Region of Peel

Schedule B Class EA, Albion Vaughan Road and King Street, Transportation and Traffic Study Report

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February 2020

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PREPARED BY:

Maurice Masliah, Ph.D.

Project Manager, Transportation

VERIFIED BY:

Jaime Garcia, Ph.D., P.Eng.

Associate Partner, Senior Project Director

Traffic Engineering, Transportation

Table of Contents

1. Introduction 1

2. Existing Conditions 2

2.1 Roadway Elements Inventory 2

2.2 Vehicular Traffic 16

2.3 Active Transportation 17

3. Future Conditions 18

3.1 Vehicular Traffic 18

3.2 Active Transportation 18

4. Development of Alternatives (2031 Scenario) 22

4.1 Vehicular Traffic 22

4.1.1 Do-Nothing Scenario 22

4.1.2 BRES Report Option 6 23

4.1.3 Double Left Turn (Westbound) 23

4.1.4 Double Left Turn and Road Widening (North-South) 24

4.1.5 Widening to Four Lanes 25

4.2 Storage Requirements 26

5. Traffic Safety 28

5.1 Collision Analysis 28

5.2 Speed Data Analysis 31

5.3 Field Investigation Findings 34

5.3.1 Pedestrian Facilities 34

5.3.2 Guiderail 34

5.3.3 Street Name Signs 35

5.3.4 Truck Route Restrictions 36

5.3.5 Pedestrians Ahead Sign 39

6. Summary of Proposed Improvements 41

7. Revisions to Transportation and Traffic Study Report Preliminary Findings 42

7.1 Modification to the Interim Option 42

7.2 Modification to the Full Widening 43

7.3 Town of Caledon and Region of York Transportation Master Plans 44

B00669

Table of Figures

Figure 1: Intersection Study Area Albion Vaughan Road and King Street (Source: Google Maps) 1
Figure 2: Existing (January 2016) Peak Hour Volumes 16
Figure 3: Option 6 Location and Trip Distribution 19
Figure 4: Projected Peak Hour Volumes 19
Figure 5: Existing and Proposed Pedestrian Facilities 20
Figure 6: Proposed Cycling Facilities 20
Figure 7: Number of Collisions by Year and Severity 28
Figure 8: Collision Diagram (2011-2015 Data) 29
Figure 9: Collisions by Month and Severity (2011-2015 Data) 30
Figure 10: Collisions by Day of the Week and Severity (2011-2015 Data) 30
Figure 11: Collisions by Hour and Severity (2011-2015 Data) 31
Figure 12: Driver's View Eastbound on King Street Approaching Albion Vaughan Road 32
Figure 13: Driver's View southbound on Albion Vaughan Road approaching King Street 32
Figure 14: Damaged Guiderail at Southeast Corner 35
Figure 15: Street Name and Advance Street Name Signs 36
Figure 16: Truck Restriction Sign at King and Albion 37
Figure 17: No Truck Left-Turns Signs 37
Figure 18: Trucks Must Turn Left Signs 38
Figure 19: Truck Restriction Ends Sign at King and Albion 39
Figure 20: Pedestrian Ahead (Wc-7) 40
Figure 21 Preliminary Design – Full Widening as proposed on 2017 42
Figure 22 Preliminary Design – Interim Option (2019) 43

Table of Tables

Table 1 Southbound Approach – Roadway Elements 2
Table 2 Northbound Approach - Roadway Elements 5
Table 3 Eastbound Approach – Roadway Elements 8
Table 4 Westbound Approach – Roadway Elements 12

Table 5: Existing Intersection Operations (BRES April 2016) 17
Table 6: 2031 Intersection Operations (Do-Nothing) 22
Table 7: 2031 Intersection Operations (BRES Option 6) 23
Table 8: Double Left Turn (Westbound) 24
Table 9: 2031 Intersection Operations (Double Left Turn and Road Widening) 24
Table 10: Widening to Four Lanes 25
Table 11: Storage Requirements for Auxiliary Lanes 26
Table 12: Speed Study Data Summary – North Ridge Trail 33
Table 13: Summary of Proposed Safety Improvements 41

B00669

1. Introduction

The Transportation and Safety review has been conducted as part of the Schedule 'B' Class Environmental Assessment of the intersection of Albion Vaughan Road and King Street East (Peel Regional Road 9) / King Road (York Regional Road 11), in the Town of Caledon. CIMA+ was retained by the Region of Peel for this project. The location and intersection configuration is shown in Figure 1. The intersection is signalized and the posted speed limit within the study area is 60 km/h. The area is mostly rural with residential homes scattered throughout.

Figure 1: Intersection Study Area Albion Vaughan Road and King Street (Source: Google Maps)

The current configuration of the intersection under study – referred to as the intersection of King and Albion in this report, includes exclusive left-turn, through, and right-turn lanes in the southbound and eastbound directions, and exclusive left-turn and shared through/right-turn lanes in the northbound and westbound directions.

The intersection of King and Albion was included as part of an operational analysis previously completed for the April 2016 Bolton Residential Expansion Areas Study (BRES). The purpose of the BRES was to conduct intersection analysis and provide recommendations for intersection improvements on Regional Roads, based on eight land development scenarios. A resulting conclusion from the BRES report was the requirement of modifications to the King and Albion intersection - referred to as King/Townline in the BRES report, such as additional auxiliary turn lanes to mitigate the projected performance of this intersection.

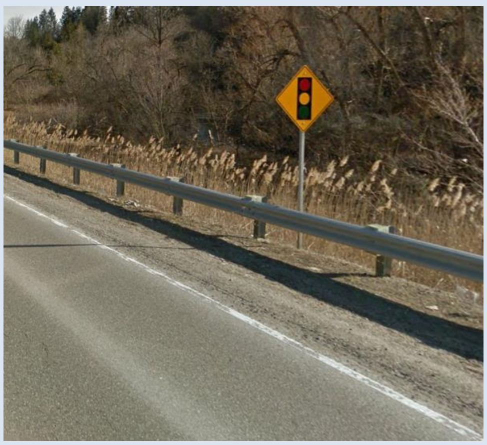
B000709

2. Existing Conditions

2.1 Roadway Elements Inventory

An inventory of the roadway elements currently present along the four segments of the intersection was completed as part of the review of existing conditions. The following tables summarize the elements identified as part of the inventory.

Table 1 Southbound Approach – Roadway Elements

Type of Roadway Element	Description and Distance to Intersection
	Signal Ahead warning sign. 285 m upstream from stop bar.
	60 km/h posted speed regulation sign. 245 m upstream from stop bar.

B000709

Type of Roadway Element	Description and Distance to Intersection
	Advanced road information sign. 115 m upstream from stop bar.
	Right turn lane designation regulation sign. 55 m upstream from stop bar.
	No trucks turning right except for local deliveries regulation sign and road information sign. At intersection.

B000709

Type of Roadway Element	Description and Distance to Intersection
	60 km/h posted speed regulation sign. 15 m downstream of south leg crosswalk.
Southbound Pavement Markings	**Length**
Southbound left-turn taper	84 m
Southbound left-turn storage	90 m
Southbound right-turn taper	38 m
Southbound right-turn storage	15 m
	Southbound stop bar and crosswalk.

B000709

Table 2 Northbound Approach - Roadway Elements

Type of Roadway Element	Description and Distance to Intersection
	Signal Ahead warning sign. 275 m upstream of stop bar.
	60 km/h posted speed regulation sign. 240 m upstream of stop bar.

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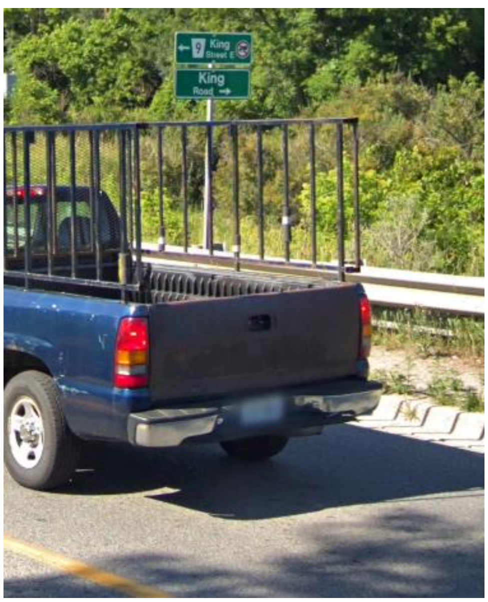
Type of Roadway Element	Description and Distance to Intersection
	No trucks left-turn 200m ahead regulation sign. 215 m upstream of stop bar.
	Advanced road information sign. 130 m upstream of stop bar.

B000709

Type of Roadway Element	Description and Distance to Intersection
	No trucks turning left except for local deliveries regulation sign and road information sign. No At intersection.
	Road information sign. At intersection.
	No Heavy trucks regulation sign. Only 5 tonnes per axle between March 15 to May 15. 15 m downstream of north leg crosswalk.
Northbound Pavement Markings	**Length**
Northbound left-turn lane taper	47 m
Northbound left-turn lane storage	77 m

B000709

Type of Roadway Element	Description and Distance to Intersection
	Northbound stop bar and crosswalk.

Table 3 Eastbound Approach – Roadway Elements

Type of Roadway Element	Description and Distance to Intersection
	60 km/h posted speed with Begins tab regulation sign. 345 m upstream of stop bar.

B000709

Type of Roadway Element	Description and Distance to Intersection
	Crosswalk warning sign. 245 m upstream of stop bar.
	Signal Ahead warning sign. 220 m upstream of stop bar.

B000709

Type of Roadway Element	Description and Distance to Intersection
	Advanced road information sign. 125 m upstream of stop bar.
	No heavy trucks ends regulation sign. 45 m upstream of stop bar.

B000709

Type of Roadway Element	Description and Distance to Intersection
	Road information sign. At intersection.
	Deer crossing warning signs. 10 m downstream of east leg crosswalk.
Eastbound Pavement Markings	**Length**
Eastbound left-turn lane taper	72 m
Eastbound left-turn lane storage	22 m
Eastbound right-turn lane taper	55 m
Eastbound right-turn lane storage	37 m

B000709

Type of Roadway Element	Description and Distance to Intersection
	Eastbound stop bar and crosswalk.

Table 4 Westbound Approach – Roadway Elements

Type of Roadway Element	Description and Distance to Intersection
	60 km/h posted speed regulation sign. 345 m upstream of stop bar.

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Type of Roadway Element	Description and Distance to Intersection
	Advanced road information sign. 275 m upstream of stop bar.
	Signal Ahead warning sign. 220 m upstream of stop bar.

Type of Roadway Element	Description and Distance to Intersection
	Truck route regulation sign. Left turn permitted regulation sign. 130 m upstream of stop bar.
	Road information sign at intersection.

B000709

Type of Roadway Element	Description and Distance to Intersection
	60 km/h posted speed regulation sign. 15 m downstream of west leg crosswalk.
	Crosswalk warning sign. 35 m downstream of west leg crosswalk.
Westbound Pavement Markings	**Length**
Westbound left-turn lane taper	150 m

Type of Roadway Element	Description and Distance to Intersection
Westbound left-turn lane storage	45 m
	Westbound stop bar and crosswalk.

2.2 Vehicular Traffic

Existing traffic volumes collected as part of BRES on January 2016 are shown in **Figure 2**. Existing configuration of the intersection includes the following lanes:

- NB: 1 Left Turn, 1 Through - Right
- SB: 1 Left Turn, 1 Through, 1 Right
- EB: 1 Left Turn, 1 Through, 1 Right
- WB: 1 Left Turn, 1 Through-Right

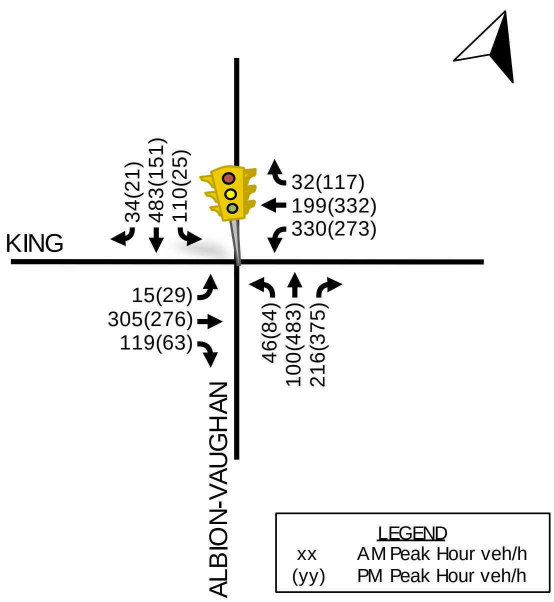

Figure 2: Existing (January 2016) Peak Hour Volumes

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The existing traffic movements at this intersection operating at Level of Service D or higher – as described in the BRES report are shown in **Table 5.**

Table 5: Existing Intersection Operations (BRES April 2016)

Mov.	Weekday AM Peak Hour				Weekday PM Peak Hour			
	LOS	v/c	Control Delay(s)	95th %ile Queue Length (m)	LOS	v/c	Control Delay(s)	95th %ile Queue Length (m)
Overall	C	0.63	34.9	-	E	1.02	69.9	-
EB T	D	0.50	36.8	68.7	D	0.59	44.1	78.0
WB L	C	0.63	20.8	122.1	D	0.86	50.4	128.3
NB T	D	0.51	35.0	81.8	F	1.11	97.6	353.5
SB T	D	0.78	45.0	136.1	B	0.18	17.4	52.0

Under existing conditions, northbound through movements during the PM peak period are operating under a Level of Service F which affects the overall level of service of the intersection.

2.3 Active Transportation

Recent turning movement counts at the King and Albion intersection indicate a negligible amount of pedestrian and cyclist activity around the intersection (1 observed pedestrian during an 8-hr traffic count). However, it should be noted that the data provided was collected during the month of January, 2016.

With regard to current facilities provided for active transportation, within the vicinity of the King and Albion intersection, the following should be noted.

- Narrow (approximately 1 m wide) asphalt kill strip along both sides of Albion Vaughan Road, north of King Street for approximately 85 m before transitioning to unpaved granular shoulders;
- Approximate 2 m wide concrete sidewalk along the west side of Albion Vaughan Road between King Street and Old King Street, which connects to the Humber Valley Heritage Trail;
- Narrow (approximately 1 m wide) asphalt kill strip along the east side of Albion Vaughan Road, south of King Street;
- Paved shoulders along the south side of King Street, east of Albion Vaughan Road;
- Narrow (approximately 1 m wide) asphalt kill strip along the north side of King Street, east of Albion Vaughan Road for approximately 150 m before transitioning to paved shoulders; and
- Narrow (approximately 1 m wide) asphalt kill strip along both sides of King Street, west of the Albion Vaughan Road.

Based on the foregoing, existing pedestrian and cycling facilities are considered to be fairly limited; however, this is common for rural locations where pedestrian and cycling demand is low due to greater distances between origins/destinations.

With regard to transit, bus stops are currently located around the intersection as follow:

- At the north side of King Street approximately 60 m west of the intersection; and

B000709

- At the south side of King Street approximately 40 m west of the intersection.

These bus stops currently serve GO Transit Route #38, which provides the following service:

- two scheduled buses in the eastbound direction (buses on King Street turn right to head southbound on Albion Vaughan Road) during the weekday morning peak (6:01 AM and 6:44 AM); and
- two scheduled buses in the westbound direction (buses on Albion Vaughan Road turn left to head westbound on King Street) during the weekday afternoon peak (5:45 PM and 6:40 PM).

3. Future Conditions

3.1 Vehicular Traffic

As described in the BRES report, future traffic volumes were derived based on growth rates developed using the regional EMME model and projected site-generated traffic from known development areas as follow:

1. EMME model outputs for the 2011 horizon year (based on Transportation Tomorrow Survey (TTS) data) and the 2031 horizon year provided by the Region were used to identify the “existing” and future link traffic volumes for all selected corridors under evaluation.

2. Pertinent link volumes were used to calculate the estimated growth in link volumes from 2011 to 2031, providing the 20-year growth for each link. The 20-year growth was then reduced to reflect the anticipated 15-year growth which is consistent with this study’s 2031 horizon year.

3. These link volumes were distributed to adjacent intersections based on existing turning movement volume proportions and summed with existing turning movement volumes to produce the estimated 2031 future background turning movement volumes.

To this purpose, the BRES report considered a total of eight development scenarios for further analysis (e.g. “Option 1” considered 2031 background growth and generated trips from expansion “Area 1”, “Option 2” considered 2031 background growth and generated trips from expansion “area 2”, etc.).

For the purposes of this project, Option 6 was carried forward for review. Option 6 is located in the south portion of Bolton south of Healey Road and east of Humber Station Road, as shown in **Figure 3**, and is expected to contain approximately 2699 residential units and create 2520 jobs.

It should be noted that due to the location of this option, no additional traffic – aside of future background traffic growth, was assigned to use this intersection.

The projected volumes at this location are depicted in **Figure 4** and were obtained from the BRES report.

3.2 Active Transportation

With respect to the Region’s November 2011 Active Transportation Study there are plans to provide paved shoulders along King Street, east and west of the King and Albion intersection. The following **Figures 5 and 6**, depict existing and proposed active transportation facilities.

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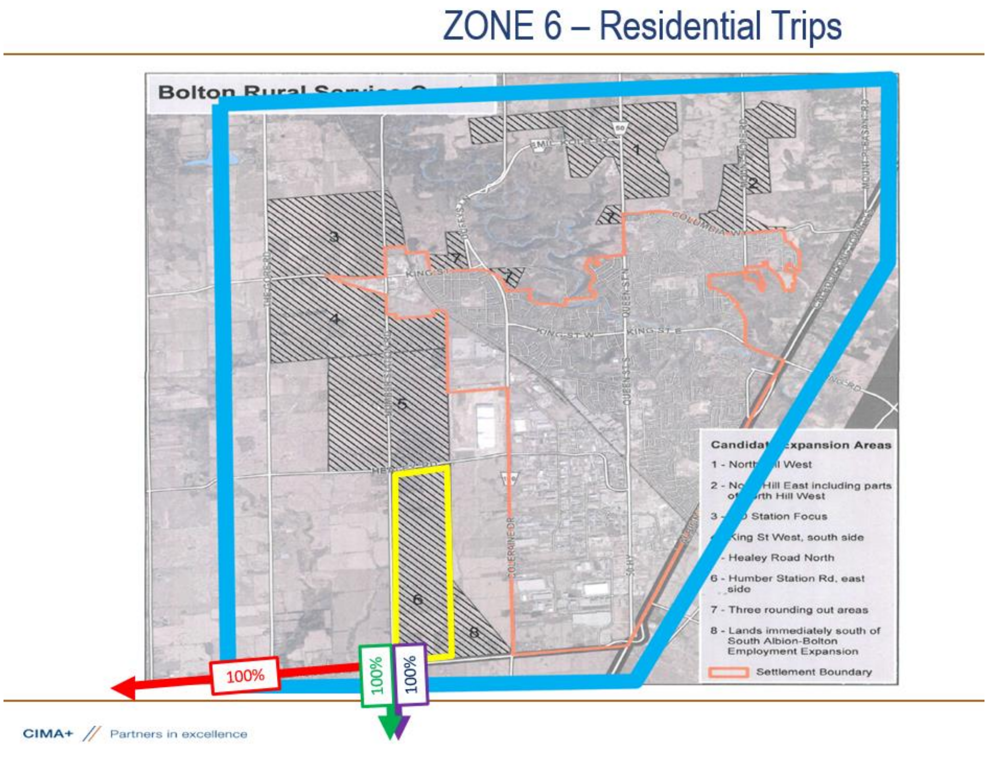
Figure 3: Option 6 Location and Trip Distribution



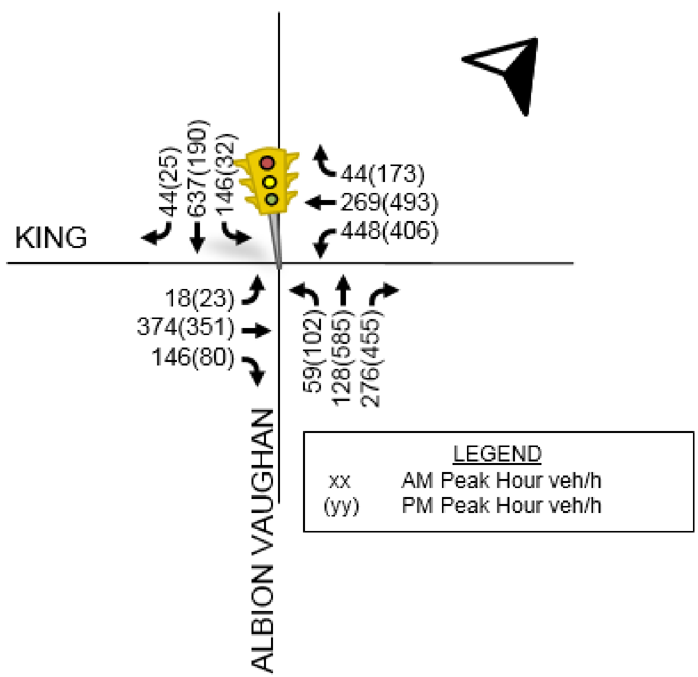


Figure 4: Projected Peak Hour Volumes

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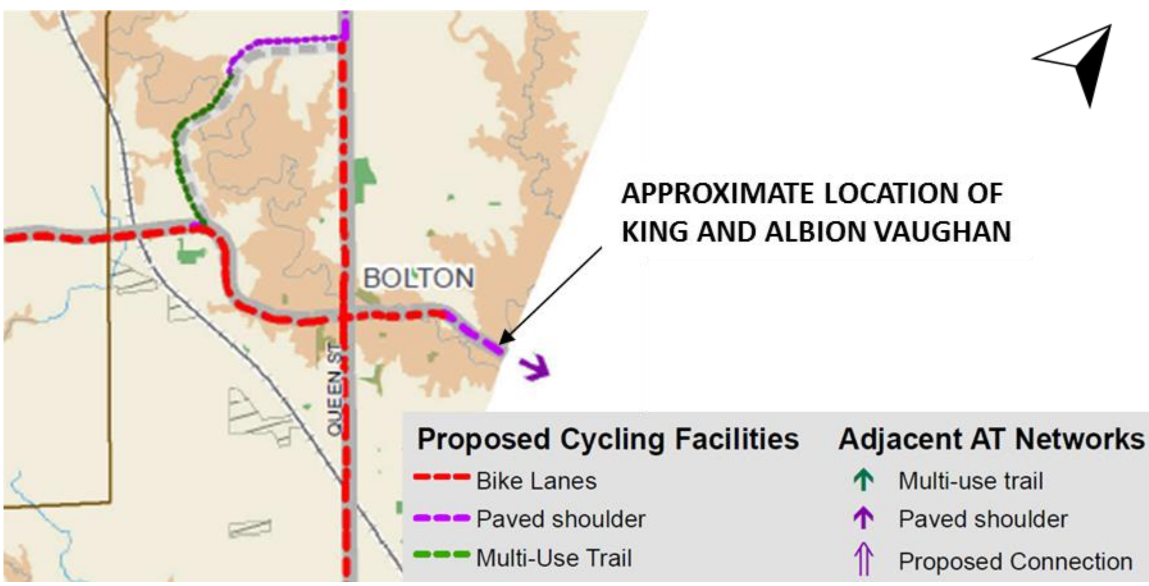
Figure 5: Existing and Proposed Pedestrian Facilities

Figure 6: Proposed Cycling Facilities



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Since the Region's November 2011 Active Transportation Study did not recommend pedestrian infrastructure improvements for the area under study, development of alternative cross-sections may consider the following active transportation elements:

- A new concrete sidewalk along the north and south side of King Street between the existing bus stops and Albion Vaughan Road (approximately 60 m and 40 m of new sidewalk respectively).
- With regard to cycling facilities, demand for cycling appears to be very low, given the available data. However, providing dedicated cycling lanes between the east and westbound through and auxiliary right-turn lanes (for the length of the provided east and westbound auxiliary right-turn lanes) will be a notable improvement for cyclists along King Street, which is planned to be a cycling route, as depicted in **Figure 4**.

Possible TDM measures, in addition to providing safer facilities for pedestrians and cyclists, can include the following.

- Bus shelters and benches (i.e. make it more comfortable when waiting for transit)
- Bike storage at transit stops (e.g. post and rings to secure bikes when biking to/from transit stops)
- Improved lighting along sidewalks (i.e. make it safer for pedestrians and cyclists at night)
- Landscaping (i.e. make the pedestrian experience more attractive with landscaping)
- Increased transit service (i.e. make transit more attractive by making it more convenient)

In order to encourage active and transit modes, strategies to help make the pedestrian and cyclists experience safer, and more comfortable need to be implemented first. Following the implementation of safer and more comfortable pedestrian and cycling facilities, programs and surveys can be developed to help further encourage active and transit modes.

Surveys can be valuable tools to help determine what local residents need (e.g. schedule/convenience, safety/comfort, etc.) to switch to active modes or transit. Surveys can also reveal what residents may appreciate as an incentives (i.e. programs promoting alternative modes). Possible programs/incentives may include:

- Competition within a public forum (e.g. an online bulletin, ranking individuals with the most non-auto kilometers travelled)
- Free transit rides (e.g. ride transit for five days and get the sixth free)
- Promote safety (e.g. free flashing bicycle light handed out to on-road cyclists)
- A travel planner, which considers mixing travel modes (e.g. calculating a route and travel time for biking to a bus stop, catching a bus, and walking to a destination. This can be a one-on-one in person info session or a more permanent online tool)

Designing a well-made survey can not only reveal what residents possibly need to switch to non-auto modes, it can also encourage the use of active transportation by simply getting people to think about non-auto modes.

The foregoing possible TDM strategies are important to consider when the objective is to encourage the use of transit or active modes of transportation.

B000709

4. Development of Alternatives (2031 Scenario)

As described in previous sections of this report, work conducted as part of the BRES report was used as the basis for the development of alternatives for the 2031 horizon year.

Capacity analysis was undertaken using procedures described in the Highway Capacity Manual (HCM). The analysis primarily focuses on performance measures such as level-of-service (LOS), v/c ratio, and queueing. The operational analysis is consistent with the Region's Transportation Impact Study (TIS) Guidelines which indicates the following targets to identify where improvements may be required:

- v/c ratios for overall intersection operations, through movements or shared through/turning movements increased to 0.90 or above;
- v/c ratios for exclusive movements that will exceed 1.00; and
- 95th percentile queue lengths for individual movements that exceed available lane storage.

4.1 Vehicular Traffic

4.1.1 Do-Nothing Scenario

Under the Do-Nothing Scenario, no improvements to the current configuration of the King and Albion intersection are considered. The results of the operational analysis are presented in **Table 6** for all critical movements.

Table 6: 2031 Intersection Operations (Do-Nothing)

Mov.	Weekday AM Peak Hour				Weekday PM Peak Hour			
	LOS	v/c	Control Delay(s)	95th %ile Queue Length (m)	LOS	v/c	Control Delay(s)	95th %ile Queue Length (m)
Overall	F	1.21	91.4	-	F	1.35	124.7	-
EB T	F	1.00	96.5	180.9	F	0.95	89.9	144.8
WB L	F	1.20	153.9	218.7	F	1.39	235.6	185.1
NB T	E	0.82	56.5	151.5	F	1.29	177.8	408.9
SB T	F	1.14	128.0	300.0	B	0.20	18.3	38.3

Under the Do-Nothing scenario the existing configuration remains as follow:

- NB: 1 Left Turn, 1 Through - Right
- SB: 1 Left Turn, 1 Through, 1 Right
- EB: 1 Left Turn, 1 Through, 1 Right
- WB: 1 Left Turn, 1 Through-Right

B000709

4.1.2 BRES Report Option 6

The alternative presented in the BRES report for the intersection of King and Albion includes the following improvements:

- Addition of an Auxiliary Northbound Right Turn Lane
- Addition of an Auxiliary Westbound Right Turn Lane

The results of the proposed improvements are presented in **Table 7**.

Table 7: 2031 Intersection Operations (BRES Option 6)

Mov.	Weekday AM Peak Hour				Weekday PM Peak Hour			
	LOS	v/c	Control Delay(s)	95th %ile Queue Length (m)	LOS	v/c	Control Delay(s)	95th %ile Queue Length (m)
Overall	E	1.10	71.3	-	D	0.89	42.5	-
EB T	F	1.00	96.9	254.4	D	0.60	39.9	92.9
WB L	F	1.15	132.7	136.3	D	0.90	45.8	149.3
NB T	C	0.23	32.7	51.1	D	0.87	51.1	251.2
SB T	F	1.01	81.2	300.9	C	0.29	29.6	54.8

Changes to the existing configuration of the intersection are the following (in red):

- NB: 1 Left Turn, 1 Through, **1 Right**
- SB: 1 Left Turn, 1 Through, 1 Right
- EB: 1 Left Turn, 1 Through, 1 Right
- WB: 1 Left Turn, 1 Through, **1 Right**

It should be noted that although the proposed improvements mitigates the effects of the projected background traffic during the PM peak period, the overall performance of the intersection is still critical under the AM peak period.

4.1.3 Double Left Turn (Westbound)

This option expands the recommendations of the BRES Report mentioned above. This alternative was not included as part of the BRES report, due to the potential implications to property and structures surrounding the study area and it's presented in the report for discussion purposes. Improvements considered as part of this alternative are the following:

- Converting existing Southbound exclusive right turn lane to southbound through right lane (Requires two Southbound receiving lanes)
- Adding Westbound Through-Right Lane (Requires two westbound receiving lanes)

The results of the proposed improvements are presented in **Table 8**.

B000709

Table 8: Double Left Turn (Westbound)

Mov.	Weekday AM Peak Hour				Weekday PM Peak Hour			
	LOS	v/c	Control Delay(s)	95th %ile Queue Length (m)	LOS	v/c	Control Delay(s)	95th %ile Queue Length (m)
Overall	D	0.77	48.3	-	D	0.86	40.5	-
EB T	D	0.69	47.1	139.9	D	0.79	54.4	115.8
WB L	E	0.82	64.5	87.4	E	0.75	56.1	51.0
NB T	D	0.39	19.2	53.3	D	0.84	45.7	179.4
SB T	D	0.42	35.1	127.9	C	0.26	28.3	23.0

Changes to the existing configuration of the intersection are the following (in red):

- NB: 1 Left Turn, 1 Through, **1 Right**
- SB: 1 Left Turn, 1 Through, **1 Through-Right**
- EB: 1 Left Turn, 1 Through, 1 Right
- WB: **2 Left Turn**, 1 Through-Right

4.1.4 Double Left Turn and Road Widening (North-South)

This alternative was not included as part of the BRES report, due to the potential implications to property and structures surrounding the study area and it's presented in the report for discussion purposes. Improvements considered as part of this alternative are the following:

- Addition of a Second Auxiliary Westbound Left Turn Lane (Dual Left with protected Phase)
- Addition of a Northbound Through Lane (Requires two northbound receiving lanes)
- Converting the existing Southbound exclusive right turn lane to southbound through right lane (Requires two Southbound receiving lanes)

The results of the proposed improvements are presented in **Table 9**.

Table 9: 2031 Intersection Operations (Double Left Turn and Road Widening)

Mov.	Weekday AM Peak Hour				Weekday PM Peak Hour			
	LOS	v/c	Control Delay(s)	95th %ile Queue Length (m)	LOS	v/c	Control Delay(s)	95th %ile Queue Length (m)
Overall	D	0.79	48.9	-	D	0.83	39.5	-
EB T	D	0.69	47.1	139.9	D	0.75	50.4	111.9
WB L	E	0.82	64.5	87.4	D	0.73	53.3	48.7
NB T	D	0.36	49.9	34.5	D	0.82	41.4	139.1
SB T	E	0.86	59.5	127.9	C	0.14	21.9	24.4

B000709

Changes to the existing configuration of the intersection are the following (in red):

- NB: 1 Left Turn, **1 Through**, 1 Through - Right
- SB: 1 Left Turn, 1 Through, **1 Through-Right**
- EB: 1 Left Turn, 1 Through, 1 Right
- WB: **2 Left Turn**, 1 Through-Right

4.1.5 Widening to Four Lanes

This alternative was not included as part of the BRES report, due to the potential implications to property and structures surrounding the study area and it's presented in the report for discussion purposes. Improvements considered as part of this alternative are the following:

- Addition of a Northbound Through-Right Lane (Requires two northbound receiving lanes)
- Converting existing Southbound exclusive right turn lane to southbound through right lane (Requires two Southbound receiving lanes)
- Addition of a Westbound Through-Right Lane (Requires two westbound receiving lanes)
- Converting existing Eastbound exclusive right turn lane to eastbound through right lane (Requires two Eastbound receiving lanes)

The results of the proposed improvements are presented in **Table 10**.

Table 10: Widening to Four Lanes

Mov.	Weekday AM Peak Hour				Weekday PM Peak Hour			
	LOS	v/c	Control Delay(s)	95th %ile Queue Length (m)	LOS	v/c	Control Delay(s)	95th %ile Queue Length (m)
Overall	D	0.91	47.4	-	D	0.82	36.3	-
EB T	D	0.66	50.5	96.3	D	0.67	51.5	68.0
WB L	D	0.88	44.0	144.0	C	0.77	30.5	103.3
NB T	D	0.37	50.6	34.5	D	0.85	45.8	141.1
SB T	D	0.59	40.3	129.3	C	0.35	32.8	24.7

Changes to the existing configuration of the intersection are the following (in red):

- NB: 1 Left Turn, 1 Through, **1 Through - Right**
- SB: 1 Left Turn, 1 Through, **1 Through-Right**
- EB: 1 Left Turn, 1 Through, **1 Through - Right**
- WB: 1 Left Turn, 1 Through, **1 Through - Right**

B000709

4.2 Storage Requirements

With regard to recommended storage for auxiliary turn lanes at the King and Albion intersection, **Table 11** summarizes the following information for all alternatives:

- Existing vehicle storage provided,
- TAC's recommended vehicle storage (based on the highest projected volumes between Option 6 and TAC's geometric design standards),
- CIMA+'s recommended vehicle storage (based on expected queue lengths resulting from the SimTraffic analysis and taking into account geometric restrictions such as nearby bridge structures) and,
- The distance to nearby bridge structures.

Table 11: Storage Requirements for Auxiliary Lanes

BRES Report Option 6				
Movement	Existing	TAC	CIMA+	Distance to Structure (m)
NBL	90	35	140	175m
NBR	n/a	160	75	175m
SBL	90	50	175	75m
SBR	15	15	40	75m
EBL	20	10	50	n/a
EBR	35	50	85	n/a
WBL	25	155	150	15m
WBR	n/a	60	75	15m

Double Left Turn (Westbound)				
Movement	Existing	TAC	CIMA+	Distance to Structure (m)
NBL	90	35	30	175m
NBR	n/a	160	75	175m
SBL	90	50	50	75m
EBL	20	10	15	n/a

B000709

Movement	Existing	TAC	CIMA+	Distance to Structure (m)
EBR	35	50	25	n/a
WBL	25	155	90	15m

Double Left Turn and Road Widening (North-South)				
Movement	Existing	TAC	CIMA+	Distance to Structure (m)
NBL	90	35	35	175m
SBL	90	50	50	75m
EBL	20	10	15	n/a
EBR	35	50	15	n/a
WBL	25	155	90	15m

Widening to Four Lanes				
Movement	Existing	TAC	CIMA+	Distance to Structure (m)
NBL	90	35	35	175m
SBL	90	50	50	75m
EBL	20	10	15	n/a
WBL	25	155	155	15m

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5. Traffic Safety

5.1 Collision Analysis

In 2012, CIMA+ conducted a safety network screening analysis for the Region of Peel using collision data from 2005 to 2009. Safety network screening is a systematic ranking of locations in terms of their potential for safety improvements. Sites ranked high have a higher potential for a safety improvement. In the 2012 CIMA+ report, the subject intersection (described as intersection ALBION VAUGHAN RD/CALEDON KING TOWN LI @ KING ST E (INT_452)) was ranked 147 out of 587 signalized intersections putting the intersection in the top 25% of intersections in terms of the potential for a safety improvement. During the 2005 to 2009 period there had been twenty-five property damage only collisions and four injury collisions and the average intersection entering traffic volume over the five year period was 19,000 AADT.

For the current study, CIMA+ reviewed the 2011-2015 collision data, which was the most recent five years of collision data available. During the 2011-2015 period there were nineteen property damage only collisions and two injury collisions. The single biggest predictor of collisions is traffic volume. An increase in traffic volume usually means an increase in the predicted number of collisions, though the relationship is often non-linear. Based upon an eight-hour traffic count conducted in 2015, the AADT at that time would be approximate 27,500, an increase of 45% from the 2005-2009 period. Using the CIMA safety performance functions, a 45% increase in traffic volume would have been expected to result in a 75% increase in the predicted number of collisions.

Figure 7: Number of Collisions by Year and Severity

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Overall, the number of collisions at King and Albion appears to have gone down for the 2011-2015 period compared to the 2005-2009 period both in the total number of collisions and their corresponding severity. The traffic volumes have gone up, but the safety of King and Albion does not appear to have gotten worse over time. The observed number of collisions by year and severity in Figure 7 does not show an increase in collisions over time.

CIMA+ reviewed the individual motor vehicle collision reports and generated the collision diagram for the 2011-2015 period provided in **Figure 8**. Except for the two angle collisions which were the two injury collisions, the rest of the collisions were relatively minor property damage only collisions. The most common collision type involved one vehicle stopping or stopped for the red light while the vehicle behind not stopping in time to avoid a rear-end collision. Eleven collisions were rear-end (52%), five were turning/angle collisions (24%), three were single motor vehicle collisions (14%), and two were side-swipe collisions (10%).There were no reported pedestrian, cyclist, or fatal collisions at King and Albion during the 2011-2015 period. Given the high number of rear-end collisions and the relatively low number of angle collisions, this intersection would not be a good candidate for red-light enforcement.

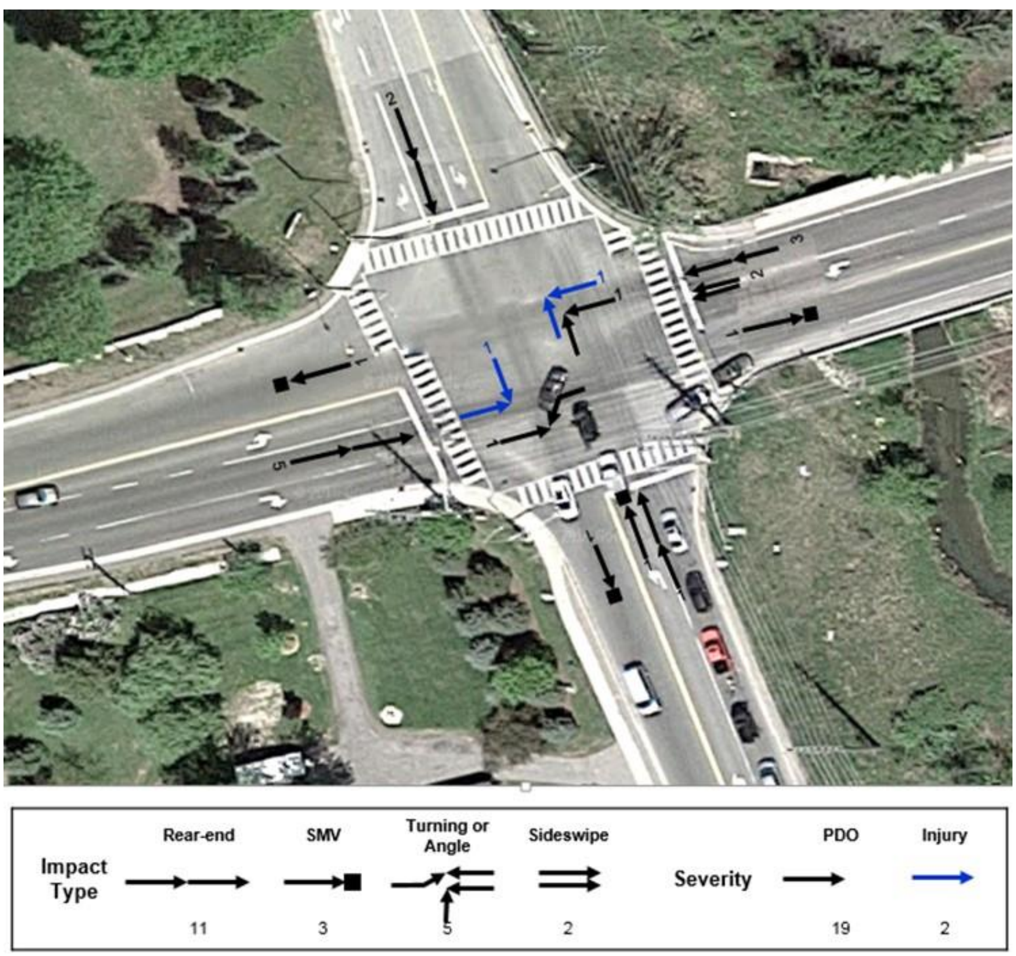

Figure 8: Collision Diagram (2011-2015 Data)

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The distribution of the number of collisions by month, day of the week, and hour do not show any pattern as shown in **Figure 9, Figure 10**, and respectively. All but two of the collisions occurred during daylight hours (see **Figure 11**)

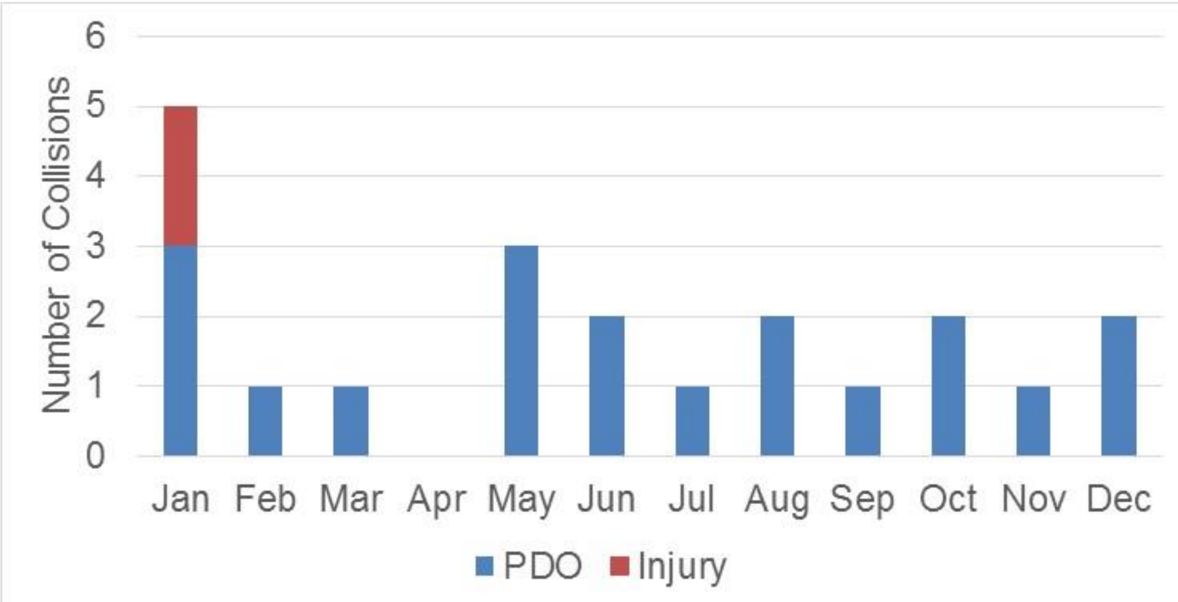

Figure 9: Collisions by Month and Severity (2011-2015 Data)

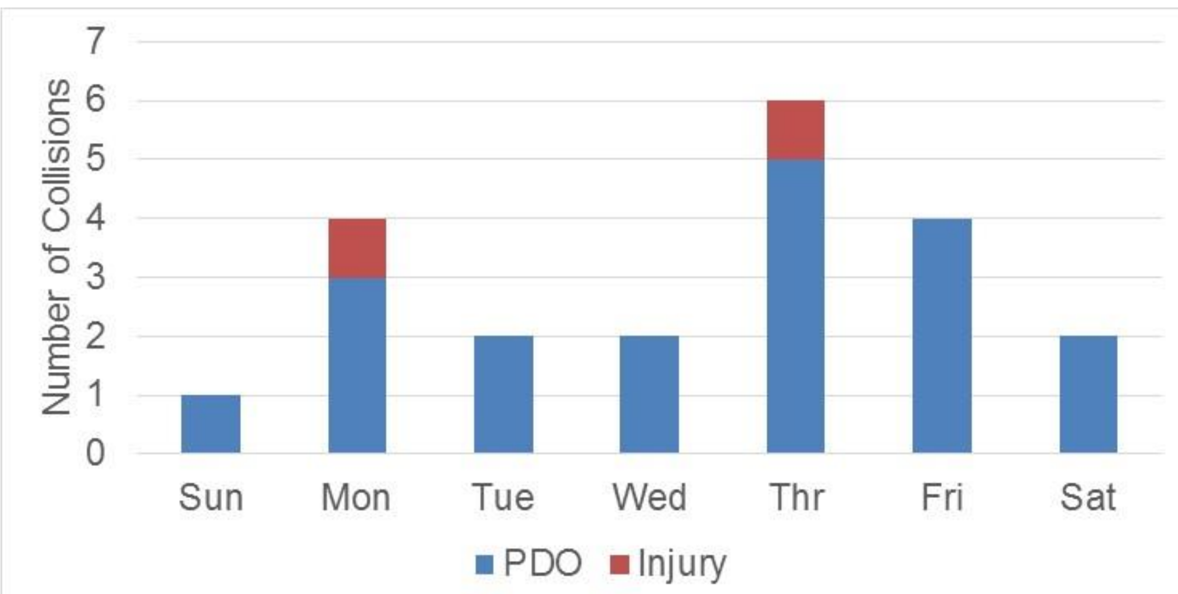

Figure 10: Collisions by Day of the Week and Severity (2011-2015 Data)

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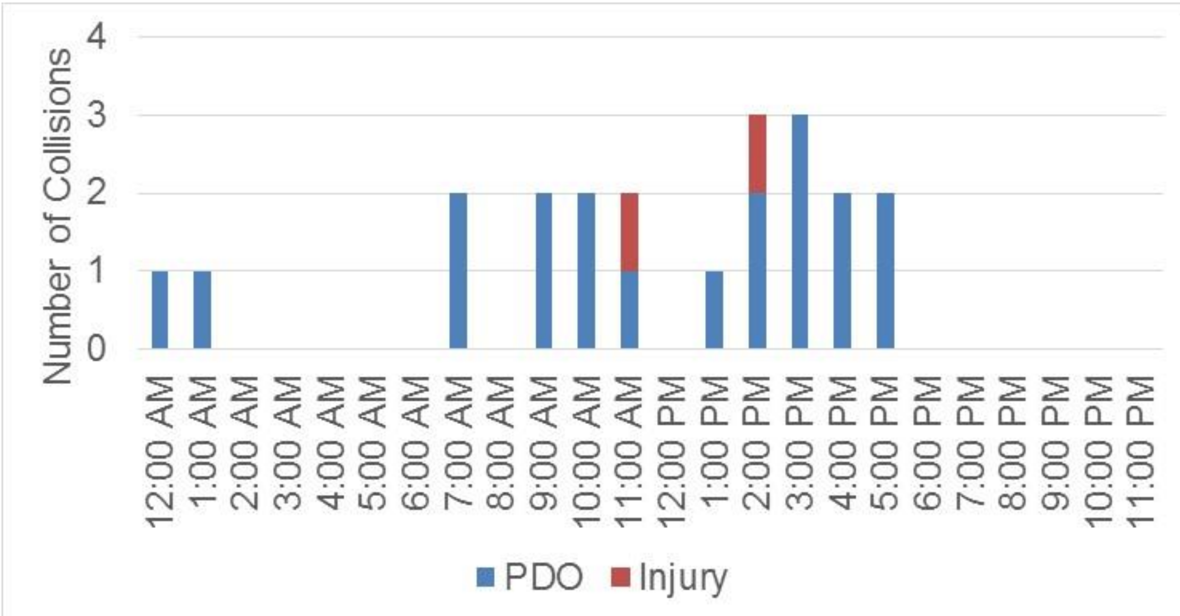

Figure 11: Collisions by Hour and Severity (2011-2015 Data)

5.2 Speed Data Analysis

The Transportation Association of Canada (TAC) *Canadian Guidelines for Establishing Posted Speed Limits*, published in 2009, states that for roads with a posted speed of 70 km/h or less, the 85th percentile speed under relatively ideal driving conditions should be within +/- 10 km/h of the posted speed limit. Therefore, according to the TAC guidelines, for a posted speed of 60 km/h, an 85th percentile speed of 71 km/h or higher would be an indication of a speeding concern.

Drivers choose their speed primarily upon what the road environment is telling them, and not necessarily based upon what is the posted speed limit. Consider the view as seen by a driver eastbound on King Street in **Figure 12,** and southbound on Albion Vaughan Road in **Figure 13.** The driver sees a rural environment, wide lanes, and plenty of sight distance. These types of features tell the driver that it is permissible to go fast, even though the road is posted at 60 km/h. As summarized in National Cooperative Highway Research Program Report (NCHRP) 600, most drivers do not perceive speeding as particularly risky and most drivers will drive at what they consider an appropriate speed regardless of the speed limit may actually be.

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Figure 12: Driver's View Eastbound on King Street Approaching Albion Vaughan Road

Figure 13: Driver's View southbound on Albion Vaughan Road approaching King Street

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A study in the United States showed that the posted speed limit has very little impact on driver's speed choice. A Federal Highway Administration (FHWA) study by Parker[1] looked at the effect of changing speed limits at 98 sites in 22 U.S. states. The posted speed limits were raised as much as 24 km/h (15 mph) and lowered as much as 32 km/h (20 mph), while no other engineering or enforcement changes were made. Before and after measurements showed minimal changes in speed, and in some cases there were changes that were opposite in direction to the change in speed limit. There was essentially no effect of changing the posted speed limit sign by itself, because the basic message of the road had not changed.

Vehicle speed data collected by the Region are summarized in **Table 12.** The speed data had been collected just 400 m west (King Street – 0.4 km West of Peel/York Boundary), 2.2 km north (Caledon King Townline - King Street & Columbia Way), and 1 km south (Albion Vaughan Road - Old King Road & Nunville Road) of the subject intersection. Based upon the TAC guidance, there is a speed concern in the vicinity of the King and Albion intersection. However, given the rural type environment and what the road is telling the driver, the speeds appear to be typical for this part of Peel Region.

Table 12: Speed Study Data Summary – North Ridge Trail

Location	Dates	Direction	Average Daily Volume	85th Percentile Speed
King Street – 0.4 km West of Peel/York Boundary	March 26- March 28, 2012	East & West	7261	70 km/h
King Street – 0.4 km West of Peel/York Boundary	April 22- April 24, 2013	East & West	7496	71 km/h*
King Street – 0.4 km West of Peel/York Boundary	April 8- April 10, 2014	East & West	8955	72 km/h
King Street – 0.4 km West of Peel/York Boundary	April 14- April 16, 2015	East & West	9490	73 km/h
Caledon King Townline - King Street & Columbia Way	September 16, 2014	North & South	8795	87 km/h
Albion Vaughan Road - Old King Road & Nunville Road	September 19, 2016	North & South	16139	81 km/h

** The 2013 85th percentile speed data is based upon westbound data only as the eastbound data had an issue with the source data.*

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[1] Parker, M. R. Jr. (1997). "Effects of raising and lowering speed limits on selected roadway sections." Rep. No. FHWA-RD-92-084, Federal Highway Administration, Washington, D.C. https://www.fhwa.dot.gov/publications/research/safety/97084/97084.pdf

5.3 Field Investigation Findings

CIMA+ conducted the field review of the King and Albion intersection on November 11th, 2016 between 7 AM and 10 AM, which overlapped with the peak AM period (approximately 7:30 AM to 8:30 AM).

All four approaches to the intersection have a downward slope towards the intersection. This allows for the intersection to be clearly visible at a far distance away without any sight restrictions. The downward slope would be expected to contribute to an increase in vehicles speed which may be contributing to the number of rear-end collisions at the intersection. The steepest slope appears to be the west leg, which also has had historically the highest number of rear-end collisions.

There has been no collision history associated with any of the driveway accesses within the operational area of the intersection. The driveway closest to the intersection is on the west leg about 24 m west from the intersection. The same property has second driveway approximate 37 m south on the south leg. No vehicles were observed going in or out of the driveway accesses during the field visit. Since the volume of vehicles accessing the driveways are low, the safety concern of driveway accesses within the operational area of the intersection appears to be low. However, if the property on the southwest corner should become a commercial property with higher in-and-out access volume, then relocating the driveway accesses as far as possible from the intersection would be recommended.

During the field investigation, traffic queues were able to clear within one cycle even during the peak AM period. No pedestrians or cyclists were observed during the field visit.

5.3.1 Pedestrian Facilities

The northeast and southeast corners of the intersection of King and Albion do not provide sufficient space for pedestrians to stand. In particular the sidewalk area is less than 1 m and therefore do not meet current Accessibility for Ontarians with Disabilities Act (AODA) requirement of a minimum clear width of 1.5 m. These two corners also do not have any curb ramps. With any major reconstruction, AODA would require that the intersection pedestrian facilities be upgraded.

None of the intersection corners include tactile walking surface indicators.

5.3.2 Guiderail

The guiderail along the southeast corner, shown in **Figure 14,** is damaged with several of the supporting wood structures knocked sideways. This is an indication that the structure may have been sideswiped by a vehicle making a right-turn as opposed to being struck directly. The guiderail's structure appears compromised and the reflectors attached to the wood are no longer oriented correctly. There is a very large hydro pole located on the southeast corner which would most likely make it very costly to make any geometric improvements to this corner of the intersection.

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Figure 14: Damaged Guiderail at Southeast Corner

5.3.3 Street Name Signs

The intersection of King and Albion is the only signalized intersection in kilometres in each direction. Thus the Region may consider installing larger street name and advanced street name signs to assist drivers. The current signs are too small to be read by unfamiliar drivers at the current operating speeds. If possible, consideration should be given to the oversized street name signs that can be mounted on the traffic signal pole.

The complexity of the street name signs could be reduced if there was a way to rename the streets to one name, because "Caledon – King Townline / Albion – Vaughan Road" is a lot of text to read as shown in **Figure 15.** Also shown in **Figure 15,** are the street name signs at the intersection which are very small. The distinction between different jurisdictions probably does not have any importance to most drivers. A simplified naming structure would reduce the complexity of navigation for unfamiliar drivers, allow for simpler signing, and allow for larger font sizes to be used for the same sized sign and increase sign visibility.

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Figure 15: Street Name and Advance Street Name Signs

5.3.4 Truck Route Restrictions

There are several truck route restrictions at the intersection of King and Albion. Trucks are not allowed to go north or west at the intersection. There is an opportunity to reduce the complexity of the truck restriction signing.

Our understanding of truck route restrictions is that they are intended to prohibit heavy trucks from using the street as a cut-through route to avoid traffic congestion on major arterial roads, not to prevent or inconvenience heavy trucks with a legitimate reason from being on the street or in the neighbourhood. Further, our understanding is that truck route restrictions must always come with exemption for vehicles actually engaged in making a delivery or a collection from a premises which cannot be reached except by way of a road or portion of road where heavy trucks are prohibited. Nonetheless, the "EXCEPT FOR LOCAL DELIVERIES" exemption is often explicitly added to truck restriction signs. A review of the literature indicates there is universal difficulty by jurisdictions in appropriately signing the restriction while at the same time allowing for exemptions. The ideal scenario would be one where the exemption is understood by drivers and the public and would not need to be added to signs.

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A truck restriction sign in use at King and Albion is shown in **Figure 16** where left turns by trucks are not allowed. This sign is complex and may not be understood by many drivers. The difficulty with the sign in Figure 16 is that there are four symbols to convey one restriction (the symbols are truck, left-turn arrow, and two circles with slashes- one left and one right though they mean the same thing). Drivers may not connect the no-left restriction with the no truck restriction.

An alternative truck movement restriction sign design for the Region's consideration is proposed in **Figure 17**.

Figure 16: Truck Restriction Sign at King and Albion

Figure 17: No Truck Left-Turns Signs

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Whether the local deliveries exception needs to be added to the truck restriction sign is a larger question about signing policies within the Region. Regardless, the sign design in **Figure 17** would be expected to have a higher comprehension rate than the sign currently in use.

A similar issue with two separate signs to convey one traffic restriction is shown in **Figure 18**. Using two physically separate signs to convey the message “TRUCKS MUST TURN LEFT” requires more effort

Figure 18: Trucks Must Turn Left Signs

Within the study area there is end of no trucks sign as shown in Figure 19. The purpose of this sign is unclear as it would only be seen by trucks already in violation of the no-trucks restriction. This sign may be part of a larger truck signing policy within the Region, and further discussion may be needed understand the intent of this sign.

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Figure 19: Truck Restriction Ends Sign at King and Albion

5.3.5 Pedestrians Ahead Sign

A pedestrians ahead sign, shown in Figure 20, has been installed on the eastbound approach to the intersection of King and Albion. According to Ontario Traffic Manual Book 6 Warning Signs, the purpose of the pedestrians ahead sign is to provide advance warning to motorists that pedestrians may be in the area and it is normally used in rural areas where, from visual observation, the presence of pedestrians in rather uninhabited areas would come as a surprise to the motorist. The pedestrian ahead sign should normally be installed where field observations have indicated that a significant number of pedestrians frequently cross the road or walk adjacent to it. There may be a purpose behind the installation of this sign that CIMA is not aware of. If the number of pedestrians walking along the road or crossing in the area is low, then our suggestion would be to remove the pedestrians ahead sign.

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Figure 20: Pedestrian Ahead (Wc-7)

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6. Summary of Proposed Improvements

Based on the results of the operational analysis conducted for the projected 2031 horizon year, it is recommended that the full widening of the intersection should be consider for further analysis as part of the evaluation process. As such the following configuration changes needs to be considered (in red):

- NB: 1 Left Turn, 1 Through, **1 Through - Right**
- SB: 1 Left Turn, 1 Through, **1 Through-Right**
- EB: 1 Left Turn, 1 Through, **1 Through - Right**
- WB: 1 Left Turn, 1 Through, **1 Through - Right**

With respect of infrastructure supporting active transportation the following elements are recommended to be considered during the evaluation process:

- A new concrete sidewalk along the north and south side of King Street between the existing bus stops and Albion Vaughan Road (approximately 60 m and 40 m of new sidewalk respectively).
- Consideration for implementation of Travel Demand Management (TDM) measures.

A summary of the proposed safety improvements is provided in **Table 13**.

Table 13: Summary of Proposed Safety Improvements

#	Proposed Improvement for Consideration by the Region
1.	With any major reconstruction, include sufficiently wide sidewalks with curb ramps and tactile walking surface indicators.
2.	Repair/replace damaged guiderail along the southeast corner.
3.	Install oversized street name signs that can be mounted on the traffic signal pole. Consider a simplified naming structure for the street names to reduce the complexity of navigation for unfamiliar drivers.
4.	Consider a redesign of the truck restriction signs to simplify the signing.
5.	Consider removing the pedestrians ahead sign from the eastbound approach.

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7. Revisions to Transportation and Traffic Study Report Preliminary Findings

After receiving comments from the general public and stakeholders during the TAC and PIC meetings, including comments received from the Toronto and Region Conservation Authority (TRCA) regarding the content of the draft technical reports and the design alternatives evaluation, the following changes to the technically preferred alternative were subjected to further investigation and discussion with the Region.

7.1 Modification to the Interim Option

Information provided as part of the TAC Meeting (November 06, 2017) and PIC meeting (December 5, 2017) identified the advantage of completing the implementation of the technically preferred alternative (the full widening of the intersection) in two phases:

- Phase 1, in which an interim solution (addition of a northbound right-turn lane) will be completed prior to implementation of the preferred solution to address existing safety concerns; and
- Phase 2, implementation of the ultimate solution (full widening of the intersection).

Since the original design of the northbound right-turn lane (included as part of the full widening – see **Figure 21**) required the construction of a retaining wall in the southeast portion of the intersection, TRCA requested a review of the alignment of the intersection and/or the exploration of other alternatives that mitigates the potential effects of the proposed interim option.

Figure 21 Preliminary Design – Full Widening as proposed on 2017

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Design reviews and discussions with the Region conducted during 2018 and 2019 resulted in the realignment to the west of the south segment of the intersection to eliminate the need for a retaining wall as well as to avoid the relocation of the hydro pole located at the southeast corner of the intersection (**Figure 22**)

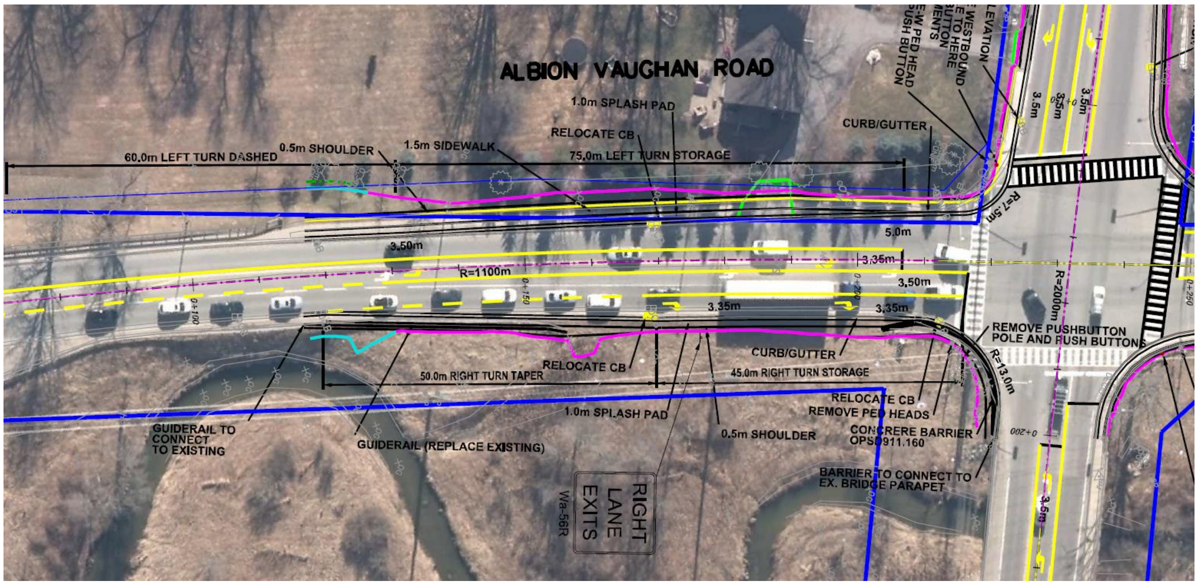

Figure 22 Preliminary Design – Interim Option (2019)

7.2 Modification to the Full Widening

The design criteria originally proposed for the design of the full widening of the intersection as well as the need for specific roadway elements originally considered as part of the design were reviewed and discussed with the Region. The following summarizes the comments provided by the Region:

- Pedestrian Facilities. Removal of south leg and east leg crosswalks of the intersection was proposed due to the following:
  - A negligible amount of pedestrian and cyclist activity;
  - The south-east corner doesn't provide space for pedestrians to stand. In particular, the sidewalk area is less than 1m and therefore doesn't meet the AODA requirement of a minimum clear width of 1.5m;
  - There is no connectivity to any existing facilities on the east side and through the other three crosswalks, pedestrians can cross the intersection safely;
  - The existing hydro pole and cold creek tributary (under TRCA's jurisdiction) impose significant physical constraints. Realty has recommended to contain the interim intersection improvements within road allowance and avoid encroaching private property located at the south-west corner.

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- Intersection Configuration. Based on turning movements and increased volume, changes to the existing configuration of the intersection are the following (in red)
  - NB: 1 Left Turn, 1 Through, 1 Right
  - SB: 1 Left Turn, 1 Through, 1 Through -Right
  - EB: 1 Left Turn, 1 Through, 1 Right
  - WB: 1 Left Turn, 1 Through, 1 Right

7.3 Town of Caledon and Region of York Transportation Master Plans

Since the preparation of the original report long range transportation plans were completed by the Region of York and the Town of Caledon.

The Region of York completed a region-wide Transportation Master Plan in November 2016 which includes a series of maps graphically describing the proposed improvements to the roadway network under the Region's jurisdiction for the 1-5, 6-10, 11-15, and 16-25 horizon years. As part of Project 2011, widening of King Road to 4 lanes between Caledon-King Townline to Highway 27 is scheduled for 2032 to 2041; however, the required completion of a Schedule C Class EA is identified as Not Started.

With respect of the Town of Caledon Transportation Master Plan completed on November 2017, the widening (2-4 lanes) of Albion Vaughan Road from Mayfield Road to King Street was proposed for implementation by the year 2031. At the time of the present report, the status of the required Schedule C Class EA is unknown.

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APPENDIX A – SYNCHRO OUTPUTS

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	18	374	146	448	269	44	59	128	276	146	637	44
Future Volume (vph)	18	374	146	448	269	44	59	128	276	146	637	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.6	6.6	6.6	6.6	6.6		6.3	6.3		6.3	6.3	6.3
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.90		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1750	1842	1479	1700	1801		1668	1541		1750	1842	1566
Flt Permitted	0.55	1.00	1.00	0.10	1.00		0.09	1.00		0.19	1.00	1.00
Satd. Flow (perm)	1014	1842	1479	185	1801		160	1541		347	1842	1566
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	20	420	164	503	302	49	66	144	310	164	716	49
RTOR Reduction (vph)	0	0	97	0	4	0	0	56	0	0	0	32
Lane Group Flow (vph)	20	420	67	503	347	0	66	398	0	164	716	17
Heavy Vehicles (%)	2%	2%	8%	5%	2%	3%	7%	6%	11%	2%	2%	2%
Turn Type	Perm	NA	Perm	pm+pt	NA		pm+pt	NA		pm+pt	NA	Perm
Protected Phases		2		1	6		3	8		7	4	
Permitted Phases	2		2	6			8			4		4
Actuated Green, G (s)	32.1	32.1	32.1	69.1	69.1		48.0	44.0		55.4	47.7	47.7
Effective Green, g (s)	32.1	32.1	32.1	69.1	69.1		48.0	44.0		55.4	47.7	47.7
Actuated g/C Ratio	0.23	0.23	0.23	0.49	0.49		0.34	0.31		0.40	0.34	0.34
Clearance Time (s)	6.6	6.6	6.6	6.6	6.6		6.3	6.3		6.3	6.3	6.3
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Grp Cap (vph)	232	422	339	420	888		97	484		214	627	533
v/s Ratio Prot		0.23		c0.26	0.19		0.02	0.26		c0.04	c0.39	
v/s Ratio Perm	0.02		0.05	c0.33			0.21			0.26		0.01
v/c Ratio	0.09	1.00	0.20	1.20	0.39		0.68	0.82		0.77	1.14	0.03
Uniform Delay, d1	42.4	53.9	43.6	44.0	22.2		37.4	44.4		34.7	46.1	30.8
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	0.7	42.7	1.3	109.9	1.3		22.4	12.1		17.5	81.9	0.1
Delay (s)	43.1	96.5	44.9	153.9	23.5		59.8	56.5		52.2	128.0	30.8
Level of Service	D	F	D	F	C		E	E		D	F	C
Approach Delay (s)		80.7			100.3			56.9			109.5	
Approach LOS		F			F			E			F	

Intersection Summary			
HCM 2000 Control Delay	91.4	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.21		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	25.8
Intersection Capacity Utilization	102.9%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT	SBR
Lane Group Flow (vph)	20	420	164	503	351	66	454	164	716	49
v/c Ratio	0.09	1.00	0.38	1.20	0.39	0.68	0.84	0.77	1.14	0.08
Control Delay	43.8	96.1	15.2	147.3	23.4	62.4	51.7	52.8	123.7	0.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	43.8	96.1	15.2	147.3	23.4	62.4	51.7	52.8	123.7	0.2
Queue Length 50th (m)	4.4	117.0	8.4	~154.0	58.3	11.0	99.0	29.0	~231.1	0.0
Queue Length 95th (m)	11.6	#180.9	27.7	#218.7	80.8	#26.8	#151.5	#53.4	#300.0	0.0
Internal Link Dist (m)		1224.7			338.1		4515.2		778.4	
Turn Bay Length (m)	50.0		60.0	115.0		120.0		130.0		40.0
Base Capacity (vph)	232	422	436	420	892	97	540	214	627	618
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.09	1.00	0.38	1.20	0.39	0.68	0.84	0.77	1.14	0.08

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	23	351	80	406	493	173	102	585	455	32	190	25
Future Volume (vph)	23	351	80	406	493	173	102	585	455	32	190	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	3.5	3.7	3.5	3.5	3.7	3.5	3.5	3.7	3.5	3.5	3.7	3.5
Total Lost time (s)	6.6	6.6	6.6	6.6	6.6		6.3	6.3		6.3	6.3	6.3
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.93		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1750	1883	1566	1653	1819		1750	1745		1716	1865	1536
Flt Permitted	0.17	1.00	1.00	0.12	1.00		0.64	1.00		0.06	1.00	1.00
Satd. Flow (perm)	315	1883	1566	206	1819		1175	1745		105	1865	1536
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	23	351	80	406	493	173	102	585	455	32	190	25
RTOR Reduction (vph)	0	0	64	0	9	0	0	20	0	0	0	12
Lane Group Flow (vph)	23	351	16	406	657	0	102	1020	0	32	190	13
Heavy Vehicles (%)	2%	2%	2%	8%	2%	0%	2%	2%	4%	4%	3%	4%
Turn Type	Perm	NA	Perm	pm+pt	NA		Perm	NA		pm+pt	NA	Perm
Protected Phases		6		5	2			8		7	4	
Permitted Phases	6		6	2			8			4		4
Actuated Green, G (s)	27.2	27.2	27.2	54.2	54.2		62.8	62.8		71.4	71.4	71.4
Effective Green, g (s)	27.2	27.2	27.2	54.2	54.2		62.8	62.8		71.4	71.4	71.4
Actuated g/C Ratio	0.20	0.20	0.20	0.39	0.39		0.45	0.45		0.52	0.52	0.52
Clearance Time (s)	6.6	6.6	6.6	6.6	6.6		6.3	6.3		6.3	6.3	6.3
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Grp Cap (vph)	61	369	307	293	711		532	791		80	961	791
v/s Ratio Prot		0.19		c0.20	0.36			c0.58		0.01	c0.10	
v/s Ratio Perm	0.07		0.01	c0.34			0.09			0.20		0.01
v/c Ratio	0.38	0.95	0.05	1.39	0.92		0.19	1.29		0.40	0.20	0.02
Uniform Delay, d1	48.3	55.0	45.2	42.2	40.2		22.7	37.9		32.1	18.1	16.4
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	8.0	34.9	0.1	193.4	18.4		0.4	139.9		6.7	0.2	0.0
Delay (s)	56.3	89.9	45.3	235.6	58.6		23.0	177.8		38.9	18.3	16.4
Level of Service	E	F	D	F	E		C	F		D	B	B
Approach Delay (s)		80.3			125.6			163.9			20.8	
Approach LOS		F			F			F			C	

Intersection Summary			
HCM 2000 Control Delay	124.7	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.35		
Actuated Cycle Length (s)	138.5	Sum of lost time (s)	25.8
Intersection Capacity Utilization	132.4%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT	SBR
Lane Group Flow (vph)	23	351	80	406	666	102	1040	32	190	25
v/c Ratio	0.37	0.93	0.19	1.36	0.91	0.19	1.26	0.32	0.20	0.03
Control Delay	67.9	86.4	2.4	213.7	55.7	23.7	159.1	24.9	18.9	0.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	67.9	86.4	2.4	213.7	55.7	23.7	159.1	24.9	18.9	0.1
Queue Length 50th (m)	5.2	89.7	0.0	~125.5	159.3	15.5	~334.8	3.9	25.1	0.0
Queue Length 95th (m)	14.5	#144.8	2.9	#185.1	#229.3	27.0	#408.9	8.8	38.3	0.0
Internal Link Dist (m)		1221.3			338.1		4333.6		2204.7	
Turn Bay Length (m)	50.0		60.0	115.0		120.0		130.0		40.0
Base Capacity (vph)	62	376	413	299	734	543	824	100	1003	862
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.37	0.93	0.19	1.36	0.91	0.19	1.26	0.32	0.19	0.03

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	18	374	146	448	269	44	59	128	276	146	637	44
Future Volume (vph)	18	374	146	448	269	44	59	128	276	146	637	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.6	6.6	6.6	4.0	6.6	6.6	4.0	6.3	6.3	4.0	6.3	6.3
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1750	1842	1479	1700	1842	1551	1668	1773	1439	1750	1842	1566
Flt Permitted	0.58	1.00	1.00	0.11	1.00	1.00	0.08	1.00	1.00	0.60	1.00	1.00
Satd. Flow (perm)	1061	1842	1479	202	1842	1551	144	1773	1439	1098	1842	1566
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	20	420	164	503	302	49	66	144	310	164	716	49
RTOR Reduction (vph)	0	0	90	0	0	25	0	0	202	0	0	31
Lane Group Flow (vph)	20	420	74	503	302	24	66	144	108	164	716	18
Heavy Vehicles (%)	2%	2%	8%	5%	2%	3%	7%	6%	11%	2%	2%	2%
Turn Type	Perm	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases		2		1	6		3	8		7	4	
Permitted Phases	2		2	6		6	8		8	4		4
Actuated Green, G (s)	31.4	31.4	31.4	67.4	67.4	67.4	51.9	48.7	48.7	59.5	52.5	52.5
Effective Green, g (s)	31.4	31.4	31.4	67.4	67.4	67.4	51.9	48.7	48.7	59.5	52.5	52.5
Actuated g/C Ratio	0.22	0.22	0.22	0.48	0.48	0.48	0.37	0.35	0.35	0.42	0.38	0.38
Clearance Time (s)	6.6	6.6	6.6	4.0	6.6	6.6	4.0	6.3	6.3	4.0	6.3	6.3
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Lane Grp Cap (vph)	237	413	331	439	886	746	88	616	500	499	690	587
v/s Ratio Prot		0.23		c0.26	0.16		c0.02	0.08		0.02	c0.39	
v/s Ratio Perm	0.02		0.05	c0.29		0.02	0.26		0.07	0.12		0.01
v/c Ratio	0.08	1.02	0.22	1.15	0.34	0.03	0.75	0.23	0.22	0.33	1.04	0.03
Uniform Delay, d1	42.9	54.3	44.3	43.4	22.5	19.1	39.7	32.4	32.2	26.3	43.8	27.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.7	48.6	1.6	89.3	1.0	0.1	34.3	0.4	0.5	0.8	44.4	0.0
Delay (s)	43.6	102.9	45.9	132.7	23.6	19.2	74.1	32.8	32.6	27.1	88.1	27.7
Level of Service	D	F	D	F	C	B	E	C	C	C	F	C
Approach Delay (s)		85.5			87.6			37.9			74.2	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	74.0	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.11		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	20.9
Intersection Capacity Utilization	98.8%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Intersection: 27: Townline Road & King Street

Movement	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	T	R	L	T	R	L	T	R	L	T	R
Maximum Queue (m)	57.3	245.5	67.5	122.5	348.0	29.0	45.6	71.4	57.1	137.4	256.3	47.5
Average Queue (m)	8.6	133.9	45.3	119.9	284.7	4.2	17.3	25.2	30.8	83.3	213.2	9.9
95th Queue (m)	33.8	254.4	84.4	136.3	443.8	15.9	37.3	51.1	54.1	173.4	300.9	38.7
Link Distance (m)		1223.4			346.9			238.1			244.5	
Upstream Blk Time (%)					28						26	
Queuing Penalty (veh)					0						0	
Storage Bay Dist (m)	50.0		60.0	115.0		50.0	120.0		50.0	130.0		40.0
Storage Blk Time (%)		46	0	57	4			1	2	0	58	0
Queuing Penalty (veh)		75	2	180	18			2	4	0	110	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	23	351	80	406	493	173	102	585	455	32	190	25
Future Volume (vph)	23	351	80	406	493	173	102	585	455	32	190	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.6	6.6	6.6	4.0	6.6	6.6	6.3	6.3	6.3	6.3	6.3	6.3
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1750	1842	1566	1653	1842	1597	1750	1842	1536	1716	1824	1536
Flt Permitted	0.15	1.00	1.00	0.34	1.00	1.00	0.58	1.00	1.00	0.11	1.00	1.00
Satd. Flow (perm)	278	1842	1566	586	1842	1597	1068	1842	1536	201	1824	1536
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	24	369	84	427	519	182	107	616	479	34	200	26
RTOR Reduction (vph)	0	0	53	0	0	69	0	0	152	0	0	16
Lane Group Flow (vph)	24	369	31	427	519	113	107	616	327	34	200	10
Heavy Vehicles (%)	2%	2%	2%	8%	2%	0%	2%	2%	4%	4%	3%	4%
Turn Type	Perm	NA	Perm	pm+pt	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases		2		1	2			4			4	
Permitted Phases	2		2	2		2	4		4	4		4
Actuated Green, G (s)	43.9	43.9	43.9	66.8	43.9	43.9	50.2	50.2	50.2	50.2	50.2	50.2
Effective Green, g (s)	43.9	43.9	43.9	66.8	43.9	43.9	50.2	50.2	50.2	50.2	50.2	50.2
Actuated g/C Ratio	0.33	0.33	0.33	0.50	0.33	0.33	0.37	0.37	0.37	0.37	0.37	0.37
Clearance Time (s)	6.6	6.6	6.6	4.0	6.6	6.6	6.3	6.3	6.3	6.3	6.3	6.3
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Lane Grp Cap (vph)	91	603	513	474	603	523	400	690	575	75	683	575
v/s Ratio Prot		0.20		c0.15	0.28			c0.33			0.11	
v/s Ratio Perm	0.09		0.02	c0.29		0.07	0.10		0.21	0.17		0.01
v/c Ratio	0.26	0.61	0.06	0.90	0.86	0.22	0.27	0.89	0.57	0.45	0.29	0.02
Uniform Delay, d1	33.1	37.8	30.9	24.9	42.1	32.5	29.1	39.3	33.3	31.5	29.4	26.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.2	2.7	0.1	21.1	13.0	0.4	0.8	14.8	2.1	8.8	0.5	0.0
Delay (s)	36.3	40.5	31.0	46.0	55.1	33.0	29.8	54.1	35.4	40.4	29.9	26.4
Level of Service	D	D	C	D	E	C	C	D	D	D	C	C
Approach Delay (s)		38.6			48.1			44.5			30.9	
Approach LOS		D			D			D			C	

Intersection Summary			
HCM 2000 Control Delay	43.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	133.9	Sum of lost time (s)	16.9
Intersection Capacity Utilization	97.8%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Intersection: 27: Townline Road & King Street

Movement	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	T	R	L	T	R	L	T	R	L	T	R
Maximum Queue (m)	50.8	114.5	67.4	122.4	335.9	57.5	127.4	254.6	57.5	66.9	63.8	28.8
Average Queue (m)	8.3	54.4	13.1	100.7	192.9	35.6	51.0	244.9	51.4	36.1	29.8	3.8
95th Queue (m)	27.5	92.9	47.9	149.3	362.4	72.1	136.4	251.2	72.6	68.5	54.8	16.1
Link Distance (m)		1223.9			346.9			238.2			244.5	
Upstream Blk Time (%)					7			51				
Queuing Penalty (veh)					0			0				
Storage Bay Dist (m)	50.0		60.0	115.0		50.0	120.0		50.0	130.0		40.0
Storage Blk Time (%)		13	0	9	36	0	0	48	4		5	0
Queuing Penalty (veh)		13	0	62	208	2	0	266	25		3	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	18	374	146	448	269	44	59	128	276	146	637	44
Future Volume (vph)	18	374	146	448	269	44	59	128	276	146	637	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.6	6.6	6.6	6.6	6.6		6.3	6.3	6.3	6.3	6.3	
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00		1.00	1.00	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1750	1842	1479	3298	1801		1668	1773	1439	1750	3466	
Flt Permitted	0.55	1.00	1.00	0.95	1.00		0.15	1.00	1.00	0.48	1.00	
Satd. Flow (perm)	1014	1842	1479	3298	1801		257	1773	1439	893	3466	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	20	420	164	503	302	49	66	144	310	164	716	49
RTOR Reduction (vph)	0	0	86	0	4	0	0	0	245	0	4	0
Lane Group Flow (vph)	20	420	78	503	347	0	66	144	65	164	761	0
Heavy Vehicles (%)	2%	2%	8%	5%	2%	3%	7%	6%	11%	2%	2%	2%
Turn Type	Perm	NA	Perm	Prot	NA		pm+pt	NA	Perm	pm+pt	NA	
Protected Phases		2		1	6		3	8		7	4	
Permitted Phases	2		2				8		8	4		
Actuated Green, G (s)	46.2	46.2	46.2	26.0	78.8		35.6	29.2	29.2	48.3	35.6	
Effective Green, g (s)	46.2	46.2	46.2	26.0	78.8		35.6	29.2	29.2	48.3	35.6	
Actuated g/C Ratio	0.33	0.33	0.33	0.19	0.56		0.25	0.21	0.21	0.34	0.25	
Clearance Time (s)	6.6	6.6	6.6	6.6	6.6		6.3	6.3	6.3	6.3	6.3	
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	
Lane Grp Cap (vph)	334	607	488	612	1013		129	369	300	386	881	
v/s Ratio Prot		c0.23		c0.15	0.19		0.02	0.08		c0.04	c0.22	
v/s Ratio Perm	0.02		0.05				0.11		0.04	0.11		
v/c Ratio	0.06	0.69	0.16	0.82	0.34		0.51	0.39	0.22	0.42	0.86	
Uniform Delay, d1	32.1	40.7	33.2	54.8	16.6		41.7	47.7	45.9	33.5	49.9	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.3	6.4	0.7	9.7	0.9		6.7	1.4	0.8	1.6	9.6	
Delay (s)	32.4	47.1	33.9	64.5	17.5		48.4	49.2	46.7	35.1	59.5	
Level of Service	C	D	C	E	B		D	D	D	D	E	
Approach Delay (s)		43.0			45.2			47.6			55.2	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM 2000 Control Delay	48.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	25.8
Intersection Capacity Utilization	76.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	20	420	164	503	351	66	144	310	164	765
v/c Ratio	0.06	0.67	0.28	0.82	0.34	0.45	0.41	0.58	0.44	0.87
Control Delay	35.1	47.8	10.9	66.6	17.5	41.8	51.1	9.3	37.5	60.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	35.1	47.8	10.9	66.6	17.5	41.8	51.1	9.3	37.5	60.8
Queue Length 50th (m)	4.0	107.7	7.1	68.8	53.6	11.8	33.8	0.0	31.0	105.3
Queue Length 95th (m)	10.2	139.9	23.5	87.4	69.5	23.0	53.3	23.7	50.1	127.9
Internal Link Dist (m)		1224.7			338.1		4515.2			778.4
Turn Bay Length (m)	50.0		60.0	115.0		120.0		50.0	130.0	
Base Capacity (vph)	352	638	597	645	1052	147	403	567	370	912
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.06	0.66	0.27	0.78	0.33	0.45	0.36	0.55	0.44	0.84

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	23	351	80	406	493	173	102	585	455	32	190	25
Future Volume (vph)	23	351	80	406	493	173	102	585	455	32	190	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	3.5	3.7	3.5	3.5	3.7	3.5	3.5	3.7	3.5	3.5	3.7	3.5
Total Lost time (s)	6.6	6.6	6.6	6.6	6.6		6.3	6.3	6.3	6.3	6.3	
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00		1.00	1.00	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.96		1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1750	1883	1566	3206	1819		1750	1883	1536	1716	3478	
Flt Permitted	0.34	1.00	1.00	0.95	1.00		0.62	1.00	1.00	0.12	1.00	
Satd. Flow (perm)	620	1883	1566	3206	1819		1137	1883	1536	222	3478	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	23	351	80	406	493	173	102	585	455	32	190	25
RTOR Reduction (vph)	0	0	61	0	9	0	0	0	165	0	7	0
Lane Group Flow (vph)	23	351	19	406	657	0	102	585	290	32	208	0
Heavy Vehicles (%)	2%	2%	2%	8%	2%	0%	2%	2%	4%	4%	3%	4%
Turn Type	Perm	NA	Perm	Prot	NA		Perm	NA	Perm	pm+pt	NA	
Protected Phases		6		5	2			8		7	4	
Permitted Phases	6		6				8		8	4		
Actuated Green, G (s)	29.4	29.4	29.4	20.8	56.8		45.7	45.7	45.7	54.1	54.1	
Effective Green, g (s)	29.4	29.4	29.4	20.8	56.8		45.7	45.7	45.7	54.1	54.1	
Actuated g/C Ratio	0.24	0.24	0.24	0.17	0.46		0.37	0.37	0.37	0.44	0.44	
Clearance Time (s)	6.6	6.6	6.6	6.6	6.6		6.3	6.3	6.3	6.3	6.3	
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	
Lane Grp Cap (vph)	147	447	371	538	834		419	695	567	122	1519	
v/s Ratio Prot		0.19		0.13	c0.36			c0.31		0.00	c0.06	
v/s Ratio Perm	0.04		0.01				0.09		0.19	0.11		
v/c Ratio	0.16	0.79	0.05	0.75	0.79		0.24	0.84	0.51	0.26	0.14	
Uniform Delay, d1	37.4	44.2	36.4	49.1	28.4		27.1	35.7	30.4	25.9	20.9	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.0	10.1	0.1	7.1	5.7		0.6	10.0	1.6	2.4	0.1	
Delay (s)	38.4	54.4	36.6	56.1	34.1		27.7	45.7	31.9	28.3	21.0	
Level of Service	D	D	D	E	C		C	D	C	C	C	
Approach Delay (s)		50.4			42.5			38.6			21.9	
Approach LOS		D			D			D			C	

Intersection Summary			
HCM 2000 Control Delay	40.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	123.8	Sum of lost time (s)	25.8
Intersection Capacity Utilization	104.6%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	23	351	80	406	666	102	585	455	32	215
v/c Ratio	0.16	0.78	0.17	0.74	0.77	0.24	0.83	0.61	0.22	0.15
Control Delay	43.7	58.0	2.0	59.7	35.5	30.2	46.9	17.2	25.0	20.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	43.7	58.0	2.0	59.7	35.5	30.2	46.9	17.2	25.0	20.7
Queue Length 50th (m)	4.6	83.0	0.0	51.0	139.0	17.3	130.9	38.2	4.4	15.1
Queue Length 95th (m)	12.1	115.8	2.7	#69.6	186.8	31.0	179.4	72.9	10.2	23.0
Internal Link Dist (m)		1221.3			338.1		4333.6			2204.7
Turn Bay Length (m)	50.0		60.0	115.0		120.0		50.0	130.0	
Base Capacity (vph)	187	569	561	618	1011	515	854	839	144	1893
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.12	0.62	0.14	0.66	0.66	0.20	0.69	0.54	0.22	0.11

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	18	374	146	448	269	44	59	128	276	146	637	44
Future Volume (vph)	18	374	146	448	269	44	59	128	276	146	637	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.6	6.6	6.6	6.6	6.6		6.3	6.3		6.3	6.3	
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.90		1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1750	1842	1479	3298	1801		1668	2929		1750	3466	
Flt Permitted	0.55	1.00	1.00	0.95	1.00		0.16	1.00		0.23	1.00	
Satd. Flow (perm)	1014	1842	1479	3298	1801		279	2929		432	3466	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	20	420	164	503	302	49	66	144	310	164	716	49
RTOR Reduction (vph)	0	0	110	0	4	0	0	250	0	0	4	0
Lane Group Flow (vph)	20	420	54	503	347	0	66	204	0	164	761	0
Heavy Vehicles (%)	2%	2%	8%	5%	2%	3%	7%	6%	11%	2%	2%	2%
Turn Type	Perm	NA	Perm	Prot	NA		pm+pt	NA		pm+pt	NA	
Protected Phases		2		1	6		3	8		7	4	
Permitted Phases	2		2				8			4		
Actuated Green, G (s)	46.2	46.2	46.2	26.0	78.8		33.3	26.9		48.3	35.6	
Effective Green, g (s)	46.2	46.2	46.2	26.0	78.8		33.3	26.9		48.3	35.6	
Actuated g/C Ratio	0.33	0.33	0.33	0.19	0.56		0.24	0.19		0.34	0.25	
Clearance Time (s)	6.6	6.6	6.6	6.6	6.6		6.3	6.3		6.3	6.3	
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	
Lane Grp Cap (vph)	334	607	488	612	1013		129	562		291	881	
v/s Ratio Prot		c0.23		c0.15	0.19		0.02	0.07		c0.06	c0.22	
v/s Ratio Perm	0.02		0.04				0.10			0.13		
v/c Ratio	0.06	0.69	0.11	0.82	0.34		0.51	0.36		0.56	0.86	
Uniform Delay, d1	32.1	40.7	32.6	54.8	16.6		43.2	49.1		34.4	49.9	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.3	6.4	0.5	9.7	0.9		6.7	0.8		4.1	9.6	
Delay (s)	32.4	47.1	33.1	64.5	17.5		49.9	49.9		38.5	59.5	
Level of Service	C	D	C	E	B		D	D		D	E	
Approach Delay (s)		42.8			45.2			49.9			55.8	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM 2000 Control Delay	48.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	25.8
Intersection Capacity Utilization	76.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	20	420	164	503	351	66	454	164	765
v/c Ratio	0.06	0.67	0.27	0.82	0.34	0.45	0.57	0.57	0.87
Control Delay	35.1	47.8	5.1	66.6	17.5	42.5	18.4	41.5	60.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	35.1	47.8	5.1	66.6	17.5	42.5	18.4	41.5	60.8
Queue Length 50th (m)	4.0	107.7	0.0	68.8	53.6	11.8	17.4	31.0	105.3
Queue Length 95th (m)	10.2	139.9	13.1	87.4	69.5	23.0	34.5	50.1	127.9
Internal Link Dist (m)		1224.7			338.1		4515.2		778.4
Turn Bay Length (m)	50.0		60.0	115.0		120.0		130.0	
Base Capacity (vph)	352	638	627	645	1052	147	845	294	912
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.06	0.66	0.26	0.78	0.33	0.45	0.54	0.56	0.84

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	23	351	80	406	493	173	102	585	455	32	190	25
Future Volume (vph)	23	351	80	406	493	173	102	585	455	32	190	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	3.5	3.7	3.5	3.5	3.7	3.5	3.5	3.7	3.5	3.5	3.7	3.5
Total Lost time (s)	6.6	6.6	6.6	6.6	6.6		6.3	6.3		6.3	6.3	
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.93		1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1750	1883	1566	3206	1819		1750	3315		1716	3478	
Flt Permitted	0.37	1.00	1.00	0.95	1.00		0.62	1.00		0.08	1.00	
Satd. Flow (perm)	680	1883	1566	3206	1819		1137	3315		149	3478	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	23	351	80	406	493	173	102	585	455	32	190	25
RTOR Reduction (vph)	0	0	60	0	9	0	0	99	0	0	8	0
Lane Group Flow (vph)	23	351	20	406	657	0	102	941	0	32	207	0
Heavy Vehicles (%)	2%	2%	2%	8%	2%	0%	2%	2%	4%	4%	3%	4%
Turn Type	Perm	NA	Perm	Prot	NA		Perm	NA		pm+pt	NA	
Protected Phases		6		5	2			8		7	4	
Permitted Phases	6		6				8			4		
Actuated Green, G (s)	30.0	30.0	30.0	21.1	57.7		42.1	42.1		50.8	50.8	
Effective Green, g (s)	30.0	30.0	30.0	21.1	57.7		42.1	42.1		50.8	50.8	
Actuated g/C Ratio	0.25	0.25	0.25	0.17	0.48		0.35	0.35		0.42	0.42	
Clearance Time (s)	6.6	6.6	6.6	6.6	6.6		6.3	6.3		6.3	6.3	
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	
Lane Grp Cap (vph)	168	465	386	557	864		394	1149		93	1455	
v/s Ratio Prot		0.19		0.13	c0.36			c0.28		c0.01	0.06	
v/s Ratio Perm	0.03		0.01				0.09			0.14		
v/c Ratio	0.14	0.75	0.05	0.73	0.76		0.26	0.82		0.34	0.14	
Uniform Delay, d1	35.6	42.3	34.8	47.4	26.2		28.5	36.2		26.2	21.8	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.8	8.1	0.1	5.8	4.6		0.7	5.3		4.6	0.1	
Delay (s)	36.4	50.4	35.0	53.3	30.8		29.2	41.4		30.8	21.9	
Level of Service	D	D	C	D	C		C	D		C	C	
Approach Delay (s)		47.0			39.3			40.3			23.1	
Approach LOS		D			D			D			C	

Intersection Summary			
HCM 2000 Control Delay	39.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	121.4	Sum of lost time (s)	25.8
Intersection Capacity Utilization	104.6%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	23	351	80	406	666	102	1040	32	215
v/c Ratio	0.14	0.75	0.16	0.72	0.75	0.25	0.82	0.26	0.15
Control Delay	40.8	53.9	1.9	56.9	31.9	32.8	37.3	28.2	22.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	40.8	53.9	1.9	56.9	31.9	32.8	37.3	28.2	22.1
Queue Length 50th (m)	4.4	80.2	0.0	48.7	130.2	17.5	104.8	4.4	15.2
Queue Length 95th (m)	11.6	111.9	2.6	68.4	174.9	32.8	139.1	10.8	24.4
Internal Link Dist (m)		1221.3			338.1		4333.6		2204.7
Turn Bay Length (m)	50.0		60.0	115.0		120.0		130.0	
Base Capacity (vph)	229	635	611	659	1100	476	1477	124	1801
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.10	0.55	0.13	0.62	0.61	0.21	0.70	0.26	0.12

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	18	374	146	448	269	44	59	128	276	146	637	44
Future Volume (vph)	18	374	146	448	269	44	59	128	276	146	637	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.6	6.6		6.6	6.6		6.3	6.3		6.3	6.3	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frt	1.00	0.96		1.00	0.98		1.00	0.90		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1750	3298		1700	3422		1668	2929		1750	3466	
Flt Permitted	0.54	1.00		0.21	1.00		0.15	1.00		0.23	1.00	
Satd. Flow (perm)	997	3298		383	3422		268	2929		419	3466	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	20	420	164	503	302	49	66	144	310	164	716	49
RTOR Reduction (vph)	0	28	0	0	9	0	0	252	0	0	4	0
Lane Group Flow (vph)	20	556	0	503	342	0	66	202	0	164	761	0
Heavy Vehicles (%)	2%	2%	8%	5%	2%	3%	7%	6%	11%	2%	2%	2%
Turn Type	Perm	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases		2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	35.9	35.9		80.1	80.1		32.0	26.2		47.0	34.9	
Effective Green, g (s)	35.9	35.9		80.1	80.1		32.0	26.2		47.0	34.9	
Actuated g/C Ratio	0.26	0.26		0.57	0.57		0.23	0.19		0.34	0.25	
Clearance Time (s)	6.6	6.6		6.6	6.6		6.3	6.3		6.3	6.3	
Vehicle Extension (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Grp Cap (vph)	255	845		572	1957		119	548		278	864	
v/s Ratio Prot		0.17		c0.24	0.10		0.02	0.07		c0.06	c0.22	
v/s Ratio Perm	0.02			c0.27			0.10			0.14		
v/c Ratio	0.08	0.66		0.88	0.17		0.55	0.37		0.59	0.88	
Uniform Delay, d1	39.5	46.6		28.5	14.2		44.3	49.7		35.4	50.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.6	4.0		15.4	0.2		9.2	0.9		4.9	11.2	
Delay (s)	40.1	50.5		44.0	14.4		53.5	50.6		40.3	61.7	
Level of Service	D	D		D	B		D	D		D	E	
Approach Delay (s)		50.2			31.8			50.9			58.0	
Approach LOS		D			C			D			E	

Intersection Summary			
HCM 2000 Control Delay	47.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	25.8
Intersection Capacity Utilization	83.7%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Widening to Four Lanes

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	20	584	503	351	66	454	164	765
v/c Ratio	0.08	0.65	0.87	0.18	0.49	0.59	0.60	0.88
Control Delay	44.9	48.7	42.8	13.7	45.4	18.8	43.8	62.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	44.9	48.7	42.8	13.7	45.4	18.8	43.8	62.9
Queue Length 50th (m)	4.5	76.0	96.7	22.4	12.4	18.0	32.7	106.4
Queue Length 95th (m)	11.8	96.3	#144.0	30.2	23.2	34.5	50.5	129.3
Internal Link Dist (m)		1224.7		338.1		4515.2		778.4
Turn Bay Length (m)	50.0		115.0		120.0		130.0	
Base Capacity (vph)	264	903	613	2013	136	830	279	887
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.08	0.65	0.82	0.17	0.49	0.55	0.59	0.86

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	23	351	80	406	493	173	102	585	455	32	190	25
Future Volume (vph)	23	351	80	406	493	173	102	585	455	32	190	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	3.5	3.7	3.5	3.5	3.7	3.5	3.5	3.7	3.5	3.5	3.7	3.5
Total Lost time (s)	6.6	6.6		6.6	6.6		6.3	6.3		6.3	6.3	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frt	1.00	0.97		1.00	0.96		1.00	0.93		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1750	3479		1653	3457		1750	3315		1716	3478	
Flt Permitted	0.40	1.00		0.24	1.00		0.62	1.00		0.08	1.00	
Satd. Flow (perm)	734	3479		426	3457		1137	3315		151	3478	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	23	351	80	406	493	173	102	585	455	32	190	25
RTOR Reduction (vph)	0	14	0	0	25	0	0	100	0	0	7	0
Lane Group Flow (vph)	23	417	0	406	641	0	102	940	0	32	208	0
Heavy Vehicles (%)	2%	2%	2%	8%	2%	0%	2%	2%	4%	4%	3%	4%
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		pm+pt	NA	
Protected Phases		6		5	2			8		7	4	
Permitted Phases	6			2			8			4		
Actuated Green, G (s)	22.2	22.2		61.3	61.3		41.4	41.4		50.2	50.2	
Effective Green, g (s)	22.2	22.2		61.3	61.3		41.4	41.4		50.2	50.2	
Actuated g/C Ratio	0.18	0.18		0.49	0.49		0.33	0.33		0.40	0.40	
Clearance Time (s)	6.6	6.6		6.6	6.6		6.3	6.3		6.3	6.3	
Vehicle Extension (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Grp Cap (vph)	130	620		530	1703		378	1103		92	1403	
v/s Ratio Prot		0.12		c0.20	0.19			c0.28		c0.01	0.06	
v/s Ratio Perm	0.03			c0.18			0.09			0.13		
v/c Ratio	0.18	0.67		0.77	0.38		0.27	0.85		0.35	0.15	
Uniform Delay, d1	43.3	47.7		22.8	19.6		30.4	38.6		28.1	23.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.4	3.7		7.7	0.3		0.8	7.1		4.7	0.1	
Delay (s)	44.7	51.5		30.5	19.9		31.2	45.8		32.8	23.6	
Level of Service	D	D		C	B		C	D		C	C	
Approach Delay (s)		51.1			23.9			44.5			24.8	
Approach LOS		D			C			D			C	

Intersection Summary			
HCM 2000 Control Delay	36.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	124.4	Sum of lost time (s)	25.8
Intersection Capacity Utilization	90.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	23	431	406	666	102	1040	32	215
v/c Ratio	0.17	0.67	0.75	0.38	0.26	0.85	0.26	0.16
Control Delay	50.5	52.1	33.2	18.8	34.3	40.7	29.6	23.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	50.5	52.1	33.2	18.8	34.3	40.7	29.6	23.5
Queue Length 50th (m)	4.9	51.4	67.6	50.0	18.2	109.3	4.6	15.9
Queue Length 95th (m)	12.8	68.0	103.3	63.3	33.2	141.1	11.0	24.7
Internal Link Dist (m)		1221.3		338.1		4333.6		2204.7
Turn Bay Length (m)	50.0		115.0		120.0		130.0	
Base Capacity (vph)	170	823	583	2060	451	1406	121	1713
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.14	0.52	0.70	0.32	0.23	0.74	0.26	0.13

Intersection Summary

Widening to Four Lanes

3027 Harvester Road, Suite 400
Burlington, ON L7N 3G7
CANADA
T. 289.288.0287
F. 289.288.0285

www.cima.ca

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