Ontario

Ministry of Transportation

407 East Environmental Assessment

Alternative Methods Technical Report (Air Quality)

FINAL DRAFT

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Table of Contents

1. Introduction

This report documents the assessment and evaluation of the short-listed alternative routes identified for the 407 East Environmental Assessment (EA) from the Air Quality perspective. Following completion of the screening phase, alternative routes were short-listed for detailed assessment and/or comparative evaluation. The short-listed routes were broken down into 5 sections:

- West Mainline
  - Brock Road to Audley Road – 1 route
  - Audley Road to Ashburn Road – 2 route alternatives
- Central Mainline
  - Ashburn Road to Simcoe Street – 1 route
  - Simcoe Street to Enfield Road – 2 route alternatives
- East Mainline
  - Enfield Road to Highway 35/115 – 12 route alternatives
- West Link
  - West Durham Link – 9 route alternatives
- East Link
  - East Durham Link – 13 route alternatives

This report is one of nine stand-alone documents that outline the evaluation of the alternative routes process from the perspective of each discipline. These reports will be used in concert with one another as supporting documents to the Alternative Methods Report. The following 9 discipline specific reports have been prepared and made available for comment:

- Natural Environment
- Noise
- Socio-economic
- Air Quality
- Agricultural
- Waste Contamination
- Archaeology
- Cultural Heritage
- Technical

The evaluation of alternative routes was a three-step process. The first step entailed a detailed field inventory of conditions associated with each alternative route. Each environmental feature was examined to determine the extent of impact and the findings of these were outlined within each of the disciplines Field Investigations Reports. The second step was to assess the findings of the field investigations against the established Criteria and Indicators listed in Table 1 (Appendix A of Alternative Methods Report) for each of the 5 Factor Areas (Natural, Social, Economic, Cultural

and Technical). After determining the initial potential effects, standard mitigation, avoidance, enhancement and compensation measures were applied in order to determine the Net Effects.

The third step was the evaluation itself. This step involved a comparative analysis of the alternative routes considered to select a preferred alternative. At this stage, the relative importance of the environmental features was determined.

1.1 Air Quality Study Team

A study team consisting of RWDI AIR Inc. (RWDI) staff undertook the Air Quality assessment and evaluation of route alternatives. The actual individuals and their specific roles are provided as follows:

- ***Mike Lepage, M.Sc., CCM, Project Director:*** *Supervised all technical aspects of the study and was responsible for ensuring that all work conformed to RWDI's standards for quality assurance.*

- ***Scott Shayko, Hon.B.Comm, B.Sc., Project Manager:*** *Provided technical direction and was responsible for the day-to-day communication with the 407 East Project Team.*

- ***Terri-Lyn Pearson, B.Sc., Technical Coordinator:*** *Conducted the technical work under the direction of the Project Manager and Project Director.*

2. Assessment and Evaluation of the Short Listed Alternative Routes

2.1 Methodology

The assessment and evaluation of the alternative routes was conducted in three steps:

Step 1: Confirm Evaluation Criteria and Indicators/Measures

The approved 407 East EA Terms of Reference (ToR) set out the draft criteria and indicators in **Table 5.2** for evaluating the 'alternative methods' in the EA. In addition, **Supporting Document C** of the 407 East EA ToR provided proposed data sources and measures for each of the indicators. As a result, the draft criteria, indicators, and measures provided for in the ToR were reviewed and modified appropriately to suit the evaluation of the alternative routes.

Specifically, the criteria, indicators and measures were modified in consultation with review agencies and the public to ensure that an appropriate level of scrutiny and rigour was applied in evaluating the short listed routes. By doing so, the results of the evaluation phase consist of clearly defined net effects for each short listed route that were suitable for comparison.

Step 2: Undertake the Net Effects Analysis

With the evaluation criteria, indicators and measures confirmed through the preceding step, a net effects analysis of the short listed alternative routes was carried out consisting of the following activities:

- Identify potential effects (based on measures) on the environment;
- Develop and apply avoidance/ mitigation/ compensation/ enhancement measures; and
- Determine net effects on the environment.

The following summarizes the methodology used for the comparison. This methodology includes emission factor development, dispersion modelling, scoring, and comparative evaluation.

Emission Factor Development

Emission factors for NO_X and PM_{10} were derived for the Year 2031 using the U.S. Environmental Protection Agency's (EPA's) MOBILE6.2 vehicle emissions model for tailpipe vehicle emission factors, and the U.S. EPA's AP-42, Chapter 13.2.1 for road dust (re-suspended particulate matter) emission factors for paved roads. For PM_{10}, the tailpipe emission factor is added to the road dust emission factor in order to account for both types of emission sources. The following three tables summarize the major inputs and outputs of the models.

Table 2.1.1: MOBILE6.2 Key Input Parameters

Parameter	Input
Evaluation Month	January
Ambient Temperature	Minimum Daily Temperature = 15.4 °F (-9.22°C) Maximum Daily Temperature = 29.5 °F (-1.39°C) (Canadian Climate Normals, Oshawa)
Altitude	Low
Absolute Humidity	20 Grains/lb
Fuel Volatility	Reid Vapour Pressure (RVP) = 9 psi
Fuel Program	Conventional Gasoline East
Vehicle Speed	100 km/hr

Table 2.1.2: MOBILE6.2 Tailpipe Emission Factor Outputs

Route Alternative	% Light Duty Vehicles [1]	% Heavy Duty Vehicles [1]	Average Emission Factors (g/VMT)	
			NO_X	PM_{10}
Highway Vehicles				
West Mainline	88	12	0.4268	0.2320
Central Mainline	91	9	0.4191	0.1580
East Mainline	98	2	0.4012	0.0250
West Link	88	12	0.4268	0.2320

East Link	86	14	0.4319	0.2840
Transitway Buses	0	100	1.2250	21.701

[1] Light duty and heavy duty vehicle percentages were provided by TSH.

VMT – Vehicle Miles Travelled

Table 2.1.3: AP-42 Re-Suspended Particulate Matter Emission Factors

Route Alternative	% Light Duty Vehicles	% Heavy Duty Vehicles	Re-Suspended PM_{10} Emission Factors
Highway Vehicles			
West Mainline	88	12	0.204
Central Mainline	91	9	0.130
East Mainline	98	2	0.000
West Link	88	12	0.204
East Link	86	14	0.255
Transitway Buses	0	100	21.639

Dispersion Modelling

The U.S. EPA's CAL3QHCR air dispersion model was used to predict maximum downwind concentrations of NO_X and PM_{10} contributed by the project at distances of up to 500 m from the centreline of the highway. CAL3QHCR is a widely used computer model designed specifically for predicting dispersion of roadway emissions. The maximum predicted concentrations are associated with worst-case meteorological conditions; therefore, most of the time the concentrations would be significantly lower. The following table presents the major inputs into the dispersion model.

Table 2.1.4: CAL3QHCR Key Input Parameters

Parameter	Input	
Meteorological Data	Year 2003 hourly data from Toronto International Airport Year 2003 upper air data from Buffalo International Airport	
Traffic Volumes (AADT) (Provided by TSH)	**Highway Vehicles**	
	West Mainline (10 lanes)	119,150
	Central Mainline (6 lanes)	78,550
	East Mainline (4 lanes)	39,200
	West Link (4 lanes)	52,800
	East Link (4 lanes)	46,490
	Transitway Buses	2,400
Hourly Traffic Volume Distribution	Institute of Transportation Engineers (ITE) hourly traffic volume distribution for a 24-hour period.	
Atmospheric Stability and Mixing Height	Calculated hour-by-hour based on a Rural Setting.	
Deposition Velocity	PM_{10} = 1.1 cm/s	
Settling Velocity	PM_{10} = 0.5 cm/s	

The predicted concentrations for NO_X were converted to NO_2 using the Ozone Limiting Method (OLM). This conversion is completed in order to assess compliance with the Ambient Air Quality Criteria (AAQC) for NO_2 (i.e., an AAQC for NO_X does not exist).

The predicted maximum NO_2 and PM_{10} concentrations contributed by the project, as estimated by the dispersion model, were then added to the 90th percentile background concentrations in order to determine the cumulative effect. The 90th percentile measured values, along with their applicable AAQC are summarized in the following table.

Table 2.1.5: Measured Background Concentrations and AAQC's

Contaminant	MOE Station No.	Averaging Period	90th Percentile Background Concentration	MOE AAQC
NO_2	45025 (Oshawa)	1 hour	64 $\mu g/m^3$	400 $\mu g/m^3$
PM_{10} [1]	45025 (Oshawa)	24 hours	28 $\mu g/m^3$	50 $\mu g/m^3$

[1] Oshawa station $PM_{2.5}$ data were used to calculated PM_{10} concentrations using $PM_{10} = PM_{2.5} / 0.6$ (equation provided by MOE)

The predicted cumulative concentrations were plotted to derive a relationship between predicted concentration and distance from the centreline for the different route alternatives. **Figures 1 to 5** present the cumulative effects results of the modelling for the different route alternatives.

Step 3: Carry Out the Comparative Evaluation

In Step 3, the net effects identified for each short listed route segments in Step 2 were compared to one another in order to identify a "recommended route segment". The comparison of net effects was completed using a "Reasoned Argument" or "Trade-off" evaluation methodology, as provided for in the approved 407 East EA ToR.

A scoring system was developed in order to assist in the comparative evaluation of the route alternatives. This system was based on the dispersion modelling results presented above and the number and type of sensitive receptors that could potentially be impacted.

The number of sensitive receptors impacted within the Right of Way (ROW) to 200 m, 200 to 300 m, 300 to 400 m, and 400 to 500 m away from the centerline were determined by (1) identifying the sensitive receptors using land-use information provided by Meridian Planning Consultants Inc. and (2) tallying the number of sensitive receptors within the different ranges using GIS Software. A sensitive receptor was defined as a residence, church, school, daycare or senior housing facility. Special consideration was given to the critical receptors consisting of either churches, schools, daycares or senior housing facilities. If a route alternative had the potential to impact a critical receptor, a penalty was assigned to the final score after it was calculated as described below. A penalty of 50 was assigned to a church and 100 to schools, daycares, and senior housing facilities. These penalties were assigned based on a number of factors such as, professional experience,

number of people potentially exposed, anticipated age of people and potential duration of exposure.

The number of sensitive receptors impacted within the different ranges was multiplied by a score factor for NO_2 and PM_{10} in order to derive a NO_2 and PM_{10} score. Factors were established for NO_2 and PM_{10} within each range by dividing the worst-case predicted cumulative concentration within each range by the applicable AAQC. As anticipated, the sensitive receptors residing within the ranges closer to the highway received higher factors because their potential exposure is higher (i.e., predicted concentrations decline as you move further from the highway).

Finally, a total score for each route alternative was established by summing the NO_2 and PM_{10} individual scores. A lower score indicates that a route alternative is better from an air quality perspective. The following runs through an example calculation of this scoring system for West Mainline Route WM2.

Example - West Mainline Route WM2

1. The number of sensitive receptors are tallied using GIS Software.

Route	Number of Impacted Sensitive Receptors			
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m
WM2	18	20	22	18

2. Factors are derived by dividing the predicted maximum cumulative concentrations within each range for NO_2 and PM_{10} (**Figure WM2**) by the NO_2 AAQC of 400 $\mu g/m^3$ and PM_{10} AAQC of 50 $\mu g/m^3$.

WM2	Factors			
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m
NO_2	$\frac{133\mu g/m^3}{400\mu g/m^3} = 0.33$	$\frac{114\mu g/m^3}{400\mu g/m^3} = 0.29$	$\frac{105\mu g/m^3}{400\mu g/m^3} = 0.26$	$\frac{99\mu g/m^3}{400\mu g/m^3} = 0.25$
PM_{10}	$\frac{66\mu g/m^3}{50\mu g/m^3} = 1.32$	$\frac{39\mu g/m^3}{50\mu g/m^3} = 0.78$	$\frac{36\mu g/m^3}{50\mu g/m^3} = 0.72$	$\frac{34\mu g/m^3}{50\mu g/m^3} = 0.68$

3. A NO_2 and PM_{10} score is established for each range by multiplying the number of sensitive receptors by the factor.

WM2	Scores			
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m
NO_2	18 x 0.33 = 5.94	20 x 0.29 = 5.8	22 x 0.26 = 5.72	18 x 0.25 = 4.5
PM_{10}	18 x 1.32 = 23.76	20 x 0.78 = 15.6	22 x 0.72 = 15.84	18 x 0.68 = 12.24

4. The scores are summed to derive a NO_2, PM_{10}, and total score.

WM2	Scores				Total
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m	
NO_2	5.94	5.8	5.72	4.5	22
PM_{10}	23.76	15.6	15.84	12.24	67
Total					**89**

5. The final step is to determine if any critical receptors could potentially be impacted. In this situation, only one critical receptor (a daycare facility) resides within the area of influence and a penalty of 100 is added to the total score. Therefore, the final score is 89 + 100 = 189.

2.2 West Mainline – Brock Road to Audley Road

For the West Mainline, the modelling was conducted for the year 2031, based on a 10-lane rural highway with an AADT of 119,150, and a bus transitway with a traffic volume of 100 buses per hour. The maximum predicted concentrations resulting from this modelling scenario, including 90th percentile background concentrations, for the contaminants of interest are summarized below.

Table 2.2.1: Summary of Modelling Results for West Mainline

Contaminant	Maximum Predicted Concentration	AAQC ($\mu g/m^3$)	Percentage of AAQC	Distance at which Attainment Occurs [3]
NO_2	133 $\mu g/m^3$ (1-hour)[1]	400 $\mu g/m^3$	33%	Edge of ROW
PM_{10}	66 $\mu g/m^3$ (24-hour)[2]	50 $\mu g/m^3$	132%	160 m

[1] Includes 90th percentile background concentration for NO_2 which is 64 $\mu g/m^3$

[2] Includes 90th percentile background concentration for PM_{10} which is 28 $\mu g/m^3$

[3] Distance measured from the centreline of the highway. ROW extends approximately 115 m from the centreline on the transitway side and 55 m from the centreline on the opposite side

As expected, the maximum predicted concentrations occur in close proximity to the edge of the Right of Way (ROW). As you move further away from the ROW the predicted concentrations decrease to a point where the predicted concentrations from the highway become indistinguishable from the background concentrations. This is the point on **Figure 1** where the curve begins to flatten out and little change occurs amongst the predicted concentrations.

For this modelling scenario, only PM_{10} was predicted to exceed the AAQC. At a distance greater than 160 m from the centreline of the highway the PM_{10} predicted concentrations decline below the AAQC (note that the ROW extends 115 m from the centreline on the transitway side and 55 m from the centreline on the opposite side). These modelling results are typical of other similar highways within Ontario. The background concentrations are a major contributor to the cumulative concentration and to the predicted excursion above the AAQC within 160 m of the centerline.

2.2.1 Net Effects Analysis

Although there was only one route alternative for this section of highway, a score was calculated for completeness and to understand any potential impacts.

- Total score for PM_{10} for this route alternative is 42 and the total score for NO_2 is 14. Therefore, the total combined score is 56. Refer to **Table 2a** and **Figure WM** for more detail.

2.3 West Mainline – Audley Road to Ashburn Road

The dispersion modelling for this section was identical to that for the section from Brock Road to Audley Road, as presented in Section 2.2.

2.3.1 Net Effects Analysis

WM1

- Total score for PM_{10} for this route alternative is 57 and the total score for NO_2 is 19. Therefore, the total combined score is 76. Refer to **Table 2a** and **Figure WM1** for more detail.

WM2

- Total score for PM_{10} for this route alternative is 67 and the total score for NO_2 is 22. An additional penalty of 100 was assessed because this route alternative could potentially impact a critical receptor, a daycare facility in the area of influence. Therefore, the total combined score is 189. Refer to **Table 2a** and **Figure WM2** for more detail.

2.3.2 Evaluation Results

The following table summarizes the evaluation of results for the West Mainline alternatives.

Table 2.3.1: Summary of Evaluation Results for the West Mainline

Route	Number of Impacted Sensitive Receptors				Critical Receptor	Total Score
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m		
WM1	9	22	16	24	No	76
WM2	18	20	22	18	Yes	189

- Refer to Step 2 for an explanation of the scoring system

2.4 Central Mainline – Ashburn Road to Simcoe Street

For the Central Mainline the modelling was conducted for the year 2031, based on a six-lane rural highway with an AADT of 78,500 and a bus transitway with a traffic volume of 100 buses per hour. The maximum predicted concentrations resulting from this modelling scenario, including 90th percentile background concentrations, for the contaminants of interest are summarized below.

Table 2.4.1: Summary of Modelling Results for Central Mainline

Contaminant	Maximum Predicted Concentration	AAQC ($\mu g/m^3$)	Percentage of AAQC	Distance at which Attainment Occurs [3]
NO_2	115 $\mu g/m^3$ (1-hour)[1]	400 $\mu g/m^3$	29%	Edge of ROW
PM_{10}	64 $\mu g/m^3$ (24-hour)[2]	50 $\mu g/m^3$	128%	152 m

[1] Includes 90th percentile background concentration for NO_2 which is 64 $\mu g/m^3$

[2] Includes 90th percentile background concentration for PM_{10} which is 28 $\mu g/m^3$

[3] Distance measured from the centreline of the highway. ROW extends approximately 115 m from the centreline on the transitway side and 55 m from the centreline on the opposite side

As expected, the maximum predicted concentrations occur in close proximity to the edge of the Right of Way (ROW). As you move further away from the ROW the predicted concentrations decrease to a point where the predicted concentrations from the highway become indistinguishable from the background concentrations. This is the point on **Figure 2** where the curve begins to flatten out and little change occurs amongst the predicted concentrations.

For this modelling scenario, only PM_{10} was predicted to exceed the AAQC. At a distance greater than 152 m from the centreline of the highway the PM_{10} predicted concentrations decline below the AAQC (note that the ROW extends 115 m from the centreline on the transitway side and 55 m from the centreline on the opposite side). These modelling results are typical of other similar highways within Ontario. The background concentrations are a major contributor to the cumulative concentration and to the predicted excursion above the AAQC within 152 m of the centerline.

2.4.1 Net Effects Analysis

Although there was only one route alternative for this section of highway, a score was calculated for completeness and to understand any potential impacts.

- Total score for PM_{10} for this route alternative is 71 and the total score for NO_2 is 21. Therefore, the total combined score is 93. Refer to **Table 2a** and **Figure CM** for more detail.

2.5 Central Mainline – Simcoe Street to Enfield Road

The dispersion modelling for this section was identical to that for the section from Ashburn Road to Simcoe Street, as presented in Section 2.4.

2.5.1 Net Effects Analysis

CM1

- Total score for PM_{10} for this route alternative is 72 and the total score for NO_2 is 21. Therefore, the total combined score is 93. Refer to **Table 2a** and **Figure CM2** for more detail.

CM2

- Total score for PM_{10} for this route alternative is 35 and the total score for NO_2 is 11. Therefore, the total combined score is 46. Refer to **Table 2a** and **Figure CM1** for more detail.

2.5.2 Evaluation Results

The following table summarizes the evaluation results for the Central Mainline Alternatives.

Table 2.5.1: Summary of Evaluation Results for the Central Mainline

Route	Number of Impacted Sensitive Receptors				Critical Receptor	Total Score
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m		
CM1	16	19	32	23	No	93
CM2	6	18	9	12	No	46

- Refer to Step 2 for an explanation of the scoring system

2.6 East Mainline – Enfield Road to Hwy 35/115

For the East Mainline the modelling was conducted for the year 2031, based on a four-lane rural highway with an AADT of 39,200, and a bus transitway with a traffic volume of 100 buses per hour. The maximum predicted concentrations resulting from this modelling scenario, including 90th percentile background concentrations, for the contaminants of interest are summarized below.

Table 2.6.1: Summary of Modelling Results for East Mainline

Contaminant	Maximum Predicted Concentration	AAQC ($\mu g/m^3$)	Percentage of AAQC	Distance at which Attainment Occurs [3]
NO_2	123 $\mu g/m^3$ (1-hour)[1]	400 $\mu g/m^3$	31%	Edge of ROW
PM_{10}	46 $\mu g/m^3$ (24-hour)[2]	50 $\mu g/m^3$	93%	Edge of ROW

[1] Includes 90th percentile background concentration for NO_2 which is 64 $\mu g/m^3$

[2] Includes 90th percentile background concentration for PM_{10} which is 28 $\mu g/m^3$

[3] Distance measured from the centreline of the highway. ROW extends approximately 115 m from the centreline on the transitway side and 55 m from the centreline on the opposite side

For this modelling scenario, both PM_{10} and NO_2 did not exceed their respective AAQC's at the edge of the ROW. This means that NO_2 and PM_{10} are not expected to ever exceed their respective

AAQC's outside of the highway ROW under reasonable worst-case conditions. **Figure 3** shows how predicted concentration varies with distance from the centreline of the highway for this section of highway.

The following summarizes the results for each of the East Mainline route alternatives.

2.6.1 Net Effects Analysis

The dispersion modelling for this section was identical to that for the section from Simcoe Street to Enfield Road, as presented in Section 2.5.

EM1

- Total score for PM_{10} for this route alternative is 139 and the total score for NO_2 is 42. Therefore, the total combined score is 182. Refer to **Table 2a** and **Figure EM1** for more detail.

EM2

- Total score for PM_{10} for this route alternative is 119 and the total score for NO_2 is 36. Therefore, the total combined score is 155. Refer to **Table 2a** and **Figure EM2** for more detail.

EM3

- Total score for PM_{10} for this route alternative is 123 and the total score for NO_2 is 38. Therefore, the total combined score is 161. Refer to **Table 2a** and **Figure EM3** for more detail.

EM4

- Total score for PM_{10} for this route alternative is 144 and the total score for NO_2 is 44. Therefore, the total combined score is 188. Refer to **Table 2a** and **Figure EM4** for more detail.

EM5

- Total score for PM_{10} for this route alternative is 134 and the total score for NO_2 is 41. Therefore, the total combined score is 175 Refer to **Table 2a** and **Figure EM5** for more detail.

EM6

- Total score for PM_{10} for this route alternative is 132 and the total score for NO_2 is 41. Therefore, the total combined score is 172. Refer to **Table 2a** and **Figure EM6** for more detail.

EM7

- Total score for PM_{10} for this route alternative is 129 and the total score for NO_2 is 40. Therefore, the total combined score is 169. Refer to **Table 2a** and **Figure EM7** for more detail.

EM8

- Total score for PM_{10} for this route alternative is 148 and the total score for NO_2 is 46. Therefore, the total combined score is 194. Refer to **Table 2a** and **Figure EM8** for more detail.

EM9

- Total score for PM_{10} for this route alternative is 141 and the total score for NO_2 is 43. Therefore, the total combined score is 184. Refer to **Table 2a** and **Figure EM9** for more detail.

EM10

- Total score for PM_{10} for this route alternative is 132 and the total score for NO_2 is 41. Therefore, the total combined score is 173. Refer to **Table 2a** and **Figure EM10** for more detail.

EM11

- Total score for PM_{10} for this route alternative is 161 and the total score for NO_2 is 50. Therefore, the total combined score is 211. Refer to **Table 2a** and **Figure EM11** for more detail.

EM12

- Total score for PM_{10} for this route alternative is 133 and the total score for NO_2 is 40. Therefore, the total combined score is 173. Refer to **Table 2a** and **Figure EM12** for more detail.

2.6.2 Evaluation Results

The following table summarizes the evaluation results for the East Mainline Alternatives.

Table 2.6.1: Summary of Evaluation Results for the East Mainline

Route	Number of Impacted Sensitive Receptors				Critical Receptor	Total Score
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m		
EM1	22	39	74	68	No	182
EM2	27	34	52	57	No	155
EM3	25	23	62	68	No	161
EM4	38	37	65	63	No	188
EM5	30	41	56	64	No	175
EM6	38	33	57	57	No	172
EM7	34	52	50	45	No	169
EM8	42	62	55	47	No	194
EM9	39	66	46	45	No	184
EM10	39	56	47	41	No	173
EM11	53	39	69	62	No	211
EM12	27	60	56	46	No	173

- Refer to Step 2 for an explanation of the scoring system

2.7 West Link

For the West Link the modelling was conducted for the year 2031, based on a four-lane rural highway with an AADT of 52,800 and a bus transitway with a traffic volume of 100 buses per hour. The maximum predicted concentrations resulting from this modelling scenario, including 90th percentile background concentrations, for the contaminants of interest are summarized below.

Table 2.7.1: Summary of Modelling Results for West Link

Contaminant	Maximum Predicted Concentration	AAQC ($\mu g/m^3$)	Percentage of AAQC	Distance at which Attainment Occurs [3]
NO_2	104 $\mu g/m^3$ (1-hour)[1]	400 $\mu g/m^3$	26%	Edge of ROW
PM_{10}	75 $\mu g/m^3$ (24-hour)[2]	50 $\mu g/m^3$	150%	166 m

[1] Includes 90th percentile background concentration for NO_2 which is 64 $\mu g/m^3$

[2] Includes 90th percentile background concentration for PM_{10} which is 28 $\mu g/m^3$

[3] Distance measured from the centreline of the highway. ROW extends approximately 115 m from the centreline on the transitway side and 55 m from the centreline on the opposite side

As expected, the maximum predicted concentrations occur in close proximity to the edge of the Right of Way (ROW). As you move further away from the ROW the predicted concentrations decrease to a point where the predicted concentrations from the highway become indistinguishable from the background concentrations. This is the point on **Figure 4** where the curve begins to flatten out and little change occurs amongst the predicted concentrations.

For this modelling scenario, only PM_{10} was predicted to exceed the AAQC. At a distance greater than 166 m from the centreline of the highway the PM_{10} predicted concentrations decline below the AAQC (note that the ROW extends 115 m from the centreline on the transitway side and 55 m from the centreline on the opposite side). These modelling results are typical of other similar highways within Ontario. The background concentrations are a major contributor to the cumulative concentration and to the predicted excursion above the AAQC within 166 m of the centerline.

The following summarizes the results for each of the West Link route alternatives.

2.7.1 Net Effects Analysis

The dispersion modelling for this section was identical to that for the section from Enfield Road to Highway 35/115, as presented in Section 2.6.

WL1

- Total score for PM_{10} for this route alternative is 79 and the total score for NO_2 is 21. Therefore, the total combined score is 100. Refer to **Table 2a** and **Figure WL1** for more detail.

WL2

- Total score for PM_{10} for this route alternative is 83 and the total score for NO_2 is 22. Therefore, the total combined score is 105. Refer to **Table 2a** and **Figure WL2** for more detail.

WL3

- Total score for PM_{10} for this route alternative is 93 and the total score for NO_2 is 23. Therefore, the total combined score is 117. Refer to **Table 2a** and **Figure WL3** for more detail.

WL4

- Total score for PM_{10} for this route alternative is 86 and the total score for NO_2 is 22. Therefore, the total combined score is 108. Refer to **Table 2a** and **Figure WL4** for more detail.

WL5

- Total score for PM_{10} for this route alternative is 87 and the total score for NO_2 is 21. Therefore, the total combined score is 107. Refer to **Table 2a** and **Figure WL5** for more detail.

WL6

- Total score for PM_{10} for this route alternative is 102 and the total score for NO_2 is 26. An additional penalty of 100 was assessed because this route alternative could potentially impact a critical receptor, a daycare facility in the area of influence. Therefore, the total combined score is 228. Refer to **Table 2a** and **Figure WL6** for more detail.

WL7

- Total score for PM_{10} for this route alternative is 91 and the total score for NO_2 is 24. Therefore, the total combined score is 115. Refer to **Table 2a** and **Figure WL7** for more detail.

WL8

- Total score for PM_{10} for this route alternative is 94 and the total score for NO_2 is 25. Therefore, the total combined score is 119. Refer to **Table 2a** and **Figure WL8** for more detail.

WL9

- Total score for PM_{10} for this route alternative is 89 and the total score for NO_2 is 24. Therefore, the total combined score is 112. Refer to **Table 2a** and **Figure WL9** for more detail.

2.7.2 Evaluation Results

The following table summarizes the evaluation results for the West Link Alternatives.

Table 2.7.2: Summary of Evaluation Results for the West Link

Route	Number of Impacted Sensitive Receptors				Critical Receptor	Total Score
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m		
WL1	11	22	39	29	No	100
WL2	13	24	30	37	No	105
WL3	19	22	30	41	No	117
WL4	17	24	26	37	No	108
WL5	24	23	22	27	No	107
WL6	21	24	22	56	Yes	228
WL7	12	21	34	51	No	115
WL8	11	21	38	53	No	119
WL9	11	24	36	44	No	112

- Refer to Step 2 for an explanation of the scoring system

2.8 East Link

For the East Link the modelling was conducted for the year 2031, based on a four-lane rural highway with an AADT of 46,490 and a bus transitway with a traffic volume of 100 buses per hour. The maximum predicted concentrations resulting from this modelling scenario, including 90th percentile background concentrations, for the contaminants of interest are summarized below.

Table 2.8.1: Summary of Evaluation Results for the East Link

Contaminant	Maximum Predicted Concentration	AAQC ($\mu g/m^3$)	Percentage of AAQC	Distance at which Attainment Occurs [3]
NO_2	100 $\mu g/m^3$ (1-hour)[1]	400 $\mu g/m^3$	25%	Edge of ROW
PM_{10}	75 $\mu g/m^3$ (24-hour)[2]	50 $\mu g/m^3$	150%	166 m

[1] Includes 90th percentile background concentration for NO_2 which is 64 $\mu g/m^3$

[2] Includes 90th percentile background concentration for PM_{10} which is 28 $\mu g/m^3$

[3] Distance measured from the centreline of the highway. ROW extends approximately 115 m from the centreline on the transitway side and 55 m from the centreline on the opposite side

As expected, the maximum predicted concentrations occur in close proximity to the edge of the Right of Way (ROW). As you move further away from the ROW the predicted concentrations decrease to a point where the predicted concentrations from the highway become indistinguishable from the background concentrations. This is the point on **Figure 5** where the curve begins to flatten out and little change occurs amongst the predicted concentrations.

For this modelling scenario, only PM_{10} was predicted to exceed the AAQC. At a distance greater than 166 m from the centreline of the highway the PM_{10} predicted concentrations decline below the AAQC (note that the ROW extends 115 m from the centreline on the transitway side and 55 m from the centreline on the opposite side). These modelling results are typical of other similar highways within Ontario. The background concentrations are a major contributor to the cumulative concentration and to the predicted excursion above the AAQC within 166 m of the centerline.

The following summarizes the results for each of the East Link route alternatives.

2.8.1 Net Effects Analysis

The dispersion modelling for this section was identical to that for the section for the West Link, as presented in Section 2.7.

EL1

- Total score for PM_{10} for this route alternative is 145 and the total score for NO_2 is 38. Therefore, the total combined score is 183. Refer to **Table 2a** and **Figure EL1** for more detail.

EL2

- Total score for PM_{10} for this route alternative is 171 and the total score for NO_2 is 44. Therefore, the total combined score is 214. Refer to **Table 2a** and **Figure EL2** for more detail.

EL3

- Total score for PM_{10} for this route alternative is 171 and the total score for NO_2 is 44. Therefore, the total combined score is 215. Refer to **Table 2a** and **Figure EL3** for more detail.

EL4

- Total score for PM_{10} for this route alternative is 153 and the total score for NO_2 is 39. Therefore, the total combined score is 191. Refer to **Table 2a** and **Figure EL4** for more detail.

EL5

- Total score for PM_{10} for this route alternative is 173 and the total score for NO_2 is 45. Therefore, the total combined score is 219. Refer to **Table 2a** and **Figure EL5** for more detail.

EL6

- Total score for PM_{10} for this route alternative is 176 and the total score for NO_2 is 45. Therefore, the total combined score is 222. Refer to **Table 2a** and **Figure EL6** for more detail.

EL7

- Total score for PM_{10} for this route alternative is 158 and the total score for NO_2 is 40. Therefore, the total combined score is 199. Refer to **Table 2a** and **Figure EL7** for more detail.

EL8

- Total score for PM_{10} for this route alternative is 160 and the total score for NO_2 is 40. Therefore, the total combined score is 200. Refer to **Table 2a** and **Figure EL8** for more detail.

EL9

- Total score for PM_{10} for this route alternative is 180 and the total score for NO_2 is 46. An additional penalty of 100 was assessed because this route alternative could potentially impact a critical receptor, a school in the area of influence. Therefore, the total combined score is 325. Refer to **Table 2a** and **Figure EL9** for more detail.

EL10

- Total score for PM_{10} for this route alternative is 178 and the total score for NO_2 is 46. An additional penalty of 100 was assessed because this route alternative could potentially impact a critical receptor, a school in the area of influence. Therefore, the total combined score is 324. Refer to **Table 2a** and **Figure EL10** for more detail.

EL11

- Total score for PM_{10} for this route alternative is 179 and the total score for NO_2 is 46. An additional penalty of 100 was assessed because this route alternative could potentially impact a critical receptor, a school in the area of influence. Therefore, the total combined score is 325. Refer to **Table 2a** and **Figure EL11** for more detail.

EL12

- Total score for PM_{10} for this route alternative is 176 and the total score for NO_2 is 46. Therefore, the total combined score is 223. Refer to **Table 2a** and **Figure EL12** for more detail.

EL13

- Total score for PM_{10} for this route alternative is 177 and the total score for NO_2 is 47. An additional penalty of 100 was assessed because this route alternative could potentially impact a critical receptor, a school in the area of influence. Therefore, the total combined score is 324. Refer to **Table 2a** and **Figure EL13** for more detail.

2.8.2 Evaluation Results

The following table summarizes the evaluation results for the East Link alternatives.

Table 2.8.2: Summary of Results for the East Link

Route	Number of Impacted Sensitive Receptors				Critical Receptor	Total Score
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m		
EL1	19	21	66	83	No	183
EL2	24	42	69	83	No	214
EL3	24	36	72	87	No	215
EL4	25	28	69	72	No	191
EL5	21	41	75	89	No	219
EL6	25	37	75	89	No	222
EL7	26	30	68	75	No	199
EL8	29	26	68	75	No	200
EL9	27	69	72	56	Yes	325
EL10	23	71	73	59	Yes	324
EL11	26	67	73	59	Yes	325
EL12	19	41	97	75	No	223
EL13	18	45	99	72	Yes	324

- Refer to Step 2 for an explanation of the scoring system

3. Summary

The results of this evaluation are best characterized by looking at the total scores for each set of route alternatives. The lower the score, the better the route is from an air quality perspective.

The following tables are replicated from their applicable sections for convenience to view a summary of the air quality comparative evaluation results.

West Mainline

Table 2.3.1: Summary of Evaluation Results for the West Mainline

Route	Number of Impacted Sensitive Receptors				Critical Receptor	Total Score
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m		
WM1	9	22	16	24	No	76
WM2	18	20	22	18	Yes	189

- Refer to Step 2 for an explanation of the scoring system

Route Alternative WM1 is preferred as it has least net effects impacting the fewest sensitive receptors.

Central Mainline

Table 2.5.1: Summary of Evaluation Results for the Central Mainline

Route	Number of Impacted Sensitive Receptors				Critical Receptor	Total Score
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m		
CM1	16	19	32	23	No	93
CM2	6	18	9	12	No	46

- Refer to Step 2 for an explanation of the scoring system

Route Alternative CM1 is preferred as it has least net effects impacting the fewest sensitive receptors.

East Mainline

Table 2.6.1: Summary of Evaluation Results for the East Mainline

Route	Number of Impacted Sensitive Receptors				Critical Receptor	Total Score
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m		
EM1	22	39	74	68	No	182
EM2	27	34	52	57	No	155
EM3	25	23	62	68	No	161
EM4	38	37	65	63	No	188
EM5	30	41	56	64	No	175
EM6	38	33	57	57	No	172
EM7	34	52	50	45	No	169
EM8	42	62	55	47	No	194
EM9	39	66	46	45	No	184
EM10	39	56	47	41	No	173
EM11	53	39	69	62	No	211-
EM12	27	60	56	46	No	173-

- Refer to Step 2 for an explanation of the scoring system

Route Alternatives EM2 and EM3 are preferred as they have least net effects impacting the fewest sensitive receptors.

West Link

Table 2.7.2: Summary of Evaluation Results for the West Link

Route	Number of Impacted Sensitive Receptors				Critical Receptor	Total Score
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m		
WL1	11	22	39	29	No	100
WL2	13	24	30	37	No	105
WL3	19	22	30	41	No	117
WL4	17	24	26	37	No	108
WL5	24	23	22	27	No	107
WL6	21	24	22	56	Yes	228
WL7	12	21	34	51	No	115
WL8	11	21	38	53	No	119
WL9	11	24	36	44	No	112

- Refer to Step 2 for an explanation of the scoring system

Route Alternatives WL1, WL2 and WL5 are preferred as they have least net effects impacting the fewest sensitive receptors.

East Link

Table 2.8.2: Summary of Results for the East Link

Route	Number of Impacted Sensitive Receptors				Critical Receptor	Total Score
	ROW to 200 m	200 to 300 m	300 to 400 m	400 to 500 m		
EL1	19	21	66	83	No	183
EL2	24	42	69	83	No	214
EL3	24	36	72	87	No	215
EL4	25	28	69	72	No	191
EL5	21	41	75	89	No	219
EL6	25	37	75	89	No	222
EL7	26	30	68	75	No	199
EL8	29	26	68	75	No	200
EL9	27	69	72	56	Yes	325
EL10	23	71	73	59	Yes	324
EL11	26	67	73	59	Yes	325
EL12	19	41	97	75	No	223
EL13	18	45	99	72	Yes	324

- Refer to Step 2 for an explanation of the scoring system

Route Alternative EL1 is preferred as it has least net effects impacting the fewest sensitive receptors.

Glossary of Terms

Nitrogen Oxides (NO_x): A general term pertaining to compounds of nitric oxide (NO), nitrogen dioxide (NO_2) and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes, and are major contributors to smog formation and acid deposition. NO_2 may result in numerous adverse health effects.

PM_{10} (Coarse Particulate Matter) : Small particles with an aerodynamic diameter less than or equal to a nominal 10 microns. PM_{10} can result in adverse heath effects and visibility reduction.

Ambient Air: The air quality at a particular time and place outside of structures. Often used interchangeably with “outdoor air.”

Absolute Humidity: Mass of water vapour per unit mass of dry air.

Fuel Volatility: A measure of how easily a fuel vapourizes. If the fuel does not vapourize completely, it will not burn properly completely.

g/VMT: grams per vehicle mile traveled.

AADT: Annual average daily traffic volumes

Mixing Height: The height above the surface through which relatively vigorous vertical mixing of the atmosphere occurs. The mixing height depth is least in the evening period and is at a maximum in the daytime.

Deposition Velocity: The rate at which particles are removed from the atmosphere through a number of removal mechanisms.

Settling Velocity: The rate at which particles are removed from the atmosphere due to gravitational settling.

AAQC: Ambient Air Quality Criteria

90^{th} Percentile: A term used in statistics to describe the distribution of data. A 90^{th} percentile value selected to represent ambient background concentrations means that the selected background concentration is greater than or equal to 90% of all of the measured values in the dataset; 10% of the measured values are higher than the selected ambient background concentration.

µg/m3: Micrograms per cubic metre.

Sensitive Receptors: A theoretical location used for modeling purposes set to represent residential properties, schools, nursing homes, healthcare facility, churches, and daycare facilities where the dispersion model calculates contaminant concentrations.