Block 221, Riverside South Phase 8

Transportation Impact Assessment

Final Report

September 26, 2019

Prepared for:

Richcraft Group of Companies

Prepared by:

Stantec Consulting Ltd.

Sign-off Sheet

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1.0 SCREENING

1.1 SUMMARY OF DEVELOPMENT

Municipal Address	
Description of Location	Riverside South, east of Ralph Hennessy Ave, south of Earl Armstrong Rd, north of Markdale Terrace.
Land Use Classification	Residential
Development Size (units)	103 residential units
Development Size (m^2)	14,205 m^2 GFA (152,900 sq.ft. GFA)
Number of Accesses and Locations	1 Full Movement Access on Ralph Hennessy Avenue 1 Full Movement Access on Markdale Terrace
Phase of Development	1 Phase
Buildout Year	Fall 2020

If available, please attach a sketch of the development or site plan to this form.

1.2 TRIP GENERATION TRIGGER

Considering the Development's Land Use type and Size (as filled out in the previous section), please refer to the Trip Generation Trigger checks below.

Land Use Type	Minimum Development Size	Triggered
Single-family homes	40 units	✗
Townhomes or apartments	90 units	✓
Office	3,500 m^2	✗
Industrial	5,000 m^2	✗
Fast-food restaurant or coffee shop	100 m^2	✗
Destination retail	1,000 m^2	✗
Gas station or convenience market	75 m^2	✗

** If the development has a land use type other than what is presented in the table above, estimates of person-trip generation may be made based on average trip generation characteristics represented in the current edition of the Institute of Transportation Engineers (ITE) Trip Generation Manual.*

If the proposed development size is greater than the sizes identified above, the Trip Generation Trigger is satisfied.

1.3 LOCATION TRIGGERS

	Yes	No
Does the development propose a new driveway to a boundary street that is designated as part of the City's Transit Priority, Rapid Transit or Spine Bicycle Networks?		✗
Is the development in a Design Priority Area (DPA) or Transit-oriented Development (TOD) zone? *		✗

**DPA and TOD are identified in the City of Ottawa Official Plan (DPA in Section 2.5.1 and Schedules A and B; TOD in Annex 6). See Chapter 4 for a list of City of Ottawa Planning and Engineering documents that support the completion of TIA).*

If any of the above questions were answered with 'Yes,' the Location Trigger is satisfied.

1.4 SAFETY TRIGGERS

	Yes	No
Are posted speed limits on a boundary street are 80 km/hr or greater?	✓	
Are there any horizontal/vertical curvatures on a boundary street limits sight lines at a proposed driveway?		✗
Is the proposed driveway within the area of influence of an adjacent traffic signal or roundabout (i.e. within 300 m of intersection in rural conditions, or within 150 m of intersection in urban/ suburban conditions)?	✓	
Is the proposed driveway within auxiliary lanes of an intersection?	✓	
Does the proposed driveway make use of an existing median break that serves an existing site?		✗
Is there is a documented history of traffic operations or safety concerns on the boundary streets within 500 m of the development?		✗
Does the development include a drive-thru facility?		✗

If any of the above questions were answered with 'Yes,' the Safety Trigger is satisfied.

1.5 SUMMARY

	Yes	No
Does the development satisfy the Trip Generation Trigger?	✓	
Does the development satisfy the Location Trigger?		✗
Does the development satisfy the Safety Trigger?	✓	

If none of the triggers are satisfied, the TIA Study is complete. If one or more of the triggers is satisfied, the TIA Study must continue into the next stage (Screening and Scoping).

2.0 SCOPING

2.1 EXISTING AND PLANNED CONDITIONS

2.1.1 Proposed Development

The proposed development is located at the southeast corner of Earl Armstrong Road and Ralph Hennessy Avenue in the Riverside South community in Ottawa, Ontario. The site is bound by Earl Armstrong to the north, Ralph Hennessy Avenue to the west, Markdale Terrace to the south, and existing residential homes to the east.

Figure 1 illustrates the site location. The site is currently zoned as R4Z; the purpose of the R4 – Residential Fourth Density Zone is to:

- Allow a wide mix of residential building forms ranging from detached to low rise apartment dwellings, in some cases limited to four units, and in no case more than four storeys, in areas designated as General Urban Area in the Official Plan;
- Allow a number of other residential uses to provide additional housing choices within the fourth density residential areas;
- Permit ancillary uses to the principal residential use to allow residents to work at home;
- Regulate development in a manner that is compatible with existing land use patterns so that the mixed building form, residential character of a neighbourhood is maintained or enhanced; and
- Permit different development standards, identified in the Z subzone, primarily for areas designated as Developing Communities, which promote efficient land use and compact form while showcasing newer design approaches.

The proposed development consists of a total of 103 residential townhomes. It is noted that recent changes to the draft plan resulted in minor modifications to the unit counts. The minor discrepancy between the unit count in **Figure 2** below and the analysis contained in this report is acknowledged, however, it does not impact the findings of recommendations of the report.

One full movement access is proposed along Ralph Hennessy Avenue and another full movement access is proposed along Markdale Terrace. A total of 8 visitor parking spaces will be provided on-site as part of the development.

Buildout and occupancy of the proposed development is anticipated to occur within one development phase in Fall 2020.

The Semi-detached dwellings, townhomes, rowhouses land use (LUC 224) rates from the *TRANS Trip Generation Residential Trip Rates Study Report* were adopted for this study. **Figure 2** illustrates the proposed site plan.

Figure 1 - Site Location

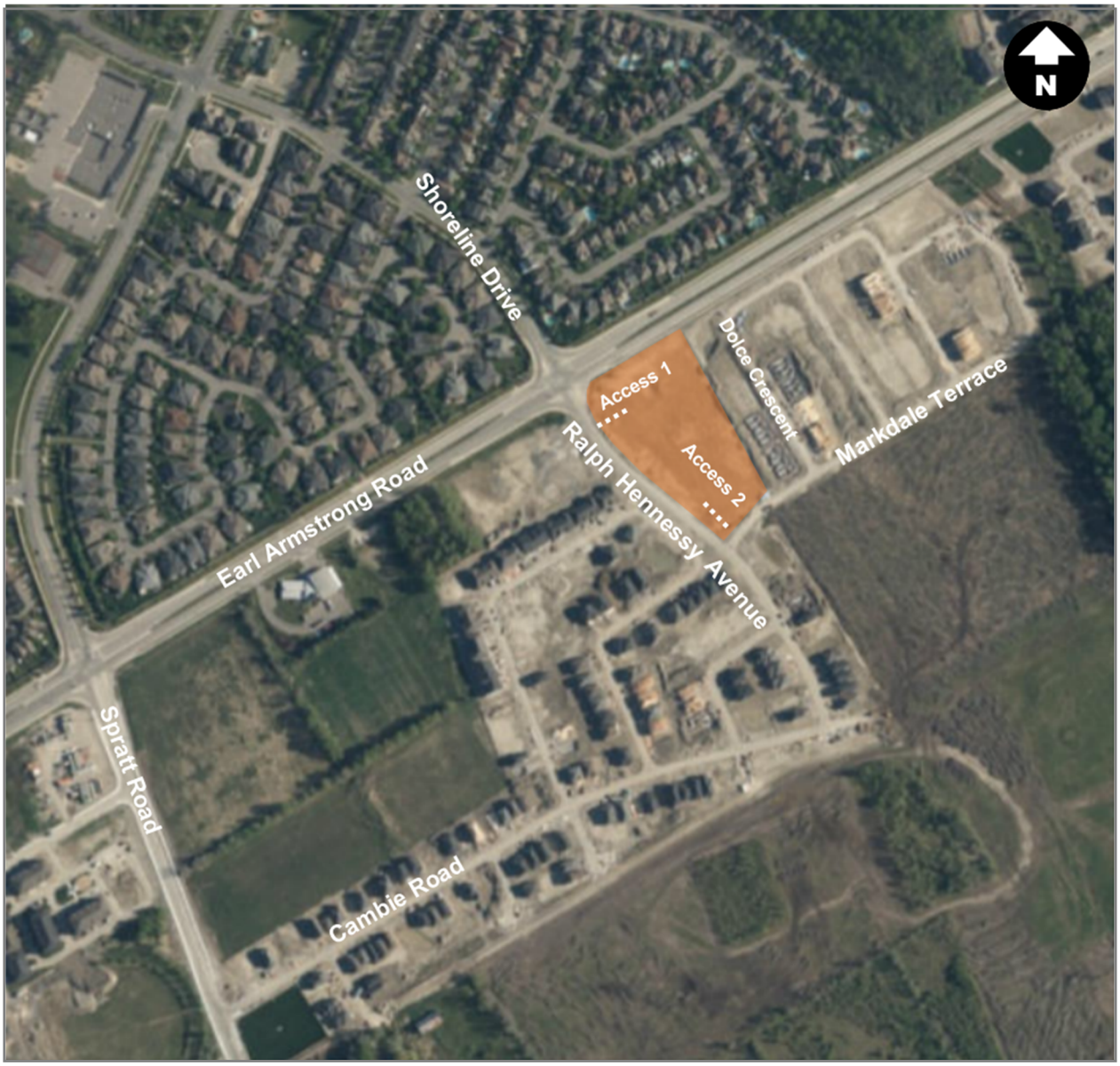
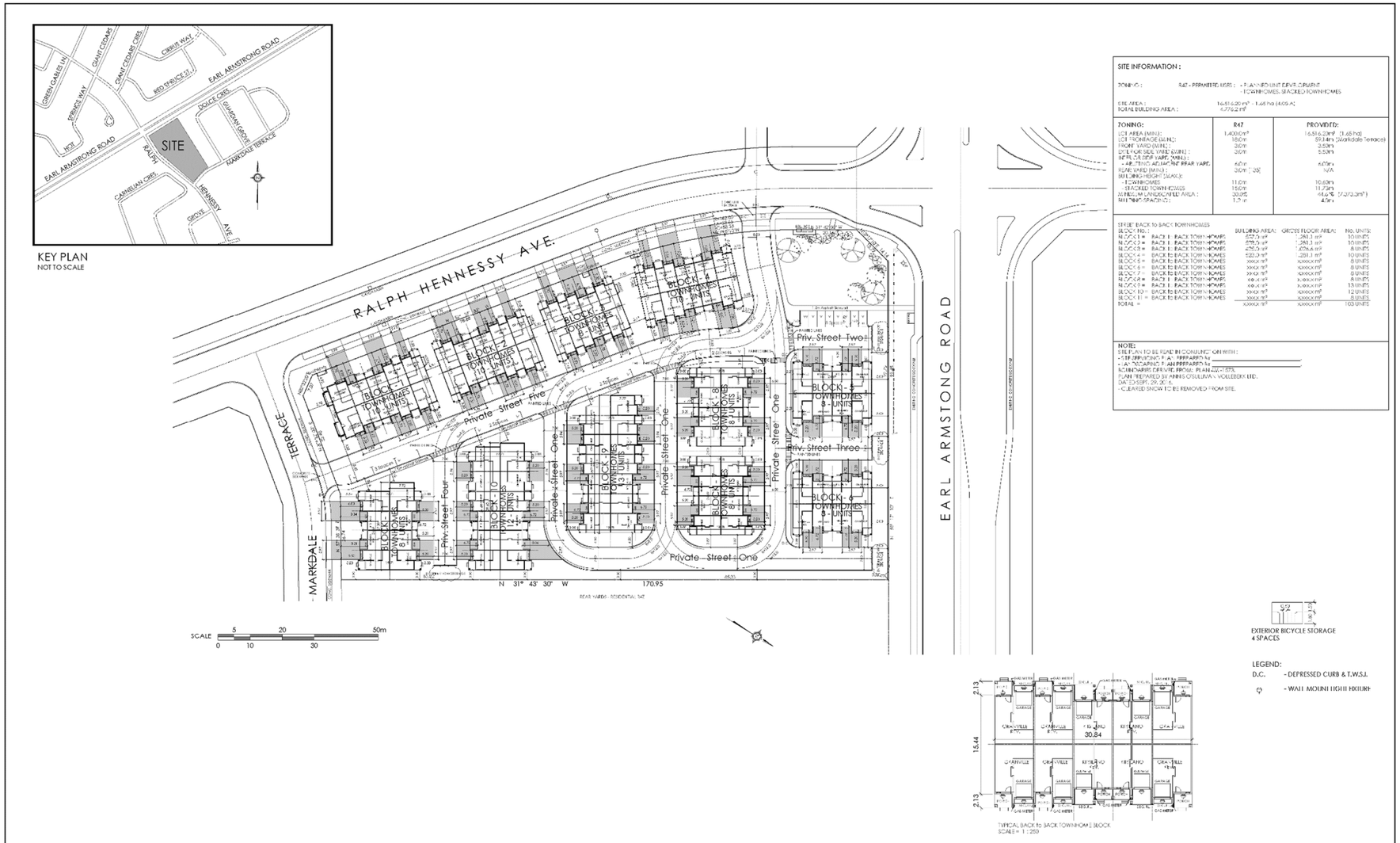


Figure 2 - Proposed Site Plan



2.1.2 Existing Conditions

2.1.2.1 Roads and Traffic Control

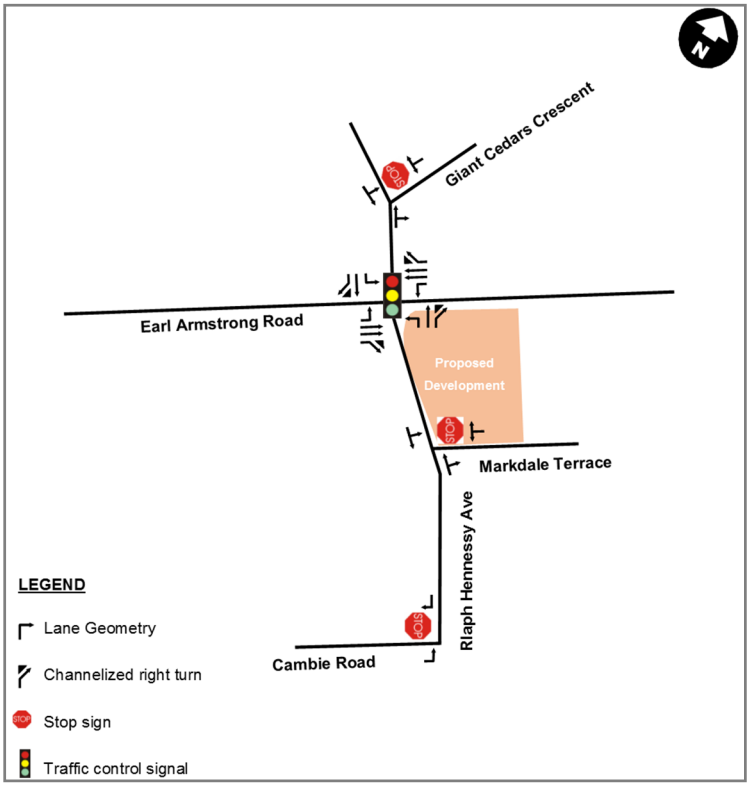
The boundary roads are as follows:

Earl Armstrong Road	Earl Armstrong Road is a municipally-owned, four-lane divided arterial roadway with a posted speed limit of 80 kph across the frontage of the proposed site.
Ralph Hennessy Avenue / Shoreline Drive	Ralph Hennessy Avenue is a municipally-owned, two-lane undivided collector roadway with a default speed limit of 50 kph across the frontage of the proposed site.
Markdale Terrace	Markdale Terrace is a municipally-owned, two-lane undivided local roadway with a default speed limit of 50 kph across the frontage of the proposed site.

The proposed development is adjacent to the signalized intersection of Earl Armstrong Road and Ralph Hennessy Avenue. Nearby intersections include the intersection of Ralph Hennessey Avenue and Markdale Terrace (stop-control on minor approach), Cambie Road and Ralph Hennessy Avenue (stop-control on minor approach), and Shoreline Drive and Giant Cedars Crescent (stop-control on minor approach).

Figure 3 illustrates the existing lane configuration and traffic control.

Figure 3 - Existing Lane Configuration and Traffic Control



2.1.2.2 Walking and Cycling

Figure 4 illustrates the existing pedestrian and cycling facilities.

Figure 4 - Existing Pedestrian and Cycling Network

Source: geoOttawa, accessed July 2018

2.1.2.3 Transit

The proposed development is currently serviced by the following OC Transpo route:

Route 278 — Route 278 is a Connexion route which operates during weekdays between 6-9 am and 3-6 pm between Mackenzie King station and the Riverside South community.

The entire site is located within 400 metres of six existing on-street transit stops. The site is also within one kilometer (10 – 15 minute walk) from the Riverview Park & Ride Station.

Figure 5 illustrates the transit routes and stops.

Figure 5 - Study Area Transit Routes and Stops

Source: OC Transpo System Map, accessed July 2018

2.1.2.4 Traffic Management Measures

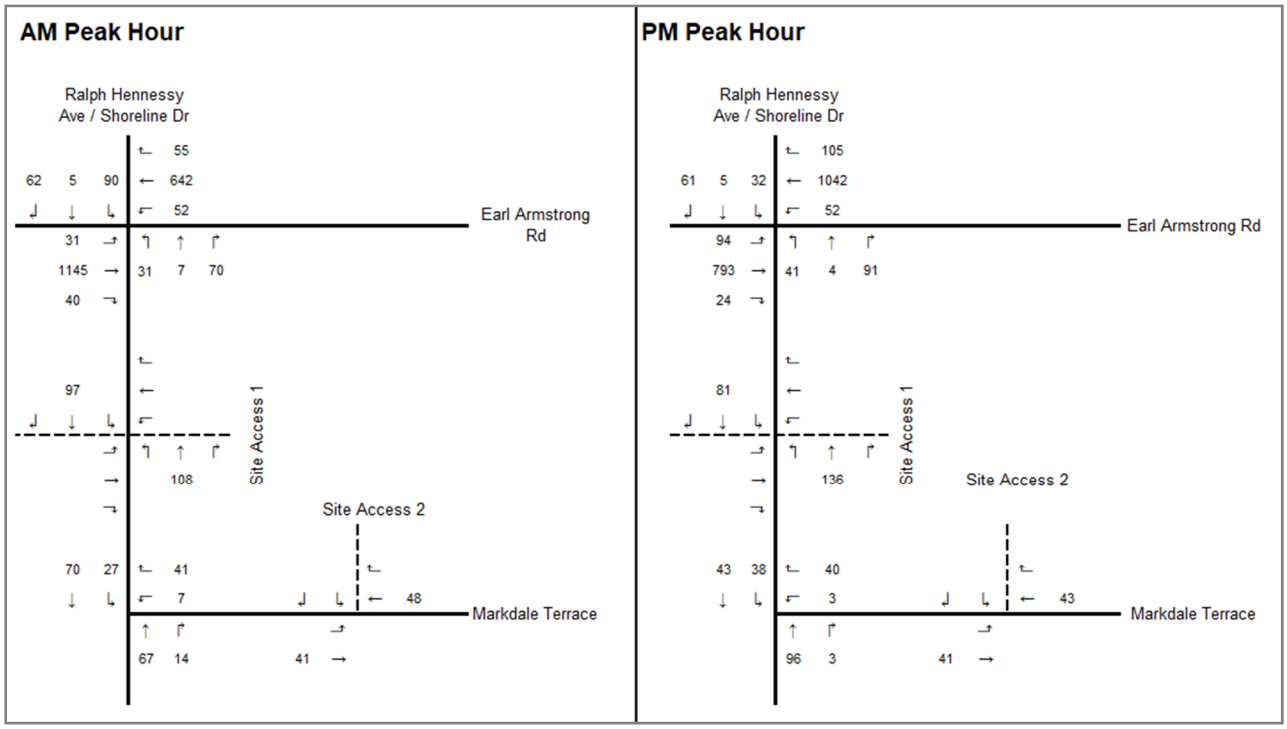
No traffic management measures are provided near the site.

2.1.2.5 Traffic Volumes

2017 turning movement counts for the Earl Armstrong Road at Ralph Hennessy Avenue intersection were obtained from the City of Ottawa. Traffic counts at the Ralph Hennessy Ave at Markdale Terrace were conducted in 2018 by Stantec.

Figure 6 illustrates the 2018 existing traffic volumes at the study area intersections.

Figure 6 - 2018 Existing Traffic Volumes



2.1.2.6 Collision History

Earl Armstrong Road at Ralph Hennessy Avenue experienced 6 collisions over a four-year period. Out of the 6 recorded collisions, 3 were classified as single vehicle collisions (50%). The remaining were classified as angle and "other" collisions. The recorded collisions involved 3 non-fatal injuries (50%) and 3 property damage only (50%).

Two of the collisions (33%) involved one vehicle going westbound and one vehicle making the southbound left turn movement. Three of the collision (50%) involved single vehicles traveling in the eastbound or westbound directions. One of the collisions (17%) involved a snow plow reversing in the northbound direction and a stopped vehicle in the southbound direction. No discernable collision patterns have been identified at this intersection, therefore, no further investigation is required.

Appendix A contains the collision data and is provided for reference.

2.1.3 Planned Conditions

2.1.3.1 Road Network Modifications

Table 1 identifies the City of Ottawa Transportation Master Plan projects located near of the study area.

Table 1 - City of Ottawa Transportation Master Plan Projects

Project	Description	TMP Phase
Trillium O-Train Extension	Extension of the existing Trillium O-Train Light Rail Transit (LRT) line from South Keys to the future Limebank Station	Stage 2 O-Train Extension (i.e. 2021)
North-South LRT (Network Concept)	New LRT right of way between Boulevard Alexandre-Tache in Gatineau and Riverside South Town Centre. Includes airport link.	Network Concept (i.e. Beyond 2031 horizon)
South Transitway	At-grade BRT between the Southwest Transitway and Riverside South Town Centre	Network Concept (i.e. Beyond 2031 horizon)
Chapman Mills / Strandherd Drive / Earl Armstrong Road	Transit signal priority and queue jump lanes between Barrhaven Town Centre Station and Bowesville / Riverside South Station.	Affordable Network (2031 horizon)
Earl Armstrong Road	Widen from two to four lanes between Limebank Road and Bowesville Road New two-lane road between Albion Road and Bank Street New two-lane road between Bank Street and Hawthorne Road	Affordable Network (Phase 3: 2026-2031) EA: Complete Network Concept (i.e. Beyond 2031 horizon) EA: In Progress Network Concept (i.e. Beyond 2031 horizon) EA: Not Started

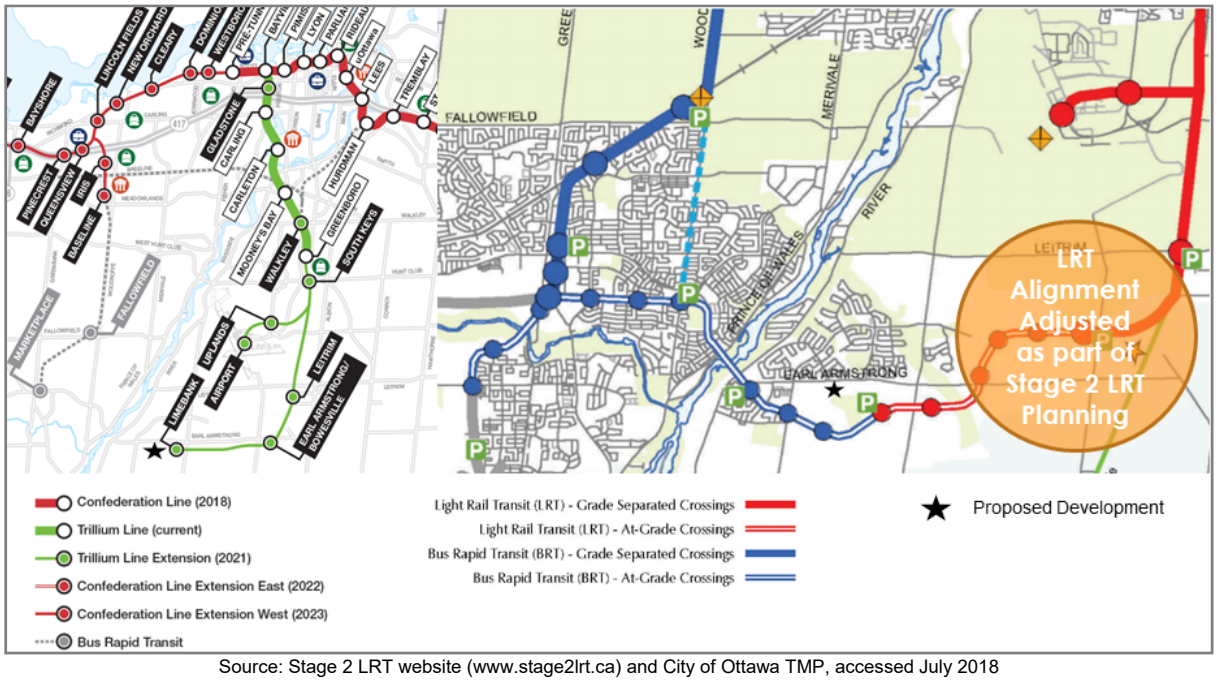
As outlined in **Table 1,** a number of transit improvements are expected to occur near the proposed development.

Under the TMP Affordable Network, the existing Trillium O-Train Light Rail Transit (LRT) line will be extended from South Keys to the future Limebank Station. This will occur as part of Stage 2 of the Trillium Line O-Train extension which is expected to go into revenue service in 2021.

In addition to the LRT extension to the Limebank Station, an at-grade BRT system is planned, under the Network Concept, between the Barrhaven community and the Riverside South community. Given that this project is under the Network Concept, it is not expected that construction of this new BRT system will start before 2031.

Figure 7 illustrates planned network modifications near the proposed development.

Figure 7 - Planned Transit Network Modifications



Source: Stage 2 LRT website (www.stage2lrt.ca) and City of Ottawa TMP, accessed July 2018

2.1.3.2 Future Background Developments

One development located at 800 Ralph Hennessy Avenue (the southwest quadrant of the Earl Armstrong Road at Ralph Hennessy Avenue intersection) was identified as a background development. The nearby background development, which features 8 stacked apartment-style buildings with a total of 66 units, is proposed to have a shared access with the subject development on Ralph Hennessy Avenue. It is anticipated that the background development will be built and occupied in 2023. Furthermore, Riverside South Phase 8 will continue to expand and is expected to be fully built by 2023.

2.2 STUDY AREA AND TIME PERIODS

2.2.1 Study Area

The study area was limited to the following intersections:

1. Earl Armstrong Road and Ralph Hennessy Avenue;
2. Ralph Hennessy Avenue and Site Access 1;
3. Ralph Hennessy Avenue and Markdale Terrace; and
4. Markdale Terrace and Site Access 2 (Private Street Two).

2.2.2 Time Periods

The scope of the transportation assessment includes the following analysis time periods:

- Weekday AM peak hour of roadway; and
- Weekday PM peak hour of roadway.

2.2.3 Horizon Years

The scope of the transportation assessment includes the following horizon years:

- 2018 existing conditions;
- 2020 future background conditions;
- 2020 total future conditions (site build-out); and
- 2025 total future conditions (5 years beyond build-out).

2.3 EXEMPTIONS REVIEW

Table 2 summarizes the Exemptions Review table from the City of Ottawa's *2017 Transportation Impact Assessment Guidelines*.

Table 2 - Exemptions Review

Module	Element	Exemption Considerations	Exempted?
Design Review Component			
4.1 Development Design	4.1.2 Circulation and Access	Only required for site plans	No
	4.1.3 New Street Networks	Only required for plans of subdivision	Yes
4.2 Parking	4.2.1 Parking Supply	Only required for site plans	No
	4.2.2 Spillover Parking	Only required for site plans where parking supply is 15% below unconstrained demand	Yes
Network Impact Component			
4.5 Transportation Demand Management	All Elements	Not required for site plans expected to have fewer than 60 employees and/or students on location at any given time	Yes
4.6 Neighbourhood Traffic Management	4.6.1 Adjacent Neighbourhoods	Only required when the development relies on local or collector streets for access and total volumes exceed ATM capacity thresholds	No
4.8 Network Concept		Only required when proposed development generates more than 200 person-trips during the peak hour in excess of the equivalent volume permitted by established zoning	Yes

3.0 FORECASTING

3.1 DEVELOPMENT-GENERATED TRAVEL DEMAND

3.1.1 Trip Generation and Mode Shares

The semi-detached dwellings, townhomes, rowhouses land use (LUC 224) rates from the *TRANS Trip Generation Residential Trip Rates Study Report* were used to forecast auto trip generation for the proposed development.

Table 3 outlines the assumed land use and the vehicle trip generation rates for each land use.

As per the City of Ottawa TIA Guidelines, the auto trip generation rates for the residential portion of the proposed development were converted to person trips using the auto mode share rates outlined in Table 3.13 in the *TRANS Residential Trip Generation Residential Trip Rates Study Report* (*August 2009*).

Table 4 shows development-generated person trips for each land use.

Table 3 - Land Uses and Trip Generation Rates

LUC	Land Use	Size	Weekday AM Peak Hour			Weekday PM Peak Hour		
			In	Out	Auto	In	Out	Auto
224	Semi-Detached Dwellings, Townhomes, Rowhouses	118 units	37%	63%	0.54	53%	47%	0.71

Table 4 - Person Trips Generated by Land Use

LUC	Land Use	Trip Conversion	Weekday AM Peak Hour			Weekday PM Peak Hour		
			In	Out	Total	In	Out	Total
224	Semi-Detached Dwellings, Townhomes, Rowhouses	Auto Trips	24	40	64	44	39	83
		Auto Mode Share	55%	55%	55%	61%	61%	61%
		Person Trips	**43**	**73**	**116**	**73**	**65**	**138**

To reflect local travel characteristics, the person trips were assigned to the four primary modal shares (i.e. auto, passenger, transit, and active moves) according to the TRANS Committee's 2011 Origin-Destination (O-D) Survey for the South Gloucester / Leitrim District. Due to the nature of the proposed land uses, the transit modal share was increased from approximately 5% (as per the OD survey) to 12%, to capture the "Other" modal share as per the OD survey.

Table 5 outlines the anticipated trip generation potential of the proposed development by travel mode based on assumed mode shares.

Table 5 - Trips Generated by Travel Mode

LUC	Land Use	Trip Conversion		Weekday AM Peak Hour			Weekday PM Peak Hour		
				In	Out	Total	In	Out	Total
224	Semi-Detached Dwellings, Townhomes, Rowhouses	Auto	70%	30	51	81	51	45	96
		Passenger	15%	7	11	18	11	10	21
		Walk / Bike	3%	1	2	3	2	2	4
		Transit	12%	5	9	14	9	8	17

3.1.2 Trip Distribution

Table 6 summarizes the assumed trip distribution for the proposed development. The distribution of traffic to / from the proposed is derived from the *TRANS Committee's 2011 Origin-Destination (O-D) Summary* for the South Gloucester / Leitrim District, in combination with other sources and engineering judgement.

Table 6 - Trip Distribution

Direction		Via (to/from)			
		Shoreline Dr (North)	Ralph Hennessy Ave (South)	Earl Armstrong Rd (East)	Earl Armstrong Rd (West)
North	**30%**	3%		12%	15%
East	**10%**			10%	
South	**0%**				
West	**5%**				5%
Nominal	**55%**	5.5%		22%	27.5%
Total	**100%**	**8.5%**	**0%**	**44%**	**47.5%**

3.1.3 Trip Assignment

Site generated trips were assigned to the study area road network based on the trip distribution assumptions outlined in **Table 6**.

Figure 8 outlines site assignment assumptions.

Figure 9 illustrates new site generated trips during the AM and PM peak hours.

Figure 8 - Site Traffic Assignment Assumptions

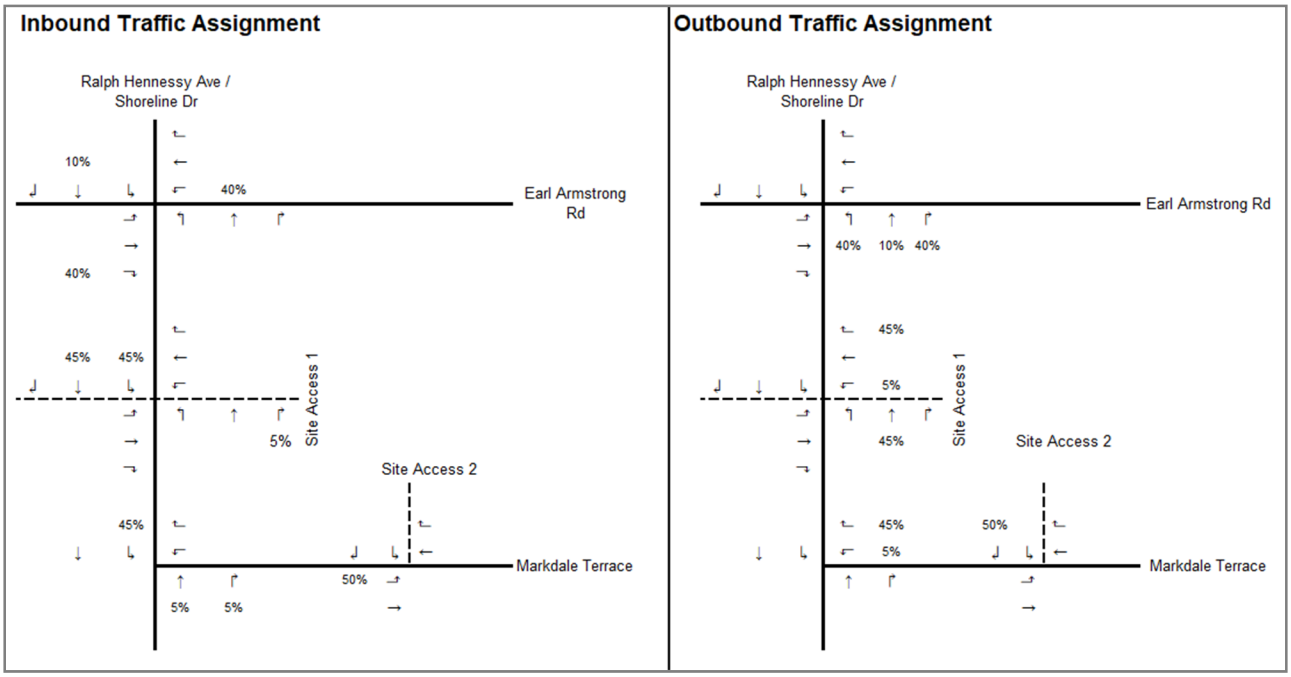
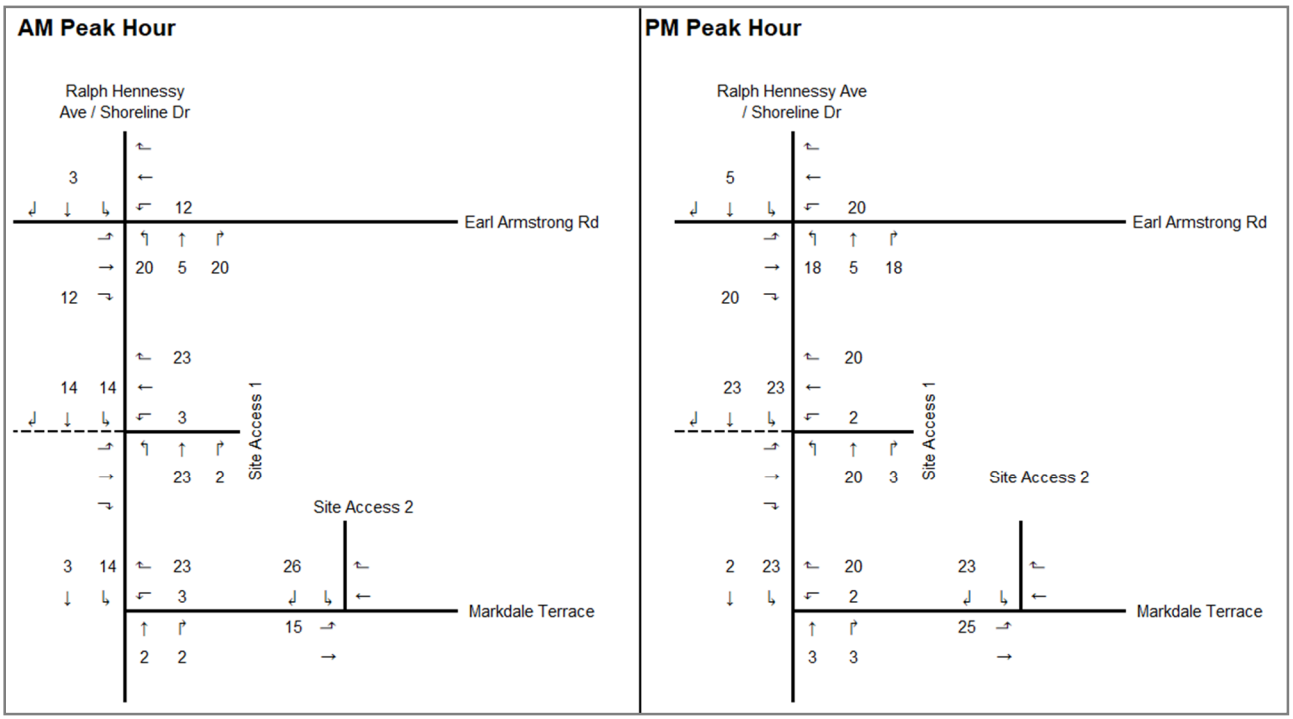


Figure 9 - Site Generated Volumes



3.2 BACKGROUND NETWORK TRAVEL DEMAND

3.2.1 Background Growth

The existing traffic counts were grown at a rate of 2% annually, non-compounding, to represent 2020 background traffic volumes.

3.2.2 Other Developments

As outlined in in **section 2.1.3.2**, a number of background developments are assumed to occur between 2018 and 2025. The site trips of these background developments were explicitly accounted for in this study. 2025 future background traffic volumes associated with the full build-out of Riverside South Phase 8 were obtained from the Riverside South Phase 8 Transportation Impact Study Update (Final Report – August 2015). Traffic volumes from the adjacent development at Ralph Hennessy Avenue were obtained from the 800 Ralph Hennessy Avenue Access Operational Assessment Technical Memo (December 5, 2017).

3.3 DEMAND RATIONALIZATION

3.3.1 2020 Future Background Traffic

Figure 10 illustrates the 2020 future background weekday AM, weekday PM, and Saturday peak hour traffic volumes.

The 2020 future background traffic demands are not expected to exceed capacity and therefore demand rationalization was not required.

3.3.2 2020 Total Future Traffic

Figure 11 illustrates the 2020 total future weekday AM, weekday PM, and Saturday peak hour traffic volumes.

The 2020 total future traffic demands are not expected to exceed capacity and therefore demand rationalization was not required.

3.3.3 2025 Ultimate Traffic

Figure 12 illustrates the 2025 ultimate weekday AM, weekday PM, and Saturday peak hour traffic volumes.

The 2025 ultimate traffic demands are not expected to exceed capacity and therefore demand rationalization was not required.

Figure 10 - 2020 Future Background Traffic Volumes

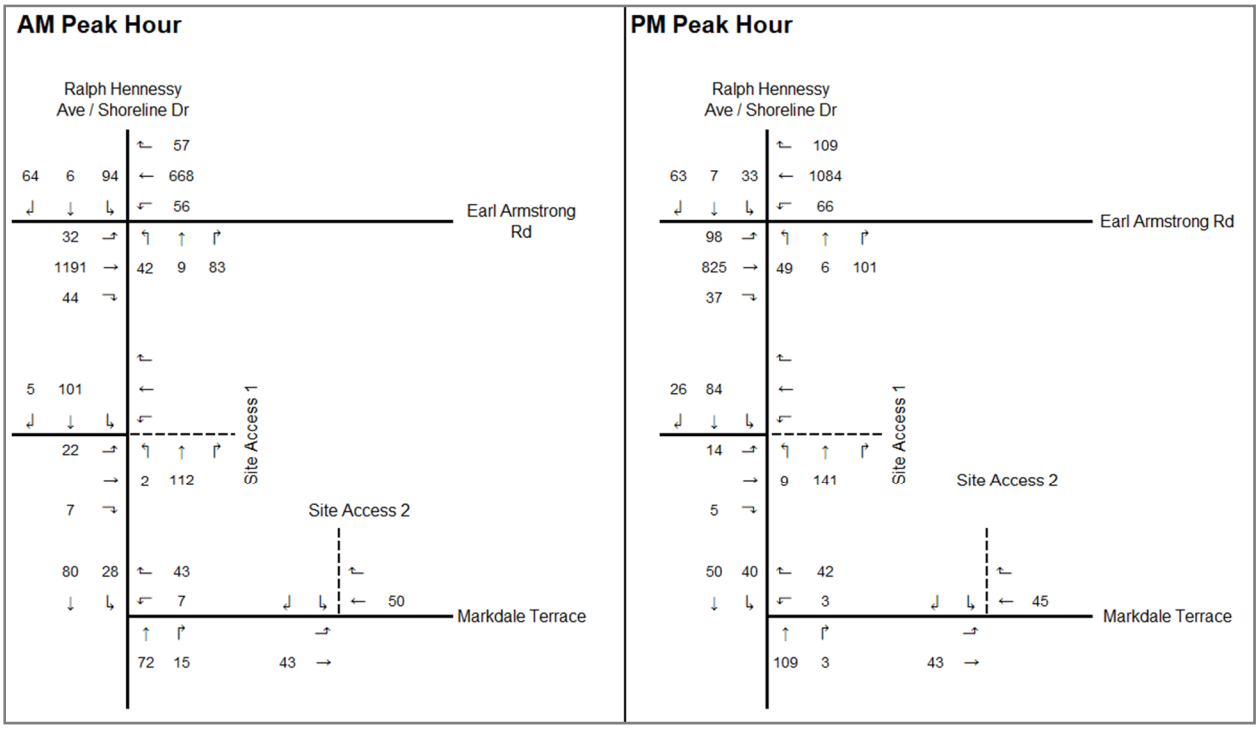


Figure 11 - 2020 Total Future Traffic Volumes

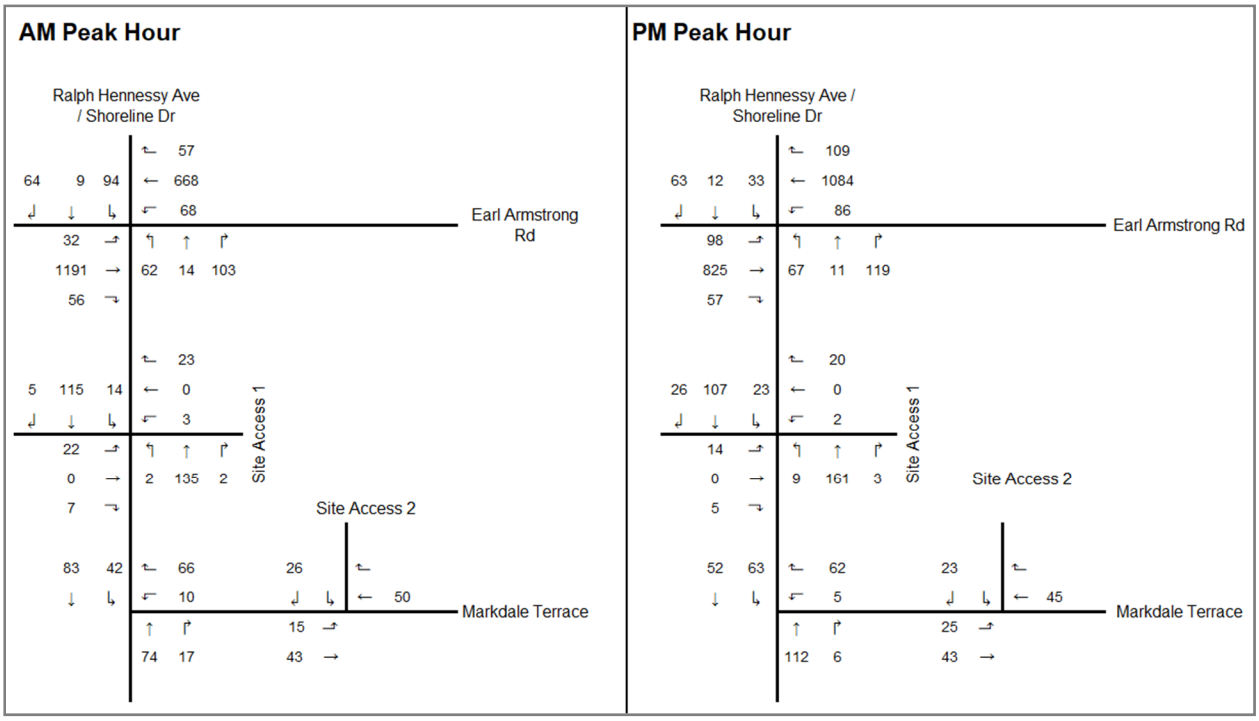
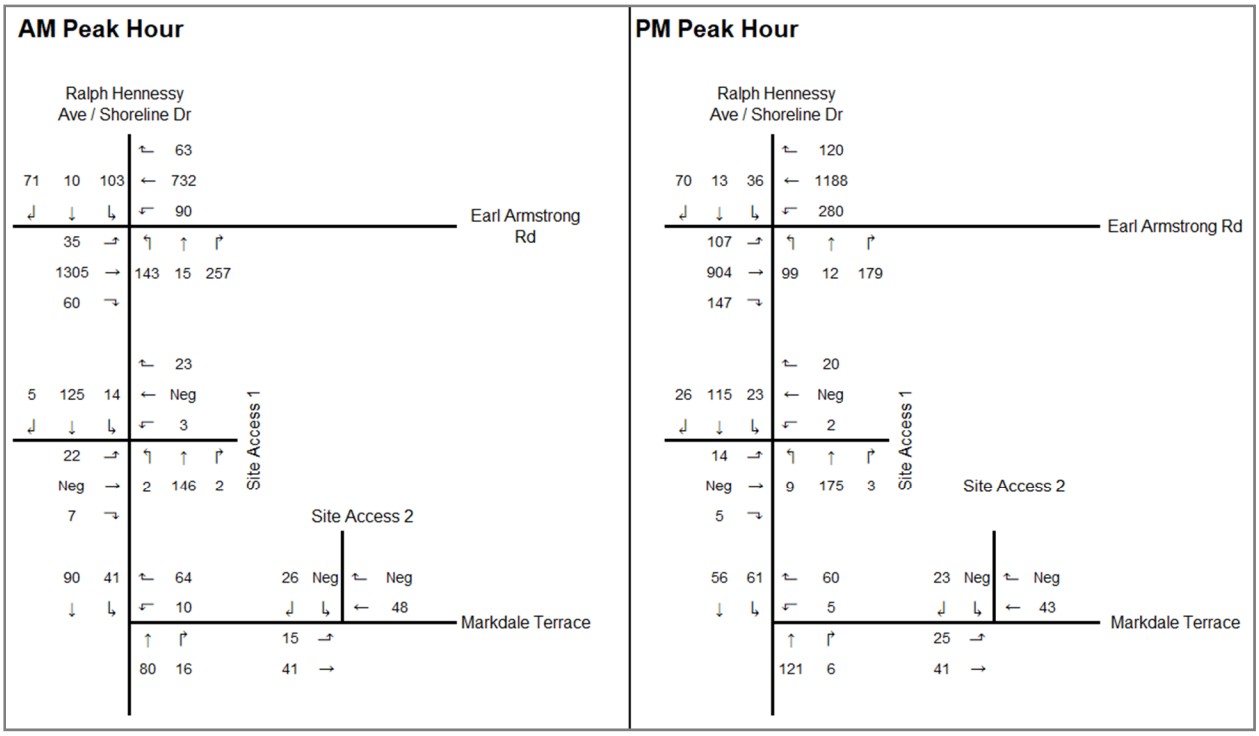


Figure 12 - 2025 Ultimate Traffic Volumes



4.0 STRATEGY

4.1 DEVELOPMENT DESIGN

4.1.1 Design for Sustainable Modes

Bicycle facilities: As the development consists entirely of townhomes with driveways and garages, no dedicated bicycle parking is provided.

Parking areas: Each residential dwelling contains two parking spaces: one in the garage and one in the driveway. In addition to this, a total of 8 visitor parking spaces are provided as part of the proposed development to account for any potential parking surplus.

Transit facilities: Transit stops for OC Transpo route 278 are currently located at the intersection of Earl Armstrong Road at Ralph Hennessy Avenue. There are sidewalks along both sides of these roads for pedestrians to access the transit stops.

The City of Ottawa's Transportation Demand Management checklists were completed and can be seen in **Appendix B**.

4.1.2 Circulation and Access

Two full movements accesses are proposed; one along Ralph Hennessy Avenue and one along Markdale Terrace. Within the vicinity of the subject site, pedestrian access is facilitated through the existing sidewalks along Ralph Hennessy Avenue and Earl Armstrong Road. The proposed development also contains sidewalks throughout the site connecting the buildings to the parking lots and to the boundary road network.

4.1.3 New Street Networks

Not applicable; exempted during screening and scoping.

4.2 PARKING

4.2.1 Parking Supply

Auto Parking - As per City of Ottawa Zoning By-law 2016-249 (Sections 101 and 102), the minimum parking space requirement is 1 space per dwelling unit for residents and 0.2 spaces per dwelling unit for visitor parking. Based on the proposed site plan, a minimum of 103 parking spaces are required for residents and 21 vehicle parking spaces are required for visitors, for a total of 124.

Each dwelling unit contains sufficient space to park two vehicles: one in the garage and one in the driveway. In addition, there are 8 visitor parking spaces available on site to account for any potential parking surplus. Based on this, there are a total of 214 provided parking spaces in the subject development which meets the minimum requirements.

Bicycle Parking – As the development consists entirely of townhomes with driveways and garages, no dedicated bicycle parking is required.

4.2.2 Spillover Parking

Not applicable; exempted during screening and scoping.

4.3 BOUNDARY STREET DESIGN

4.3.1 Design Concept

As outlined in the City of Ottawa's *Official Plan* Schedule B, Earl Armstrong Road, Ralph Hennessy Avenue, and Markdale Terrace are part of the 'General Urban Area'. With these designations, the MMLOS targets are prescribed in the City of Ottawa's *Multi-Modal Level of Service (MMLOS) Guidelines*.

Based on the aforementioned, the Pedestrian Level of Service (PLOS) target is C for all three road segments. The Ultimate Cycling Network from the City of Ottawa's *Transportation Master Plan* (2013) designates Earl Armstrong Road as a spine cycling route, therefore the Bicycle Level of Service (BLOS) target is C. As Ralph Hennessy Avenue and Markdale Terrace do not have cycling designations, the Bicycle Level of Service (BLOS) target is D for both segments. Transit service travelling on Earl Armstrong Road and Ralph Hennessy Avenue currently operate within mixed traffic, and as such, the Transit Level of Service (TLOS) target is D for both facilities. Markdale Terrace does not have any transit service, therefore, there is no Transit Level of Service (TLOS) target. Earl Armstrong Road is designated as full truck route and therefore has a Truck Level of Service (TkLOS) target of D. Ralph Hennessy Avenue and Markdale Terrace are not designated truck routes, therefore there are no Truck Level of Service (TkLOS) targets for both facilities.

Table 7 presents the MMLOS conditions for both roadway segments.

Earl Armstrong Road currently does not meet the Pedestrian Level of Service (PLOS) target of C due to the high volume of vehicles and the high operating speeds. Ralph Hennessy Avenue and Markdale Terrace both meet the Pedestrian Level of Service (PLOS) target of C.

Earl Armstrong Road currently does not meet the Bicycle Level of Service (BLOS) target of C. This is primarily due to the high operating speed of the roadway. Ralph Hennessy Avenue and Markdale Terrace both meet the Bicycle Level of Service (BLOS) target of D.

In terms of Transit Level of Service (TLOS), Earl Armstrong Road and Ralph Hennessy Avenue both meet the target Transit Level of Service (TLOS) target of D. As Markdale Terrace does not have transit service along the road, the Transit Level of Service (TLOS) is not applicable for this roadway segment.

Earl Armstrong Road currently meets the Truck Level of Service (TkLOS) target of D. As Ralph Hennessy Avenue and Markdale Terrace are not designated truck routes, they do not have a Truck Level of Service (TkLOS) target and therefore, the truck level of service is not applicable.

Table 7 - MMLOS Conditions (Segments)

Segment		Earl Armstrong Road (arterial, spine cycling route)		Ralph Hennessy Avenue (collector)		Markdale Terrace (local)		Target
		Existing	Build-out	Existing	Build-out	Existing	Build-out	
Pedestrian	Sidewalk width (m)	2 or more	**	1.8	**	1.8	**	C
	Boulevard width (m)	> 2	**	0	**	0	**	
	Average Daily Curb Lane Traffic (One-Way) > 3000?	Yes	**	No	**	No	**	
	On-Street parking	No	**	N/A	**	N/A	**	
	Operating speed (kph)	> 60	**	60	**	60	**	
	Level of Service	**D**	**	**C**	**	**C**	**	
Bicycle	Type of facility	Bike Lane	**	Mixed Traffic	**	Mixed Traffic	**	C / D / D
	Number of travel lanes	2 (each direction)	**	2 (total)	**	2 (total)	**	
	Raised Median?	Yes	**	No	**	No	**	
	Bike lane width (m)	> 1.8	**	N/A	**	N/A	**	
	Operating speed (kph)	> 70	**	50	**	50	**	
	Bike lane blockage freq.	Rare	**	Rare	**	Rare	**	
	Level of Service	**E**	**	**B**	**	**B**	**	
Transit	Type of facility	Mixed	**	Mixed	**	Not Applicable	***	D / D / No Target
	Parking/driveway friction	Limited	**	Limited	**			
	Level of Service	**D**	**	**D**	**			
Truck	Curb lane width (m)	~3.5m	**	Not Applicable	**	Not Applicable	**	D / No Target / No Target
	Number of travel lanes (both directions)	> 2	**					
	Level of Service	**A**	**					

Notes: C / D / D indicates the target is C for Earl Armstrong, D for Ralph Hennessy, and D for Markdale Terrace
** Indicates there are no changes between horizons or scenarios

4.4 ACCESS INTERSECTIONS DESIGN

4.4.1 Location and Design of Access

The proposed access to Ralph Hennessy Avenue is located opposite the planned access on the west side of Ralph Hennessy Avenue, approximately 45m south of Earl Armstrong Road and approximately 160m north of Markdale Terrace. It will feature a pavement width of 8.5m with 5m curb radii. It will be a full movements access with stop-control along the Site Access approach.

The proposed access to Markdale Terrace is located approximately 40m east of Ralph Hennessy Avenue. It will feature a pavement width of approximately 7.0m with 4.0m – 5.0m curb radii. It will be a full movements access with stop-control along the Site Access approach.

As outlined in the City of Ottawa's Private Approach By-law (No. 2003-447, S.25, L.), the minimum distance between the private approach and the nearest intersecting street is 30m based on 100 to 199 parking spaces. This minimum distance is satisfied with both site accesses.

4.4.2 Intersection Control

The site accesses are low-volume driveways located on collector and local roadways and therefore stop control on the minor site access approach is appropriate.

4.4.3 Intersection Design

Section 4.9.2 contains the detailed intersection and MMLOS analysis under all four horizons.

4.5 TRANSPORTATION DEMAND MANAGEMENT

4.5.1 Context for TDM

Not applicable; exempted during screening and scoping.

4.5.2 Need and Opportunity

Not applicable; exempted during screening and scoping.

4.5.3 TDM Program

Not applicable; exempted during screening and scoping.

4.6 NEIGHBOURHOOD TRAFFIC MANAGEMENT

Not applicable; exempted during screening and scoping.

4.7 TRANSIT

4.7.1 Route Capacity

An assumed transit modal share of 12% was adopted for both the residential land use. The forecasted transit trips for the proposed development is 14 and 17 total transit trips during the AM and PM peak hours, respectively. Transit service headways for OC Transpo route 278 is anticipated to remain at approximately 15 minutes during the weekday morning and afternoon peak periods. Standard and articulated buses have seated capacities of 40 and 60 people; respectively, and therefore the combined hourly transit capacity is estimated at 160 - 240 people per hour during the weekday AM and PM peak periods. The proposed development is therefore anticipated to occupy between 5% and 10% of transit capacity.

4.7.2 Transit Priority

The proposed development will be utilizing existing transit stops along Earl Armstrong Road and is therefore not expected to impact the transit travel times or trigger the need for transit priority measures.

4.8 REVIEW OF NETWORK CONCEPT

Not applicable; exempted during screening and scoping.

4.9 INTERSECTION DESIGN

4.9.1 Intersection Control

The existing intersection control will be maintained as the default control for the Earl Armstrong Road at Ralph Hennessy Avenue intersection. Any intersection improvements triggered through the intersection level of service analysis will be highlighted and adopted accordingly.

4.9.2 Intersection Design

An assessment of the study area intersections was undertaken to determine the operational characteristics of the study area intersections under the different horizons identified in the Screening and Scoping report. Intersection operational analysis was facilitated by Synchro 10.0™ software package and the MMLOS analysis was completed for all modes and compared against the City of Ottawa's MMLOS targets.

4.9.2.1 2018 Existing Conditions

Figure 6 illustrates 2018 Existing AM and PM peak hour traffic volumes at the study area intersections.

Table 8 summarizes the results of the Synchro analysis under 2018 existing conditions. Both existing study area intersections currently operate acceptably under 2018 existing conditions.

Appendix C contains detailed intersection performance worksheets.

Table 8 - 2018 Existing Intersection Operations

Scenario	Intersection Control	Approach / Movement		LOS	V/C	Delay (s)	Queue 95th (m)
Earl Armstrong Road at Ralph Hennessy Avenue	Traffic Signals	EB	Left	A (A)	0.07 (0.27)	5.0 (4.3)	4.6 (8.1)
			Through	A (A)	0.54 (0.35)	10.4 (6.5)	108.1 (53.8)
			Right	A (A)	0.03 (0.02)	6.2 (4.7)	0.6 (0.0)
		WB	Left	A (A)	0.19 (0.12)	5.9 (4.0)	6.8 (5.1)
			Through	A (A)	0.30 (0.47)	7.3 (8.3)	49.4 (79.7)
			Right	A (A)	0.04 (0.08)	5.8 (5.5)	2.7 (5.7)
		NB	Left	A (A)	0.22 (0.43)	48.6 (55.5)	16.4 (21.7)
			Through	A (A)	0.04 (0.03)	47.0 (51.2)	6.0 (4.3)
			Right	A (A)	0.05 (0.07)	47.1 (51.5)	11.5 (15.8)
		SB	Left	B (A)	0.62 (0.33)	57.9 (54.2)	38.0 (17.8)
			Through	A (A)	0.02 (0.04)	46.9 (51.2)	4.6 (5.0)
			Right	A (A)	0.04 (0.04)	47.1 (51.3)	8.8 (9.0)
		Overall Intersection		**A (A)**	**0.53 (0.45)**	**14.0 (11.7)**	**-**
Ralph Hennessy at Markdale Terrace	Minor Stop	WB	Left / Right	A (A)	0.06 (0.05)	9.1 (9.1)	1.4 (1.2)
		NB	Through / Right	A (A)	0.05 (0.06)	0.0 (0.0)	0.0 (0.0)
		SB	Left / Through	A (A)	0.02 (0.03)	2.2 (3.6)	0.4 (0.6)
		Overall Intersection		**A (A)**	**-**	**2.9 (3.0)**	**-**

Notes:
1. Table format: AM (PM)
2. v/c – represents the anticipated volume divided by the predicted capacity
3. # - 95th percentile volume exceeds capacity, queue may be longer

MMLOS – Earl Armstrong Road at Ralph Hennessy Avenue Intersection (2018 Existing):

Based on the land-use designations for Earl Armstrong Road and Ralph Hennessy Avenue, the Pedestrian Level of Service (PLOS) target is C for the intersection of Earl Armstrong Road and Ralph Hennessy Avenue. The Ultimate Cycling Network from the City of Ottawa's *Transportation Master Plan* (2013) designates Earl Armstrong Road as a spine cycling route, therefore the Bicycle Level of Service (BLOS) target is C. As Ralph Hennessy Avenue does not have a cycling designation, the Bicycle Level of Service (BLOS) target is D, however, the BLOS target at the intersection is governed by the most conservative target, therefore, the intersection BLOS target is C. Transit service travelling on Earl Armstrong Road and Ralph Hennessy Avenue currently operate within mixed traffic, and as such, the Transit Level of Service (TLOS) target is D for the intersection. Earl Armstrong Road is designated as full truck routes and therefore has a Truck Level of Service (TkLOS) target of D. Ralph Hennessy Avenue is not a designated truck route, therefore there is no Truck Level of Service (TkLOS) target, however, the TkLOS target at the intersection is governed by the most conservative target, therefore, the TkLOS target is D for the intersection. The vehicle level of service (VLOS) target for the intersection is D.

Table 9 presents the MMLOS conditions for the signalized intersection of Earl Armstrong Road at Ralph Hennessy Avenue under 2018 existing conditions.

The Pedestrian Level of Service (PLOS) at the intersection is currently operating with a PLOS of F, which is below the desired target of C. Based on the MMLOS guidelines, intersection PLOS is largely influenced by the number of lanes pedestrians cross. Reducing the number of vehicle lanes is not a feasible option as it would be to the detriment of the vehicle level of service particularly with the amount of future growth anticipated in the area.

The Bicycle Level of Service (BLOS) at the intersection is currently operating with a BLOS of F, which is below the desired target of C. Based on the MMLOS guidelines, intersection BLOS is influenced by the availability of dedicated cycling amenities, number of lanes cyclists must cross to negotiate a turn at intersections, and roadway operating speeds. Due to the nature of arterial to collector intersections, the number of vehicle travel lanes is often more than one in each direction. This increases the number of lanes cyclists must cross to navigate left turning movements at the intersection. In addition, the posted speed limit is typically 60 km/h or greater along arterial and most collector roadways. These two factors limit the potential BLOS at signalized arterial to collector intersections. Implementing bike boxes at the intersection would improve the BLOS at the intersection, however, bike boxes are typically applied in urban areas where the vehicle speeds are relatively low, therefore, it is not applicable for the subject intersection. Implementing a physically separated cycling facility (i.e. cycle track or multi-use pathway) with cross-rides at the intersection would also improve the BLOS. This type of treatment would likely require additional right-of-way along both Earl Armstrong Road and Ralph Hennessy Avenue.

The transit level of service at the intersection is currently operating with a TLOS of C, which is within the TLOS target of D. Based on the MMLOS guidelines, intersection TLOS is governed by the delay at the intersection.

The truck level of service at the intersection is currently operating with a TkLOS of C, which is within the TkLOS target of D. Based on the MMLOS guidelines, TkLOS is governed by the corner radii and the number of receiving lanes.

The vehicle level of service at the intersection is currently operating at a VLOS of B, which is within the VLOS target of D.

Table 9 - 2018 Existing Intersection MMLOS (Earl Armstrong / Ralph Hennessy)

Segment		2018 Existing Traffic				Target
		East Leg	West Leg	North Leg	South Leg	
PLOS	Lanes crossed	7	7	6	5	C
	Median >=2.4m (yes/no)	No	No	No	No	
	Left turn phasing	Protected / Permissive	Protected / Permissive	Permissive	Permissive	
	Right turn conflict	Yield Control	Yield Control	Yield Control	Yield Control	
	RTOR (yes/no)	Yes	Yes	Yes	Yes	
	Leading ped interval (yes/no)	No	No	No	No	
	Right turn corner radius (m)	Right-turn Channel	Right-turn Channel	Right-turn Channel	Right-turn Channel	
	Crosswalk treatment	Standard	Standard	Standard	Standard	
	Cycle length (s)	120	120	120	120	
	Effective walk time (s)	58.9	58.9	7.7	7.7	
	PETSI Points	11	14	32	49	
	PETSI Points LOS	F	F	E	D	
	Average Pedestrian Delay (s)	15.5	15.5	52.5	52.5	
	Ped Delay LOS	B	B	E	E	
	Level of Service	F	F	E	E	
	Level of Service	**F**				
BLOS	Type of bike lane	Pocket Bike Lane	Pocket Bike Lane	Mixed Traffic	Mixed Traffic	C
	Left-turn - lanes crossed	2	2	N/A	N/A	
	Left-turn - vehicle operating speed (km/hr)	> 60	> 60	> 60	> 60	
	Right-turn - number of turn lanes	1	1	1	1	
	Right-turn - turn lane length (m)	> 50	> 50	N/A - Channelized	N/A - Channelized	
	Right-turn - turning speed (km/hr)	< 30	< 30	> 25	> 25	
	Right-turn - location of bike lane	RTL introduced to the right of the bike lane	RTL introduced to the right of the bike lane	N/A	N/A	
	Level of Service	F	F	F	F	
	Level of Service	**F**				
TLOS	Intersection Average Delay (s)	≤ 20				D
	Level of Service	**C**				
TkLOS	Effective corner radius (m)	>15	>15	> 15m	>15	D
	Number of receiving lanes	2	1	2	2	
	Level of Service	A	C	A	A	
	Level of Service	**C**				
VLOS	Maximum Volume-to-capacity (v/c)	0.47	0.54	0.62	0.43	D
	Level of Service	A	A	B	A	
	Level of Service	**B**				

4.9.2.2 2020 Future Background Conditions

Figure 10 illustrates 2020 future background AM and PM peak hour traffic volumes at the study area intersections.

Table 10 summarizes the results of the Synchro analysis for 2020 future background conditions. All study area intersections are anticipated to operate acceptably under 2020 future background conditions.

Appendix C contains detailed intersection performance worksheets.

Table 10 – 2020 Future Background Intersection Operations

Scenario	Intersection Control	Approach / Movement		LOS	V/C	Delay (s)	Queue 95th (m)
Earl Armstrong Road at Ralph Hennessy Avenue	Traffic Signals	EB	Left	A (A)	0.07 (0.30)	5.1 (4.8)	4.8 (9.0)
			Through	A (A)	0.56 (0.37)	10.9 (7.0)	116.7 (58.8)
			Right	A (A)	0.03 (0.03)	6.3 (5.0)	1.2 (0.2)
		WB	Left	A (A)	0.22 (0.16)	6.4 (4.2)	7.3 (6.4)
			Through	A (A)	0.31 (0.49)	7.5 (8.9)	52.3 (88.1)
			Right	A (A)	0.04 (0.08)	5.9 (5.8)	3.1 (6.1)
		NB	Left	A (A)	0.29 (0.47)	49.1 (55.4)	20.4 (24.4)
			Through	A (A)	0.05 (0.05)	46.8 (50.7)	6.8 (6.0)
			Right	A (A)	0.06 (0.07)	46.9 (50.9)	14.0 (16.4)
		SB	Left	B (A)	0.64 (0.32)	58.4 (53.3)	39.4 (18.1)
			Through	A (A)	0.03 (0.05)	46.7 (50.7)	5.6 (6.4)
			Right	A (A)	0.05 (0.05)	46.8 (50.7)	9.6 (9.5)
		Overall Intersection		**A (A)**	**0.55 (0.48)**	**14.6 (12.3)**	-
Ralph Hennessy Avenue at Site Access 1	Minor Stop	EB	Left / Through / Right	A (A)	0.04 (0.03)	9.8 (9.9)	1.0 (0.6)
		NB	Left / Through / Right	A (A)	0.00 (0.01)	0.1 (0.5)	0.0 (0.2)
		SB	Left / Through / Right	A (A)	0.07 (0.07)	0.0 (0.0)	0.0 (0.0)
		Overall Intersection		**A (A)**	-	**1.2 (0.9)**	-
Ralph Hennessy at Markdale Terrace	Minor Stop	WB	Left / Right	A (A)	0.06 (0.05)	9.1 (9.2)	1.4 (1.3)
		NB	Through / Right	A (A)	0.06 (0.07)	0.0 (0.0)	0.0 (0.0)
		SB	Left / Through	A (A)	0.02 (0.03)	2.0 (3.5)	0.5 (0.7)
		Overall Intersection		**A (A)**	-	**2.8 (2.9)**	-

Notes:
1. Table format: AM (PM)
2. v/c – represents the anticipated volume divided by the predicted capacity
3. # - 95th percentile volume exceeds capacity, queue may be longer

MMLOS – Earl Armstrong Road at Ralph Hennessy Avenue Intersection (2020 Future Background):

Based on the land-use designations for Earl Armstrong Road and Ralph Hennessy Avenue, the Pedestrian Level of Service (PLOS) target is C for the intersection of Earl Armstrong Road and Ralph Hennessy Avenue. The Ultimate Cycling Network from the City of Ottawa's *Transportation Master Plan* (2013) designates Earl Armstrong Road as a spine cycling route, therefore the Bicycle Level of Service (BLOS) target is C. As Ralph Hennessy Avenue does not have a cycling designation, the Bicycle Level of Service (BLOS) target is D, however, the BLOS target at the intersection is governed by the most conservative target, therefore, the intersection BLOS target is C. Transit service travelling on Earl Armstrong Road and Ralph Hennessy Avenue currently operate within mixed traffic, and as such, the Transit Level of Service (TLOS) target is D for the intersection. Earl Armstrong Road is designated as full truck routes and therefore has a Truck Level of Service (TkLOS) target of D. Ralph Hennessy Avenue is not a designated truck route, therefore there is no Truck Level of Service (TkLOS) target, however, the TkLOS target at the intersection is governed by the most conservative target, therefore, the TkLOS target is D for the intersection. The vehicle level of service (VLOS) target for the intersection is D.

Table 11 presents the MMLOS conditions for the signalized intersection of Earl Armstrong Road at Ralph Hennessy Avenue under 2020 future background conditions.

The Pedestrian Level of Service (PLOS) at the intersection is projected to continue to operate with a PLOS of F, which is below the desired target of C. Based on the MMLOS guidelines, intersection PLOS is largely influenced by the number of lanes pedestrians cross. Reducing the number of vehicle lanes is not a feasible option as it would be to the detriment of the vehicle level of service particularly with the amount of future growth anticipated in the area.

The Bicycle Level of Service (BLOS) at the intersection is currently operating with a BLOS of F, which is below the desired target of C. Based on the MMLOS guidelines, intersection BLOS is influenced by the availability of dedicated cycling amenities, number of lanes cyclists must cross to negotiate a turn at intersections, and roadway operating speeds. Due to the nature of arterial to collector intersections, the number of vehicle travel lanes is often more than one in each direction. This increases the number of lanes cyclists must cross to navigate left turning movements at the intersection. In addition, the posted speed limit is typically 60 km/h or greater along arterial and most collector roadways. These two factors limit the potential BLOS at signalized arterial to collector intersections. Implementing bike boxes at the intersection would improve the BLOS at the intersection, however, bike boxes are typically applied in urban areas where the vehicle speeds are relatively low, therefore, it is not applicable for the subject intersection. Implementing a physically separated cycling facility (i.e. cycle track or multi-use pathway) with cross-rides at the intersection would also improve the BLOS. This type of treatment would likely require additional right-of-way along both Earl Armstrong Road and Ralph Hennessy Avenue.

The transit level of service at the intersection is projected to continue to operate with a TLOS of C, which is within the TLOS target of D. Based on the MMLOS guidelines, intersection TLOS is governed by the delay at the intersection.

The truck level of service at the intersection is projected to continue to operate with a TkLOS of C, which is within the TkLOS target of D. Based on the MMLOS guidelines, TkLOS is governed by the corner radii and the number of receiving lanes.

The vehicle level of service at the intersection is projected to continue to operate at a VLOS of B, which is within the target of D.

Table 11 – 2020 Future Background Intersection MMLOS (Earl Armstrong / Ralph Hennessy)

Segment		2018 Existing Traffic				Target
		East Leg	West Leg	North Leg	South Leg	
PLOS	Lanes crossed	7	7	6	5	C
	Median >=2.4m (yes/no)	No	No	No	No	
	Left turn phasing	Protected / Permissive	Protected / Permissive	Permissive	Permissive	
	Right turn conflict	Yield Control	Yield Control	Yield Control	Yield Control	
	RTOR (yes/no)	Yes	Yes	Yes	Yes	
	Leading ped interval (yes/no)	No	No	No	No	
	Right turn corner radius (m)	Right-turn Channel	Right-turn Channel	Right-turn Channel	Right-turn Channel	
	Crosswalk treatment	Standard	Standard	Standard	Standard	
	Cycle length (s)	120	120	120	120	
	Effective walk time (s)	58.9	58.9	7.7	7.7	
	PETSI Points	11	14	32	49	
	PETSI Points LOS	F	F	E	D	
	Average Pedestrian Delay (s)	15.5	15.5	52.5	52.5	
	Ped Delay LOS	B	B	E	E	
	Level of Service	F	F	E	E	
	Level of Service	**F**				
BLOS	Type of bike lane	Pocket Bike Lane	Pocket Bike Lane	Mixed Traffic	Mixed Traffic	C
	Left-turn - lanes crossed	2	2	N/A	N/A	
	Left-turn - vehicle operating speed (km/hr)	> 60	> 60	> 60	> 60	
	Right-turn - number of turn lanes	1	1	1	1	
	Right-turn - turn lane length (m)	> 50	> 50	N/A - Channelized	N/A - Channelized	
	Right-turn - turning speed (km/hr)	< 30	< 30	> 25	> 25	
	Right-turn - location of bike lane	RTL introduced to the right of the bike lane	RTL introduced to the right of the bike lane	N/A	N/A	
	Level of Service	F	F	F	F	
	Level of Service	**F**				
TLOS	Intersection Average Delay (s)	≤ 20				D
	Level of Service	**C**				
TkLOS	Effective corner radius (m)	>15	>15	> 15m	>15	D
	Number of receiving lanes	2	1	2	2	
	Level of Service	A	C	A	A	
	Level of Service	**C**				
VLOS	Maximum Volume-to-capacity (v/c)	0.49	0.56	0.64	0.47	D
	Level of Service	A	A	B	A	
	Level of Service	**B**				

4.9.2.3 2020 Total Future Conditions

Figure 11 illustrates 2020 Total Future AM and PM peak hour traffic volumes at the study area intersections.

Table 12 summarizes the results of the Synchro analysis for 2020 total future conditions. All study area intersections are anticipated to operate acceptably under 2020 total future conditions.

Appendix C contains detailed intersection performance worksheets.

Table 12 – 2020 Total Future Intersection Operations

Scenario	Intersection Control	Approach / Movement		LOS	V/C	Delay (s)	Queue 95th (m)
Earl Armstrong Road at Ralph Hennessy Avenue	Traffic Signals	EB	Left	A (A)	0.07 (0.31)	5.2 (5.6)	4.8 (10.1)
			Through	A (A)	0.56 (0.38)	11.1 (8.4)	117.9 (64.8)
			Right	A (A)	0.04 (0.04)	6.5 (6.1)	3.0 (2.9)
		WB	Left	A (A)	0.26 (0.20)	6.7 (4.6)	8.6 (8.9)
			Through	A (A)	0.31 (0.51)	7.6 (9.8)	52.3 (95.2)
			Right	A (A)	0.04 (0.08)	5.9 (6.4)	3.1 (6.6)
		NB	Left	A (A)	0.42 (0.55)	50.6 (56.5)	27.6 (30.7)
			Through	A (A)	0.07 (0.07)	46.9 (49.2)	9.1 (8.2)
			Right	A (A)	0.07 (0.09)	47.0 (49.4)	15.3 (17.0)
		SB	Left	B (A)	0.63 (0.27)	58.1 (51.2)	39.4 (17.6)
			Through	A (A)	0.05 (0.07)	46.7 (49.2)	6.8 (8.6)
			Right	A (A)	0.05 (0.04)	46.7 (49.0)	9.6 (9.3)
		Overall Intersection		**A (A)**	**0.56 (0.50)**	**15.3 (13.7)**	-
Ralph Hennessy Avenue at Site Access 1	Minor Stop	EB	Left / Through / Right	B (B)	0.05 (0.03)	10.8 (11.2)	1.2 (0.8)
		WB	Left / Through / Right	A (A)	0.03 (0.03)	9.3 (9.5)	0.8 (0.7)
		NB	Left / Through / Right	A (A)	0.00 (0.01)	0.1 (0.5)	0.0 (0.2)
		SB	Left / Through / Right	A (A)	0.01 (0.02)	0.9 (1.3)	0.2 (0.4)
		Overall Intersection		**A (A)**	-	**2.1 (1.9)**	-
Ralph Hennessy at Markdale Terrace	Minor Stop	WB	Left / Right	A (A)	0.09 (0.08)	9.3 (9.4)	2.3 (2.0)
		NB	Through / Right	A (A)	0.06 (0.08)	0.0 (0.0)	0.0 (0.0)
		SB	Left / Through	A (A)	0.03 (0.05)	2.7 (4.3)	0.7 (1.1)
		Overall Intersection		**A (A)**	-	**3.6 (3.7)**	-
Markdale Terrace at Site Access 2	Minor Stop	EB	Through / Right	A (A)	0.01 (0.02)	1.9 (2.8)	0.2 (0.4)
		WB	Left / Through	A (A)	0.03 (0.03)	0.0 (0.0)	0.0 (0.0)
		SB	Left / Right	A (A)	0.03 (0.02)	8.7 (8.6)	0.6 (0.6)
		Overall Intersection		**A (A)**	-	**2.5 (2.8)**	-

Notes:
1. Table format: AM (PM)
2. v/c – represents the anticipated volume divided by the predicted capacity
3. # - 95th percentile volume exceeds capacity, queue may be longer

MMLOS – Earl Armstrong Road at Ralph Hennessy Avenue Intersection (2020 Total Future):

Based on the land-use designations for Earl Armstrong Road and Ralph Hennessy Avenue, the Pedestrian Level of Service (PLOS) target is C for the intersection of Earl Armstrong Road and Ralph Hennessy Avenue. The Ultimate Cycling Network from the City of Ottawa's *Transportation Master Plan* (2013) designates Earl Armstrong Road as a spine cycling route, therefore the Bicycle Level of Service (BLOS) target is C. As Ralph Hennessy Avenue does not have a cycling designation, the Bicycle Level of Service (BLOS) target is D, however, the BLOS target at the intersection is governed by the most conservative target, therefore, the intersection BLOS target is C. Transit service travelling on Earl Armstrong Road and Ralph Hennessy Avenue currently operate within mixed traffic, and as such, the Transit Level of Service (TLOS) target is D for the intersection. Earl Armstrong Road is designated as full truck routes and therefore has a Truck Level of Service (TkLOS) target of D. Ralph Hennessy Avenue is not a designated truck route, therefore there is no Truck Level of Service (TkLOS) target, however, the TkLOS target at the intersection is governed by the most conservative target, therefore, the TkLOS target is D for the intersection. The vehicle level of service (VLOS) target for the intersection is D.

Table 13 presents the MMLOS conditions for the signalized intersection of Earl Armstrong Road at Ralph Hennessy Avenue under 2020 total future conditions.

The Pedestrian Level of Service (PLOS) at the intersection is projected to continue to operate with a PLOS of F, which is below the desired target of C. Based on the MMLOS guidelines, intersection PLOS is largely influenced by the number of lanes pedestrians cross. Reducing the number of vehicle lanes is not a feasible option as it would be to the detriment of the vehicle level of service particularly with the amount of future growth anticipated in the area.

The Bicycle Level of Service (BLOS) at the intersection is currently operating with a BLOS of F, which is below the desired target of C. Based on the MMLOS guidelines, intersection BLOS is influenced by the availability of dedicated cycling amenities, number of lanes cyclists must cross to negotiate a turn at intersections, and roadway operating speeds. Due to the nature of arterial to collector intersections, the number of vehicle travel lanes is often more than one in each direction. This increases the number of lanes cyclists must cross to navigate left turning movements at the intersection. In addition, the posted speed limit is typically 60 km/h or greater along arterial and most collector roadways. These two factors limit the potential BLOS at signalized arterial to collector intersections. Implementing bike boxes at the intersection would improve the BLOS at the intersection, however, bike boxes are typically applied in urban areas where the vehicle speeds are relatively low, therefore, it is not applicable for the subject intersection. Implementing a physically separated cycling facility (i.e. cycle track or multi-use pathway) with cross-rides at the intersection would also improve the BLOS. This type of treatment would likely require additional right-of-way along both Earl Armstrong Road and Ralph Hennessy Avenue.

The transit level of service at the intersection is projected to continue to operate with a TLOS of C, which is within the TLOS target of D. Based on the MMLOS guidelines, intersection TLOS is governed by the delay at the intersection.

The truck level of service at the intersection is projected to continue to operate with a TkLOS of C, which is within the TkLOS target of D. Based on the MMLOS guidelines, TkLOS is governed by the corner radii and the number of receiving lanes.

The vehicle level of service at the intersection is projected to continue to operate at a VLOS of B, which is within the VLOS target of D.

Table 13 – 2020 Total Future Intersection MMLOS (Earl Armstrong / Ralph Hennessy)

Segment		2018 Existing Traffic				Target
		East Leg	West Leg	North Leg	South Leg	
PLOS	Lanes crossed	7	7	6	5	C
	Median >=2.4m (yes/no)	No	No	No	No	
	Left turn phasing	Protected / Permissive	Protected / Permissive	Permissive	Permissive	
	Right turn conflict	Yield Control	Yield Control	Yield Control	Yield Control	
	RTOR (yes/no)	Yes	Yes	Yes	Yes	
	Leading ped interval (yes/no)	No	No	No	No	
	Right turn corner radius (m)	Right-turn Channel	Right-turn Channel	Right-turn Channel	Right-turn Channel	
	Crosswalk treatment	Standard	Standard	Standard	Standard	
	Cycle length (s)	120	120	120	120	
	Effective walk time (s)	58.9	58.9	7.7	7.7	
	PETSI Points	11	14	32	49	
	PETSI Points LOS	F	F	E	D	
	Average Pedestrian Delay (s)	15.5	15.5	52.5	52.5	
	Ped Delay LOS	B	B	E	E	
	Level of Service	F	F	E	E	
	Level of Service	**F**				
BLOS	Type of bike lane	Pocket Bike Lane	Pocket Bike Lane	Mixed Traffic	Mixed Traffic	C
	Left-turn - lanes crossed	2	2	N/A	N/A	
	Left-turn - vehicle operating speed (km/hr)	> 60	> 60	> 60	> 60	
	Right-turn - number of turn lanes	1	1	1	1	
	Right-turn - turn lane length (m)	> 50	> 50	N/A - Channelized	N/A - Channelized	
	Right-turn - turning speed (km/hr)	< 30	< 30	> 25	> 25	
	Right-turn - location of bike lane	RTL introduced to the right of the bike lane	RTL introduced to the right of the bike lane	N/A	N/A	
	Level of Service	F	F	F	F	
	Level of Service	**F**				
TLOS	Intersection Average Delay (s)	≤ 20				D
	Level of Service	**C**				
TkLOS	Effective corner radius (m)	>15	>15	> 15m	>15	D
	Number of receiving lanes	2	1	2	2	
	Level of Service	A	C	A	A	
	Level of Service	**C**				
VLOS	Maximum Volume-to-capacity (v/c)	0.51	0.56	0.63	0.55	D
	Level of Service	A	A	B	A	
	Level of Service	**B**				

4.9.2.4 2025 Ultimate Conditions

Figure 12 illustrates 2025 Ultimate AM and PM peak hour traffic volumes at the study area intersections.

Table 14 summarizes the results of the Synchro analysis for 2025 ultimate conditions. All study area intersections are anticipated to operate acceptably under 2025 ultimate conditions.

Appendix C contains detailed intersection performance worksheets.

Table 14 – 2025 Ultimate Intersection Operations

Scenario	Intersection Control	Approach / Movement		LOS	V/C	Delay (s)	Queue 95th (m)
Earl Armstrong Road at Ralph Hennessy Avenue	Traffic Signals	EB	Left	A (A)	0.09 (0.39)	7.2 (8.6)	5.9 (13.1)
			Through	B (A)	0.67 (0.47)	16.0 (13.1)	151.8 (87.8)
			Right	A (A)	0.04 (0.11)	8.6 (9.6)	3.9 (9.0)
		WB	Left	A (B)	0.40 (0.69)	11.1 (11.6)	12.3 (#38.4)
			Through	A (A)	0.36 (0.58)	9.7 (12.6)	64.8 (126.4)
			Right	A (A)	0.04 (0.09)	7.4 (7.7)	4.2 (9.2)
		NB	Left	C (B)	0.74 (0.65)	61.5 (58.2)	55.2 (40.9)
			Through	A (A)	0.06 (0.06)	43.1 (46.3)	9.1 (8.2)
			Right	B (A)	0.61 (0.13)	51.8 (46.9)	54.8 (19.4)
		SB	Left	A (A)	0.54 (0.23)	49.3 (47.9)	40.7 (17.8)
			Through	A (A)	0.04 (0.06)	43.0 (46.3)	7.1 (8.5)
			Right	A (A)	0.05 (0.05)	43.1 (46.3)	11.0 (11.3)
		Overall Intersection		**B (B)**	**0.66 (0.70)**	**21.3 (17.0)**	**-**
Ralph Hennessy Avenue at Site Access 1	Minor Stop	EB	Left / Through / Right	B (B)	0.05 (0.03)	10.9 (11.4)	1.2 (0.8)
		WB	Left / Through / Right	A (A)	0.03 (0.03)	9.4 (9.6)	0.8 (0.7)
		NB	Left / Through / Right	A (A)	0.00 (0.01)	0.1 (0.4)	0.0 (0.2)
		SB	Left / Through / Right	A (A)	0.01 (0.02)	0.8 (1.2)	0.2 (0.4)
		Overall Intersection		**A (A)**	**-**	**2.0 (1.8)**	**-**
Ralph Hennessy at Markdale Terrace	Minor Stop	WB	Left / Right	A (A)	0.09 (0.08)	9.3 (9.4)	2.2 (2.0)
		NB	Through / Right	A (A)	0.06 (0.08)	0.0 (0.0)	0.0 (0.0)
		SB	Left / Through	A (A)	0.03 (0.05)	2.5 (4.1)	0.7 (1.1)
		Overall Intersection		**A (A)**	**-**	**3.4 (3.5)**	**-**
Markdale Terrace at Site Access 2	Minor Stop	EB	Through / Right	A (A)	0.01 (0.02)	2.0 (2.8)	0.2 (0.4)
		WB	Left / Through	A (A)	0.03 (0.03)	0.0 (0.0)	0.0 (0.0)
		SB	Left / Right	A (A)	0.03 (0.02)	8.6 (8.6)	0.6 (0.6)
		Overall Intersection		**A (A)**	**-**	**2.6 (2.9)**	**-**

Notes:
1. Table format: AM (PM)
2. v/c – represents the anticipated volume divided by the predicted capacity
3. # - 95th percentile volume exceeds capacity, queue may be longer

MMLOS – Earl Armstrong Road at Ralph Hennessy Avenue Intersection (2025 Ultimate):

Based on the land-use designations for Earl Armstrong Road and Ralph Hennessy Avenue, the Pedestrian Level of Service (PLOS) target is C for the intersection of Earl Armstrong Road and Ralph Hennessy Avenue. The Ultimate Cycling Network from the City of Ottawa's *Transportation Master Plan* (2013) designates Earl Armstrong Road as a spine cycling route, therefore the Bicycle Level of Service (BLOS) target is C. As Ralph Hennessy Avenue does not have a cycling designation, the Bicycle Level of Service (BLOS) target is D, however, the BLOS target at the intersection is governed by the most conservative target, therefore, the intersection BLOS target is C. Transit service travelling on Earl Armstrong Road and Ralph Hennessy Avenue currently operate within mixed traffic, and as such, the Transit Level of Service (TLOS) target is D for the intersection. Earl Armstrong Road is designated as full truck routes and therefore has a Truck Level of Service (TkLOS) target of D. Ralph Hennessy Avenue is not a designated truck route, therefore there is no Truck Level of Service (TkLOS) target, however, the TkLOS target at the intersection is governed by the most conservative target, therefore, the TkLOS target is D for the intersection. The vehicle level of service (VLOS) target for the intersection is D.

Table 15 presents the MMLOS conditions for the signalized intersection of Earl Armstrong Road at Ralph Hennessy Avenue under 2025 ultimate conditions.

The Pedestrian Level of Service (PLOS) at the intersection is projected to continue to operate with a PLOS of F, which is below the desired target of C. Based on the MMLOS guidelines, intersection PLOS is largely influenced by the number of lanes pedestrians cross. Reducing the number of vehicle lanes is not a feasible option as it would be to the detriment of the vehicle level of service particularly with the amount of future growth anticipated in the area.

The Bicycle Level of Service (BLOS) at the intersection is currently operating with a BLOS of F, which is below the desired target of C. Based on the MMLOS guidelines, intersection BLOS is influenced by the availability of dedicated cycling amenities, number of lanes cyclists must cross to negotiate a turn at intersections, and roadway operating speeds. Due to the nature of arterial to collector intersections, the number of vehicle travel lanes is often more than one in each direction. This increases the number of lanes cyclists must cross to navigate left turning movements at the intersection. In addition, the posted speed limit is typically 60 km/h or greater along arterial and most collector roadways. These two factors limit the potential BLOS at signalized arterial to collector intersections. Implementing bike boxes at the intersection would improve the BLOS at the intersection, however, bike boxes are typically applied in urban areas where the vehicle speeds are relatively low, therefore, it is not applicable for the subject intersection. Implementing a physically separated cycling facility (i.e. cycle track or multi-use pathway) with cross-rides at the intersection would also improve the BLOS. This type of treatment would likely require additional right-of-way along both Earl Armstrong Road and Ralph Hennessy Avenue.

The transit level of service at the intersection is projected to continue to operate with a TLOS of C, which is within the TLOS target of D. Based on the MMLOS guidelines, intersection TLOS is governed by the delay at the intersection.

The truck level of service at the intersection is projected to continue to operate with a TkLOS of C, which is within the TkLOS target of D. Based on the MMLOS guidelines, TkLOS is governed by the corner radii and the number of receiving lanes.

The vehicle level of service at the intersection is projected to continue to operate at a VLOS of B, which is within the VLOS target of D.

Table 15 – 2025 Ultimate Intersection MMLOS (Earl Armstrong / Ralph Hennessy)

Segment		2018 Existing Traffic				Target
		East Leg	West Leg	North Leg	South Leg	
PLOS	Lanes crossed	7	7	6	5	C
	Median >=2.4m (yes/no)	No	No	No	No	
	Left turn phasing	Protected / Permissive	Protected / Permissive	Permissive	Permissive	
	Right turn conflict	Yield Control	Yield Control	Yield Control	Yield Control	
	RTOR (yes/no)	Yes	Yes	Yes	Yes	
	Leading ped interval (yes/no)	No	No	No	No	
	Right turn corner radius (m)	Right-turn Channel	Right-turn Channel	Right-turn Channel	Right-turn Channel	
	Crosswalk treatment	Standard	Standard	Standard	Standard	
	Cycle length (s)	120	120	120	120	
	Effective walk time (s)	58.9	58.9	7.7	7.7	
	PETSI Points	11	14	32	49	
	PETSI Points LOS	F	F	E	D	
	Average Pedestrian Delay (s)	15.5	15.5	52.5	52.5	
	Ped Delay LOS	B	B	E	E	
	Level of Service	F	F	E	E	
	Level of Service	**F**				
BLOS	Type of bike lane	Pocket Bike Lane	Pocket Bike Lane	Mixed Traffic	Mixed Traffic	C
	Left-turn - lanes crossed	2	2	N/A	N/A	
	Left-turn - vehicle operating speed (km/hr)	> 60	> 60	> 60	> 60	
	Right-turn - number of turn lanes	1	1	1	1	
	Right-turn - turn lane length (m)	> 50	> 50	N/A - Channelized	N/A - Channelized	
	Right-turn - turning speed (km/hr)	< 30	< 30	> 25	> 25	
	Right-turn - location of bike lane	RTL introduced to the right of the bike lane	RTL introduced to the right of the bike lane	N/A	N/A	
	Level of Service	F	F	F	F	
	Level of Service	**F**				
TLOS	Intersection Average Delay (s)	≤ 20				D
	Level of Service	**C**				
TkLOS	Effective corner radius (m)	>15	>15	> 15m	>15	D
	Number of receiving lanes	2	1	2	2	
	Level of Service	A	C	A	A	
	Level of Service	**C**				
VLOS	Maximum Volume-to-capacity (v/c)	0.69	0.67	0.54	0.74	D
	Level of Service	B	B	B	C	
	Level of Service	**C**				

5.0 CONCLUSION

This Transportation Impact Assessment (TIA) was prepared in support of a Site Plan application for a proposed development located at the southeast corner of Earl Armstrong Road and Ralph Hennessy Avenue in the Riverside South community in Ottawa, Ontario. The site is bound by Earl Armstrong to the north, Ralph Hennessy Avenue to the west, Markdale Terrace to the south, and existing residential homes to the east.

The proposed development consists of a total of 118 residential units comprised of 38 townhomes and 80 condo terrace homes with a combined 152,900 sq.ft. of gross-floor-area (GFA). One full movement access is proposed along Ralph Hennessy Avenue and another full movement access is proposed along Markdale Terrace.

The study area intersections currently operate acceptably, and the development generated site trips are not anticipated to adversely impact traffic operations. All study area intersections are projected to operate acceptably under the 2020 site build-out (total future) horizon and the 20205 ultimate (+5 year) horizon.

The multi-modal level of service (MMLOS) assessment for roadway segments identified that the Pedestrian Level of Service (PLOS) and Bicycle Level of Service (BLOS) targets are met for both the Ralph Hennessy Avenue and Markdale Terrace roadway segments due to the provision of sidewalk facilities, the relatively low traffic volumes, and the low operating speeds. Due to the high operating speeds and traffic volumes, the PLOS and BLOS targets are not met along Earl Armstrong Road. The transit level of service (TLOS) targets are met for both Earl Armstrong Road and Ralph Hennessy Avenue. As transit service does not run along Markdale Terrace, the TLOS is not applicable for this roadway segment. The truck level of service (TkLOS) target along Earl Armstrong Road is currently met due to the number of receiving lanes. As neither Ralph Hennessy Avenue nor Markdale Terrace are truck routes, the TkLOS does not apply on these roadway segments.

The MMLOS assessment for signalized intersections found that under all horizons, the Pedestrian and Bicycle Level of Service both operate below the desired targets at the Earl Armstrong Road at Ralph Hennessy Avenue intersection. As this intersection is an arterial to collector intersection, significant capacity has been allocated to vehicular demands. Due to the number of lanes that pedestrians must cross at this intersection on all legs, there is little that can be done to improve the pedestrian level of service. Implementing a physically separated cycling facility (i.e. cycle track or multi-use pathway) with cross-rides at the intersection would improve the bicycle level of service. This type of treatment would likely require additional right-of-way along both Earl Armstrong Road and Ralph Hennessy Avenue.

Based on the transportation evaluation presented in this study, the proposed residential development can be supported and should be permitted to proceed from a transportation impact perspective.

Appendix A COLLISION REPORTS

City Operations - Transportation Services

Collision Details Report - Public Version

From: January 1, 2013 **To:** December 31, 2017

Location: EARL ARMSTRONG RD @ SHORELINE DR

Traffic Control: Stop sign **Total Collisions:** 6

Date/Day/Time	Environment	Impact Type	Classification	Surface Cond'n	Veh. Dir	Vehicle Manoeuver	Vehicle type	First Event	No. Ped
2015-Jan-05, Mon,07:52	Clear	Angle	P.D. only	Slush	West	Going ahead	Automobile, station wagon	Other motor vehicle	
					South	Turning left	Automobile, station wagon	Other motor vehicle	
2015-Feb-02, Mon,15:46	Snow	Other	Non-fatal injury	Loose snow	North	Reversing	Snow plow	Other motor vehicle	
					South	Stopped	Automobile, station wagon	Other motor vehicle	
2015-Nov-16, Mon,16:23	Clear	Angle	P.D. only	Dry	West	Going ahead	Automobile, station wagon	Other motor vehicle	
					South	Turning right	Passenger van	Other motor vehicle	
2016-Jun-09, Thu,10:20	Clear	SMV other	Non-fatal injury	Dry	East	Going ahead	Automobile, station wagon	Curb	
2016-Aug-31, Wed,15:49	Clear	SMV other	Non-fatal injury	Dry	West	Going ahead	Pick-up truck	Pole (utility, power)	
2017-Feb-11, Sat,09:08	Clear	SMV other	P.D. only	Slush	West	Turning right	Automobile, station wagon	Skidding/sliding	

Appendix B TRANSPORTATION DEMAND MANAGEMENT CHECKLISTS

TDM-Supportive Development Design and Infrastructure Checklist:
Residential Developments (multi-family or condominium)

Legend

REQUIRED	The Official Plan or Zoning By-law provides related guidance that must be followed
BASIC	The measure is generally feasible and effective, and in most cases would benefit the development and its users
BETTER	The measure could maximize support for users of sustainable modes, and optimize development performance

		TDM-supportive design & infrastructure measures: *Residential developments*	Check if completed & add descriptions, explanations or plan/drawing references
	1.	**WALKING & CYCLING: ROUTES**	
	1.1	**Building location & access points**	
BASIC	1.1.1	Locate building close to the street, and do not locate parking areas between the street and building entrances	☑
BASIC	1.1.2	Locate building entrances in order to minimize walking distances to sidewalks and transit stops/stations	☑
BASIC	1.1.3	Locate building doors and windows to ensure visibility of pedestrians from the building, for their security and comfort	☐
	1.2	**Facilities for walking & cycling**	
REQUIRED	1.2.1	Provide convenient, direct access to stations or major stops along rapid transit routes within 600 metres; minimize walking distances from buildings to rapid transit; provide pedestrian-friendly, weather-protected (where possible) environment between rapid transit accesses and building entrances; ensure quality linkages from sidewalks through building entrances to integrated stops/stations *(see Official Plan policy 4.3.3)*	☑
REQUIRED	1.2.2	Provide safe, direct and attractive pedestrian access from public sidewalks to building entrances through such measures as: reducing distances between public sidewalks and major building entrances; providing walkways from public streets to major building entrances; within a site, providing walkways along the front of adjoining buildings, between adjacent buildings, and connecting areas where people may congregate, such as courtyards and transit stops; and providing weather protection through canopies, colonnades, and other design elements wherever possible *(see Official Plan policy 4.3.12)*	☑

		TDM-supportive design & infrastructure measures: *Residential developments*	Check if completed & add descriptions, explanations or plan/drawing references
REQUIRED	1.2.3	Provide sidewalks of smooth, well-drained walking surfaces of contrasting materials or treatments to differentiate pedestrian areas from vehicle areas, and provide marked pedestrian crosswalks at intersection sidewalks *(see Official Plan policy 4.3.10)*	☑
REQUIRED	1.2.4	Make sidewalks and open space areas easily accessible through features such as gradual grade transition, depressed curbs at street corners and convenient access to extra-wide parking spaces and ramps *(see Official Plan policy 4.3.10)*	☑
REQUIRED	1.2.5	Include adequately spaced inter-block/street cycling and pedestrian connections to facilitate travel by active transportation. Provide links to the existing or planned network of public sidewalks, multi-use pathways and on-road cycle routes. Where public sidewalks and multi-use pathways intersect with roads, consider providing traffic control devices to give priority to cyclists and pedestrians *(see Official Plan policy 4.3.11)*	☑
BASIC	1.2.6	Provide safe, direct and attractive walking routes from building entrances to nearby transit stops	☐
BASIC	1.2.7	Ensure that walking routes to transit stops are secure, visible, lighted, shaded and wind-protected wherever possible	☐
BASIC	1.2.8	Design roads used for access or circulation by cyclists using a target operating speed of no more than 30 km/h, or provide a separated cycling facility	☐
	1.3	**Amenities for walking & cycling**	
BASIC	1.3.1	Provide lighting, landscaping and benches along walking and cycling routes between building entrances and streets, sidewalks and trails	☐
BASIC	1.3.2	Provide wayfinding signage for site access (where required, e.g. when multiple buildings or entrances exist) and egress (where warranted, such as when directions to reach transit stops/stations, trails or other common destinations are not obvious)	☐

		TDM-supportive design & infrastructure measures: *Residential developments*	Check if completed & add descriptions, explanations or plan/drawing references
	2.	**WALKING & CYCLING: END-OF-TRIP FACILITIES**	
	2.1	**Bicycle parking**	
REQUIRED	2.1.1	Provide bicycle parking in highly visible and lighted areas, sheltered from the weather wherever possible *(see Official Plan policy 4.3.6)*	☑
REQUIRED	2.1.2	Provide the number of bicycle parking spaces specified for various land uses in different parts of Ottawa; provide convenient access to main entrances or well-used areas *(see Zoning By-law Section 111)*	☑
REQUIRED	2.1.3	Ensure that bicycle parking spaces and access aisles meet minimum dimensions; that no more than 50% of spaces are vertical spaces; and that parking racks are securely anchored *(see Zoning By-law Section 111)*	☑
BASIC	2.1.4	Provide bicycle parking spaces equivalent to the expected number of resident-owned bicycles, plus the expected peak number of visitor cyclists	☐
	2.2	**Secure bicycle parking**	
REQUIRED	2.2.1	Where more than 50 bicycle parking spaces are provided for a single residential building, locate at least 25% of spaces within a building/structure, a secure area (e.g. supervised parking lot or enclosure) or bicycle lockers *(see Zoning By-law Section 111)*	☑
BETTER	2.2.2	Provide secure bicycle parking spaces equivalent to at least the number of units at condominiums or multi-family residential developments	☐
	2.3	**Bicycle repair station**	
BETTER	2.3.1	Provide a permanent bike repair station, with commonly used tools and an air pump, adjacent to the main bicycle parking area (or secure bicycle parking area, if provided)	☐
	3.	**TRANSIT**	
	3.1	**Customer amenities**	
BASIC	3.1.1	Provide shelters, lighting and benches at any on-site transit stops	☐
BASIC	3.1.2	Where the site abuts an off-site transit stop and insufficient space exists for a transit shelter in the public right-of-way, protect land for a shelter and/or install a shelter	☐
BETTER	3.1.3	Provide a secure and comfortable interior waiting area by integrating any on-site transit stops into the building	☐

		TDM-supportive design & infrastructure measures: *Residential developments*	Check if completed & add descriptions, explanations or plan/drawing references
	4.	**RIDESHARING**	
	4.1	**Pick-up & drop-off facilities**	
BASIC	4.1.1	Provide a designated area for carpool drivers (plus taxis and ride-hailing services) to drop off or pick up passengers without using fire lanes or other no-stopping zones	☐
	5.	**CARSHARING & BIKESHARING**	
	5.1	**Carshare parking spaces**	
BETTER	5.1.1	Provide up to three carshare parking spaces in an R3, R4 or R5 Zone for specified residential uses *(see Zoning By-law Section 94)*	☐
	5.2	**Bikeshare station location**	
BETTER	5.2.1	Provide a designated bikeshare station area near a major building entrance, preferably lighted and sheltered with a direct walkway connection	☐
	6.	**PARKING**	
	6.1	**Number of parking spaces**	
REQUIRED	6.1.1	Do not provide more parking than permitted by zoning, nor less than required by zoning, unless a variance is being applied for	☑
BASIC	6.1.2	Provide parking for long-term and short-term users that is consistent with mode share targets, considering the potential for visitors to use off-site public parking	☐
BASIC	6.1.3	Where a site features more than one use, provide shared parking and reduce the cumulative number of parking spaces accordingly *(see Zoning By-law Section 104)*	☐
BETTER	6.1.4	Reduce the minimum number of parking spaces required by zoning by one space for each 13 square metres of gross floor area provided as shower rooms, change rooms, locker rooms and other facilities for cyclists in conjunction with bicycle parking *(see Zoning By-law Section 111)*	☐
	6.2	**Separate long-term & short-term parking areas**	
BETTER	6.2.1	Provide separate areas for short-term and long-term parking (using signage or physical barriers) to permit access controls and simplify enforcement (i.e. to discourage residents from parking in visitor spaces, and vice versa)	☐

TDM Measures Checklist:
Residential Developments (multi-family, condominium or subdivision)

Legend

BASIC — The measure is generally feasible and effective, and in most cases would benefit the development and its users

BETTER — The measure could maximize support for users of sustainable modes, and optimize development performance

★ — The measure is one of the most dependably effective tools to encourage the use of sustainable modes

		TDM measures: *Residential developments*	Check if proposed & add descriptions
	1.	**TDM PROGRAM MANAGEMENT**	
	1.1	**Program coordinator**	
BASIC ★	1.1.1	Designate an internal coordinator, or contract with an external coordinator	☐
	1.2	**Travel surveys**	
BETTER	1.2.1	Conduct periodic surveys to identify travel-related behaviours, attitudes, challenges and solutions, and to track progress	☐
	2.	**WALKING AND CYCLING**	
	2.1	**Information on walking/cycling routes & destinations**	
BASIC	2.1.1	Display local area maps with walking/cycling access routes and key destinations at major entrances *(multi-family, condominium)*	☐
	2.2	**Bicycle skills training**	
BETTER	2.2.1	Offer on-site cycling courses for residents, or subsidize off-site courses	☐

			TDM measures: *Residential developments*	Check if proposed & add descriptions
		3.	**TRANSIT**	
		3.1	**Transit information**	
BASIC		3.1.1	Display relevant transit schedules and route maps at entrances *(multi-family, condominium)*	☐
BETTER		3.1.2	Provide real-time arrival information display at entrances *(multi-family, condominium)*	☐
		3.2	**Transit fare incentives**	
BASIC	★	3.2.1	Offer PRESTO cards preloaded with one monthly transit pass on residence purchase/move-in, to encourage residents to use transit	☐
BETTER		3.2.2	Offer at least one year of free monthly transit passes on residence purchase/move-in	☐
		3.3	**Enhanced public transit service**	
BETTER	★	3.3.1	Contract with OC Transpo to provide early transit services until regular services are warranted by occupancy levels *(subdivision)*	☐
		3.4	**Private transit service**	
BETTER		3.4.1	Provide shuttle service for seniors homes or lifestyle communities (e.g. scheduled mall or supermarket runs)	☐
		4.	**CARSHARING & BIKESHARING**	
		4.1	**Bikeshare stations & memberships**	
BETTER		4.1.1	Contract with provider to install on-site bikeshare station (*multi-family)*	☐
BETTER		4.1.2	Provide residents with bikeshare memberships, either free or subsidized *(multi-family)*	☐
		4.2	**Carshare vehicles & memberships**	
BETTER		4.2.1	Contract with provider to install on-site carshare vehicles and promote their use by residents	☐
BETTER		4.2.2	Provide residents with carshare memberships, either free or subsidized	☐
		5.	**PARKING**	
		5.1	**Priced parking**	
BASIC	★	5.1.1	Unbundle parking cost from purchase price *(condominium)*	☐
BASIC	★	5.1.2	Unbundle parking cost from monthly rent *(multi-family)*	☐

			TDM measures: *Residential developments*	Check if proposed & add descriptions
		6.	**TDM MARKETING & COMMUNICATIONS**	
		6.1	**Multimodal travel information**	
BASIC	★	6.1.1	Provide a multimodal travel option information package to new residents	☐
		6.2	**Personalized trip planning**	
BETTER	★	6.2.1	Offer personalized trip planning to new residents	☐

Appendix B TRANSPORTATION DEMAND MANAGEMENT CHECKLISTS

TDM-Supportive Development Design and Infrastructure Checklist:
Residential Developments (multi-family or condominium)

Legend

REQUIRED	The Official Plan or Zoning By-law provides related guidance that must be followed
BASIC	The measure is generally feasible and effective, and in most cases would benefit the development and its users
BETTER	The measure could maximize support for users of sustainable modes, and optimize development performance

		TDM-supportive design & infrastructure measures: *Residential developments*	Check if completed & add descriptions, explanations or plan/drawing references
	1.	**WALKING & CYCLING: ROUTES**	
	1.1	**Building location & access points**	
BASIC	1.1.1	Locate building close to the street, and do not locate parking areas between the street and building entrances	☑
BASIC	1.1.2	Locate building entrances in order to minimize walking distances to sidewalks and transit stops/stations	☑
BASIC	1.1.3	Locate building doors and windows to ensure visibility of pedestrians from the building, for their security and comfort	☐
	1.2	**Facilities for walking & cycling**	
REQUIRED	1.2.1	Provide convenient, direct access to stations or major stops along rapid transit routes within 600 metres; minimize walking distances from buildings to rapid transit; provide pedestrian-friendly, weather-protected (where possible) environment between rapid transit accesses and building entrances; ensure quality linkages from sidewalks through building entrances to integrated stops/stations *(see Official Plan policy 4.3.3)*	☑
REQUIRED	1.2.2	Provide safe, direct and attractive pedestrian access from public sidewalks to building entrances through such measures as: reducing distances between public sidewalks and major building entrances; providing walkways from public streets to major building entrances; within a site, providing walkways along the front of adjoining buildings, between adjacent buildings, and connecting areas where people may congregate, such as courtyards and transit stops; and providing weather protection through canopies, colonnades, and other design elements wherever possible *(see Official Plan policy 4.3.12)*	☑

		TDM-supportive design & infrastructure measures: *Residential developments*	Check if completed & add descriptions, explanations or plan/drawing references
REQUIRED	1.2.3	Provide sidewalks of smooth, well-drained walking surfaces of contrasting materials or treatments to differentiate pedestrian areas from vehicle areas, and provide marked pedestrian crosswalks at intersection sidewalks *(see Official Plan policy 4.3.10)*	☑
REQUIRED	1.2.4	Make sidewalks and open space areas easily accessible through features such as gradual grade transition, depressed curbs at street corners and convenient access to extra-wide parking spaces and ramps *(see Official Plan policy 4.3.10)*	☑
REQUIRED	1.2.5	Include adequately spaced inter-block/street cycling and pedestrian connections to facilitate travel by active transportation. Provide links to the existing or planned network of public sidewalks, multi-use pathways and on-road cycle routes. Where public sidewalks and multi-use pathways intersect with roads, consider providing traffic control devices to give priority to cyclists and pedestrians *(see Official Plan policy 4.3.11)*	☑
BASIC	1.2.6	Provide safe, direct and attractive walking routes from building entrances to nearby transit stops	☐
BASIC	1.2.7	Ensure that walking routes to transit stops are secure, visible, lighted, shaded and wind-protected wherever possible	☐
BASIC	1.2.8	Design roads used for access or circulation by cyclists using a target operating speed of no more than 30 km/h, or provide a separated cycling facility	☐
	1.3	**Amenities for walking & cycling**	
BASIC	1.3.1	Provide lighting, landscaping and benches along walking and cycling routes between building entrances and streets, sidewalks and trails	☐
BASIC	1.3.2	Provide wayfinding signage for site access (where required, e.g. when multiple buildings or entrances exist) and egress (where warranted, such as when directions to reach transit stops/stations, trails or other common destinations are not obvious)	☐

		TDM-supportive design & infrastructure measures: *Residential developments*	Check if completed & add descriptions, explanations or plan/drawing references
	2.	**WALKING & CYCLING: END-OF-TRIP FACILITIES**	
	2.1	**Bicycle parking**	
REQUIRED	2.1.1	Provide bicycle parking in highly visible and lighted areas, sheltered from the weather wherever possible *(see Official Plan policy 4.3.6)*	☑
REQUIRED	2.1.2	Provide the number of bicycle parking spaces specified for various land uses in different parts of Ottawa; provide convenient access to main entrances or well-used areas *(see Zoning By-law Section 111)*	☑
REQUIRED	2.1.3	Ensure that bicycle parking spaces and access aisles meet minimum dimensions; that no more than 50% of spaces are vertical spaces; and that parking racks are securely anchored *(see Zoning By-law Section 111)*	☑
BASIC	2.1.4	Provide bicycle parking spaces equivalent to the expected number of resident-owned bicycles, plus the expected peak number of visitor cyclists	☐
	2.2	**Secure bicycle parking**	
REQUIRED	2.2.1	Where more than 50 bicycle parking spaces are provided for a single residential building, locate at least 25% of spaces within a building/structure, a secure area (e.g. supervised parking lot or enclosure) or bicycle lockers *(see Zoning By-law Section 111)*	☑
BETTER	2.2.2	Provide secure bicycle parking spaces equivalent to at least the number of units at condominiums or multi-family residential developments	☐
	2.3	**Bicycle repair station**	
BETTER	2.3.1	Provide a permanent bike repair station, with commonly used tools and an air pump, adjacent to the main bicycle parking area (or secure bicycle parking area, if provided)	☐
	3.	**TRANSIT**	
	3.1	**Customer amenities**	
BASIC	3.1.1	Provide shelters, lighting and benches at any on-site transit stops	☐
BASIC	3.1.2	Where the site abuts an off-site transit stop and insufficient space exists for a transit shelter in the public right-of-way, protect land for a shelter and/or install a shelter	☐
BETTER	3.1.3	Provide a secure and comfortable interior waiting area by integrating any on-site transit stops into the building	☐

		TDM-supportive design & infrastructure measures: *Residential developments*	Check if completed & add descriptions, explanations or plan/drawing references
	4.	**RIDESHARING**	
	4.1	**Pick-up & drop-off facilities**	
BASIC	4.1.1	Provide a designated area for carpool drivers (plus taxis and ride-hailing services) to drop off or pick up passengers without using fire lanes or other no-stopping zones	☐
	5.	**CARSHARING & BIKESHARING**	
	5.1	**Carshare parking spaces**	
BETTER	5.1.1	Provide up to three carshare parking spaces in an R3, R4 or R5 Zone for specified residential uses *(see Zoning By-law Section 94)*	☐
	5.2	**Bikeshare station location**	
BETTER	5.2.1	Provide a designated bikeshare station area near a major building entrance, preferably lighted and sheltered with a direct walkway connection	☐
	6.	**PARKING**	
	6.1	**Number of parking spaces**	
REQUIRED	6.1.1	Do not provide more parking than permitted by zoning, nor less than required by zoning, unless a variance is being applied for	☑
BASIC	6.1.2	Provide parking for long-term and short-term users that is consistent with mode share targets, considering the potential for visitors to use off-site public parking	☐
BASIC	6.1.3	Where a site features more than one use, provide shared parking and reduce the cumulative number of parking spaces accordingly *(see Zoning By-law Section 104)*	☐
BETTER	6.1.4	Reduce the minimum number of parking spaces required by zoning by one space for each 13 square metres of gross floor area provided as shower rooms, change rooms, locker rooms and other facilities for cyclists in conjunction with bicycle parking *(see Zoning By-law Section 111)*	☐
	6.2	**Separate long-term & short-term parking areas**	
BETTER	6.2.1	Provide separate areas for short-term and long-term parking (using signage or physical barriers) to permit access controls and simplify enforcement (i.e. to discourage residents from parking in visitor spaces, and vice versa)	☐

TDM Measures Checklist:
Residential Developments (multi-family, condominium or subdivision)

Legend

BASIC — The measure is generally feasible and effective, and in most cases would benefit the development and its users

BETTER — The measure could maximize support for users of sustainable modes, and optimize development performance

★ — The measure is one of the most dependably effective tools to encourage the use of sustainable modes

		TDM measures: *Residential developments*	Check if proposed & add descriptions
	1.	**TDM PROGRAM MANAGEMENT**	
	1.1	**Program coordinator**	
BASIC ★	1.1.1	Designate an internal coordinator, or contract with an external coordinator	☐
	1.2	**Travel surveys**	
BETTER	1.2.1	Conduct periodic surveys to identify travel-related behaviours, attitudes, challenges and solutions, and to track progress	☐
	2.	**WALKING AND CYCLING**	
	2.1	**Information on walking/cycling routes & destinations**	
BASIC	2.1.1	Display local area maps with walking/cycling access routes and key destinations at major entrances *(multi-family, condominium)*	☐
	2.2	**Bicycle skills training**	
BETTER	2.2.1	Offer on-site cycling courses for residents, or subsidize off-site courses	☐

			TDM measures: *Residential developments*	Check if proposed & add descriptions
		3.	**TRANSIT**	
		3.1	**Transit information**	
BASIC		3.1.1	Display relevant transit schedules and route maps at entrances *(multi-family, condominium)*	☐
BETTER		3.1.2	Provide real-time arrival information display at entrances *(multi-family, condominium)*	☐
		3.2	**Transit fare incentives**	
BASIC	★	3.2.1	Offer PRESTO cards preloaded with one monthly transit pass on residence purchase/move-in, to encourage residents to use transit	☐
BETTER		3.2.2	Offer at least one year of free monthly transit passes on residence purchase/move-in	☐
		3.3	**Enhanced public transit service**	
BETTER	★	3.3.1	Contract with OC Transpo to provide early transit services until regular services are warranted by occupancy levels *(subdivision)*	☐
		3.4	**Private transit service**	
BETTER		3.4.1	Provide shuttle service for seniors homes or lifestyle communities (e.g. scheduled mall or supermarket runs)	☐
		4.	**CARSHARING & BIKESHARING**	
		4.1	**Bikeshare stations & memberships**	
BETTER		4.1.1	Contract with provider to install on-site bikeshare station (*multi-family)*	☐
BETTER		4.1.2	Provide residents with bikeshare memberships, either free or subsidized *(multi-family)*	☐
		4.2	**Carshare vehicles & memberships**	
BETTER		4.2.1	Contract with provider to install on-site carshare vehicles and promote their use by residents	☐
BETTER		4.2.2	Provide residents with carshare memberships, either free or subsidized	☐
		5.	**PARKING**	
		5.1	**Priced parking**	
BASIC	★	5.1.1	Unbundle parking cost from purchase price *(condominium)*	☐
BASIC	★	5.1.2	Unbundle parking cost from monthly rent *(multi-family)*	☐

			TDM measures: *Residential developments*	Check if proposed & add descriptions
		6.	**TDM MARKETING & COMMUNICATIONS**	
		6.1	**Multimodal travel information**	
BASIC	★	6.1.1	Provide a multimodal travel option information package to new residents	☐
		6.2	**Personalized trip planning**	
BETTER	★	6.2.1	Offer personalized trip planning to new residents	☐

Appendix C INTERSECTION PERFORMANCE WORKSHEETS

C.1 2018 EXISTING CONDITIONS

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	34	1245	43	57	698	60	34	8	76	98	5	67
v/c Ratio	0.06	0.53	0.04	0.18	0.29	0.05	0.22	0.04	0.30	0.62	0.02	0.27
Control Delay	4.2	11.2	0.2	5.2	7.7	0.9	49.1	44.1	11.1	66.8	43.6	8.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	4.2	11.2	0.2	5.2	7.7	0.9	49.1	44.1	11.1	66.8	43.6	8.6
Queue Length 50th (m)	1.5	72.2	0.0	2.6	31.9	0.0	7.4	1.7	0.0	22.3	1.1	0.0
Queue Length 95th (m)	4.6	108.1	0.6	6.8	49.4	2.7	16.4	6.0	11.5	38.0	4.6	8.8
Internal Link Dist (m)		397.1			476.2			36.9			157.1	
Turn Bay Length (m)	50.0		60.0	45.0		60.0	37.5		30.0	50.0		37.5
Base Capacity (vph)	583	2352	1078	344	2430	1111	276	367	378	276	367	378
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.06	0.53	0.04	0.17	0.29	0.05	0.12	0.02	0.20	0.36	0.01	0.18

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	31	1145	40	52	642	55	31	7	70	90	5	62
Future Volume (vph)	31	1145	40	52	642	55	31	7	70	90	5	62
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	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)	1695	3390	1517	1695	3390	1517	1695	1784	1517	1695	1784	1517
Flt Permitted	0.38	1.00	1.00	0.18	1.00	1.00	0.75	1.00	1.00	0.75	1.00	1.00
Satd. Flow (perm)	674	3390	1517	318	3390	1517	1346	1784	1517	1343	1784	1517
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	34	1245	43	57	698	60	34	8	76	98	5	67
RTOR Reduction (vph)	0	0	14	0	0	18	0	0	67	0	0	59
Lane Group Flow (vph)	34	1245	29	57	698	42	34	8	9	98	5	8
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)	85.9	82.0	82.0	88.9	83.5	83.5	14.1	14.1	14.1	14.1	14.1	14.1
Effective Green, g (s)	85.9	82.0	82.0	88.9	83.5	83.5	14.1	14.1	14.1	14.1	14.1	14.1
Actuated g/C Ratio	0.72	0.68	0.68	0.74	0.70	0.70	0.12	0.12	0.12	0.12	0.12	0.12
Clearance Time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	515	2316	1036	297	2358	1055	158	209	178	157	209	178
v/s Ratio Prot	0.00	c0.37		c0.01	0.21			0.00			0.00	
v/s Ratio Perm	0.05		0.02	0.13		0.03	0.03		0.01	c0.07		0.01
v/c Ratio	0.07	0.54	0.03	0.19	0.30	0.04	0.22	0.04	0.05	0.62	0.02	0.04
Uniform Delay, d1	5.0	9.5	6.1	5.6	7.0	5.7	47.9	46.9	47.0	50.4	46.9	47.0
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	0.1	0.9	0.1	0.3	0.3	0.1	0.7	0.1	0.1	7.5	0.0	0.1
Delay (s)	5.0	10.4	6.2	5.9	7.3	5.8	48.6	47.0	47.1	57.9	46.9	47.1
Level of Service	A	B	A	A	A	A	D	D	D	E	D	D
Approach Delay (s)		10.1			7.1			47.5			53.3	
Approach LOS		B			A			D			D	

Intersection Summary				
HCM 2000 Control Delay	14.0	HCM 2000 Level of Service	B	
HCM 2000 Volume to Capacity ratio	0.53			
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.5	
Intersection Capacity Utilization	64.9%	ICU Level of Service	C	
Analysis Period (min)	15			

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	7	41	67	14	27	70
Future Volume (Veh/h)	7	41	67	14	27	70
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	8	45	73	15	29	76
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						179
pX, platoon unblocked						
vC, conflicting volume	214	80			88	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	214	80			88	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	95			98	
cM capacity (veh/h)	759	980			1508	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	53	88	105
Volume Left	8	0	29
Volume Right	45	15	0
cSH	938	1700	1508
Volume to Capacity	0.06	0.05	0.02
Queue Length 95th (m)	1.4	0.0	0.4
Control Delay (s)	9.1	0.0	2.2
Lane LOS	A		A
Approach Delay (s)	9.1	0.0	2.2
Approach LOS	A		

Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	22.1%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	102	867	26	57	1133	114	45	4	99	35	5	66
v/c Ratio	0.27	0.35	0.02	0.12	0.47	0.10	0.43	0.03	0.47	0.33	0.04	0.34
Control Delay	4.4	6.9	0.0	3.2	8.8	1.4	63.9	49.2	17.4	59.5	49.4	11.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	4.4	6.9	0.0	3.2	8.8	1.4	63.9	49.2	17.4	59.5	49.4	11.1
Queue Length 50th (m)	3.6	36.4	0.0	2.0	54.3	0.0	10.3	0.9	0.0	7.9	1.1	0.0
Queue Length 95th (m)	8.1	53.8	0.0	5.1	79.7	5.7	21.7	4.3	15.8	17.8	5.0	9.0
Internal Link Dist (m)		397.1			476.2			36.9			157.1	
Turn Bay Length (m)	50.0		60.0	45.0		60.0	37.5		30.0	50.0		37.5
Base Capacity (vph)	399	2488	1136	522	2404	1108	276	367	390	277	367	378
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.26	0.35	0.02	0.11	0.47	0.10	0.16	0.01	0.25	0.13	0.01	0.17

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	94	798	24	52	1042	105	41	4	91	32	5	61
Future Volume (vph)	94	798	24	52	1042	105	41	4	91	32	5	61
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	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)	1695	3390	1517	1695	3390	1517	1695	1784	1517	1695	1784	1517
Flt Permitted	0.21	1.00	1.00	0.31	1.00	1.00	0.75	1.00	1.00	0.76	1.00	1.00
Satd. Flow (perm)	381	3390	1517	561	3390	1517	1346	1784	1517	1347	1784	1517
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	102	867	26	57	1133	114	45	4	99	35	5	66
RTOR Reduction (vph)	0	0	7	0	0	33	0	0	91	0	0	61
Lane Group Flow (vph)	102	867	19	57	1133	81	45	4	8	35	5	5
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)	93.9	86.9	86.9	90.3	85.1	85.1	9.4	9.4	9.4	9.4	9.4	9.4
Effective Green, g (s)	93.9	86.9	86.9	90.3	85.1	85.1	9.4	9.4	9.4	9.4	9.4	9.4
Actuated g/C Ratio	0.78	0.72	0.72	0.75	0.71	0.71	0.08	0.08	0.08	0.08	0.08	0.08
Clearance Time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	374	2454	1098	471	2404	1075	105	139	118	105	139	118
v/s Ratio Prot	c0.02	0.26		0.01	c0.33			0.00			0.00	
v/s Ratio Perm	0.20		0.01	0.09		0.05	c0.03		0.01	0.03		0.00
v/c Ratio	0.27	0.35	0.02	0.12	0.47	0.08	0.43	0.03	0.07	0.33	0.04	0.04
Uniform Delay, d1	3.9	6.1	4.6	3.9	7.6	5.4	52.7	51.1	51.2	52.3	51.1	51.1
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	0.4	0.4	0.0	0.1	0.7	0.1	2.8	0.1	0.2	1.9	0.1	0.2
Delay (s)	4.3	6.5	4.7	4.0	8.3	5.5	55.5	51.2	51.5	54.2	51.2	51.3
Level of Service	A	A	A	A	A	A	E	D	D	D	D	D
Approach Delay (s)		6.3			7.9			52.7			52.3	
Approach LOS		A			A			D			D	

Intersection Summary				
HCM 2000 Control Delay	11.7	HCM 2000 Level of Service	B	
HCM 2000 Volume to Capacity ratio	0.45			
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.5	
Intersection Capacity Utilization	60.4%	ICU Level of Service	B	
Analysis Period (min)	15			

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	3	40	96	3	38	43
Future Volume (Veh/h)	3	40	96	3	38	43
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	43	104	3	41	47
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						179
pX, platoon unblocked						
vC, conflicting volume	234	106			107	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	234	106			107	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	95			97	
cM capacity (veh/h)	733	949			1484	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	46	107	88
Volume Left	3	0	41
Volume Right	43	3	0
cSH	931	1700	1484
Volume to Capacity	0.05	0.06	0.03
Queue Length 95th (m)	1.2	0.0	0.6
Control Delay (s)	9.1	0.0	3.6
Lane LOS	A		A
Approach Delay (s)	9.1	0.0	3.6
Approach LOS	A		

Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	21.3%	ICU Level of Service	A
Analysis Period (min)	15		

C.2 2020 FUTURE BACKGROUND CONDITIONS

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	35	1295	48	61	726	62	46	10	90	102	7	70
v/c Ratio	0.07	0.55	0.04	0.21	0.30	0.06	0.29	0.05	0.34	0.63	0.03	0.27
Control Delay	4.3	11.8	0.5	5.6	8.0	1.0	50.6	44.0	12.7	66.9	43.5	9.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	4.3	11.8	0.5	5.6	8.0	1.0	50.6	44.0	12.7	66.9	43.5	9.3
Queue Length 50th (m)	1.6	77.7	0.0	2.8	33.8	0.0	10.0	2.1	0.0	23.2	1.5	0.0
Queue Length 95th (m)	4.8	116.7	1.2	7.3	52.3	3.1	20.4	6.8	14.0	39.4	5.6	9.6
Internal Link Dist (m)		397.1			476.2			36.9			157.1	
Turn Bay Length (m)	50.0		60.0	45.0		60.0	37.5		30.0	50.0		37.5
Base Capacity (vph)	566	2339	1072	326	2418	1106	276	367	383	275	367	378
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.06	0.55	0.04	0.19	0.30	0.06	0.17	0.03	0.23	0.37	0.02	0.19

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	32	1191	44	56	668	57	42	9	83	94	6	64
Future Volume (vph)	32	1191	44	56	668	57	42	9	83	94	6	64
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	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	1.00	0.85	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)	1695	3390	1517	1695	3390	1517	1695	1784	1517	1695	1784	1517
Flt Permitted	0.37	1.00	1.00	0.16	1.00	1.00	0.75	1.00	1.00	0.75	1.00	1.00
Satd. Flow (perm)	652	3390	1517	294	3390	1517	1344	1784	1517	1340	1784	1517
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	35	1295	48	61	726	62	46	10	90	102	7	70
RTOR Reduction (vph)	0	0	15	0	0	19	0	0	79	0	0	62
Lane Group Flow (vph)	35	1295	33	61	726	43	46	10	11	102	7	8
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)	85.5	81.6	81.6	88.7	83.2	83.2	14.4	14.4	14.4	14.4	14.4	14.4
Effective Green, g (s)	85.5	81.6	81.6	88.7	83.2	83.2	14.4	14.4	14.4	14.4	14.4	14.4
Actuated g/C Ratio	0.71	0.68	0.68	0.74	0.69	0.69	0.12	0.12	0.12	0.12	0.12	0.12
Clearance Time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	498	2305	1031	281	2350	1051	161	214	182	160	214	182
v/s Ratio Prot	0.00	c0.38		c0.01	0.21			0.01			0.00	
v/s Ratio Perm	0.05		0.02	0.15		0.03	0.03		0.01	c0.08		0.01
v/c Ratio	0.07	0.56	0.03	0.22	0.31	0.04	0.29	0.05	0.06	0.64	0.03	0.05
Uniform Delay, d1	5.1	9.9	6.3	6.0	7.2	5.8	48.1	46.7	46.8	50.3	46.6	46.7
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	0.1	1.0	0.1	0.4	0.3	0.1	1.0	0.1	0.1	8.1	0.1	0.1
Delay (s)	5.1	10.9	6.3	6.4	7.5	5.9	49.1	46.8	46.9	58.4	46.7	46.8
Level of Service	A	B	A	A	A	A	D	D	D	E	D	D
Approach Delay (s)		10.6			7.3			47.6			53.4	
Approach LOS		B			A			D			D	

Intersection Summary					
HCM 2000 Control Delay	14.6	HCM 2000 Level of Service	B		
HCM 2000 Volume to Capacity ratio	0.55				
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.5		
Intersection Capacity Utilization	66.5%	ICU Level of Service	C		
Analysis Period (min)	15				

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	22	7	2	112	101	5
Future Volume (Veh/h)	22	7	2	112	101	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	24	8	2	122	110	5
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)					61	
pX, platoon unblocked						
vC, conflicting volume	238	112	115			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	238	112	115			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	99	100			
cM capacity (veh/h)	749	940	1474			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	32	124	115
Volume Left	24	2	0
Volume Right	8	0	5
cSH	789	1474	1700
Volume to Capacity	0.04	0.00	0.07
Queue Length 95th (m)	1.0	0.0	0.0
Control Delay (s)	9.8	0.1	0.0
Lane LOS	A	A	
Approach Delay (s)	9.8	0.1	0.0
Approach LOS	A		

Intersection Summary				
Average Delay	1.2			
Intersection Capacity Utilization	17.9%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	7	43	72	15	28	80
Future Volume (Veh/h)	7	43	72	15	28	80
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	8	47	78	16	30	87
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						179
pX, platoon unblocked						
vC, conflicting volume	233	86			94	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	233	86			94	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	95			98	
cM capacity (veh/h)	740	973			1500	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	55	94	117
Volume Left	8	0	30
Volume Right	47	16	0
cSH	930	1700	1500
Volume to Capacity	0.06	0.06	0.02
Queue Length 95th (m)	1.4	0.0	0.5
Control Delay (s)	9.1	0.0	2.0
Lane LOS	A		A
Approach Delay (s)	9.1	0.0	2.0
Approach LOS	A		

Intersection Summary				
Average Delay	2.8			
Intersection Capacity Utilization	22.7%	ICU Level of Service	A	
Analysis Period (min)	15			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	107	897	40	72	1178	118	53	7	110	36	8	68
v/c Ratio	0.30	0.36	0.04	0.15	0.49	0.11	0.47	0.05	0.48	0.32	0.05	0.33
Control Delay	5.0	7.5	0.1	3.6	9.5	1.5	64.9	48.7	16.4	57.8	48.9	11.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	5.0	7.5	0.1	3.6	9.5	1.5	64.9	48.7	16.4	57.8	48.9	11.4
Queue Length 50th (m)	4.0	39.3	0.0	2.6	59.4	0.1	12.1	1.5	0.0	8.1	1.8	0.0
Queue Length 95th (m)	9.0	58.8	0.2	6.4	88.1	6.1	24.4	6.0	16.4	18.1	6.4	9.5
Internal Link Dist (m)		397.1			476.2			36.9			157.1	
Turn Bay Length (m)	50.0		60.0	45.0		60.0	37.5		30.0	50.0		37.5
Base Capacity (vph)	379	2463	1125	502	2381	1100	276	367	399	276	367	378
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.28	0.36	0.04	0.14	0.49	0.11	0.19	0.02	0.28	0.13	0.02	0.18

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	98	825	37	66	1084	109	49	6	101	33	7	63
Future Volume (vph)	98	825	37	66	1084	109	49	6	101	33	7	63
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	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)	1695	3390	1517	1695	3390	1517	1695	1784	1517	1695	1784	1517
Flt Permitted	0.20	1.00	1.00	0.30	1.00	1.00	0.75	1.00	1.00	0.75	1.00	1.00
Satd. Flow (perm)	357	3390	1517	538	3390	1517	1343	1784	1517	1344	1784	1517
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	107	897	40	72	1178	118	53	7	110	36	8	68
RTOR Reduction (vph)	0	0	11	0	0	35	0	0	101	0	0	62
Lane Group Flow (vph)	107	897	29	72	1178	83	53	7	9	36	8	6
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)	93.1	86.0	86.0	89.7	84.3	84.3	10.1	10.1	10.1	10.1	10.1	10.1
Effective Green, g (s)	93.1	86.0	86.0	89.7	84.3	84.3	10.1	10.1	10.1	10.1	10.1	10.1
Actuated g/C Ratio	0.78	0.72	0.72	0.75	0.70	0.70	0.08	0.08	0.08	0.08	0.08	0.08
Clearance Time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	356	2429	1087	454	2381	1065	113	150	127	113	150	127
v/s Ratio Prot	c0.02	0.26		0.01	c0.35			0.00			0.00	
v/s Ratio Perm	0.22		0.02	0.11		0.05	c0.04		0.01	0.03		0.00
v/c Ratio	0.30	0.37	0.03	0.16	0.49	0.08	0.47	0.05	0.07	0.32	0.05	0.05
Uniform Delay, d1	4.4	6.6	4.9	4.1	8.1	5.6	52.4	50.5	50.6	51.7	50.6	50.5
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	0.5	0.4	0.0	0.2	0.7	0.1	3.1	0.1	0.2	1.6	0.1	0.1
Delay (s)	4.8	7.0	5.0	4.2	8.9	5.8	55.4	50.7	50.9	53.3	50.7	50.7
Level of Service	A	A	A	A	A	A	E	D	D	D	D	D
Approach Delay (s)		6.7			8.4			52.3			51.5	
Approach LOS		A			A			D			D	

Intersection Summary				
HCM 2000 Control Delay	12.3	HCM 2000 Level of Service	B	
HCM 2000 Volume to Capacity ratio	0.48			
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.5	
Intersection Capacity Utilization	62.3%	ICU Level of Service	B	
Analysis Period (min)	15			

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	14	5	9	141	84	26
Future Volume (Veh/h)	14	5	9	141	84	26
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	15	5	10	153	91	28
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)					61	
pX, platoon unblocked						
vC, conflicting volume	278	105	119			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	278	105	119			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	99	99			
cM capacity (veh/h)	707	949	1469			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	20	163	119
Volume Left	15	10	0
Volume Right	5	0	28
cSH	755	1469	1700
Volume to Capacity	0.03	0.01	0.07
Queue Length 95th (m)	0.6	0.2	0.0
Control Delay (s)	9.9	0.5	0.0
Lane LOS	A	A	
Approach Delay (s)	9.9	0.5	0.0
Approach LOS	A		

Intersection Summary				
Average Delay	0.9			
Intersection Capacity Utilization	25.0%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	3	42	109	3	40	50
Future Volume (Veh/h)	3	42	109	3	40	50
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	46	118	3	43	54
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						179
pX, platoon unblocked						
vC, conflicting volume	260	120			121	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	260	120			121	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	95			97	
cM capacity (veh/h)	708	932			1467	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	49	121	97
Volume Left	3	0	43
Volume Right	46	3	0
cSH	914	1700	1467
Volume to Capacity	0.05	0.07	0.03
Queue Length 95th (m)	1.3	0.0	0.7
Control Delay (s)	9.2	0.0	3.5
Lane LOS	A		A
Approach Delay (s)	9.2	0.0	3.5
Approach LOS	A		

Intersection Summary				
Average Delay	2.9			
Intersection Capacity Utilization	21.8%	ICU Level of Service	A	
Analysis Period (min)	15			

C.3 2020 TOTAL FUTURE CONDITIONS

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	35	1295	61	74	726	62	67	15	112	102	10	70
v/c Ratio	0.07	0.56	0.06	0.25	0.30	0.06	0.42	0.07	0.40	0.63	0.05	0.27
Control Delay	4.4	12.0	1.1	6.0	8.0	1.0	55.2	44.6	12.3	66.9	44.0	9.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	4.4	12.0	1.1	6.0	8.0	1.0	55.2	44.6	12.3	66.9	44.0	9.3
Queue Length 50th (m)	1.6	78.4	0.0	3.4	33.9	0.0	14.8	3.2	0.0	23.2	2.1	0.0
Queue Length 95th (m)	4.8	117.9	3.0	8.6	52.3	3.1	27.6	9.1	15.3	39.4	6.8	9.6
Internal Link Dist (m)		397.1			476.2			36.9			157.1	
Turn Bay Length (m)	50.0		60.0	45.0		60.0	37.5		30.0	50.0		37.5
Base Capacity (vph)	565	2332	1070	325	2418	1106	275	367	401	274	367	378
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.06	0.56	0.06	0.23	0.30	0.06	0.24	0.04	0.28	0.37	0.03	0.19

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	32	1191	56	68	668	57	62	14	103	94	9	64
Future Volume (vph)	32	1191	56	68	668	57	62	14	103	94	9	64
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	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)	1695	3390	1517	1695	3390	1517	1695	1784	1517	1695	1784	1517
Flt Permitted	0.37	1.00	1.00	0.16	1.00	1.00	0.75	1.00	1.00	0.75	1.00	1.00
Satd. Flow (perm)	654	3390	1517	292	3390	1517	1340	1784	1517	1334	1784	1517
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	35	1295	61	74	726	62	67	15	112	102	10	70
RTOR Reduction (vph)	0	0	20	0	0	19	0	0	98	0	0	62
Lane Group Flow (vph)	35	1295	41	74	726	43	67	15	14	102	10	8
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)	85.2	81.3	81.3	88.8	83.1	83.1	14.5	14.5	14.5	14.5	14.5	14.5
Effective Green, g (s)	85.2	81.3	81.3	88.8	83.1	83.1	14.5	14.5	14.5	14.5	14.5	14.5
Actuated g/C Ratio	0.71	0.68	0.68	0.74	0.69	0.69	0.12	0.12	0.12	0.12	0.12	0.12
Clearance Time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	498	2296	1027	282	2347	1050	161	215	183	161	215	183
v/s Ratio Prot	0.00	c0.38		c0.01	0.21			0.01			0.01	
v/s Ratio Perm	0.05		0.03	0.18		0.03	0.05		0.01	c0.08		0.01
v/c Ratio	0.07	0.56	0.04	0.26	0.31	0.04	0.42	0.07	0.07	0.63	0.05	0.05
Uniform Delay, d1	5.2	10.1	6.4	6.2	7.2	5.8	48.8	46.8	46.8	50.2	46.6	46.6
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	0.1	1.0	0.1	0.5	0.3	0.1	1.7	0.1	0.2	7.9	0.1	0.1
Delay (s)	5.2	11.1	6.5	6.7	7.6	5.9	50.6	46.9	47.0	58.1	46.7	46.7
Level of Service	A	B	A	A	A	A	D	D	D	E	D	D
Approach Delay (s)		10.8			7.4			48.2			53.1	
Approach LOS		B			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	15.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.5
Intersection Capacity Utilization	66.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	22	0	7	3	0	23	2	135	2	14	115	5
Future Volume (Veh/h)	22	0	7	3	0	23	2	135	2	14	115	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	24	0	8	3	0	25	2	147	2	15	125	5
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)											61	
pX, platoon unblocked	1.00	1.00	1.00	1.00	1.00		1.00					
vC, conflicting volume	334	310	128	318	312	148	130			149		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	333	309	125	316	310	148	128			149		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	96	100	99	100	100	97	100			99		
cM capacity (veh/h)	597	597	924	625	596	899	1456			1432		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	32	28	151	145
Volume Left	24	3	2	15
Volume Right	8	25	2	5
cSH	655	858	1456	1432
Volume to Capacity	0.05	0.03	0.00	0.01
Queue Length 95th (m)	1.2	0.8	0.0	0.2
Control Delay (s)	10.8	9.3	0.1	0.9
Lane LOS	B	A	A	A
Approach Delay (s)	10.8	9.3	0.1	0.9
Approach LOS	B	A		

Intersection Summary				
Average Delay		2.1		
Intersection Capacity Utilization		29.8%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	10	66	74	17	42	83
Future Volume (Veh/h)	10	66	74	17	42	83
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	72	80	18	46	90
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						179
pX, platoon unblocked						
vC, conflicting volume	271	89			98	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	271	89			98	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	98	93			97	
cM capacity (veh/h)	696	969			1495	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	83	98	136
Volume Left	11	0	46
Volume Right	72	18	0
cSH	921	1700	1495
Volume to Capacity	0.09	0.06	0.03
Queue Length 95th (m)	2.3	0.0	0.7
Control Delay (s)	9.3	0.0	2.7
Lane LOS	A		A
Approach Delay (s)	9.3	0.0	2.7
Approach LOS	A		

Intersection Summary				
Average Delay		3.6		
Intersection Capacity Utilization		25.3%	ICU Level of Service	A
Analysis Period (min)		15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	15	43	50	0	0	26
Future Volume (Veh/h)	15	43	50	0	0	26
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	16	47	54	0	0	28
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	54				133	54
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	54				133	54
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				100	97
cM capacity (veh/h)	1551				852	1013

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	63	54	28
Volume Left	16	0	0
Volume Right	0	0	28
cSH	1551	1700	1013
Volume to Capacity	0.01	0.03	0.03
Queue Length 95th (m)	0.2	0.0	0.6
Control Delay (s)	1.9	0.0	8.7
Lane LOS	A		A
Approach Delay (s)	1.9	0.0	8.7
Approach LOS			A

Intersection Summary				
Average Delay		2.5		
Intersection Capacity Utilization		19.9%	ICU Level of Service	A
Analysis Period (min)		15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	107	897	62	93	1178	118	73	12	129	36	13	68
v/c Ratio	0.31	0.38	0.06	0.21	0.51	0.11	0.55	0.07	0.48	0.27	0.07	0.30
Control Delay	5.6	9.1	1.0	4.4	10.6	1.7	66.2	47.3	14.4	53.4	47.4	10.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	5.6	9.1	1.0	4.4	10.6	1.7	66.2	47.3	14.4	53.4	47.4	10.1
Queue Length 50th (m)	4.4	42.5	0.0	3.8	63.2	0.1	16.7	2.6	0.0	8.0	2.8	0.0
Queue Length 95th (m)	10.1	64.8	2.9	8.9	95.2	6.6	30.7	8.2	17.0	17.6	8.6	9.3
Internal Link Dist (m)		397.1			476.2			36.9			157.1	
Turn Bay Length (m)	50.0		60.0	45.0		60.0	37.5		30.0	50.0		37.5
Base Capacity (vph)	371	2333	1070	480	2326	1077	274	367	414	275	367	378
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.29	0.38	0.06	0.19	0.51	0.11	0.27	0.03	0.31	0.13	0.04	0.18

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	98	825	57	86	1084	109	67	11	119	33	12	63
Future Volume (vph)	98	825	57	86	1084	109	67	11	119	33	12	63
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	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)	1695	3390	1517	1695	3390	1517	1695	1784	1517	1695	1784	1517
Flt Permitted	0.20	1.00	1.00	0.29	1.00	1.00	0.75	1.00	1.00	0.75	1.00	1.00
Satd. Flow (perm)	356	3390	1517	518	3390	1517	1337	1784	1517	1338	1784	1517
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	107	897	62	93	1178	118	73	12	129	36	13	68
RTOR Reduction (vph)	0	0	19	0	0	37	0	0	116	0	0	61
Lane Group Flow (vph)	107	897	43	93	1178	81	73	12	13	36	13	7
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)	89.8	82.6	82.6	89.4	82.4	82.4	11.9	11.9	11.9	11.9	11.9	11.9
Effective Green, g (s)	89.8	82.6	82.6	89.4	82.4	82.4	11.9	11.9	11.9	11.9	11.9	11.9
Actuated g/C Ratio	0.75	0.69	0.69	0.75	0.69	0.69	0.10	0.10	0.10	0.10	0.10	0.10
Clearance Time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	346	2333	1044	454	2327	1041	132	176	150	132	176	150
v/s Ratio Prot	c0.02	0.26		0.01	c0.35			0.01			0.01	
v/s Ratio Perm	0.21		0.03	0.14		0.05	c0.05		0.01	0.03		0.00
v/c Ratio	0.31	0.38	0.04	0.20	0.51	0.08	0.55	0.07	0.09	0.27	0.07	0.04
Uniform Delay, d1	5.1	7.9	6.0	4.4	9.0	6.2	51.5	49.0	49.1	50.0	49.0	48.9
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	0.5	0.5	0.1	0.2	0.8	0.1	4.9	0.2	0.2	1.1	0.2	0.1
Delay (s)	5.6	8.4	6.1	4.6	9.8	6.4	56.5	49.2	49.4	51.2	49.2	49.0
Level of Service	A	A	A	A	A	A	E	D	D	D	D	D
Approach Delay (s)		8.0			9.2			51.8			49.7	
Approach LOS		A			A			D			D	

Intersection Summary					
HCM 2000 Control Delay		13.7	HCM 2000 Level of Service		B
HCM 2000 Volume to Capacity ratio		0.50			
Actuated Cycle Length (s)		120.0	Sum of lost time (s)		18.5
Intersection Capacity Utilization		63.4%	ICU Level of Service		B
Analysis Period (min)		15			

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	14	0	5	2	0	20	9	161	3	23	107	26
Future Volume (Veh/h)	14	0	5	2	0	20	9	161	3	23	107	26
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	15	0	5	2	0	22	10	175	3	25	116	28
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)											61	
pX, platoon unblocked	0.99	0.99	0.99	0.99	0.99		0.99					
vC, conflicting volume	398	378	130	382	390	176	144			178		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	390	369	119	372	382	176	133			178		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	99	100	100	97	99			98		
cM capacity (veh/h)	540	542	925	566	533	867	1440			1398		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	20	24	188	169
Volume Left	15	2	10	25
Volume Right	5	22	3	28
cSH	603	830	1440	1398
Volume to Capacity	0.03	0.03	0.01	0.02
Queue Length 95th (m)	0.8	0.7	0.2	0.4
Control Delay (s)	11.2	9.5	0.5	1.3
Lane LOS	B	A	A	A
Approach Delay (s)	11.2	9.5	0.5	1.3
Approach LOS	B	A		

Intersection Summary					
Average Delay		1.9			
Intersection Capacity Utilization		28.8%	ICU Level of Service		A
Analysis Period (min)		15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	5	62	112	6	63	52
Future Volume (Veh/h)	5	62	112	6	63	52
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	67	122	7	68	57
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						179
pX, platoon unblocked						
vC, conflicting volume	318	126			129	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	318	126			129	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	93			95	
cM capacity (veh/h)	643	925			1457	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	72	129	125
Volume Left	5	0	68
Volume Right	67	7	0
cSH	898	1700	1457
Volume to Capacity	0.08	0.08	0.05
Queue Length 95th (m)	2.0	0.0	1.1
Control Delay (s)	9.4	0.0	4.3
Lane LOS	A		A
Approach Delay (s)	9.4	0.0	4.3
Approach LOS	A		

Intersection Summary			
Average Delay		3.7	
Intersection Capacity Utilization		24.2%	ICU Level of Service A
Analysis Period (min)		15	

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	25	43	45	0	0	23
Future Volume (Veh/h)	25	43	45	0	0	23
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	27	47	49	0	0	25
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	49				150	49
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	49				150	49
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				100	98
cM capacity (veh/h)	1558				827	1020

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	74	49	25
Volume Left	27	0	0
Volume Right	0	0	25
cSH	1558	1700	1020
Volume to Capacity	0.02	0.03	0.02
Queue Length 95th (m)	0.4	0.0	0.6
Control Delay (s)	2.8	0.0	8.6
Lane LOS	A		A
Approach Delay (s)	2.8	0.0	8.6
Approach LOS			A

Intersection Summary			
Average Delay		2.8	
Intersection Capacity Utilization		20.5%	ICU Level of Service A
Analysis Period (min)		15	

C.4 2025 ULTIMATE CONDITIONS

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	38	1418	65	98	796	68	155	16	279	112	11	77
v/c Ratio	0.08	0.67	0.07	0.40	0.35	0.06	0.74	0.06	0.75	0.54	0.04	0.25
Control Delay	5.8	17.4	1.6	10.3	10.3	1.6	68.1	40.5	32.8	55.0	39.9	9.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	5.8	17.4	1.6	10.3	10.3	1.6	68.1	40.5	32.8	55.0	39.9	9.4
Queue Length 50th (m)	2.1	105.7	0.0	5.6	43.7	0.0	35.1	3.2	27.0	24.5	2.2	0.0
Queue Length 95th (m)	5.9	151.8	3.9	12.3	64.8	4.2	55.2	9.1	54.8	40.7	7.1	11.0
Internal Link Dist (m)		397.1			476.2			36.9			157.1	
Turn Bay Length (m)	50.0		60.0	45.0		60.0	37.5		30.0	50.0		37.5
Base Capacity (vph)	502	2125	982	262	2289	1052	275	367	438	274	367	378
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.08	0.67	0.07	0.37	0.35	0.06	0.56	0.04	0.64	0.41	0.03	0.20

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	35	1305	60	90	732	63	143	15	257	103	10	71
Future Volume (vph)	35	1305	60	90	732	63	143	15	257	103	10	71
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	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	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)	1695	3390	1517	1695	3390	1517	1695	1784	1517	1695	1784	1517
Flt Permitted	0.34	1.00	1.00	0.12	1.00	1.00	0.75	1.00	1.00	0.75	1.00	1.00
Satd. Flow (perm)	601	3390	1517	212	3390	1517	1339	1784	1517	1333	1784	1517
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	38	1418	65	98	796	68	155	16	279	112	11	77
RTOR Reduction (vph)	0	0	24	0	0	23	0	0	134	0	0	65
Lane Group Flow (vph)	38	1418	41	98	796	45	155	16	145	112	11	12
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)	79.3	75.3	75.3	86.1	78.7	78.7	18.8	18.8	18.8	18.8	18.8	18.8
Effective Green, g (s)	79.3	75.3	75.3	86.1	78.7	78.7	18.8	18.8	18.8	18.8	18.8	18.8
Actuated g/C Ratio	0.66	0.63	0.63	0.72	0.66	0.66	0.16	0.16	0.16	0.16	0.16	0.16
Clearance Time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	433	2127	951	243	2223	994	209	279	237	208	279	237
v/s Ratio Prot	0.00	c0.42		c0.02	0.23			0.01			0.01	
v/s Ratio Perm	0.06		0.03	c0.26		0.03	c0.12		0.10	0.08		0.01
v/c Ratio	0.09	0.67	0.04	0.40	0.36	0.04	0.74	0.06	0.61	0.54	0.04	0.05
Uniform Delay, d1	7.1	14.3	8.6	10.0	9.3	7.3	48.3	43.1	47.2	46.6	42.9	43.0
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	0.1	1.7	0.1	1.1	0.5	0.1	13.2	0.1	4.6	2.7	0.1	0.1
Delay (s)	7.2	16.0	8.6	11.1	9.7	7.4	61.5	43.1	51.8	49.3	43.0	43.1
Level of Service	A	B	A	B	A	A	E	D	D	D	D	D
Approach Delay (s)		15.5			9.7			54.8			46.6	
Approach LOS		B			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	21.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.5
Intersection Capacity Utilization	76.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	22	0	7	3	0	23	2	146	2	14	125	5
Future Volume (Veh/h)	22	0	7	3	0	23	2	146	2	14	125	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	24	0	8	3	0	25	2	159	2	15	136	5
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)											61	
pX, platoon unblocked	0.99	0.99	0.99	0.99	0.99		0.99					
vC, conflicting volume	358	334	138	340	335	160	141			161		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	349	324	128	332	326	160	131			161		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	96	100	99	100	100	97	100			99		
cM capacity (veh/h)	579	582	915	606	581	885	1444			1418		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	32	28	163	156
Volume Left	24	3	2	15
Volume Right	8	25	2	5
cSH	637	844	1444	1418
Volume to Capacity	0.05	0.03	0.00	0.01
Queue Length 95th (m)	1.2	0.8	0.0	0.2
Control Delay (s)	10.9	9.4	0.1	0.8
Lane LOS	B	A	A	A
Approach Delay (s)	10.9	9.4	0.1	0.8
Approach LOS	B	A		

Intersection Summary				
Average Delay	2.0			
Intersection Capacity Utilization	30.5%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	10	64	80	16	41	90
Future Volume (Veh/h)	10	64	80	16	41	90
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	70	87	17	45	98
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						179
pX, platoon unblocked						
vC, conflicting volume	284	96			104	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	284	96			104	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	98	93			97	
cM capacity (veh/h)	685	961			1488	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	81	104	143
Volume Left	11	0	45
Volume Right	70	17	0
cSH	911	1700	1488
Volume to Capacity	0.09	0.06	0.03
Queue Length 95th (m)	2.2	0.0	0.7
Control Delay (s)	9.3	0.0	2.5
Lane LOS	A		A
Approach Delay (s)	9.3	0.0	2.5
Approach LOS	A		

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	25.5%	ICU Level of Service	A
Analysis Period (min)	15		

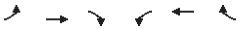
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	15	41	48	0	0	26
Future Volume (Veh/h)	15	41	48	0	0	26
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	16	45	52	0	0	28
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	52				129	52
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	52				129	52
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				100	97
cM capacity (veh/h)	1554				856	1016

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	61	52	28
Volume Left	16	0	0
Volume Right	0	0	28
cSH	1554	1700	1016
Volume to Capacity	0.01	0.03	0.03
Queue Length 95th (m)	0.2	0.0	0.6
Control Delay (s)	2.0	0.0	8.6
Lane LOS	A		A
Approach Delay (s)	2.0	0.0	8.6
Approach LOS			A

Intersection Summary				
Average Delay	2.6			
Intersection Capacity Utilization	19.8%	ICU Level of Service		A
Analysis Period (min)	15			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	116	983	160	304	1291	130	108	13	195	39	14	76
v/c Ratio	0.39	0.47	0.16	0.69	0.58	0.13	0.65	0.06	0.54	0.23	0.06	0.29
Control Delay	8.7	14.1	2.2	14.9	13.8	2.6	66.4	43.5	11.9	48.2	43.6	10.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	8.7	14.1	2.2	14.9	13.8	2.6	66.4	43.5	11.9	48.2	43.6	10.5
Queue Length 50th (m)	5.7	63.1	0.0	16.7	81.1	0.9	24.6	2.8	0.0	8.4	3.0	0.0
Queue Length 95th (m)	13.1	87.8	9.0	#38.4	126.4	9.2	40.9	8.2	19.4	17.8	8.5	11.3
Internal Link Dist (m)		397.1			476.2			36.9			157.1	
Turn Bay Length (m)	50.0		60.0	45.0		60.0	37.5		30.0	50.0		37.5
Base Capacity (vph)	319	2092	997	440	2222	1035	274	367	467	274	367	378
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.36	0.47	0.16	0.69	0.58	0.13	0.39	0.04	0.42	0.14	0.04	0.20

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)	107	904	147	280	1188	120	99	12	179	36	13	70
Future Volume (vph)	107	904	147	280	1188	120	99	12	179	36	13	70
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	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)	1695	3390	1517	1695	3390	1517	1695	1784	1517	1695	1784	1517
Flt Permitted	0.17	1.00	1.00	0.23	1.00	1.00	0.75	1.00	1.00	0.75	1.00	1.00
Satd. Flow (perm)	308	3390	1517	408	3390	1517	1335	1784	1517	1337	1784	1517
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	116	983	160	304	1291	130	108	13	195	39	14	76
RTOR Reduction (vph)	0	0	61	0	0	41	0	0	170	0	0	66
Lane Group Flow (vph)	116	983	99	304	1291	89	108	13	25	39	14	10
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)	81.8	74.1	74.1	91.0	78.7	78.7	15.1	15.1	15.1	15.1	15.1	15.1
Effective Green, g (s)	81.8	74.1	74.1	91.0	78.7	78.7	15.1	15.1	15.1	15.1	15.1	15.1
Actuated g/C Ratio	0.68	0.62	0.62	0.76	0.66	0.66	0.13	0.13	0.13	0.13	0.13	0.13
Clearance Time (s)	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.3	6.3	6.3	6.3	6.3
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	298	2093	936	441	2223	994	167	224	190	168	224	190
v/s Ratio Prot	0.02	0.29		c0.07	c0.38			0.01			0.01	
v/s Ratio Perm	0.24		0.07	c0.45		0.06	c0.08		0.02	0.03		0.01
v/c Ratio	0.39	0.47	0.11	0.69	0.58	0.09	0.65	0.06	0.13	0.23	0.06	0.05
Uniform Delay, d1	7.8	12.4	9.4	7.2	11.5	7.6	49.9	46.2	46.6	47.2	46.2	46.1
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	0.8	0.8	0.2	4.5	1.1	0.2	8.3	0.1	0.3	0.7	0.1	0.1
Delay (s)	8.6	13.1	9.6	11.6	12.6	7.7	58.2	46.3	46.9	47.9	46.3	46.3
Level of Service	A	B	A	B	B	A	E	D	D	D	D	D
Approach Delay (s)		12.3			12.1			50.8			46.8	
Approach LOS		B			B			D			D	

Intersection Summary				
HCM 2000 Control Delay	17.0	HCM 2000 Level of Service		B
HCM 2000 Volume to Capacity ratio	0.70			
Actuated Cycle Length (s)	120.0	Sum of lost time (s)		18.5
Intersection Capacity Utilization	70.6%	ICU Level of Service		C
Analysis Period (min)	15			

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	14	0	5	2	0	20	9	175	3	23	115	26
Future Volume (Veh/h)	14	0	5	2	0	20	9	175	3	23	115	26
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	15	0	5	2	0	22	10	190	3	25	125	28
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)											61	
pX, platoon unblocked												
vC, conflicting volume	422	402	139	406	414	192	153			193		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	422	402	139	406	414	192	153			193		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	99	100	100	97	99			98		
cM capacity (veh/h)	518	523	909	542	515	850	1428			1380		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	20	24	203	178
Volume Left	15	2	10	25
Volume Right	5	22	3	28
cSH	580	812	1428	1380
Volume to Capacity	0.03	0.03	0.01	0.02
Queue Length 95th (m)	0.8	0.7	0.2	0.4
Control Delay (s)	11.4	9.6	0.4	1.2
Lane LOS	B	A	A	A
Approach Delay (s)	11.4	9.6	0.4	1.2
Approach LOS	B	A		

Intersection Summary				
Average Delay	1.8			
Intersection Capacity Utilization	29.6%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	5	60	121	6	61	56
Future Volume (Veh/h)	5	60	121	6	61	56
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	65	132	7	66	61
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						179
pX, platoon unblocked						
vC, conflicting volume	328	136			139	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	328	136			139	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	93			95	
cM capacity (veh/h)	636	913			1445	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	70	139	127
Volume Left	5	0	66
Volume Right	65	7	0
cSH	886	1700	1445
Volume to Capacity	0.08	0.08	0.05
Queue Length 95th (m)	2.0	0.0	1.1
Control Delay (s)	9.4	0.0	4.1
Lane LOS	A		A
Approach Delay (s)	9.4	0.0	4.1
Approach LOS	A		

Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	28.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	25	41	43	0	0	23
Future Volume (Veh/h)	25	41	43	0	0	23
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	27	45	47	0	0	25
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	47				146	47
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	47				146	47
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				100	98
cM capacity (veh/h)	1560				832	1022

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	72	47	25
Volume Left	27	0	0
Volume Right	0	0	25
cSH	1560	1700	1022
Volume to Capacity	0.02	0.03	0.02
Queue Length 95th (m)	0.4	0.0	0.6
Control Delay (s)	2.8	0.0	8.6
Lane LOS	A		A
Approach Delay (s)	2.8	0.0	8.6
Approach LOS			A

Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	20.4%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix D STEP 4 COMMENT RESPONSE LETTER

Stantec

Memo

To:	Mike Giampa 110 Laurier Avenue West, 4th Floor Ottawa, ON K1P 1J1	From:	Lauren O'Grady, P.Eng. 400 – 1331 Clyde Avenue Ottawa, ON K2C 3G4
File:	801 Ralph Hennessy Avenue	Date:	September 26, 2019

Reference: 160401482 – Riverside South Block 221

In January 2019 Stantec Consulting Ltd. (Stantec) prepared the *Block 221, Riverside South Phase 8* on behalf of Richcraft Group of Companies (Richcraft) for a proposed residential development located in the Riverside South community of Ottawa, Ontario. **Table 1** below includes the comments from the City of Ottawa along with the accompanying responses by Stantec.

City of Ottawa Comment		Stantec Response
Transportation Engineering Services		
1	Provide TDM checklists as indicated in TIA Guidelines Element 4.1.1 – Design for Sustainable Modes.	Transportation Demand Management checklists will be provided in the final TIA as part of Element 4.1.1.
2	Complete Element 4.4.1 of the TIA Guidelines to include the access design parameters, proximity to adjacent driveways and driveways on opposite side of the street.	The proposed access to Ralph Hennessy Avenue is located opposite the planned access on the west side of Ralph Hennessy approximately 45m south of Earl Armstrong Road and appx 160m north of Markdale Terrace. It will feature a pavement width of 8.5m with 5m curb radii. Section 4.4.1 will be revised in the final TIA.
3	Provide minimum corner clearance of 55m from the signal to the access as per TAC Guidelines.	The subject access to Ralph Hennessy was aligned opposite the planned and approved access on the west side of Ralph Hennessy, which is approximately 45m south of Earl Armstrong Road. Shifting the subject access by 10m to respect the 55m corner clearance would result in the accesses across Ralph Hennessy being 10m offset. Aligning the accesses across Ralph Hennessy is ideal to avoid any potential conflicts that may arise from having them offset, therefore, it is recommended to keep the subject site access to Ralph Hennessy as shown on the site plan. In addition, the access location was confirmed with City of Ottawa staff during the initial stages of the project.
4	Confirm that there is adequate sight lines for motorists turning into and out of the access on Ralph Hennessy Avenue.	Using a design speed of 60 km/h and a passenger car design vehicle, there is adequate sight distance for vehicles to turn out of the proposed access onto Ralph Hennessy Avenue.
5	Provide updated photos of Earl Armstrong Road, Ralph Hennessy Avenue and Markdale Terrace at the development site. Google street view does not show the sidewalks along Ralph Hennessy Avenue and Markdale Terrace.	The existing subdivision is currently under development. All sidewalks have not yet been constructed.

Reference: **160401482 – Riverside South Block 221**

6	Review the site frontage at Earl Armstrong Road for an opportunity to upgrade sidewalks and the bus stop infrastructure.	There is an existing concrete sidewalk with decorative patio stones and bus stop along Earl Armstrong Road which will not be impacted by the proposed development. The proposed development does not warrant improvements to the existing infrastructure along this arterial which was reconstructed less than ten years ago.
Traffic Signal Operations		
7	Table 7 for MMLOS – justify why the operating speed is different for analyzing pedestrian LOS versus bike LOS.	In the City's MMLOS Guidelines, both the PLOS and BLOS for roadway segments use the 'operating speed' as a criterion for determining the MMLOS. The Guidelines do not go into detail about how this operating speed should be determined in the absence of speed surveys, therefore, it is understood that the posted speed limit could be used. The City issued an Addendum to the MMLOS Guidelines, and in it, Section 2.5 states that the operating speed for PLOS segment evaluation can be the posted speed limit plus 10km/h. This addendum provided no reference to the operating speed for BLOS; therefore, it is understood that the operating speed for BLOS can still be the posted speed limit. If the BLOS for roadway segments should be based on the posted speed plus 10km/h to make it consistent with the PLOS, a second Addendum to the MMLOS Guidelines should be issued. This rationale has been accepted by the City on previous TIAs for other developments. No revision to the TIA is required.
8	Tables 9, 11, 13, and 15 all show the same v/c ratios for the vehicle levels of service. These should be different considering each table is evaluating a difference scenario with different volumes.	Noted. The v/c ratios in Tables 11, 13, and 15 were incorrectly copied from Table 9. The correct v/c ratios can be seen in Tables 10, 12, and 14. These values will be corrected in the final TIA.
9	Although the full access intersection of Private Street 2 at Ralph Hennesey Avenue meets the Private Approach Bylaw as stated in the report, this access is still very close to the intersection at Earl Armstrong Road. There are concerns regarding proximity especially considering the turn channels and high speed on Earl Armstrong Road. In 2025, the northbound left and northbound right turn queues are shown to be over 50m, which would restrict turning movements at the proposed access.	Refer to response to comment #3 above regarding the rationale behind the location of this access. While the 95th percentile queues in the northbound direction at the Earl Armstrong intersection is anticipated to extend beyond the proposed site access, motorists can rely on courtesy gaps to exit the proposed development. The majority of the residents will be making the westbound right turn movement at this access towards Earl Armstrong during peak hours, which means they only have to wait for gaps in northbound traffic. In addition, residents have the option of using the Site Access 2 at Markdale Terrace to access Ralph Hennessy Avenue.
Traffic Signal Design		
10	No comments to this TIA for this circulation. Traffic Signal Design and Specification reserves the right to make future comments based on subsequent submissions.	Noted.

Reference: **160401482 – Riverside South Block 221**

11	Future considerations: If there are any future changes in the existing roadway geometry (or no changes to existing geometry) for the purpose of construction of a new TCS(s) or modifications to existing TCS(s) [new cycling cross ride(s)], the City of Ottawa Traffic Signal Design and Specification Unit is required to complete a review for traffic signal plant re-design and provide the actual re-design. If the proposed traffic signals are warranted/approved for installation or modifications to existing TCS are approved, and RMA approved, please forward an approved geometry detail design drawings (dwg digital format in NAD 83 coordinates) including base mapping, existing and new underground utilities/sewers, new/existing catch basins locations, Turn-Radius Modeling and approved pavement markings drawings in separate files for detail traffic plant design lay out. Please send all digital (CADD) design files to Peter.Grajcar@ottawa.ca 613-580-2424 extension 23035.	Noted.
Street Lighting		
12	No comment regarding this TIA submission. Street Lighting reserves the right to make future comment on subsequent submissions for this project.	Noted.

We trust that the above addresses the City's outstanding comments and concerns. Should you have any further questions or concerns related to the above please feel free to contact the undersigned at your earliest convenience.

Regards,

Stantec Consulting Ltd.

Lauren O'Grady P.Eng.
Transportation Engineer
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lauren.o'grady@stantec.com