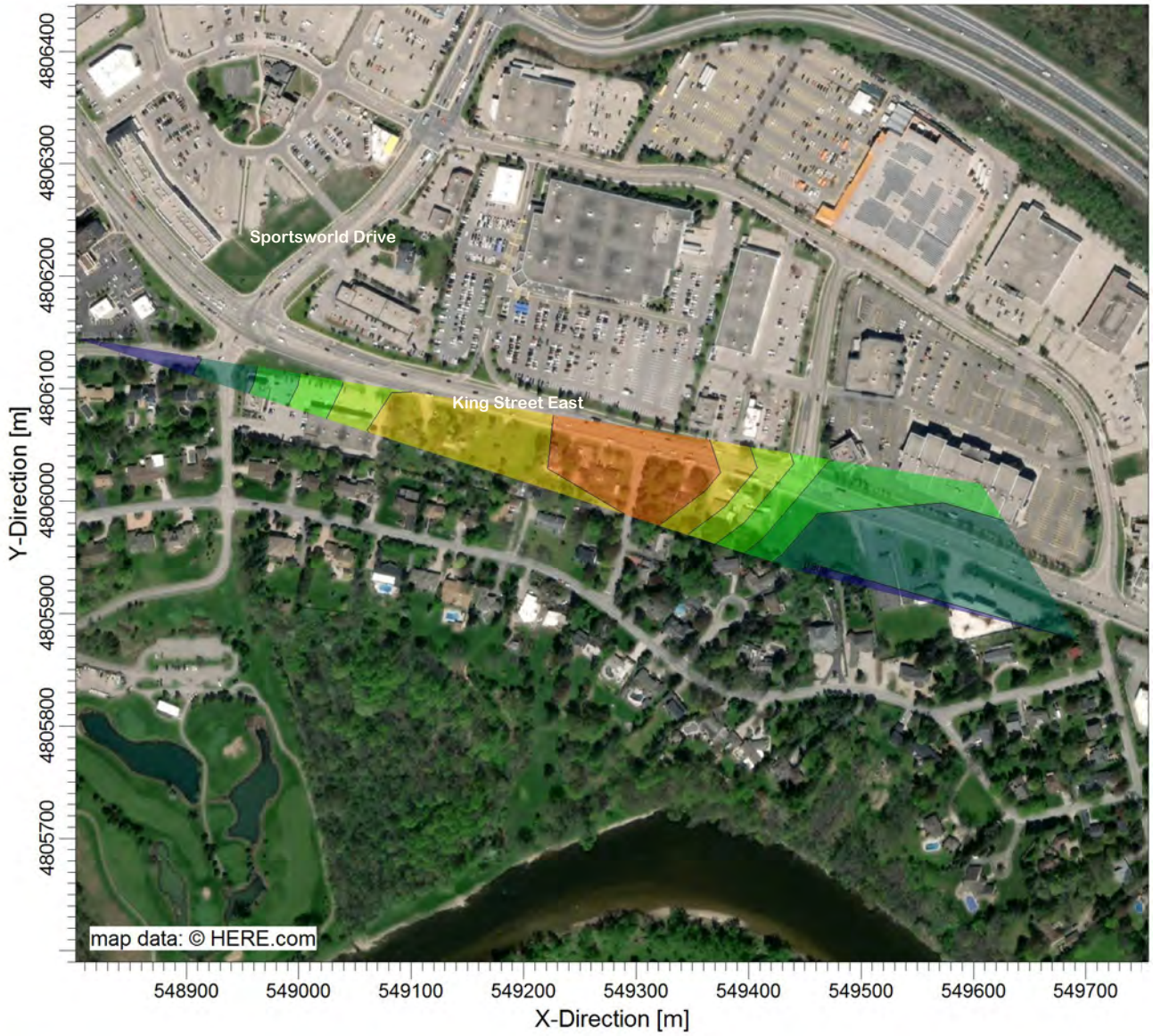
Waterloo Stage 2 ION
Study Area 1 Full Build Scenario (2031) - 24 hour

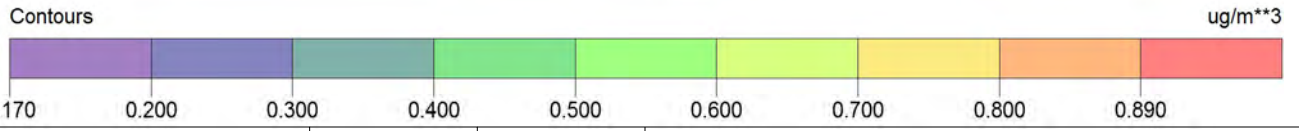


COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **2.74**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:7,000 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 1 Full Build Scenario (2031) - Annual

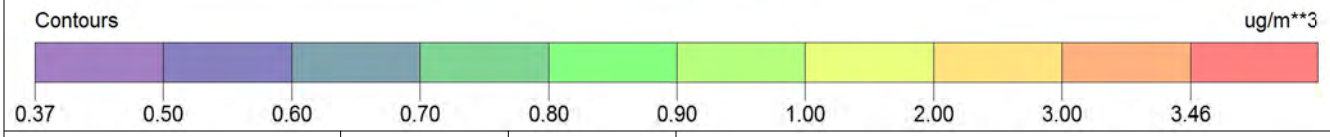




COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **0.89**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **57**	RECEPTORS: **7**		
	SCALE: 1:6,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

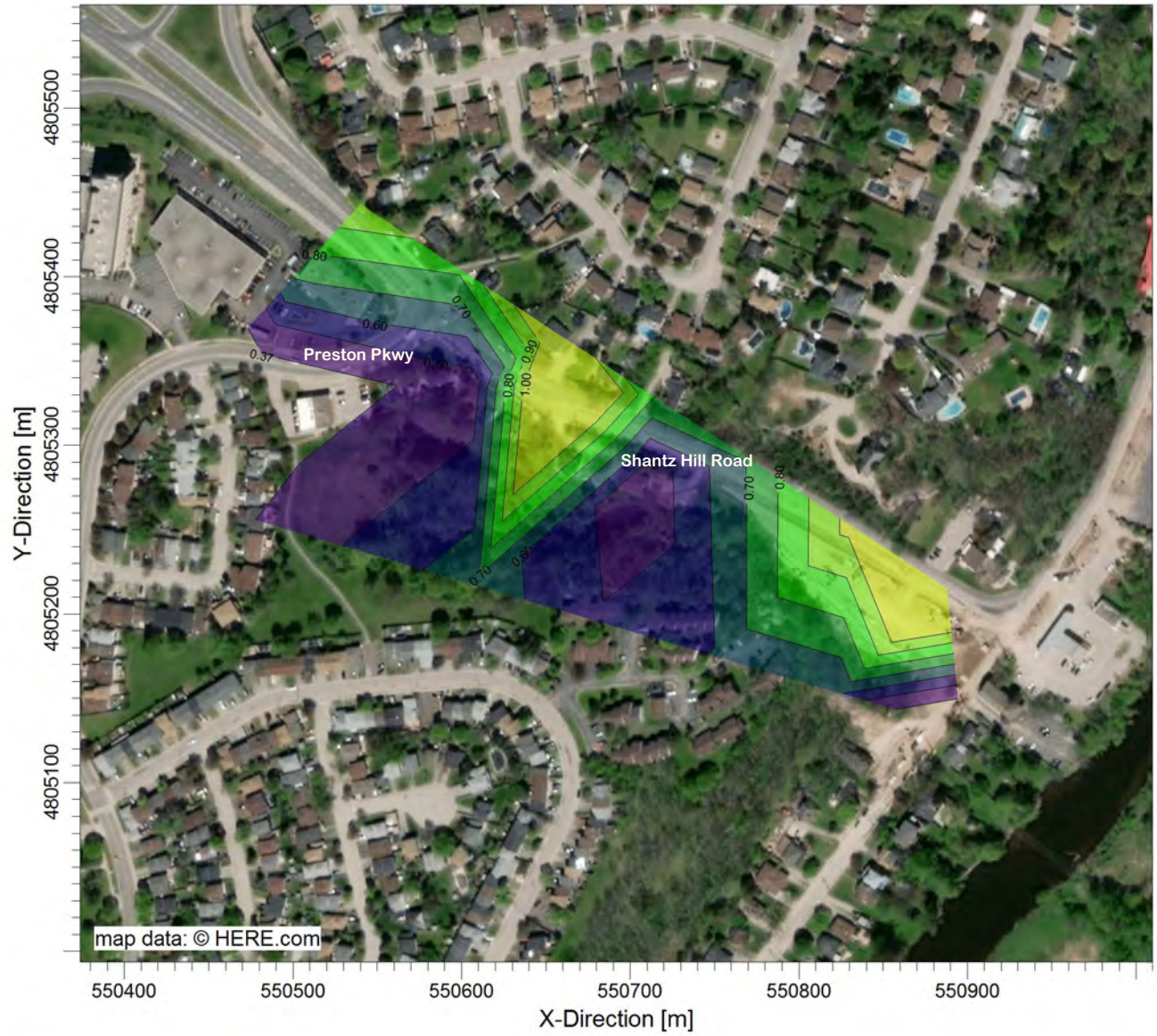
Waterloo Stage 2 ION
Study Area 2 Full Build Scenario (2031) - 24 hour

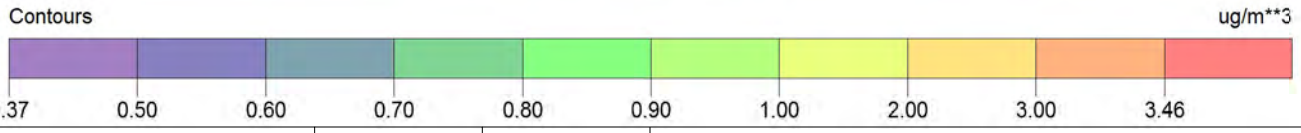


COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **3.46**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:5,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 2 Full Build Scenario (2031) - Annual

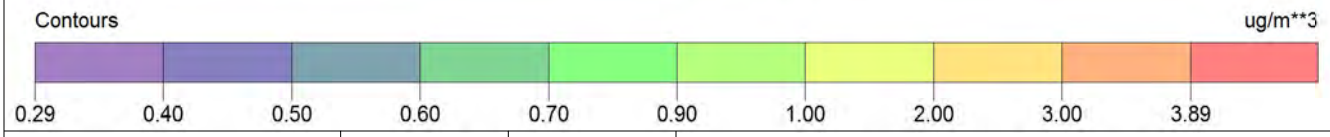




COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **1.41**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **43**	RECEPTORS: **8**		
	SCALE: 1:4,000 0 0.1 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

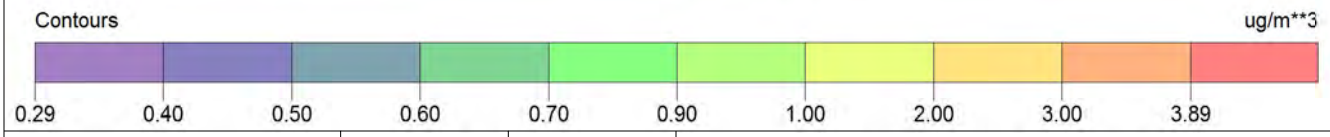
Waterloo Stage 2 ION
Study Area 3 Full Build Scenario (2031) - 24 hours



COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **3.89**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:13,000 0 0.4 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

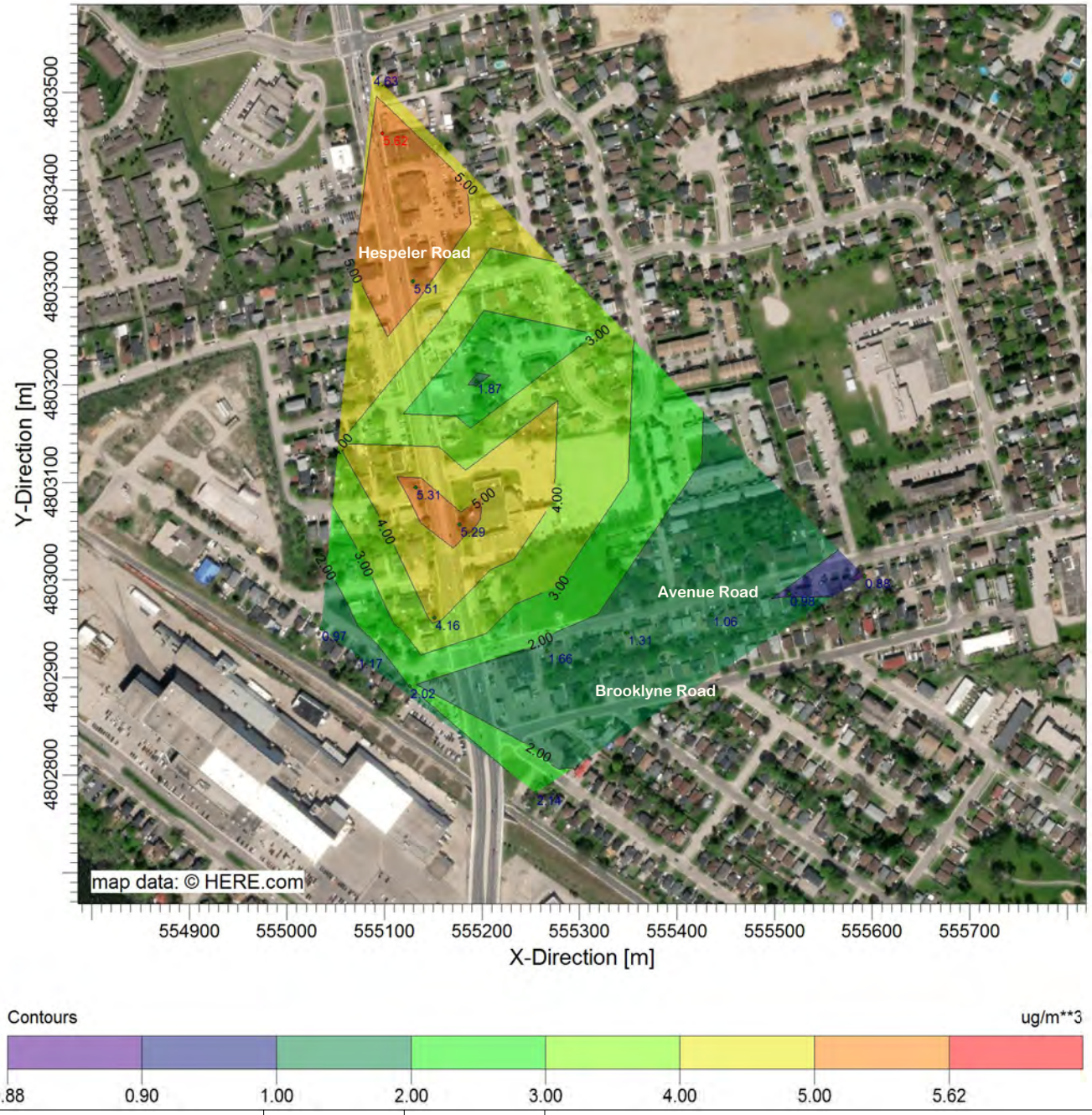
Waterloo Stage 2 ION
Study Area 3 Full Build Scenario (2031) - Annual



COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **1.46**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **49**	RECEPTORS: **34**		
	SCALE: 1:13,000 0 0.4 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

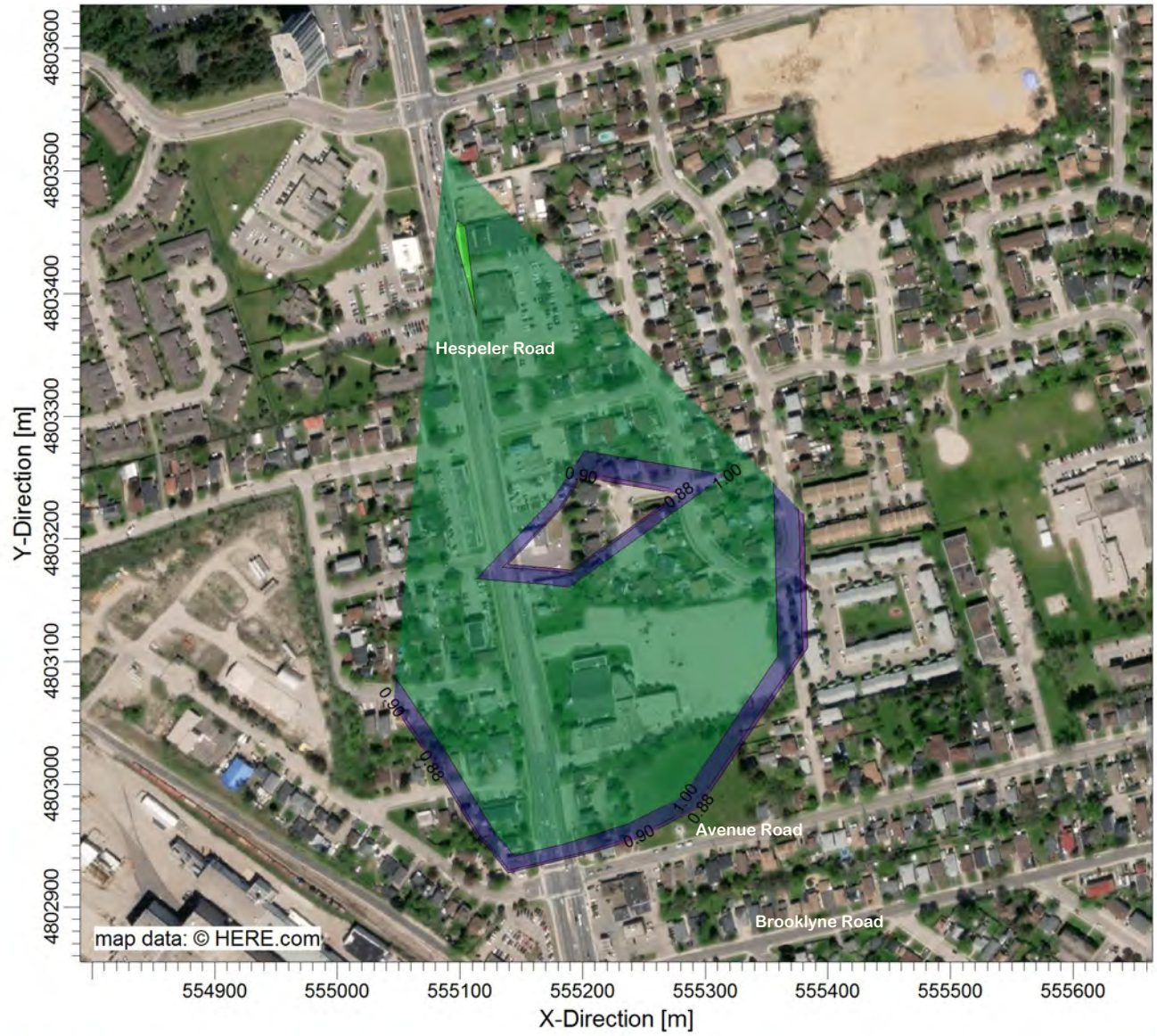
Waterloo Stage 2 ION
Study Area 4 Full Build Scenario (2031) - 24 hour

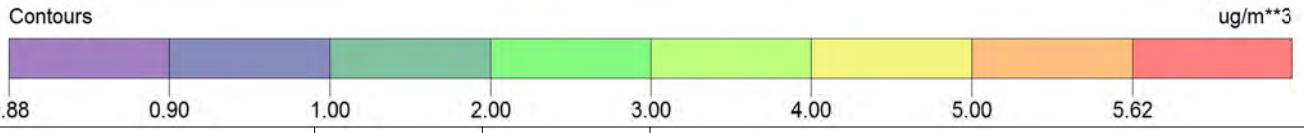


COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**	
	MAX: **5.62**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**	
	LINKS: **34**	RECEPTORS: **16**		
	SCALE: 1:6,500 0 0.2 m		DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**

PROJECT TITLE:

Waterloo Stage 2 ION
Study Area 4 Full Build Scenario (2031) - Annual





COMMENTS: PM10	MODEL: **CAL3QHCR**	POLLUTANT: **Particulate**	COMPANY NAME: **WSP Canada Inc.**
	MAX: **2.02**	UNITS: **ug/m**3**	MODELER: **Stephanie Clarke**
	LINKS: **34**	RECEPTORS: **16**	
	SCALE: 1:5,500 (0 — 0.1 m)	DATE: **28-Jan-21**	PROJECT / PLOT NO.: **161-07859-01**