APPENDIX H: HIGHWAY 416 AND BARNSDALE INTERCHANGE EA AIR QUALITY ASSESSMENT

FINAL REPORT

HIGHWAY 416/BARNSDALE INTERCHANGE EA

BARRHAVEN, ONTARIO

AIR QUALITY ASSESSMENT
RWDI # 2003291 MTO ASSIGNMENT 4019-E-0023
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EXECUTIVE SUMMARY

RWDI was retained by Morrison Hershfield to conduct an air quality impact assessment for the new interchange proposed for Highway 416 and Barnsdale Road in Barrhaven, Ontario. The undertaking covers the roadway segment from Bankfield Road to Cambrian Road.

The objective of the study is to predict air quality impacts as it relates to the Project. The assessment was undertaken for the Future No-Build and Future Build scenarios for the project for the year 2041. The No-Build scenario represents Highway 416 without the proposed interchange and the Build scenario includes the proposed interchange, with the projected traffic volumes for the year assessed.

The emission modelling was based on the US EPA's roadway emissions model latest version, MOVES3, and the dispersion modelling was based on the US EPA's dispersion model, AERMOD version 19191. The background concentrations were estimated using air quality monitoring data collected by the Ontario Ministry of Environment, Conservation and Parks (MECP) and Environment and Climate Change Canada (ECCC).

A cartesian grid of receptors were modelled to represent worst-case impacts within 500 m of the interchange in the study area. Three sensitive receptors (residences) were identified and were included in the study.

Air contaminants assessed as part of the study included $PM_{2.5}$, PM_{10}, CO, NO_2, acetaldehyde, acrolein, 1,3-butadiene, benzene, benzo(a)pyrene and formaldehyde. For the year 2041, MOVES3 estimated zero emissions of 1,3-butadiene due to US EPA updates of the toxic fractions of VOCs in vehicle exhaust; therefore, results for 1,3-butadiene were not quantified for the Future No-Build and Future Build scenarios.

The proposed project is expected to have little to no impact on local air contaminant levels at the receptors, with the maximum predicted cumulative concentrations for most contaminants and averaging periods less than current respective thresholds. For NO_2, the 1-hour and annual cumulative maximum predicted concentration is less than the AAQC and the CAAQS (2025) for the Future Build and Future No Build scenarios. Annual and 24-hour average benzo(a)pyrene concentrations exceed their respective AAQC thresholds but are attributed to high ambient background concentrations, with the background annual average exceeding its AAQC on its own. Overall, the Future Build scenario is predicted to have similar air quality impacts to the Future No-build scenario; therefore, the Project is not expected to have a significant impact on local air quality. No mitigation measures are recommended beyond those which are already in place through phased-in federal regulations for on-road vehicle and engine emissions, which are expected to reduce NO_2 and other tailpipe emissions beyond the horizon years used for emission factors in the present study.

The annual emissions from the Future Build scenario compared to provincial annual emissions of CO, NOx, $PM_{2.5}$, VOCs and greenhouse gas CO_2e are very low (less than 0.001%) and therefore the Project is not expected to have a significant impact on regional air quality.

Construction phase impacts were addressed qualitatively in Section 5 of the report. It is recommended that in order to minimize potential air quality impacts during construction, the construction tendering process should include requirements for implementation of an Air Quality Management Plan.

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1 INTRODUCTION

RWDI was retained by Morrison Hershfield to conduct an air quality assessment for the for the new interchange proposed for Highway 416 and Barnsdale Road in Barrhaven, Ontario. The Project is under the Ontario Ministry of Transportation (MTO) assignment GWP 4019-E-0023. The Study Area covers the highway segment from Bankfield Road to Cambrian Road (See Figure 1).

The scope of the study is itemized below:

- Use vehicle emissions modelling techniques to estimate tailpipe, brake wear, tire wear and road dust emissions associated with the traffic for 2041, or 10 years after the inaugural year of 2031 for the project.
- Use a computer simulation of atmospheric dispersion to predict maximum contaminant concentrations at representative sensitive receptors due to vehicle emissions from the future conditions without the project (No-Build scenario), and future conditions with the project (Build scenario).
- Use representative historical monitoring data to establish background concentrations for each contaminant of interest, due to various other sources in the surrounding area other than those associated with the proposed project.
- Combine the dispersion model results with the background concentrations and compare to applicable air quality thresholds for all scenarios.
- Conduct a semi-quantitative assessment to determine the incremental impact to the local airshed and greenhouse gas burden.
- Estimate the annual emissions from vehicles travelling in the project area and compare to Ontario-wide emissions from transportation and other sources.

2 PROJECT DESCRIPTION

The Project involves a proposed new interchange at Highway 416 and Barnsdale Road. The intent of the Project is to accommodate future traffic demand. The Study Area covers the Highway 416 segment from Bankfield Road to Cambrian Road.

Figure 1 shows the Study Area and its surrounding land use. The study area consists of mostly residential and commercial land uses. Agricultural uses are located to the west and north of the study area with additional employment uses to the south.

Most nearby sensitive and critical receptors identified were found to be at least 1,000 m from the proposed interchange and are expected to be minimally impacted by the Project. A receptor grid centred on and extending up to 500 m from the interchange was used to assess the worst-case impacts within the Study Area and included three sensitive receptors (residences) identified through satellite imagery.

3 ASSESSMENT METHODOLOGY

This assessment generally followed the methodology described in the MTO "Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects" (May 2020) (the "MTO Air Quality Guide").

3.1 Modelled Scenarios

The assessment was undertaken for the following scenarios:

- Future No-Build of the proposed project for 10-years post inauguration (2041); and,
- Future Build of the proposed project for 10-years post inauguration (2041).

The assessment assumes that for the Future No-Build scenario, no major roadway improvements have occurred to the existing road alignment, with traffic volumes based on demand for the 2041 horizon year. The Future Build scenario includes the proposed project improvement to the roadway along with the traffic volumes predicted for the 2041 horizon year with the new roadway configuration.

3.2 Modelled Roadways

The modelling included all of Highway 416 within the study area, as well as Barnsdale Road between Moodie Drive and Viewbank Road. The modelled roadway segments for the Future No-Build scenario are shown in **Figure 2** and the modelled segments for the Future Build scenario are shown in **Figure 3**.

3.3 Traffic Data

Road traffic data was provided by Morrison Hershfield for Highway 416 and main arterial roads. The data included AM and PM peak traffic volumes, including data for the year 2041 for the Future No-Build and Future Build scenarios. Vehicle breakdown and truck percentages for the roads under investigation for the 2041 assessment year were obtained from the MTO iCorridor website (https://icorridor-mto-on-ca.hub.arcgis.com). **Table 1** provides a summary of the modelled traffic volumes and speed data for each scenario.

In order to assign the vehicle distribution percentages to appropriate vehicle classes, the MOVES vehicle classification by source type was used. Vehicle distribution percentages were obtained from MTO for single occupancy vehicles (SOV), medium trucks and heavy trucks for the highway and arterial roads within the study area. The vehicle distribution percentages were assigned to vehicle classes for Passenger Cars (Source Type 11), Single Unit Short Haul Truck (Source Type 52), and Single Unit Long Haul Trucks (Source Type 53), respectively.

Hourly all-traffic vehicle distribution of northbound and southbound traffic on Highway 416 was obtained from the MTO iCorridor website. Table A.1 in **Appendix A** outlines these hourly traffic vehicle counts, and the ratios used to estimate hourly traffic on the highway and arterial roads. Hourly traffic for 2041 was estimated based on the peak hour values and these hourly ratios.

3.4 Key Air Contaminants

Vehicular traffic produces a variety of air contaminants from fuel combustion inside the engine, evaporation of fuel from the tank, brake and tire wear, and re-suspension (also known as re-entrainment) of loose particles on the road surface (silt) as the vehicle travels over the road surface. The following key contaminants were assessed in accordance with the MTO Air Quality Guide:

- respirable particulate matter ($PM_{2.5}$)
- inhalable particulate matter (PM_{10})
- carbon monoxide (CO)
- nitrogen dioxide (NO_2)
- acetaldehyde
- acrolein
- benzene
- 1,3-butadiene
- benzo(a)pyrene
- formaldehyde

3.5 Air Quality Thresholds

The Ontario Ministry of Environment, Conservation and Parks (MECP) has Ontario Ambient Air Quality Criteria (AAQC) for airborne concentrations of PM_{10}, CO, NO_2, Acetaldehyde, Acrolein, Benzene, Benzo(a)pyrene, 1,3-Butadiene, and Formaldehyde. The MECP does not have a benchmark for $PM_{2.5}$. The Canadian Council of Ministers of the Environment (CCME) has established Canadian Ambient Air Quality Standards (CAAQS) for $PM_{2.5}$ (CCME, 2022). CCME also has established standards for 1-hour and annual concentrations of NO_2 that will come into effect in 2025. The AAQCs and CAAQS are collectively referred to as air quality thresholds in this report. The thresholds are summarized in **Table 2** (in micrograms per cubic metre, $\mu g/m^3$).

The CAAQS were developed for use by provinces and territories to guide air zone management actions. They are not project-level regulatory standards; measures mandated to achieve the CAAQS should consider technical achievability, practicality, and implementation costs (CCME, 2019).

3.6 Background Air Quality Data

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

The ambient background data for each key contaminant were taken from representative air quality monitoring stations within the ECCC National Air Pollution Surveillance (NAPS) Program and MECP ambient air monitoring station network. A review of representative stations with relevant data for the key contaminants was completed.

The NAPS and MECP monitoring stations were selected for parameters available from the stations. Volatile organic compounds (VOCs) and select polycyclic aromatic hydrocarbons (PAHs) are only monitored at select monitoring stations. The sources of background monitoring data used for this study are presented in **Table 3.**

In the case of NO_2 and ozone (O_3), hourly monitoring data were available for the Ottawa Downtown monitoring station that allowed estimation of background concentration by hour of day. Project contribution of ozone was not assessed against air quality thresholds, but background ozone concentrations were used for converting nitrogen oxides (NO_X) to NO_2 using the Ozone Limiting Method (OLM). (See section 3.8.2 for discussion of OLM.) As background concentrations vary widely from day to day, a 90th percentile concentration was calculated for each hour of the day using 5 years of hourly monitoring data from 2016 to 2020, as this represents the most recent data set available. The resulting background concentrations represented the highest background conditions likely to coincide with maximum predicted concentrations from the highway. They were used when predicting maximum 1-hour and 24-hour cumulative concentrations of NO_2. The hourly background concentrations for NO_2 and O_3 are presented in **Table 4**. For the annual averaging period the annual mean values were used.

PM_{10} monitoring data were not available; therefore, PM_{10} background concentrations were estimated from the $PM_{2.5}$ values using a $PM_{2.5}/PM_{10}$ ratio of 0.54 (Lall et. Al., 2004).

For benzene and benzo(a)pyrene, the monitoring data consisted of 24-hour average concentrations. It was not possible to calculate background values by hour of the day, therefore, for these contaminants, the background concentrations for the 24-hour averaging period consisted of 90th percentile values. For 0.5-hour acetaldehyde and 1-hour acrolein, the background values were calculated from the corresponding 24-hour average background value following Section 4.4 of the Air Dispersion Modelling Guideline for Ontario. The summary of all background values used for the assessment is presented in **Error! Reference source not found.**

3.7 Emissions Model

The standard approach for estimating vehicular emissions is to use computer simulation techniques that are based on extensive previous testing of a wide range of vehicles. Motor Vehicle Emission Simulator (MOVES3) is such a model that has been developed for this purpose by the U.S. Environmental Protection Agency (EPA). MOVES3 was used to generate vehicle emission factors for the year 2041.

Exhaust emissions vary widely by vehicle type and speed, and MOVES3 was configured to generate emission factors based on the vehicle type and travel speed. These individual emission factors were aggregated to produce a composite emission factor for each key air contaminant, representing the average vehicle for each road segment assessed.

For particulate matter, it is necessary to account for the re-suspension of dust as vehicles travel over a roadway surface, in addition to tailpipe emissions. The road dust emissions were calculated based on the revised version of U.S. EPA's AP-42, Chapter 13.2.1 (US EPA, 2011). The tailpipe emission factor for particulate matter, from MOVES3, was added to the road dust emission factor to account for both emission sources.

For the year 2041, MOVES3 estimated zero emissions of 1,3-butadiene due to US EPA updates of the toxic fractions of VOCs in vehicle exhaust (US EPA, 2020); therefore, results for 1,3-butadiene were not quantified in Table 6 for the Future No-Build and Future Build scenarios.

3.8 Dispersion Model

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

Dispersion modelling is a common approach for assessing local air quality near an emission source such as vehicular traffic The dispersion model used in this study is the US EPA's AERMOD version 19191. This is a widely used dispersion model and is an approved model for regulatory purposes in Ontario. The model predicts how emissions from the vehicles travelling within each segment disperse and contribute to air pollutant concentrations within the study area. The dispersion model requires information on emission rates for the air pollutants of interest, the layout of the project corridor, terrain elevation data, and hourly meteorological data.

Site-specific meteorological data were processed for input to the AERMOD model. Fully processed 5-year (2017-2021) site-specific meteorological data were prepared in-house at RWDI. Upper air weather data were obtained from the upper air monitoring station at Maniwaki, Quebec, and surface weather data were obtained from Ottawa Macdonald Cartier International Airport.

Figure 1 shows the study area and its surrounding land use. The study area consists of mostly residential and commercial land uses. Agricultural uses are located to the west and north of the study area with additional employment uses to the south.

Terrain information for the study area was obtained from the Regional Meteorological and Terrain Data for Air Dispersion Modelling website of the MECP. The terrain data are based on the North American Datum 1983 (NAD83) horizontal reference datum. The rural dispersion coefficient was used in the dispersion modelling analysis.

3.8.1 Selection of Receptors

The MTO Air Quality Guide requires assessment of local air quality impacts up to 500 m from the mixing zone at the edge of the highway, with pollutant concentrations determined through dispersion modelling and the modelling results used to generate site-specific isoconcentration contour maps. Receptors were placed within a 500 m setback boundary representing the worst-case selection of gridded receptors outlined in the MTO Air Quality Guide. Receptor grid spacing follow the US EPA document Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas (US EPA, 2015). **Figures 2** and **3** show the sensitive receptor locations within the study area.

3.8.2 Conversion of NO_x to NO_2, Ozone Limiting Method

Any chemical reactions among pollutants are not considered in the assessment of local air quality impacts, except for the conversion of nitric oxide (NO) to NO_2, through reaction with ambient ground-level ozone (O_3). Vehicle exhausts initially consist mainly of NO. However, NO can convert to NO_2 once in the outside air. The Ozone Limiting Method (OLM) was used to estimate this conversion for the credible worst-case NO concentration.

The OLM assumes that the conversion of NO to NO_2 is limited only by the amount of ozone (O_3) present in the outside air. If the concentration of available O_3 (parts per million or ppm) is less than that of the NO contributed by the modelled roadway emissions, then the portion of NO that is converted to NO_2 equals the available O_3. On the other hand, if the concentration of available O_3 exceeds that of the NO contributed by the modelled roadway, then all of the NO is converted to NO_2. For the credible worst-case analysis, a fixed hourly concentration of ozone was used in the OLM, shown in **Table 4**, corresponding to the 90th percentile of measured values from historical monitoring data recorded at a nearby monitoring station operated by the MECP.

3.9 Regional Air Quality and Greenhouse Gas Emissions Analysis

The potential for the Project to affect regional air quality and climate change was assessed by calculating the total annual emissions for the Future No-Build and Future Build scenarios. The regional air quality component focused on the emissions of the pollutants that are known to have significant impacts on regional air quality events. Specifically, these pollutants include $PM_{2.5}$, NOx, CO, and total VOCs. Note that the re-entrained road dust portion of the $PM_{2.5}$ emissions were not included in this analysis as per the MTO Air Quality Guide; most road dust falls into the coarse fraction of PM_{10}, which is excluded from the provincial air quality impact assessment due to its short range, and the remaining $PM_{2.5}$ from road dust is a small, less significant component of provincial $PM_{2.5}$ (MTO, 2020). The climate change component of this analysis focused on the emissions of greenhouse gases in terms of CO_2e (CO_2 equivalent).

This analysis included the emissions from Highway 416, the proposed interchange, and Barnsdale Road within the Study Area.

In order to assess the effect of the Project on regional air quality, annual Project-related emissions were compared with the annual total Ontario-wide emissions of the same pollutants from transportation and other sources.

4 RESULTS

4.1 Assessment of Maximum Cumulative Concentrations

Table 6 presents a summary of the predicted maximum cumulative concentrations (maximum modelled project contribution plus the 90th percentile 1-hour or 24-hour background concentration) at the most impacted gridded receptors for the Future No-Build and Future Build scenarios. The resultant concentrations are compared to the applicable thresholds. Figures showing the maximum predicted cumulative concentrations for contaminants of greatest concern (NO_2, $PM_{2.5}$ and acrolein) are provided in **Appendix B**.

The resultant concentrations for the Future Build scenario were similar to the concentrations for the Future No-Build scenario as a result of minimal changes in traffic volumes from the Project.

For the Future No-Build and Future Build scenarios, the cumulative maximum predicted concentrations for 24-hour and annual average benzo(a)pyrene exceeded the AAQC. The cumulative maximum predicted concentrations for all other contaminants were below their respective criteria.

As shown in **Table 6**, the background levels of benzo(a)pyrene are 84% and 220% of the AAQC for 24-hour and annual averaging periods, respectively. The incremental change in predicted concentration between the Future Build and Future No-Build scenarios is small (<0.1%) compared to the ambient background.

Table 7 shows the relative change in emissions for each contaminant, with the percent change relative to from the Future Build versus the Future No-Build scenario. The Future Build scenario is predicted to result in less than 1% change in predicted concentrations for all contaminants, with the majority of contaminants seeing a less than 0.1% change in predicted air quality concentrations; therefore, overall, the proposed Project will result in similar air quality impacts as in the Future No-Build scenario.

4.2 Assessment of Regional Air Quality and Greenhouse Gas Emissions

The impact of the Project on regional air quality and greenhouse gas emissions was assessed by calculating the total annual emissions associated with the section of the Highway 416 within the Study Area. See **Table 8**. The annual regional emissions of air pollutants are projected to increase slightly between the Future No-Build and Future Build scenarios due to a small increase in projected traffic as a result of the Project. Overall, the emissions from this section of highway are very small in relation to provincial totals, and there is very little change in the regional emissions between the Future No-Build and Future Build scenarios.

4.3 Emissions During the Construction Phase

Construction activities involve heavy equipment that generates air pollutants and dust; however, these impacts are temporary in nature. The emissions are highly variable, difficult to predict, and depend on the specific activities that are taking place and the effectiveness of the mitigation measures. The best manner to deal with these emissions is through diligent implementation of operating procedures such as application of dust suppressants, reduced travel speeds for heavy vehicles, efficient staging of activities and minimization of haul distances, covering up stockpiles, etc. It is recommended that in order to minimize potential air quality impacts during construction, the construction tendering process should include requirements for implementation of an Air Quality Management Plan. Such a Plan would set out established best management practices for dust and other emissions. Some of the best practices include the following:

- Use of reformulated fuels, emulsified fuels, exhaust catalyst and filtration technologies, cleaner engine repowers, and new alternative-fueled trucks to reduce emissions from construction equipment.
- Regular cleaning of construction sites and access roads to remove construction-caused debris and dust.
- Dust suppression on unpaved haul roads and other traffic areas susceptible to dust, subject to the area being free of sensitive plant, water or other ecosystems that may be affected by dust suppression chemicals.
- Covered loads when hauling fine-grained materials.
- Prompt cleaning of paved streets/roads where tracking of soil, mud or dust has occurred.
- Tire washes and other methods to prevent trucks and other vehicles from tracking soil, mud or dust onto paved streets or roads.
- Covered stockpiles of soil, sand and aggregate, as necessary.
- Compliance with posted speed limits and, as appropriate, further reductions in speeds when travelling sites on unpaved surfaces.

5 CONCLUSIONS

The proposed Project is expected to have little to no impacts on local air contaminant levels at the most-impacted receptors, with the maximum predicted cumulative concentrations for most contaminants and averaging periods less than current respective thresholds. Annual and 24-hour average benzo(a)pyrene are predicted to exceed their respective AAQC thresholds but are significantly attributed to high ambient background concentrations that exceed the respective AAQCs on their own. Overall, the Project is predicted to have similar air quality impacts to the do-nothing alternative, and therefore, not expected to have a significant impact on local air quality. No mitigation measures are recommended, beyond those which are already in place through phased-in federal regulations for on-road vehicle and engine emissions, which are expected to reduce NO_2 and other tailpipe emissions beyond the 2041 horizon year used for emission factors in this assessment.

The emissions from the project compared to the regional provincial emissions of CO, NOx, $PM_{2.5}$, VOCs and greenhouse gas CO_2e are very low (less than 0.001%) and therefore the project is not expected to have an impact on the regional air quality.

Construction phase impacts were addressed qualitatively. It is recommended that in order to minimize potential air quality impacts during construction, the construction tendering process should include requirements for implementation of an Air Quality Management Plan.

6 REFERENCES

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TABLES

Table 1: 2041 Traffic Volumes and Speeds for the Study Area

Road	Portion of Road	Description	Direction	No-Build		Build		Posted Speed Limit (km/hour)
				AM Peak Volume	PM Peak Volume	AM Peak Volume	PM Peak Volume	
Highway 416	Bankfield Rd. to Barnsdale Rd.	Hwy-416	NB	2,078	1,240	2,124	1,255	100
	Barnsdale Rd. to Fallowfield Rd.	Hwy-416	NB	2,078	1,240	2,090	1,250	100
	Bankfield Rd. to Barnsdale Rd.	Hwy-416	SB	775	2,301	796	2,339	100
	Barnsdale Rd. to Fallowfield Rd.	Hwy-416	SB	775	2,301	781	2,259	100
Barnsdale Rd.	Moodie Dr. to Trail Rd.	Barnsdale Rd.	EB	268	97	269	117	80
	Trail Rd. to Borrisokane Rd.	Barnsdale Rd.	EB	280	112	317	147	80
	Borrisokane Rd. to Viewbank Rd.	Barnsdale Rd.	EB	241	153	290	229	80
	Viewbank Rd. to Kilbirnie Dr.	Barnsdale Rd.	EB	241	153	290	229	80
	Kilbirnie Dr. to Greenbank Rd.	Barnsdale Rd.	EB	159	141	216	212	80
	Moodie Dr. to Trail Rd.	Barnsdale Rd.	WB	139	229	135	226	80
	Trail Rd. to Borrisokane Rd.	Barnsdale Rd.	WB	157	272	230	346	80
	Borrisokane Rd. to Viewbank Rd.	Barnsdale Rd.	WB	147	226	278	337	80
	Viewbank Rd. to Kilbirnie Dr.	Barnsdale Rd.	WB	105	161	237	273	80
	Kilbirnie Dr. to Greenbank Rd.	Barnsdale Rd.	WB	105	160	238	271	80

Table 2: Summary of Relevant Air Quality Thresholds (μg/m³)

Pollutant	Criterion (μg/m³)	Averaging Period	Source of Threshold Value
$PM_{2.5}$	27	24-hour	CAAQS 2020[1]
	8.8	Annual	CAAQS 2020[2]
PM_{10}	50	24-hour	AAQC
CO	36,200	1-hour	AAQC
	15,700	8-hour	AAQC
NO_2	400	1-hour	AAQC
	113	1-hour	CAAQS 2020 [3]
	79.0	1-hour	CAAQS 2025 [3]
	200	24-hour	AAQC
	32.0	Annual	CAAQS 2020[4]
	22.6	Annual	CAAQS 2025[4]
Acetaldehyde	500	24-hour	AAQC
Acrolein	4.5	1-hour	AAQC
	0.4	24-hour	AAQC
Benzene	2.3	24-hour	AAQC
	0.45	Annual	AAQC
Benzo(a)pyrene	5.0E-05	24-hour	AAQC
	1.0E-05	Annual	AAQC
Formaldehyde	65	24-hour	AAQC

Note: [1]: The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.
[2] The 3-year average of the annual average concentrations.
[3] The 3-year average of the annual 98th percentile daily maximum 1-hour average concentrations.
[4] The average over a single calendar year of all the 1-hour average concentrations.

Table 3: Source of Background Monitoring Data Used

Contaminant	NAPS ID and Location	Years Included [1] [2]
$PM_{2.5}$	60104 – Ottawa Downtown	2016, 2017, 2018, 2019, 2020
PM_{10} [3]	60104 – Ottawa Downtown	2016, 2017, 2018, 2019, 2020
CO	60104 – Ottawa Downtown	2016, 2017, 2018, 2019, 2020
NO_2	60104 – Ottawa Downtown	2016, 2017, 2018, 2019, 2020
Benzo(a)pyrene	62601 – Experimental Farm – Simcoe	2016, 2017, 2018, 2019, 2020
Acetaldehyde	60211 – Windsor West	2015, 2016, 2017, 2018, 2019
Acrolein	60211 – Windsor West	2014, 2015, 2016, 2017
Formaldehyde	60211 – Windsor West	2015, 2016, 2017, 2018, 2019
Benzene	60104 – Ottawa Downtown	2015, 2016, 2017, 2018, 2019
1,3-Butadiene	60104 – Ottawa Downtown	2015, 2016, 2017, 2018, 2019
Ozone (O_3) [4]	60104 – Ottawa Downtown	2016, 2017, 2018, 2019, 2020

Note:
[1] Data availability from 2020 were insufficient for use in estimating a background value.
[2] The most recent years with valid data were used.
[3] PM_{10} background data based on $PM_{2.5}$.
[4] Ozone (O_3) was not assessed against air quality thresholds; background ozone concentration was used in the Ozone Limiting Method to estimate conversion of NO_x to NO_2.

Table 4: 90th Percentile Background NO_2 and Ozone by Hour of Day

Hour of Day	NO_2 (ppb)	O_3 (ppb)
1	15.9	37.0
2	15.0	36.0
3	15.0	36.0
4	14.6	35.0
5	14.5	34.0
6	15.8	33.0
7	17.3	32.0
8	18.1	33.0
9	17.0	35.0
10	14.0	38.0
11	12.3	40.0
12	11.0	42.0
13	10.0	43.0
14	10.0	44.0
15	10.2	45.0
16	11.5	44.0
17	13.0	44.0
18	14.7	43.0
19	16.0	42.0
20	17.0	40.0
21	17.6	38.7
22	17.9	38.0
23	17.6	38.0
24	16.1	37.0

Table 5: Summary of Background Concentrations

Pollutant	Averaging Period	Adopted Background Value (µg/m³)	Description	Criterion (µg/m³)
PM_{10}	24-hour	18.5	90th Percentile	50
$PM_{2.5}$	24-hour	10.0	90th Percentile	27
	Annual	6.0	Annual Average	8.8
CO	1-hour	325	90th Percentile	36,200
	8-hour	340	90th Percentile	15,700
NO_2	Annual	13.4	Annual Average	22.6 [1]
Acetaldehyde	0.5-hour [2]	4.7	90th Percentile	500
	24-hour	1.6	90th Percentile	500
Acrolein	1-hour [3]	0.17	90th Percentile	4.5
	24-hour	0.06	90th Percentile	0.4
Benzene	24-hour	0.64	90th Percentile	0.45
	Annual	0.38	Annual Average	2.3
Formaldehyde	24-hour	2.0	90th Percentile	65
Benzo(a)pyrene	24-hour	4.2E-05	90th Percentile	10
	Annual	2.2E-05	Annual Average	2

Notes: [1] CAAQS-2025 - The average over a single calendar year of all the 1-hour average concentrations.
[2] 0.5-hour average converted from 24-hour average background following Section 4.4 of the Air Dispersion Modelling Guideline for Ontario.
[3] 1-hour average converted from 24-hour average background value following Section 4.4 of the Air Dispersion Modelling Guideline for Ontario.

Table 6a: Maximum Predicted Concentrations (µg/m^3) for the 2041 No-Build Scenario

Pollutant [2]	Averaging Period	Predicted Conc.	Background Conc.	Combined Conc.	Threshold	Source of Threshold Value	% of Threshold
PM_{10}	24-hour	17.7	18.5	36.2	50	AAQC	72%
$PM_{2.5}$	24-hour	2.0	10.0	12.0	27	CAAQS	44%
	Annual	0.7	6.0	6.7	8.8	CAAQS	76%
CO	1-hour	959	325	1284	36200	AAQC	3.5%
	8-hour	231	340	571	15700	AAQC	3.6%
NO_2	1-hour [1]	39.3	27.8	67.1	400	AAQC	17%
	1-hour [1]	21.5	30.3	51.9	79	CAAQS 2025	66%
	24-hour [1]	7.5	27.3	34.8	200	AAQC	17%
	Annual	1.3	13.4	14.6	22.6	CAAQS 2025	65%
Acetaldehyde	0.5-hour	0.09	4.7	4.8	500	AAQC	1.0%
	24-hour	0.011	1.6	1.6	500	AAQC	0.3%
Acrolein	1-hour	0.007	0.167	0.174	4.50	AAQC	3.9%
	24-hour	1.0E-03	0.057	0.058	0.4	AAQC	14%
Benzene	24-hour	0.03	0.64	0.7	2.3	AAQC	29%
	Annual	0.006	0.38	0.38	0.45	AAQC	86%
Formaldehyde	24-hour	1.5E-02	2.0	2.0	65	AAQC	3.1%
Benzo(a)Pyrene	24-hour	4.6E-05	4.2E-05	8.7E-05	5.0E-05	AAQC	175%
	Annual	7.8E-06	2.2E-05	2.9E-05	1.0E-05	AAQC	293%

Notes: [1] Background levels based on difference between receptor concentration with and without background concentrations in model

[2] Results for 1,3-butadiene not quantified because MOVES3 estimated zero emissions of 1,3-butadiene due to US EPA updates of the toxic fractions of VOCs in vehicle exhaust.

Table 6b: Maximum Predicted Concentrations (µg/m³) for the 2041 Build Scenario

Pollutant [2]	Averaging Period	Predicted Conc.	Background Conc.	Combined Conc.	Threshold	Source of Threshold Value	% of Threshold
PM_{10}	24-h	17.5	18.5	36.0	50	AAQC	72%
$PM_{2.5}$	24-h	2.0	10.0	12.0	27	CAAQS	44%
	Annual	0.7	6.0	6.7	8.8	CAAQS	76%
CO	1-h	958	325	1283	36200	AAQC	3.5%
	8-h	231	340	571	15700	AAQC	3.6%
NO_2	1-h [1]	39.3	27.8	67.1	400	AAQC	17%
	1-h [1]	21.5	30.4	51.9	79.0	CAAQS 2025	66%
	24-h [1]	7.5	27.3	34.8	200	AAQC	17%
	Annual	1.3	13.4	14.6	22.6	CAAQS 2025	65%
Acetaldehyde	0.5-h	0.09	4.7	4.8	500	AAQC	1.0%
	24-h	0.011	1.6	1.6	500	AAQC	0.3%
Acrolein	1-h	0.007	0.167	0.174	4.50	AAQC	3.9%
	24-h	1.0E-03	0.057	0.058	0.4	AAQC	14%
Benzene	24-h	0.03	0.64	0.7	2.3	AAQC	29%
	Annual	0.006	0.38	0.38	0.45	AAQC	86%
Formaldehyde	24-hour	1.52E-02	2.0	2.0	65	AAQC	3.1%
Benzo(a)Pyrene	24-hour	4.6E-05	4.2E-05	8.7E-05	5.0E-05	AAQC	175%
	Annual	7.8E-06	2.2E-05	2.9E-05	1.0E-05	AAQC	293%

Notes: [1] Background levels based on difference between receptor concentration with and without background concentrations in model

[2] Results for 1,3-butadiene not quantified because MOVES3 estimated zero emissions of 1,3-butadiene due to US EPA updates of the toxic fractions of VOCs in vehicle exhaust.

Table 7: Relative Change in the Worst-Case Concentrations between Scenarios – 2041

Pollutant	Averaging Period	Predicted Cumulative Concentration (µg/m³)		% Change of Future Build Relative to Future No-Build
		Future No-Build (2041)	Future Build (2041)	
PM_{10}	24-hour	36.2	36.0	-0.56%
$PM_{2.5}$	24-hour	12.0	12.0	<0.1%
	Annual	6.7	6.7	<0.1%
CO	1-hour	1284	1283	<-0.1%
	8-hour	571	571	<0.1%
NO_2	1-hour [1]	67.1	67.1	<0.1%
	1-hour [1]	51.9	51.9	<0.1%
	24-hour [1]	34.8	34.8	<0.1%
	Annual	14.6	14.6	<0.1%
Acetaldehyde	0.5-hour	4.8	4.8	<0.1%
	24-hour	1.6	1.6	<0.1%
Acrolein	1-hour	0.174	0.174	<0.1%
	24-hour	0.058	0.058	<0.1%
Benzene	24-hour	0.7	0.7	<0.1%
	Annual	0.38	0.38	<0.1%
Formaldehyde	24-hour	2.0	2.0	<0.1%
Benzo(a)Pyrene	24-hour	8.7E-05	8.7E-05	<0.1%
	Annual	2.9E-05	2.9E-05	<0.1%

Table 8: Total Annual Emissions Compared to Ontario's Total Annual Emissions for Project Year 2041

Pollutant	Ontario Emissions [1] (tonnes/year)	Ontario Emissions: Transportation Sector (tonnes/year)	Ontario Emissions: Road Transportation Sector (tonnes/year)	Highway Emissions: 2041 No-Build (tonnes/year)	Highway Emissions: 2041 Build (tonnes/year)	Change in Emissions due to the Project [4] (tonnes/year)
CO	1,128,216	891,638	424,866	82.10	82.91	0.00007%
NOx	229,260	147,440	82,887	4.92	4.99	0.00003%
$PM_{2.5}$ [2]	126,098	7,258	3,167	0.34	0.34	0.000004%
Total VOCs	308,195	75,863	32,155	0.49	0.49	0.0000018%
CO_2e [3]	150,000,000	52,200,000	40,100,000	23336	23572	0.00016%

Notes: [1] The total Ontario emissions include emissions from all sources obtained from Environment Climate Change Canada Air Pollutant Emission Inventory (APEI) for the year 2020.

[2] Particulate matter emissions do not include emissions from re-entrained road dust (paved and unpaved roads).

[3] CO_2e emissions obtained from Environment and Climate Change Canada National Inventory Report – 2022 Edition, with data from 2020.

[4] Relative to total Ontario emissions.

FIGURES

Area plan showing study area, modelled roadways, and sensitive receptors

True North

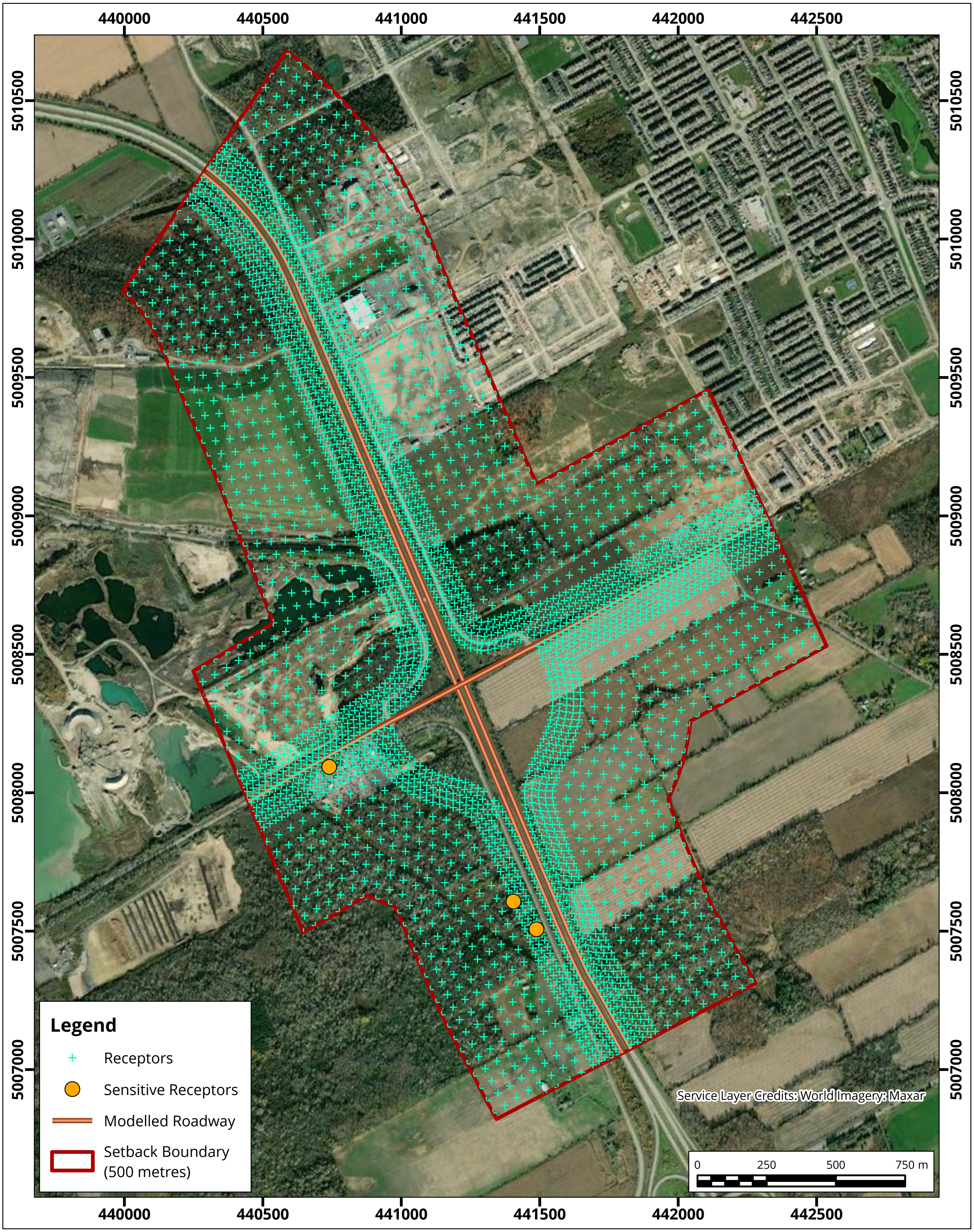
Drawn by: DJH	Figure: 1
Approx. Scale:	1:22,000
Date Revised:	Jan 17, 2023

Map Projection: NAD 1983 UTM Zone 18N

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

Project #: 2003291

Map Document: C:\GIS Temp - Copy\2003291\P2003291_HWY416_2.aprx



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2041 No-Build Scenario: Area plan showing setback boundary, modelled roadways, and receptors

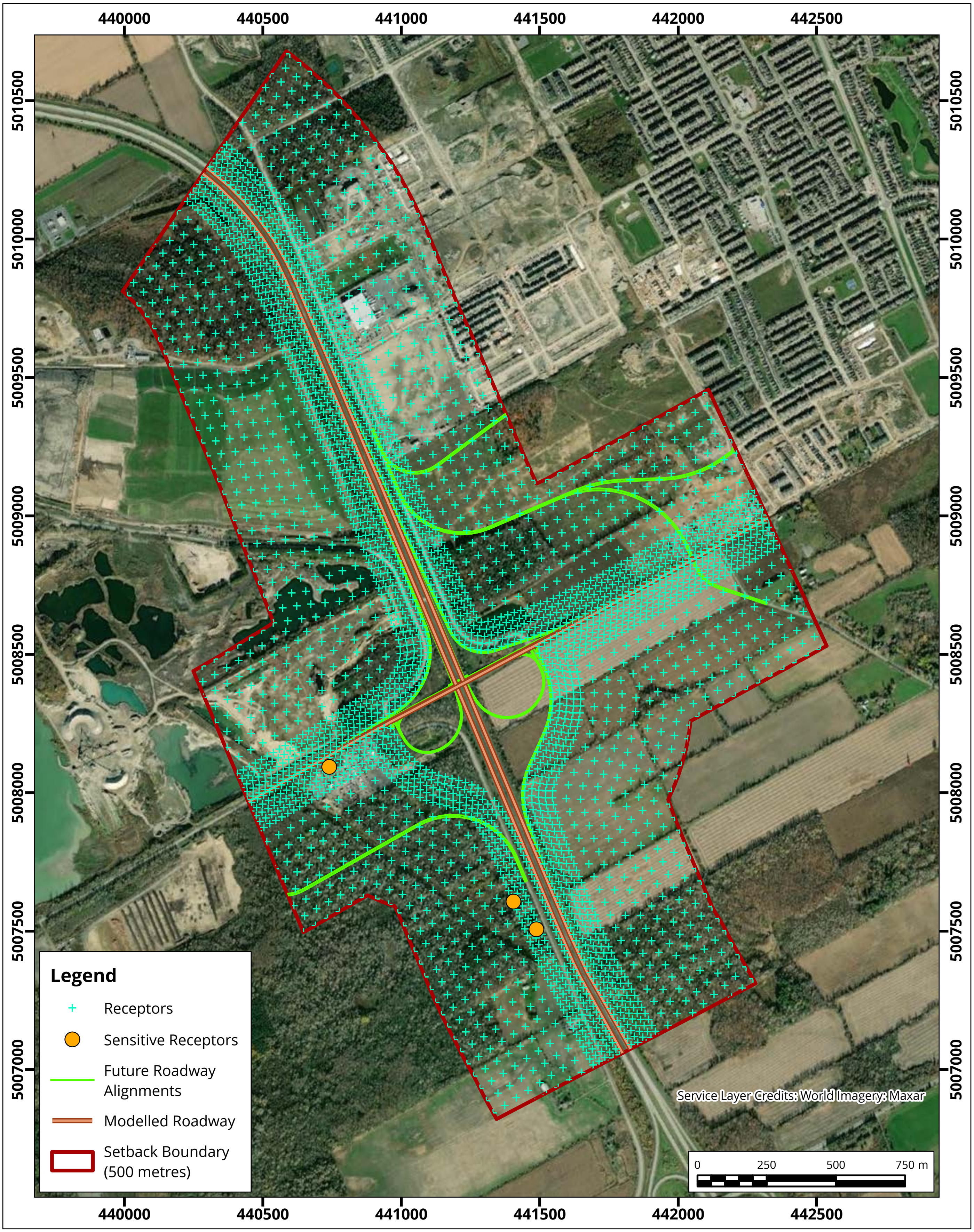
True North

Map Projection: NAD 1983 UTM Zone 18N

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

Project #: 2003291

Drawn by: DJH	Figure: 2
Approx. Scale: 1:19,000	
Date Revised: Jan 17, 2023	



2041 Build Scenario: Area plan showing setback boundary, modelled roadways, and receptors

*Note: Traffic data for the on and off ramps at the interchange were not available for the Future Build scenario.

Map Projection: NAD 1983 UTM Zone 18N

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

Project #: 2003291

True North

Drawn by: DJH	Figure: 3
Approx. Scale:	1:19,000
Date Revised:	Jan 17, 2023

Map Document: C:\GIS Temp - Copy\2003291\P2003291_HWY416_2.aprx

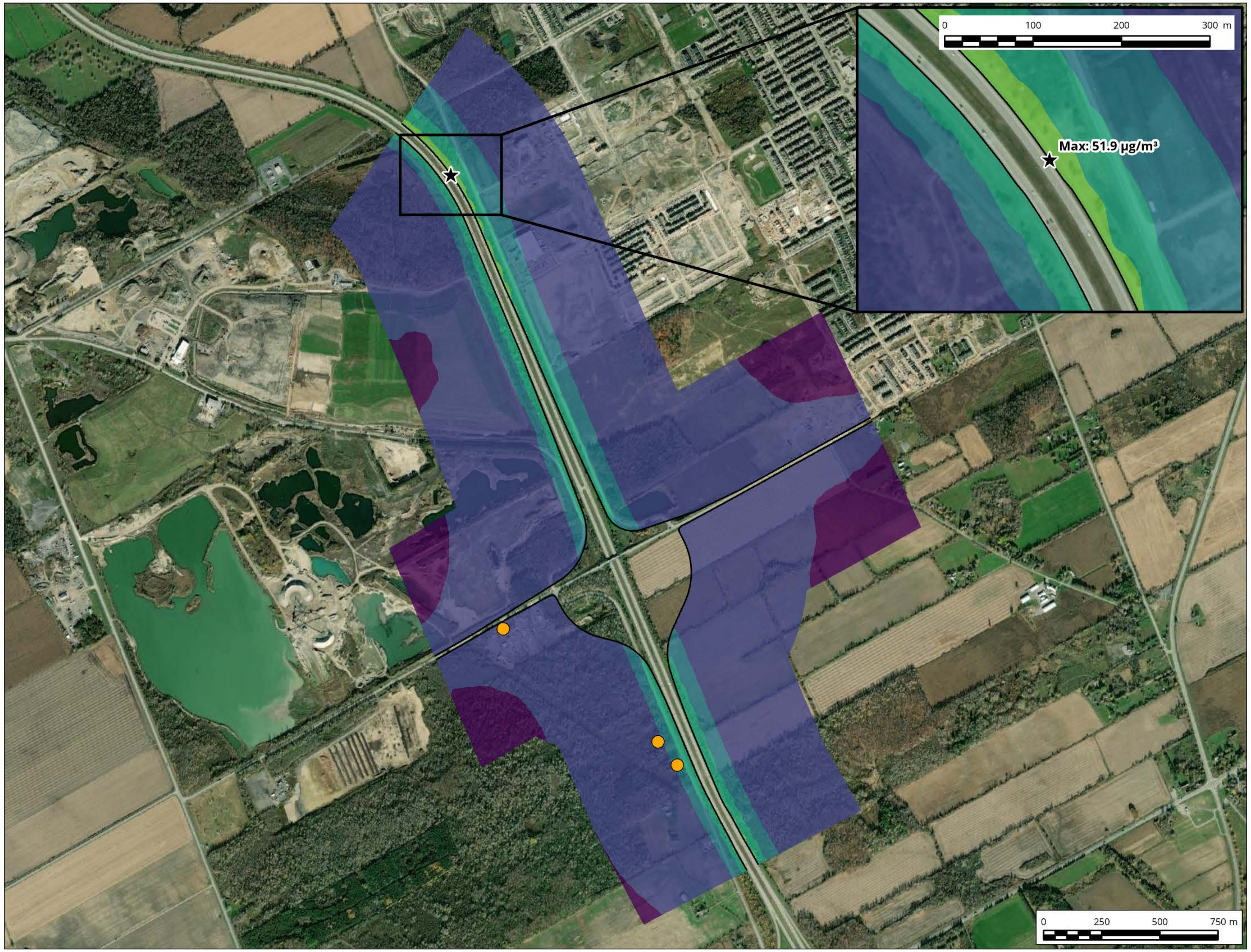
APPENDIX A

Table A.1: Hourly Traffic Distribution on Highway 416

Hour of Day (Hour Ending)	Hourly Northbound Traffic volume on Hwy-416 [1]	Northbound Hourly Ratio of Traffic to Peak Hours	Hourly Southbound Traffic volume on Hwy-416 [1]	Southbound Hourly Ratio of Traffic to Peak Hours	Average Hourly Ratio
1	118	12.4%	105	9.4%	10.9%
2	81	8.5%	63	5.6%	7.1%
3	67	7.1%	41	3.7%	5.4%
4	58	6.1%	38	3.4%	4.8%
5	88	9.3%	54	4.8%	7.0%
6	299	31.5%	109	9.7%	20.6%
7	844	88.9%	258	23.0%	56.0%
8	949	100.0%	435	38.8%	69.4%
9	677	71.3%	548	48.9%	60.1%
10	548	57.7%	632	56.4%	57.1%
11	512	54.0%	654	58.4%	56.2%
12	547	57.6%	672	60.0%	58.8%
13	522	55.0%	617	55.1%	55.0%
14	566	59.6%	624	55.7%	57.7%
15	662	69.8%	677	60.4%	65.1%
16	734	77.3%	855	76.3%	76.8%
17	758	79.9%	1080	96.4%	88.2%
18	734	77.3%	1120	100.0%	88.7%
19	570	60.1%	743	66.3%	63.2%
20	411	43.3%	465	41.5%	42.4%
21	351	37.0%	367	32.8%	34.9%
22	317	33.4%	318	28.4%	30.9%
23	282	29.7%	227	20.3%	25.0%
24	193	20.3%	185	16.5%	18.4%

Source: MTO, 2022. MTO iCorridor Hourly Traffic 2008.
https://icorridor-mto-on-ca.hub.arcgis.com/apps/5df2b225af994a3c9ae7e815d89bd576/explore. Accessed November 2022.

APPENDIX B



Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 35
- 35 - 37.5
- 37.5 - 40
- 40 - 45
- 45 - 79
- > 79

1-Hour NO_2 CAAQS = 79 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted 1-hour NO_2 Concentrations with Ambient Background, 2041 No-Build Scenario

Based on the 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations

Map Projection: NAD 1983 UTM Zone 18N (km)

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.1
Approx. Scale:	1:19,000
Date Revised:	Jan 12, 2023

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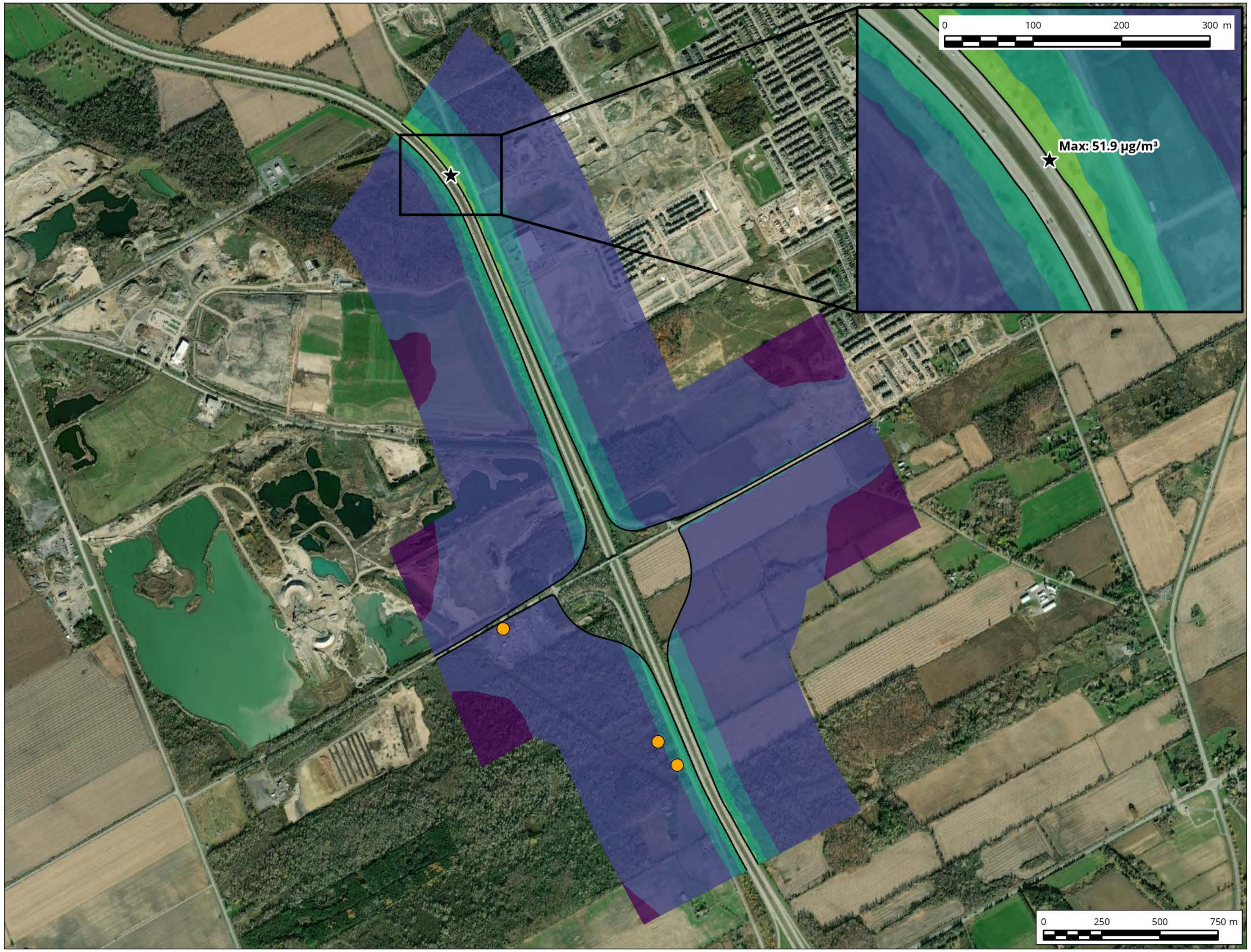

Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 35
- 35 - 37.5
- 37.5 - 40
- 40 - 45
- 45 - 79
- > 79

1-Hour NO_2 CAAQS = 79 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted 1-hour NO_2 Concentrations with Ambient Background, 2041 Build Scenario

Based on the 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations

Map Projection: NAD 1983 UTM Zone 18N (km)

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.2
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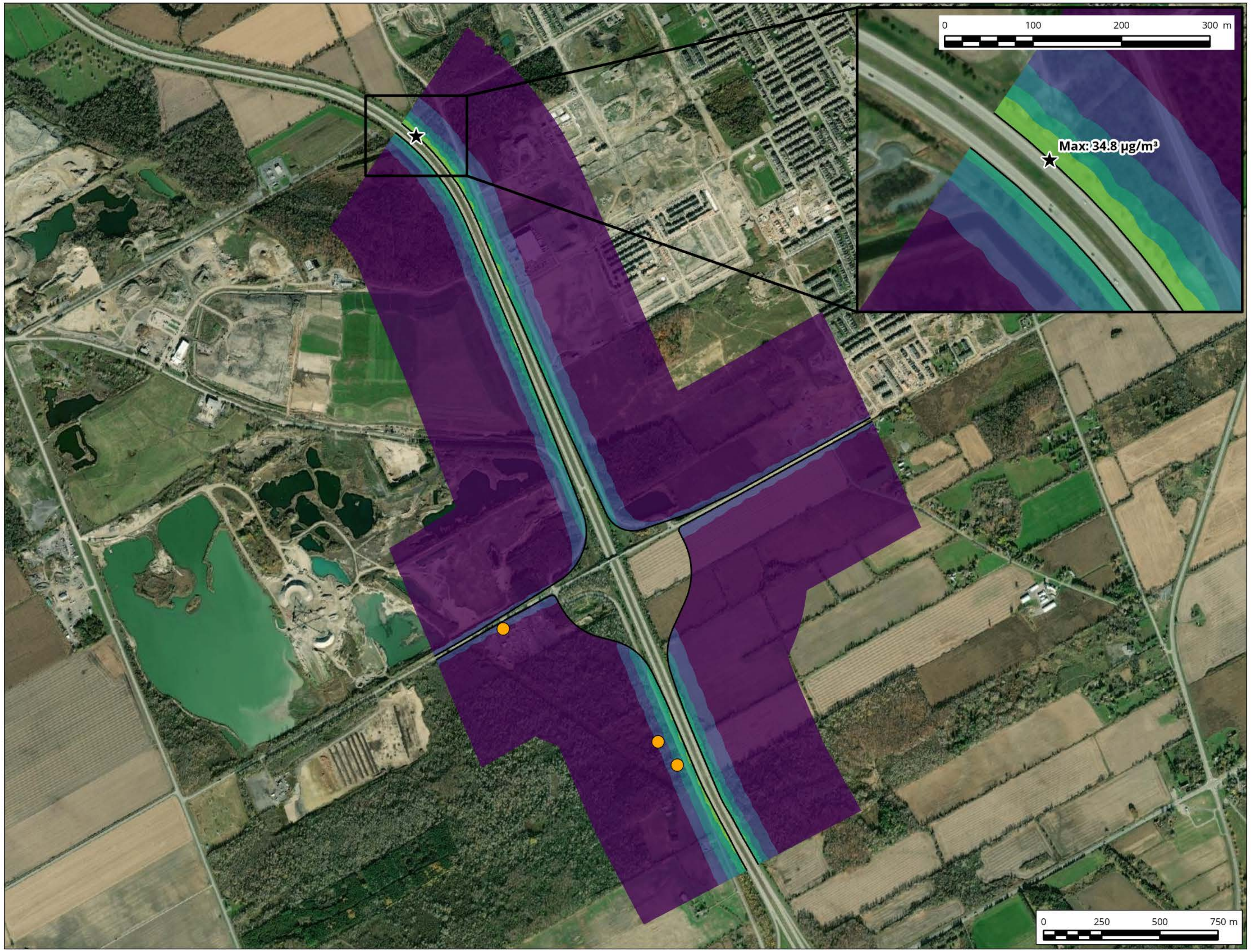


Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 30
- 30 - 30.5
- 30.5 - 31.5
- 31.5 - 32.5
- 32.5 - 200
- > 200

24-Hour NO_2 AAQC = 200 µg/m³

Maximum Predicted 24-hour NO_2 Concentrations with Ambient Background, 2041 No-Build Scenario

Based on maximum 24-hour average

Map Projection: NAD 1983 UTM Zone 18N (km)

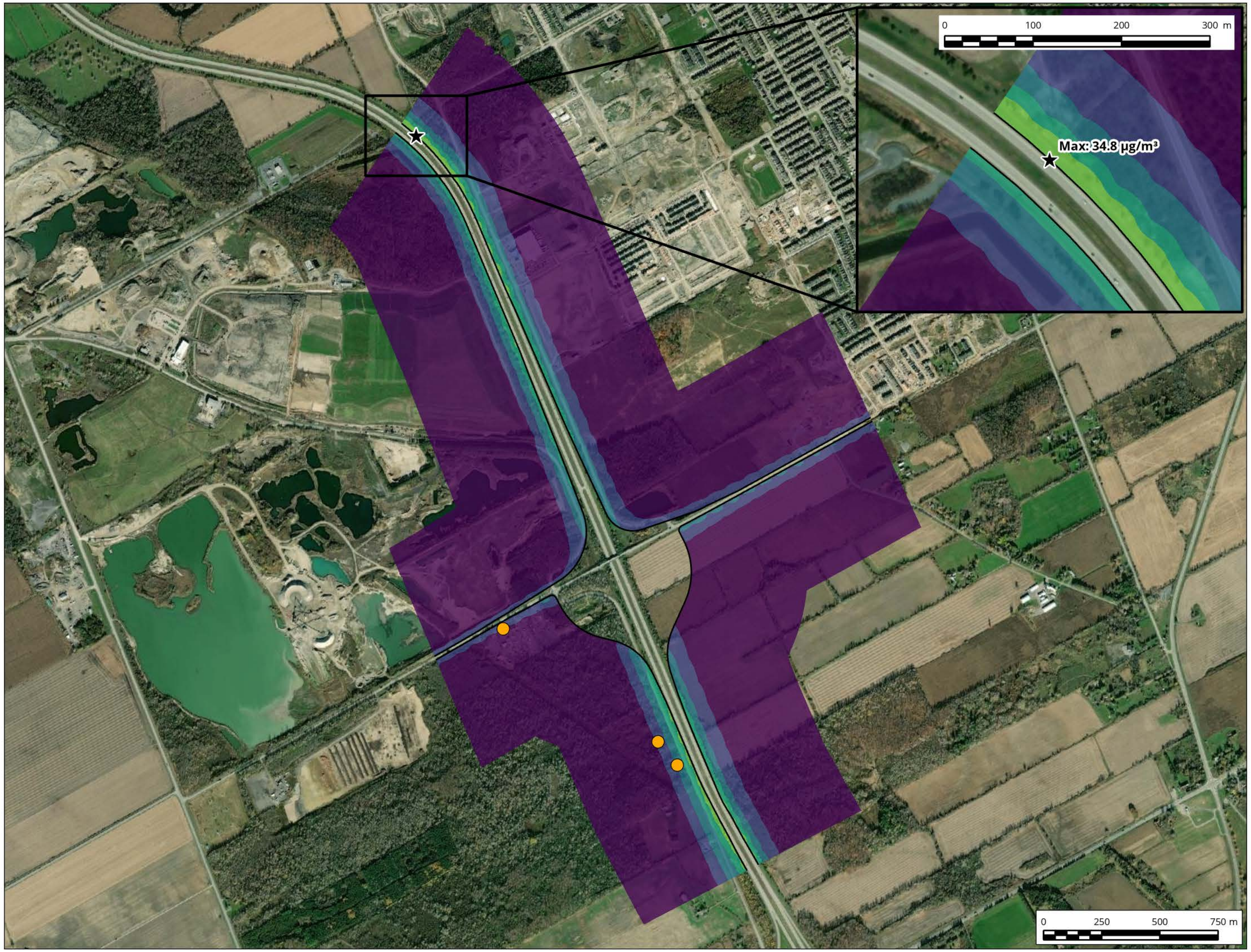
Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.3
Approx. Scale:	1:19,000
Date Revised:	Jan 12, 2023

Map Document: C:\GIS Temp - Copy\2003291\P2003291_HWY416_2.aprx



Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 30
- 30 - 30.5
- 30.5 - 31.5
- 31.5 - 32.5
- 32.5 - 200
- > 200

24-Hour NO_2 AAQC = 200 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted 24-hour NO_2 Concentrations with Ambient Background, 2041 Build Scenario

Based on maximum 24-hour average

Map Projection: NAD 1983 UTM Zone 18N (km)

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.4
Approx. Scale:	1:19,000
Date Revised:	Jan 12, 2023

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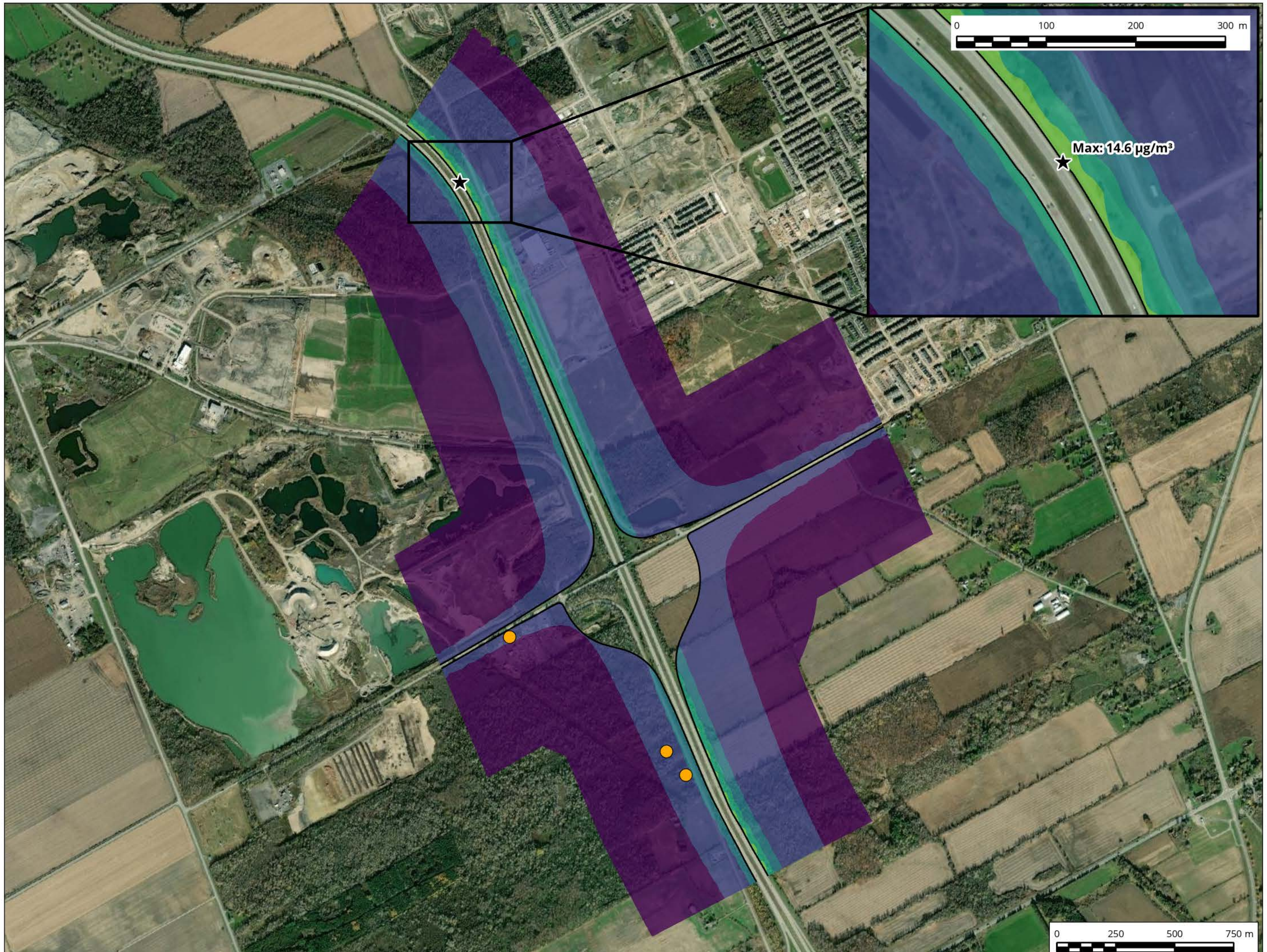

Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 13.5
- 13.5 - 13.8
- 13.8 - 14
- 14 - 14.2
- 14.2 - 22.6
- > 22.6

Background Concentration = 13.4 µg/m³
Annual NO_2 CAAQS = 22.6 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted Annual NO_2 Concentrations with Ambient Background, 2041 No-Build Scenario

Based on the average over a single calendar year of all 1-hour average concentrations

Map Projection: NAD 1983 UTM Zone 18N (km)

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH		Figure: B.5
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Date Revised:	Jan 12, 2023	

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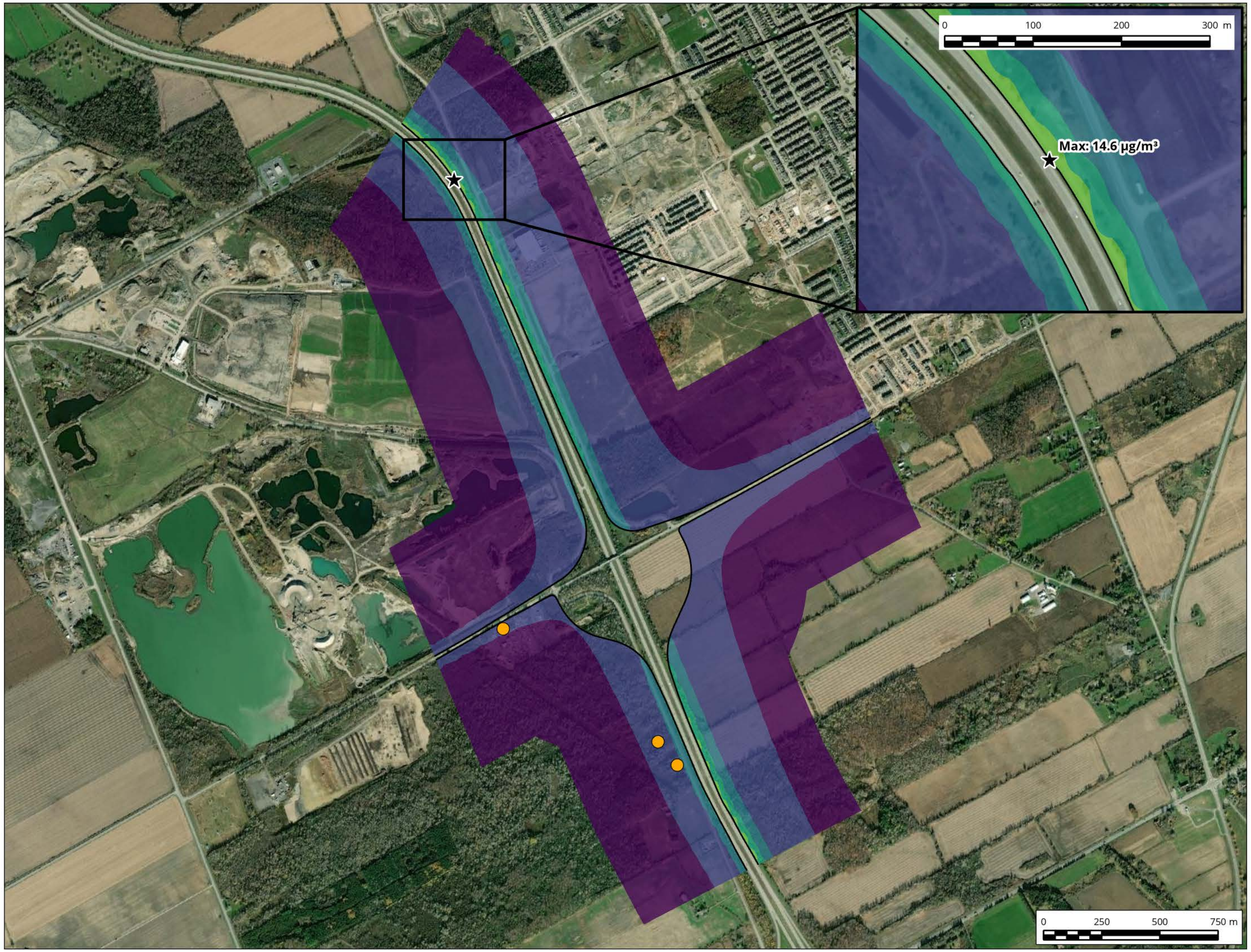

Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 13.5
- 13.5 - 13.8
- 13.8 - 14
- 14 - 14.2
- 14.2 - 22.6
- > 22.6

Background Concentration = 13.4 µg/m³
Annual NO_2 CAAQS = 22.6 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted Annual NO_2 Concentrations with Ambient Background, 2041 Build Scenario

Based on the average over a single calendar year of all 1-hour average concentrations

Map Projection: NAD 1983 UTM Zone 18N (km)

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.6
Approx. Scale:	1:19,000
Date Revised:	Jan 12, 2023

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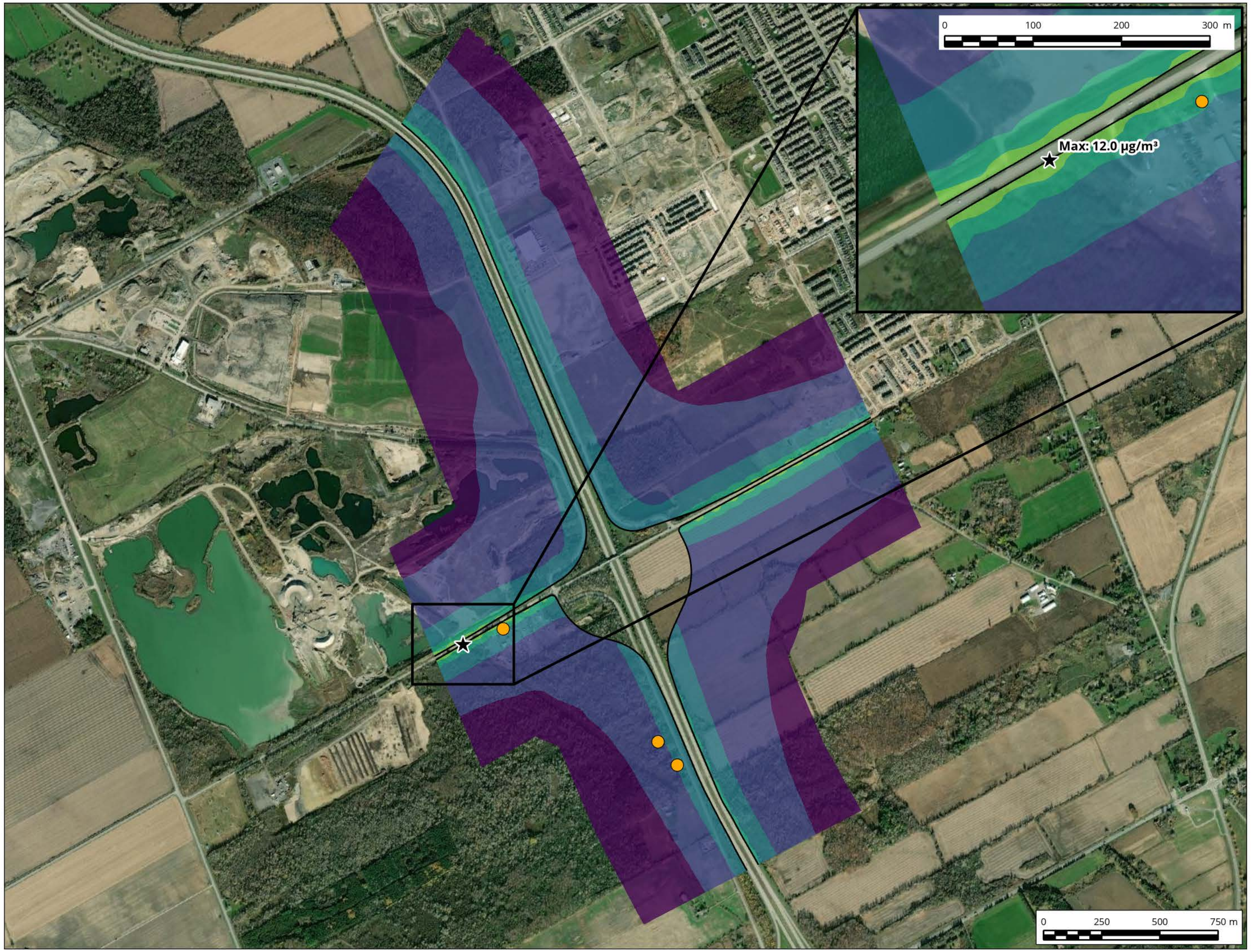

Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 10.2
- 10.2 - 10.5
- 10.5 - 11
- 11 - 11.5
- 11.5 - 27
- > 27

Background Concentration = 10.0 µg/m³
24-Hour $PM_{2.5}$ CAAQS = 27 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted 24-hour $PM_{2.5}$ Concentrations with Ambient Background, 2041 No-Build Scenario

Based on the 3-year average of the annual 98th percentile of the daily 24-hour average concentrations

Map Projection: NAD 1983 UTM Zone 18N (km)

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.7
Approx. Scale:	1:19,000
Date Revised:	Jan 12, 2023

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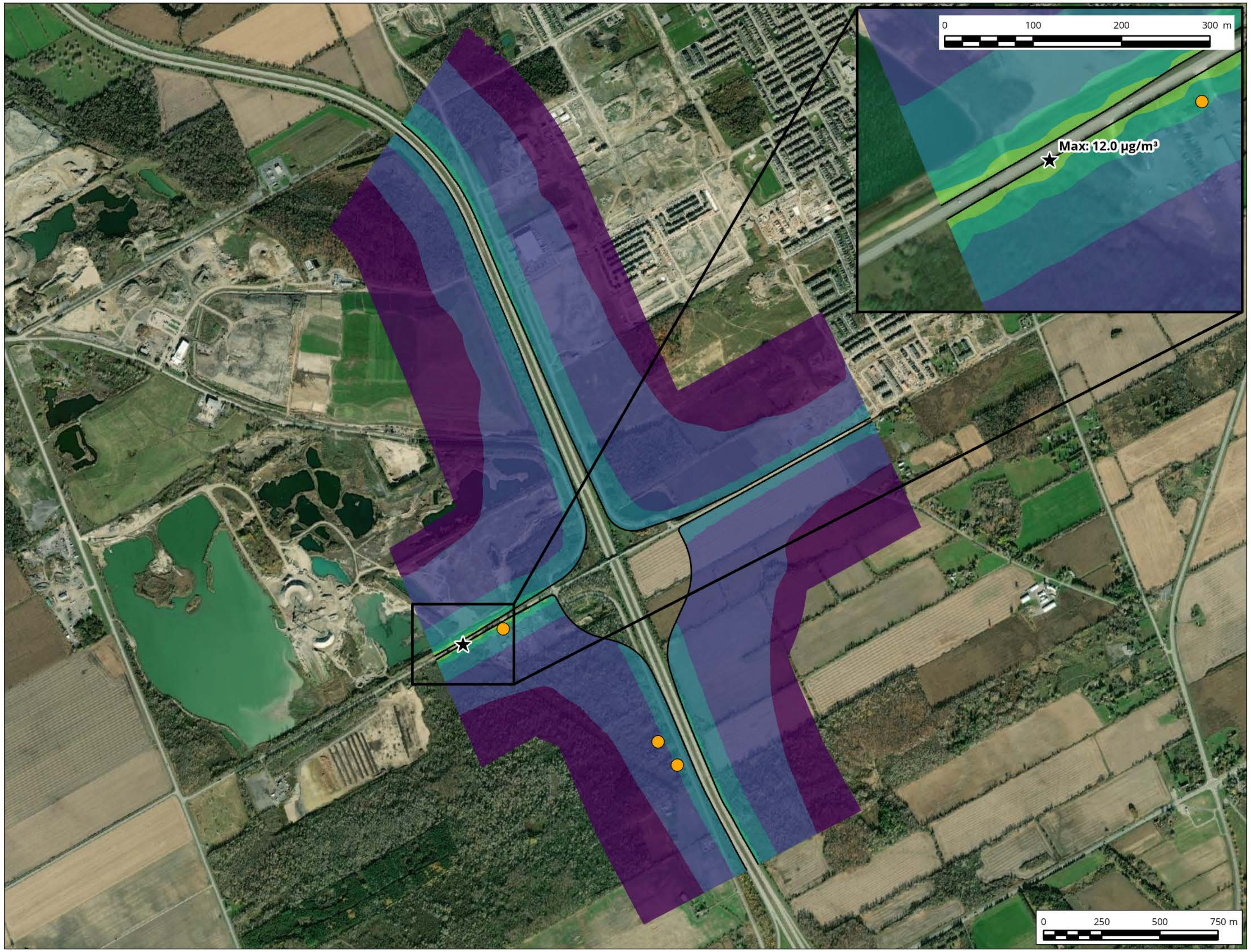


Legend

- ★ Maximum Concentration
- ● Sensitive Receptors
- ☐ Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 10.2
- 10.2 - 10.5
- 10.5 - 11
- 11 - 11.5
- 11.5 - 27
- > 27

Background Concentration = 10.0 µg/m³
24-Hour $PM_{2.5}$ CAAQS = 27 µg/m³

Service Layer Credits: World Imagery: Maxar

Map Document: C:\GIS Temp - Copy\2003291\P2003291_HWY416_2.aprx

Maximum Predicted 24-hour $PM_{2.5}$ Concentrations with Ambient Background, 2041 Build Scenario

Based on the 3-year average of the annual 98th percentile of the daily 24-hour average concentrations

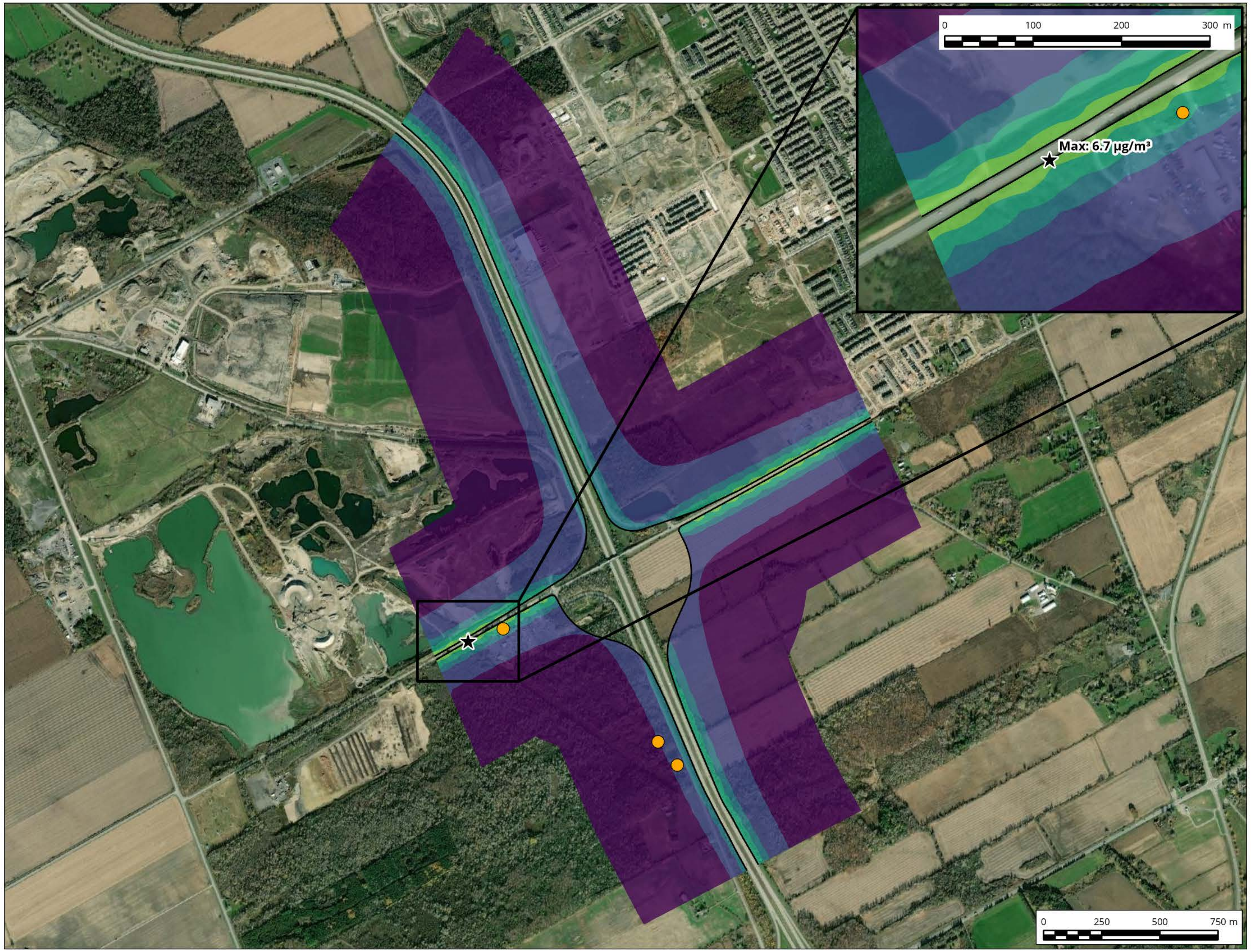
Map Projection: NAD 1983 UTM Zone 18N (km)

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.8
Approx. Scale:	1:19,000
Date Revised:	Jan 12, 2023



Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 6.1
- 6.1 - 6.2
- 6.2 - 6.3
- 6.3 - 6.5
- 6.5 - 8.8
- > 8.8

Background Concentration = 6.0 µg/m³
Annual $PM_{2.5}$ CAAQS = 8.8 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted Annual $PM_{2.5}$ Concentrations with Ambient Background, 2041 No-Build Scenario

Based on the 3-year average of the annual average of the daily 24-hour average concentrations

Map Projection: NAD 1983 UTM Zone 18N (km)

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.9
Approx. Scale:	1:19,000
Date Revised:	Jan 12, 2023

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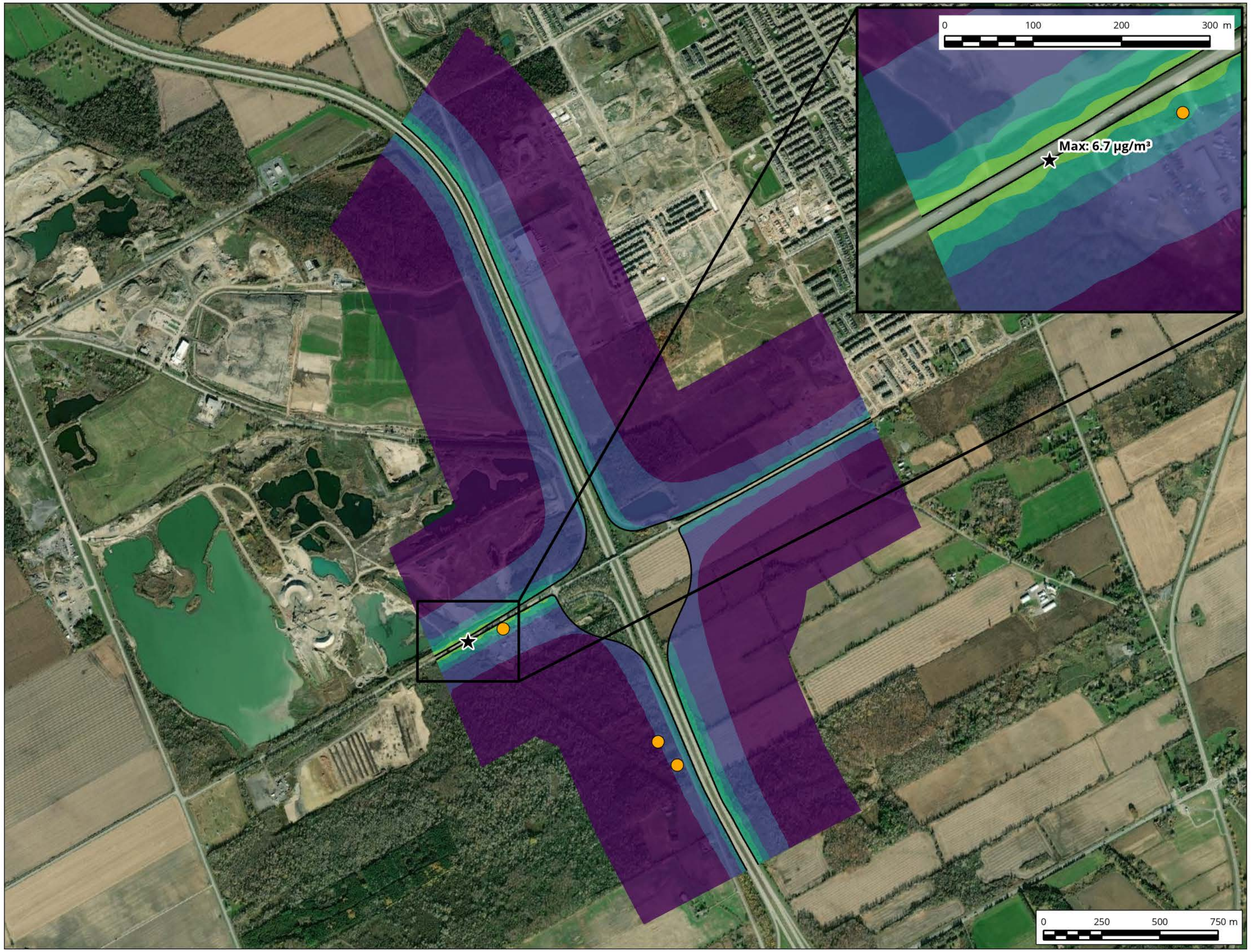

Legend

- ★ Maximum Concentration
- ● Sensitive Receptors
- ▭ Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 6.1
- 6.1 - 6.2
- 6.2 - 6.3
- 6.3 - 6.5
- 6.5 - 8.8
- > 8.8

Background Concentration = 6.0 µg/m³
Annual $PM_{2.5}$ CAAQS = 8.8 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted Annual $PM_{2.5}$ Concentrations with Ambient Background, 2041 Build Scenario

Based on the 3-year average of the annual average of the daily 24-hour average concentrations

Map Projection: NAD 1983 UTM Zone 18N (km)

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.10
Approx. Scale:	1:19,000
Date Revised:	Jan 12, 2023

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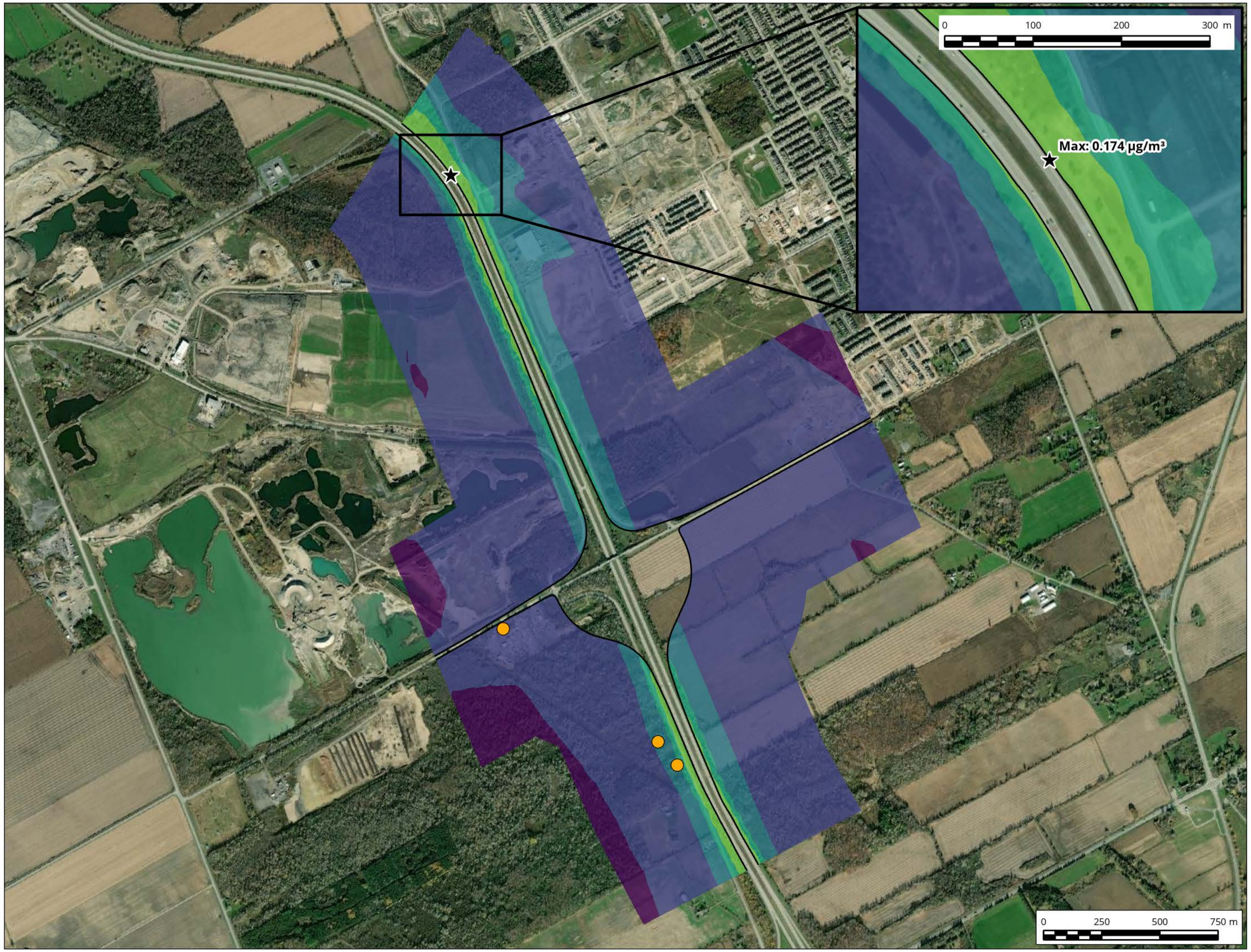

Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 0.168
- 0.168 - 0.169
- 0.169 - 0.170
- 0.170 - 0.171
- 0.171 - 4.5
- > 4.5

Background Concentration = 0.167 µg/m³
1-Hour Acrolein AAQC = 4.5 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted 1-hour Acrolein Concentrations with Ambient Background, 2041 No-Build Scenario

Based on maximum 1-hour average

Map Projection: NAD 1983 UTM Zone 18N (km)

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.11
Approx. Scale:	1:19,000
Date Revised:	Jan 17, 2023

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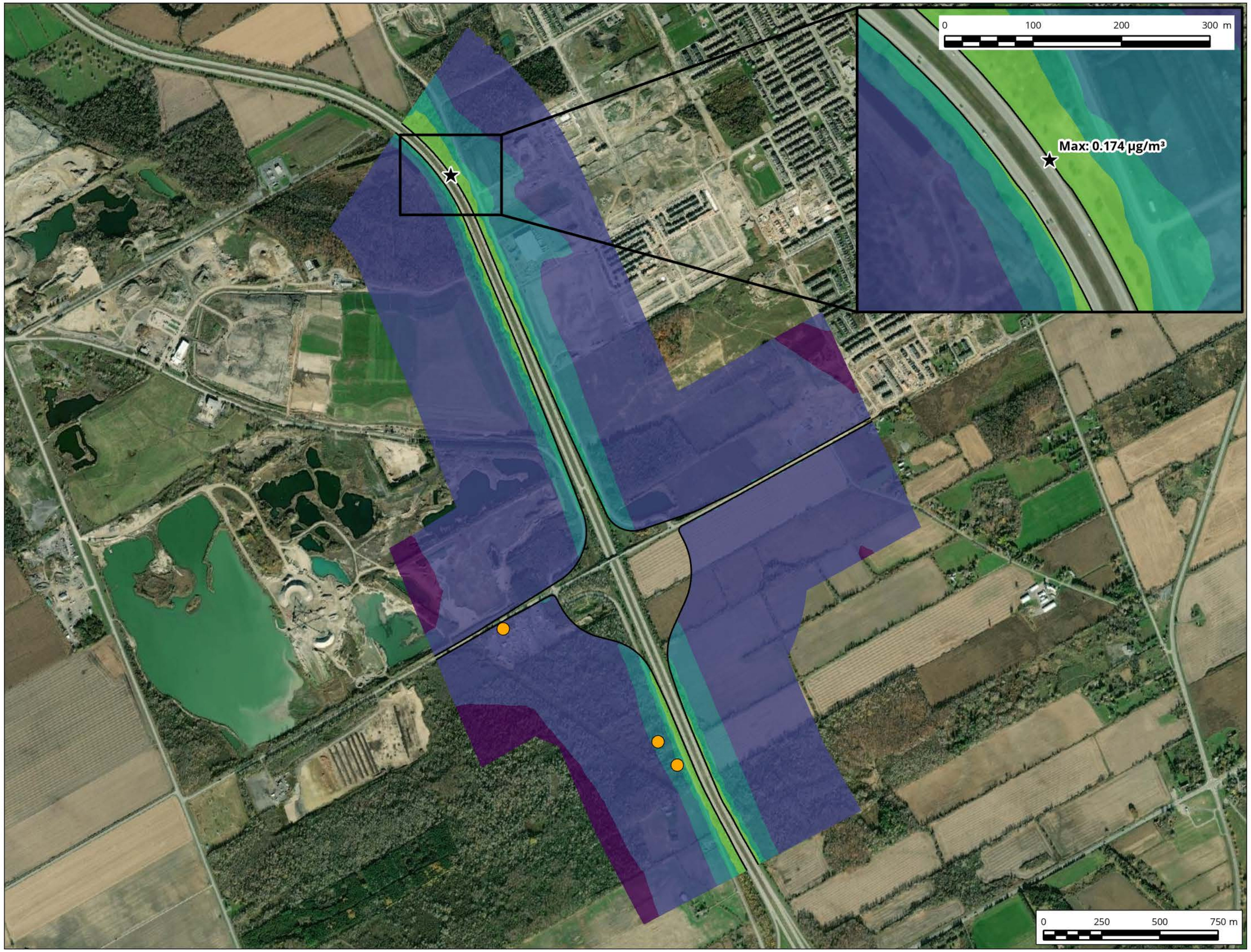


Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 0.168
- 0.168 - 0.169
- 0.169 - 0.170
- 0.170 - 0.171
- 0.171 - 4.5
- > 4.5

Background Concentration = 0.167 µg/m³
1-Hour Acrolein AAQC = 4.5 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted 1-hour Acrolein Concentrations with Ambient Background, 2041 Build Scenario

Based on maximum 1-hour average

Map Projection: NAD 1983 UTM Zone 18N (km)

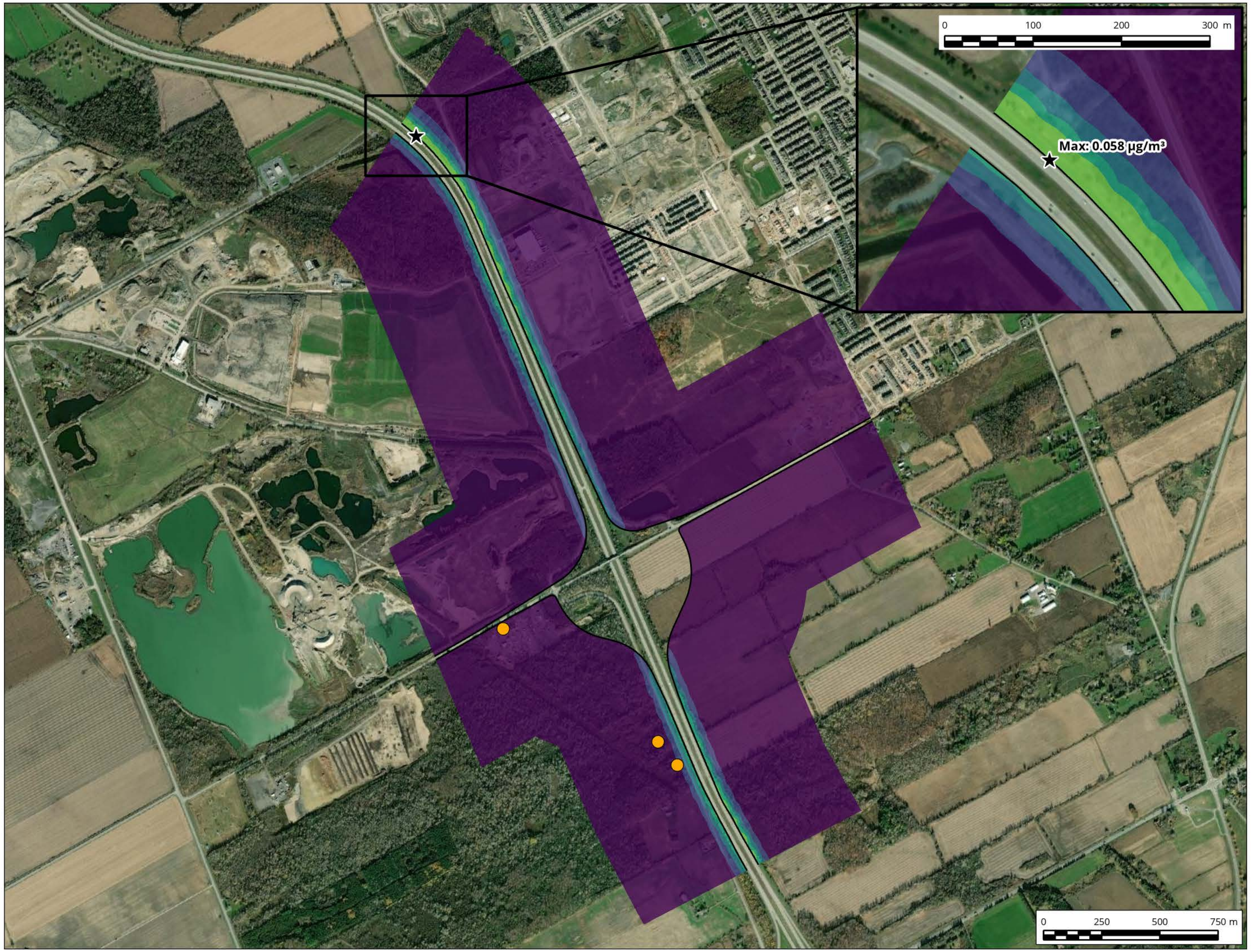
Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.12
Approx. Scale:	1:19,000
Date Revised:	Jan 17, 2023

Map Document: C:\GIS Temp - Copy\2003291\P2003291_HWY416_2.aprx



Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 5.70E-02
- 5.70E-02 - 5.71E-02
- 5.71E-02 - 5.72E-02
- 5.72E-02 - 5.73E-02
- 5.73E-02 - 0.4
- > 0.4

Background Concentration = 0.057 µg/m³
24-Hour Acrolein AAQC = 0.4 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted 24-hour Acrolein Concentrations with Ambient Background, 2041 No-Build Scenario

Based on maximum 24-hour average

Map Projection: NAD 1983 UTM Zone 18N (km)

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.13
Approx. Scale:	1:19,000
Date Revised:	Jan 17, 2023

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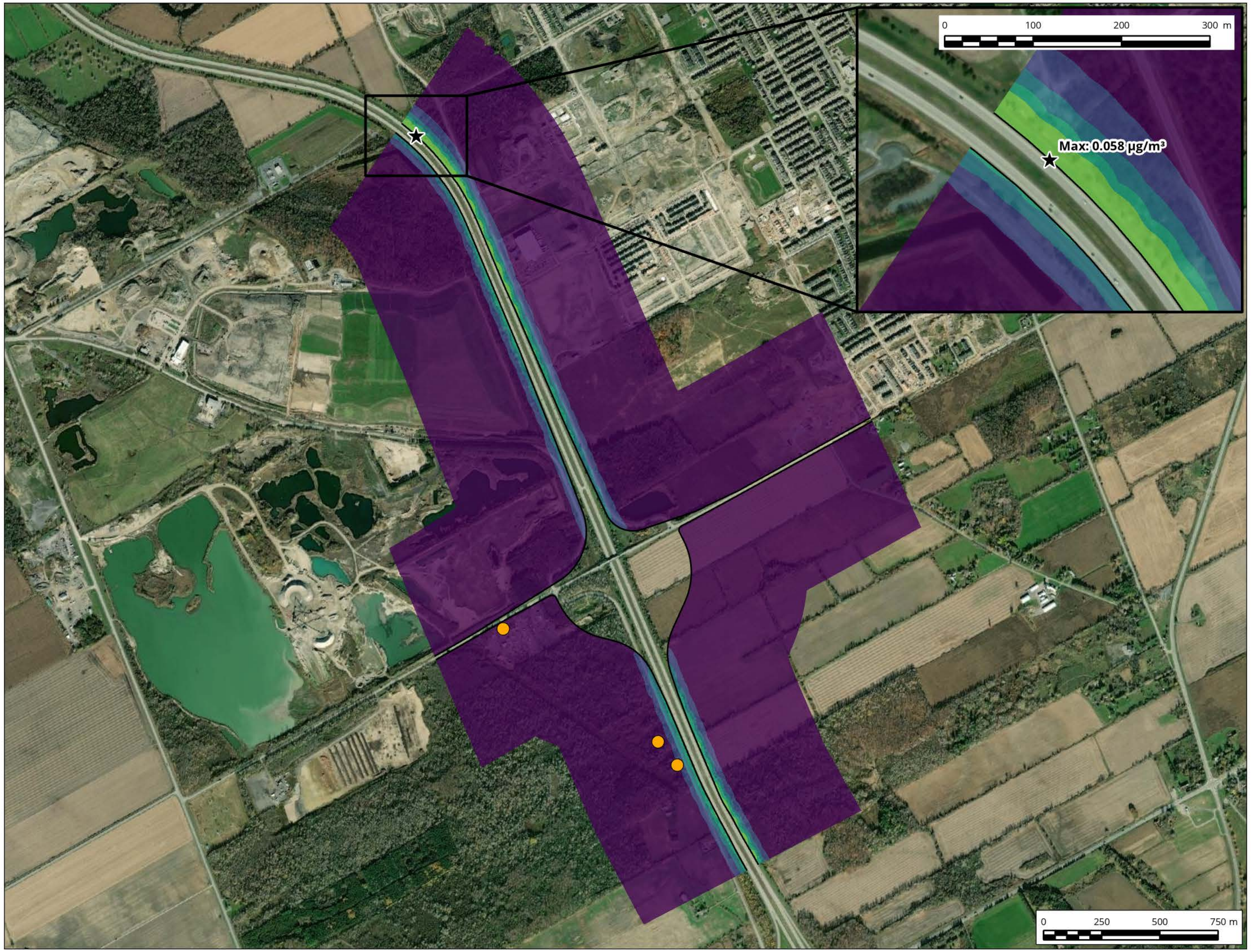

Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 5.70E-02
- 5.70E-02 - 5.71E-02
- 5.71E-02 - 5.72E-02
- 5.72E-02 - 5.73E-02
- 5.73E-02 - 0.4
- > 0.4

Background Concentration = 0.057 µg/m³
24-Hour Acrolein AAQC = 0.4 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted 24-hour Acrolein Concentrations with Ambient Background, 2041 Build Scenario

Based on maximum 24-hour average

Map Projection: NAD 1983 UTM Zone 18N (km)

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.14
Approx. Scale:	1:19,000
Date Revised:	Jan 17, 2023

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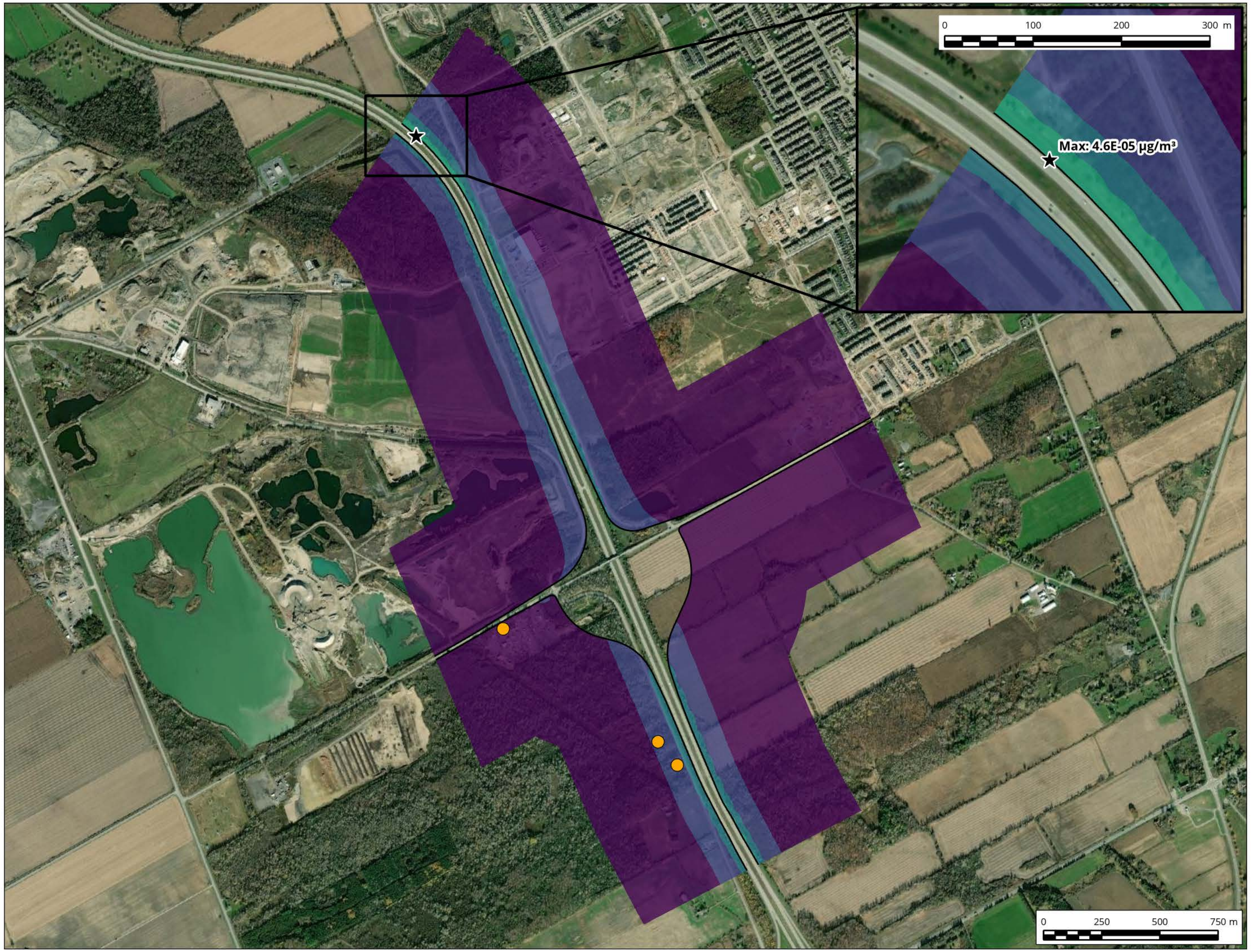


Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 1.0E-05
- 1.0E-05 - 2.0E-05
- 2.0E-05 - 3.0E-05
- 3.0E-05 - 4.0E-05
- 4.0E-05 - 5.0E-05
- > 5.0E-05

Background Concentration = 4.2E-05 µg/m³
24-Hour Benzo(a)pyrene AAQC = 0.00005 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted 24-hour Benzo(a)pyrene Concentrations without Ambient Background, 2041 No-Build Scenario

Based on maximum 24-hour average

Map Projection: NAD 1983 UTM Zone 18N (km)

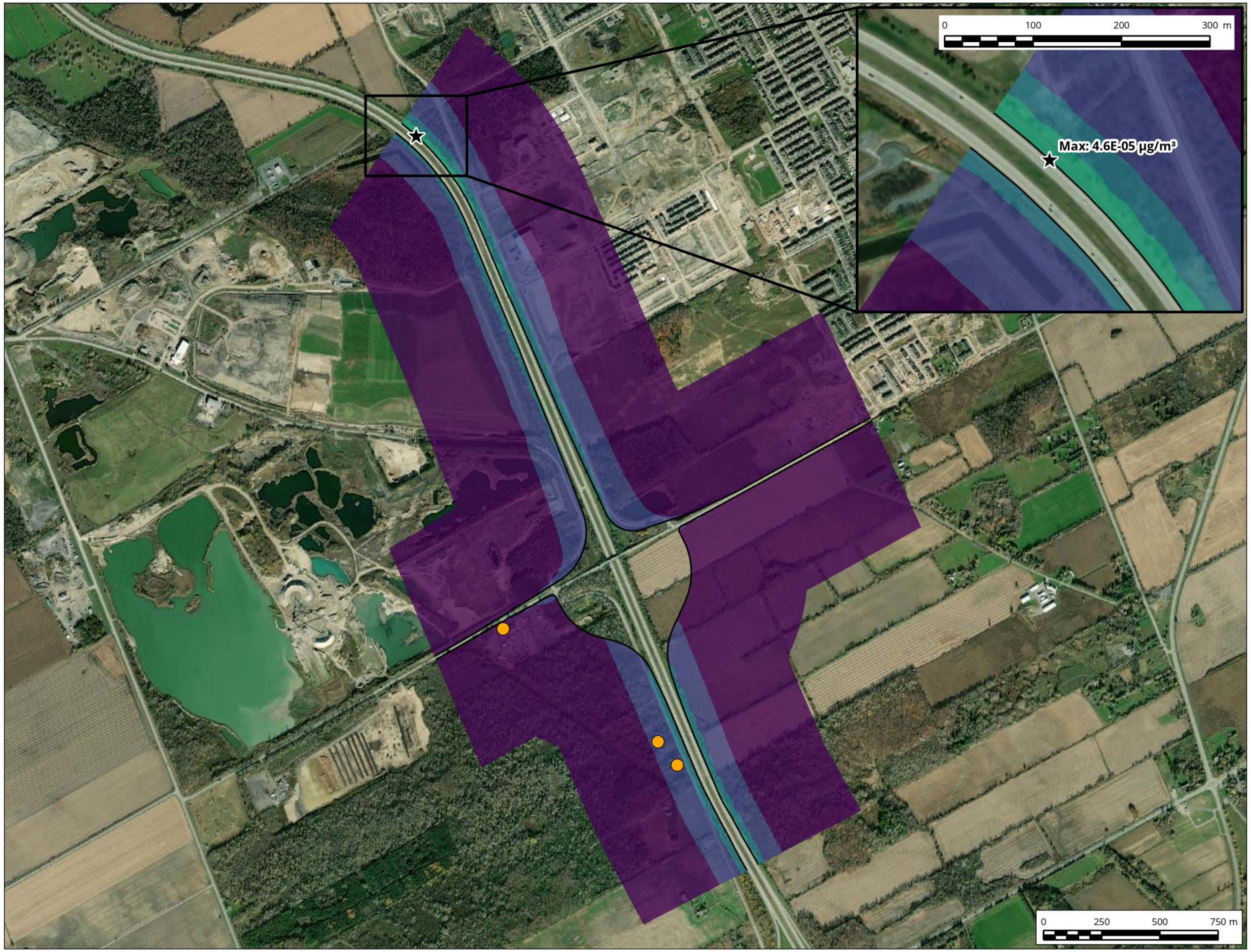
Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.15
Approx. Scale:	1:19,000
Date Revised:	Jan 12, 2023

Map Document: C:\GIS Temp - Copy\2003291\P2003291_HWY416_2.aprx



Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 1.0E-05
- 1.0E-05 - 2.0E-05
- 2.0E-05 - 3.0E-05
- 3.0E-05 - 4.0E-05
- 4.0E-05 - 5.0E-05
- > 5.0E-05

Background Concentration = 4.2E-05 µg/m³
24-Hour Benzo(a)pyrene AAQC = 0.00005 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted 24-hour Benzo(a)pyrene Concentrations without Ambient Background, 2041 Build Scenario

Based on maximum 24-hour average

Map Projection: NAD 1983 UTM Zone 18N (km)

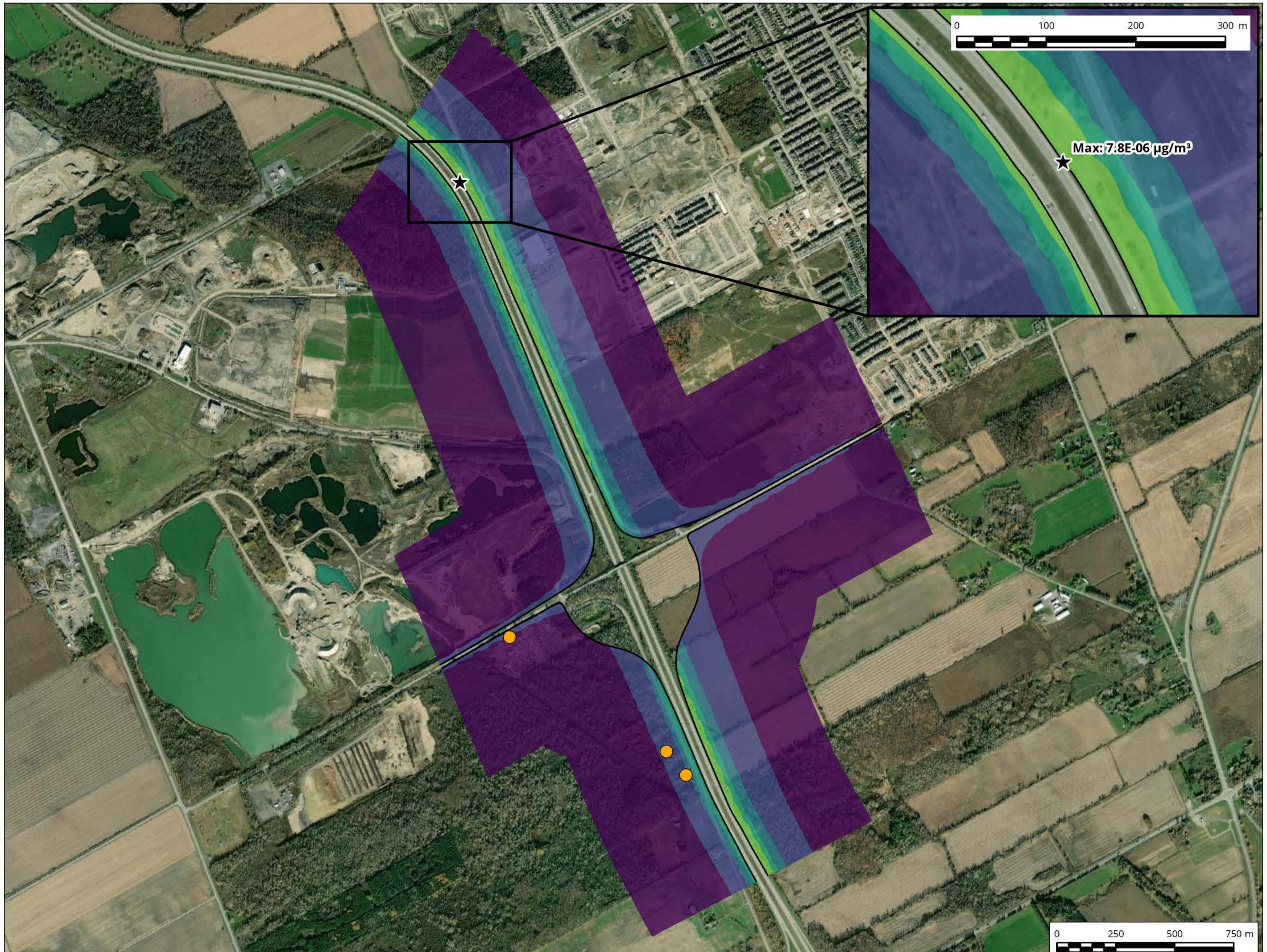
Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.16
Approx. Scale:	1:19,000
Date Revised:	Jan 12, 2023

Map Document: C:\GIS Temp - Copy\2003291\P2003291_HWY416_2.aprx



Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 1.0E-06
- 1.0E-06 - 2.0E-06
- 2.0E-06 - 3.0E-06
- 3.0E-06 - 4.0E-06
- 4.0E-06 - 1.0E-05
- > 1.0E-05

Background Concentration = 2.2E-05 µg/m³
Annual Benzo(a)pyrene AAQC = 0.00001 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted Annual Benzo(a)pyrene Concentrations without Ambient Background, 2041 No-Build Scenario

Based on maximum annual average

Map Projection: NAD 1983 UTM Zone 18N (km)

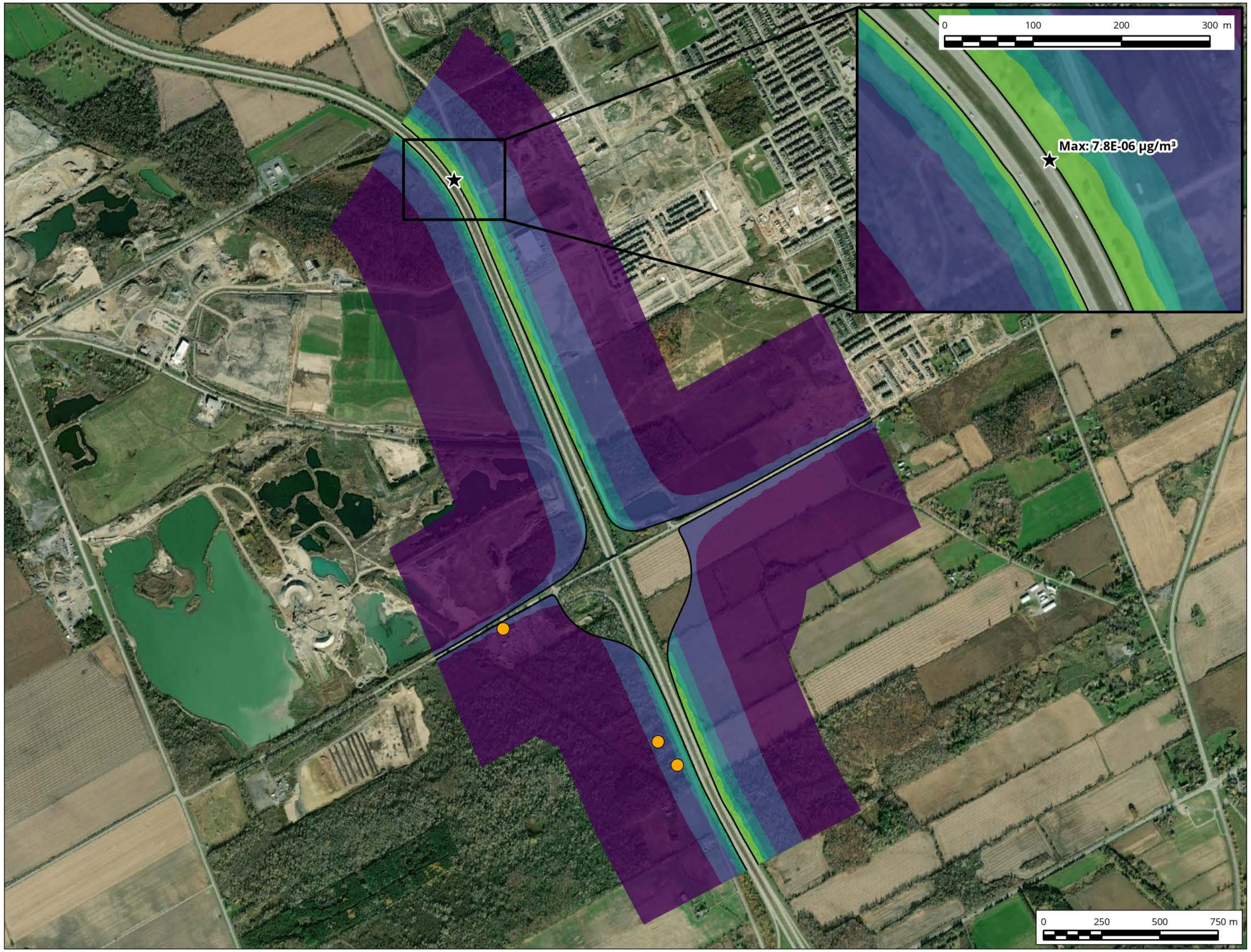
Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.17
Approx. Scale:	1:19,000
Date Revised:	Jan 17, 2023

Map Document: C:\GIS Temp - Copy\2003291\P2003291_HWY416_2.aprx



Legend

- ★ Maximum Concentration
- Sensitive Receptors
- Proposed Alignment Footprint

Concentration (µg/m³)

- ≤ 1.0E-06
- 1.0E-06 - 2.0E-06
- 2.0E-06 - 3.0E-06
- 3.0E-06 - 4.0E-06
- 4.0E-06 - 1.0E-05
- > 1.0E-05

Background Concentration = 2.2E-05 µg/m³
Annual Benzo(a)pyrene AAQC = 0.00001 µg/m³

Service Layer Credits: World Imagery: Maxar

Maximum Predicted Annual Benzo(a)pyrene Concentrations without Ambient Background, 2041 Build Scenario

Based on maximum annual average

Map Projection: NAD 1983 UTM Zone 18N (km)

Highway 416 and Barnsdale Road Interchange - Barrhaven, ON

True North

Project #: 2003291

Drawn by: DJH	Figure: B.18
Approx. Scale:	1:19,000
Date Revised:	Jan 17, 2023

Map Document: C:\GIS Temp - Copy\2003291\P2003291_HWY416_2.aprx