APPENDIX B – EXISTING AND FUTURE TRAFFIC OPERATIONS REPORT

Toronto Transit Commission (TTC)

SCARBOROUGH - MALVERN LRT EA FINAL TRAFFIC ANALYSIS REPORT

FINAL REPORT

SEPTEMBER 2009

IBI GROUP

TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND 1

1.1 Background 1

1.2 Study Area 2

1.3 Project Description 3

1.4 Study Objectives 4

2. TRAFFIC ANALYSIS 5

2.1 Overall Methodology 5

2.2 Study Horizons 5

2.3 Traffic Data 5

2.4 Analysis Parameters 7

2.4.1 Capacity and Level of Service 7

2.4.2 Queue Lengths 7

3. EXISTING CONDITION 8

3.1 Existing Transportation Systems 8

3.1.1 Transit Services in the Study Area 8

3.1.1.1 Directly Along SMLRT Alignment 8

3.1.1.2 Intersecting Routes 9

3.1.2 Road Network 10

3.2 Assessment of Existing Traffic Operations 11

3.3 Existing Condition Overall Traffic Impacts 11

4. FUTURE CONDITION 23

4.1 Future Transportation Systems 23

4.1.1 Transit Services in the Study Area 23

4.1.2 Road Network 23

4.2 Assessment of Future Traffic Operations 23

4.3 Future Condition Overall Traffic Impacts 24

4.3.1 Traffic Capacity Reduction 24

TABLE OF CONTENTS (CONT'D)

4.3.2 Impacts to Unsignalized Intersections 25

4.3.3 Left-Turn Prohibitions 26

5. DETAILED TRAFFIC STUDIES 27

5.1 Eglinton Avenue at Brimley Road and Danforth Road 27

5.1.1 Study Purpose 27

5.1.2 Site Traffic Issues 27

5.1.3 Background 27

5.1.4 Proposed Scenarios 28

5.1.5 Recommendations 29

5.2 Eglinton Avenue at Kingston Road 30

5.2.1 Study Purpose 30

5.2.2 Site Traffic Issues 30

5.2.3 Background 30

5.2.4 Proposed Scenarios 30

5.2.5 Recommendations 32

5.3 Kingston Road at Morningside Avenue 33

5.3.1 Study Purpose 33

5.3.2 Site Traffic Issues 33

5.3.3 Background 33

5.3.4 Proposed Scenarios 33

5.3.5 Recommendations 34

5.4 Morningside Avenue at Highway 401 35

5.4.1 Study Purpose 35

5.4.2 Site Traffic Issues 35

5.4.3 Background 36

5.4.4 Traffic Analysis and Results 37

5.4.5 Proposed Mitigation 38

5.4.6 Conclusion 38

6. TRAFFIC ANALYSIS SUMMARY 39

6.1 Preliminary Traffic Analysis 39

IBI GROUP

TABLE OF CONTENTS (CONT'D)

6.2 More Detailed Analyses 39
6.2.1 Eglinton Avenue at Brimley Road and Danforth Road 39
6.2.2 Eglinton Avenue at Kingston Road 39
6.2.3 Kingston Road at Morningside Avenue 39
6.3 Traffic Impact Study 40
6.3.1 Morningside Avenue at Highway 401 40

IBI GROUP FINAL REPORT

TABLE OF CONTENTS (CONT'D)

List of Exhibits

Exhibit 1-1: Toronto Transit City Light Rail Plan 1
Exhibit 1-2: SMLRT Study Area 2
Exhibit 1-3: Typical Urban Intersection Section and Rendering of the LRT 3
Exhibit 2-1: List of Traffic Analysis Signalized Intersections 6
Exhibit 3-1: Existing Transit Services Map 9
Exhibit 3-2: Eglinton Avenue East: Existing and Future Traffic Conditions 12
Exhibit 3-3: Kingston Road: Existing and Future Traffic Conditions 16
Exhibit 3-4: Morningside Avenue-Military Trail: Existing and Future Traffic Conditions 20
Exhibit 4-1: Existing and Future Movements at Unsignalized Intersections 25
Exhibit 5-1: The Eglinton at Brimley and Danforth Study Area 28
Exhibit 5-2: Preferred Scenario for Eglinton Avenue at Brimley Road and Danforth Road 29
Exhibit 5-3: The Eglinton Avenue at Kingston Road Study Area 31
Exhibit 5-4: Preferred Scenario for Eglinton Avenue at Kingston Road Area 32
Exhibit 5-5: The Eglinton Avenue at Kingston Road Study Area 34
Exhibit 5-6: Preferred Scenario for Kingston Road at Morningside Avenue Area 35
Exhibit 5-7: The Morningside Avenue TIS Study Area 36
Exhibit 5-8: Existing and Future Morningside Avenue Roadway Configurations 37

Attachments

ATTACHMENT I – EXISTING CONDITION TRAFFIC ANALYSIS SUMMARIES I-1

ATTACHMENT II – FUTURE CONDITION TRAFFIC ANALYSIS SUMMARIES II-1

ATTACHMENT III – SCARBOROUGH - MALVERN LRT EA - EGLINTON AVENUE AT BRIMLEY ROAD AND DANFORTH ROAD SYNCHRO ASSESSMENT III-1

ATTACHMENT IV – SCARBOROUGH - MALVERN LRT EA - KINGSTON ROAD AT EGLINTON AVENUE SYNCHRO ASSESSMENT IV-1

ATTACHMENT V – SCARBOROUGH - MALVERN LRT EA - KINGSTON ROAD AT MORNINGSIDE AVENUE SYNCHRO ASSESSMENT V-1

ATTACHMENT VI – SCARBOROUGH - MALVERN LRT EA – HIGHWAY 401 & MORNINGSIDE AVENUE TRAFFIC IMPACT STUDY V-1

1. INTRODUCTION AND BACKGROUND

1.1 Background

This report describes the traffic analysis completed as part of the Scarborough Malvern Light Rail Transit (SMLRT) Environmental Assessment process.

During the past decade, the Toronto Transit Commission (TTC) in conjunction with the City of Toronto has been examining high-quality and reliable transit technology and routes that would cross the City, cumulating in the *Toronto Transit City – Light Rail Plan*. Released in March 2007, Transit City is a high-level plan for a Light Rail Transit (LRT) network for the City of Toronto and consolidates various light rail plans and studies undertaken by the City and the TTC during this period. **Exhibit 1-1** shows a map of the proposed LRT lines in the Toronto Transit City Light Rail Plan.

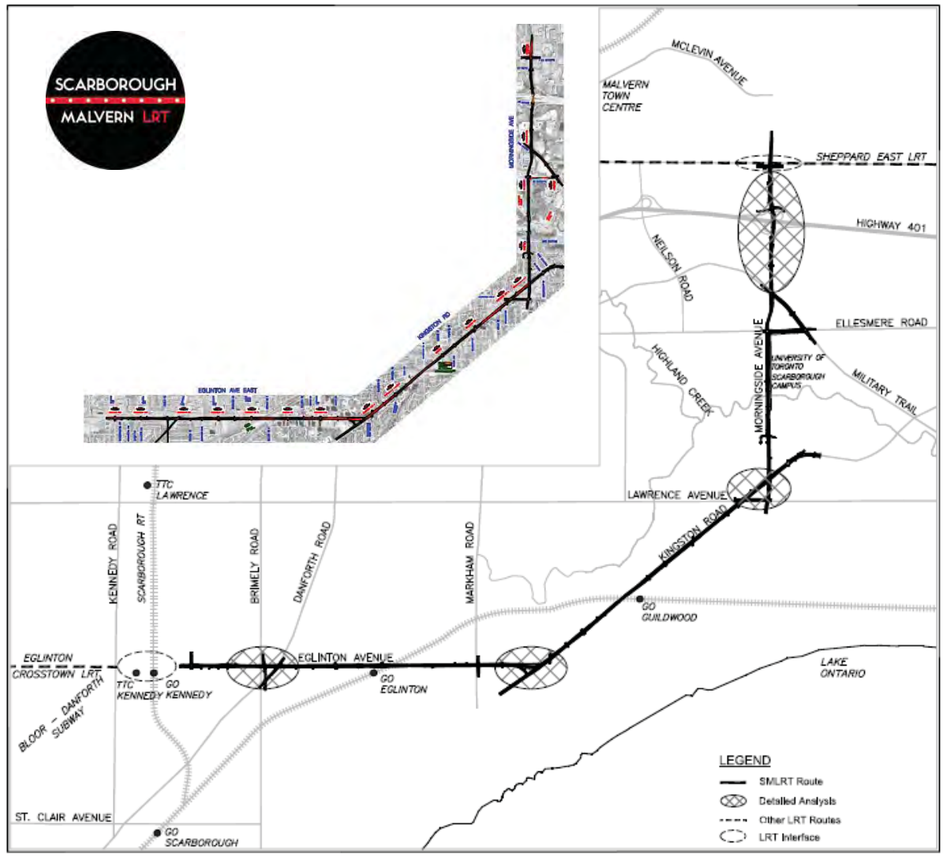
Exhibit 1-1: Toronto Transit City Light Rail Plan

The SMLRT is one of seven light rail lines proposed in the Transit City plan. Metrolinx, the Province's agency responsible for the regional transportation plan, has adopted this plan in its entirety in September 2008. The core objective of the Transit City Plan calls for the development of a network of light rail transit lines across the City of Toronto that offer seamless interconnection between each other, with the City's existing and proposed rapid transit lines, and with regional transit services.

1.2 Study Area

The study area and preferred alignment for the SMLRT is shown in **Exhibit 1-2**. It was developed based on a feasibility study that was undertaken in early 2008 as part of the overall environmental assessment study. The SMLRT route would begin at Kennedy Station and end at Morningside Avenue / Sheppard Avenue intersection to provide service to the University of Toronto Scarborough Campus (UTSC), Centennial College Ellesmere Campus, and many residential neighbourhoods.

Exhibit 1-2: SMLRT Study Area



1.3 Project Description

Light Rail Transit (LRT) – electrically powered "light rail" vehicles are the preferred technology of choice for the SMLRT. The proposed LRT will operate as an at-grade transit line, generally in reserved right-of-way in the centre of the existing road right-of-way. Throughout the entire alignment, a minimum of two through traffic lanes will be maintained in each direction. **Exhibit 1-3** shows a typical roadway cross section with the proposed LRT.

Exhibit 1-3: Typical Urban Intersection Section and Rendering of the LRT

The approximate length of the entire SMLRT alignment is 12 km, and its average width is 7.3m. At proposed stop locations, a 3m platform is required, which will generally be placed on the far side of the intersection in the shadow of the existing left-turn lane, thereby requiring no additional right-of-way width.

The south-western terminus of the SMLRT is the Kennedy Subway Station at 2455 Eglinton Avenue East (just east of Kennedy Road). There are transit connections at Kennedy station to the Bloor-Danforth Subway, the Scarborough Rapid Transit, the proposed Eglinton Crosstown LRT, GO Transit Kennedy Rail Station, and TTC bus routes. The north-eastern terminus of the SMLRT is the

vicinity of Morningside Avenue and Sheppard Avenue where a transit connection with the planned Sheppard East LRT is planned.

The proposed alignment of the SMLRT is as follows:

- **Eglinton Avenue East** – the SMLRT will travel in the centre of the roadway, from Kennedy Subway Station to Kingston Road, where a high quality connection with local bus routes and the proposed Kingston Road Bus Rapid Transit (BRT) is provided;
- **Kingston Road –** the SMLRT will travel in the centre of the roadway, from Eglinton Avenue to the Morningside Avenue intersection, where a high quality connection with local bus routes is provided; and
- **Morningside Avenue –** the SMLRT will travel in the centre of the roadway, from Kingston Road to a realigned Beath Street, then along the east side of Morningside Avenue to Ellesmere Road through the Highland Creek area, then easterly along Ellesmere Road into the UTSC on the south side, and then back into the centre of the roadway northerly along Military Trail and Morningside Avenue, terminating at Sheppard Avenue.

In the beginning of the study, the recommended alignment also included a direct connection to Malvern Town Centre, via the Sheppard Avenue and Neilson Road corridors. However, since that time, an extension of the Scarborough Rapid Transit (SRT) to the Malvern Town Centre has been planned and the recommended northern terminus of the SMLRT has been modified to Morningside Avenue at Sheppard Avenue. The results of the traffic analysis do not include the analysis of intersections on the Neilson Road corridor.

1.4 Study Objectives

The primary objectives of the traffic analysis are to conduct a preliminary assessment of the future Light Rail Vehicle (LRV) operation, to determine impacts on traffic operations, and develop concepts that reasonably mitigate traffic concerns. Ultimately, the results of the traffic analysis will be used to guide and advance the design of the SMLRT from the preliminary to the final design. Therefore, the analysis conducted in this report is the foundation for that work.

2. TRAFFIC ANALYSIS

2.1 Overall Methodology

Existing intersection capacity analyses were undertaken using the Highway Capacity Manual (HCM) methodology, and specifically the Synchro 6.0 Traffic Signal Coordination Software package by Trafficware. The Synchro analysis consisted of two steps, namely:

1. An analysis of existing and future conditions to identify areas of potential problems for more detailed analysis

2. A detailed analysis of the locations selected for more analysis to develop an effective LRT operation that will be refined during preliminary and detailed design.

To evaluate LRV operation in transit right-of-ways, a priority ranking was developed and employed at signalized intersections. The priority ensures that a safe transportation system is in place for all roadway users including pedestrians, cyclists, transit (bus and LRV) and traffic. The priority ranking consists of the following measures:

1. Ensure high quality LRT operations (i.e. speed, reliability);

2. Facilitate the movement of pedestrians;

3. Facilitate bus operation and transfer of passengers between bus and LRT; and

4. Facilitate the movement of vehicles at the signalised intersections.

2.2 Study Horizons

Two study horizons were analyzed as part of the overall SMLRT traffic analysis:

- **Existing Condition –** Current 2008 condition in which the analysis is based on existing roadway/intersection configurations, signal timing plans and turning movement counts.

- **Future Condition –** Assumes a future time period in which the SMLRT is in place and fully operational. The analysis is based on revised roadway/intersection configurations, modified signal timing plans and existing turning movement counts (assumes roadway is at near capacity during existing condition).

2.3 Traffic Data

Morning and afternoon peak hour traffic turning movement counts of traffic at all signalized intersections along the preferred alignment were requested from the City of Toronto's Transportation Services - Traffic Safety Unit. At locations where counts were unavailable or insufficient, turning movement counts were undertaken by IBI Group.

Current signal phasing and splits for the signalized study intersections were obtained from the City of Toronto's Transportation Services Division - Traffic Management Centre. Intersection lane configurations were obtained through aerial photography, and field studies undertaken by IBI Group staff.

A list of signalized intersections analyzed in this study are shown in **Exhibit 2-1**.

Exhibit 2-1: List of Traffic Analysis Signalized Intersections

#	Main Street	Secondary Street	Intersection #	Traffic Signal Control System	Signal Timing Date	Data
2	Eglinton Ave. East	Midland Avenue	0461	SCOOT	2008-05-22	2005-06-20
3	Eglinton Ave. East	Falmouth Avenue/ Gilder Drive	0217	SCOOT	2008-05-21	2005-07-13
4	Eglinton Ave. East	Brimley Road	0462	SCOOT	2008-05-23	2005-04-19
5	Eglinton Ave. East	Danforth Road	0379	SCOOT	2008-05-21	2006-04-18
6	Eglinton Ave. East	McCowan Road	0192	SCOOT	2008-05-23	2005-06-20
7	Eglinton Ave. East	Torrance Road/ Home Depot Drive	1825	SCOOT	2008-05-23	2007-06-26
8	Eglinton Ave. East	Bellamy Road North	0191	SCOOT	2008-05-23	2005-06-30
9	Eglinton Ave. East	Mason Road/ Conn Smyth Drive	0638	SCOOT	2008-05-23	2007-09-19
10	Eglinton Ave. East	Beachell Street	1293	SCOOT	2008-05-22	2004-02-26
11	Eglinton Ave. East	Markham Road	0463	SCOOT	2008-05-22	2007-03-22
12	Eglinton Ave. East	Cedar Drive	1562	SCOOT	2008-05-22	2005-07-12
13	Kingston Road	Eglinton Ave. East	0147	MTSS	2008-03-25	2004-09-07
14	Kingston Road	Scarborough Golf Club Road	1053	MTSS	2008-03-25	2004-03-25
15	Kingston Road	Cromwell Road/ Guildwood Parkway	0146	MTSS	2008-03-25	2003-12-11
16	Kingston Road	Celeste Drive	1193	MTSS	2008-03-25	2005-09-01
17	Kingston Road	Galloway Road	0145	MTSS	2008-03-25	2006-11-22
18	Kingston Road	Poplar Road	1373	MTSS	2008-03-25	2005-10-06
19	Kingston Road	Lawrence Ave. E.	0144	TransSuite	2007-12-27	2006-12-21
20	Kingston Road	Morningside Ave.	0143	TransSuite	2007-11-21	2006-04-13
21	Morningside Ave.	Tefft Road	1739	MTSS	2008-03-25	2007-10-17
22	Morningside Ave.	Beath St. (95m N. of West Hill C.I.)	1394	MTSS	2008-03-25	2003-02-27
23	Morningside Ave.	Ellesmere Road	0719	MTSS	2008-03-25	2007-09-17
24	Morningside Ave.	Military Trail	1112	MTSS	2008-03-25	2006-11-09
25	Morningside Ave.	401 C E South Ramp	1032	MTSS	2008-03-25	2007-04-03
26	Morningside Ave.	401 C W North Ramp/ Cinemart Dr.	1546	MTSS	2008-03-25	2007-04-02
27	Morningside Ave.	Milner Avenue	1584	TransSuite	2006-07-25	2002-05-01
28	Military Trail	Ellesmere Road	1195	MTSS	2008-03-25	2004-11-01
29	Military Trail	Morningside (355m E. of U of T Access)	2003	MTSS	2008-03-25	2005-03-30
30	Morningside Ave.	Sheppard Avenue East	1108	TransSuite	2006-10-05	2006-09-21

2.4 Analysis Parameters

The City of Toronto's *Guidelines for Using Synchro Software v.5.0 (*2004 and the Ontario's Ministry of Transportation's (MTO) *General Guidelines for the Preparation of Traffic Impact Studies (2008)* were consulted for the base parameters of this study.

2.4.1 CAPACITY AND LEVEL OF SERVICE

An intersection's overall operating conditions are typically characterized by two standard measures: the volume to capacity ratio (V/C) and the level of service (LOS). Taken together, they provide an indication of delay and the number of vehicles that can be accommodated through an intersection. The V/C ratio is an indication of the volume of traffic attempting to make a specific movement through an intersection (i.e., northbound left, westbound straight through), versus the theoretical capacity of that movement given the lane configurations, operating conditions and signal timings provided at the intersection. A V/C ratio of 1.0 represents a condition where all available capacity for a particular movement is being used.

The level of service (LOS) of the overall intersection or a particular movement is a measure of the average vehicle delay experienced by the motorists attempting to travel through the intersection. LOS is expressed as "A" to "F" with peak hour LOS in the "A" to "D" range being considered acceptable by most and a LOS of F representing unacceptable delays.

Critical movements were identified as those operating with a volume-to-capacity (V/C) ratio of 0.85 or higher and/or the poorest level of service (LOS).

2.4.2 QUEUE LENGTHS

The Synchro 6.0 Traffic Signal Coordination Software measures both the 50th percentile and 95th percentile maximum queue lengths. The 50th percentile queue (the median) is the back of queue length during a typical traffic cycle. The 95th percentile queue is the maximum back of queue length during a typical traffic cycle with 95th percentile traffic volumes. The 95th percentile queue measures the queue length that 95 percent of the samples lie below.

Critical queue lengths were identified as movements that surpassed the estimated length of the existing left-turn or right-turn storage bay, or extended through to the upstream signalized intersection.

3. EXISTING CONDITION

3.1 Existing Transportation Systems

The SMLRT will be located entirely within the former City of Scarborough, now part of the City of Toronto. Scarborough has an extensive transportation network including the east-west highway 401, a grid network of major arterial roadways, Scarborough Rapid Transit line, Bloor-Danforth Subway line and many surface bus transit routes. A description of these elements is provided in the following.

3.1.1 TRANSIT SERVICES IN THE STUDY AREA

A brief description of transit services operating in the Study Area is provided below, and a summary map is provided in **Exhibit 3-1**. At Kennedy Station (Eglinton Avenue East and Kennedy Road), the SMLRT will connect with the east-west Bloor-Danforth Subway and Scarborough Rapid Transit lines. There are many bus routes that travel partially along or intersect with the proposed SMLRT alignment.

3.1.1.1 Directly Along SMLRT Alignment

Bus routes that operate within the Study Area include the following:

- **Route 12B: Kingston Road –** TTC Route 12B is a north-south bus route that operates between Victoria Park and Kennedy Subway Stations via Victoria Park Avenue, Kingston Road, Brimley Road and Eglinton Avenue East. In the vicinity of the Study Area, Route 12B buses operate along Eglinton Avenue East between Kennedy Subway Station and Brimley Road.

- **Route 20: Cliffside –** TTC Route 20 is an east-west bus route that operates between Main Street and Kennedy Subway Stations via Danforth Avenue, Birchmount Road, Kennedy Road, Midland Avenue and Eglinton Avenue East. In the vicinity of the Study Area, Route 20 buses operate along Eglinton Avenue East between Midland Avenue and Kennedy Subway Station.

- **Route 21: Brimley –** TTC Route 21 is a north-south bus route that operates between Kennedy Subway Station and Scarborough Centre RT Station via Eglinton Avenue East and Brimley Road. In the vicinity of the Study Area, Route 21 buses operate along Eglinton Avenue East between Kennedy Subway Station and Brimley Road.

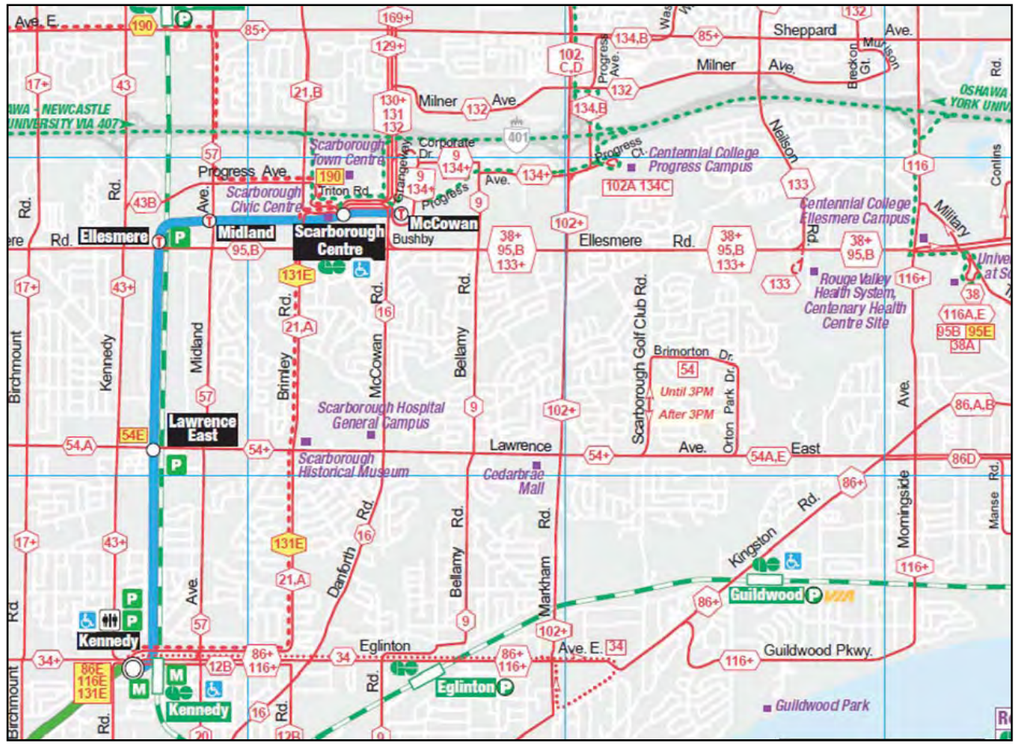
- **Route 34: Eglinton East –** TTC Route 34 is an east-west bus route that operates between Eglinton Subway Station and Kingston Road via Eglinton Avenue East with TTC Route 34C operating between Eglinton and Kennedy Subway Stations. In the vicinity of the Study Area, Route 34 buses operate along Eglinton Avenue East between Kennedy Subway Station and Kingston Road.

- **Route 57: Midland –** TTC Route 57 is a north-south bus route that operates between Kennedy Subway Station and Steeles Avenue East via Eglinton Avenue East and Midland Avenue. In the vicinity of the Study Area, Route 57 buses operate along Eglinton Avenue East between Kennedy Subway Station and Midland Avenue.

- **Route 86: Scarborough –** TTC Route 86 is an east-west bus route that operates between Kennedy Subway Station and Sheppard Avenue East (at Meadowvale Road) via Eglinton Avenue East, Kingston Road and Meadowvale Road. In the vicinity of the Study Area, Route 86

buses operate along Eglinton Avenue East and Kingston Road between Kennedy Subway Station and Morningside Avenue.

Exhibit 3-1: Existing Transit Services Map



- **Route 116: Morningside –** TTC Route 116 is a bus route that travels between the Kennedy Subway Station and Old Finch Avenue via Eglinton Avenue East, Guildwood Parkway and Morningside Avenue. In the Study Area, Route 116 buses operate along Eglinton Avenue and Morningside Avenue with Route 116A and Route 116E buses short turning at Ellesmere Road and Military Trail.

- **Route 131: Nugget –** TTC Route 131 is a north-south bus route that operates between Kennedy Subway Station and Scarborough Centre RT Station via Eglinton Avenue East and Brimley Road. From and Scarborough Centre RT, it continues east to Old Finch Avenue (at Morningview Trail). In the vicinity of the Study Area, Route 131 buses operate along Eglinton Avenue East between Kennedy Subway Station and Brimley Road.

3.1.1.2 Intersecting Routes

Bus routes that intersect the proposed route include the following:

- Route 9: Bellamy;

- Route 38: Highland Creek;
- Route 54: Lawrence East;
- Route 85: Sheppard East;
- Route 95: York Mills;
- Route 102: Markham Road;
- Route 132: Milner; and
- Route 133: Neilson.

3.1.2 ROAD NETWORK

- **Eglinton Avenue** is a major east-west arterial that connects Highway 407 in Mississauga and Kingston Road in Toronto (Scarborough). From Midland Avenue to Kingston Road, Eglinton Avenue East generally operates with three eastbound and three westbound travel lanes with a shared centre left-turn lane. At most major and minor signalized intersections, there are exclusive left-turn lanes and some exclusive or channelized right-turn lanes. One curb lane in each direction between Leslie Street and Cedar Drive is designated for High Occupancy Vehicles (HOVs) only.

- **Kingston Road** (also known as Highway 2) is a major northeast-southwest arterial that connects Eastern Avenue in Toronto to municipalities to the east. From Eglinton Avenue East to Morningside Avenue, Kingston Road generally operates with three northeastbound and three southwestbound travel lanes with a concrete centre median. At most major and minor signalized intersections there are exclusive left-turn lanes and some exclusive or channelized right-turn lanes.

- **Morningside Avenue** is a major north-south arterial that connects Guildwood Parkway in the south (Scarborough Bluffs) with Oasis Boulevard in the north (Town of Markham boundary). Just north of Kingston Road, Morningside Avenue has two northbound and two southbound travel lanes. Further north in the vicinity of Highway 401, Morningside Avenue has three northbound and three southbound travel lanes separated by a 2.5 metre centre median. At most major signalized intersections, there are exclusive northbound and southbound left-turn lanes at and some signalized intersections also have exclusive or channelized northbound and southbound right-turn lanes.

- **Military Trail** is a diagonal street that connects Kingston Road in the southeast with Ellesmere Road in the northwest. From Kingston Road to Morningside Avenue, Military Trail is oriented northwest-southeast and is classified as a collector roadway. From Morningside Avenue to Ellesmere Road, Military Trail is oriented east-west and northeast-southwest and is classified as a minor roadway. At its intersection with Morningside Avenue, both the eastbound and westbound approaches of Military Trail has three travel lanes, respectively – one dedicated left-turn lane, one though lane and one shared through/right-turn lane.

- **Sheppard Avenue** is a major east-west arterial that connects Weston Road in the west with Kingston Road (at Port Union Road) in the east. From Neilson Road to Morningside Avenue, Sheppard Avenue East has two eastbound and two westbound travel lanes and exclusive left-turn lanes at signalized intersections.

3.2 Assessment of Existing Traffic Operations

The assessment of existing traffic operations followed these steps:

1. Turning movement, pedestrian and bicycle data were compiled for 37-study area intersections. Two signalized intersections along Sheppard Avenue (Breckon Gate/Brenyon Way and Murison Boulevard) were not analyzed because they are part of the Sheppard Avenue LRT study area. The signalized intersection of Eglinton Avenue East and Kennedy Road was analyzed, although it is part of the Eglinton Crosstown LRT study area.

2. Along Eglinton Avenue East at intersections where there are HOV lanes, existing eastbound and westbound through volumes were reduced to account for HOV traffic. The underlying assumption is that some of the traffic operates in the HOV lanes. Spot counts along Eglinton in the AM and PM peak period were used to confirm the percentage of eastbound and westbound HOV traffic on Eglinton Avenue.

3. Lane configurations along Eglinton Avenue East were adjusted to account for the removal of HOV traffic in the existing condition. (the HOV lanes were removed along with the corresponding traffic.)

4. Traffic volume adjustments were made to intersection movements in which volumes did not appear consistent with other intersections.

5. A map of the study area alignment was developed in Synchro 6.0 for the existing condition AM and PM peak hours and all required data was entered.

6. The length of turning lanes/bays were measured using Google Earth.

7. The results of the existing condition Synchro 6.0 HCM analysis and Synchro 6.0 queue length analysis were summarized for each intersection.

8. For each intersection movement, the following thresholds were classified as impacts:

   - A Volume to Capacity Ratio (V/C) ≥ 0.85;
   - A Level of Service (LOS) = E or F; and
   - A 95th percentile queue length for a turning bay/lane that exceeds its actual measured length.

9. A series of existing condition summary tables and maps of areas identified for more detailed study were created for the AM and PM peak hours.

3.3 Existing Condition Overall Traffic Impacts

The results of the existing condition traffic analysis are summarized in **Exhibit 3-2** through **Exhibit 3-4**, for the three major segments of the proposed route. Table rows highlighted in orange were selected for more detailed analysis as described in **Section 5 – Detailed Traffic Studies**.

Exhibit 3-2: Eglinton Avenue East: Existing and Future Traffic Conditions

INTERSECTION	SIGNALIZED / UNSIGNALIZED	EXISTING CONDITIONS	FUTURE CONDITIONS	RECOMMENDATION	COMMENTS
Midland Avenue (proposed stop)	Signalized, Major-Major Intersection	- AM Peak: NB left-turn and WB & SB though movements operate with V/C > 1.0 - PM Peak: EB left-turn & through movements operates with V/C close to 1.0	- AM Peak: EB & NB left-turn movements experience major delays - AM Peak: Each direction has at least one movement with V/C > 1.0	- Investigate increasing storage lengths for all left-turn lanes in preliminary and detail design	- Increasing left turn storage length will reduce the likelihood that though traffic is delayed by left turning traffic.
Commonwealth Avenue	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- WBL becomes: WBL @ Midland; SBL @ Brussels - NBL becomes: SBR @ Brussels; WBR @ Midland; NBL @ Midland
Huntington Avenue	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- WBL becomes: WBL @ Falmouth; SBR @ Brussels - NBL becomes: SBR @ Brussels; WBR @ Midland; NBL @ Midland
Winter Avenue	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- WBL becomes: WBL @ Falmouth; SBR @ Brussels - NBL becomes: SBL @ Brussels; WBL @ Midland; NBL @ Midland
Falmouth Avenue / Gilder Drive (proposed stop)	Signalized, Major-Minor Intersection	- PM Peak: WB left-turn movement operates with V/C of 0.86	- AM Peak: WB left-turn & through movements operates with V/C > 0.85 - PM Peak: WB left-turn movement operates with V/C of 1.36	- More detailed analysis as included in Danforth/ Eglinton Report - Investigate increasing storage lengths for WB left-turn lane	- Increasing left turn storage length will reduce the likelihood that though traffic is delayed by left turning traffic.
Bimbrok Avenue	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- EBL becomes: EBR @ Danforth; SBR @ Brimley; NBL @ Eglinton; WBR @ Bimbrok - SBL becomes: SBR @ Eglinton; WBU @ Falmouth/Gilder

Exhibit 3-2: Eglinton Avenue East: Existing and Future Traffic Conditions

INTERSECTION	SIGNALIZED / UNSIGNALIZED	EXISTING CONDITIONS	FUTURE CONDITIONS	RECOMMENDATION	COMMENTS
Brimley Road	Signalized, Unique Intersection	- AM Peak: WB through movement operates with V/C of 0.90	- AM Peak: EB left-turn, WB through and NB left-turn movements operate with V/C of 0.95, 0.99 and 1.04, respectively - PM Peak: EB left-turn movement operates with V/C of 3.0 and queue exceeds storage length. EB through movement operates with V/C of 1.33	- More detailed analysis in Danforth/Eglinton Report - Four phase signal operation at Brimley/Eglinton with restricted east-west left turn movements	
Danforth Road (proposed stop)	Signalized, Unique Intersection	- AM Peak: WB through movement operates with V/C of 0.97 - PM Peak: EB left-turn and WB through movements operate with V/C of 0.88 and 0.97, respectively	- AM Peak: EB, WB & SB left-turn movements operate with V/C of 0.99, 0.95 and 0.99, respectively - PM Peak: EB left-turn & through, WB left-turn and SB left-turn movements operate with V/C of 0.92, 1.11, 0.96 and 0.96 respectively	- More detailed analysis in Danforth/Eglinton Report - Four phase signal operation at Danforth/Eglinton with restricted east-west left turn movements	
North Townhouse Development Road	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- EBL becomes: EBR @ Danforth; SBR at Brimley; NBR at Whetherby; EBR @ Danforth; NBR at Townhouse Development - SBL becomes: WBL @ Danforth; SBR @ Eglinton
Oswego Road	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- WBL becomes: WBU @ Falmouth/Gilder; EBR @ Oswego - NBL becomes: SBR @ Boyce; WBR @ Brimley; NBL @ Eglinton
Barbados Boulevard	Unsignalized	- N/A	- Right-in and right-out	- More detailed analysis in Danforth/Eglinton Report - Add traffic signal	- Will improve vehicular access to industrial uses along Barbados Boulevard

Exhibit 3-2: Eglinton Avenue East: Existing and Future Traffic Conditions

INTERSECTION	SIGNALIZED / UNSIGNALIZED	EXISTING CONDITIONS	FUTURE CONDITIONS	RECOMMENDATION	COMMENTS
McCowan Road (proposed stop)	Signalized, Major-Major Intersection	- Operates well during existing condition	- AM Peak: WB left-turn & through movements operates with V/C > 1.0 - PM Peak: EB left-turn & through and WB left-turn movements operate with V/C ≥ 1.1. EB & WB left-turn queues exceeds storage lengths	- Investigate increasing storage lengths for EB & WB left-turn lanes	- Increasing left turn storage length will reduce the likelihood that though traffic is delayed by left turning traffic.
Torrance Road	Signalized, Major-Minor Intersection	- Operates well during existing condition	- AM Peak: WB left-turn & through movements operate with V/C ≥ 0.85 - PM Peak: EB left-turn & through and WB left-turn movements operate with V/C > 0.90. WB left-turn queue exceeds storage length	- Investigate increasing storage lengths for EB & WB left-turn lanes under preliminary and detail design	- Increasing left turn storage length will reduce the likelihood that though traffic is delayed by left turning traffic.
Bellamy Road North (Eglinton GO Station entrance) (proposed stop)	Signalized, Major-Minor Intersection	- AM Peak: WB through movement operates with V/C of 0.9	- AM Peak: EB left-turn & WB through movements operate with V/C of 1.06 and 0.95, respectively - PM Peak: EB left-turn movement operates with V/C of 2.93 and the queue exceeds storage length	- Reconfigure GO Transit pick-up/drop-off area - Improve sightlines along Eglinton Avenue East	- Sightlines along Eglinton Avenue East affected by railroad bridge
Mason Road (proposed stop)	Signalized, Major-Minor Intersection	- Operates well during existing condition	- AM Peak: WB left-turn movement operates with V/C of 1.21 - PM Peak: EB left-turn & through and WB left-turn movements operate with V/C > 0.85. EB & WB left-turn queues exceeds storage lengths	- Investigate increasing storage lengths for EB & WB left-turn lanes	- Increasing left turn storage length will reduce the likelihood that though traffic is delayed by left turning traffic.
Beachell Street	Signalized, Major-Minor Intersection	- Operates well during existing condition	- AM Peak: EB left-turn movement operates with V/C of 0.87 - PM Peak: EB & WB left-turn movements operate with V/C of 0.86 and 0.88, respectively	- Investigate increasing storage lengths for EB & WB left-turn lanes	- Increasing left turn storage length will reduce the likelihood that though traffic is delayed by left turning traffic.

Exhibit 3-2: Eglinton Avenue East: Existing and Future Traffic Conditions

INTERSECTION	SIGNALIZED / UNSIGNALIZED	EXISTING CONDITIONS	FUTURE CONDITIONS	RECOMMENDATION	COMMENTS
Markham Road (proposed stop)	Signalized, Major-Major Intersection	- Operates well during existing condition	- AM Peak: EB left-turn and WB through movements operate with V/C of 1.73 and 0.93, respectively - PM Peak: EB left-turn movement operates with V/C of 1.62, an average vehicle delay of 344.6 seconds and the queue exceeds the storage length	- Investigate increasing storage lengths for EB left-turn lane	- Increasing left turn storage length will reduce the likelihood that though traffic is delayed by left turning traffic.
Cedar Drive (proposed stop between Cedar and Kingston)	Signalized, Unique Intersection	- Operates well during existing condition	- AM Peak: EB left-turn movement operates with V/C of 1.65, an average vehicle delay of 370.8 seconds and the queue exceeds the storage length - PM Peak: EB left-turn movement operates with V/C of 1.82, an average vehicle delay of 438.1 seconds and the queue exceeds the storage length	- More detailed analysis in Kingston/Eglinton Report	
Kingston Road (proposed stop between Cedar and Kingston + special trackwork requirements)	Signalized, Unique Intersection	- AM Peak: EB left-turn movement operates with V/C of 0.97 - PM Peak: EB left-turn movement operates with V/C of 0.95	- AM Peak: EB left-turn movement operates with V/C of 0.97 - PM Peak: EB left-turn movement operates with V/C of 0.95	- More detailed analysis in Kingston/Eglinton Report	

Exhibit 3-3: Kingston Road: Existing and Future Traffic Conditions

INTERSECTION		SIGNALIZED / UNSIGNALIZED	EXISTING CONDITIONS	FUTURE CONDITIONS	RECOMMENDATION	COMMENTS
Eglinton Avenue (proposed stop between Cedar and Kingston + special trackwork requirements)	Eglinton EB (existing) Eglinton WB (new intersection)	Signalized, Unique Intersection			- More detailed analysis in Kingston/Eglinton Report - 3 phase signal operation at Kingston/Eglinton - Allow NBL at Kingston/Eglinton - Channelize SBR at Kingston/ Eglinton - All transit movements, with the exception of the northbound left bus phase on Kingston Road, occur simultaneously	- NBL vehicles accessing north residential neighbourhood NBL at Kingston/Eglinton - SBR vehicles accessing north Eglinton Avenue leg RT at Kingston/Eglinton through a channelized RTL -
Scarborough Golf Club Road (proposed stop - new)		Signalized, Unique Intersection	- AM Peak: WB & SB through movements operate with V/C > 0.85 - PM Peak: EB through movement operates with V/C of 0.87	- AM Peak: WB through movement operates with V/C > 1.36 - PM Peak: EB left-turn & through movements operate with V/C ≥ 1.35	- More detailed analysis in Kingston/Eglinton Report	
Saunders Road		Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- EBL becomes: EBL @ Scarborough Golf Club; NBR @ Dale; EBR @ Saunders - NBL becomes: WBR @ Scarborough Golf Club; NBL @ Kingston - WBL becomes: WBU @ Scarborough Golf Club; EBR @ Guildcrest - SBL becomes: SBR @ Kingston; WBU @ Scarborough Golf Club
Cromwell Road / Guildwood Parkway (proposed stop)		Signalized, Major-Minor Intersection	- PM Peak: EB through movement operates with V/C of 0.87	- AM Peak: WB through & SB left-turn movements operate with V/C of 1.27 and 0.87, respectively - PM Peak: EB through movement operate with V/C = 1.37	- Further signal optimization is required to better balance competing traffic demands.	-

Exhibit 3-3: Kingston Road: Existing and Future Traffic Conditions

INTERSECTION	SIGNALIZED / UNSIGNALIZED	EXISTING CONDITIONS	FUTURE CONDITIONS	RECOMMENDATION	COMMENTS
Celeste Drive / Guildwood GO Station (proposed stop)	Signalized, Major-Minor Intersection	- Operates well during existing condition	- AM Peak: EB left-turn and WB left-turn & through movements operate with V/C > 1.0 - PM Peak: EB through movement operates with V/C of 1.09	- Investigate increasing storage lengths for left turn lanes.	- Increasing left turn storage length will reduce the likelihood that though traffic is delayed by left turning traffic.
Payzac Avenue / Overture Road	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- EBL becomes: EBU @ Galloway; WBR @ Overture - NBL becomes: NBR @ Kingston; EBU @ Galloway - WBL becomes: WBU @ Celeste/GO Station; EBR @ Payzac - SBL becomes: SBR @ Kingston; WBU @ Celeste/GO Station
Galloway Road (proposed stop)	Signalized, Major-Minor Intersection	- AM Peak: EB left-turn and NB & SB through movements operate with V/C of 0.97, 0.95 and 0.90, respectively	- AM Peak: EB left-turn and WB & NB through movements operate with V/C of 1.13, 1.36 and 0.95, respectively - PM Peak: WB left-turn movement operates with V/C of 0.85	- Investigate increasing storage lengths for left turn lanes.	- Increasing left turn storage length will reduce the likelihood that though traffic is delayed by left turning traffic.
North Sideroad	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- EBL becomes: EBU @ Poplar; WBR @ North Sideroad - NBL becomes: NBR @ Kingston; EBU @ Poplar - WBL becomes: WBU @ Galloway; EBR @ North Sideroad - SBL becomes: SBR at Kingston; WBU @ Galloway

Exhibit 3-3: Kingston Road: Existing and Future Traffic Conditions

INTERSECTION	SIGNALIZED / UNSIGNALIZED	EXISTING CONDITIONS	FUTURE CONDITIONS	RECOMMENDATION	COMMENTS
Poplar Road	Signalized	- PM Peak: WB left-turn movement operates with V/C of 0.85 and the queue exceeds the storage length	- AM Peak: EB left-turn and WB through movements operate with V/C of 2.0 and 0.86, respectively. EB left-turn has an average vehicle delay of 906.9 - PM Peak: EB through and WB left-turn movements operate with V/C > 0.90	- Investigate increasing storage lengths for left turn lanes.	- Increasing left turn storage length will reduce the likelihood that though traffic is delayed by left turning traffic.
Lawrence Avenue (proposed stop)	Signalized, Unique Intersection	- AM Peak: SB through movement operates with V/C of 0.99 - PM Peak: EB left-turn and NB through movements operate with V/C of 0.85 and 1.00, respectively	- AM Peak: SB through movement operates with V/C of 1.43 - PM Peak: EB left-turn movement operates with V/C of 0.85	- More detailed analysis in Kingston/Morningside Report - Add a southwest right turn lane at Kingston/Lawrence (allows additional 440 vph through the Kingston corridor in the AM southwest direction) - Add a northeast right turn lane at Kingston/Lawrence (allows additional 310 vph through the Kingston corridor in the PM northeast direction)	

Exhibit 3-3: Kingston Road: Existing and Future Traffic Conditions

INTERSECTION	SIGNALIZED / UNSIGNALIZED	EXISTING CONDITIONS	FUTURE CONDITIONS	RECOMMENDATION	COMMENTS
Morningside Avenue (proposed stop)	Signalized, Unique Intersection	- AM Peak: EB left-turn and WB through movements operate with V/C of 0.97 and 0.92, respectively - PM Peak: EB & SB through movements operate with V/C of 0.99 and 0.86, respectively	- AM Peak: EB left-turn and WB through movements operate with V/C of 0.99 and 1.76, respectively	- More detailed analysis in Kingston/Morningside Report - 4 phase signal operation at Kingston/Morningside - Restrict all left turn movements at Kingston/Morningside - Overlapping eastbound vehicle and pedestrian phase and northbound vehicle and pedestrian phase with LRV phase - Short turn half of the LRV at the Kingston/Morningside platform - Add a southbound right turn lane at Kingston/Morningside and allow protected southbound right turns during LRV phases - Split north/south pedestrian crossing into a 2-stage crossing and provide a mid-intersection pedestrian crossing for pedestrians traveling north-east/south-west - Restrict northeast right turns at Kingston/Morningside - Add a northbound right turn lane at Kingston/Morningside	

Exhibit 3-4: Morningside Avenue-Military Trail: Existing and Future Traffic Conditions

INTERSECTION	SIGNALIZED / UNSIGNALIZED	EXISTING CONDITIONS	FUTURE CONDITIONS	RECOMMENDATION	COMMENTS
Tefft Road	Signalized, Major-Minor Intersection	- Operates well during existing condition	- Operates well during future condition	- More detailed analysis in Kingston/Morningside Report - Relocate SB left-turn to a new traffic signal at Beath Street	
Warnsworth Street	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- EBL becomes: EBL @ Morningside & new west Beath extension; - NBL becomes: NBL @ New west Beath extension
Beath Street	Unsignalized	- N/A	- Right-in and right-out	- Add traffic signal (realign and extend Beath Street westward to West Hill C.I.)	
West Hill C.I. (proposed stop)	Signalized, Major-Minor Intersection	- Operates well during existing condition	- AM Peak: NB left-turn movement operates with V/C of 0.85	- Relocate existing traffic signal southward to Beath Street	
City Access Road	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- EBL becomes: EBR @ Morningside; SBU @ Beath - NBL becomes: NBU @ Ellesmere, SBR @ City Access
Morningside Park Access Road	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- EBL becomes: EBR @ Morningside; SBU @ Beath - NBL becomes: NBU @ Ellesmere, SBR @ Morningside Park
Ellesmere Road (proposed stop)	Signalized, Unique Intersection	- AM Peak: EB left-turn movement operates with V/C of 0.96 - PM Peak: WB left-turn and SB right-turn movements operate with V/C of 0.96 and 1.00, respectively	- AM Peak: EB & NB left-turn movements operates with V/C of 0.97 and 0.89, respectively - PM Peak: WB, NB and SB approaches has at least one movement with a V/C in the range of 0.94 to 1.03	- Signal optimization	- Planned LRT service / operations trackwork

Exhibit 3-4: Morningside Avenue-Military Trail: Existing and Future Traffic Conditions

INTERSECTION	SIGNALIZED / UNSIGNALIZED	EXISTING CONDITIONS	FUTURE CONDITIONS	RECOMMENDATION	COMMENTS
Military Trail @ Ellesmere Road	Signalized	- Operates well during existing condition	- PM Peak: NB left-turn movement operates with V/C of 1.20 and an average vehicle delay of 193.9 seconds	- Investigate increasing left turn lane storage length	- Increasing left turn storage length will reduce the likelihood that though traffic is delayed by left turning traffic.
Military Trail @ U of T Parking Lot Access (potential future stop)	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- All movements: divert to signalised Parking Access
Military Trail @ U of T Parking Lot Access	Signalized	- Operates well during existing condition	- AM Peak: WB left-turn movement operates with V/C of 1.02 and an average vehicle delay of 158.2 seconds	- Investigate increasing left turn lane storage length	- Increasing left turn storage length will reduce the likelihood that though traffic is delayed by left turning traffic.
Military Trail @ U of T Parking Lot Access	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- All movements: divert to signalised Parking Access
Military Trail (proposed stop)	Signalized, Unique Intersection	- AM Peak: EB left-turn & through and SB left-turn movements operate with V/C ≥ 0.85	- AM Peak: EB left-turn & through movements operate with V/C ≥ 0.85. SB left-turn movement operates with V/C of 3.15 and an average vehicle delay over 1,000 seconds - PM Peak: SB left-turn movement operates with V/C of 1.78 and an average vehicle delay of nearly 400 seconds	- More detailed analysis in 401/Morningside Report - Signal optimization - Convert the northbound left-turn lane turn type from permitted to protected and permitted - Increase the length of the westbound right-turn lane	
Tams Road	Unsignalized	- N/A	- Right-in and right-out	- Restrict left turns	- EBL becomes: EBR @ Morningside; SBU @ Military Trail - NBL becomes: SBU @ Ramp E(401); SBR @ Tams
Ramp E(401) – N/S (Morningside)	Signalized, Major-Major Intersection	- AM Peak: EB right-turn movement operates with V/C of 0.99 - PM Peak: EB right-turn movement operates with V/C of 0.91	- AM Peak: EB right-turn movement operates with V/C of 0.99 - PM Peak: EB right-turn and SB through movements operate with V/C of 0.91 and 0.96, respectively	- More detailed analysis in 401/Morningside Report - Signal optimization - Add an additional eastbound right-turn lane for a total of two eastbound right-turn lanes	- Add detection on highway 401 EB and WB off-ramps that are linked to traffic signals

IBI GROUP FINAL REPORT

Toronto Transit Commission (TTC)
SCARBOROUGH - MALVERN LRT EA FINAL TRAFFIC ANALYSIS REPORT

Exhibit 3-4: Morningside Avenue-Military Trail: Existing and Future Traffic Conditions

INTERSECTION	SIGNALIZED / UNSIGNALIZED	EXISTING CONDITIONS	FUTURE CONDITIONS	RECOMMENDATION	COMMENTS
Ramp W(401) – N/S(Morningside) / Cinemart Drive	Signalized, Major-Major Intersection	- AM Peak: WB through & right-turn and NB left-turn movements operate with V/C ~ 0.93	- AM Peak: WB through & right-turn and NB left-turn movements operate with V/C > 0.9 - PM Peak: SB through movement operates with V/C of 1.13	- More detailed analysis in 401/Morningside Report - Signal optimization -	- Add detection on highway 401 EB and WB off-ramps that are linked to traffic signals
Milner Avenue	Signalized, Major-Major Intersection	- AM Peak: NB left-turn movement operates with V/C of 0.98	- AM Peak: NB left-turn movement operates with V/C of 1.27, an average vehicle delay of 162.3 and the queue exceeds storage length - PM Peak: NB left-turn & through movements operate with V/C of 1.48 and 1.13, respectively	- More detailed analysis in 401/Morningside Report - Add one NB and one SB through lane - Increase the length of the eastbound left-turn lane - Increase the length of the westbound left-turn lane - Increase the length of the northbound left-turn lane - Increase the length of the southbound left-turn lane	
Sheppard Avenue (proposed stop)	Signalized, Major-Major Intersection	- AM Peak: Each approach has at least one movement with a V/C ≥ 0.85 - PM Peak: Each approach has at least one movement with a V/C > 0.85	- AM Peak: WB, NB and SB approaches has at least one movement with a V/C > 1.0 and delays > 100 seconds - PM Peak: Each approach has at least one movement with a V/C ≥ 0.90 and delays > 100 seconds.	- Restrict all left-turns at this intersection	- All LRT movements will need to be provided at this intersection - Scarborough Malvern LRT and Sheppard East LRT will interface in this area - Keeping left-turns will create too many signal phases

4. FUTURE CONDITION

4.1 Future Transportation Systems

4.1.1 TRANSIT SERVICES IN THE STUDY AREA

The implementation of the SMLRT will result in changes to existing transit services in the Study Area:

- **Route Elimination –** Some existing TTC bus routes such as Route 34: Eglinton (between Kennedy Station and Kingston Road) will be replaced by the SMLRT; and
- **Route Modification –** Some existing TTC bus routes such as Route 86: Scarborough and Route 116: Morningside will be shorted and/or re-routed to interface with the SMLRT.

Future transit operation plans have not been finalized by the TTC.

4.1.2 ROAD NETWORK

No new roadways are projected to be added to the Study Area. There will be changes to existing roadway configurations such as the reassignment of road space to create transit only lanes and some geometric modifications to a few major intersections (i.e. Eglinton Avenue East and Kingston Road) to accommodate the SMLRT.

4.2 Assessment of Future Traffic Operations

The assessment of future traffic operations followed these steps:

1. Traffic, pedestrian and bicycle volumes were assumed to remain the same in the future LRT condition (traffic counts were the most recent counts available from the City of Toronto). Again, two signalized intersections along Sheppard Avenue (Breckon Gate/Brenyon Way and Murison Boulevard) were not analyzed because they are part of the Sheppard Avenue LRT study area. The signalized intersection of Eglinton Avenue East and Kennedy Road was analyzed, although it is part of the Eglinton Crosstown LRT study area.
2. Eastbound and westbound through HOV volumes that were reduced at intersections along Eglinton Avenue East (for existing conditions) were added back.
3. Lane/roadway configurations along the entire study area alignment were adjusted to conform to the future roadway layout with the SMLRT right-of-way in place. Along the entire SMLRT alignment, two lanes of through traffic and, typically, one dedicated left-turn lane are assumed at signalized intersections. At signalized intersections, no lane/roadway configuration changes were made to streets that intersect the LRT alignment.
4. A map of the study area alignment was developed in Synchro 6.0 for the future condition AM and PM peak hours and all required data was entered.
5. The results of future condition Synchro 6.0 HCM analysis and Synchro 6.0 queue length analysis were summarized for each intersection.
6. For each intersection movement, the same impact threshold movements used in the existing condition analysis following thresholds were classified as impacts:

   - A Volume to Capacity Ratio (V/C) ≥ 0.85;
   - A Level of Service (LOS) = E or F; and
   - A 95th percentile queue length for a turning bay/lane that exceeds its measured length.
7. A series of future condition summary tables and maps of areas requiring more detailed analysis were created for the AM and PM peak hours.

4.3 Future Condition Overall Traffic Impacts

The results of the future condition traffic analysis are summarized in **Exhibit 3-2** through **Exhibit 3-5**. Table rows highlighted in orange were included in **Section 5 – Detailed Traffic Studies**.

The implementation of the SMLRT is projected to result in the following traffic changes:

- To ensure safe LRT operations, there will be a right-in/right-out arrangement at non-signalized side streets and entrances. Left-turn and U-turn opportunities will be provided at other signalized intersections.
- Some left-turns may not be provided at specific major signalized intersections to ensure efficient LRT operations (speed, reliability, safety).
- Transit operation will be improved but travelling by car maybe more difficult due to the removal of one travel lane in each direction along Eglinton Avenue East and Kingston Road.
- Possible increased delays for vehicular traffic, particularly for left-turn movements, due to the introduction of separate left-turn and U-turn traffic signal phases in order to accommodate SMLRT service through the intersection.

Some of these changes are discussed in further detail below:

4.3.1 TRAFFIC CAPACITY REDUCTION

The SMLRT will allocate some roadway space to a dedicated transit right-of-way (i.e. one travel lane in each direction along Eglinton Avenue East and Kingston Road), which in turn will reduce the overall traffic carrying capacity in the Study Area. The following reductions are projected:

- **Eglinton Avenue East –** The removal of one traffic lane in each direction and the continuous centre left-turn lane will:
  - Reduce existing traffic volumes by 10-15%; and
  - Reduce existing east-west traffic capacity by 30-35%.
- **Kingston Road –** The removal of one traffic lane in each direction will:
  - Reduce existing traffic volumes and east-west traffic capacity by 30-35%.
- **Kingston Road and Morningside Avenue Intersection –** The removal of one traffic lane in each direction of Kingston traffic and the elimination of some turning movements will:
  - Reduce intersection capacity by 60%.
- **Morningside Avenue –** The introduction of the SMLRT right-of-way will:
  - Minimally reduce existing traffic volumes,

- Reduce north-south traffic capacity.

As part of the future condition traffic analysis, a preliminary assessment was undertaken to project changes in traffic patterns if Study Area roadways were reduced from a six to four traffic lanes to accommodate the SMLRT. Initial findings indicate that there is little vehicle diversion to alternative travel routes (i.e. Lawrence Avenue East, local streets) as most alternatives routes are presently operating at, or near capacity. Projected increases in traffic volumes along potential alternative routes were marginal (i.e. less than 100 vehicles in the peak hour).

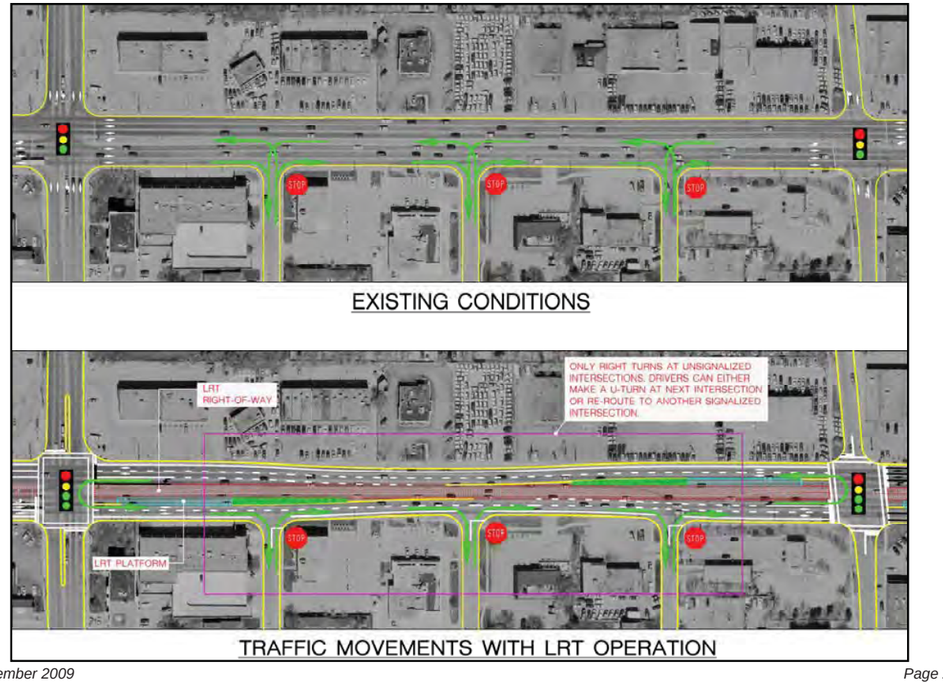
4.3.2 IMPACTS TO UNSIGNALIZED INTERSECTIONS

To ensure safe LRT operations, there will be a right-in/right-out arrangement at non-signalized side streets and entrances. Left –turn and U-turn opportunities will be provided at other nearby signalized intersections. (**Exhibit 4-1**). The recommended design for the SMLRT has carefully considered each unsignalized and driveway location to ensure that either one or both of the following is available or provided:

- A local alternative route; and
- A downstream signalized intersection has a U-turn movement.

During the design phase, the City and the TTC will conduct additional studies to investigate opportunities to minimize these impacts. In addition, the City will undertake local traffic monitoring studies during the LRT operations to investigate any identified issues.

Exhibit 4-1: Existing and Future Movements at Unsignalized Intersections



4.3.3 LEFT-TURN PROHIBITIONS

During the development of the recommended design, three intersections/locations were identified in which traffic movements could cause potential SMLRT operational and safety issues (i.e. the speed and reliability of the transit vehicle, safety issues associated with transit users, pedestrians, and vehicular traffic). A detailed transit-traffic analysis was conducted for each location and specific design recommendations were made to ensure efficient and safe SMLRT operations. As a result, left-turns may not be provided at the following two intersections/locations, to improve transit operations:

- Eglinton Avenue at Brimley Avenue and at Danforth Road; and
- Kingston Road and Morningside Avenue.

Left turn and U-turn opportunities will be provided at other locations to facilitate the prohibited movements.

5. DETAILED TRAFFIC STUDIES

Detailed traffic studies were undertaken at three locations identified in the Existing and Future Condition traffic analysis.

- Eglinton Avenue at Brimley Road and Danforth Road;
- Eglinton Avenue East at Kingston Road; and
- Kingston Road and Morningside Avenue.

In addition, a detailed transportation impact study that follows MTO guidelines was conducted along Morningside Avenue from Military Trail north to Milner Avenue, which encompasses the Highway 401 area. Each of these detailed traffic and transportation impact studies are summarized below. The final reports are presented in **Attachment III through VI**, respectively.

5.1 Eglinton Avenue at Brimley Road and Danforth Road

5.1.1 STUDY PURPOSE

A detailed Synchro traffic analysis was conducted for the Eglinton Avenue at Brimley Road and Danforth Road area. The purpose of the analysis was to conduct a preliminary assessment of the future SMLRT operations, and to determine the impacts to traffic operations and the surrounding land use. The findings from the study were used to advance the initial design of the SMLRT and provide a foundation for future preliminary and detailed design.

Ultimately, the goals of the recommended scenarios were to ensure that the SMLRT could travel through the Brimley Road and Danforth Road intersections with minimum stops and to ensure that traffic queues do not spill through Brimley Road and Danforth Road intersections.

The full *TTC Scarborough Malvern LRT – Eglinton Avenue at Brimley Road and Danforth Road Synchro Assessment* report can be found in **Attachment III**.

5.1.2 SITE TRAFFIC ISSUES

There are several site traffic issues associated with the Eglinton Avenue at Brimley Road and Danforth Road area:

- Significant through and turning traffic volumes during AM and PM peak hours;
- Poor roadway geometrics including short intersection spacing and extreme skewing; and
- Removing one travel lane in each direction present SMLRT and local bus operational issues.

5.1.3 BACKGROUND

The study area for the detailed Synchro traffic analysis included the Eglinton Avenue and Brimley Road signalized intersection, the Eglinton Avenue and Danforth Road signalized intersection, and the surrounding road network (**Exhibit 5-1**).

Exhibit 5-1: The Eglinton at Brimley and Danforth Study Area

5.1.4 PROPOSED SCENARIOS

Two scenarios were developed for the Eglinton Avenue at Brimley Road and Danforth Road area that explore different signal phasing alternatives:

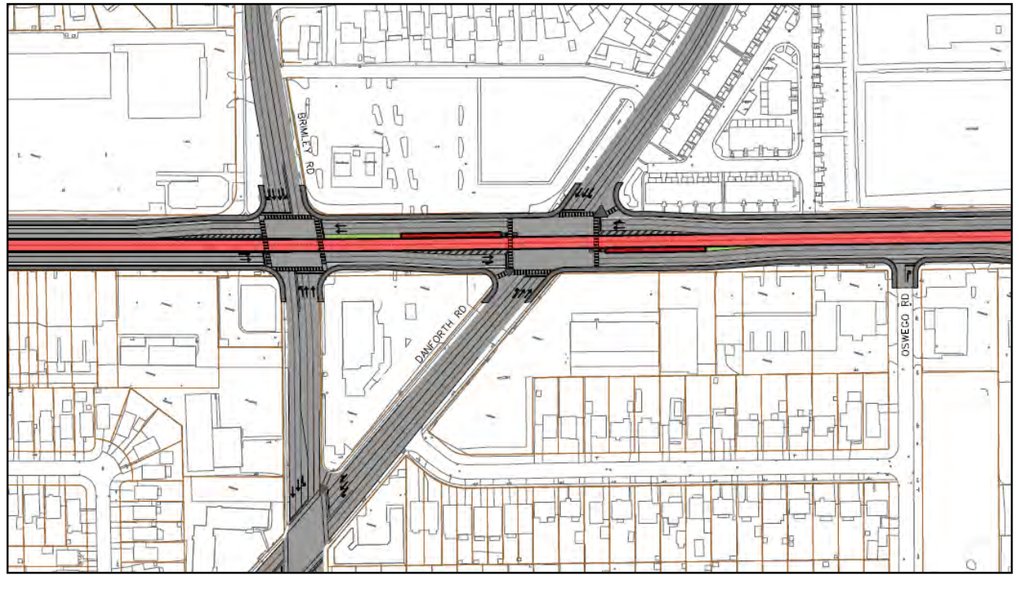
- **Scenario 1 –** The existing six phase operation was maintained, with the east-west left-turn phases operating protected only. During the PM peak period, a seventh phase was added for southbound left-turns at the Eglinton-Brimley intersection only.
- **Scenario 2 –** The existing east-west left turn phase operation was removed. In a separate test, the southbound left-turn phase was also removed at the Eglinton-Brimley intersection. The eastbound and westbound left-turn volumes were carried through the intersections and made into U-turn movements at the nearest downstream intersections.

5.1.5 RECOMMENDATIONS

Based on the results of the three iteration Synchro analysis, Scenario 2 was the preferred alternative (**Exhibit 5-2**) as it provides the SMLRT with the most benefits. The following is recommended to be implemented:

- Four phase signal operation at the Eglinton Avenue East at Brimley Road and Eglinton Avenue East at Danforth Road intersections, with restricted east-west left-turn movements at these intersections;
- Minimum cycle length is 85 seconds, but 110-120s cycle length is recommended based on current conditions;
- East-west green time should be a minimum of 57 seconds to allow coordinated progression for LRT between both intersections; and
- Introduce signalized intersection at Barbados Court to permit U-turns; and
- Provide far side SMLRT platforms at Danforth Road only.

Exhibit 5-2: Preferred Scenario for Eglinton Avenue at Brimley Road and Danforth Road



5.2 Eglinton Avenue at Kingston Road

5.2.1 STUDY PURPOSE

A detailed Synchro analysis was conducted at the Eglinton Avenue at Kingston Road intersection. The purpose of the analysis was to conduct a preliminary assessment of the future SMLRT operations, and to determine the impacts to traffic operation and the surrounding land use. The findings from the study were used to advance the initial design of the SMLRT and provide a foundation for future preliminary and detailed design.

The full *TTC Scarborough Malvern LRT – Kingston Road at Eglinton Avenue Synchro Assessment* report can be found in **Attachment IV**.

5.2.2 SITE TRAFFIC ISSUES

While the Eglinton Avenue at Kingston Road intersection offers the opportunity to design a high quality interface between the SMLRT and the proposed Kingston Road BRT and TTC local bus routes, there are a number of site traffic issues:

- Maintaining existing traffic and pedestrian movements;
- The removal of one travel lane in each direction along each roadway;
- Allowing for efficient SMLRT operations including turning movements onto Kingston Road, and storage and turn-back capability;
- The need to turn the SMLRT at a major “T” intersection; and
- Design terminus connections to the Kingston BRT and local bus routes present SMLRT and bus operational issues.

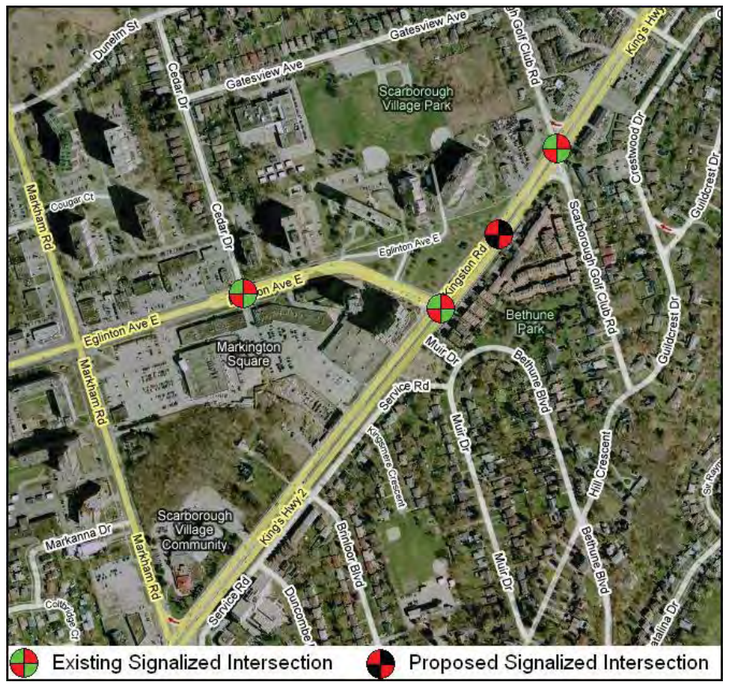
5.2.3 BACKGROUND

The study area for the detailed Synchro traffic analysis included the three signalized intersections of Eglinton Avenue at Kingston Road, Eglinton Avenue at Cedar Drive, and Kingston Road at Scarborough Golf Club Road as well as the surrounding road network (**Exhibit 5-3**). Eglinton Avenue consists of one eastbound left-turn lane and one shared eastbound left-turn/right-turn lane. Kingston Road consists of three northbound and three southbound travel lanes. There is a dedicated southbound right-turn lane for vehicles turning from Kingston Road to Eglinton Avenue. Cedar Drive is a north-south collector road and Scarborough Golf Club Road is a north-south minor arterial.

5.2.4 PROPOSED SCENARIOS

Three Synchro scenarios (along with sub-scenarios) were proposed for the Eglinton Avenue at Kingston Road intersection. Each scenario assumed a new transit mall would be in place at Kingston Road and Eglinton Avenue (on Eglinton Avenue) to facilitate the transfer of passengers between the LRT and bus.

Exhibit 5-3: The Eglinton Avenue at Kingston Road Study Area



- **Scenario 1 –** SMLRT movements (southbound right and eastbound left) would occur at the Kingston Road at Eglinton Avenue East north signalized intersection. Vehicular traffic is not permitted to make northbound left-turns from Kingston Road onto Eglinton Avenue. As a result, to access the residential neighbourhood, vehicles making northbound left-turns are required to make a U-turn at Scarborough Golf Club Road. The north pedestrian crossing is separated into two-stages with a flash don't walk time of 32 seconds. The southbound right-turn is a channelized lane.

- **Scenario 2 –** Similar to Scenario 1, but with several changes. Buses are prohibited from entering Kingston Road via the bus only lane and can only enter Kingston via the south Eglinton Avenue East intersection. The bus only lane is relocated to the south of the intersection, separating the bus activity from the intersection, thus shortening the north pedestrian crossing flash don't walk time to 16 seconds. The addition of a protected/permitted phase permits vehicles to make northbound left-turns at the Kingston Road at Eglinton Avenue North intersection.

- **Scenario 3 –** Similar to Scenarios 1 and 2, but with several changes. Buses are prohibited from accessing Kingston Road via the bus only lane. The north pedestrian crossing remains as a 2-stage crossing with a flash don't walk time of 16 seconds. The northbound left-turn bus phase activates simultaneously with the SMLRT phase. Northbound left-turn vehicular movements are permitted, but no protected phase is provided.

5.2.5 RECOMMENDATIONS

Based on the results of the Synchro analysis, Scenario 2 was the preferred alternative (**Exhibit 5-4**) as it offers similar traffic operational results as Scenario 1 and 2, while also permitting northbound left-turns. The following is recommended to be implemented:

- A three phase signal operation at the Eglinton Avenue at Kingston Road intersection;
- Provide southbound right-turns with a channelized lane to access Eglinton Avenue;
- Synchronize all transit movements to occur simultaneously (with the exception of the northbound left-turn bus phase on Kingston Road);
- Buses are enter Kingston Road via the bus only lane on the souoth side of Eglinton Avenue.
- Add a protected/permitted phase that permits vehicles to make northbound left-turns at the Eglinton Avenue at Kingston Road North intersection;
- Physically relocate the bus only lane to the south end of the Eglinton Avenue at Kingston Road intersection, thus shortening the north pedestrian crossing flash don't walk time to 16 seconds; and
- Separate the north pedestrian crossing into two-stages with a flash don't walk time of 32 seconds.

Exhibit 5-4: Preferred Scenario for Eglinton Avenue at Kingston Road Area

5.3 Kingston Road at Morningside Avenue

5.3.1 STUDY PURPOSE

A detailed Synchro analysis was conducted for the Kingston Road at Morningside Avenue area including the adjacent intersection along Lawrence Avenue East. The purpose of the analysis was to conduct a preliminary assessment of the future SMLRT operations, and to determine the impacts to traffic operation and the surrounding land use. The findings from the study were used to advance the initial design of the SMLRT and provide a foundation for future preliminary and detailed design.

The full *TTC Scarborough Malvern LRT – Kingston Road at Morningside Avenue Synchro Assessment* report can be found in **Attachment V**.

5.3.2 SITE TRAFFIC ISSUES

The proximity of Lawrence Avenue East to the Kingston Road at Morningside Avenue area creates several site traffic issues:

- SMLRT turning at a major intersection with significant through and turning traffic volumes during AM and PM peak hours;
- Removing one travel lane in each direction present SMLRT and local bus operational issues; and
- The Kingston Road at Morningside Avenue signalized intersection is projected to have high future transfer, boarding and alighting volumes.

5.3.3 BACKGROUND

The study area for the detailed Synchro traffic analysis included the three signalized intersections along Kingston Road and an additional three signalized intersections along Morningside Avenue (**Exhibit 5-5**). Kingston Road consists of three eastbound and three westbound travel lanes with dedicated left-turn lanes. Morningside Avenue consists of two northbound and two southbound travel lanes with dedicated left-turn lanes. In consultation with City of Toronto and TTC staff, a three iteration Synchro analysis was developed.

5.3.4 PROPOSED SCENARIOS

Three Synchro scenarios (along with sub-scenarios) were proposed for the Kingston Road at Morningside Avenue area:

- **Scenario 1 –** The existing eight phase signal operation was maintained, with the north-east/south-west left-turn phase operating as a protected movement. A protected transit phase was inserted at two points in the signal cycle (eastbound left-turn and southbound right-turn).
- **Scenario 2 –** The existing north-south left-turn phase operation was removed, with the east-west left-turn phases operating as protected only. A protected transit phase was inserted at two points in the signal cycle (eastbound left-turn and southbound right-turn).
- **Scenario 3 –** The existing north-south and east-west left-turn phase operation is removed. A protected transit phase was inserted at two points in the signal cycle (eastbound left-turn and southbound right-turn).

Exhibit 5-5: The Eglinton Avenue at Kingston Road Study Area

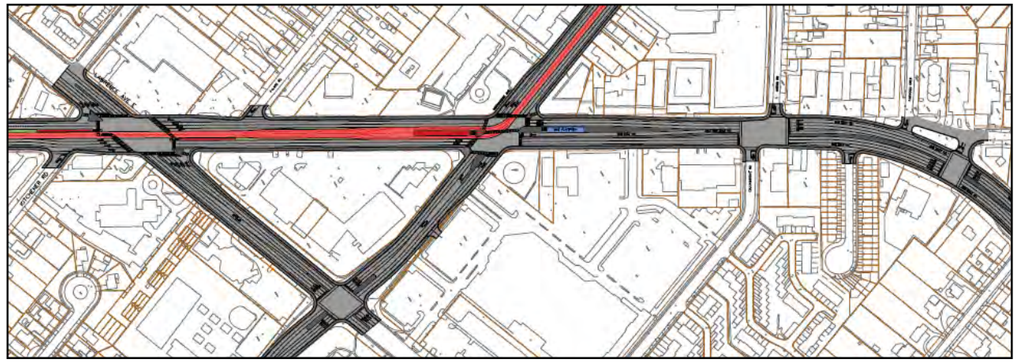
5.3.5 RECOMMENDATIONS

Based on the results of the three iteration Synchro analysis, Scenario 3-4C was the preferred alternative (**Exhibit 5-6**) as it provides the most overall benefit to the over capacity movements, without the need to expand the roadway. The following is recommended to be implemented:

- Provide a four phase signal operation at Kingston/Morningside;
- Restrict all left-turn movements at Kingston/Morningside;
- Provide two transit phases (27 sec – 5 green, 20 amber, 2 all red);
- Overlap the eastbound vehicle and pedestrian phase and northbound vehicle and pedestrian phase with the SMLRT phase;
- Add a northeast right-turn lane at the Kingston Road at Lawrence Avenue East intersection;
- Add a southwest right-turn lane at the Kingston Road at Lawrence Avenue East intersection;
- Short-turn half of the SMLRT vehicles at the Kingston Road at Morningside Avenue intersection platform (17 LRV phases per hour instead of 29);

- Add a southbound right-turn lane at the Kingston Road at Lawrence Avenue East intersection and allow protected southbound right-turns during SMLRT phases;
- Split north/south pedestrian crossing into a 2-stage crossing and provide a mid-intersection pedestrian crossing for pedestrians traveling north-east/south-west;
- Restrict northeast right-turns at the Kingston Road at Morningside Avenue intersection; and
- Add a northbound right-turn lane at the Kingston Road at Morningside Avenue intersection.

Exhibit 5-6: Preferred Scenario for Kingston Road at Morningside Avenue Area



5.4 Morningside Avenue at Highway 401

5.4.1 STUDY PURPOSE

A Traffic Impact Study (TIS) was required for the Morningside Avenue SMLRT alignment (in the vicinity of Highway 401). The purpose of the study was to assess the impacts of the proposed SMLRT on the provincial and city road network and to recommend mitigation measures. The MTO's *General Guidelines for the Preparation of Traffic Impact Studies (January 2008*) were followed.

The TIS involved an intersection capacity analysis at four signalized intersections along Morningside Avenue: Military Trail, Highway 401 Eastbound Off-Ramp, Highway 401 Westbound Off-Ramp/ Cinemart Drive and Milner Avenue. The study looked at the 2008 Existing Condition and three future year scenarios – 2018 Opening, 2023 5-Year Horizon and 2028 10-Year Horizon.

The full *TTC Scarborough Malvern LRT – Highway 401 & Morningside Avenue Traffic Impact Study* report can be found in **Attachment VI**.

5.4.2 SITE TRAFFIC ISSUES

There is potential for the SMLRT to affect the MTO's ability for safe and efficient movement of people and goods, and the MTO's ability to effectively and easily maintain the Morningside Bridge structure.

5.4.3 BACKGROUND

The primary study area for the TIS was Morningside Avenue from Military Trail north to Milner Avenue (**Exhibit 5-7**). The TIS analyzed existing traffic operations at four Morningside Avenue signalized intersections and future operations with and without the removal of existing traffic lanes to accommodate the SMLRT (**Exhibit 5-8**). The operation of the eastbound and westbound Highway 401 off-ramps was evaluated to ensure that their operations would not be impacted by the SMLRT.

Exhibit 5-7: The Morningside Avenue TIS Study Area

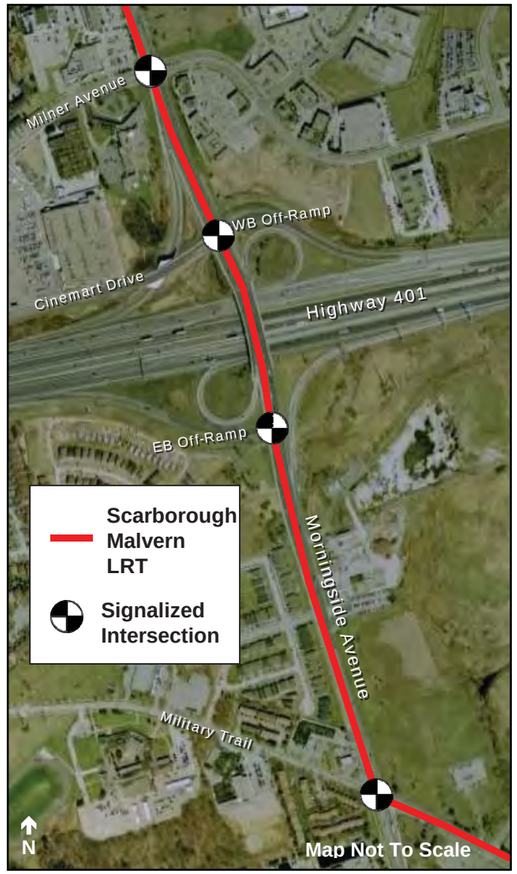
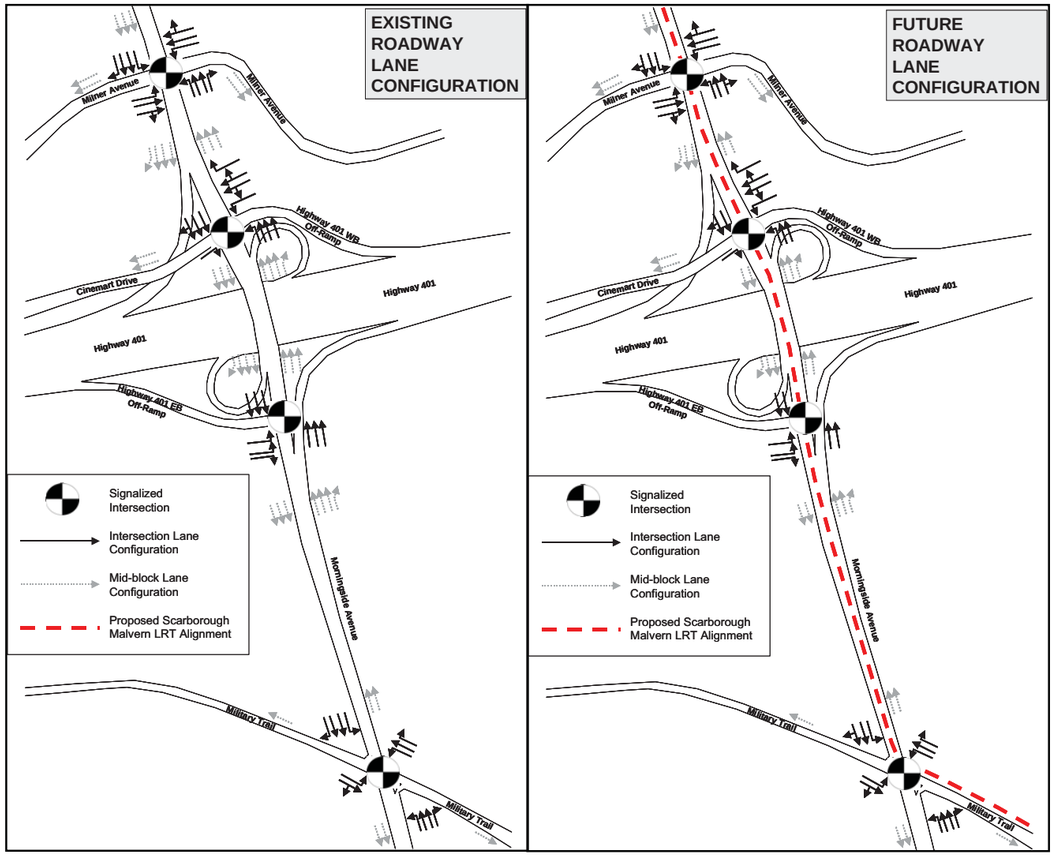


Exhibit 5-8: Existing and Future Morningside Avenue Roadway Configurations



Morningside Avenue crosses Highway 401 as a bridge with six travel lanes (three in each direction). There are on-ramps and off-ramps to and from the eastbound and westbound collector lanes on Highway 401 on either side of the Morningside Avenue Bridge. This bridge, its ramps and signalized intersections are maintained by the MTO. North of Highway 401 is Milner Avenue, a busy minor arterial and commercial shopping plaza, and south of Highway 401 is Military Trail and the University of Toronto Scarborough and Centennial College campuses.

5.4.4 TRAFFIC ANALYSIS AND RESULTS

The analysis determined that in the 2008 existing condition, the four signalized intersections have turning movements that experience critical capacity and delay issues during both the AM and PM peak periods. In future scenarios with the SMLRT in place, some of these existing operational concerns are projected to remain and some new traffic concerns are introduced.

Many of the operational concerns can be alleviated through simple mitigation measures such as signal timing optimization and roadway configuration changes. However, there are some operational concerns that require more complex geometrical improvements such as adding traffic lanes. For example, due to heavy projected traffic volumes in the PM peak period, the Milner Avenue and Morningside Avenue intersection experiences over-capacity operation and significant delay at its northbound and southbound intersection approaches that require additional travel lanes.

5.4.5 PROPOSED MITIGATION

In order to alleviate critical traffic movements and traffic spillbacks, mitigation measures were investigated at the 2028 10-Year Horizon intersection operations. Mitigation measures included:

- Adjusting signal timing;
- Changing lane configurations;
- Increasing existing lane storage lengths; and
- Adding additional travel lanes;

The results of the mitigation measures were mixed, with some but not all critical movements being reduced or eliminated. For example, the Morningside Avenue and Milner Avenue intersection has some capacity, delay and queuing issues that cannot be alleviated.

5.4.6 CONCLUSION

Generally, the existing and future conditions traffic analysis indicate that two travel lanes can be removed on Morningside Avenue to accommodate the SMLRT without adversely affecting traffic operations along Morningside Avenue, or affecting vehicle queues and safety along the Highway 401 eastbound and westbound off-ramps.

The Morningside Avenue and Milner Avenue intersection has some capacity, delay and queuing issues that may warrant further analysis. While the traffic analysis indicated no direct impacts to the Highway 401 On-Ramps and Off-Ramps, queuing issues at the northbound left-turn at Milner Avenue are present back to the Highway 401 Westbound Off-Ramp.

6. TRAFFIC ANALYSIS SUMMARY

6.1 Preliminary Traffic Analysis

The SMLRT is a 13 kilometre long corridor that will connect Kennedy Station in the southwest with various neighbourhoods and communities in central and northern Scarborough. The alignment of the SMLRT is proposed to follow three corridors: Eglinton Avenue East, Kingston Road and Morningside Avenue. An existing and future condition traffic analysis was conducted at 32 signalized intersections to determine the impacts of the SMLRT on study area intersections. Several factors that affect future traffic conditions include heavy traffic volumes at study area intersections, the removal of travel lanes along some travel corridors and the need to turn SMLRT vehicles at specific intersections.

The preliminary traffic analysis determined that traffic capacity will decrease and delay will increase at some study area intersections. Queue lengths were also projected to lengthen at some turning movements. The analysis also identified three locations that required more detailed Synchro analyses: Eglinton Avenue at Brimley Road and Danforth Road; Eglinton Avenue at Kingston Road; and Kingston Road at Morningside Avenue.

6.2 More Detailed Analyses

The results of the existing and future conditions traffic analysis helped identified three areas that required more detailed Synchro analyses. The results of these analyses are summarized below.

6.2.1 EGLINTON AVENUE AT BRIMLEY ROAD AND DANFORTH ROAD

The close proximity of Brimley Road and Danforth Road creates many challenges for the SMLRT. The results of the Synchro analysis recommends that a four phase signal operation be used at the Eglinton Avenue East at Brimley Road and Eglinton Avenue East at Danforth Road intersections, with restricted east-west left-turn movements at these intersections. Due to changing traffic patterns in the area, a signalized intersection that permits U-turns is proposed downstream at Barbados Court. It is also recommended that SMLRT platforms be placed at Danforth Road only.

6.2.2 EGLINTON AVENUE AT KINGSTON ROAD

The SMLRT alignment requires light rail vehicles to turn at this intersection and also proposes a high quality interface between the SMLRT and the proposed Kingston Road BRT and TTC local bus routes. The results of the Synchro analysis recommends a three phase signal operation for this intersection and that all transit movements are synchronized to occur simultaneously. Southbound right-turns would be provided with a channelized lane to access Eglinton Avenue and a protected/permitted phase would be added that permits vehicles to make northbound left-turns. Other pedestrian and signal timing improvements are also recommended.

6.2.3 KINGSTON ROAD AT MORNINGSIDE AVENUE

The SMLRT alignment requires light rail vehicles to turn at this intersection, which already has significant through and turning traffic volumes. This area is also projected to be a busy transfer point between the SMLRT and other local transit routes. The results of the Synchro analysis indicates that in order for the SMLRT to proceed efficiently and safely through this intersection, several traffic modifications are required. These include providing a four phase signal operation with two transit phases, restricting all left-turn movements and northeast right-turns, adding a

northbound right-turn lane, pedestrian crossing improvements and geometric improvements to the Kingston Road at Lawrence Avenue East intersection.

6.3 Traffic Impact Study

Due to the proximity of the SMLRT alignment with Highway 401, a TIS that followed MTO guidelines was conducted along Morningside Avenue between Military Trail and Milner Avenue.

6.3.1 MORNINGSIDE AVENUE AT HIGHWAY 401

The results of the TIS indicate that most future critical traffic movements and traffic spillbacks can be alleviated by mitigation measures. The removal of one travel lane in each direction of Morningside Avenue will have no adverse affects on traffic operations nor will it affect vehicle queues and safety along the Highway 401 off-ramps.

ATTACHMENT I

EXISTING CONDITION TRAFFIC ANALYSIS SUMMARIES

July 2009

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
1	Eglinton Avenue East	Kennedy Road	EBL	0.74	43.5	D	#42.2	40.6
			EBT	0.39	25.2	C	61.1	
			EBR	0.04	21.3	C	7.6	51.6
			WBL	0.49	21.1	C	m33.0	109.0
			WBT	1.54	284.9	F	m#404.8	
			WBR	0.19	26.3	C	m21.5	45.3
			NBL	0.49	26.7	C	30.8	61.0
			NBT	0.40	32.6	C	58.4	
			NBR	0.07	28.3	C	10.6	59.4
			SBL	0.68	33.9	C	#51.4	46.3
			SBT	0.57	35.6	D	86	
			SBR	0.23	30.6	C	28.2	33.5
			Intersection	1.01	142.8	F		
2	Eglinton Avenue East	Midland Avenue	EBL	0.77	57.6	E	m#38.0	72.5
			EBT	0.35	27.2	C	73.3	
			EBR	0.06	62.0	E	m15.4	
			WBL	0.11	22.1	C	11.3	56.0
			WBT	0.99	55.9	E	#224.1	
			WBR	0.11	21.7	C	14.3	
			NBL	0.57	29.0	C	32.7	88.7
			NBT	0.49	31.2	C	74.6	
			NBR					
			SBL	0.16	23.7	C	13.2	63.4
			SBT	0.70	40.0	D	125.3	
			SBR	0.93	65.9	E	#160.8	
			Intersection	0.93	45.4	D		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
3	Eglinton Avenue East	Falmouth Avenue / Gilder Drive	EBL	0.14	7.2	A	3.3	38.6
			EBT	0.29	7.3	A	35.3	
			EBR	0.02	5.9	A	2.9	
			WBL	0.03	10.0	B	m2.0	35.5
			WBT	0.79	19.3	B	164.4	
			WBR	0.02	15.5	B	m1.6	
			NBL					
			NBT	0.17	34.0	C	21.7	
			NBR					
			SBL					
			SBT	0.20	34.3	C	24.9	
			SBR					
			Intersection	0.63	17.0	B		
4	Eglinton Avenue East	Brimley Road	EBL	0.76	64.5	E	#51.0	56.0
			EBT	0.26	8.2	A	27.6	
			EBR	0.02	5.9	A	2.5	
			WBL	0.07	14.0	B	7.6	43.4
			WBT	0.90	32.8	C	#202.1	
			WBR	0.23	15.8	B	28.5	
			NBL	0.77	72.7	E	#48.4	95.5
			NBT	0.61	36.9	D	78.8	
			NBR					
			SBL	0.45	42.5	D	24.8	82.0
			SBT	0.59	36.3	D	76.2	
			SBR	0.36	33.5	C	41	35.8
			Intersection	0.85	31.8	C		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
5	Eglinton Avenue East	Danforth Road	EBL	0.88	67.2	E	#55.2	79.0
			EBT	0.31	19.9	B	47.5	
			EBR	0.02	16.7	B	5	
			WBL	0.41	19.5	B	m38.9	51.1
			WBT	0.97	45.4	D	#249.8	
			WBR	0.12	28.6	C	m14.2	
			NBL	0.11	28.2	C	7.4	15.8
			NBT	0.69	36.6	D	106.3	
			NBR					
			SBL	0.80	79.2	E	#50.1	66.5
			SBT	0.66	36.1	D	99.9	
			SBR					
			Intersection	0.90	38.7	D		
6	Eglinton Avenue East	McCowan Road	EBL	0.66	47.3	D	m#23.1	36.1
			EBT	0.23	15.7	B	m41.8	
			EBR	0.07	35.3	D	m10.4	
			WBL	0.26	7.3	A	m10.0	45.4
			WBT	0.80	10.8	B	54.5	
			WBR	0.04	3.5	A	m0.6	
			NBL	0.73	52.3	D	#74.5	78.0
			NBT	0.09	28.2	C	11.1	
			NBR					
			SBL					
			SBT	0.46	34.0	C	51.5	
			SBR					
			Intersection	0.78	18.7	B		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
7	Eglinton Avenue East	Torrance Road	EBL	0.21	5.6	A	m4.1	40.0
			EBT	0.23	4.8	A	22.8	
			EBR	0.02	5.5	A	m2.4	
			WBL	0.05	5.6	A	4.7	35.0
			WBT	0.73	12.3	B	147.5	
			WBR	0.01	5.4	A	1.5	
			NBL	0.10	37.1	D	11.4	60.0
			NBT	0.03	35.6	D	8	
			NBR					
			SBL					
			SBT	0.34	41.0	D	39.4	
			SBR					
			Intersection	0.63	12.5	B		
8	Eglinton Avenue East	Bellamy Road North	EBL	0.56	24.0	C	27.2	85.1
			EBT	0.20	10.0	B	26.6	
			EBR	0.02	8.9	A	3.2	
			WBL	0.07	15.4	B	9.3	31.3
			WBT	0.90	33.0	C	#191.4	
			WBR	0.03	15.1	B	6.2	
			NBL	0.13	27.6	C	14	5.5
			NBT	0.12	27.0	C	19.4	
			NBR					
			SBL	0.25	29.5	C	27.3	70.0
			SBT	0.21	27.9	C	21.9	
			SBR					
			Intersection	0.63	27.4	C		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
9	Eglinton Avenue East	Mason Road / Conn Smyth Drive	EBL	0.01	9.7	A	0.8	37.5
			EBT	0.28	11.4	B	34.7	
			EBR	0.03	9.8	A	4.6	
			WBL	0.31	16.3	B	m16.2	42.3
			WBT	0.72	23.1	C	67	
			WBR	0.00	15.1	B	m0.2	60.5
			NBL	0.23	22.3	C	27.7	
			NBT	0.06	20.0	B	9.4	
			NBR					
			SBL					
			SBT	0.02	19.6	B	5.3	
			SBR					
			Intersection	0.52	19.6	B		
10	Eglinton Avenue East	Beachell Street	EBL	0.19	6.2	A	3.4	29.2
			EBT	0.28	5.7	A	20.1	
			EBR	0.00	5.0	A	m0.3	
			WBL	0.02	9.7	A	m1.1	19.2
			WBT	0.67	13.2	B	102.8	
			WBR	0.01	12.2	B	m0.8	
			NBL					
			NBT	0.03	25.1	C	6.3	
			NBR					
			SBL					
			SBT	0.00	24.8	C	2.6	
			SBR					
			Intersection	0.48	11.1	B		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
11	Eglinton Avenue East	Markham Road	EBL	1.50	312.2	F	#54.5	43.9
			EBT	0.18	8.6	A	10.4	
			EBR	0.07	3.4	A	2.3	
			WBL	0.09	11.2	B	m4.5	40.7
			WBT	0.75	15.6	B	46.9	
			WBR	0.05	5.5	A	m1.7	
			NBL	0.26	20.1	C	21.2	90.0
			NBT	0.23	18.5	B	28.4	
			NBR	0.02	16.5	B	4.7	
			SBL	0.21	19.2	B	19.7	34.0
			SBT	0.25	18.7	B	31.2	
			SBR	0.37	18.5	B	42.2	92.1
			Intersection	0.97	34.1	C		
12	Eglinton Avenue East	Cedar Drive	EBL	0.59	19.5	B	43.6	39.8
			EBT	0.19	12.5	B	28.4	
			EBR	0.01	13.8	B	3.1	
			WBL	0.01	8.1	A	1.8	50.9
			WBT	0.53	12.1	B	72.4	
			WBR	0.09	8.6	A	6.5	
			NBL					
			NBT	0.22	24.4	C	26.9	
			NBR					
			SBL					
			SBT	0.30	25.8	C	33.2	
			SBR					
			Intersection	0.49	14.4	B		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
13	Eglinton Avenue East	Kingston Road	EBL	0.97	80.9	F	#82.9	
			EBT					
			EBR					
			WBL					
			WBT					
			WBR					
			NBL					
			NBT	0.20	3.4	A	16.6	
			NBR					
			SBL					
			SBT	0.66	2.9	A	m36.5	
			SBR	0.77	19.2	B	m0.0	
			Intersection	0.81	14.1	B		
14	Kingston Road	Scarborough Golf Club Road	EBL	0.82	56.9	E	m#26.2	55.1
			EBT	0.28	1.8	A	m11.7	
			EBR					
			WBL	0.01	1.3	A	m0.1	
			WBT	0.87	12.3	B	270.7	
			WBR					
			NBL					
			NBT	0.06	47.8	D	21.8	
			NBR					
			SBL					
			SBT	c0.13	81.7	F	#65.4	
			SBR					
			Intersection	0.88	16.0	B		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
15	Kingston Road	Cromwell Road / Guildwood Parkway	EBL	0.03	5.7	A	m0.4	32.2
			EBT	0.31	6.1	A	m28.5	
			EBR					
			WBL	0.09	8.7	A	m3.5	51.9
			WBT	0.83	26.0	C	227.8	
			WBR					
			NBL	0.78	49.8	D	#104.3	
			NBT	0.65	42.3	D	77.2	
			NBR					
			SBL	0.87	86.1	F	#52.1	
			SBT					
			SBR	0.10	33.1	C	14.3	
			Intersection	0.84	25.0	C		
16	Kingston Road	Celeste Drive / Guildwood GO Station	EBL	0.13	10.6	B	m4.6	46.5
			EBT	0.29	12.1	B	m76.6	
			EBR					
			WBL	0.03	1.2	A	m0.3	41.0
			WBT	0.72	1.8	A	m26.5	
			WBR					
			NBL	0.25	46.9	D	17.7	20.5
			NBT	0.08	42.6	D	12.6	
			NBR					
			SBL					
			SBT	0.37	48.6	D	29.7	
			SBR					
			Intersection	0.67	6.3	A		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
17	Kingston Road	Galloway Road	EBL	0.97	105.8	F	#52.6	34.8
			EBT	0.48	15.1	B	100.7	
			EBR					
			WBL	0.29	15.0	B	12.6	30.7
			WBT	0.90	24.2	C	198.9	
			WBR					
			NBL					
			NBT	0.95	57.7	E	#112.6	
			NBR					
			SBL					
			SBT	0.34	28.3	C	36.4	
			SBR					
			Intersection	0.97	28.0	C		
18	Kingston Road	Poplar Road	EBL					
			EBT	0.28	A	2.7	20	
			EBR					
			WBL	0.09	A		m0.7	35.2
			WBT	0.58	A	0.9	m15.0	
			WBR					
			NBL					
			NBT	0.41	E	62.9	23.7	
			NBR					
			SBL					
			SBT					
			SBR					
			Intersection	0.56	3.8	A		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
19	Lawrence Avenue East	Kingston Road	EBL	0.75	48.5	D	#44.4	
			EBT	0.26	36.5	D	39.7	
			EBR	0.08	34.4	C	15.7	
			WBL	0.76	39.4	D	94.2	
			WBT	0.76	44.2	D	138.3	
			WBR					
			NBL					
			NBT	0.38	18.6	B	200.7	
			NBR					
			SBL					
			SBT	0.99	50.7	D	360.2	
			SBR					
			Intersection	0.88	42.0	D		
20	Kingston Road	Morningside Avenue	EBL	0.97	87.8	F	#69.4	31.3
			EBT	0.25	9.3	A	28.6	
			EBR					
			WBL	0.29	17.2	B	22.6	42.5
			WBT	0.92	31.0	C	186.9	
			WBR					
			NBL	0.23	29.8	C	13.4	34.2
			NBT	0.83	41.8	D	107.1	
			NBR					
			SBL	0.66	72.9	E	#28.8	74.5
			SBT	0.61	36.3	D	68.1	
			SBR					
			Intersection	0.91	32.5	C		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
21	Tefft Road	Morningside Avenue	EBL					
			EBT					
			EBR					
			WBL	0.30	27.6	C	20.4	
			WBT					
			WBR					
			NBL					
			NBT	0.39	3.7	A	32.7	
			NBR					
			SBL					
			SBT	0.43	9.0	A	80.8	
			SBR					
			Intersection	0.41	7.7	A		
22	West Hill Cl	Morningside Avenue	EBL	0.34	19.5	B	32.7	38.0
			EBT					
			EBR	0.10	17.8	B	10.5	38.0
			WBL					
			WBT					
			WBR					
			NBL	0.45	13.1	B	19.3	46.0
			NBT	0.46	6.0	A	15	
			NBR					
			SBL					
			SBT	0.63	11.2	B	62.8	
			SBR					
			Intersection	0.53	10.1	B		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
23	Ellesmere Road	Morningside Avenue	EBL	0.96	83.6	F	#67.8	128.8
			EBT	0.29	17.6	B	26.3	
			EBR					
			WBL	0.37	18.8	B	34.7	68.1
			WBT	0.82	27.2	C	121.4	
			WBR	0.10	12.8	B	8.3	30.6
			NBL	0.61	23.2	C	#27.1	71.0
			NBT	0.67	25.5	C	88.7	
			NBR	0.08	17.7	B	10.6	31.7
			SBL	0.29	14.3	B	m0.0	41.8
			SBT	0.81	30.3	C	m121.6	
			SBR	0.26	18.2	B	m26.9	
			Intersection	0.87	27.8	C		
24	Military Trail	Morningside Avenue	EBL	0.94	101.0	F	#48.5	72.3
			EBT	0.85	56.3	E	#82.9	
			EBR					
			WBL	0.35	35.8	D	m10.9	82.2
			WBT	0.73	41.4	D	#70.4	
			WBR	0.66	22.0	C	#35.4	74.5
			NBL	0.35	4.8	A	m2.8	184.0
			NBT	0.43	3.2	A	m11.6	
			NBR	0.05	0.6	A	m0.2	
			SBL	1.08	86.2	F	m#61.1	182.5
			SBT	0.47	1.9	A	m11.5	
			SBR	0.06	0.5	A	m0.3	
			Intersection	1.04	23.2	C		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

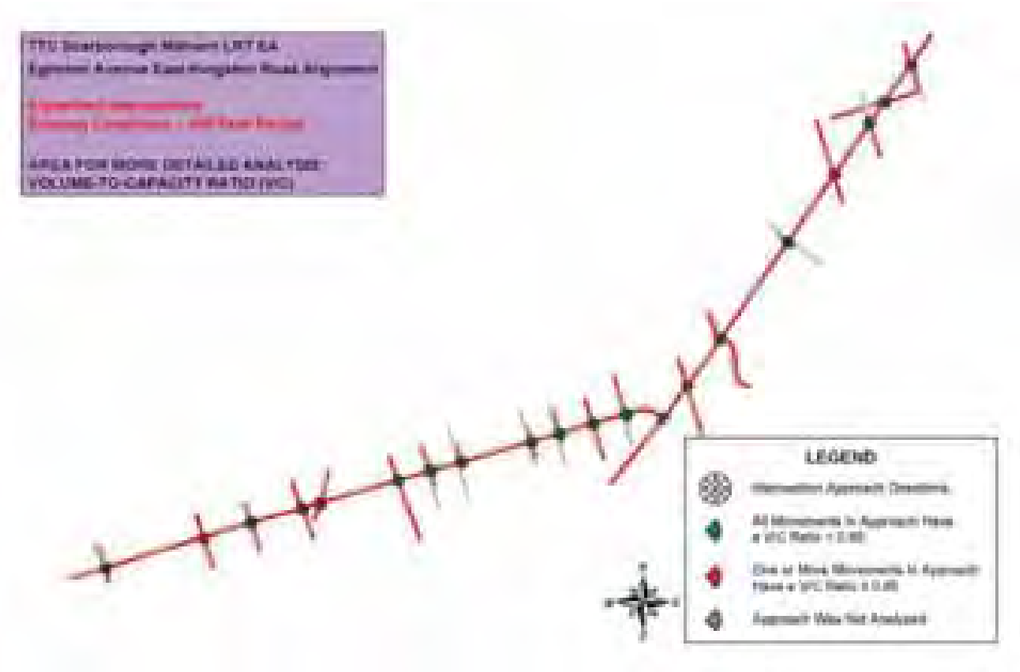
INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
25	401 EB Ramp	Morningside Avenue	EBL	0.37	21.1	C	40.5	
			EBT					
			EBR	0.99	59.7	E	#183.3	
			WBL					
			WBT					
			WBR					
			NBL					
			NBT	0.37	14.4	B	m54.7	
			NBR					
			SBL					
			SBT	0.36	23.0	C	63.5	
			SBR					
			Intersection	0.62	28.4	C		
26	401 WB Ramp / Cinemart Drive	Morningside Avenue	EBL					
			EBT					
			EBR	0.21	37.9	D	13.7	
			WBL	0.44	23.4	C	58.3	85.0
			WBT	0.94dr	35.9	D	#116.4	
			WBR	0.93	54.5	D	#141.7	85.0
			NBL	0.94	104.2	F	#67.1	83.0
			NBT	0.56	9.4	A	44.2	
			NBR					
			SBL					
			SBT	0.40	12.6	B	21.5	
			SBR					
			Intersection	0.73	25.0	C		

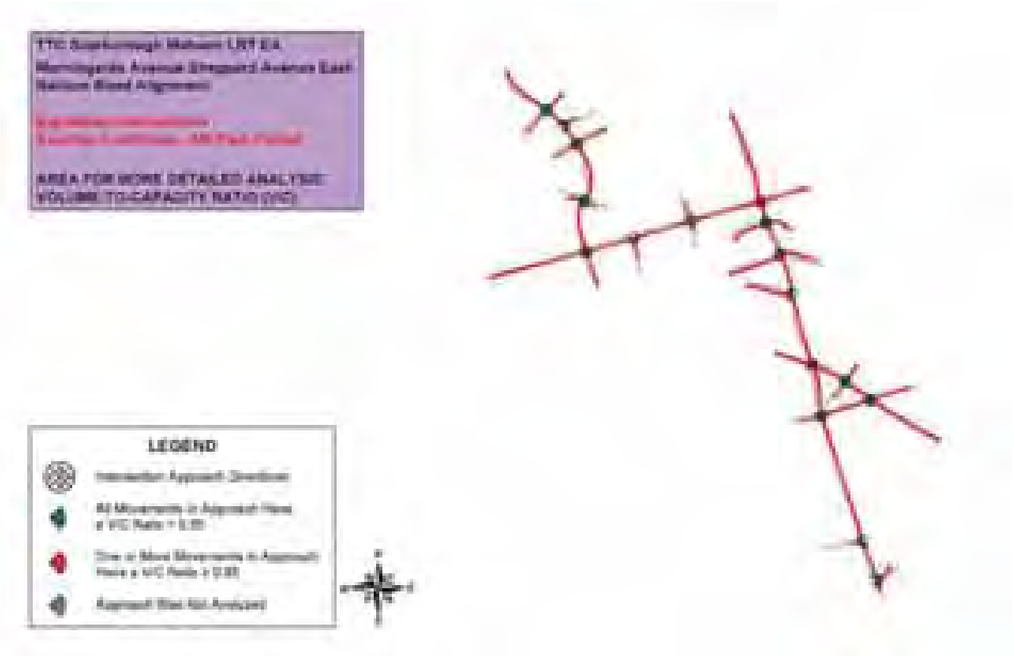
TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
27	Milner Avenue	Morningside Avenue	EBL	0.31	30.5	C	13.3	112.0
			EBT	0.12	27.9	C	10.3	
			EBR					
			WBL	0.56	33.9	C	36.5	90.0
			WBT	0.57	32.2	C	44.1	
			WBR					
			NBL	0.98	51.8	D	m#173.7	140.0
			NBT	0.67	15.4	B	m132.8	
			NBR	0.15	23.7	C	m18.2	
			SBL	0.38	35.1	D	#16.9	38.4
			SBT	0.54	26.5	C	51.6	
			SBR					
			Intersection	0.86	27.1	C		
28	Ellesmere Road	Military Trail	EBL					
			EBT	0.14	10.6	B	16.8	
			EBR					
			WBL					
			WBT	0.38	15.2	B	43	
			WBR					
			NBL	0.10	14.5	B	9.5	85.3
			NBT	0.19	15.0	B	22.7	
			NBR					
			SBL	0.35	19.6	B	33.7	80.2
			SBT	0.31	18.4	B	41.1	
			SBR					
			Intersection	0.37	15.4	B		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
AM Peak Period

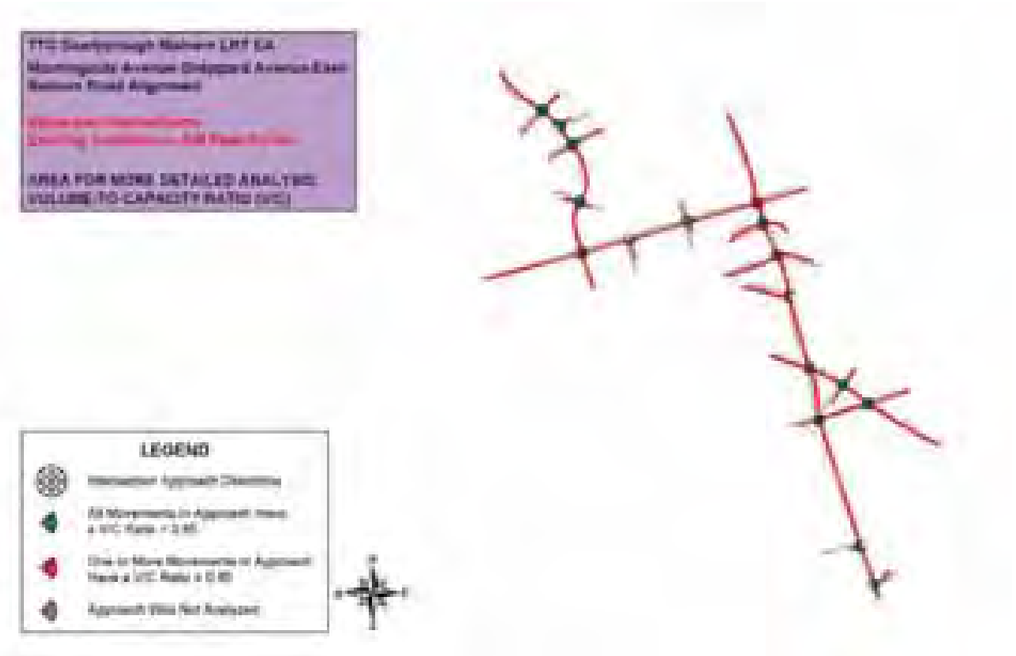
INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
29	Military Trail	U of T Access (East of Morningside)	EBL					
			EBT	0.30	2.3	A	m5.3	
			EBR					
			WBL	0.08	2.6	A	6.1	63.1
			WBT	0.28	4.0	A	45.7	
			WBR					
			NBL	0.63	46.4	D	33.6	64.6
			NBT					
			NBR	0.01	36.7	D	5.4	
			SBL					
			SBT					
			SBR					
			Intersection	0.34	8.1	A		
30	Sheppard Avenue East	Morningside Avenue	EBL	1.00	119.5	F	#50.3	66.2
			EBT	0.29	20.5	C	32.9	
			EBR	0.11	19.0	B	14.8	54.9
			WBL	0.93	47.1	D	#107.8	57.7
			WBT	0.74	21.3	C	119.1	
			WBR	0.53	18.6	B	69.9	30.0
			NBL	0.77	57.1	E	#47.4	114.4
			NBT	0.85	31.8	C	129.9	
			NBR	0.17	18.3	B	16.6	49.7
			SBL	0.99	109.8	F	#54.8	57.5
			SBT	0.64	24.6	C	86.1	
			SBR	0.33	22.0	C	25.6	37.0
			Intersection	1.00	30.5	C		

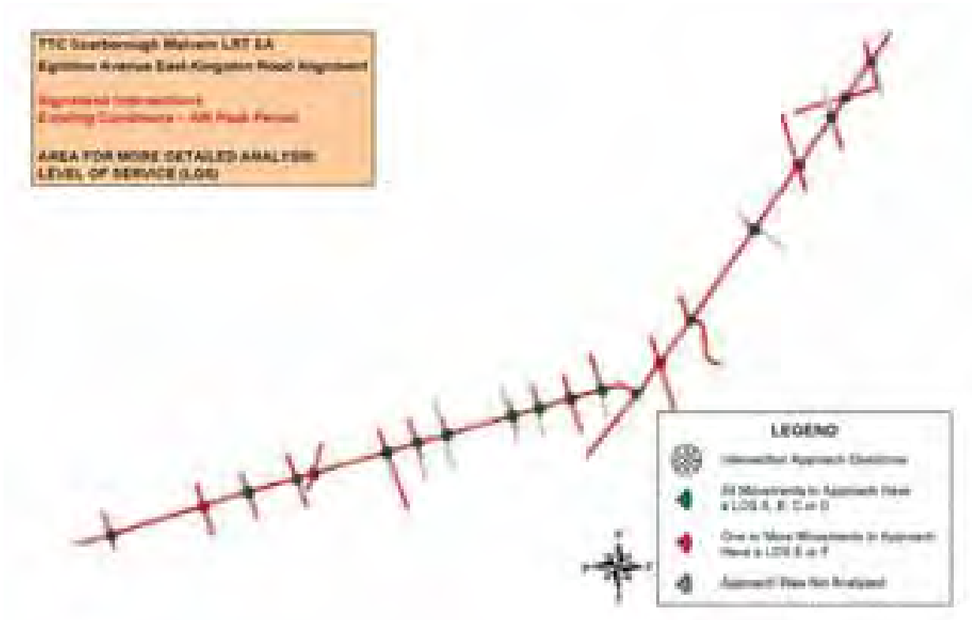


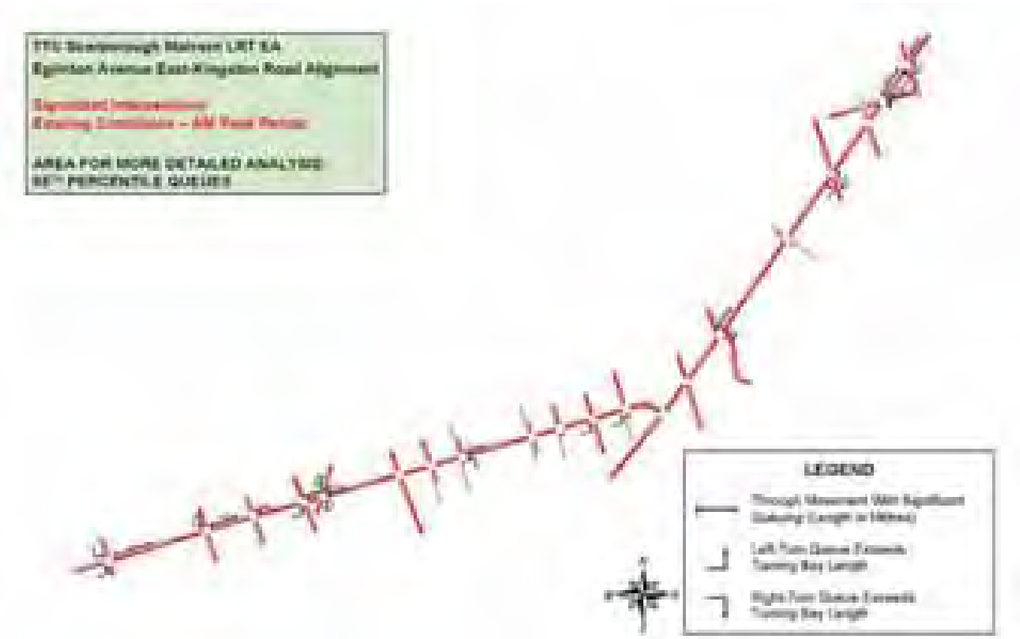


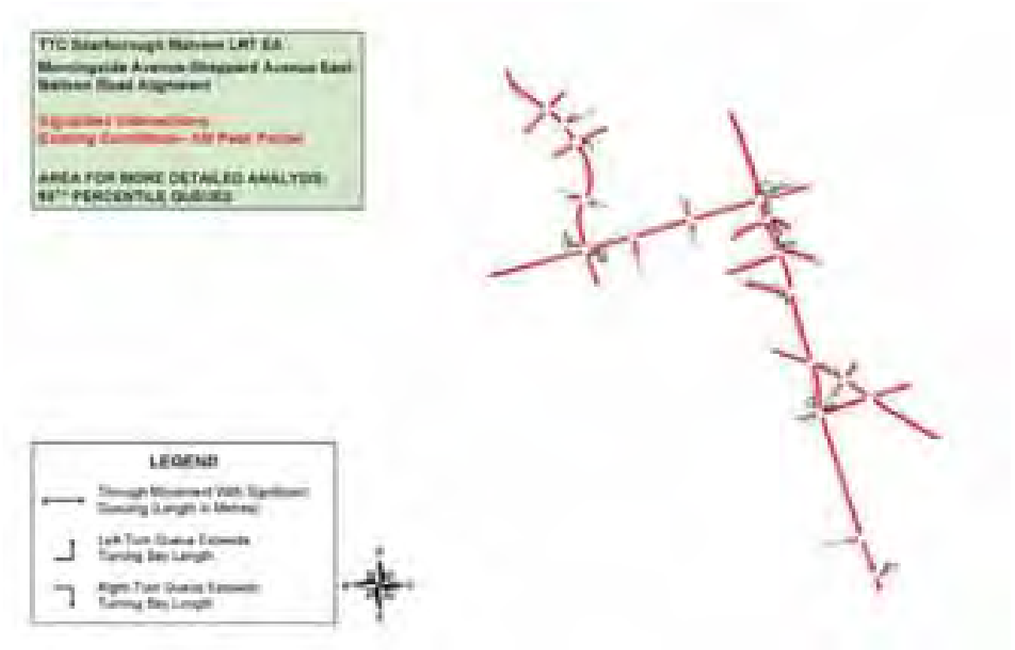
IBI GROUP FINAL

Toronto Transit Commission
SCARBOROUGH - MALVERN LRT EA FINAL TRAFFIC ANALYSIS REPORT




TTC Scarborough Malvern LRT EA
Eglinton Avenue East-Kingston Road Alignment
AREA FOR MORE DETAILED ANALYSIS:
LEVEL OF SERVICE (LOS)
LEGEND


TTC Scarborough Malvern LRT EA
Eglinton Avenue East-Kingston Road Alignment
AREA FOR MORE DETAILED ANALYSIS:
95TH PERCENTILE QUEUES
LEGEND
Through Movement With Significant Queuing (Length in Metres)
Left Turn Queue Exceeds Turning Bay Length
Right Turn Queue Exceeds Turning Bay Length



TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
1	Eglinton Avenue East	Kennedy Road	EBL	1.12	124.7	F	#88.8	40.6
			EBT	1.34	193.9	F	#333.1	
			EBR	0.15	23.7	C	21.8	51.6
			WBL	1.10	149.4	F	m#83.6	109.0
			WBT	0.76	39.0	D	140.4	
			WBR	0.28	42.0	D	m34.8	45.3
			NBL	0.42	24.4	C	32.5	61.0
			NBT	0.58	34.6	C	89.4	
			NBR	0.16	28.4	C	15	59.4
			SBL	1.04	102.5	F	#96.2	46.3
			SBT	0.43	31.5	C	64.9	
			SBR	0.18	28.4	C	19.1	33.5
			Intersection	1.14	97.4	F		
2	Eglinton Avenue East	Midland Avenue	EBL	0.92	37.7	D	m62.2	72.5
			EBT	0.96	40.1	D	m183.8	
			EBR	0.18	38.5	D	m17.4	
			WBL	0.60	40.5	D	m#24.4	56.0
			WBT	0.48	24.4	C	43.8	
			WBR	0.07	31.5	C	7.2	
			NBL	0.69	39.3	D	#41.2	88.7
			NBT	0.40	27.1	C	62.2	
			NBR					
			SBL	0.46	38.7	D	40	63.4
			SBT	0.65	38.4	D	89.6	
			SBR					
			Intersection	0.84	35.6	D		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
3	Eglinton Avenue East	Falmouth Avenue / Gilder Drive	EBL	0.04	8.0	A	m2.0	38.6
			EBT	0.76	11.8	B	m102.7	
			EBR	0.03	12.7	B	m1.4	
			WBL	0.86	74.2	E	#45.3	35.5
			WBT	0.29	8.0	A	49.7	
			WBR	0.03	15.8	B	m4.7	
			NBL					
			NBT	0.09	36.5	D	14.9	
			NBR					
			SBL					
			SBT	0.47	44.1	D	54.6	
			SBR					
			Intersection	0.76	17.8	B		
4	Eglinton Avenue East	Brimley Road	EBL	0.80	49.8	D	m#53.5	56.0
			EBT	0.93	47.5	D	#237.4	
			EBR	0.09	37.5	D	m10.5	
			WBL	0.44	29.2	C	m7.4	43.4
			WBT	0.40	24.1	C	41	
			WBR	0.12	35.8	D	6.9	
			NBL	0.51	35.9	D	44.4	95.5
			NBT	0.54	31.0	C	82.4	
			NBR					
			SBL	0.63	32.5	C	#36.9	82.0
			SBT	0.32	22.1	C	50.9	
			SBR	0.12	20.0	C	11.3	35.8
			Intersection	0.78	36.4	D		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
5	Eglinton Avenue East	Danforth Road	EBL	0.64	19.0	B	m19.3	79.0
			EBT	0.98	21.5	C	m#223.7	
			EBR	0.02	3.9	A	m0.0	
			WBL	0.97	93.4	F	#57.5	51.1
			WBT	0.45	18.6	B	64.7	
			WBR	0.08	26.1	C	13	
			NBL					15.8
			NBT	0.72	35.0	C	116.3	
			NBR					
			SBL	0.96	112.9	F	#60.0	66.5
			SBT	0.56	30.8	C	85.1	
			SBR					
			Intersection	0.94	29.6	C		
6	Eglinton Avenue East	McCowan Road	EBL	0.39	32.2	C	m34.5	36.1
			EBT	0.81	44.1	D	m192.5	
			EBR	0.14	68.9	E	m21.8	
			WBL	0.78	65.0	E	#38.6	45.4
			WBT	0.31	8.7	A	30.5	
			WBR	0.03	5.3	A	2.2	
			NBL	0.44	36.0	D	45.7	78.0
			NBT	0.13	28.7	C	15.1	
			NBR					
			SBL					
			SBT	0.23	30.2	C	25	
			SBR					
			Intersection	0.68	35.7	D		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
7	Eglinton Avenue East	Torrance Road	0.24	9.7	A	m12.7	40.0	0.24
			0.72	10.5	B	81.4		0.72
			0.04	13.6	B	m1.7		0.04
			0.44	48.1	D	27.3	35.0	0.44
			0.25	5.2	A	26		0.25
			0.04	3.8	A	1.4		0.04
			0.30	41.8	D	27.9	60.0	0.30
			0.19	38.8	D	25.5		0.19
			0.34	42.1	D	35.9		0.34
			0.60	14.2	B			0.60
8	Eglinton Avenue East	Bellamy Road North	0.81	32.0	C	#54.1	85.1	0.81
			0.56	15.1	B	66.4		0.56
			0.02	16.2	B	m1.5		0.02
			0.05	14.5	B	3.6	31.3	0.05
			0.38	17.6	B	61.2		0.38
			0.04	14.3	B	6.5		0.04
			0.12	31.3	C	13.5	5.5	0.12
			0.09	30.7	C	16.8		0.09
			0.21	33.0	C	23.4	70.0	0.21
			0.09	30.5	C	9.1		0.09
			0.61	20.0	C			0.61

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
9	Eglinton Avenue East	Mason Road / Conn Smyth Drive	0.22	10.2	B	16	37.5	0.22
			0.57	13.2	B	80.5		0.57
			0.14	9.5	A	8.3		0.14
			0.52	20.7	C	33.9	42.3	0.52
			0.30	16.0	B	32.9		0.30
			0.00	16.5	B	m0.7	60.5	0.00
			0.20	23.2	C	24.3		0.20
			0.39	26.2	C	45.6		0.39
			0.08	21.7	C	12.3		0.08
			0.50	15.5	B			0.50
10	Eglinton Avenue East	Beachell Street	0.10	5.3	A	m4.3	29.2	0.10
			0.56	6.7	A	46.7		0.56
			0.00	4.2	A	m0.1		0.00
			0.01	4.4	A	m0.4	19.2	0.01
			0.28	6.2	A	28.9		0.28
			0.02	2.9	A	1.1		0.02
			0.00	24.8	C	0		0.00
			0.02	25.1	C	6.2		0.02
			0.40	6.7	A			0.40

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
11	Eglinton Avenue East	Markham Road	EBL	0.61	14.7	B	36.3	43.9
			EBT	0.45	11.1	B	39.9	
			EBR	0.07	16.1	B	m6.9	
			WBL	0.15	12.1	B	6.7	40.7
			WBT	0.22	12.2	B	17.8	
			WBR	0.09	6.0	A	2.6	
			NBL	0.32	24.3	C	28.4	90.0
			NBT	0.24	21.7	C	29.4	
			NBR	0.08	20.3	C	11.1	
			SBL	0.32	24.5	C	28.2	34.0
			SBT	0.24	21.7	C	28.6	
			SBR	0.18	16.6	B	17	92.1
			Intersection	0.49	15.4	B		
12	Eglinton Avenue East	Cedar Drive	EBL	0.29	10.3	B	18.8	39.8
			EBT	0.54	12.4	B	54.7	
			EBR	0.03	11.7	B	m4.1	
			WBL	0.07	8.4	A	4	50.9
			WBT	0.23	9.2	A	24.8	
			WBR	0.03	8.1	A	3.9	
			NBL					
			NBT	0.19	24.4	C	22	
			NBR					
			SBL					
			SBT	0.12	23.5	C	15.9	
			SBR					
			Intersection	0.42	12.5	B		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
13	Eglinton Avenue East	Kingston Road	EBL	0.95	52.2	D	#132.7	
			EBT					
			EBR					
			WBL					
			WBT					
			WBR					
			NBL					
			NBT	0.82	16.7	B	144.3	
			NBR					
			SBL					
			SBT	0.33	9.4	A	38	
			SBR	0.35	9.7	A	11.1	
			Intersection	0.86	21.3	C		
14	Kingston Road	Scarborough Golf Club Road	EBL	0.59	7.9	A	10	55.1
			EBT	0.87	10.2	B	155.1	
			EBR					
			WBL	0.41	8.1	A	m13.2	
			WBT	0.46	3.9	A	37.1	
			WBR					
			NBL					
			NBT	0.30	39.9	D	19.4	
			NBR					
			SBL					
			SBT	0.23	38.7	D	16.3	
			SBR					
			Intersection	0.78	9.9	A		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
15	Kingston Road	Cromwell Road / Guildwood Parkway	EBL	0.11	5.0	A	m2.2	32.2
			EBT	0.87	9.9	A	121.6	
			EBR					
			WBL	0.31	18.3	B	m9.3	51.9
			WBT	0.34	4.9	A	39.5	
			WBR					
			NBL	0.56	40.4	D	50.8	
			NBT	0.52	39.3	D	46.4	
			NBR					
			SBL	0.14	35.3	D	10.8	
			SBT					
			SBR	0.01	34.2	C	5.4	
			Intersection	0.81	10.6	B		
16	Kingston Road	Celeste Drive / Guildwood GO Station	EBL	0.20	1.6	A	m1.5	46.5
			EBT	0.72	4.3	A	73.1	
			EBR					
			WBL	0.36	9.3	A	m11.0	41.0
			WBT	0.33	5.3	A	49.2	
			WBR					
			NBL	0.49	46.2	D	34.8	20.5
			NBT	0.57	48.5	D	43.5	
			NBR					
			SBL					
			SBT	0.28	40.9	D	21	
			SBR					
			Intersection	0.69	7.6	A		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
17	Kingston Road	Galloway Road	EBL	0.28	2.6	A	m2.5	34.8
			EBT	0.73	3.3	A	25	
			EBR					
			WBL	0.64	25.3	C	#12.3	30.7
			WBT	0.31	4.8	A	29.1	
			WBR					
			NBL					
			NBT	0.69	46.0	D	46.4	
			NBR					
			SBL					
			SBT	0.30	36.1	D	24.1	
			SBR					
			Intersection	0.73	8.4	A		
18	Kingston Road	Poplar Road	EBL					
			EBT	0.64	4.8	A	83.4	
			EBR					
			WBL	0.85	66.0	E	m#39.2	35.2
			WBT	0.27	1.0	A	9.5	
			WBR					
			NBL					
			NBT	0.50	64.5	E	30.2	
			NBR					
			SBL					
			SBT					
			SBR					
			Intersection	0.80	6.9	A		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
19	Lawrence Avenue East	Kingston Road	EBL	0.85	47.1	D	#112.6	
			EBT	0.58	38.5	D	104.4	
			EBR	0.12	30.8	C	20.1	
			WBL	0.81	52.9	D	#65.4	
			WBT	0.37	38.2	D	57.4	
			WBR					
			NBL					
			NBT	1.00	47.3	D	#195.7	
			NBR					
			SBL					
			SBT	0.51	24.8	C	88	
			SBR					
			Intersection	0.92	40.3	D		
20	Kingston Road	Morningside Avenue	EBL	0.61	14.4	B	27.9	31.3
			EBT	0.99	40.1	D	#213.1	
			EBR					
			WBL	0.38	21.7	C	10	42.5
			WBT	0.42	17.0	B	53.5	
			WBR					
			NBL	0.39	41.5	D	13	34.2
			NBT	0.60	30.8	C	72.3	
			NBR					
			SBL	0.48	39.4	D	24	74.5
			SBT	0.86	41.3	D	#105.1	
			SBR					
			Intersection	0.89	33.8	C		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
21	Tefft Road	Morningside Avenue	EBL					
			EBT					
			EBR					
			WBL	0.15	28.7	C	11.3	
			WBT					
			WBR					
			NBL					
			NBT	0.35	2.8	A	25.8	
			NBR					
			SBL					
			SBT	0.49	6.6	A	79.4	
			SBR					
			Intersection	0.45	5.6	A		
22	West Hill Cl	Morningside Avenue	EBL	0.07	27.0	C	5.5	38.0
			EBT					
			EBR	0.01	26.6	C	3.5	38.0
			WBL					
			WBT					
			WBR					
			NBL	0.24	3.7	A	7	46.0
			NBT	0.32	2.4	A	26.6	
			NBR					
			SBL					
			SBT	0.48	3.9	A	67.2	
			SBR					
			Intersection	0.42	3.6	A		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
23	Ellesmere Road	Morningside Avenue	EBL	0.49	17.8	B	46.5	128.8
			EBT	0.73	19.8	B	117.1	
			EBR					
			WBL	0.96	96.9	F	#53.9	68.1
			WBT	0.22	11.4	B	22.2	
			WBR	0.14	11.4	B	13.9	30.6
			NBL	0.74	36.2	D	#38.3	71.0
			NBT	0.56	23.5	C	69.4	
			NBR	0.33	21.0	C	35.6	31.7
			SBL	0.59	34.8	C	#37.6	41.8
			SBT	0.81	37.1	D	88.2	
			SBR	0.10	25.5	C	12.3	
			Intersection	0.86	25.7	C		
24	Military Trail	Morningside Avenue	EBL	0.42	33.7	C	30.9	72.3
			EBT	0.52	34.9	C	41	
			EBR					
			WBL	0.04	30.5	C	3.4	82.2
			WBT	0.13	31.0	C	15.8	
			WBR	0.14	24.0	C	16.5	74.5
			NBL	0.28	12.4	B	13.3	184.0
			NBT	0.38	10.7	B	45.2	
			NBR	0.00	8.0	A	1.7	
			SBL	0.76	12.3	B	#39.6	182.5
			SBT	0.51	6.0	A	56.1	
			SBR	0.06	3.6	A	3.4	
			Intersection	0.71	12.0	B		

TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

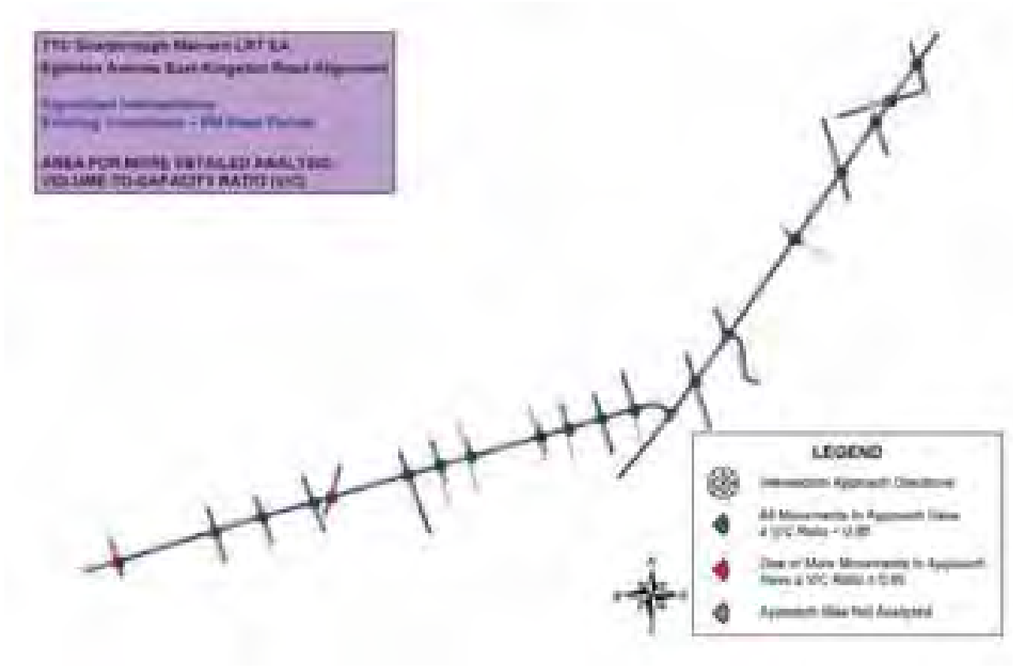
INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
25	401 EB Ramp	Morningside Avenue	EBL	0.60	25.8	C	75.3	
			EBT					
			EBR	0.91	47.6	D	#155.6	
			WBL					
			WBT					
			WBR					
			NBL					
			NBT	0.36	13.3	B	46.5	
			NBR					
			SBL					
			SBT	0.66	17.5	B	98.2	
			SBR					
			Intersection	0.76	22.2	C		
26	401 WB Ramp / Cinemart Drive	Morningside Avenue	EBL					
			EBT					
			EBR	0.74	42.1	D	#68.5	
			WBL	0.15	24.0	C	21.3	85.0
			WBT	0.18	24.1	C	18.8	
			WBR	0.22	24.6	C	25.6	85.0
			NBL	0.62	36.3	D	57.7	83.0
			NBT	0.48	9.7	A	56.7	
			NBR					
			SBL					
			SBT	0.79	28.3	C	102.3	
			SBR					
			Intersection	0.59	21.9	C		

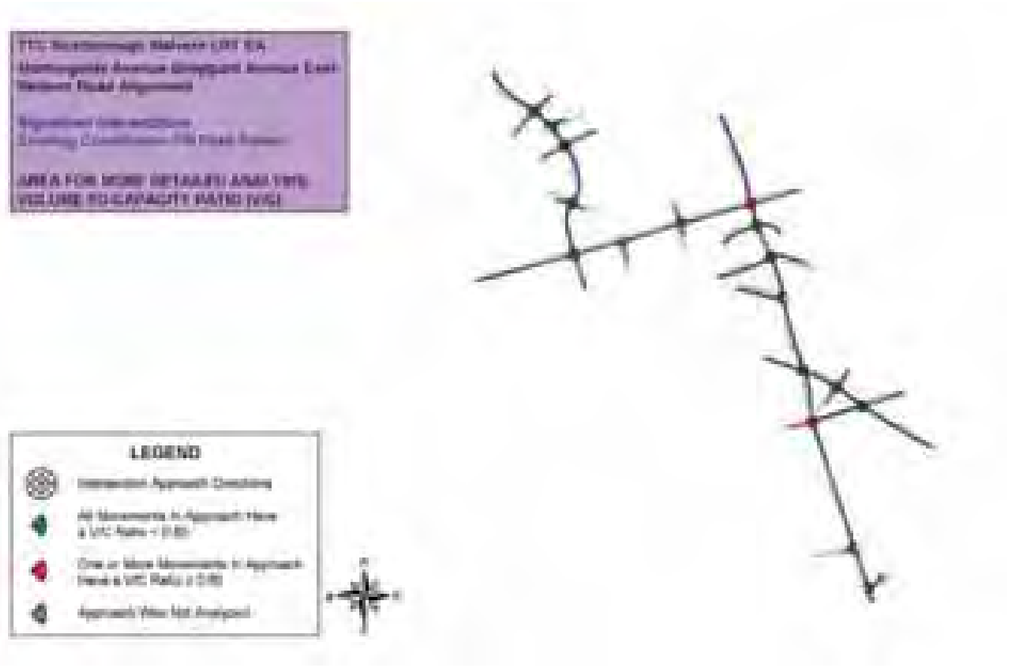
TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

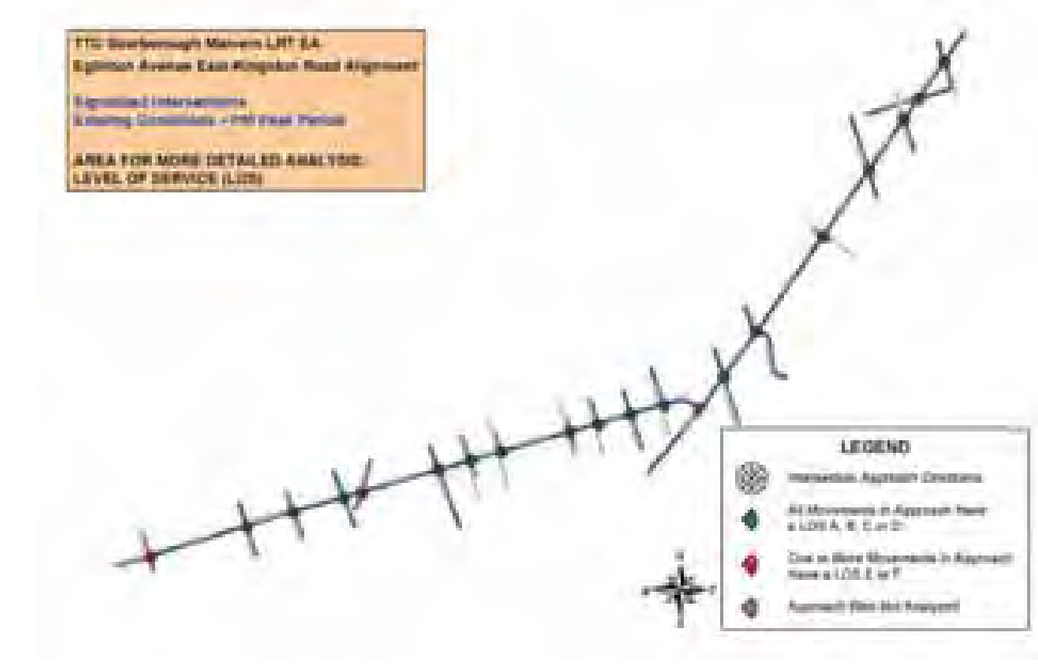
INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
27	Milner Avenue	Morningside Avenue	EBL	0.48	25.8	C	49.5	112.0
			EBT	0.22	22.7	C	19	
			EBR					
			WBL	0.66	23.0	C	45.3	90.0
			WBT	0.07	14.7	B	9.8	
			WBR					
			NBL	0.71	23.7	C	#47.5	140.0
			NBT	0.80	25.8	C	128.3	
			NBR	0.09	14.6	B	9.6	
			SBL	0.35	37.5	D	13.1	38.4
			SBT	0.47	27.5	C	50.3	
			SBR					
			Intersection	0.72	24.7	C		
28	Ellesmere Road	Military Trail	EBL		12.2	B		
			EBT	0.42			34.7	
			EBR					
			WBL		15.0	B		
			WBT	0.15			15.4	
			WBR					
			NBL	0.19	18.9	B	20.2	85.3
			NBT	0.26	19.6	B	40.4	
			NBR					
			SBL	0.28	17.6	B	28.1	80.2
			SBT	0.24	16.7	B	36.1	
			SBR					
			Intersection	0.35	15.0	B		

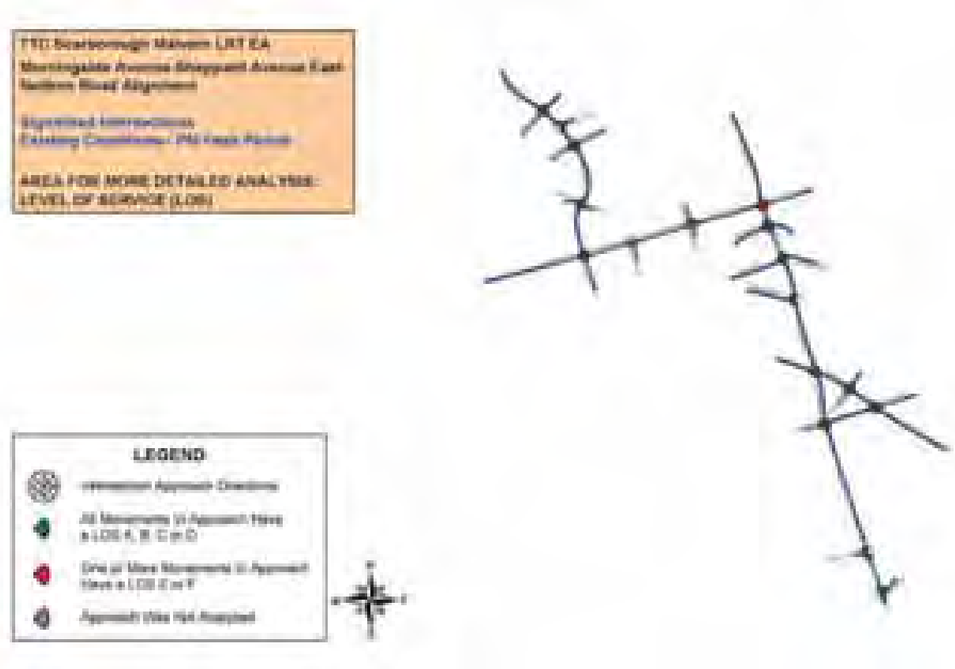
TTC Scarborough Malvern LRT
Signalized Intersections - Existing Condition
PM Peak Period

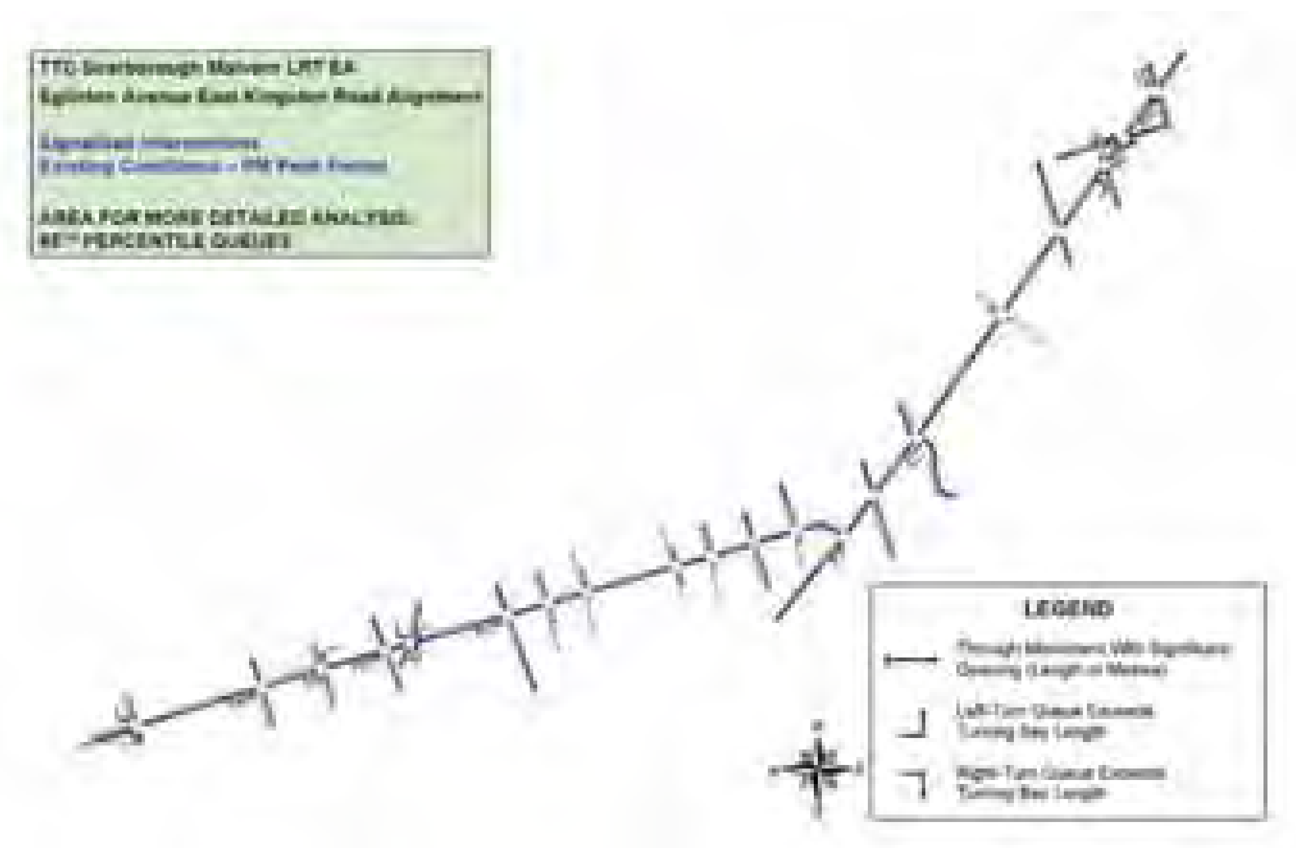
INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
29	Military Trail	U of T Access (East of Morningside)	EBL					
			EBT	0.40	3.1	A	25.7	
			EBR					
			WBL	0.11	3.1	A	10.5	63.1
			WBT	0.24	4.0	A	42.1	
			WBR					
			NBL	0.54	44.6	D	30	64.6
			NBT					
			NBR	0.01	39.2	D	6.8	
			SBL					
			SBT					
			SBR					
			Intersection	0.42	7.5	A		
30	Sheppard Avenue East	Morningside Avenue	EBL	0.43	26.1	C	41	66.2
			EBT	0.98	51.6	D	#178.0	
			EBR	0.13	20.1	C	17.8	54.9
			WBL	0.99	85.5	F	#61.7	57.7
			WBT	0.19	14.6	B	20.3	
			WBR					30.0
			NBL	0.99	107.9	F	#62.8	114.4
			NBT	0.89	44.6	D	#126.7	
			NBR	0.23	27.1	C	23.4	49.7
			SBL	0.87	52.8	D	#59.8	57.5
			SBT	0.72	26.7	C	106.5	
			SBR	0.07	16.9	B	9.8	37.0
			Intersection	0.96	41.9	D		

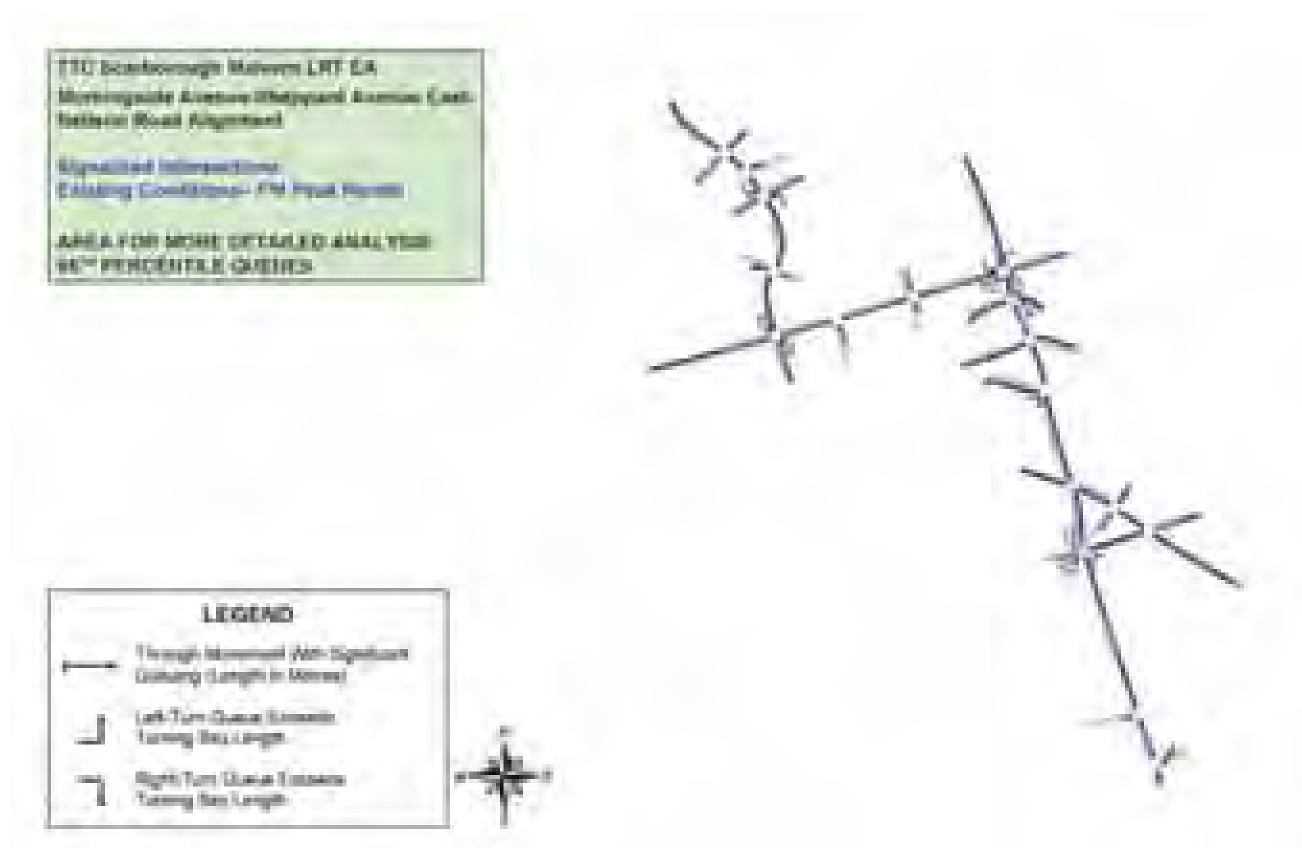

LEGEND


LEGEND


TTC Scarborough Malvern LRT EA
Eglinton Avenue East-Kingston Road Alignment
Signalized Intersections
Existing Conditions - PM Peak Period
AREA FOR MORE DETAILED ANALYSIS:
LEVEL OF SERVICE (LOS)
LEGEND
Intersection Approach Directions
All Movements in Approach Have a LOS A, B, C or D
One or More Movements in Approach Have a LOS E or F
Approach Was Not Analyzed


TTC Scarborough Malvern LRT EA
Morningside Avenue-Sheppard Avenue East-Neilson Road Alignment
Signalized Intersections
Existing Conditions - PM Peak Period
AREA FOR MORE DETAILED ANALYSIS:
LEVEL OF SERVICE (LOS)
LEGEND
Intersection Approach Directions
All Movements in Approach Have a LOS A, B, C or D
One or More Movements in Approach Have a LOS E or F
Approach Was Not Analyzed


TTC Scarborough Malvern LRT EA
Eglinton Avenue East-Kingston Road Alignment
Signalized Intersections
Existing Conditions – PM Peak Period
AREA FOR MORE DETAILED ANALYSIS:
95TH PERCENTILE QUEUES
LEGEND


TTC Scarborough Malvern LRT EA
Signalized Intersections
AREA FOR MORE DETAILED ANALYSIS:
95TH PERCENTILE QUEUES
LEGEND

ATTACHMENT II

FUTURE CONDITION TRAFFIC ANALYSIS SUMMARIES

July 2009

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
1	Eglinton Avenue East	Kennedy Road	EBL	1.11	173.5	F	#71.3	40.6
			EBT	0.51	26.8	C	78.3	
			EBR					51.6
			WBL	1.62	347.1	F	m#69.0	109.0
			WBT	1.72	363.7	F	m#446.7	
			WBR					45.3
			NBL	0.49	26.7	C	30.8	61.0
			NBT	0.40	32.6	C	58.4	
			NBR	0.06	22.8	C	8.8	59.4
			SBL	0.68	33.9	C	#51.4	46.3
			SBT	0.57	35.6	D	86	
			SBR	0.27	24.9	C	36.7	33.5
			Intersection	1.19	200.4	F		
2	Eglinton Avenue East	Midland Avenue	EBL	0.98	119.3	F	m#61.1	72.5
			EBT	0.43	28.1	C	91.3	
			EBR					
			WBL	0.55	67.8	E	17.8	56.0
			WBT	0.97	46.8	D	#239.7	
			WBR					
			NBL	0.95	94.4	F	#56.7	88.7
			NBT	0.48	31.0	C	71.5	
			NBR					
			SBL	0.22	35.8	D	18.2	63.4
			SBT	1.09dr	96.1	F	#153.4	
			SBR					
			Intersection	1.03	56.4	E		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
3	Eglinton Avenue East	Falmouth Avenue / Gilder Drive	EBL	0.82	103.2	F	#32.5	38.6
			EBT	0.43	11.8	B	62.8	
			EBR					
			WBL	0.88	78.7	E	m17.0	35.5
			WBT	0.95	29.2	C	m158.8	
			WBR					
			NBL					
			NBT	0.18	34.5	C	21.7	
			NBR					
			SBL					
			SBT	0.20	34.8	C	24.9	
			SBR					
			Intersection	0.74	27.3	C		
4	Eglinton Avenue East	Brimley Road	EBL	0.95	102.4	F	m#77.6	56.0
			EBT	0.31	8.2	A	28.8	
			EBR					
			WBL	0.41	56.8	E	14.6	43.4
			WBT	0.99	44.4	D	#260.7	
			WBR					
			NBL	1.04	148.4	F	#54.6	95.5
			NBT	0.74	44.9	D	83.2	
			NBR					
			SBL	0.68	73.5	E	#31.2	82.0
			SBT	0.71	43.8	D	80.4	
			SBR	0.49	29.7	C	65.3	35.8
			Intersection	1.00	4.3	D		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
5	Eglinton Avenue East	Danforth Road	EBL	0.99	125.1	F	#74.4	79.0
			EBT	0.36	21.8	C	53.1	
			EBR					
			WBL	0.95	63.9	E	m#55.6	51.1
			WBT	1.07	82.4	F	m#249.0	
			WBR					
			NBL	0.13	31.3	C	7.9	15.8
			NBT	0.74	40.5	D	111	
			NBR					
			SBL	0.99	131.7	F	#55.1	66.5
			SBT	0.72	39.8	D	**104.2**	
			SBR					
			Intersection	1.01	61.3	E		
6	Eglinton Avenue East	McCowan Road	EBL	0.73	87.4	F	m#22.0	36.1
			EBT	0.41	30.2	C	m82.2	
			EBR					
			WBL	1.50	324.2	F	m#56.7	45.4
			WBT	1.01	32.4	C	#278.2	
			WBR					
			NBL	0.75	54.6	D	#74.5	78.0
			NBT	0.09	28.7	C	11.1	
			NBR					
			SBL					
			SBT	0.38	33.0	C	40	
			SBR					
			Intersection	0.92	44.8	D		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
7	Eglinton Avenue East	Torrance Road	EBL	0.80	92.0	F	#43.6	40.0
			EBT	0.28	5.0	A	20.6	
			EBR					
			WBL	0.88	113.2	F	#47.2	35.0
			WBT	0.85	21.7	C	199	
			WBR					
			NBL	0.11	37.4	D	11.6	60.0
			NBT	0.03	35.9	D	8.1	
			NBR					
			SBL					
			SBT	0.36	41.8	D	41.3	
			SBR					
			Intersection	0.73	24.0	C		
8	Eglinton Avenue East	Bellamy Road North	EBL	1.06	141.5	F	#82.0	85.1
			EBT	0.31	16.2	B	46.4	
			EBR					
			WBL	0.69	66.9	E	33.5	31.3
			WBT	0.95	40.1	D	#222.8	
			WBR					
			NBL	0.13	28.2	C	14	5.5
			NBT	0.12	27.6	C	19.4	
			NBR					
			SBL	0.25	30.2	C	27.3	70.0
			SBT	0.33	30.2	C	39.3	
			SBR					
			Intersection	0.73	40.5	D		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
9	Eglinton Avenue East	Mason Road / Conn Smyth Drive	EBL	0.25	78.1	E	1.8	37.5
			EBT	0.35	15.7	B	46.6	
			EBR					
			WBL	1.21	186.9	F	m#43.4	42.3
			WBT	0.76	13.6	B	#67.4	
			WBR					60.5
			NBL	0.26	24.8	C	28.2	
			NBT	0.06	22.1	C	9.6	
			NBR					
			SBL					
			SBT	0.02	21.7	C	5.4	
			SBR					
			Intersection	0.60	25.3	C		
10	Eglinton Avenue East	Beachell Street	EBL	0.87	103.6	F	#35.0	29.2
			EBT	0.38	9.4	A	29.3	
			EBR					
			WBL	0.67	46.2	D	m14.3	19.2
			WBT	0.84	27.6	C	m116.9	
			WBR					
			NBL					
			NBT	0.03	24.4	C	6.3	
			NBR					
			SBL					
			SBT	0.00	24.1	C	2.6	
			SBR					
			Intersection	0.57	25.0	C		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
11	Eglinton Avenue East	Markham Road	EBL	1.73	421.0	F	#95.7	43.9
			EBT	0.34	22.8	C	33.4	
			EBR					
			WBL	0.60	65.3	E	m10.4	40.7
			WBT	0.93	26.1	C	**m#152.8**	
			WBR					
			NBL	0.27	21.1	C	21.2	90.0
			NBT	0.24	19.3	B	28.4	
			NBR	0.02	15.3	B	3.8	
			SBL	0.22	20.1	C	19.7	34.0
			SBT	0.26	19.5	B	31.2	
			SBR	0.35	16.6	B	38.9	92.1
			Intersection	0.73	47.4	D		
12	Eglinton Avenue East	Cedar Drive	EBL	1.65	370.8	F	#92.3	39.8
			EBT	0.23	9.6	A	19.7	
			EBR					
			WBL	0.66	63.1	E	#24.6	50.9
			WBT	0.73	21.2	C	**110.9**	
			WBR					
			NBL					
			NBT	0.22	24.6	C	26.9	
			NBR					
			SBL					
			SBT	0.36	26.9	C	39.4	
			SBR					
			Intersection	0.66	51.1	D		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
13	Eglinton Avenue East	Kingston Road	EBL	0.97	80.9	F	322.6	
			EBT					
			EBR					
			WBL					
			WBT					
			WBR					
			NBL					
			NBT	0.20	3.4	A	690.1	
			NBR					
			SBL					
			SBT	0.66	1.4	A	320.8	
			SBR	0.77	32.2	C		
			Intersection	0.81	16.3	B		
14	Kingston Road	Scarborough Golf Club Road	EBL	0.75	88.7	F	m20.3	55.1
			EBT	0.41	2.4	A	m28.1	
			EBR					
			WBL	0.67	100.5	F	m0.0	
			WBT	1.36	185.5	F	m#422.3	
			WBR					
			NBL					
			NBT	0.48	51.7	D	21.8	
			NBR					
			SBL					
			SBT	0.87dr	67.3	E	#46.4	
			SBR					
			Intersection	1.26	133.6	F		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
15	Kingston Road	Cromwell Road / Guildwood Parkway	EBL	0.67	276.4	F	m0.9	32.2
			EBT	0.50	7.9	A	49.8	
			EBR					
			WBL	0.52	55.3	E	m5.4	51.9
			WBT	1.27	148.9	F	m#397.1	
			WBR					
			NBL	0.78	49.8	D	#104.3	
			NBT	0.65	42.3	D	77.2	
			NBR					
			SBL	0.87	86.1	F	#52.1	
			SBT					
			SBR	0.02	32.4	C	8.2	
			Intersection	1.17	102.1	F		
16	Kingston Road	Celeste Drive / Guildwood GO Station	EBL	1.50	586.4	F	m3.0	46.5
			EBT	0.41	13.0	B	**m131.8**	
			EBR					
			WBL	1.50	341.0	F	m2.4	41.0
			WBT	1.08	48.1	D	**m262.6**	
			WBR					
			NBL	0.27	48.3	D	17.7	20.5
			NBT	0.08	43.4	D	12.6	
			NBR					
			SBL					
			SBT	0.10	43.7	D	15.5	
			SBR					
			Intersection	0.93	40.9	D		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
17	Kingston Road	Galloway Road	EBL	1.13	182.3	F	#58.4	34.8
			EBT	0.53	17.9	B	91.8	
			EBR					
			WBL	0.62	66.8	E	#23.6	30.7
			WBT	1.36	192.6	F	#401.3	
			WBR					
			NBL					
			NBT	c0.31	59.2	E	#112.6	
			NBR					
			SBL					
			SBT	0.08	27.9	C	25.9	
			SBR					
			Intersection	1.19	123.5	F		
18	Kingston Road	Poplar Road	EBL	2.00	906.9	F	2.8	
			EBT	0.38	5.4	A	42.9	
			EBR					
			WBL	0.68	76.0	E	11.6	35.2
			WBT	0.86	6.2	A	33.8	
			WBR					
			NBL					
			NBT	0.42	63.7	E	12.2	
			NBR					
			SBL					
			SBT					
			SBR					
			Intersection	0.79	11.5	B		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
19	Lawrence Avenue East	Kingston Road	EBL	0.75	48.5	D	#44.4	
			EBT	0.26	36.5	D	39.7	
			EBR	0.08	34.4	C	15.7	
			WBL	0.76	39.4	D	94.2	
			WBT	0.76	44.2	D	138.3	
			WBR					
			NBL					
			NBT	0.56	19.6	B	63.8	
			NBR					
			SBL					
			SBT	1.43	233.0	F	#532.7	
			SBR					
			Intersection	1.12	131.0	F		
20	Kingston Road	Morningside Avenue	EBL	0.99	110.7	F	#84.9	31.3
			EBT	0.53	25.2	C	80.7	
			EBR					
			WBL	0.71	66.3	E	35.9	42.5
			WBT	1.76	377.0	F	#436.7	
			WBR					
			NBL	0.58	67.3	E	16	34.2
			NBT	0.78	38.2	D	#110.5	
			NBR					
			SBL	0.71	81.6	F	#25.2	74.5
			SBT	0.58	33.3	C	68.5	
			SBR					
			Intersection	1.29	202.5	F		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
21	Tefft Road	Morningside Avenue	EBL					
			EBT					
			EBR					
			WBL	0.30	27.6	C	20.4	
			WBT					
			WBR					
			NBL					
			NBT	0.47	8.1	A	54.5	
			NBR					
			SBL	0.56	37.1	D	#20.7	
			SBT	0.39	3.7	A	31.4	
			SBR					
			Intersection	0.45	8.3	A		
22	West Hill Cl	Morningside Avenue	EBL	0.39	24.8	C	38.9	38.0
			EBT					
			EBR	0.15	22.9	C	14.7	38.0
			WBL					
			WBT					
			WBR					
			NBL	0.85	68.2	E	#49.4	46.0
			NBT	0.42	7.8	A	43.2	
			NBR					
			SBL					
			SBT	0.76	19.7	B	94	
			SBR					
			Intersection	0.45	8.3	A		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
23	Ellesmere Road	Morningside Avenue	EBL	0.97	85.6	F	#68.0	128.8
			EBT	0.24	17.7	B	24.8	
			EBR					
			WBL	0.36	17.9	B	m29.4	68.1
			WBT	0.84	26.7	C	m105.8	
			WBR	0.11	10.0	A	m9.5	30.6
			NBL	0.89	86.4	F	#52.2	71.0
			NBT	0.73	27.1	C	97.8	
			NBR					31.7
			SBL	0.60	50.5	D	m18.8	41.8
			SBT	0.96	36.9	D	m#150.3	
			SBR					
			Intersection	0.95	32.8	C		
24	Military Trail	Morningside Avenue	EBL	0.94	101.0	F	#48.5	72.3
			EBT	0.85	56.3	E	#82.9	
			EBR					
			WBL	0.35	27.0	C	m8.5	82.2
			WBT	0.73	33.9	C	#74.6	
			WBR	0.64	23.6	C	80.3	74.5
			NBL	0.75	68.7	E	m24.2	184.0
			NBT	0.48	3.8	A	m15.1	
			NBR					
			SBL	3.15	1029.5	F	**m#166.1**	182.5
			SBT	0.61	4.7	A	m33.7	
			SBR					
			Intersection	0.86	131.9	F		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

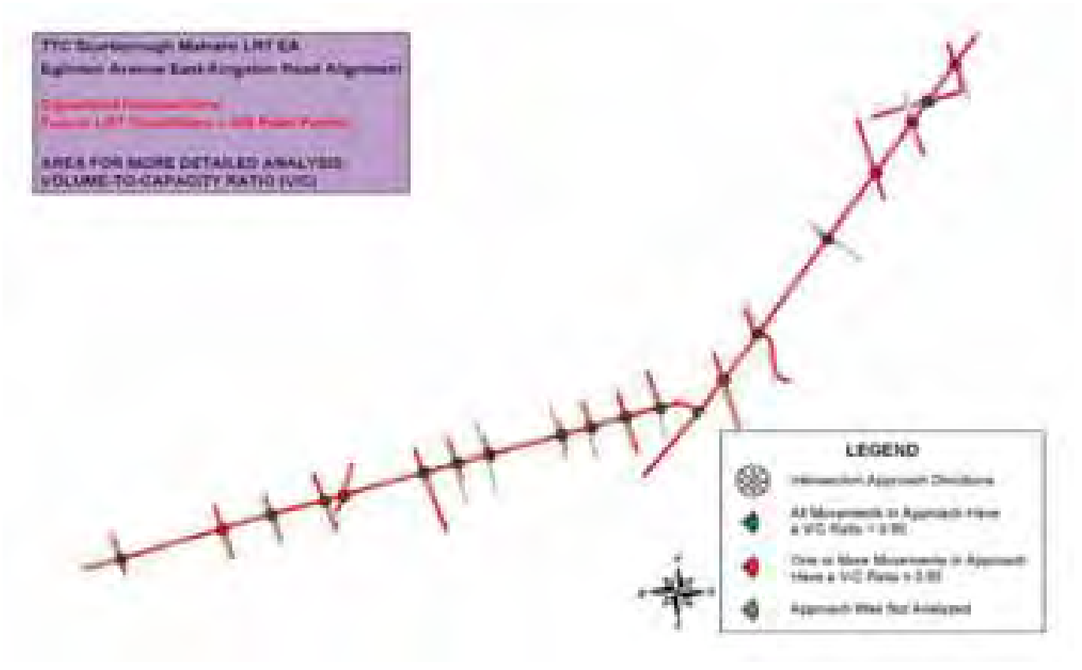
INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
25	401 EB Ramp	Morningside Avenue	EBL	0.37	21.1	C	40.5	
			EBT					
			EBR	0.99	59.7	E	#183.3	
			WBL					
			WBT					
			WBR					
			NBL					
			NBT	0.53	15.2	B	m89.6	
			NBR					
			SBL					
			SBT	0.52	25.8	C	104.5	
			SBR					
			Intersection	0.72	29.5	C		
26	401 WB Ramp / Cinemart Drive	Morningside Avenue	EBL					
			EBT					
			EBR	0.21	37.9	D	13.7	
			WBL	0.44	23.4	C	58.3	85.0
			WBT	0.94dr	35.9	D	#116.4	
			WBR	0.93	54.5	D	#141.7	85.0
			NBL	0.94	100.6	F	#67.1	83.0
			NBT	0.81	17.0	B	**124.3**	
			NBR					
			SBL					
			SBT	0.57	15.4	B	m34.8	
			SBR					
			Intersection	0.85	28.3	C		

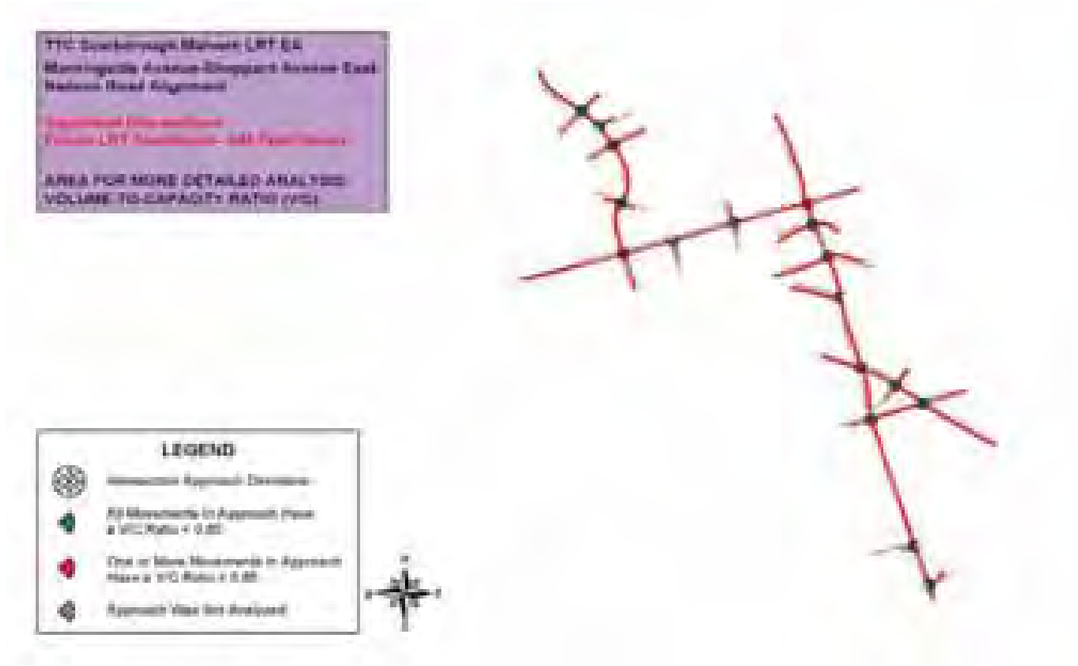
TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

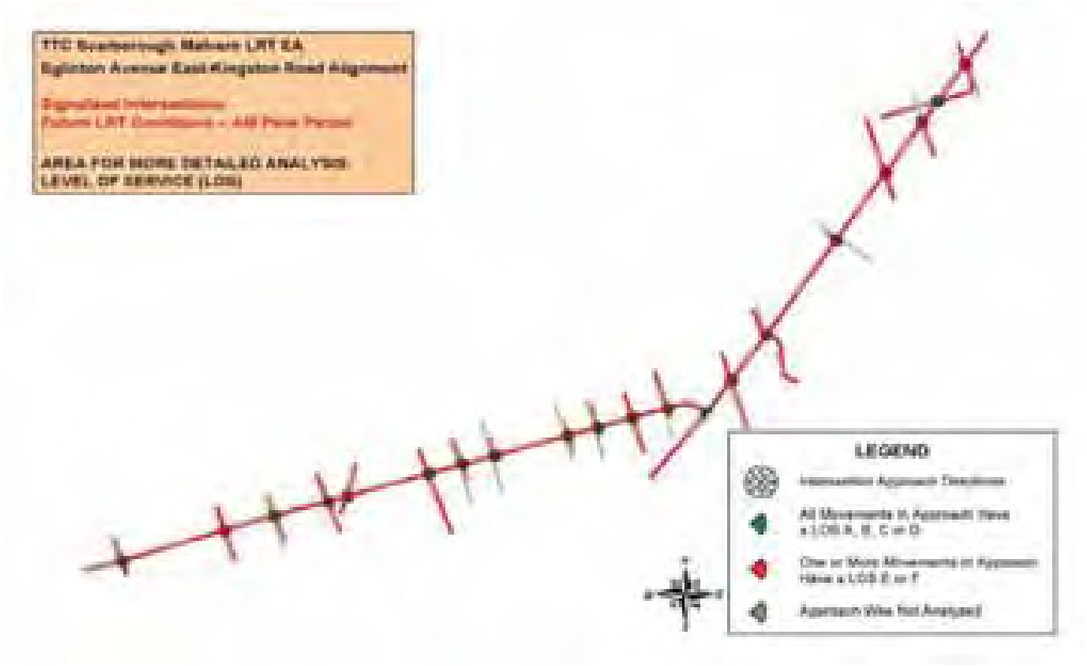
INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
27	Milner Avenue	Morningside Avenue	EBL	0.32	30.8	C	13.3	112.0
			EBT	0.12	28.1	C	10.3	
			EBR					
			WBL	0.57	34.1	C	36.5	90.0
			WBT	0.56	32.2	C	43	
			WBR					
			NBL	1.27	162.3	F	m#238.7	140.0
			NBT	0.83	24.3	C	m#211.7	
			NBR	0.17	17.6	B	m13.5	
			SBL	0.52	41.9	D	26.9	38.4
			SBT	0.54	26.5	C	51.6	
			SBR					
			Intersection	0.91	49.0	D		
28	Ellesmere Road	Military Trail	EBL		7.3	A		
			EBT	0.14			m9.2	
			EBR					
			WBL		15.2	B		
			WBT	0.38			43	
			WBR					
			NBL	0.38	63.3	E	19.2	85.3
			NBT	0.13	11.0	B	9.2	
			NBR					
			SBL	1.45	287.8	F	#75.7	80.2
			SBT	0.22	23.4	C	23.2	
			SBR					
			Intersection	0.41	47.4	D		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
AM Peak Period

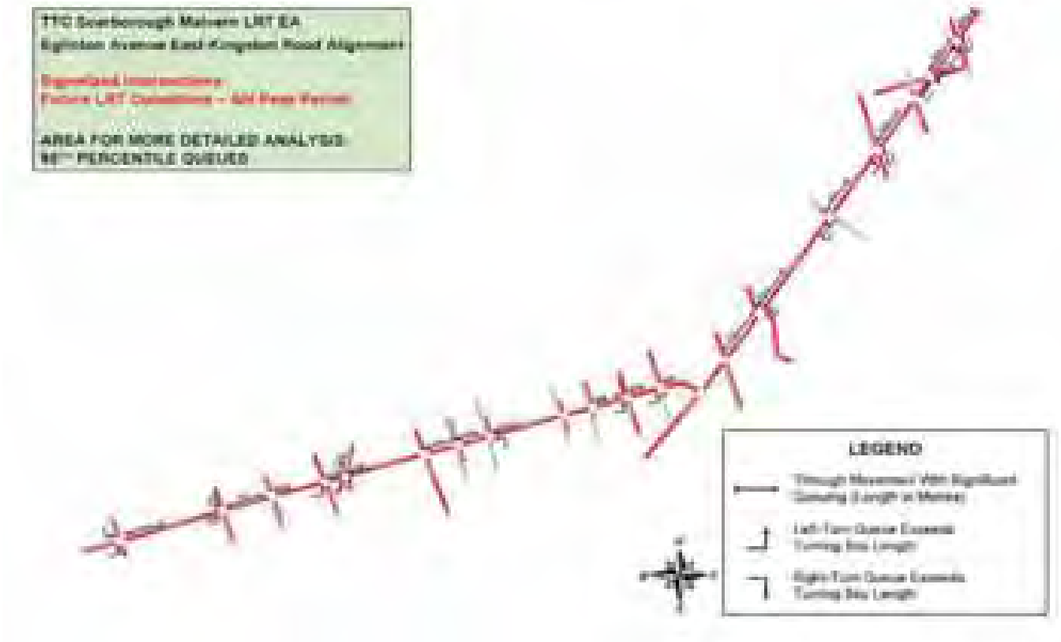
INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
29	Military Trail	U of T Access (East of Morningside)	EBL					
			EBT	0.17	5.5	A	m0.0	
			EBR					
			WBL	1.02	158.2	F	#21.8	63.1
			WBT	0.15	0.9	A	3.3	
			WBR					
			NBL	0.63	46.4	D	33.6	64.6
			NBT					
			NBR	0.01	41.9	D	5.7	
			SBL					
			SBT					
			SBR					
			Intersection	0.25	17.4	B		
30	Sheppard Avenue East	Morningside Avenue	EBL	0.88	92.1	F	#47.5	66.2
			EBT	0.39	24.5	C	41.9	
			EBR					54.9
			WBL	2.44	706.3	F	#187.3	57.7
			WBT	1.29	164.2	F	#247.2	
			WBR					30.0
			NBL	1.01	133.6	F	#53.8	114.4
			NBT	1.29	170.3	F	#210.3	
			NBR					49.7
			SBL	1.06	147.4	F	#55.9	57.5
			SBT	1.04	72.4	E	**#142.1**	
			SBR					37.0
			Intersection	1.40	178.8	F		

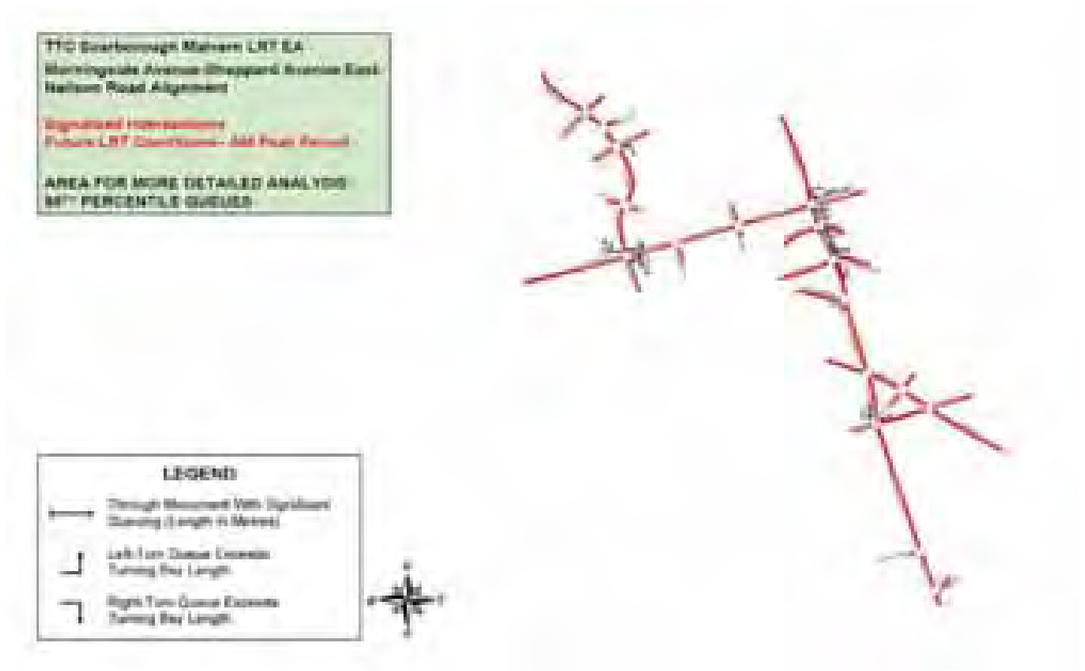



TTC Scarborough Malvern LRT EA
Morningside Avenue-Sheppard Avenue East
Nielson Road Alignment
Signalized Intersections
Future LRT Conditions - 440 Peak Period
AREA FOR MORE DETAILED ANALYSIS:
VOLUME TO CAPACITY RATIO (V/C)
LEGEND
Intersection Approach Directions
All Movements in Approach Have a V/C Ratio < 0.85
One or More Movements in Approach Have a V/C Ratio > 0.85
Approach Was Not Analyzed


TTC Scarborough Malvern LRT EA
Eglinton Avenue East-Kingston Road Alignment
Signalized Intersections
Future LRT Conditions - 440 Peak Period
AREA FOR MORE DETAILED ANALYSIS:
LEVEL OF SERVICE (LOS)
LEGEND
Intersection Approach Directions
All Movements in Approach Have a LOS A, B, C or D
One or More Movements on Approach Have a LOS E or F
Approach Was Not Analyzed


TTC Scarborough Malvern LRT EA
Morningside Avenue-Sheppard Avenue East-
Neilson Road Alignment
Signalized Intersections
Future LRT Operations – AM Peak Period
AREA FOR MORE DETAILED ANALYSIS:
LEVEL OF SERVICE (LOS)
LEGEND
Intersection Approach Direction
All Movements in Approach Have
a LOS A, B, C or D
One or More Movements in Approach
Have a LOS E or F
Approach Was Not Analyzed


TTC Scarborough Malvern LRT EA
Eglinton Avenue East-Kingston Road Alignment
Signalized Intersections
Future LRT Operations – AM Peak Period
AREA FOR MORE DETAILED ANALYSIS:
95TH PERCENTILE QUEUES
LEGEND
Through Movements With Significant
Queuing (Length in Metres)
Left-Turn Queue Exceeds
Turning Bay Length
Right-Turn Queue Exceeds
Turning Bay Length



TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
1	Eglinton Avenue East	Kennedy Road	EBL	1.95	512.6	F	#128.8	40.6
			EBT	1.65	331.6	F	#435.5	
			EBR					51.6
			WBL	1.68	385.8	F	**m#108.0**	109.0
			WBT	1.08	89.9	F	**#231.3**	
			WBR					45.3
			NBL	0.42	24.4	C	32.5	61.0
			NBT	0.58	34.6	C	89.4	
			NBR	0.32	24.5	C	37.2	59.4
			SBL	1.04	102.5	F	#96.2	46.3
			SBT	0.43	31.5	C	64.9	
			SBR	0.25	23.6	C	32.7	33.5
			Intersection	1.34	187.8	F		
2	Eglinton Avenue East	Midland Avenue	EBL	1.79	390.6	F	m#80.1	72.5
			EBT	1.51	275.9	F	m#249.1	
			EBR					
			WBL	0.19	67.8	E	m18.4	56.0
			WBT	0.72	21.0	C	60.2	
			WBR					
			NBL	0.71	45.3	D	#41.2	88.7
			NBT	0.40	28.1	C	61.6	
			NBR					
			SBL	0.46	40.7	D	40	63.4
			SBT	0.66	39.9	D	89.6	
			SBR					
			Intersection	1.20	168.0	F		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
3	Eglinton Avenue East	Falmouth Avenue / Gilder Drive	EBL	0.80			m13.4	38.6
			EBT	1.03	47.0	D	m107.0	
			EBR		49.3	D		
			WBL	1.36			m#73.9	35.5
			WBT	0.43			74.7	
			WBR		258.6	F		
			NBL		20.1	C		
			NBT	0.14			17.4	
			NBR					
			SBL		36.9	D		
			SBT	0.49			54.6	
			SBR					
			Intersection	0.90	44.1	D		
4	Eglinton Avenue East	Brimley Road	EBL	3.00	961.8	F	**m#102.6**	56.0
			EBT	1.33	186.5	F	m#309.7	
			EBR					
			WBL	0.33	77.3	E	m11.8	43.4
			WBT	0.64	21.0	C	59.4	
			WBR					
			NBL	0.51	37.4	D	44.4	95.5
			NBT	0.54	32.1	C	82.4	
			NBR					
			SBL	0.65	36.1	D	#36.9	82.0
			SBT	0.32	23.1	C	50.9	
			SBR	0.22	17.7	B	20.7	35.8
			Intersection	1.10	143.7	F		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
5	Eglinton Avenue East	Danforth Road	EBL	0.92	80.0	F	m50.9	79.0
			EBT	1.11	66.5	E	m35.2	
			EBR					
			WBL	0.96	100.6	F	#75.2	51.1
			WBT	0.65	37.1	D	92.6	
			WBR					
			NBL					15.8
			NBT	0.72	35.0	C	116.3	
			NBR					
			SBL	0.96	112.9	F	#60.0	66.5
			SBT	0.56	30.8	C	85.1	
			SBR					
			Intersection	1.04	52.2	D		
6	Eglinton Avenue East	McCowan Road	EBL	1.74	385.6	F	m#55.2	36.1
			EBT	1.10	102.9	F	m#252.6	
			EBR					
			WBL	1.22	228.9	F	m#64.2	45.4
			WBT	0.47	12.0	B	m44.2	
			WBR					
			NBL	0.44	36.0	D	45.7	78.0
			NBT	0.17	28.6	C	14.7	
			NBR					
			SBL					
			SBT	0.27	30.2	C	25	
			SBR					
			Intersection	0.90	86.1	F		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
7	Eglinton Avenue East	Torrance Road	EBL	0.99	79.9	E	m39.6	40.0
			EBT	0.92	19.5	B	m87.3	
			EBR					
			WBL	0.94	103.9	F	m#75.4	35.0
			WBT	0.42	9.2	A	m34.2	
			WBR					
			NBL	0.30	41.8	D	27.9	60.0
			NBT	0.31	39.5	D	29.8	
			NBR					
			SBL					
			SBT	0.40	42.1	D	35.9	
			SBR					
			Intersection	0.78	26.2	C		
8	Eglinton Avenue East	Bellamy Road North	EBL	2.93	939.4	F	**m#199.9**	85.1
			EBT	0.80	18.7	B	m93.8	
			EBR					
			WBL	0.43	59.7	E	26.8	31.3
			WBT	0.49	18.6	B	78.9	
			WBR					
			NBL	0.11	31.6	C	13.5	5.5
			NBT	0.13	31.2	C	19.1	
			NBR					
			SBL	0.21	33.3	C	23.4	70.0
			SBT	0.24	31.7	C	16.1	
			SBR					
			Intersection	0.79	145.8	F		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
9	Eglinton Avenue East	Mason Road / Conn Smyth Drive	EBL	0.86	90.7	F	#45.4	37.5
			EBT	0.94	34.9	C	**#182.9**	
			EBR					
			WBL	0.88	102.5	F	m#47.5	42.3
			WBT	0.44	12.9	B	m25.6	
			WBR					60.5
			NBL	0.20	23.7	C	24.3	
			NBT	0.38	24.3	C	26.1	
			NBR					
			SBL					
			SBT	0.12	22.1	C	12.3	
			SBR					
			Intersection	0.67	32.3	C		
10	Eglinton Avenue East	Beachell Street	EBL	0.88	71.2	E	m#24.0	29.2
			EBT	0.77	16.0	B	m80.0	
			EBR					
			WBL	0.48	48.1	D	#21.4	19.2
			WBT	0.41	16.8	B	58	
			WBR					
			NBL					
			NBT	0.01	25.3	C	0	
			NBR					
			SBL					
			SBT	0.04	25.5	C	6.2	
			SBR					
			Intersection	0.53	19.4	B		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
11	Eglinton Avenue East	Markham Road	EBL	1.62	344.6	F	m#130.5	43.9
			EBT	0.77	25.4	C	56.2	
			EBR					
			WBL	0.21	54.2	D	m17.0	40.7
			WBT	0.43	12.3	B	m20.6	
			WBR					
			NBL	0.28	23.9	C	26.1	90.0
			NBT	0.23	21.8	C	29.4	
			NBR	0.06	15.2	B	6.9	
			SBL	0.50	29.5	C	44.7	34.0
			SBT	0.23	21.8	C	28.6	
			SBR	0.28	14.7	B	22	92.1
			Intersection	0.77	55.6	E		
12	Eglinton Avenue East	Cedar Drive	EBL	1.82	438.1	F	m#80.1	39.8
			EBT	0.66	20.8	C	86.2	
			EBR					
			WBL	0.63	84.5	F	#30.7	50.9
			WBT	0.31	14.6	B	34.7	
			WBR					
			NBL					
			NBT	0.22	24.8	C	22	
			NBR					
			SBL					
			SBT	0.20	23.8	C	15.9	
			SBR					
			Intersection	0.56	61.0	E		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
13	Eglinton Avenue East	Kingston Road	EBL	0.95	52.2	D	#132.7	
			EBT					
			EBR					
			WBL					
			WBT					
			WBR					
			NBL					
			NBT	0.82	16.7	B	144.3	
			NBR					
			SBL					
			SBT	0.33	9.4	A	38	
			SBR	0.47	9.7	A	11.1	
			Intersection	0.86	21.3	C		
14	Kingston Road	Scarborough Golf Club Road	EBL	1.37	263.3	F	#75.6	55.1
			EBT	1.35	175.1	F	#504.0	
			EBR					
			WBL	0.31	61.1	E	m12.2	
			WBT	0.71	5.4	A	33.8	
			WBR					
			NBL					
			NBT	0.29	40.5	D	16.8	
			NBR					
			SBL					
			SBT	0.31	40.1	D	16.3	
			SBR					
			Intersection	1.21	123.9	F		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
15	Kingston Road	Cromwell Road / Guildwood Parkway	EBL	0.30	40.8	D	m4.1	32.2
			EBT	1.33	187.5	F	m#273.2	
			EBR					
			WBL	0.23	90.7	F	m7.3	51.9
			WBT	0.53	16.8	B	**136.7**	
			WBR					
			NBL	0.54	39.8	D	49.4	
			NBT	0.51	38.4	D	42.4	
			NBR					
			SBL	0.14	35.4	D	10.8	
			SBT					
			SBR	0.05	34.2	C	5.4	
			Intersection	1.14	131.3	F		
16	Kingston Road	Celeste Drive / Guildwood GO Station	EBL	0.55	55.7	E	m8.0	46.5
			EBT	1.09	61.9	E	**m224.8**	
			EBR					
			WBL	0.27	145.4	F	m8.9	41.0
			WBT	0.53	6.4	A	**105.2**	
			WBR					
			NBL	0.49	51.3	D	34.8	20.5
			NBT	0.43	40.5	D	22.3	
			NBR					
			SBL					
			SBT	0.37	45.1	D	21	
			SBR					
			Intersection	1.01	45.3	D		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
17	Kingston Road	Galloway Road	EBL	0.79	48.7	D	m16.5	34.8
			EBT	1.15	78.1	E	**m#290.1**	
			EBR					
			WBL	0.48	118.2	F	19.8	30.7
			WBT	0.52	9.7	A	73.4	
			WBR					
			NBL					
			NBT	0.68	48.2	D	44.8	
			NBR					
			SBL					
			SBT	0.31	37.4	D	24.1	
			SBR					
			Intersection	1.06	56.5	E		
18	Kingston Road	Poplar Road	EBL	0.03	144.2	F	3.6	
			EBT	0.94	19.4	B	**330.2**	
			EBR					
			WBL	0.74	158.9	F	m22.2	35.2
			WBT	0.40	1.2	A	19.7	
			WBR					
			NBL					
			NBT	0.40	60.0	E	20.9	
			NBR					
			SBL					
			SBT					
			SBR					
			Intersection	0.85	17.7	B		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
19	Lawrence Avenue East	Kingston Road	EBL	0.87			#112.6	
			EBT	0.58	231.1	F	104.4	
			EBR	0.19			20.1	
			WBL	0.82			#65.4	
			WBT	0.37	31.5	C	57.4	
			WBR					
			NBL		47.1	D		
			NBT	1.44	38.5	D	#495.3	
			NBR		30.8	C		
			SBL		52.9	D		
			SBT	0.74	38.2	D	**157.4**	
			SBR					
			Intersection	1.15	123.1	F		
20	Kingston Road	Morningside Avenue	EBL	0.96	54.7	D	#82.7	31.3
			EBT	1.52	40.5	D	#413.1	
			EBR					
			WBL	0.61	91.6	F	#30.4	42.5
			WBT	0.72	73.8	E	**103.6**	
			WBR					
			NBL	0.29	92.8	F	13.6	34.2
			NBT	0.71	264.4	F	82	
			NBR					
			SBL	0.65	79.1	E	#32.4	74.5
			SBT	0.96	27.0	C	#137.1	
			SBR					
			Intersection	1.27	151.0	F		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
21	Tefft Road	Morningside Avenue	EBL					
			EBT					
			EBR					
			WBL	0.20	28.7	C	11.3	
			WBT					
			WBR					
			NBL					
			NBT	0.40	6.8	A	46.8	
			NBR					
			SBL	0.57	34.9	C	m17.6	
			SBT	0.39	7.2	A	**101.1**	
			SBR					
			Intersection	0.40	8.8	A		
22	West Hill Cl	Morningside Avenue	EBL	0.03	27.0	C	5.5	38.0
			EBT					
			EBR	0.03	26.6	C	3.5	38.0
			WBL					
			WBT					
			WBR					
			NBL	0.60	36.0	D	m#38.4	46.0
			NBT	0.29	2.3	A	25.1	
			NBR					
			SBL					
			SBT	0.58	10.7	B	**#103.5**	
			SBR					
			Intersection	0.53	9.0	A		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
23	Ellesmere Road	Morningside Avenue	EBL	0.49	18.1	B	46.5	128.8
			EBT	0.74	20.2	C	117.1	
			EBR					
			WBL	0.98	102.7	F	m#44.8	68.1
			WBT	0.22	10.7	B	m19.3	
			WBR	0.15	9.4	A	m11.3	30.6
			NBL	0.97	106.2	F	#63.4	71.0
			NBT	0.99	62.1	E	**#124.8**	
			NBR					31.7
			SBL	0.94	109.1	F	#50.8	41.8
			SBT	1.03	73.1	E	**#126.0**	
			SBR					
			Intersection	0.96	46.6	D		
24	Military Trail	Morningside Avenue	EBL	0.42	33.7	C	30.9	72.3
			EBT	0.57	34.9	C	41	
			EBR					
			WBL	0.04	30.5	C	3.4	82.2
			WBT	0.13	31.0	C	15.8	
			WBR	0.31	22.6	C	17.6	74.5
			NBL	0.32	40.5	D	21.9	184.0
			NBT	0.40	12.0	B	48.5	
			NBR					
			SBL	1.79	407.0	F	**#161.0**	182.5
			SBT	0.66	14.0	B	**110.3**	
			SBR					
			Intersection	0.79	67.0	E		

TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

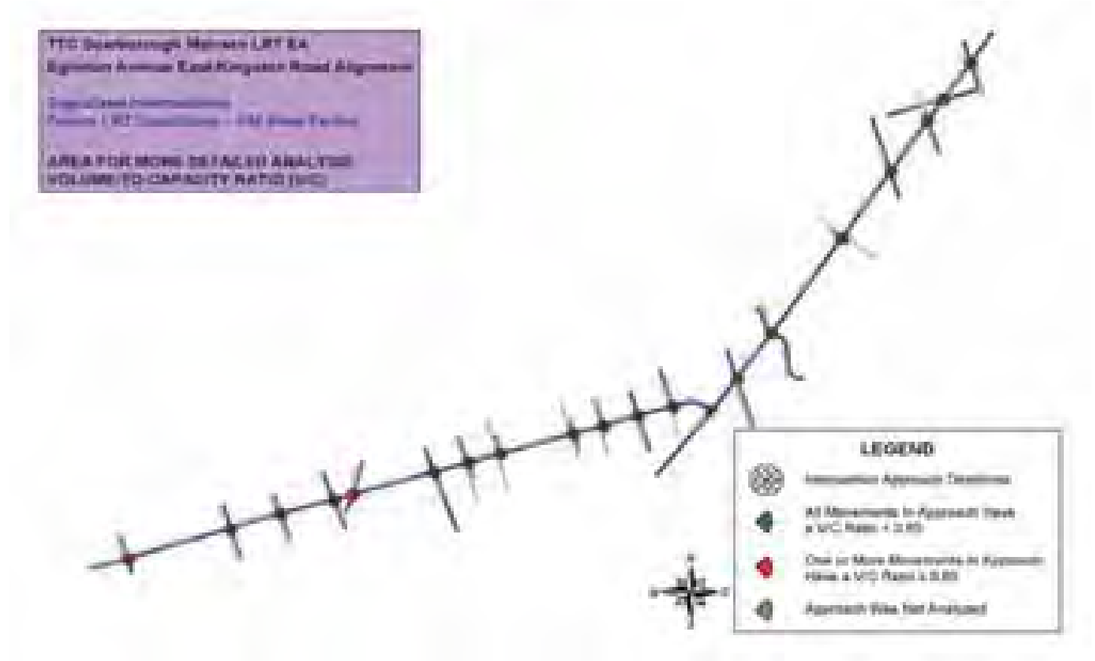
INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
25	401 EB Ramp	Morningside Avenue	EBL	0.59	25.8	C	75.3	
			EBT					
			EBR	0.91	47.6	D	#155.6	
			WBL					
			WBT					
			WBR					
			NBL					
			NBT	0.51	15.4	B	77.1	
			NBR					
			SBL					
			SBT	0.96	35.1	D	#225.1	
			SBR					
			Intersection	0.94	30.5	C		
26	401 WB Ramp / Cinemart Drive	Morningside Avenue	EBL					
			EBT					
			EBR	0.74	42.1	D	#68.5	
			WBL	0.15	24.0	C	21.3	85.0
			WBT	0.21	24.1	C	18.8	
			WBR	0.27	24.6	C	25.6	85.0
			NBL	0.63	36.3	D	57.7	83.0
			NBT	0.70	13.2	B	**105.8**	
			NBR					
			SBL					
			SBT	1.13	98.3	F	#206.5	
			SBR					
			Intersection	0.74	50.8	D		

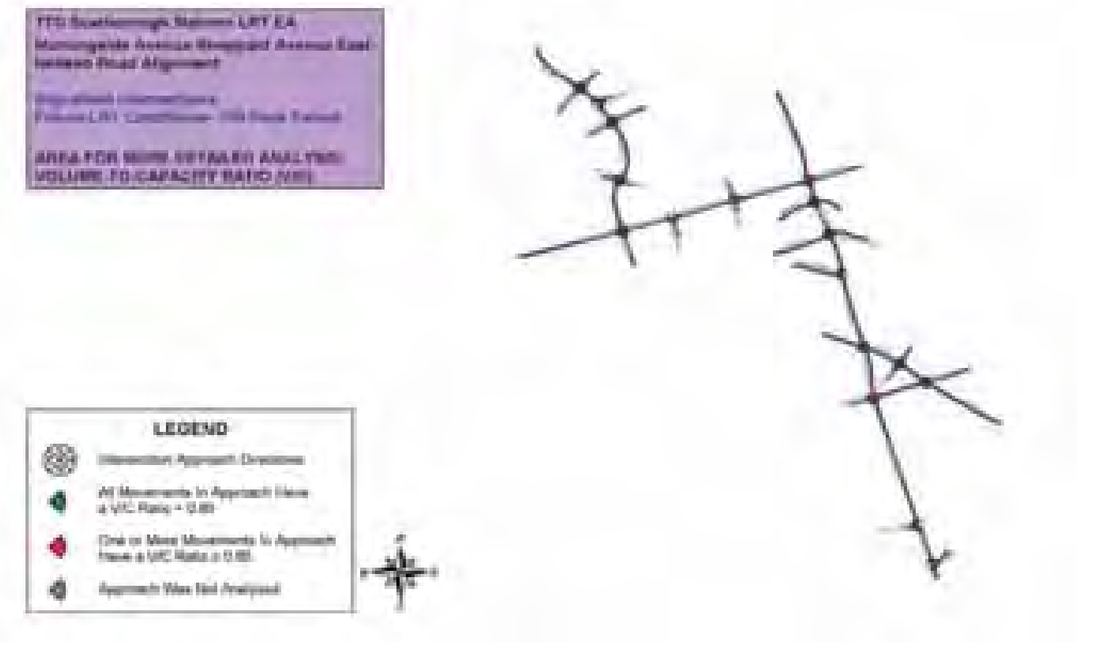
TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

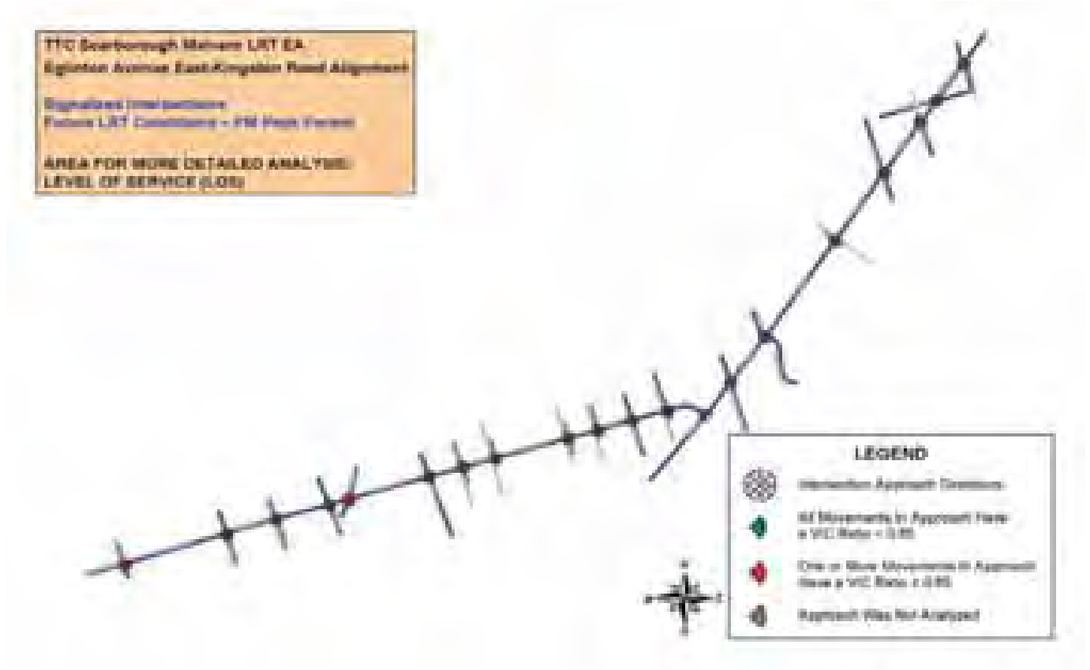
INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
27	Milner Avenue	Morningside Avenue	EBL	0.48	25.8	C	49.5	112.0
			EBT	0.37	23.3	C	27.5	
			EBR					
			WBL	0.65	23.0	C	45.3	90.0
			WBT	0.08	14.7	B	8.7	
			WBR					
			NBL	1.48	281.6	F	#125.6	140.0
			NBT	1.11	100.2	F	#204.3	
			NBR	0.26	22.2	C	17.5	
			SBL	0.44	46.7	D	27	38.4
			SBT	0.69	32.7	C	80.4	
			SBR					
			Intersection	0.94	75.3	E		
28	Ellesmere Road	Military Trail	EBL					
			EBT	0.42	9.9	A	m25.8	
			EBR					
			WBL					
			WBT	0.18	15.0	B	15.4	
			WBR					
			NBL	0.81	89.5	F	#41.2	85.3
			NBT	0.18	23.0	C	20.7	
			NBR					
			SBL	1.20	193.9	F	#66.4	80.2
			SBT	0.17	21.8	C	20.8	
			SBR					
			Intersection	0.37	34.3	C		

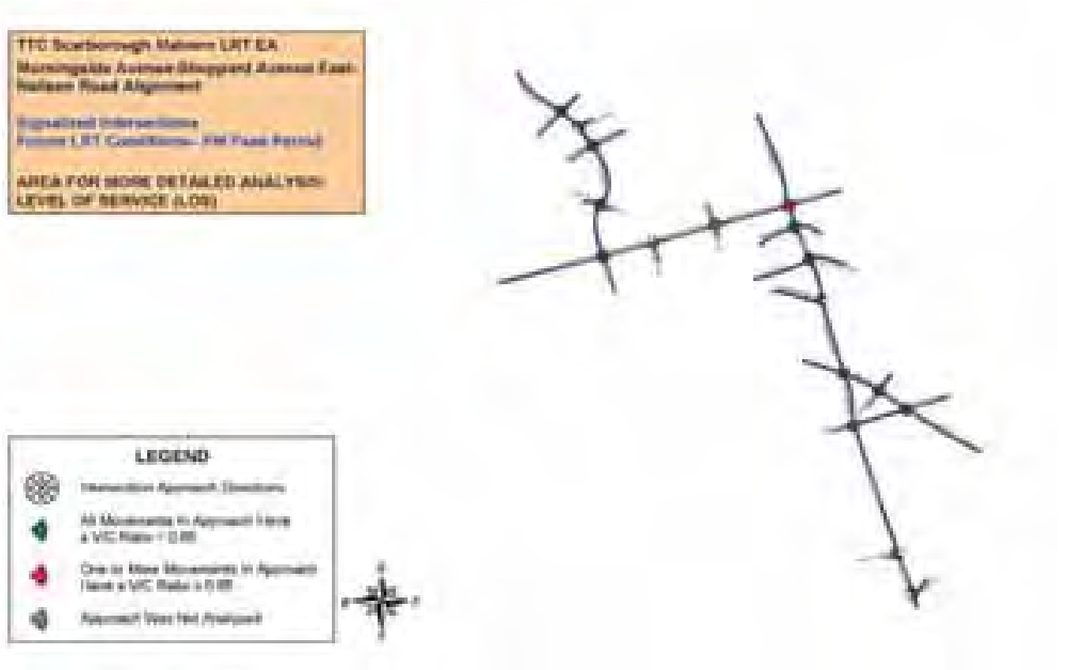
TTC Scarborough Malvern LRT
Signalized Intersections - Future Condition
PM Peak Period

INT #	INTERSECTION		TURNING MOVEMENT	V/C	DELAY	LOS	QUEUE LENGTH 95th (m)	LANE LENGTH (m)
	East-West Street	North-South Street						
29	Military Trail	U of T Access (East of Morningside)	EBL					
			EBT	0.22	4.3	A	0.24	
			EBR					
			WBL	0.79	72.5	E	0.63	63.1
			WBT	0.13	1.0	A	0.13	
			WBR					
			NBL	0.54	44.6	D	0.45	64.6
			NBT					
			NBR	0.01	39.2	D	0.12	
			SBL					
			SBT					
			SBR					
			Intersection	0.29	11.3	B		
30	Sheppard Avenue East	Morningside Avenue	EBL	1.13	162.6	F	#75.6	66.2
			EBT	1.10	87.6	F	#205.3	
			EBR					54.9
			WBL	1.36	248.2	F	#88.8	57.7
			WBT	0.28	21.7	C	27	
			WBR					30.0
			NBL	0.97	113.5	F	#62.2	114.4
			NBT	1.16	122.3	F	#178.6	
			NBR					49.7
			SBL	1.33	234.6	F	#88.8	57.5
			SBT	1.11	98.0	F	**#166.2**	
			SBR					37.0
			Intersection	1.17	109.4	F		

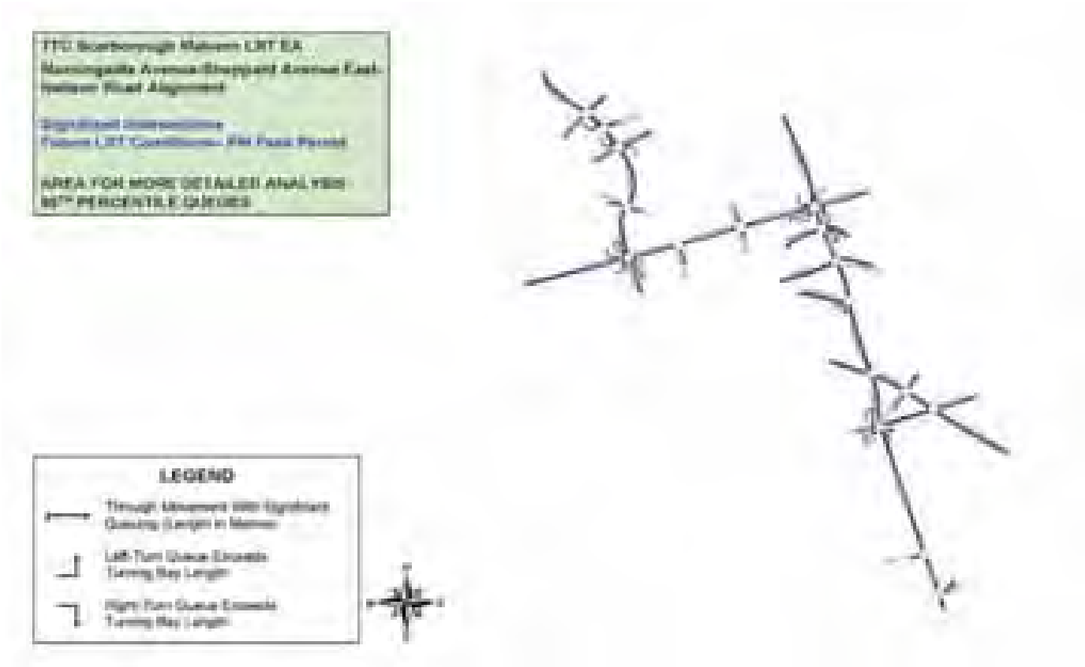

TTC Scarborough Malvern LRT EA
Eglinton Avenue East/Kingston Road Alignment
AREA FOR MORE DETAILED ANALYSIS
VOLUME TO CAPACITY RATIO (V/C)
LEGEND
Intersection Approach Directions
All Movements in Approach Have a V/C Ratio < 0.85
One or More Movements in Approach Have a V/C Ratio ≥ 0.85
Approach Was Not Analyzed


TTC Scarborough Malvern LRT EA
Morningside Avenue/Sheppard Avenue East between Road Alignment
AREA FOR MORE DETAILED ANALYSIS
VOLUME TO CAPACITY RATIO (V/C)
LEGEND
Intersection Approach Directions
All Movements in Approach Have a V/C Ratio < 0.85
One or More Movements in Approach Have a V/C Ratio ≥ 0.85
Approach Was Not Analyzed


TTC Scarborough Malvern LRT EA
Eglinton Avenue East/Kingston Road Alignment
Signalized Intersections
Future LRT Conditions – PM Peak Period
AREA FOR MORE DETAILED ANALYSIS:
LEVEL OF SERVICE (LOS)
LEGEND
Intersection Approach Operations
All Movements in Approach Have a V/C Ratio < 0.85
One or More Movements in Approach Have a V/C Ratio ≥ 0.85
Approach Was Not Analyzed


TTC Scarborough Malvern LRT EA
Morningside Avenue/Sheppard Avenue East-Neilson Road Alignment
Signalized Intersections
Future LRT Conditions – PM Peak Period
AREA FOR MORE DETAILED ANALYSIS:
LEVEL OF SERVICE (LOS)
LEGEND
Intersection Approach Operations
All Movements in Approach Have a V/C Ratio < 0.85
One or More Movements in Approach Have a V/C Ratio ≥ 0.85
Approach Was Not Analyzed


TTC Scarborough Malvern LRT EA
Eglinton Avenue East-Kingston Road Alignment
Signalized Intersections
Future LRT Conditions – PM Peak Period
AREA FOR MORE DETAILED ANALYSIS:
95TH PERCENTILE QUEUES
LEGEND
Through Movement With Significant Queuing (Length in Metres)
Left-Turn Queue Exceeds Turning Bay Length
Right-Turn Queue Exceeds Turning Bay Length


TTC Scarborough Malvern LRT EA
Morningside Avenue-Sheppard Avenue East-Nelson Road Alignment
Signalized Intersections
Future LRT Conditions PM Peak Period
AREA FOR MORE DETAILED ANALYSIS:
95TH PERCENTILE QUEUES
LEGEND
Through Movement With Significant Queuing (Length in Metres)
Left-Turn Queue Exceeds Turning Bay Length
Right-Turn Queue Exceeds Turning Bay Length

ATTACHMENT III

SCARBOROUGH – MALVERN LRT EA – EGLINTON AVENUE AT BRIMLEY ROAD AND DANFORTH ROAD SYNCHRO ASSESSMENT

December 18, 2008

Toronto Transit Commission (TTC)

SCARBOROUGH - MALVERN LRT EA - EGLINTON AVENUE AT BRIMLEY ROAD AND DANFORTH ROAD SYNCHRO ASSESSMENT

FINAL REPORT

DECEMBER 18, 2008

December 18, 2008

TABLE OF CONTENTS

1. PROJECT SCOPE III-1

2. DATA III-2

2.1 Traffic Volume Reductions III-2

2.2 LRV Phase III-3

3. SYNCHRO ANALYSIS FIRST ITERATION - SIGNAL PHASING SCENARIOS III-3

3.1 Traffic Volume III-4

3.2 Scenarios III-4

3.2.1 Scenario 1 ..... III-4

3.2.2 Scenario 2 ..... III-5

3.2.3 Stage 1 – Analysis Results and Preferred Scenario III-7

4. SECOND ITERATION – ADJUSTED DISTRIBUTION OF VOLUMES III-9

4.1 Traffic Volumes III-10

4.2 Scenarios III-11

4.2.1 Scenario 3-1 – Base Scenario (Redistributed Eastbound Left Turns) III-11

4.2.2 Scenario 3-2 – Base Scenario Plus Redistributed Westbound Left Turns Via No Frills Lane (AM peak only) III-12

4.2.3 STAGE 2 – Analysis Results and Preferred Scenario III-12

5. THIRD ITERATION – NEW SIGNAL PHASING WITH ADJUSTED DISTRIBUTION OF VOLUMES III-14

5.1 Traffic Volumes III-14

5.2 Scenarios III-15

5.2.1 Scenario 4-A – Six Phase operation at Danforth, Four Phase Operation at Brimley III-15

5.2.2 Scenario 4-B – Four phase operation at Danforth, Six Phase Operation at Brimley III-15

5.2.3 Scenario 4-C – Five Phase Operation on Eglinton Avenue III-15

5.3 Third Iteration – Analysis Results III-16

6. OPERATIONS ANALYSIS – SIGNAL COORDINATION III-19

6.1 Critical LRT Movements III-19

TABLE OF CONTENTS (CONT'D)

6.2 Scenarios III-19

6.3 Analysis Results III-19

7. ANALYSIS SUMMARY III-22

LIST OF EXHIBITS

Exhibit 1-1: Study Area 2
Exhibit 2-1: Eglinton Avenue Corridor Volume Reductions 3
Exhibit 3-1: First Iteration - Turning Movement Volumes 4
Exhibit 3-2: Six Phase Operation *(Phase 1 Added at Brimley During PM Peak Only)* 5
Exhibit 3-3: Minimum Cycle Length with Six Phase Operation *(Phase 1 Added at Brimley During PM Peak Only)* 5
Exhibit 3-4: Four Phase Operation *(Phase 1 Added at Brimley During PM Peak Only)* 6
Exhibit 3-5: Minimum Cycle Length with Four Phase Operation *(Phase 1 Added at Brimley During PM Peak Only)* 6
Exhibit 3-6: Scenario 1 - Synchro Results (AM) 7
Exhibit 3-7: Scenario 1 – Synchro Results (PM) 7
Exhibit 3-8: Scenario 2 - Synchro Results (AM) 8
Exhibit 3-9: Scenario 2 (Phase 1 Included at Brimley) - Synchro Results (PM) 8
Exhibit 3-10: Scenario 2 (Phase 1 Removed at Brimley) - Synchro Results (PM) 9
Exhibit 4-1: Redistributed Eastbound Left Turn movements 10
Exhibit 4-2: Second Iteration - Turning Movement Volumes (AM) 11
Exhibit 4-3: Redistributed Westbound Left Turns 12
Exhibit 4-4: Scenario 3-1 - Synchro Results (AM) 13
Exhibit 4-5: Scenario 3-1 - Synchro Results (PM) 13
Exhibit 4-6: Scenario 3-2 – Synchro Results (AM) 14
Exhibit 5-1: Five Phase Operation at Danforth 16
Exhibit 5-2: Five Phase Operation at Brimley *(Phase 1 Added During PM Peak Only)* 16
Exhibit 5-3: Third Iteration - Synchro Results (AM) 17
Exhibit 5-4: Third Iteration - Synchro Results (PM) 18
Exhibit 6-1: Time-Space Diagram for Scenario 1 21
Exhibit 6-2: Time-Space Diagram for Scenario 2 22

LIST OF APPENDICES

Appendix A: Calculations to determine transit phase duration

1. PROJECT SCOPE

This report documents the Synchro traffic analysis completed on the Eglinton Avenue and Brimley Road signalized intersection, the Eglinton Avenue and Danforth Road signalized intersection, and surrounding road network. The purpose of the analysis is to conduct a preliminary assessment of the future Light Rail Vehicle (LRV) operation, and to determine impacts to traffic operation and land use. The objective of this report is to advance the initial design to a point where it could be confidently presented to the public as a workable Light Rail Transit (LRT) system. The analysis conducted in this report is the foundation for future preliminary and detailed design.

Exhibit 1-1 shows the study area with the five signalized intersections included in the analysis. Of the five intersections shown, a new signalized intersection is to be implemented at the Eglinton Avenue and Barbados Boulevard intersection.

To evaluate the LRV operation, a Synchro analysis was conducted. Three iterations were developed in consultation with City of Toronto and TTC staff. The following priority scheme was used to develop the preferred scenario:

1. LRV operation
2. Pedestrian and cyclist operation
3. Bus operation (and where bus/LRV transfers occur, equivalent to #2)
4. Vehicle operation

The report describes:

- Traffic volumes that were developed for the future LRV operation (Section 2);
- The results of a three-iteration Synchro analysis that has considered:
    1. Two initial signal phasing scenarios – First iteration (Section 3);
    2. Base scenarios with adjusted volumes across the network – Second iteration (Section 4);
    3. Operational improvement scenarios with adjusted volumes across the network – Third iteration (Section 5);
- The results of a signal coordination analysis (Section 6);
- The recommended scenario and the impacts to land use (Section 7).

IBI GROUP FINAL REPORT

Toronto Transit Commission (TTC)
SCARBOROUGH - MALVERN LRT EA - EGLINTON AVENUE AT BRIMLEY ROAD AND DANFORTH ROAD SYNCHRO ASSESSMENT

Exhibit 1-1: Study Area

2. DATA

The following data was used to formulate the analysis of the road network surrounding the intersections of Eglinton Avenue and Brimley Road and Eglinton Avenue and Danforth Road.

2.1 Traffic Volume Reductions

Under future conditions, Eglinton Avenue will be reduced from three through lanes eastbound and westbound to two through lanes in each direction to accommodate the LRT. This reduction in roadway capacity will result in many of the vehicles currently using Eglinton Avenue as a corridor to switch to transit, or to detour from Eglinton Avenue to alternate routes. As a result, an analysis of the signalised intersections of Eglinton Avenue at Brimley Road and Eglinton Avenue at Danforth Road was conducted to determine the future vehicle capacity of the corridor. These two

intersections were recognised as the governing point for traffic along this section of the Eglinton corridor. Corridor volumes were reduced such that the through volume was equal to the capacity (V/C = 1.00) at both intersections. The reduced through volumes through these signalised intersections were propagated to adjacent signalised intersections in the study area.

Only the Eglinton Avenue corridor volumes that exceeded capacity were reduced. These were the westbound through volumes in the AM peak and the eastbound through volumes in the PM peak. The Eglinton corridor volume reductions are shown in **Exhibit 2-1**.

Exhibit 2-1: Eglinton Avenue Corridor Volume Reductions

	Eglinton at Brimley	Eglinton at Danforth
AM Westbound	111 vph (7%)	15 vph (.01%)
PM Eastbound	330 vph (18%)	245 vph (14%)

2.2 LRV Phase

The LRV was not allocated its own phase since it is an east-west through movement on this section of the runningway. As a result, the transit vehicle operates concurrently with the east-west through phase. However, given the proximity of the intersections of Eglinton at Brimley and Eglinton at Danforth, as well as the westbound platform being located between the two intersections, it was necessary to coordinate the signal timings. The objective is to coordinate the signals so that a 60 metre vehicle could clear both intersections within a single green band starting at the beginning of a green phase. This strategy avoids “double-stopping”. Minimum green duration was calculated by calculating the time to clear both intersections from a stopped position. This time includes the time to accelerate to a maximum speed of 25 km/hr, plus the time to slow to a stop position assuming that a far side stop from Danforth is used, board and alight passengers, and clear the Brimley intersection. The phase was calculated to be:

- 57 second minimum green;
- 9 second amber;
- 4 second all red;
- Minimum phase duration of 70 seconds.

The phase calculation can be found in Appendix A.

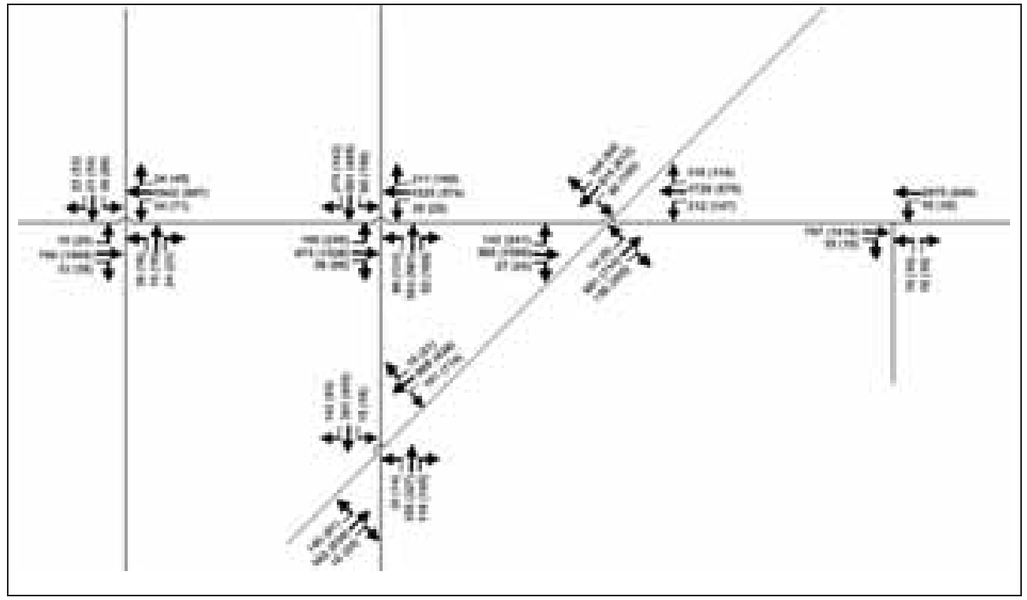
3. SYNCHRO ANALYSIS FIRST ITERATION - SIGNAL PHASING SCENARIOS

The first iteration explores signal phasing scenarios at the Kingston Road at Morningside Avenue intersection.

3.1 Traffic Volume

Exhibit 3-1 presents the intersection volumes for both the AM and PM peak periods used in the first iteration. Turning movement volumes were developed for the new signalized intersection at Eglinton Avenue and Barbados Boulevard by carrying the upstream discharge volumes. In scenarios where left turns were restricted at the intersections of Eglinton Avenue at Brimley Road and Eglinton Avenue and Danforth Road, the left turn volumes were carried through the intersections and made into U-turn movements at the nearest downstream intersections.

Exhibit 3-1: First Iteration - Turning Movement Volumes



3.2 Scenarios

Three scenarios were developed for the Kingston Road at Morningside Avenue signalized intersection. The scenarios explore three signal phasing alternatives. These three scenarios are described below.

3.2.1 SCENARIO 1

Exhibit 3-2 presents the NEMA phase diagram at both the intersections of Eglinton Avenue at Brimley Road and Eglinton Avenue and Danforth Road for Scenario 1. Under this scenario, the existing six phase operation is maintained, with the east-west left turn phases operating protected only. During the PM peak period, a seventh phase is added for southbound left turns at the Eglinton-Brimley intersection only.

Exhibit 3-2: Six Phase Operation *(Phase 1 Added at Brimley During PM Peak Only)*

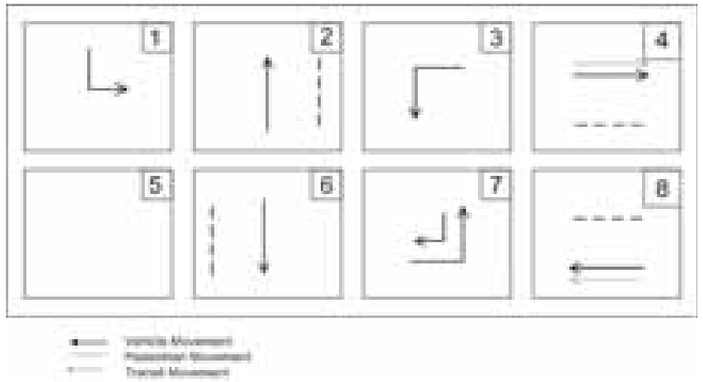


Exhibit 3-3 presents the minimum cycle length for this scenario.

Exhibit 3-3: Minimum Cycle Length with Six Phase Operation *(Phase 1 Added at Brimley During PM Peak Only)*

	Phase			
	1	**2 & 6**	**3 & 7**	**4 & 8**
Minimum Green or walk	7	7	7	7
Minimum Green and FDWK		30		29
Amber	2	3	2	3
All Red	1	3	1	3
Total	10	43	10	42
Minimum Cycle Length (AM)	95			
Minimum Cycle Length (AM)	105			

Based on the phase and cycle length composition above, the minimum cycle length is 95 seconds under six phase operation during the AM peak, and 105 seconds when Phase 1 is added at Brimley during the PM peak. However, a minimum phase duration of 70 seconds was calculated for the east-west phase (phase 4 and 8). As a result, the minimum cycle length is approximately 120 seconds during the AM peak and 130 seconds during the PM peak.

Also, the assumed transit headway is 3 minutes and 30 seconds for both directions. This translates into 34 transit vehicles per hour in two directions. As a result, the transit phase may be actuated between 17 (eastbound & westbound LRV always arriving at the same time) and 34 (eastbound and westbound LRV never arriving at the same time) times per hour. Using an average cycle length of 120 seconds translates into approximately 29 transit calls per hour. A cycle length of 120 seconds was used in the analysis.

3.2.2 SCENARIO 2

Exhibit 3-4 presents the NEMA phase diagram at both the intersections of Eglinton Avenue at Brimley Road and Eglinton Avenue and Danforth Road for Scenario 2. Under this scenario, the existing east-west left turn phase operation is removed. In a separate test, the southbound left turn phase is also removed at the Eglinton-Brimley intersection. The eastbound and westbound left turn

volumes were carried through the intersections and made into U-turn movements at the nearest downstream intersections.

Exhibit 3-4: Four Phase Operation *(Phase 1 Added at Brimley During PM Peak Only)*

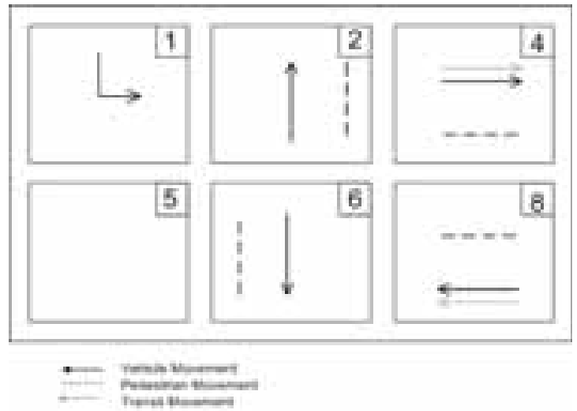


Exhibit 3-5 presents the minimum cycle length for this scenario.

Exhibit 3-5: Minimum Cycle Length with Four Phase Operation *(Phase 1 Added at Brimley During PM Peak Only)*

	Phase		
	1	**2 & 6**	**4 & 8**
Minimum Green or walk	7	7	7
Minimum Green and FDWK		30	29
Amber	2	3	3
All Red	1	3	3
Total	10	43	42
Minimum Cycle Length (AM Peak)	85		
Minimum Cycle Length (PM Peak)	95		

Based on the phase and cycle length composition above, the minimum cycle length is 85 seconds under six phase operation during the AM peak, and 95 seconds when Phase 1 is added at Brimley during the PM peak. Again, assuming a minimum east-west phase duration of 70 seconds increases the minimum cycle length to approximately 110 seconds during the AM peak and 120 seconds during the PM peak.

Also, the assumed transit headway is 3 minutes and 30 seconds for both directions, which translates into approximately 29 transit calls per hour. The additional phase time acquired from the removal of the protected left-turns was allocated to the through east-west movements to operate at a V/C ratio of 1.0 or less, and any remaining time was allocated to the north-south phases.

3.2.3 STAGE 1 – ANALYSIS RESULTS AND PREFERRED SCENARIO

Exhibit 3-6 and **Exhibit 3-7** presents the Synchro Volume to Capacity (V/C) analysis results for Scenario 1 during the AM peak and PM peak. **Exhibit 3-8**, **Exhibit 3-9** shows the results of Scenario 2 for the AM and PM peak periods respectively. **Exhibit 3-10** presents a PM peak period option with the southbound left turn phase removed at Brimley Road. The analysis results show that the east-west left-turns are above capacity in most cases, a problem which is then transferred onto through movements when the turning movements are banned, and the left turn movements are allocated to through movements.

Exhibit 3-6: Scenario 1 - Synchro Results (AM)

Eglinton Avenue & Glider Drive									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.70	0.42	0.55	0.91		0.22		0.24	
Eglinton Avenue East & Brimley Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.93	0.37	0.28	0.99	0.95	0.68	0.56	0.65	0.50
Eglinton Avenue East & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.99	0.36	1.42	1.00	0.20	0.85	1.48	0.82	
Brimley Road & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.59	0.27	0.39	0.49	0.13	0.39	0.05	0.44	
Eglinton Avenue East & Barbados Boulevard									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.34	0.10	0.85	0.06				

Exhibit 3-7: Scenario 1 – Synchro Results (PM)

Eglinton Avenue & Glider Drive									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.71	0.85	0.96	0.33		0.14		0.53	
Eglinton Avenue East & Brimley Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	1.28	0.82	0.29	0.46	0.92	0.90	1.24	0.47	0.31
Eglinton Avenue East & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	1.13	0.88	0.90	0.47		0.97	1.69	0.75	
Brimley Road & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.19	0.49	0.53	0.26	0.05	0.33	0.05	0.38	
Eglinton Avenue East & Barbados Boulevard									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.88		0.41	0.03				

Exhibit 3-8: Scenario 2 - Synchro Results (AM)

Eglinton Avenue & Glider Drive									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.70	0.53	0.97	0.91		0.22		0.24	
Eglinton Avenue East & Brimley Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.56		1.33	0.39	0.41	0.22	0.39	0.43
Eglinton Avenue East & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.47		1.06	0.13	0.74	0.99	0.73	
Brimley Road & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.43	0.27	0.39	0.37	0.13	0.39	0.05	0.44	
Eglinton Avenue East & Barbados Boulevard									
Lane Group	EBU	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	1.03	0.30	0.18	1.00	0.08				

Exhibit 3-9: Scenario 2 (Phase 1 Included at Brimley) - Synchro Results (PM)

Eglinton Avenue & Glider Drive									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	1.43	1.00	1.04	0.33		0.14		0.51	
Eglinton Avenue East & Brimley Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		1.11		0.56	0.53	0.84	0.93	0.32	0.24
Eglinton Avenue East & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.98		0.58		0.88	1.69	0.67	
Brimley Road & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.16	0.49	0.53	0.18	0.05	0.33	0.05	0.38	
Eglinton Avenue East & Barbados Boulevard									
Lane Group	EBU	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.83	0.78	0.11	0.77	0.05				

Exhibit 3-10: Scenario 2 (Phase 1 Removed at Brimley) - Synchro Results (PM)

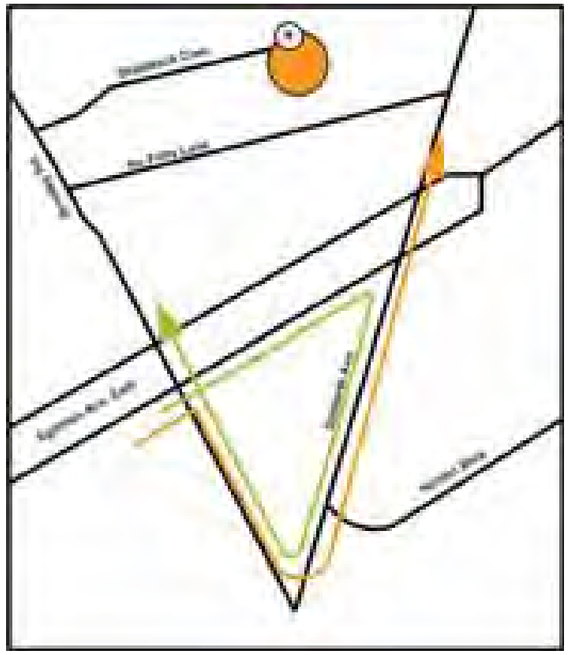
Eglinton Avenue & Glider Drive									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	1.43	1.00	1.04	0.33		0.14		0.51	
Eglinton Avenue East & Brimley Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		1.11		0.56	0.49	0.69	1.11	0.32	0.24
Eglinton Avenue East & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.98		0.58		0.88	1.69	0.67	
Brimley Road & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.16	0.49	0.53	0.18	0.05	0.33	0.05	0.38	
Eglinton Avenue East & Barbados Boulevard									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.83	0.78	0.11	0.76	0.05				

Comparing the two scenarios, the differences to the severely constrained movements are minor. Highest priority is given to east-west traffic at an intersection given the presence of the LRT. Scenario 2, therefore, is the preferred alternative for traffic signal phasing since it allows a more appropriate distribution of green time for all movements, with the southbound left-phase removed during the PM peak. However, given the configuration of the network, it may be inappropriate to assume the redistribution of left-turn flows as identified in Scenario 2. This analogy is revisited in Scenario 3, as will be discussed in Section 4.

4. SECOND ITERATION – ADJUSTED DISTRIBUTION OF VOLUMES

The second iteration explores the application of the four-phase signal operation (Scenario 2) under more realistic driving conditions. Due to the nature of the road network in the area, this scenario assumes that those who would previously perform an eastbound left-turn would now take advantage of the Brimley-Danforth-Eglinton triangle and not U-turn at a downstream intersection. The redistributed eastbound turn movements for this scenario are shown in **Exhibit 4-1**.

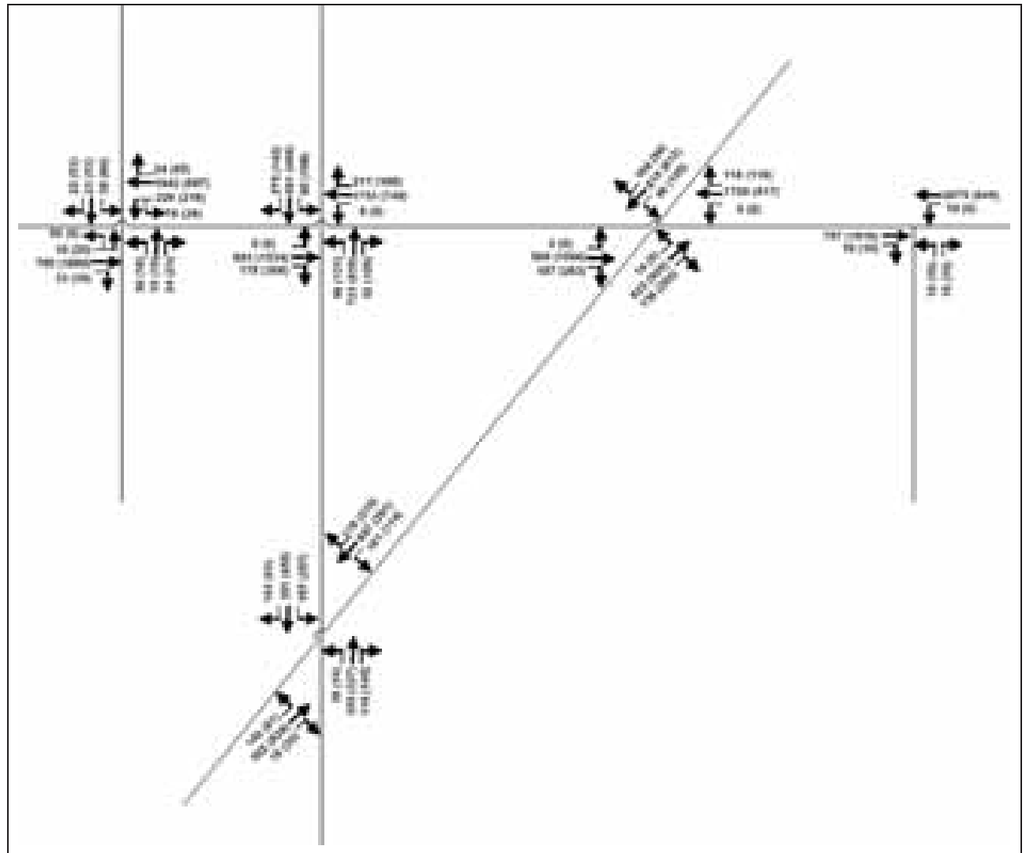
Exhibit 4-1: Redistributed Eastbound Left Turn movements



4.1 Traffic Volumes

Exhibit 4-2 presents the intersection volumes for both the AM and PM peak periods used in the second iteration. Eastbound left turn volumes were redistributed within the Eglinton-Brimley-Danforth triangle where such movements were most likely to occur. As a result, it was not necessary to develop turning movement volumes for the new signalized intersection at Eglinton Avenue and Barbados Boulevard by carrying the upstream discharge volumes, since they would now be redistributed in the Brimley-Danforth-Eglinton triangle. Westbound left turn volumes were carried through the intersections and made into U-turn movements at the nearest downstream intersections.

Exhibit 4-2: Second Iteration - Turning Movement Volumes (AM)



4.2 Scenarios

Two scenarios were built on the preferred scenario in the first iteration of analysis. The scenarios explore enhanced driver behaviour alternatives. The additional scenario beyond the base scenario are described below.

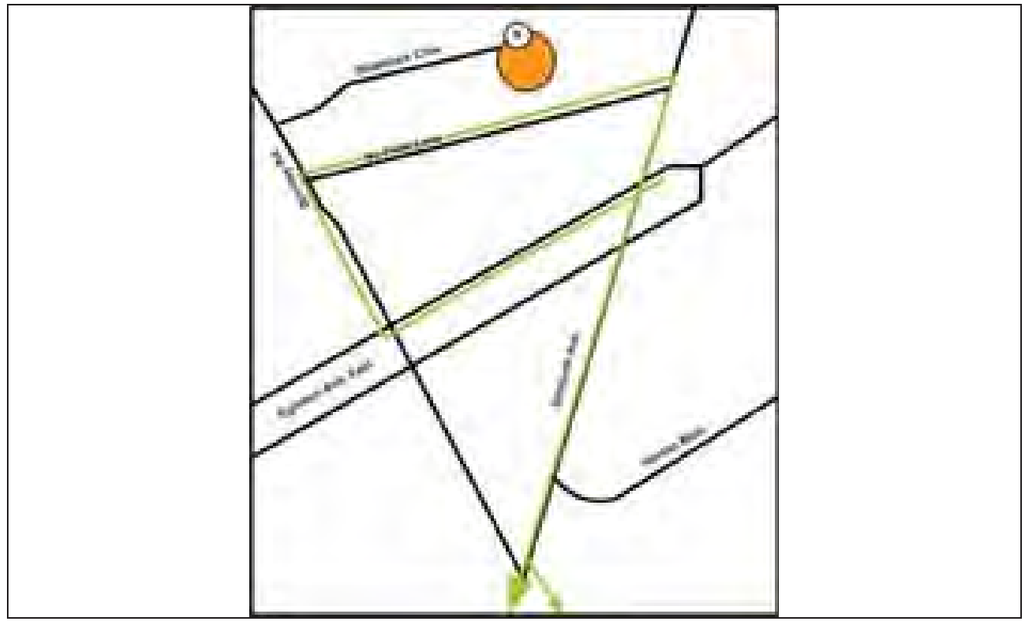
4.2.1 SCENARIO 3-1 – BASE SCENARIO (REDISTRIBUTED EASTBOUND LEFT TURNS)

Built off the preferred scenario under the first stage of analysis is described in Scenario 3.

4.2.2 SCENARIO 3-2 – BASE SCENARIO PLUS REDISTRIBUTED WESTBOUND LEFT TURNS VIA NO FRILLS LANE (AM PEAK ONLY)

Westbound traffic now loops northbound via Brimley Road, eastbound via No Frills Lane, and southwest via Danforth, as shown in **Exhibit 4-3**. This is only applicable during the AM peak when westbound through-volumes are highest.

Exhibit 4-3: Redistributed Westbound Left Turns



4.2.3 STAGE 2 – ANALYSIS RESULTS AND PREFERRED SCENARIO

Exhibit 4-4 and **Exhibit 4-5** show the results of Scenario 3-1 for the AM and PM peak periods. **Exhibit 4-6** shows the results of Scenario 3-2 for the AM peak only. As can be observed, optimal use of the existing network helps to reduce the capacity issues associated with the redistribution of green time to accommodate the LRT. However, it may be impractical to suggest the use of No Frills Lane since it is a private thoroughfare.

Exhibit 4-4: Scenario 3-1 - Synchro Results (AM)

Eglinton Avenue & Glider Drive									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.70	0.53	0.97	0.91		0.22		0.24	
Eglinton Avenue East & Brimley Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.55		1.30	0.42	0.54	0.31	0.41	0.43
Eglinton Avenue East & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.44		0.97	0.09	0.74	0.94	0.62	
Brimley Road & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.55	0.27	0.39	0.47	0.13	0.39	0.56	0.44	
Eglinton Avenue East & Barbados Boulevard									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.34	0.10	0.85	0.06				

Exhibit 4-5: Scenario 3-1 - Synchro Results (PM)

Eglinton Avenue & Glider Drive									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	1.43	1.00	1.04	0.33		0.14		0.51	
Eglinton Avenue East & Brimley Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		1.17		0.56	0.53	0.77	0.89	0.32	0.24
Eglinton Avenue East & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.88		0.45		1.09	1.69	0.67	
Brimley Road & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.23	0.49	0.53	0.32	0.05	0.33	0.79	0.38	
Eglinton Avenue East & Barbados Boulevard									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.85		0.39	0.04				

Exhibit 4-6: Scenario 3-2 – Synchro Results (AM)

Eglinton Avenue & Glider Drive									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.70	0.41	0.29	0.95		0.20		0.21	
Eglinton Avenue East & Brimley Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.56		0.94	0.39	0.51	0.29	0.39	0.42
Eglinton Avenue East & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.44		0.97	0.23	0.74	0.94	0.88	
Brimley Road & Danforth Road									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	0.77	0.27	0.46	0.58	0.13	0.39	0.56	0.44	
Eglinton Avenue East & Barbados Boulevard									
Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.34	0.10	0.85	0.06				

The analysis results show that at the subject intersections:

- Scenario 3-1 performs worse than Scenario 2 during the PM peak period, while it performs better than Scenario 2 during the AM peak period

Scenario 3-2

- The optimal use of the road network eliminates capacity issues during the AM peak period, but this scenario may not warrant consideration due to the use of a private driveway.

Based on the results of the second iteration of Synchro analysis, Scenario 3-1 is the preferred alternative as it allows the most volume to pass through the study area and assumes a balance of distribution of volumes.

5. THIRD ITERATION – NEW SIGNAL PHASING WITH ADJUSTED DISTRIBUTION OF VOLUMES

The third iteration explores operational improvement scenarios at the Kingston Road at Morningside Avenue intersection based on the results from the second iteration of Synchro analysis.

5.1 Traffic Volumes

The second iteration explores the application of a combination of four-phase and six-phase operation. Due to the nature of the road network in the area, this scenario assumes that those who would perform an eastbound left-turn would now take advantage of the Brimley-Danforth-Eglinton triangle and not U-turn at a downstream intersection when a turn restriction is implemented.

5.2 Scenarios

Three scenarios were built on the preferred scenario in the second stage of analysis, Scenario 3-1. The scenarios explore operational improvement alternatives. The four scenarios, in addition to the base scenario are described below.

5.2.1 SCENARIO 4-A – SIX PHASE OPERATION AT DANFORTH, FOUR PHASE OPERATION AT BRIMLEY

For Scenario 4-A, while the intersection of Eglinton Avenue and Danforth Road operates with six phases, the intersection of Eglinton Avenue and Brimley Road operates as a four-five phase operation with and without a southbound left turn phase during the PM peak. Under this scenario, the existing east-west left turn phase operation is removed at Brimley Road. In a separate test, the southbound left turn phase is also removed at the Eglinton-Brimley intersection. Westbound left turn volumes at Brimley were carried through the intersections and made into U-turn movements at the nearest downstream intersections. Eastbound left-turn volumes were carried two intersections downstream due to the large conflicting left-turn volumes at Danforth Road. Minimum cycle lengths for this scenario can be seen in **Exhibit 3-3** for the six-phase signal at Danforth, and **Exhibit 3-5** for the four-phase signal at Brimley.

5.2.2 SCENARIO 4-B – FOUR PHASE OPERATION AT DANFORTH, SIX PHASE OPERATION AT BRIMLEY

For Scenario 4-B, while the intersection of Eglinton Avenue and Danforth Road operates with four phases, the intersection of Eglinton Avenue and Brimley Road is six phase operation with and without the southbound left turn phase during the PM peak. Under this scenario, the existing east-west left turn phase operation is removed at Danforth Road. In a separate test, the southbound left turn phase is also removed at the Eglinton-Brimley intersection. Eastbound left turn volumes at Danforth were carried through the intersections and made into U-turn movements at the nearest downstream intersections. Westbound left-turn volumes were carried to Brimley Road, where left-turns would be performed there, followed by a westbound right-turn onto Danforth Road south of the intersection. Minimum cycle lengths for this scenario can be seen in **Exhibit 3-3** for the six-phase signal at Brimley, and **Exhibit 3-5** for the four-phase signal at Danforth.

5.2.3 SCENARIO 4-C – FIVE PHASE OPERATION ON EGLINTON AVENUE

Exhibit 5-1 presents the NEMA phase diagram at the intersection of Eglinton Avenue at Danforth Road for Scenario 4-C, and **Exhibit 5-2** presents the NEMA phase diagram for the intersection of Eglinton Avenue and Brimley Road. Under this scenario, the existing eastbound left-turn phase is removed at Danforth Road, and the existing westbound left turn phase operation is removed at Brimley Road. In a separate test, the southbound left turn phase is also removed at the Eglinton-Brimley intersection. Eastbound left turn volumes at Danforth were carried through the intersections and made into U-turn movements at the nearest downstream intersections. Westbound left-turn volumes were carried to Brimley Road, where left-turns would be performed there, followed by a westbound right-turn onto Danforth Road south of the intersection.

Exhibit 5-1: Five Phase Operation at Danforth

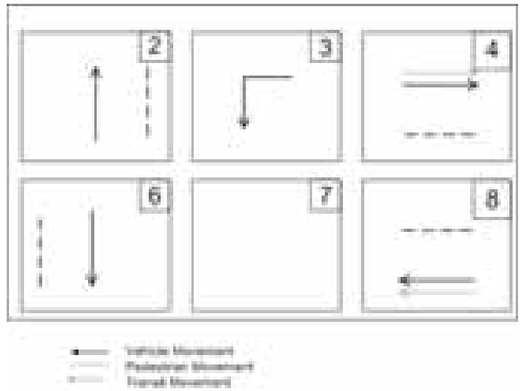
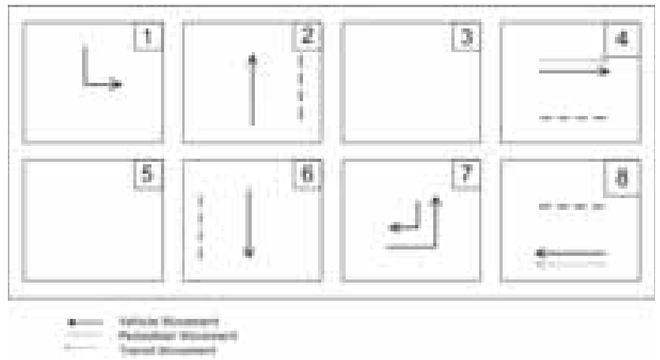


Exhibit 5-2: Five Phase Operation at Brimley *(Phase 1 Added During PM Peak Only)*



5.3 Third Iteration – Analysis Results

and **Exhibit 5-4** present the Synchro Volume to Capacity (V/C) analysis results for the scenarios of the third iteration of analysis.

The following summarizes the major findings from this third stage of Synchro analysis.

Scenario 4-A

- Many capacity issues remain on turning movements at subject intersections (impact not as severe during AM peak at Eglinton Avenue and Brimley Road).
- Impacts reduced during PM peak period with additional southbound left-turn phase at Brimley.

Scenario 4-B

- Many capacity issues remain on turning movements at subject intersections
- Impacts reduced during PM peak period with additional southbound left-turn phase at Brimley.

Scenario 4-C

- Many capacity issues remain on turning movements at subject intersections (impact not as severe during AM peak at Eglinton Avenue and Brimley Road).

Based on the below analysis results, Scenario 4-A is the preferred option due to the reduced capacity issues. However, it is not as operationally preferable as Scenario 2 in that there are fewer critical movements in Scenario 2 than in Scenario 4-A.

Exhibit 5-3: Third Iteration - Synchro Results (AM)

Eglinton Avenue East & Gilder Drive										
Lane Group	Scenario 4-A	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.70	0.44	0.56	0.96		0.20		0.21	
Lane Group	Scenario 4-B	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.70	0.42	0.55	0.91		0.22		0.24	
Lane Group	Scenario 4-C	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.70	0.43	0.56	0.94		0.21		0.22	
Eglinton Avenue East & Brimley Road										
Lane Group	Scenario 4-A	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio			0.42		0.99	0.46	0.57	0.35	0.43	0.46
Lane Group	Scenario 4-B	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		1.02	0.55	1.04	0.99	0.89	0.66	0.52	0.63	0.50
Lane Group	Scenario 4-C	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.93	0.41		0.99	0.95	0.68	0.56	0.65	0.50
Eglinton Avenue East & Danforth Road										
Lane Group	Scenario 4-A	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.99	0.49	1.00	0.99	0.23	0.87	1.48	0.85	
Lane Group	Scenario 4-B	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio			0.32		1.00	0.12	0.85	1.48	0.71	
Lane Group	Scenario 4-C	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio			0.39	1.45	0.87	0.14	0.89	1.48	0.74	
Brimley Road & Danforth Road										
Lane Group	Scenario 4-A	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.55	0.27		0.46	0.47	0.39	0.05	0.44	
Lane Group	Scenario 4-B	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.48	0.29		0.42	0.40	0.36	0.50	0.54	
Lane Group	Scenario 4-C	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.59	0.27		0.46	0.49	0.39	0.56	0.42	
Eglinton Avenue East & Barbados Boulevard										
Lane Group	Scenario 4-A	EBU	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio			0.37	0.05	0.85	0.06				
Lane Group	Scenario 4-B	EBU	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio			0.34	0.10	0.85	0.06				
Lane Group	Scenario 4-C	EBU	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio			0.34	0.10	0.85	0.06				

Exhibit 5-4: Third Iteration - Synchro Results (PM)

Eglinton Avenue East & Gilder Drive										
Lane Group	Scenario 4-A	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	with SBLT	0.71	0.85	0.96	0.33		0.14		0.53	
Lane Group	Scenario 4- A	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	without SBLT	0.71	0.85	0.96	0.33		0.14		0.53	
Lane Group	Scenario 4-B	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	with SBLT	0.71	0.85	0.96	0.33		0.14		0.53	
Lane Group	Scenario 4-B	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	without SBLT	0.71	0.85	0.96	0.33		0.21		0.22	
Lane Group	Scenario 4-C	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.71	0.85	0.96	0.33		0.14		0.53	
Eglinton Avenue East & Brimley Road										
Lane Group	Scenario 4-A	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	with SBLT		1.00		0.41	0.63	0.68	0.77	0.36	0.25
Lane Group	Scenario 4- A	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	without SBLT	0.95	1.00	1.17	0.46	1.18	0.81	2.29	0.56	0.35
Lane Group	Scenario 4-B	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	with SBLT	1.12	1.00	1.68	0.46	1.01	0.97	1.29	0.51	0.33
Lane Group	Scenario 4-B	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	without SBLT	0.93	0.41		0.99	0.95	0.68	0.56	0.65	0.50
Lane Group	Scenario 4-C	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		1.28	0.88		0.46	0.92	0.97	1.04	0.48	0.31
Eglinton Avenue East & Danforth Road										
Lane Group	Scenario 4-A	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	with SBLT	1.13	0.99	1.47	0.46		0.97	1.69	0.75	
Lane Group	Scenario 4- A	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	without SBLT		0.75		0.38		1.09	1.69	0.67	
Lane Group	Scenario 4-B	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	with SBLT		0.75		0.38		1.09	1.69	0.67	
Lane Group	Scenario 4-B	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	without SBLT		0.39	1.45	0.87	0.14	0.89	1.48	0.74	
Lane Group	Scenario 4-C	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio			0.94	1.68	0.40		0.99	1.69	0.61	
Brimley Road & Danforth Road										
Lane Group	Scenario 4-A	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	with SBLT	0.28	0.49		0.66	0.41	0.33	0.05	0.38	
Lane Group	Scenario 4- A	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	without SBLT	0.19	0.49		0.53	0.26	0.33	0.79	0.48	
Lane Group	Scenario 4-B	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	with SBLT	0.19	0.49		0.53	0.26	0.33	0.79	0.48	
Lane Group	Scenario 4-B	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	without SBLT	0.59	0.27		0.46	0.49	0.39	0.56	0.42	
Lane Group	Scenario 4-C	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio		0.19	0.49		0.63	0.26	0.33	0.79	0.36	
Eglinton Avenue East & Barbados Boulevard										
Lane Group	Scenario 4-A	EBU	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	with SBLT		0.72		0.33	0.06				
Lane Group	Scenario 4- A	EBU	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	without SBLT		0.74		0.34	0.05				
Lane Group	Scenario 4-B	EBU	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	with SBLT		0.82		0.38	0.04				
Lane Group	Scenario 4-B	EBU	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio	without SBLT		0.34	0.10	0.85	0.06				
Lane Group	Scenario 4-C	EBU	EBT	WBL	WBT	NBL	NBT	SBL	SBT	SBR
v/c Ratio			0.88		0.41	0.03				

6. OPERATIONS ANALYSIS – SIGNAL COORDINATION

To further understand a minimum green time required to clear the LRT at the intersections of Eglinton at Brimley and Eglinton at Danforth an analysis of signal coordination using a time space diagram was undertaken. The two scenarios featured a cycle length of 110 seconds, no protected left-turn phases (thus a ban on east-west left turns), a minimum green of 57 seconds for the east-west phase, and a minimum amber and all-red time of 9 and 4 seconds respectively for the east-west phase.

6.1 Critical LRT Movements

In both cases, the goal of the analysis was to understand the results of the following four LRT movements:

1. A westbound LRT traveling at the start of green at Danforth (commencing at a speed of 0km/h), stopping at the platform between Danforth and Brimley, then proceeding past Brimley;

2. A westbound LRT traveling at the end of green at Danforth while traveling at a maximum speed of 25km/h, stopping at the platform between Danforth and Brimley, then proceeding past Brimley;

3. An eastbound LRT traveling at the start of green at Brimley (commencing at a speed of 0km/h) and proceeding past Danforth to stop at the farside platform;

4. An eastbound LRT traveling at the end of green at Brimley while traveling at a maximum speed of 25km/h and proceeding past Danforth to stop at the farside platform.

6.2 Scenarios

The two scenarios analysed were as follows:

- **Scenario 5 –** 0 second offset
- **Scenario 6 –** 20 second offset at Brimley

6.3 Analysis Results

Exhibit 6-1 shows the four analyzed LRT movements through the two subject intersections under a 0 second offset. The diagram suggests that:

- LRT movement #1 can successfully clear Brimley Road with no delay;
- LRT movement #2 is delayed between Danforth Road and Brimley Road after boarding and alighting passengers at the westbound platform;
- LRT movement #3 can successfully clear Danforth Road with no delay;
- LRT movement #4 is delayed at Danforth Road, but could clear with some transit signal priority (TSP) measures;

- An east-west left turn phase could be inserted at end of the east-west green with little impact to LRV operation.

Scenario 6 was designed to help clear movements that were delayed under Scenario 5. **Exhibit 6-2** shows the four analyzed LRT movements through the two subject intersections under a 20 second offset at Brimley Road. The diagram suggests that:

- LRT movement #1 can successfully clear Brimley Road with no delay;
- LRT movement #2 is delayed between Danforth Road and Brimley Road after boarding and alighting passengers at the westbound platform, but could clear Brimley Road with some TSP measures;
- LRT movement #3 can successfully clear Danforth Road with no delay;
- LRT movement #4 is delayed at Danforth Road.

Scenario 6 shows some modest improvement for LRT movements when east-west left-turns are removed. It is therefore recommended that this scenario be implemented.

Exhibit 6-1: Time-Space Diagram for Scenario 1

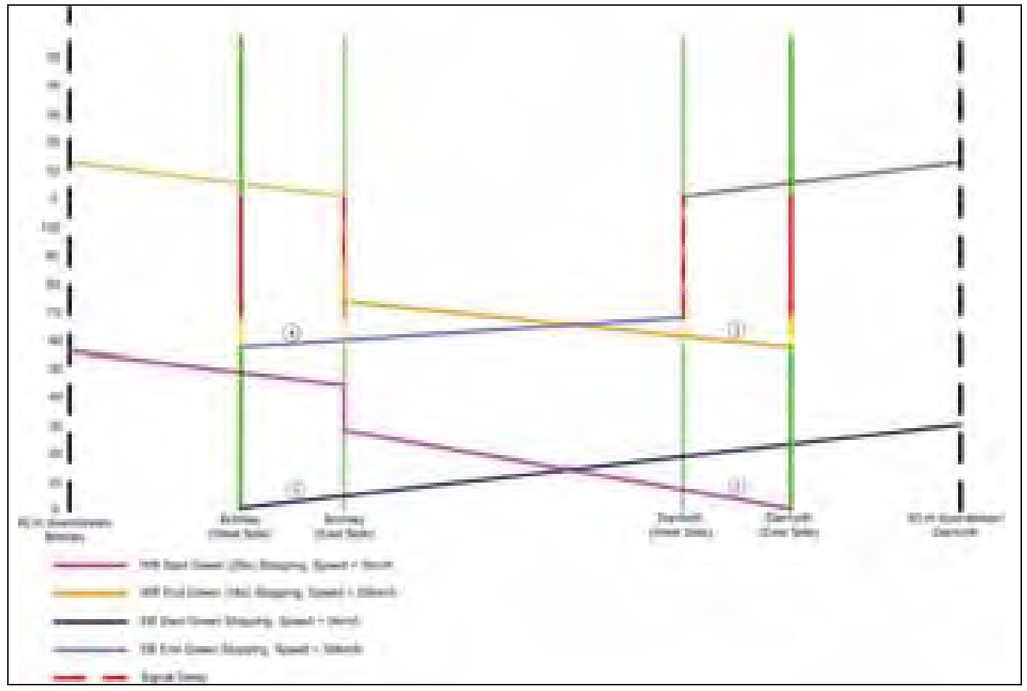
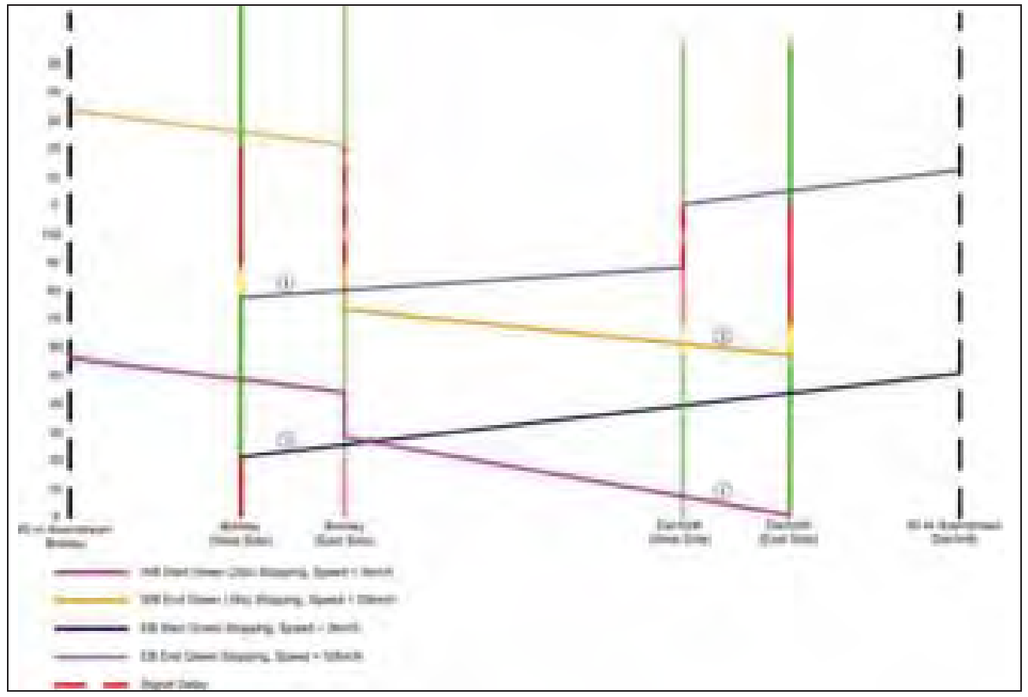


Exhibit 6-2: Time-Space Diagram for Scenario 2



7. ANALYSIS SUMMARY

Based on the results of the 3-iteraiton Synchro analysis, Scenario 2 (as supported by Scenario 6) is the preferred alternative as it provides the most overall benefit to the LRV.

Scenario 2 is to implement all of the following:

- Four phase signal operation at Brimley/Eglinton and Danforth/Eglinton, with restricted east-west left turn movements at these intersections;
- Min cycle length is 85 seconds, but 110-120s cycle length is recommended based on current conditions;
- East-west green time should be a minimum of 57 seconds to allow coordinated progression for LRT between both intersections.

APPENDIX A

CALCULATIONS TO DETERMINE TRANSIT PHASE DURATION

APPENDIX A – Calculations to Determine Transit Phase Duration

Danforth Westbound Start at Beginning of Green

Danforth Clearance:

Distance to clear (stopbar at Danforth to stopbar at Brimley) (D_t) = 158 m

Initial speed (V_i) = 0 m/s

Maximum traveling speed M_v = 25 km/hr, or 6.9 m/s

Acceleration (A_c) = 1.4 m/s^2

Deceleration (D_c) = -1.6 m/s^2

Time to accelerate (T_a) to 25 km/hr = $(M_v-V_i)/A_c$ = (6.9-0)/1.4 = 4.9 sec

Distance to accelerate (D_a) to 25 km/hr = $V_i*T_a+0.5*A_c*T_a^2$ = 0*5+0.5*1.4*5^2 = 17.0 m

Time to decelerate (T_d) from 25 km/hr = $(V_i-M_v)/D_c$ (0-25)/-1.6 = 4.3 sec

Distance to decelerate from (D_d) 25 km/hr = $V_i*T_d+0.5*D_c*T_d^2$ = 0*4.3+0.5*1.6*4.3^2 = 14.9 m

Distance at M_v (D_{Mv}) = $D_t-(D_a+D_d)$ = 158 – (17.0+14.9) = 126.1 m

Time at M_v (T_{Mv}) = D_{Mv}/M_v = 97.7/6.9 = 18.3 sec

Total Time = $T_a+T_{Mv}+T_d$ = 5+14.1+4.3 = 27.5 sec

Brimley Clearance:

Intersection clearance (D_i) = 34 m

Vehicle length (V_l) = 60 m

Distance to clear (D_t) = $D_i + V_l$ = 94 m

Initial speed (V_i) = 0 m/s

Maximum traveling speed M_v = 50 km/hr, or 13.9 m/s

Acceleration (A_c) = 1.4 m/s^2

Deceleration (D_c) = -1.6 m/s^2

Time to accelerate (T_a) to 25 km/hr = $(M_v-V_i)/A_c$ = (13.9-0)/1.4 = 9.9 sec

Distance to accelerate (D_a) to 25 km/hr = $V_i*T_a+0.5*A_c*T_a^2$ = 0*9.9+0.5*1.4*9.9^2 = 68.9 m

Distance at M_v (D_{Mv}) = D_t-D_a = 94 – 68.9 = 25.1 m

Time at M_v (T_{Mv}) = D_{Mv}/M_v = 25.1/13.9 = 1.8 sec

Total Time = T_a+T_{Mv} = 9.9+1.8 = 11.7 sec

Total Clearance of Both Intersections:

Assume start up lost time = 2 seconds

Assume boarding and alighting time at platform = 16 seconds

Total transit phase duration = 2+16+27.5+11.7 = 57.2 seconds

Using this information, the transit vehicle green duration is:

As a result the east-west (transit) phase consists of:

• 57 second minimum green

• 9 second amber

• 4 second all red.

• Minimum phase duration of 70 seconds.

ATTACHMENT IV

SCARBOROUGH – MALVERN LRT EA – KINGSTON ROAD AT EGLINTON AVENUE SYNCHRO ASSESSMENT

December 15, 2008

Toronto Transit Commission (TTC)

SCARBOROUGH - MALVERN LRT EA - KINGSTON ROAD AT EGLINTON AVENUE SYNCHRO ASSESSMENT

FINAL REPORT

DECEMBER 15, 2008

December 15, 2008

TABLE OF CONTENTS

1. PROJECT SCOPE IV-1

2. DATA IV-3

2.1 Traffic Volume Reductions IV-3

2.2 Bus Routes & Pedestrian Volumes IV-5

2.3 LRV Phase IV-6

3. DETAILED SCENARIO DESCRIPTION AND SYNCHRO ANALYSIS IV-6

3.1 Scenario 1 ..... IV-6

3.2 Scenario 2 ..... IV-7

3.3 Scenario 3 ..... IV-9

3.4 Scenario Results IV-10

3.5 Sub Scenario 1 Synchro Results IV-15

3.5.1 Sub Scenario 1 - Scenario 1 Summary IV-15

3.5.2 Sub Scenario 1 - Scenario 2 Summary IV-15

3.5.3 Sub Scenario 1 - Scenario 3 Summary IV-16

3.6 Sub Scenario 2 Synchro Results IV-16

3.6.1 Sub Scenario 2 - Scenario 1 Summary IV-16

3.6.2 Sub Scenario 2 - Scenario 2 Summary IV-16

3.6.3 Sub Scenario 2 - Scenario 3 Summary IV-16

4. RECOMMENDED SCENARIO IV-16

LIST OF EXHIBITS

Exhibit 1-1: Study Area IV-2
Exhibit 2-1: Projected Future Traffic Volume without Volume Reduction IV-3
Exhibit 2-2: Kingston Road and Eglinton Avenue Through Volume Reduction IV-4
Exhibit 2-3: Study Area Through Volume Reduction IV-4
Exhibit 2-4: Projected Future Traffic Volume with Volume Reduction IV-5
Exhibit 2-5: Exiting Transit Service IV-5
Exhibit 3-1: Scenario 1 – Kingston Road at Eglinton Avenue North leg Phasing Scheme IV-7
Exhibit 3-2: Scenario 1 – Minimum Cycle Length IV-7
Exhibit 3-3: Scenario 2 - Kingston Road at Eglinton Avenue North leg Phasing Scheme IV-8
Exhibit 3-4: Scenario 2 – Minimum Cycle Length IV-8
Exhibit 3-5: Scenario 3 – Kingston Road and Eglinton Avenue North Leg Phasing Scheme IV-9
Exhibit 3-6: Scenario 3 – Minimum Cycle Length IV-9

TABLE OF CONTENTS (CONT'D)

Exhibit 3-7: Scenario 1 – Sub Scenario 1 Synchro Model Results IV-10
Exhibit 3-8: Scenario 2 – Sub Scenario 1 Synchro Model Results IV-11
Exhibit 3-9: Scenario 3 – Sub Scenario 1 Synchro Model Results IV-12
Exhibit 3-10: Scenario 1 – Sub Scenario 2 Synchro Model Results IV-13
Exhibit 3-11: Scenario 2 – Sub Scenario 2 Synchro Model Results IV-14
Exhibit 3-12: Scenario 3 – Sub Scenario 2 Synchro Model Results IV-15

1. PROJECT SCOPE

This report documents the Synchro traffic analysis completed on the Kingston Road at Eglinton Avenue signalized intersection. The purpose of the analysis is to conduct a preliminary assessment of the future Light Rail Vehicle (LRV) operation, and to determine impacts to traffic operation and land use. The objective of this report is to advance the initial design to a point where it could be comfortably presented to the public. The analysis conducted in this report can be used as a base to develop a preliminary and detailed design.

Synchro analysis was conducted for three scenarios, which included a new transit mall at Kingston Road and Eglinton Avenue (on Eglinton Avenue). The transit mall will facilitate the transfer of passengers between the LRT and bus. **Exhibit 1-1** shows the study area with the three signalized intersections included in the analysis. Of the three intersections shown, a new signalized intersection is to be implemented on Kingston Road, approximately midway between Eglinton Avenue and Scarborough Golf Club Road. As part of the new transit mall, Eglinton Avenue was 'split' into an eastbound section (as in the current alignment, south of the transit mall), and a westbound section north of the transit mall (which required a new signalized intersection).

The report describes:

- Traffic volumes and pedestrian volumes that were developed for the future LRV operation, along with the recommended transit phase that will be used to progress the LRV through the Kingston Road at Eglinton Avenue signalized intersection.
- The results of the Synchro analysis that was used to assess each of the three scenarios.
- The recommended scenario.

IBI GROUP FINAL REPORT

TORONTO TRANSIT COMMISSION (TTC)
SCARBOROUGH - MALVERN LRT EA - KINGSTON ROAD AT EGLINTON AVENUE SYNCHRO ASSESSMENT

Exhibit 1-1: Study Area

2. DATA

The following data was used to formulate the analysis of the road network surrounding the Kingston Road at Eglinton Avenue intersection.

2.1 Traffic Volume Reductions

Exhibit 2-1 presents the projected future traffic volumes.

Exhibit 2-1: Projected Future Traffic Volume without Volume Reduction

Under future conditions, Kingston Road and Eglinton Avenue will lose one lane of through traffic in each direction to the LRT alignment. This reduction in roadway capacity will result in many of the vehicles currently using Kingston Road as a corridor to switch to transit, or detour from Kingston Road to alternate routes. As a result, the projected future volumes were adjusted to estimate the potential operating capacity of the new system, with respect to mixed traffic.

Only the Kingston Road and Eglinton Avenue corridor volumes that exceeded capacity were reduced. Specifically, these were the southwest through volumes in the AM peak and the northeast

through volumes in the PM peak. The reductions were applied to the Kingston Road at Scarborough Golf Club Road, the Kingston Road at Eglinton Avenue, and the Kingston Road at Cedar Drive intersections. The Kingston Road at Scarborough Golf Club Road intersection was recognized to be the governing point for traffic along the Kingston Road corridor, and thus corridor volumes were reduced such that the through volume was equal to the capacity (V/C = 1.00) at Kingston Road at Scarborough Golf Club Road. The Kingston Road at Scarborough Golf Club Road volume reduction was calculated in **Exhibit 2-2,** while corridor volume reductions are shown in **Exhibit 2-3**. These through volume reductions were applied to all scenarios.

Exhibit 2-2: Kingston Road and Eglinton Avenue Through Volume Reduction

Kingston Road at Scarborough Golf Club Intersection					
AM Peak - Southwest Through			PM Peak - Northeast Through		
Future Through Volume	Through Reduction (Volume)	Through Reduction (%)	Future Through Volume	Through Reduction (Volume)	Through Reduction (%)
3290	1515	46%	3250	1275	39%

** Through volume reduction was applied to achieve a through movement v/c ratio of ~ 1.00.*

Exhibit 2-3: Study Area Through Volume Reduction

Exhibit 2-4 illustrates the projected future traffic volume after volume reductions have been applied.

Exhibit 2-4: Projected Future Traffic Volume with Volume Reduction

2.2 Bus Routes & Pedestrian Volumes

Several bus routes currently service the entire study area or partially service the area. **Exhibit 2-5** identifies the bus route number, the existing frequency and additional changes to the route service once the LRV is implemented.

Exhibit 2-5: Exiting Transit Service

Route #	Description	Frequency		Comments
		AM Peak	PM Peak	
34	Eglinton East	10 minutes or less	10 minutes or less	To be replaced with LRV service
86	Scarborough	10 minutes or less	10 minutes or less	Proposed rerouting and increased frequency (~5 minutes)
102	Markham Road	10 minutes or less	10 minutes or less	Proposed rerouting and increased frequency (~5 minutes)
116	Morning Side	10 minutes or less	10 minutes or less	To be replaced by 116 Brockgrove with 20 minute frequency
Kingston BRT	To be implemented	Assumed 4 minutes	Assumed 4 minutes	To be introduced with LRV service

Pedestrian and passenger volumes were obtained from TTC staff. The bus/LRV passenger transfers will occur in the transit mall and as a result, no additional pedestrians were added to the signalized intersections within the study area. Thus, only existing pedestrian volumes were incorporated at study signalized intersections.

2.3 LRV Phase

The LRV is completing a southbound right and eastbound left at the Kingston Road at Eglinton Avenue north leg signalized intersection. An underlying assumption is that the 60 meter LRV can make both movements simultaneously. The transit phase consists of a vehicle minimum green duration, and vehicle clearance time. The transit phase duration was calculated by estimating the time to make the turn from a stopped position. This time includes the time to accelerate to the maximum turning speed (assumed to be 25 km/hr), plus the time to slow to a stop position assuming that a far side stop is used. The transit phase was calculated to be:

- 5 second minimum green
- 15.9 second amber
- 3.0 second all red.
- Minimum phase duration of 23.9 seconds.

The calculation to determine the transit phase can be found in Appendix A.

3. DETAILED SCENARIO DESCRIPTION AND SYNCHRO ANALYSIS

This section of the report reviews the three Synchro scenarios proposed for the Kingston Road at Eglinton Avenue intersection, and analyzes the LRV and other vehicle traffic movements using the Synchro model. Two sub scenarios are shown for each scenario; sub scenario 1 will analyze the Synchro model using the projected future volumes. Sub scenario 2 will analyze the Synchro model with the proposed volume reductions.

It should be noted that the assumed transit LRV headway is 3 minutes and 30 seconds for both directions. This translates into 34 transit vehicles per hour in two directions. As a result, the transit phase may be actuated between 17 (eastbound & westbound LRV always arriving at the same time) and 34 (eastbound and westbound LRV never arriving at the same time) times per hour. Based on arrival probabilities, it was assumed that there will be approximately 29 transit calls per hour (some north-eastbound and southbound transit vehicles arriving simultaneously). Using an average cycle length of 120 seconds, 30 LRV phases will be actuated per hour. Factoring the green time from 30 actuations / hour to 29 actuations / hour, the effective green time is reduced from 23.9 s to 23.1 s.

3.1 Scenario 1

Under scenario 1, the LRV movements (southbound right and eastbound left) occur at the Kingston Road and Eglinton Avenue north signalized intersection. Vehicle traffic is not permitted to make a northbound left movement from Kingston Road onto Eglinton Avenue. As a result, northbound left turning vehicles are required to make a U-turn at Scarborough Golf Club Road to access the residential neighbourhood. The north pedestrian crossing is separated into two-stages (flash don't walk time of 32 seconds). Lastly, the southbound right turning traffic approaching the Kingston

Road at Eglinton Avenue north intersection is provided with a channelized right turn lane to access the north Eglinton Avenue leg.

Signal phasing is controlled under a 3 phase system for the Kingston Road at Eglinton Avenue North and South intersections. All transit movements, with the exception of the northbound left bus phase on Kingston Road, occur simultaneously. **Exhibit 3-1** illustrates the 3 phase signal system.

Exhibit 3-1: Scenario 1 – Kingston Road at Eglinton Avenue North leg Phasing Scheme

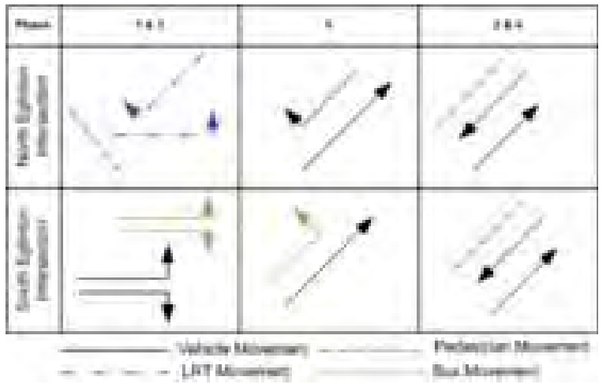


Exhibit 3-2 illustrates the minimum cycle length achieved under Scenario 1.

Exhibit 3-2: Scenario 1 – Minimum Cycle Length

	Phase		
	1 & 3	**5**	**2 & 6**
Minimum Green or walk	5	5	7
Minimum Green and FDWK	21	0	32
Amber	3	3	3
All Red	3	3	3
Total	32	11	45
Minimum Cycle Length	88		

It should be noted that the minimum phase length for the LRV is governed by the pedestrian crossing time. The minimum LRV phase is approximately 23.9 seconds, 8.1 seconds shorter than the required time for the pedestrian phase. Based on the phase and cycle length composition above, the minimum cycle length is 88 seconds. The maximum wait time for the LRV is 83 seconds from the start of the phase 1 and 3 transit amber (21+3+3+11+45).

3.2 Scenario 2

Scenario 2 is similar to Scenario 1 with the exception to the following changes:

- Buses are prohibited from entering Kingston Road via the bus only lane. Therefore buses can only enter Kingston via the south Eglinton Avenue intersection;

- Vehicle traffic has been permitted to make northbound left turns at the Kingston Road at Eglinton Avenue North intersection under a protected/permitted phase. Currently, no northbound left turning traffic exists, thus northbound left turn volume was estimated based on the expected number of vehicles to access the residential neighbourhood adjacent to Eglinton Avenue; and

- The bus only lane has been physically relocated to the south of the intersection, separating the bus activity from the intersection, and in turn shortening the north pedestrian crossing flash don't walk time to 16 seconds.

Exhibit 3-3 illustrates the Scenario 2 phasing scheme and **Exhibit 3-4** presents the minimum cycle length.

Exhibit 3-3: Scenario 2 - Kingston Road at Eglinton Avenue North leg Phasing Scheme

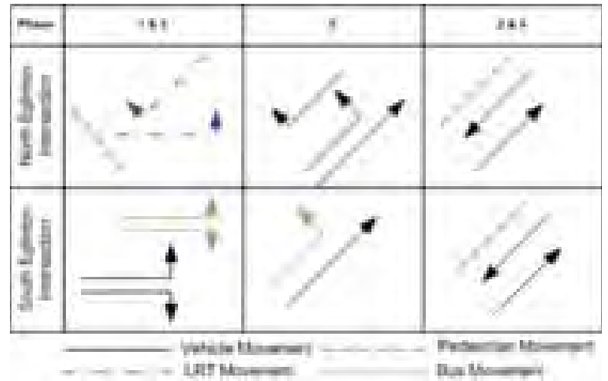


Exhibit 3-4: Scenario 2 – Minimum Cycle Length

	Phase		
	1 & 3	**5**	**2 & 6**
Minimum Green or walk	5	5	7
Minimum Green and FDWK	21	0	16
Amber	3	3	3
All Red	3	3	3
Total	32	11	29
Minimum Cycle Length	72		

Based on the phase and cycle length composition above, and the shortened north pedestrian cross-walk distance the minimum cycle length is 72 seconds. The maximum wait time for the LRV is 67 seconds from the start of the phase 1 and 3 transit amber (21+3+3+11+29).

3.3 Scenario 3

Scenario 3 is also similar to Scenario 1 and 2 with the exception of the following changes:

- Buses are prohibited from accessing Kingston Road via the bus only lane;
- The north pedestrian crossing remains as a 2-stage crossing with a flash don't walk time of 16 seconds;
- The bus northbound left turn phase activates simultaneously with the LRV phase. The bus only lane is shifted south of the intersection which allows for the west pedestrian crossing to occur at the same time; and
- The northbound left movement for vehicle traffic is now permitted and no protected phase is provided.

Exhibit 3-5: Scenario 3 – Kingston Road and Eglinton Avenue North Leg Phasing Scheme

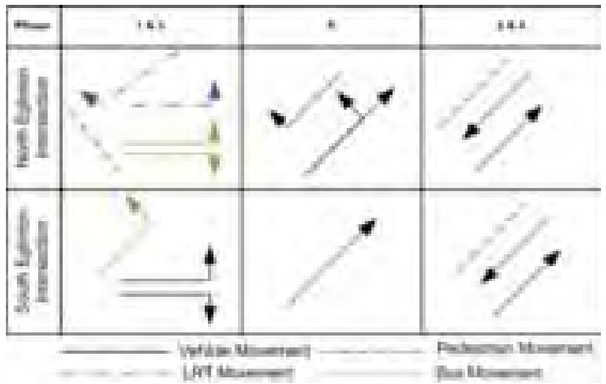


Exhibit 3-6: Scenario 3 – Minimum Cycle Length

	Phase	
	1 & 3/5	**2 & 6**
Minimum Green or walk	5	7
Minimum Green and FDWK	21	16
Amber	3	3
All Red	3	3
Total	32	29
Minimum Cycle Length	61	

Based on the phase and cycle length composition above, and the shortened north pedestrian cross-walk distance the minimum cycle length is 61 seconds. The maximum wait time for the

LRV is 56 seconds from the start of the phase 1 and 3 transit amber (21+3+3+29). This is due to combining the northbound left bus phase with the LRV phase.

3.4 Scenario Results

The Synchro models results were generated for two sub scenarios. Sub scenario 1 analyzes the models using the projected future traffic volumes, while sub scenario 2 analyzes the Synchro models with the applied volume reductions.

It should be noted that the differences between Scenarios 1, 2 and 3 are primarily adjustments to the transit phasing, and also prohibiting or permitting northbound left turning traffic onto Eglinton Avenue from Kingston Road. The results from these analyses are to confirm that the phasing scheme used in the scenarios can be applied from a traffic operations perspective.

Exhibit 3-7, Exhibit 3-8 and **Exhibit 3-9** displays the results for Scenarios 1, 2 and 3 respectively, for sub scenario 1 (prior to volume reductions).

Exhibit 3-7: Scenario 1 – Sub Scenario 1 Synchro Model Results

AM PEAK												
Kingston at Scarborough Golf Club Road												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL/U	NBT	NBR	SBL/U	SBT	SBR
V/C Ratio	-	0.35	-	-	0.14	-	0.73	0.52	-	0.04	1.77	-
Kingston at Eglinton North Leg												
	LRT		**Buses**									
Lane Group	EBL	SWR	EBL/R	NBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	-
V/C Ratio	0.19	0.21	0.45	0.20	-	-	0.40	-	-	0.91	0.80	-
Kingston at Eglinton South Leg												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.68	-	0.09	-	-	-	-	0.20	-	-	0.96	-
Kingston at Cedar Drive												
Lane Group	EBL/U	EBT	EBR	WBL/U	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.83	0.22	-	0.64	0.86	-	-	0.19	-	-	0.29	-
PM PEAK												
Kingston at Scarborough Golf Club Road												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL/U	NBT	NBR	SBL/U	SBT	SBR
V/C Ratio	-	0.15	-	-	0.13	-	0.85	1.63	-	0.69	0.81	-
Kingston at Eglinton North Leg												
	LRT		**Buses**									
Lane Group	EBL	SWR	EBL/R	NBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	-
V/C Ratio	0.19	0.21	0.45	0.20	-	-	1.09	-	-	0.35	0.34	-
Kingston at Eglinton South Leg												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.81	-	0.06	-	-	-	-	0.78	-	-	0.44	-
Kingston at Cedar Drive												
Lane Group	EBL/U	EBT	EBR	WBL/U	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.78	0.86	-	0.53	0.46	-	-	0.13	-	-	0.12	-

Exhibit 3-8: Scenario 2 – Sub Scenario 1 Synchro Model Results

AM PEAK												
Kingston at Scarborough Golf Club Road												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL/U	NBT	NBR	SBL/U	SBT	SBR
V/C Ratio	-	0.35	-	-	0.14	-	0.73	0.52	-	0.04	1.77	-
Kingston at Eglinton North Leg												
	LRT		**Buses**									
Lane Group	EBL	SWR	EBL/R	NBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	-
V/C Ratio	0.23	0.25	-	0.18	-	0.22	0.37	-	-	0.89	0.86	-
Kingston at Eglinton South Leg												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.70	-	0.09	-	-	-	-	0.20	-	-	0.98	-
Kingston at Cedar Drive												
Lane Group	EBL/U	EBT	EBR	WBL/U	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.83	0.21	-	0.64	0.82	-	-	0.20	-	-	0.31	-
PM PEAK												
Kingston at Scarborough Golf Club Road												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL/U	NBT	NBR	SBL/U	SBT	SBR
V/C Ratio	-	0.15	-	-	0.13	-	0.85	1.63	-	0.69	0.81	-
Kingston at Eglinton North Leg												
	LRT		**Buses**									
Lane Group	EBL	SWR	EBL/R	NBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	-
V/C Ratio	0.23	0.25	-	0.18	-	0.10	1.01	-	-	0.35	0.37	-
Kingston at Eglinton South Leg												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.81	-	0.06	-	-	-	-	0.78	-	-	0.44	-
Kingston at Cedar Drive												
Lane Group	EBL/U	EBT	EBR	WBL/U	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.78	0.86	-	0.53	0.46	-	-	0.13	-	-	0.12	-

Exhibit 3-9: Scenario 3 – Sub Scenario 1 Synchro Model Results

AM PEAK												
Kingston at Scarborough Golf Club Road												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL/U	NBT	NBR	SBL/U	SBT	SBR
V/C Ratio	-	0.35	-	-	0.14	-	0.73	0.52	-	0.04	1.77	-
Kingston at Eglinton North Leg												
	LRT		**Buses**									
Lane Group	EBL	SWR	EBL/R	NBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	-
V/C Ratio	0.23	0.25	-	0.20	-	0.60	0.38	-	-	0.81	0.81	-
Kingston at Eglinton South Leg												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.68	-	0.09	-	-	-	-	0.20	-	-	0.96	-
Kingston at Cedar Drive												
Lane Group	EBL/U	EBT	EBR	WBL/U	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.83	0.23	-	0.64	0.87	-	-	0.19	-	-	0.29	-
PM PEAK												
Kingston at Scarborough Golf Club Road												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL/U	NBT	NBR	SBL/U	SBT	SBR
V/C Ratio	-	0.15	-	-	0.13	-	0.85	1.63	-	0.69	0.81	-
Kingston at Eglinton North Leg												
	LRT		**Buses**									
Lane Group	EBL	SWR	EBL/R	NBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	-
V/C Ratio	0.23	0.25	-	0.20	-	0.11	1.04	-	-	0.32	0.35	-
Kingston at Eglinton South Leg												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.81	-	0.06	-	-	-	-	0.78	-	-	0.44	-
Kingston at Cedar Drive												
Lane Group	EBL/U	EBT	EBR	WBL/U	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.78	0.86	-	0.53	0.46	-	-	0.13	-	-	0.12	-

Exhibit 3-10, **Exhibit 3-11** and **Exhibit 3-12** displays the results for Scenarios 1, 2 and 3 respectively, for sub scenario 2 (volume reductions).

Exhibit 3-10: Scenario 1 – Sub Scenario 2 Synchro Model Results

AM PEAK												
Kingston at Scarborough Golf Club Road												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL/U	NBT	NBR	SBL/U	SBT	SBR
V/C Ratio	-	0.35	-	-	0.14	-	0.73	0.52	-	0.04	1.00	-
Kingston at Eglinton North Leg												
	LRT		**Buses**									
Lane Group	EBL	SWR	EBL/R	NBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	-
V/C Ratio	0.19	0.21	0.45	0.20	-	-	0.40	-	-	0.54	0.47	-
Kingston at Eglinton South Leg												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.68	-	0.09	-	-	-	-	0.20	-	-	0.57	-
Kingston at Cedar Drive												
Lane Group	EBL/U	EBT	EBR	WBL/U	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.83	0.31	-	0.64	0.78	-	-	0.14	-	-	0.22	-
PM PEAK												
Kingston at Scarborough Golf Club Road												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL/U	NBT	NBR	SBL/U	SBT	SBR
V/C Ratio	-	0.15	-	-	0.13	-	0.85	1.00	-	0.69	0.81	-
Kingston at Eglinton North Leg												
	LRT		**Buses**									
Lane Group	EBL	SWR	EBL/R	NBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	-
V/C Ratio	0.19	0.21	0.45	0.20	-	-	0.64	-	-	0.35	0.34	-
Kingston at Eglinton South Leg												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.68	-	0.07	-	-	-	-	0.43	-	-	0.40	-
Kingston at Cedar Drive												
Lane Group	EBL/U	EBT	EBR	WBL/U	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.78	0.81	-	0.53	0.68	-	-	0.11	-	-	0.10	-

Exhibit 3-11: Scenario 2 – Sub Scenario 2 Synchro Model Results

AM PEAK												
Kingston at Scarborough Golf Club Road												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL/U	NBT	NBR	SBL/U	SBT	SBR
V/C Ratio	-	0.35	-	-	0.14	-	0.73	0.52	-	0.04	1.00	-
Kingston at Eglinton North Leg												
	LRT		**Buses**									
Lane Group	EBL	SWR	EBL/R	NBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	-
V/C Ratio	0.23	0.25	-	0.18	-	0.17	0.37	-	-	0.53	0.51	-
Kingston at Eglinton South Leg												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.69	-	0.08	-	-	-	-	0.20	-	-	0.58	-
Kingston at Cedar Drive												
Lane Group	EBL/U	EBT	EBR	WBL/U	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.83	0.30	-	0.64	0.74	-	-	0.15	-	-	0.23	-
PM PEAK												
Kingston at Scarborough Golf Club Road												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL/U	NBT	NBR	SBL/U	SBT	SBR
V/C Ratio	-	0.15	-	-	0.13	-	0.85	1.00	-	0.69	0.81	-
Kingston at Eglinton North Leg												
	LRT		**Buses**									
Lane Group	EBL	SWR	EBL/R	NBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	-
V/C Ratio	0.23	0.25	-	0.18	-	0.10	0.59	-	-	0.35	0.37	-
Kingston at Eglinton South Leg												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.68	-	0.07	-	-	-	-	0.43	-	-	0.40	-
Kingston at Cedar Drive												
Lane Group	EBL/U	EBT	EBR	WBL/U	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.78	0.80	-	0.53	0.68	-	-	0.11	-	-	0.10	-

Exhibit 3-12: Scenario 3 – Sub Scenario 2 Synchro Model Results

AM PEAK												
Kingston at Scarborough Golf Club Road												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL/U	NBT	NBR	SBL/U	SBT	SBR
V/C Ratio	-	0.35	-	-	0.14	-	0.73	0.52	-	0.04	1.00	-
Kingston at Eglinton North Leg												
	LRT		**Buses**									
Lane Group	EBL	SWR	EBL/R	NBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	-
V/C Ratio	0.23	0.25	-	0.20	-	0.24	0.38	-	-	0.48	0.48	-
Kingston at Eglinton South Leg												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.68	-	0.09	-	-	-	-	0.20	-	-	0.57	-
Kingston at Cedar Drive												
Lane Group	EBL/U	EBT	EBR	WBL/U	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.83	0.30	-	0.64	0.76	-	-	0.15	-	-	0.23	-
PM PEAK												
Kingston at Scarborough Golf Club Road												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL/U	NBT	NBR	SBL/U	SBT	SBR
V/C Ratio	-	0.15	-	-	0.13	-	0.85	1.00	-	0.69	0.81	-
Kingston at Eglinton North Leg												
	LRT		**Buses**									
Lane Group	EBL	SWR	EBL/R	NBL	EBR	NBL	NBT	NBR	SBL	SBT	SBR	-
V/C Ratio	0.23	0.25	-	0.20	-	0.11	0.61	-	-	0.32	0.35	-
Kingston at Eglinton South Leg												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.68	-	0.07	-	-	-	-	0.43	-	-	0.40	-
Kingston at Cedar Drive												
Lane Group	EBL/U	EBT	EBR	WBL/U	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
V/C Ratio	0.78	0.80	-	0.53	0.68	-	-	0.11	-	-	0.10	-

3.5 Sub Scenario 1 Synchro Results

3.5.1 SUB SCENARIO 1 - SCENARIO 1 SUMMARY

The critical movements are the southbound through direction in the AM peak and in the northbound through direction in the PM peak along Kingston Road. All other movements appear to operate at a good level of service, including the LRV and bus movements. As described earlier in this report, the northbound left turns at Kingston Road and Eglinton Avenue are prohibited in this scenario, and are required to make a U-turn movement at Scarborough Golf Club Road. This movement appears to operate well from a traffic operations perspective.

3.5.2 SUB SCENARIO 1 - SCENARIO 2 SUMMARY

Scenario 2 also operates with v/c ratios above capacity in the southbound and northbound direction in the AM and PM peak respectively. The northbound left turn movement appears to operate below capacity and all remaining movements appear to operate at a good level of service.

3.5.3 SUB SCENARIO 1 - SCENARIO 3 SUMMARY

Scenario 3 is identical to Scenarios 1 and 2 with v/c ratios above capacity in the through movements during the AM and PM peak. The northbound left turn movement at Kingston Road and Eglinton Avenue, which operated under a permissive phase, appears to operate at a good level of service during both peak periods. The LRV and bus movements also operated well below capacity.

3.6 Sub Scenario 2 Synchro Results

3.6.1 SUB SCENARIO 2 - SCENARIO 1 SUMMARY

With the applied volume reductions, the overall the network in Scenario 1 operates at a good level of service and the transit phases appear to operate at a good level of service as well. As described earlier, since no northbound left turning traffic is permitted, vehicles wanting to make a left must perform a U-turn movement at the Scarborough Golf Club Road to access Eglinton Avenue.

3.6.2 SUB SCENARIO 2 - SCENARIO 2 SUMMARY

Scenario 2 also operates at a good level of service after volume reductions were applied. The northbound left turning traffic appears to operate at a good level of service under a protected and permitted phase and no transit operational concerns were detected.

Scenario 2 is the recommended and preferred alternative as it permits northbound left turning traffic as well as minimizing the wait time for the LRV's to clear the intersection.

3.6.3 SUB SCENARIO 2 - SCENARIO 3 SUMMARY

Scenario 3 also operates at a good level of service after volume reductions are applied. The northbound permitted phase does not appear to have any traffic operational concerns and the LRV phase also operates well below capacity.

4. RECOMMENDED SCENARIO

Based on the results of the Synchro analysis, Scenario 2 is the preferred alternative as it provides the same traffic operational results as Scenario 1 and 2, while also permitting northbound left turning traffic.

ATTACHMENT V

SCARBOROUGH – MALVERN LRT EA – KINGSTON ROAD AT MORNINGSIDE AVENUE SYNCHRO ASSESSMENT

December 12, 2008

Toronto Transit Commission (TTC)

SCARBOROUGH - MALVERN LRT EA - KINGSTON ROAD AT MORNINGSIDE AVENUE SYNCHRO ASSESSMENT

FINAL REPORT

DECEMBER 12, 2008

TABLE OF CONTENTS

1. PROJECT SCOPE V-1

2. DATA V-2

2.1 Traffic Volume Reductions V-2

2.2 Bus Routes & Pedestrian Volumes V-3

2.3 LRV Phase V-5

3. SYNCHRO ANALYSIS FIRST ITERATION - SIGNAL PHASING SCENARIOS V-5

3.1 Traffic Volumes V-5

3.2 Scenarios V-6

3.2.1 Scenario 1 – Eight Phase Operation with Transit Phase V-6

3.2.2 Scenario 2 – Six Phase Operation with Transit Phase V-8

3.2.3 Scenario 3 – Four Phase Operation with Transit Phase V-9

3.3 Analysis Results and Preferred Scenario V-10

4. SECOND ITERATION - OPERATIONAL IMPROVEMENTS V-11

4.1 Traffic Volumes V-11

4.2 Scenarios V-12

4.2.1 Scenario 3-1 – Base Scenario V-12

4.2.2 Scenario 3-2 – Add NE RT Lane at Kingston / Lawrence V-12

4.2.3 Scenario 3-3 – Add SW RT Lane at Kingston/Lawrence V-12

4.2.4 Scenario 3-4 – Add NE and SW RT Lanes at Kingston/Lawrence V-13

4.3 Analysis Results and Preferred Scenario V-13

5. THIRD ITERATION – OPERATIONAL IMPROVEMENTS V-15

5.1 Traffic Volumes V-15

5.2 Scenarios V-17

5.2.1 Scenario 3-4 X – Base Scenario V-17

5.2.2 Scenario 3-4 A – Short Turn Half of the LRV V-18

5.2.3 Scenario 3-4 B – Add SBR Lane V-18

5.2.4 Scenario 3-4 C – Short Turn Half of the LRV & Add SBR Lane (A+B) V-18

TABLE OF CONTENTS (CONT'D)

5.2.5 Scenario 3-4 D – Short Turn Half of the LRV, Add SBR Lane & Add SWBT Lane V-18

5.3 Analysis Results and Preferred Scenario V-18

6. ANALYSIS SUMMARY V-21

List of Exhibits

Exhibit 1-1: Study Area V-2
Exhibit 2-1: Kingston Road Corridor Volume Reductions V-3
Exhibit 2-2: Peak Transit Volumes (AM) V-3
Exhibit 2-3: Peak Pedestrian Volumes (AM) V-4
Exhibit 2-4: Peak Pedestrian Volumes (PM) V-4
Exhibit 3-1: First Iteration - Turning Movement Volumes (AM) V-6
Exhibit 3-2: Eight Phase Operation with Transit Phase V-7
Exhibit 3-3: Minimum Cycle Length with Eight Phase Operation V-7
Exhibit 3-4: Six Phase Operation with Transit Phase V-8
Exhibit 3-5: Minimum Cycle Length with Six Phase Operation V-8
Exhibit 3-6: Four Phase Operation with Transit Phase V-9
Exhibit 3-7: Minimum Cycle Length with Four Phase Operation V-9
Exhibit 3-8: First Iteration - Synchro Results (AM) V-10
Exhibit 4-1: Second Iteration - Turning Movement Volumes (AM) V-11
Exhibit 4-2: Second Iteration - Turning Movement Volumes (PM) V-12
Exhibit 4-3: Second Iteration - Synchro Results (AM) V-13
Exhibit 4-4: Second Iteration - Synchro Results (PM) V-14
Exhibit 5-1: Third Iteration – Turning Movement Volumes (AM) V-16
Exhibit 5-2: Third Iteration – Turning Movement Volumes (PM) V-16
Exhibit 5-3: Mid-Intersection Pedestrian Crossing V-17
Exhibit 5-4: Third Iteration - Synchro Results (AM) V-19
Exhibit 5-5: Third Iteration - Synchro Results (PM) V-20

List of Appendices

Appendix A: Calculations to Determine Traffic Phase Duration

1. PROJECT SCOPE

This report documents the Synchro traffic analysis completed on the Kingston Road at Morningside Avenue signalized intersection and surrounding road network. The purpose of the analysis is to conduct a preliminary assessment of the future Light Rail Vehicle (LRV) operation, and to determine impacts to traffic operation and land use. The objective of this report is to advance the initial design to a point where it could be confidently presented to the public as a workable Light Rail Transit (LRT) system. The analysis conducted in this report is the foundation for future preliminary and detailed design.

Exhibit 1-1 shows the study area with the six signalized intersections included in the analysis. Of the six intersections shown, a new signalized intersection is to be implemented at the Kingston Road at Collinsgrove Road intersection.

To evaluate the LRV operation, a Synchro analysis was conducted. Three iterations were developed in consultation with City of Toronto and TTC staff. The following priority scheme was used to develop the preferred scenario:

1. LRV operation;
2. Pedestrian and cyclist operation;
3. Bus operation (and where transfers occur, equivalent pedestrian operation);
4. Vehicle operation.

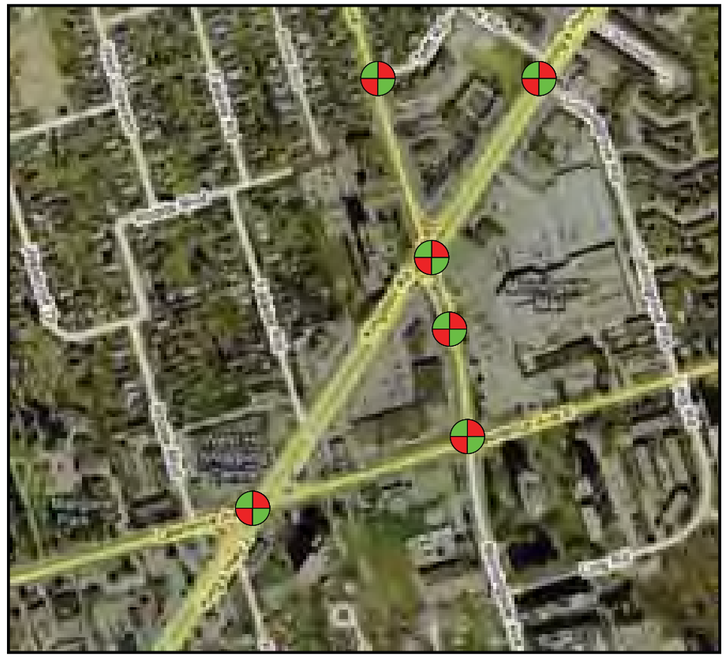
The report describes:

- Traffic volumes and pedestrian volumes that were developed for the future LRV operation, along with the recommended transit phase that will be used to progress the LRV through the Kingston Road at Morningside Avenue signalized intersection (Section 2).
- The results of a three-iteration Synchro analysis that has considered:
    1. Three initial signal phasing scenarios – First iteration (Section 3);
    2. Operational improvement scenarios – Second iteration (Section 4);
    3. Operational improvement scenarios – Third iteration (Section 5).
- The recommended scenario and the impacts to land use (Section 6).

IBI GROUP FINAL REPORT

Toronto Transit Commission (TTC)
SCARBOROUGH - MALVERN LRT EA - KINGSTON ROAD AT MORNINGSIDE AVENUE SYNCHRO ASSESSMENT

Exhibit 1-1: Study Area



2. DATA

The following data was used to formulate the analysis of the road network surrounding the Kingston Road at Morningside Avenue intersection.

2.1 Traffic Volume Reductions

Under future conditions, Kingston Road will be reduced from three through lanes north-eastbound and south-westbound to two through lanes in each direction to accommodate the LRT. This reduction in roadway capacity will result in many of the vehicles currently using Kingston Road as a corridor to switch to transit, or use alternate routes. As a result, an analysis of the signalised intersection at Kingston Road at Lawrence Avenue was conducted to determine the future capacity of the corridor. The Kingston Road at Lawrence Avenue intersection was recognised as the governing point for traffic along the Kingston corridor. Corridor volumes were reduced such that the through volume was equal to the capacity (V/C = 1.00) at Kingston Road at Lawrence Road north-eastbound and south-westbound. The through volumes travelling through the Kingston Road at Lawrence Avenue signalised intersection were propagated to adjacent signalised intersections in the study area.

The Kingston Road corridor volumes reductions were applied to the southwest through volumes in the AM peak and the northeast through volumes in the PM peak. The reductions were applied at the Kingston Road at Lawrence Road, the Kingston Road at Morningside Road, and the Kingston Road at Collinsgrove Avenue intersections. The Kingston corridor volume reductions are shown in

Exhibit 2-1. The decision to reduce through volumes on the Kingston Road corridor was made after reviewing the results from the first iteration of analysis, and thus was only applied to the second and third iterations.

Exhibit 2-1: Kingston Road Corridor Volume Reductions

PEAK PERIOD	SOUTH WEST THROUGH	NORTH EAST THROUGH
AM	790 vph (38%)	-
PM	-	560 vph (17%)

2.2 Bus Routes & Pedestrian Volumes

An LRV station will be located at the Kingston Road at Morningside Avenue signalised intersection. This station will facilitate the transfer of transit users between the Route 86 bus and the Scarborough LRT. For this reason, pedestrian volumes were estimated at the Kingston Road at Morningside Avenue signalized intersection. The pedestrian volume estimate included half of the existing pedestrian volumes, plus the estimated transit pedestrian volumes transferring between Route 86 and the LRV (refer to Exhibit 2-2).

Exhibit 2-2: Peak Transit Volumes (AM)

BOARDING LRT		ALIGHTING LRT	
Southbound/Westbound			
Transfer from WB Route 86	400	Transfer to SB route 86	20
Transfer from NB Route 86	60	Transfer to EB route 86	0
Walk ons	180	Walk offs	80
Total Ons	**640**	**Total Offs**	**100**
Northbound/Eastbound			
Transfer from WB Route 86	10	Transfer to SB route 86	20
Transfer from NB Route 86	20	Transfer to EB route 86	20
Walk ons	70	Walk offs	10
Total Ons	**100**	**Total Offs**	**50**

Exhibit 2-3 uses the above pedestrian volumes for the signalized intersection at Kingston Road at Morningside Avenue and routes them based on the location of the bus stops and LRT stations. The location of the Route 86 southbound/westbound stop is on the south-west intersection corner, while the Route 86 northbound/eastbound stop is on the south-east intersection corner. Based on the stop locations, there is an uneven distribution of pedestrians crossing the west leg of the intersection. As a result, the number of pedestrians that conflict with the southbound right and northbound left movements is 195, not 750.

Exhibit 2-3: Peak Pedestrian Volumes (AM)

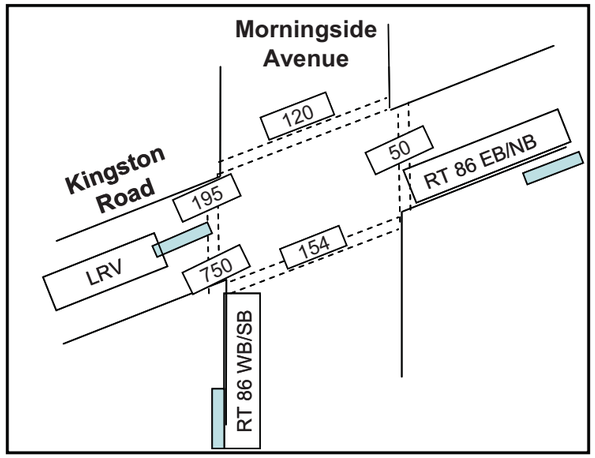
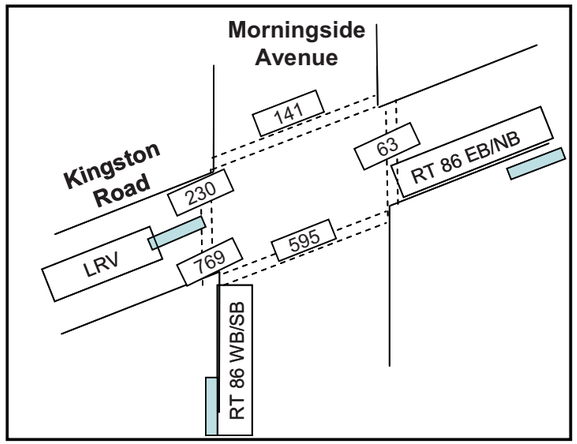


Exhibit 2-4 presents the pedestrian volumes in the PM Peak. These volumes were determined using the same method as in the AM peak; reversing the bus boarding and alighting volumes in the AM peak, and adding them to half of the existing PM pedestrian volumes.

Exhibit 2-4: Peak Pedestrian Volumes (PM)



2.3 LRV Phase

The LRV is undertaking a southbound right and north-eastbound left at the Kingston Road at Morningside Avenue signalized intersection. An LRV phase is required for the transit vehicle to make this manoeuvre. An underlying assumption is that the LRV can make both the southbound right and north-eastbound left movements simultaneously. Furthermore, complementary vehicle and pedestrian phases can overlap with the LRV phase. The transit phase consists of a vehicle minimum green duration, a vehicle clearance time, and an all red time. The transit phase duration was determined by calculating the time to make the turn from a stopped position. This time includes the time to accelerate to the maximum turning speed (assumed to be 25 km/hr), plus the time to slow to a stop position assuming that a far side stop is used (southbound left). The transit phase was found to be:

- 5 second minimum green;
- 19.6 second amber;
- 2.0 second all red;
- Minimum phase duration of 26.6 seconds.

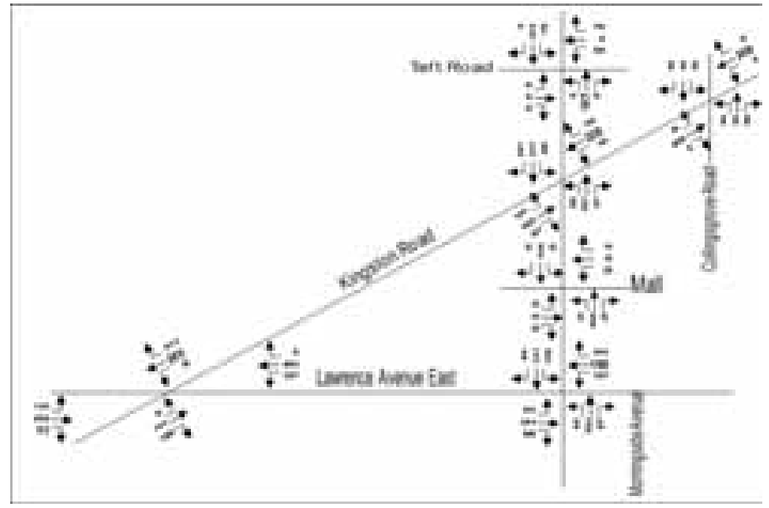
The transit maximum green could be programmed to a maximum duration of approximately 15 seconds, to provide an additional 10 seconds to accommodate transit vehicle arriving simultaneously from opposite directions. The calculations used to determine the transit phase can be found in Appendix A.

3. SYNCHRO ANALYSIS FIRST ITERATION - SIGNAL PHASING SCENARIOS

3.1 Traffic Volumes

Exhibit 3-1 presents the intersection volumes in the AM peak period used in the first iteration. For the first iteration, only an AM Synchro model was developed. Turning movement volumes were developed for the new signalized intersection at the Morningside Avenue at the mall (south of Kingston Road), and Kingston Road at Collinsgrove Road intersections by propagating the approach and discharge volumes from Kingston Road at Morningside Avenue intersection.

Exhibit 3-1: First Iteration - Turning Movement Volumes (AM)



3.2 Scenarios

Three scenarios were developed for the Kingston Road at Morningside Avenue signalized intersection in the first iteration. These three scenarios are described below.

3.2.1 SCENARIO 1 – EIGHT PHASE OPERATION WITH TRANSIT PHASE

Exhibit 3-2 presents the Kingston Road at Morningside Avenue National Electric Manufacturers Association (NEMA) phase diagram for Scenario 1. Under this scenario, the existing eight phase operation is maintained, with the north-east/south-west left turn phase operating as protected only. A protected transit phase is inserted at two points in the signal cycle (eastbound left and southbound right). Note that the northbound through and pedestrian walk (east side) overlaps with phases 10 and 12, while the eastbound through movement and pedestrian movement overlap with the transit phase 14, and 16.

Exhibit 3-2: Eight Phase Operation with Transit Phase

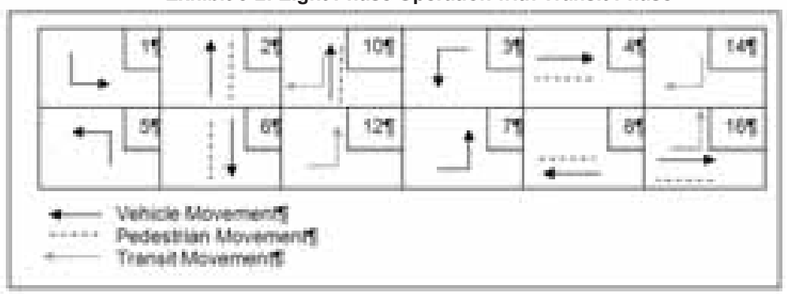


Exhibit 3-3 presents the minimum cycle length for this scenario.

Exhibit 3-3: Minimum Cycle Length with Eight Phase Operation

	Phase					
	1 & 5	**2 & 6**	**10 & 12**	**3 & 7**	**4 & 8**	**14 & 16**
Minimum Green or walk	7	7	5	7	7	5
Minimum Green and FDWK		32			24	
Amber	2	3	19.6	2	3	19.6
All Red	1	3	2	1	3	2
Total	10	45	26.6	10	37	26.6
Minimum Cycle Length	155.2					

Based on the phase and cycle length composition above, the minimum cycle length is 155.2 seconds. The maximum wait time for the LRV is 68.6 seconds from the start of the phase 10 and 12 transit amber (19.6+2+10+37), and 76.6 seconds from the start of the phase 14 & 16 transit amber (19.6+2+10+45).

For the purposes of analysis, it is assumed that only one of the transit phases is actuated per cycle (i.e. the transit phases are coded as a phase insert, rather than part of the signal cycle composition). As a result, phases 10 and 12 were eliminated from the Synchro model, which reduces the minimum cycle length to 128.6 seconds.

The assumed transit headway is 3 minutes and 30 seconds for both directions. This translates into 34 transit vehicles per hour in two directions. As a result, the transit phase may be actuated between 17 (eastbound & westbound LRV always arriving at the same time) and 34 (eastbound and westbound LRV never arriving at the same time) times per hour. Based on arrival probabilities, it was assumed that there will be approximately 29 transit calls per hour (some north-eastbound and southbound transit vehicles arriving simultaneously). Using an average cycle length of 120 seconds, 30 LRV phases will be actuated per hour. Factoring the green time from 30 actuations / hour to 29 actuations / hour, the effective green time is reduced from 26.6 s to 26 s. A cycle length of 140 seconds was used in this analysis.

3.2.2 SCENARIO 2 – SIX PHASE OPERATION WITH TRANSIT PHASE

Exhibit 3-4 presents the Kingston Road at Morningside Avenue NEMA phase diagram for Scenario 2. Under this scenario, the existing north-south left turn phase operation is removed, with the east-west left turn phases operating as protected only. A protected transit phase is inserted at two points in the signal cycle (eastbound left and southbound right). Note that the northbound through and pedestrian walk (east side) overlaps with phases 10 and 12, while the eastbound through movement and pedestrian movement overlap with the transit phase 14, and 16.

Exhibit 3-4: Six Phase Operation with Transit Phase

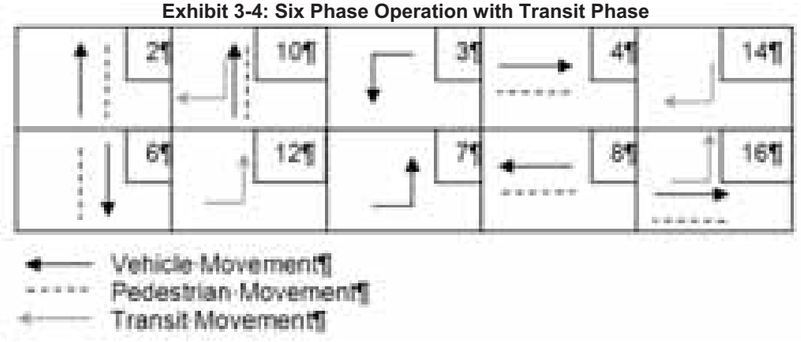


Exhibit 3-5 presents the minimum cycle length for this scenario.

Exhibit 3-5: Minimum Cycle Length with Six Phase Operation

	Phase				
	2 & 6	**10 & 12**	**3 & 7**	**4 & 8**	**14 & 16**
Minimum Green or walk	7	5	7	7	5
Minimum Green and FDWK	32			24	
Amber	3	19.6	2	3	19.6
All Red	3	2	1	3	2
Total	45	26.6	10	37	26.6
Minimum Cycle Length	145.2				

Based on the phase and cycle length composition above, the minimum cycle length is 145.2 seconds. The maximum wait time for the LRV is 68.6 seconds from the start of the phase 10 and 12 transit amber (19.6+2+10+37), and 66.6 seconds from the start of the phase 14 and 16 transit amber (19.6+2+10+45).

For the purposes of modelling, it is assumed that only one of the transit phases is actuated per cycle (i.e. the transit phases are coded as a phase insert, rather than part of the signal cycle composition). As a result, phases 10 and 12 were eliminated from the Synchro model, which reduces the minimum cycle length to 118.6 seconds. As in Scenario 1 (Section 3.2.1), the LRV phase duration was reduced to 26 seconds. A cycle length of 120 seconds was used in the analysis.

3.2.3 SCENARIO 3 – FOUR PHASE OPERATION WITH TRANSIT PHASE

Exhibit 3-6 presents the Kingston Road at Morningside Avenue NEMA phase diagram for Scenario 3. Under this scenario, the existing north-south and east-west left turn phase operation is removed. A protected transit phase is inserted at two points in the signal cycle (eastbound left and southbound right). Note that the northbound through and pedestrian walk (east side) overlaps with phases 10 and 12, while the eastbound through movement and pedestrian movement overlap with the transit phase 14, and 16.

Exhibit 3-6: Four Phase Operation with Transit Phase

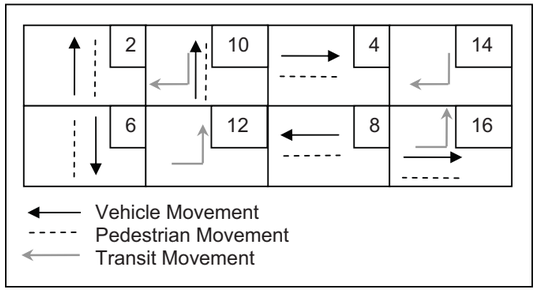


Exhibit 3-7 presents the minimum cycle length for this scenario.

Exhibit 3-7: Minimum Cycle Length with Four Phase Operation

	Phase			
	2 & 6	**10 & 12**	**4 & 8**	**14 & 16**
Minimum Green or walk	7	5	7	5
Minimum Green and FDWK	32		24	
Amber	3	19.6	3	19.6
All Red	3	2	3	2
Total	45	26.6	37	26.6
Minimum Cycle Length	135.2			

Based on the phase and cycle length composition above, the minimum cycle length is 135.2 seconds. The maximum wait time for the LRV is 58.6 seconds from the start of the phase 10 and 12 transit amber (19.6+2+37), and 66.6 seconds from the start of the phase 14 and 16 transit amber (19.6+2+45).

For the purposes of modelling, it is assumed that only one of the transit phases is actuated per cycle (i.e. the transit phases are coded as a phase insert, rather than part of the signal cycle composition). As a result, phases 10 and 12 were eliminated from the Synchro model, which reduces the minimum cycle length to 108.6 seconds.

As in Scenario 1 (Section 3.2.1), the LRV phase duration was reduced to 26 seconds. A cycle length of 110 seconds was used in the analysis.

3.3 Analysis Results and Preferred Scenario

Exhibit 3-8 presents the Synchro Volume to Capacity (V/C) analysis results for the scenarios of the first iteration of analysis.

Exhibit 3-8: First Iteration - Synchro Results (AM)

Teft & Morningside																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT	SBR						
Scenario 1				0.24		0.30		0.41			0.48	0.36							
Scenario 2				0.36		0.38	0.18	0.39			0.50	0.54							
Scenario 3				0.45		0.44	0.24	0.39			0.47	0.44							
Kingston & Morningside																			
Lane Group	EBL2	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Scenario 1	0.06	0.04						0.39	0.77		0.69	0.69		2.15	0.49		0.67	2.23	
Scenario 2	0.05	0.06							0.74			0.67		2.15	0.67		0.31	2.41	
Scenario 3	0.05	0.03							0.69			0.63			0.48			2.35	
Morningside & Mall																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR							
Scenario 1	0.15	0.11	0.12	0.15	0.11	0.12	0.04	0.29	0.02	0.05	0.19	0.02							
Scenario 2	0.14	0.11	0.11	0.14	0.11	0.11	0.04	0.32	0.02	0.12	0.19	0.02							
Scenario 3	0.14	0.11	0.11	0.14	0.11	0.11	0.04	0.32	0.02	0.12	0.19	0.02							
Lawrence & Morningside																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR							
Scenario 1	1.21	0.32		0.31	0.95		0.19	0.43		0.56	0.25								
Scenario 2	1.02	0.30		0.29	0.91		0.20	0.46		0.61	0.26								
Scenario 3	0.94	0.30		0.28	0.90		0.21	0.47		0.63	0.27								
Lawrence Aveue East & Kingston Road																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR	
Scenario 1	0.88	0.26	0.11	0.82	0.75									0.57			1.44		
Scenario 2	0.96	0.60	0.25	0.59	0.83									0.55			1.40		
Scenario 3	0.68	0.25	0.11	0.77	0.79									0.58		0.53	1.49		
Collingsgrove & Lawrence																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEU	NEL	NET	NER	SWL	SWT	SWR
Scenario 1		0.89			0.89									0.03	0.28	0.00	0.01	0.87	0.00
Scenario 2		0.81			0.81									0.03	0.29	0.00	0.01	0.89	0.00
Scenario 3		0.75			0.74								1.00	0.02	0.29	0.00	0.02	1.08	0.01

The analysis results show that the north-east and south-west through volumes at the Kingston Avenue at Morningside intersection are well over capacity in all scenarios. Comparing the three scenarios, the differences in the severely constrained movements are minor (i.e. the south-west through and north-east left at Kingston/Morningside, and the southwest through at Kingston/ Lawrence).

The highest priority is given to LRVs at an intersection, over pedestrians and motor traffic. Scenario 3, therefore, is the preferred alternative for traffic signal phasing since it has the shortest cycle length (110s), and thus the least wait time for LRVs.

Further Synchro analysis was built on the results in Scenario 3.

4. SECOND ITERATION - OPERATIONAL IMPROVEMENTS

The second iteration explores operational improvement scenarios at the Kingston Road at Morningside Avenue intersection and surrounding road network.

4.1 Traffic Volumes

Exhibit 4-1 and Exhibit 4-2 present the intersection volumes used in the second iteration. Turning movement volumes were developed for the new signalized intersection at the Morningside Avenue at the mall (south of Kingston Road), and Kingston Road at Collinsgrove Road intersections by propagating the approach and discharge volumes from Kingston Road at Morningside Avenue intersection. While left turns were restricted at the Kingston Road and Morningside Ave intersection in the first iteration of analysis, transit vehicles were permitted to make the south-west bound left turn movement.

Corridor volumes are reduced so that the V/C ratios of the south-west and north-east traffic at the Kingston Road at Lawrence Avenue intersection are preserved at 1.00 (Section 2.1). These reduced volumes were used in the second iteration of Synchro analysis.

Exhibit 4-1: Second Iteration - Turning Movement Volumes (AM)

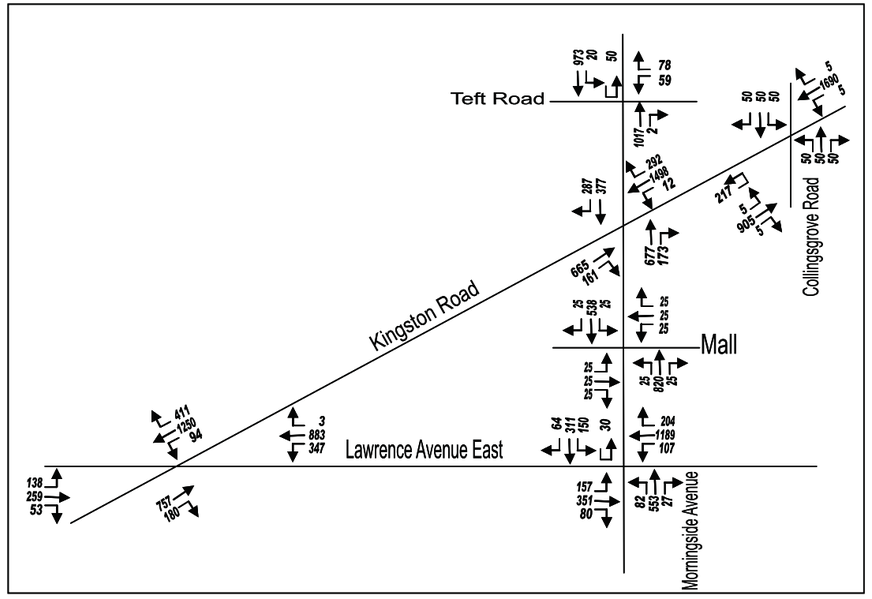
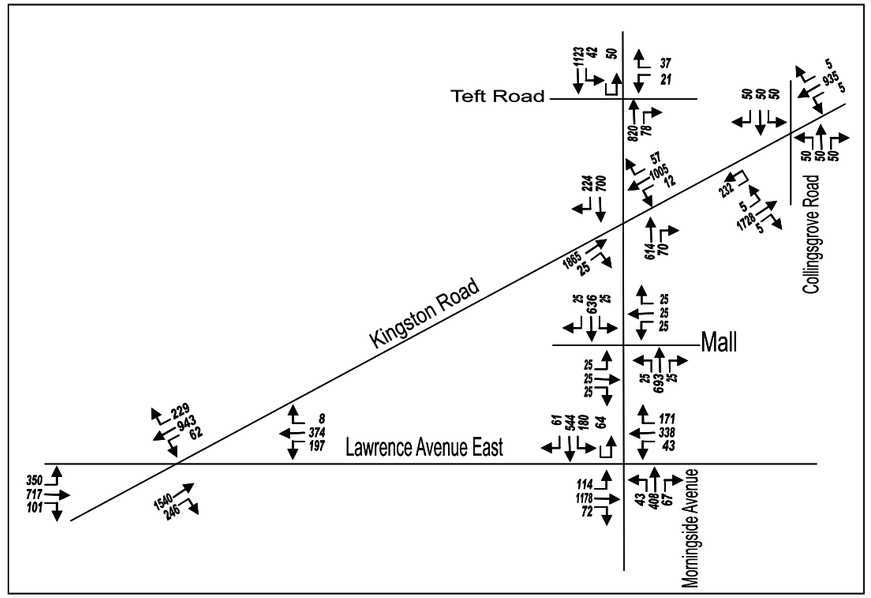


Exhibit 4-2: Second Iteration - Turning Movement Volumes (PM)



4.2 Scenarios

Four scenarios were built on the preferred scenario in the first iteration of analysis, namely Scenario 3. The four scenarios are described below.

4.2.1 SCENARIO 3-1 – BASE SCENARIO

Built on the preferred scenario under the first iteration of analysis is described in Scenario 3.

4.2.2 SCENARIO 3-2 – ADD NE RT LANE AT KINGSTON / LAWRENCE

A north-east right turn lane at the Kingston Road at Lawrence Avenue intersection is added. This modification better accommodates the north-east traffic along Kingston corridor in the PM peak period. The additional of the north-east right turn lane allows an additional 310 vehicles to pass through the Kingston corridor during the PM peak.

4.2.3 SCENARIO 3-3 – ADD SW RT LANE AT KINGSTON/LAWRENCE

A south-west right turn lane at the Kingston Road at Lawrence Avenue intersection is added. This modification better accommodates the south-west traffic along Kingston corridor in the AM peak period. The addition of the south-west right turn lane allows another 440 vehicles to pass through the Kingston corridor in the AM peak.

4.2.4 SCENARIO 3-4 – ADD NE AND SW RT LANES AT KINGSTON/LAWRENCE

The improvements stated in Scenario 3-2 and Scenario 3-3 are both applied. The corridor volume is increased by 440 vehicles in the AM peak period and 310 vehicles in the PM peak period.

4.3 Analysis Results and Preferred Scenario

Exhibit 4-3 and Exhibit 4-4 show the results of the second iteration of analysis for the AM and PM peak periods.

Exhibit 4-3: Second Iteration - Synchro Results (AM)

Teft Road & Morningside Avenue																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT	SBR						
Scenario 3-1				0.19		0.25		0.45			0.41	0.38							
Scenario 3-2				0.19		0.25		0.45			0.41	0.38							
Scenario 3-3				0.19		0.25		0.45			0.41	0.38							
Scenario 3-4				0.19		0.25		0.45			0.41	0.38							
Kingston Road & Morningside Avenue																			
Lane Group	EBL2	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Scenario 3-1	0.05	0.03							0.69			0.63			0.40			1.39	0.51
Scenario 3-2	0.05	0.03							0.69			0.63			0.40			1.35	0.51
Scenario 3-3	0.05	0.03							0.69			0.63			0.40			1.78	0.54
Scenario 3-4	0.05	0.03							0.69			0.63			0.40			1.78	0.54
Morningside Avenue & Mall																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR							
Scenario 3-1	0.14	0.11	0.11	0.14	0.11	0.11	0.03	0.29	0.02	0.05	0.19	0.02							
Scenario 3-2	0.14	0.11	0.11	0.14	0.11	0.11	0.03	0.29	0.02	0.05	0.19	0.02							
Scenario 3-3	0.14	0.11	0.11	0.14	0.11	0.11	0.03	0.29	0.02	0.05	0.19	0.02							
Scenario 3-4	0.14	0.11	0.11	0.14	0.11	0.11	0.03	0.29	0.02	0.05	0.19	0.02							
Lawrence Avenue East & Morningside Avenue																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR							
Scenario 3-1	1.55	0.26		0.23	0.77		0.27	0.58		1.07	0.33								
Scenario 3-2	1.55	0.26		0.23	0.77		0.27	0.58		1.07	0.33								
Scenario 3-3	1.55	0.26		0.23	0.77		0.27	0.58		1.07	0.33								
Scenario 3-4	1.55	0.26		0.23	0.77		0.27	0.58		1.07	0.33								
Lawrence Aveue East & Kingston Road																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR	
Scenario 3-1	0.70	0.26	0.11	0.81	0.83									0.56		0.49	1.00		
Scenario 3-2	0.65	0.25	0.11	0.78	0.81									0.45	0.23	0.38	1.00		
Scenario 3-3	0.65	0.25	0.11	0.78	0.81									0.57		0.54	1.00	0.50	
Scenario 3-4	0.65	0.25	0.11	0.78	0.81									0.45	0.23	0.38	1.00	0.50	
Collingsgrove Road & Kingston Road																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEU	NEL	NET	NER	SWL	SWT	SWR
Scenario 3-1		0.72			0.72								0.76	0.01	0.33	0.00	0.01	0.82	0.01
Scenario 3-2		0.72			0.72								0.76	0.01	0.33	0.00	0.01	0.82	0.01
Scenario 3-3		0.72			0.72								0.76	0.01	0.33	0.00	0.01	0.82	0.01
Scenario 3-4		0.72			0.72								0.76	0.01	0.33	0.00	0.01	0.82	0.01

Exhibit 4-4: Second Iteration - Synchro Results (PM)

Teft Road & Morningside Avenue																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT	SBR						
Scenario 3-1				0.07		0.12		0.41			0.49	0.44							
Scenario 3-2				0.07		0.12		0.41			0.49	0.44							
Scenario 3-3				0.07		0.12		0.41			0.49	0.44							
Scenario 3-4				0.07		0.12		0.41			0.49	0.44							
Kingston Road & Morningside Avenue																			
Lane Group	EBL2	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Scenario 3-1	0.05	0.03							0.54			0.81			1.02			0.95	0.12
Scenario 3-2	0.05	0.03							0.54			0.81			1.18			0.95	0.12
Scenario 3-3	0.05	0.03							0.54			0.81			1.02			0.95	0.12
Scenario 3-4	0.05	0.03							0.54			0.81			1.18			0.95	0.12
Morningside Avenue & Mall																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR							
Scenario 3-1	0.14	0.10	0.11	0.14	0.10	0.11	0.04	0.24	0.02	0.04	0.22	0.02							
Scenario 3-2	0.14	0.10	0.11	0.14	0.10	0.11	0.04	0.24	0.02	0.04	0.22	0.02							
Scenario 3-3	0.14	0.10	0.11	0.14	0.10	0.11	0.04	0.24	0.02	0.04	0.22	0.02							
Scenario 3-4	0.14	0.10	0.11	0.14	0.10	0.11	0.04	0.24	0.02	0.04	0.22	0.02							
Lawrence Avenue East & Morningside Avenue																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR							
Scenario 3-1	0.36	0.95		0.69	0.36		0.13	0.45		0.89	0.40	0.40							
Scenario 3-2	0.36	0.95		0.69	0.36		0.13	0.45		0.89	0.40	0.40							
Scenario 3-3	0.36	0.95		0.69	0.36		0.13	0.45		0.89	0.40	0.40							
Scenario 3-4	0.36	0.95		0.69	0.36		0.13	0.45		0.89	0.40	0.40							
Lawrence Aveue East & Kingston Road																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR	
Scenario 3-1	1.06	0.76	0.24	0.88	0.42									1.00		0.78	0.67		
Scenario 3-2	1.05	0.76	0.24	0.85	0.42									1.00	0.31	0.74	0.66		
Scenario 3-3	1.05	0.76	0.24	0.85	0.42									1.00		0.74	0.52	0.27	
Scenario 3-4	1.05	0.76	0.24	0.85	0.42									1.00	0.31	0.74	0.52	0.27	
Collingsgrove Road & Kingston Road																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEU	NEL	NET	NER	SWL	SWT	SWR
Scenario 3-1		0.66			0.66								0.70	0.01	0.63	0.00	0.04	0.48	0.01
Scenario 3-2		0.66			0.66								0.69	0.01	0.63	0.00	0.04	0.48	0.01
Scenario 3-3		0.66			0.66								0.70	0.01	0.63	0.00	0.04	0.48	0.01
Scenario 3-4		0.66			0.66								0.69	0.01	0.63	0.00	0.04	0.48	0.01

The analysis results show that for all scenarios, at the Kingston Road at Morningside Avenue intersection:

- The AM peak south-west through volume exceeds capacity;
- The PM peak north-east through volume marginally exceeds capacity.

Observations specific to each scenario:

Scenario 3-2

- Allows an additional 310 vehicles to pass through the Kingston corridor in the north-east through direction during the PM peak hour.

Scenario 3-3

- Allows another 440 vehicles to pass through the Kingston corridor in the south-west through direction during the AM peak hour.

Scenario 3-4

- Allows both 440 vehicles (south-west through in the AM peak) and 310 vehicles (north-east through in the PM peak).

Based on the results of the second iteration of Synchro analysis, Scenario 3-4 is the preferred alternative as it allows the most volume to pass through the heavily constrained Kingston corridor. Scenario 3-4 is the basis for further analysis completed in Section 5.

5. THIRD ITERATION – OPERATIONAL IMPROVEMENTS

The third iteration explores operational improvement scenarios at the Kingston Road at Morningside Avenue intersection based on the results from the second iteration of Synchro analysis, namely Scenario 3-4.

5.1 Traffic Volumes

Exhibit 5-1 and Exhibit 5-2 present the intersection volumes used in the third iteration. Turning movement volumes were developed for the new signalized intersection at the Morningside Avenue at the mall (south of Kingston Road), and Kingston Road at Collinsgrove Road intersections by carrying the upstream discharge volumes. North-east right turns at Kingston / Morningside were restricted due to the high pedestrian volumes using the south-west leg of the intersection.

Corridor volumes are reduced so that the V/C ratios of the south-west and north-east traffic at the Kingston Road at Lawrence Avenue intersection are preserved at 1.00 (methodology described in Section 2.1).

Exhibit 5-1: Third Iteration – Turning Movement Volumes (AM)

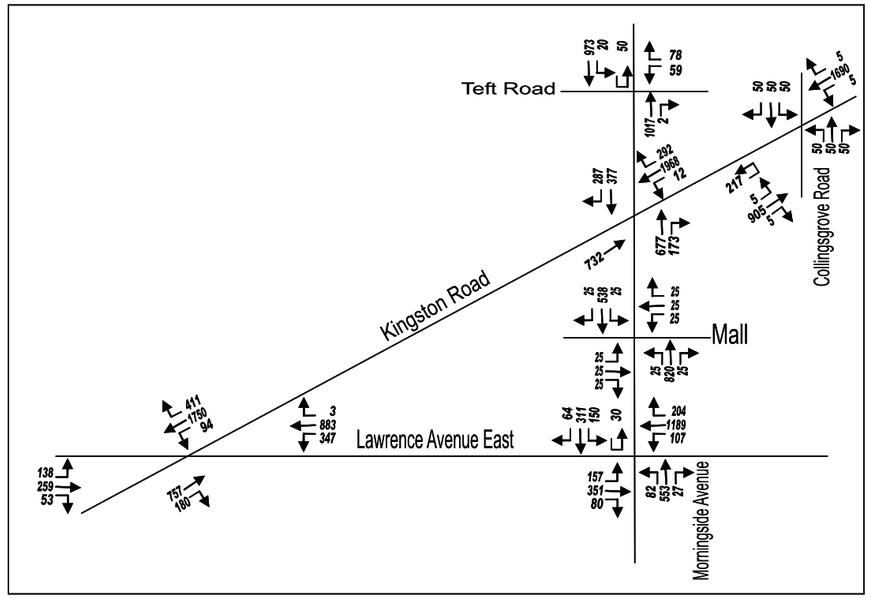
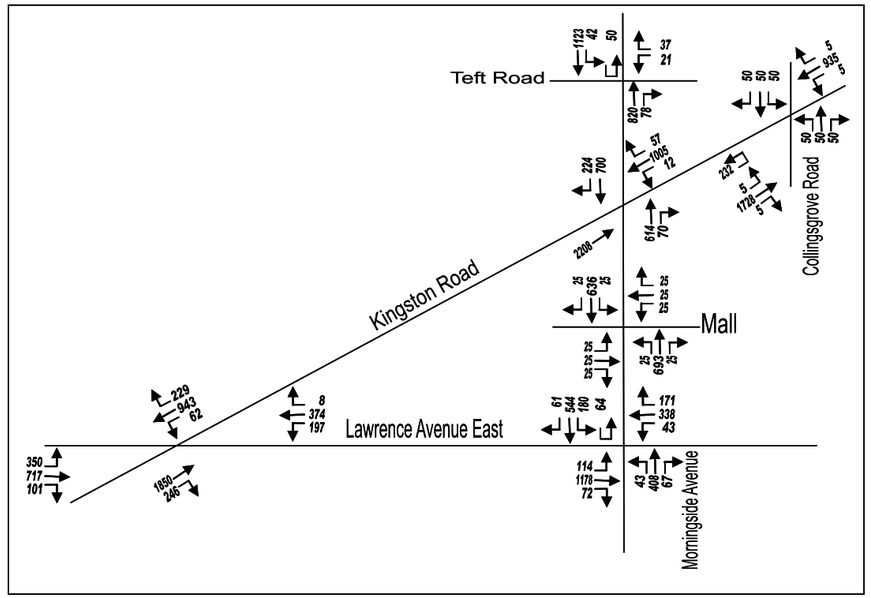


Exhibit 5-2: Third Iteration – Turning Movement Volumes (PM)



5.2 Scenarios

Four scenarios were built on the preferred scenario in the second iteration of analysis, Scenario 3-4. The scenarios explore operational improvement alternatives. The four scenarios, in addition to the base scenario are described below.

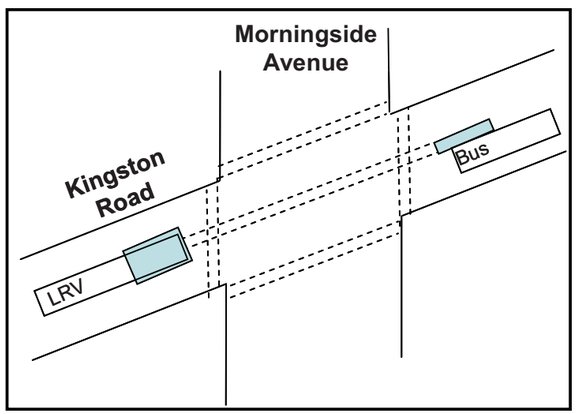
5.2.1 SCENARIO 3-4 X – BASE SCENARIO

The preferred scenario under the second stage of analysis is described in Scenario 3-4. Further scenarios in the third stage were built off of this base.

In addition:

- A northbound right turn lane at the Kingston / Morningside intersection is added.
- Buses are allowed to make permissive left turns during north-east/south-west green phase and LRV phase.
- The LRV phase is coordinated with the northbound and north-eastbound movements to improve the movements identified as more problematic in each peak. Protected northbound movements are coordinated with LRV phase in AM peak and protected north-east movements are coordinated with the LRV phase in PM peak.
- Splitting the north/south pedestrian phase allows the south-west and north-east traffic to have more of green time in the cycle. Pedestrians crossing north/south will have to cross a maximum of 3 lane widths to reach a safe place to wait. Due to the angle of the intersection, the pedestrian crossing distance of each lane is roughly 4m. Conservatively, a 17m crossing is considered the maximum pedestrian north/south crossing distance. The split pedestrian north/south phase time now becomes 27 seconds (7 seconds of walk, 14 seconds of flashing don't walk, 3 seconds of amber and 3 seconds of all red).
- In order to accommodate pedestrians transferring between the LRT platform and the Kingston bus platform, a mid-intersection crosswalk for pedestrians is also provided as shown in Exhibit 5-3.

Exhibit 5-3: Mid-Intersection Pedestrian Crossing



5.2.2 SCENARIO 3-4 A – SHORT TURN HALF OF THE LRV

This scenario suggests short turning half of the north-eastbound LRV at the platform on the west side of the Kingston Road at Morningside intersection. Short turning half of the LRV will maintain the 3.5 minute headway west of the intersection, and provide a 7 minute headway north of the intersection where the passenger demand is not expected to be as high. A benefit of this short turning is a reduction in the number of LRV phase actuations at the Kingston Road at Morningside Avenue intersection from 29 to 17. Using an average cycle length of 120 seconds, this translates to the effective green time being reduced from 26 seconds to 15 seconds.

5.2.3 SCENARIO 3-4 B – ADD SBR LANE

Adding a southbound right lane allows southbound right movements to travel during the LRT phase in addition to the north/south phase. This benefits the southbound right turn which become more problematic as signal time is shifted from the north/south phase to north-east/south-west phase with the split pedestrian crossing.

5.2.4 SCENARIO 3-4 C – SHORT TURN HALF OF THE LRV & ADD SBR LANE (A+B)

The improvements stated in Scenario 3-4 A and Scenario 3-4 B are both applied.

5.2.5 SCENARIO 3-4 D – SHORT TURN HALF OF THE LRV, ADD SBR LANE & ADD SWBT LANE

The improvements stated in Scenario 3-4 A and Scenario 3-4 B are both applied. Additionally, a south-west through lane is added to further accommodate the high south-west volume along Kingston Road in the AM peak.

5.3 Analysis Results and Preferred Scenario

Exhibit 5-4 and Exhibit 5-5 present the Synchro Volume to Capacity (V/C) analysis results for the scenarios of the 3rd iteration of analysis.

Exhibit 5-4: Third Iteration - Synchro Results (AM)

Teft Road & Morningside Avenue																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT	SBR						
Scenario 3-4 X (Base)				0.19		0.25		0.45			0.41	0.38							
Scenario 3-4 A				0.19		0.25		0.45			0.41	0.38							
Scenario 3-4 B				0.19		0.25		0.45			0.41	0.38							
Scenario 3-4 C				0.19		0.25		0.45			0.41	0.38							
Scenario 3-4 D				0.19		0.25		0.45			0.41	0.38							
Kingston Road & Morningside Avenue																			
Lane Group	EBL2	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Scenario 3-4 X (Base)	0.05	0.05							0.45	0.27		1.19dr			0.46		0.10	1.18	0.41
Scenario 3-4 A	0.10	0.10							0.54	0.31		1.14dr			0.40		0.18	1.02	0.37
Scenario 3-4 B	0.05	0.05							0.47	0.28		0.56	0.44		0.44		0.10	1.14	0.40
Scenario 3-4 C	0.10	0.10							0.58	0.32		0.56	0.55		0.38		0.18	0.98	0.35
Scenario 3-4 D	0.07	0.07							0.47	0.27		0.46	0.45		0.44		0.14	0.78	0.40
Morningside Avenue & Mall																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR							
Scenario 3-4 X (Base)	0.14	0.11	0.11	0.14	0.11	0.11	0.03	0.29	0.02	0.05	0.19	0.02							
Scenario 3-4 A	0.14	0.11	0.11	0.14	0.11	0.11	0.03	0.29	0.02	0.05	0.19	0.02							
Scenario 3-4 B	0.14	0.11	0.11	0.14	0.11	0.11	0.03	0.29	0.02	0.05	0.19	0.02							
Scenario 3-4 C	0.14	0.11	0.11	0.14	0.11	0.11	0.03	0.29	0.02	0.05	0.19	0.02							
Scenario 3-4 D	0.14	0.11	0.11	0.14	0.11	0.11	0.03	0.29	0.02	0.05	0.19	0.02							
Lawrence Avenue East & Morningside Avenue																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR							
Scenario 3-4 X (Base)	1.55	0.26		0.23	0.77		0.27	0.58		1.07	0.33								
Scenario 3-4 A	1.55	0.26		0.23	0.77		0.27	0.58		1.07	0.33								
Scenario 3-4 B	1.55	0.26		0.23	0.77		0.27	0.58		1.07	0.33								
Scenario 3-4 C	1.55	0.26		0.23	0.77		0.27	0.58		1.07	0.33								
Scenario 3-4 D	1.55	0.26		0.23	0.77		0.27	0.58		1.07	0.33								
Lawrence Aveue East & Kingston Road																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR	
Scenario 3-4 X (Base)	0.65	0.25	0.11	0.78	0.81									0.45	0.23	0.38	1.00	0.50	
Scenario 3-4 A	0.65	0.25	0.11	0.78	0.81									0.45	0.23	0.38	1.00	0.50	
Scenario 3-4 B	0.65	0.25	0.11	0.78	0.81									0.45	0.23	0.38	1.00	0.50	
Scenario 3-4 C	0.65	0.25	0.11	0.78	0.81									0.45	0.23	0.38	1.00	0.50	
Scenario 3-4 D	0.65	0.25	0.11	0.78	0.81									0.45	0.23	0.38	1.00	0.50	
Collingsgrove Road & Kingston Road																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEU	NEL	NET	NER	SWL	SWT	SWR
Scenario 3-4 X (Base)		0.72			0.72								0.72	0.01	0.33	0.00	0.02	0.83	0.01
Scenario 3-4 A		0.72			0.72								0.72	0.01	0.33	0.00	0.02	0.83	0.01
Scenario 3-4 B		0.72			0.72								0.72	0.01	0.33	0.00	0.02	0.83	0.01
Scenario 3-4 C		0.72			0.72								0.72	0.01	0.33	0.00	0.02	0.83	0.01
Scenario 3-4 D		0.72			0.72								0.72	0.01	0.33	0.00	0.02	0.83	0.01

Exhibit 5-5: Third Iteration - Synchro Results (PM)

Teft Road & Morningside Avenue																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT	SBR						
Scenario 3-4 X (Base)				0.07		0.12		0.41			0.49	0.44							
Scenario 3-4 A				0.07		0.12		0.41			0.49	0.44							
Scenario 3-4 B				0.07		0.12		0.41			0.49	0.44							
Scenario 3-4 C				0.07		0.12		0.41			0.49	0.44							
Scenario 3-4 D				0.07		0.12		0.41			0.49	0.44							
Kingston Road & Morningside Avenue																			
Lane Group	EBL2	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Scenario 3-4 X (Base)	0.05	0.05							0.59	0.16		1.04			1.04		0.19	0.74	0.10
Scenario 3-4 A	0.10	0.10							0.59	0.16		1.04			1.04		0.19	0.61	0.08
Scenario 3-4 B	0.05	0.05							0.75	0.21		0.89	0.33		0.95		0.18	0.64	0.09
Scenario 3-4 C	0.10	0.10							0.75	0.21		0.89	0.41		0.95		0.19	0.54	0.07
Scenario 3-4 D	0.10	0.10							0.71	0.20		0.84	0.39		0.97		0.19	0.38	0.08
Morningside Avenue & Mall																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR							
Scenario 3-4 X (Base)	0.14	0.10	0.11	0.14	0.10	0.11	0.04	0.24	0.02	0.04	0.22	0.02							
Scenario 3-4 A	0.14	0.10	0.11	0.14	0.10	0.11	0.04	0.24	0.02	0.04	0.22	0.02							
Scenario 3-4 B	0.14	0.10	0.11	0.14	0.10	0.11	0.04	0.24	0.02	0.04	0.22	0.02							
Scenario 3-4 C	0.14	0.10	0.11	0.14	0.10	0.11	0.04	0.24	0.02	0.04	0.22	0.02							
Scenario 3-4 D	0.14	0.10	0.11	0.14	0.10	0.11	0.04	0.24	0.02	0.04	0.22	0.02							
Lawrence Avenue East & Morningside Avenue																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR							
Scenario 3-4 X (Base)	0.32	0.88		0.59	0.33		0.15	0.48		1.01	0.43								
Scenario 3-4 A	0.32	0.88		0.59	0.33		0.15	0.48		1.01	0.43								
Scenario 3-4 B	0.32	0.88		0.59	0.33		0.15	0.48		1.01	0.43								
Scenario 3-4 C	0.32	0.88		0.59	0.33		0.15	0.48		1.01	0.43								
Scenario 3-4 D	0.32	0.88		0.59	0.33		0.15	0.48		1.01	0.43								
Lawrence Aveue East & Kingston Road																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR	
Scenario 3-4 X (Base)	1.05	0.76	0.24	0.85	0.42									1.00	0.31	0.74	0.52	0.27	
Scenario 3-4 A	1.05	0.76	0.24	0.85	0.42									1.00	0.31	0.74	0.52	0.27	
Scenario 3-4 B	1.05	0.76	0.24	0.85	0.42									1.00	0.31	0.74	0.52	0.27	
Scenario 3-4 C	1.05	0.76	0.24	0.85	0.42									1.00	0.31	0.74	0.52	0.27	
Scenario 3-4 D	1.05	0.76	0.24	0.85	0.42									1.00	0.31	0.74	0.52	0.27	
Collingsgrove Road & Kingston Road																			
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	NEU	NEL	NET	NER	SWL	SWT	SWR
Scenario 3-4 X (Base)		0.66			0.66								0.69	0.01	0.63	0.00	0.04	0.48	0.01
Scenario 3-4 A		0.66			0.66								0.69	0.01	0.63	0.00	0.04	0.48	0.01
Scenario 3-4 B		0.66			0.66								0.71	0.01	0.63	0.00	0.04	0.47	0.01
Scenario 3-4 C		0.66			0.66								0.71	0.01	0.63	0.00	0.04	0.47	0.01
Scenario 3-4 D		0.66			0.66								0.73	0.01	0.63	0.00	0.03	0.47	0.01

The following summarizes the major findings from the third iteration of Synchro analysis.

Scenario 3-4 A

- Short turning half of the LRV results in an additional 10 seconds per cycle available to vehicle phases. This extra time reduces the problematic south-west through V/C ratio by 0.16 in AM peak.

- Reduced north/south phase time creates a problem for the southbound through and southbound right movements, without a southbound right turn lane.

Scenario 3-4 B

- South-west right turn lane results in a 0.04 reduction to the problematic south-west through V/C ratio in the AM peak and a 0.09 reduction to the problematic north-east through V/C ratio in the PM peak.
- Resolves the V/C ratios of the south-west through/southbound right movements.

Scenario 3-4 C

- Combined benefits of A and B yield a 0.2 reduction to the problematic south-west through V/C ratio in AM peak.
- Combined benefits of A and B yield a 0.09 reduction to the problematic north-east through V/C ratio in PM peak.

Scenario 3-4 D

- The additional south-west through lane brings the problematic south-west through V/C below 0.9 in the AM peak. The additional lane, however, will create a queue spillback upstream of the intersection where the extra lane is terminated.

Based on the above analysis, Scenario 3-4 C is the preferred alternative.

6. ANALYSIS SUMMARY

Based on the results of the 3-iteration Synchro analysis, Scenario 3-4 C is the preferred alternative as it provides the most overall benefit to the over capacity movements, without the need to expand the roadway.

Scenario 3-4 C is to implement all of the following.

Scenario 3

- Four phase signal operation at Kingston/Morningside;
- Restrict all left turn movements at Kingston/Morningside;
- Two transit phases (27 sec – 5 green, 20 amber, 2 all red);
- Overlapping eastbound vehicle and pedestrian phase and northbound vehicle and pedestrian phase with LRV phase;

Scenario 3-4

- Add a northeast right turn lane at Kingston/Lawrence (allows additional 440 vph through the Kingston corridor in the AM southwest direction);
- Add a southwest right turn lane at Kingston/Lawrence (allows additional 310 vph through the Kingston corridor in the PM northeast direction);

Scenario 3-4 C

- Short turn half of the LRV at the Kingston/Morningside platform (17 LRV phases per hour instead of 29);
- Add a southbound right turn lane at Kingston/Morningside and allow protected southbound right turns during LRV phases;
- Split north/south pedestrian crossing into a 2-stage crossing and provide a mid-intersection pedestrian crossing for pedestrians travelling north-east/south-west;
- Restrict northeast right turns at Kingston/Morningside;
- Add a northbound right turn lane at Kingston/Morningside.

APPENDIX A

CALCULATIONS TO DETERMINE TRANSIT PHASE DURATION

APPENDIX A – Calculations to Determine Transit Phase Duration

Turning radius length (Ra) = 70 m

Vehicle length (Vl) = 60 m

Total distance travelled through signalized intersection (Dt) = Ra + Vl = 70 + 60 = 130 m

Initial speed (Vi) = 0 m/s

Maximum turning speed Mv = 25 km/hr, or 6.9 m/s

Acceleration (Ac) = 1.4 m/s^2

Deceleration (Dc) = -1.6 m/s^2

Time to accelerate (Ta) to 25 km/hr = (Mv-Vi)/ac = (6.9-0)/1.4 = 5.0 sec

Distance to accelerate (Da) to 25 km/hr = $Vi*Ta+0.5*Ac*Ta^2 = 0*5+0.5*1.4*5^2$ = 17.2 m

Time to decelerate (Td) from 25 km/hr = (Vi-Mv)/dc (0-25)/-1.6 = 4.3 sec

Distance to decelerate from (Dd) 25 km/hr = $Vi*Td+0.5*Dc*Td^2 = 0*4.3+0.5*1.6*4.3^2$ = 15.0 m

Distance at Mv (Dmv) = Dt-(Da+Dd) = 130 – (17.2+15) = 97.7 m

Time at Mv (Tmv) = Dmv/Mv = 97.7/6.9 = 14.1 sec

Total Time = Ta+Tmv+Td = 5+14.1+4.3 = 23.4 sec

Assume start up lost time = 2 seconds

Total transit phase duration = 2+23.4 = 25.4 seconds

Note that if the transit stations were located nearside, the Total transit phase duration is reduced to 23.2 seconds, since the transit vehicle does not decelerate to stop far side.

In order to accommodate transit vehicles that arrive after the start of green, a longer transit clearance interval is required in comparison to a typical vehicle clearance interval. A worse-case scenario is the time required for the transit vehicle to turn (70 m turning radius plus stopping), which is calculated as follows:

Turning radius (Ra) = 70 m

Vehicle length (Vl) = 60 m

Total distance travelled through signalized intersection (Dt) = Ra + Vl = 70 + 60 = 130 m

Maximum turning speed Mv = 25 km/hr, or 6.9 m/s

Deceleration (Dc) = -1.6 m/s^2

Time to decelerate (Td) from 25 km/hr = (Vi-Mv)/dc (0-25)/-1.6 = 4.3 sec

Distance to decelerate from (Dd) 25 km/hr = $Vi*Td+0.5*Dc*Td^2 = 0*4.3+0.5*1.6*4.3^2$ = 15.0 m

Distance at Mv (Dmv) = Dt-Dd = 130 – 15 = 115 m

Time at Mv (Tmv) = Dmv/Mv = 115/6.9 = 16.6 sec

Total Clearance Time = Tmv+Td = 16.6+5 = 21.6 sec

Using this information, the transit vehicle green duration is:

25.4-21.6 = 4 seconds. Note: The City of Toronto typically uses a minimum green of 7 seconds.

As a result the transit phase consists of:

- 5 second minimum green
- 19.6 second amber
- 2.0 second all red.
- Minimum phase duration of 26.6 seconds.

The transit maximum green could be programmed to a maximum duration of approximately 15 seconds, to provide an additional 10 seconds to accommodate transit vehicle arriving simultaneously from opposite directions.

ATTACHMENT VI

SCARBOROUGH – MALVERN LRT EA – HIGHWAY 401 & MORNINGSIDE AVENUE TRAFFIC IMPACT STUDY

October 2008

IBI GROUP

Toronto Transit Commission

TTC SCARBOROUGH MALVERN LRT
HIGHWAY 401 & MORNINGSIDE AVENUE TRAFFIC IMPACT STUDY

TRAFFIC IMPACT STUDY

OCTOBER 2008

TABLE OF CONTENTS

1. **EXECUTIVE SUMMARY** VI-1

2. **INTRODUCTION** VI-3

3. **STUDY AREA** VI-4

3.1 Study Area Road Network VI-4

3.2 Transit Services and Operations VI-5

4. **THE PROPOSED PROJECT** VI-7

4.1 Project Development Size VI-9

4.2 Planned Road Improvements VI-9

4.2.1 Morningside Avenue and Military Trail VI-10

4.2.2 Morningside Avenue and Highway 401 Eastbound Off-Ramp VI-10

4.2.3 Morningside Avenue and Highway 401 Westbound Off-Ramp/Cinemart Drive VI-10

4.2.4 Morningside Avenue and Milner Avenue VI-10

5. **EXISTING CONDITIONS** VI-11

5.1 Study Horizons VI-11

5.2 Turning Movement Counts VI-11

5.3 Signal Timings and Intersection Configurations VI-13

5.4 Traffic Analysis Parameters VI-13

5.4.1 Capacity and Level of Service VI-13

5.4.2 Queue Lengths VI-13

5.5 2008 Existing Condition VI-14

5.5.1 Traffic Analysis Results VI-14

6. **FUTURE CONDITIONS** VI-18

6.1 Background Traffic Forecasts (Non-Site Traffic) VI-18

6.2 Trip Generation VI-18

6.3 Trip Distribution / Assignment VI-18

6.4 2018 Opening Year VI-18

TABLE OF CONTENTS (CONT'D)

6.4.1 Total Traffic Volumes VI-18

6.4.2 Traffic Analysis Parameters VI-20

6.4.3 Traffic Analysis Results VI-20

6.5 2023 5-Year Horizon VI-23

6.5.1 Total Traffic Volumes VI-23

6.5.2 Traffic Analysis Parameters VI-23

6.5.3 Traffic Analysis Results VI-23

6.6 2028 10-Year Horizon VI-28

6.6.1 Total Traffic Volumes VI-28

6.6.2 Total Traffic Volumes VI-28

6.6.3 Traffic Analysis Results VI-30

7. **FUTURE CONDITIONS MITIGATION** VI-33

Mitigation Measures VI-33

7.1.1 Simple Mitigation VI-33

7.1.2 Geometrical Improvements VI-33

7.2 Proposed Mitigation Measures VI-33

7.2.1 Morningside Avenue and Military Trail VI-33

7.2.2 Morningside Avenue and Highway 401 Eastbound Off-Ramp VI-34

7.2.3 Morningside Avenue and Highway 401 Westbound Off-Ramp/Cinemart Drive VI-34

7.2.4 Morningside Avenue and Milner Avenue VI-34

7.3 Mitigation Analysis and Results VI-35

7.3.1 Total Traffic Volumes VI-35

7.3.2 Traffic Analysis Parameters VI-35

7.3.3 Traffic Analysis Results VI-35

8. **CONCLUSIONS AND RECOMMENDATIONS** VI-39

TABLE OF CONTENTS (CONT'D)

APPENDICES

APPENDIX A: 2008 EXISTING CONDITION CAPACITY ANALYSIS

APPENDIX B: 2018 OPENING YEAR CAPACITY ANALYSIS

APPENDIX C: 2023 5-YEAR HORIZON CAPACITY ANALYSIS

APPENDIX D: 2028 10-YEAR HORIZON CAPACITY ANALYSIS

APPENDIX E: 2028 10-YEAR HORIZON (MITIGATED) CAPACITY ANALYSIS

EXHIBITS

Exhibit 1-1: Proposed Alignment of TTC Scarborough Malvern LRT VI-1
Exhibit 2-1: Morningside Avenue Looking North at Highway 401 Westbound Off-Ramp VI-3
Exhibit 3-1: Study Area of Traffic Impact Study VI-4
Exhibit 3-2: Existing Transit Services Map VI-6
Exhibit 4-1: Toronto Transit City Light Rail Plan VI-7
Exhibit 4-2: Typical Cross Section and Rendering of the Proposed Scarborough Malvern LRT VI-8
Exhibit 4-3: Existing and Future Morningside Avenue Roadway Configurations VI-9
Exhibit 5-1: Traffic Count Information Used in Study VI-11
Exhibit 5-2: 2008 Existing Condition Traffic Volumes VI-12
Exhibit 5-3: 2008 Existing Intersection Operations VI-14
Exhibit 5-4: 2008 Existing Intersection Queues VI-15
Exhibit 6-1: 2018 Opening Year Traffic Volumes VI-19
Exhibit 6-2: 2018 Opening Year Intersection Operations VI-20
Exhibit 6-3: 2018 Opening Year Intersection Queues VI-21
Exhibit 6-4: 2023 5-Year Horizon Traffic Volumes VI-24
Exhibit 6-5: 2023 5-Year Horizon Intersection Operations VI-25
Exhibit 6-6: 2023 5-Year Horizon Intersection Queues VI-26
Exhibit 6-7: 2028 10-Year Horizon Traffic Volumes VI-29
Exhibit 6-8: 2028 10-Year Horizon Intersection Operations VI-30
Exhibit 6-9: 2028 10-Year Horizon Intersection Queues VI-31
Exhibit 7-1: 2028 10-Year Horizon Intersection Operations (Mitigated) VI-36
Exhibit 7-2: 2028 10-Year Horizon Intersection Queues (Mitigated) VI-37

1. EXECUTIVE SUMMARY

IBI Group, working on behalf of the Toronto Transit Commission (TTC), has completed a Traffic Impact Study (TIS) in the vicinity of Morningside Avenue and Highway 401 in the east end of the City of Toronto, for the proposed Scarborough Malvern Light Rail Transit ("Proposed Project") line (Exhibit 1-1). The Proposed Project is one of seven light rail lines proposed in the *Toronto Transit City – Light Rail Plan*, a high-level plan for light rail for Toronto released in March 2007. The ultimate goal of the *Transit City Plan* is to create a series of light-rail that cross Toronto and provide seamless interconnections between each line, and with existing and future rapid transit lines.

Exhibit 1-1: Proposed Alignment of TTC Scarborough Malvern LRT

The proposed alignment of the 15.0 km long Proposed Project is easterly along Eglinton Avenue East from Kennedy Road Subway Station to Kingston Road; northeasterly along Kingston Road from Eglinton Avenue East to Morningside Avenue; northerly along Morningside Avenue from Kingston Road to Sheppard Avenue East; westerly along Sheppard Avenue East from Morningside Avenue to Neilson Road; and northerly along Neilson Road from Sheppard Avenue East to Malvern Town Centre.

The proposed development will introduce a grade separated two-track LRT in the centre of the roadway using one northbound and one southbound travel lane, along Morningside Avenue, between Military Trail and Milner Avenue. A minimum of two travel lanes for mixed traffic will be maintained throughout the Morningside Avenue alignment of the LRT. Other planned improvements of this project include the addition of bicycle lanes, along with streetscape and landscaping improvements.

The TIS involved undertaking intersection capacity analyses at four signalized Study Area intersections for the 2008 Existing Condition and three future year scenarios (2018 Opening, 2023 5-Year Horizon and 2028 10-Year Horizon) using the Highway Capacity Manual (HCM) methodology and specifically the Synchro 6.0 Traffic Signal Coordination Software package by Trafficware. Morning and afternoon peak hour counts of traffic at the Study Area intersections were obtained from the City of Toronto, or where counts were unavailable, traffic counts were conducted by IBI Group. Future growth rates were determined using City population and employment forecasts. Signal phasing and splits for the signalized study intersections were obtained from the City of Toronto. Intersection lane configurations were obtained through aerial photography, and field studies undertaken by IBI Group.

The analysis has determined that the four Study Area intersections have turning movements that experience critical capacity and delay issues in the 2008 existing condition during the AM and PM peak periods. It was also determined that with the future Proposed Project in place, some of these existing operational concerns remain, and new traffic concerns are introduced. Many of the operational concerns can be alleviated through simple mitigation measures, such as signal timing and roadway configuration changes. However, there are some operational concerns that required geometrical improvements such as adding traffic lanes. For example, due to heavy projected traffic volumes in the PM peak period, the Milner Avenue and Morningside Avenue intersection experiences over-capacity operation and significant delay at its northbound and southbound intersection approaches that require additional travel lanes.

Mitigation measures, including shifting signal time, changing lane configurations, increasing lane storage lengths and adding additional lanes, were investigated at 2028 10-Year Horizon intersection operations to alleviate critical traffic movements and traffic spillbacks. The results of the mitigation measures were mixed, with some but not all critical movements being reduced or eliminated. For example, the Morningside Avenue and Milner Avenue intersection has some capacity, delay and queuing issues that cannot be alleviated.

Generally, existing and future conditions indicate that two travel lanes can be removed on Morningside Avenue to accommodate the Proposed Project without adversely affecting traffic operations along Morningside Avenue, or impacting vehicle queues and safety along the Highway 401 eastbound and westbound off-ramps.

Next steps will involve investigating detailed mitigation measures and other strategies that can address the outstanding critical traffic movements.

2. INTRODUCTION

A Traffic Impact Study (TIS) is required for the Morningside Avenue LRT alignment (in the vicinity of Highway 401). The purpose of the study is to assess the impacts of the proposed LRT on the provincial and city road network and to recommend mitigation measures. The Study Area for this TIS is Military Trail to the south, Milner Avenue to the north and both sides of Morningside Avenue and is shown in Section 3.

The TIS analyzes the existing operations at four Morningside Avenue signalized intersections (Exhibit 2-1), as well the future operations with and without the removal of existing traffic lanes to accommodate the LRT. Of particular importance is the operation of the eastbound and westbound off-ramps to Morningside Avenue from Highway 401. The study has been completed in accordance with the procedures set out in the MTO's *General Guidelines for the Preparation of Traffic Impact Studies* (January 2008), with the associated analysis and findings outlined in this report.

Section 3 of this report describes the study area, while Section 4 describes the Proposed Project in detail. Section 5 presents the existing condition traffic analysis, and Section 6 presents the future condition traffic analysis. Future condition mitigating measures are evaluated in Section 7. Lastly, Section 8 presents the conclusions and recommendations.

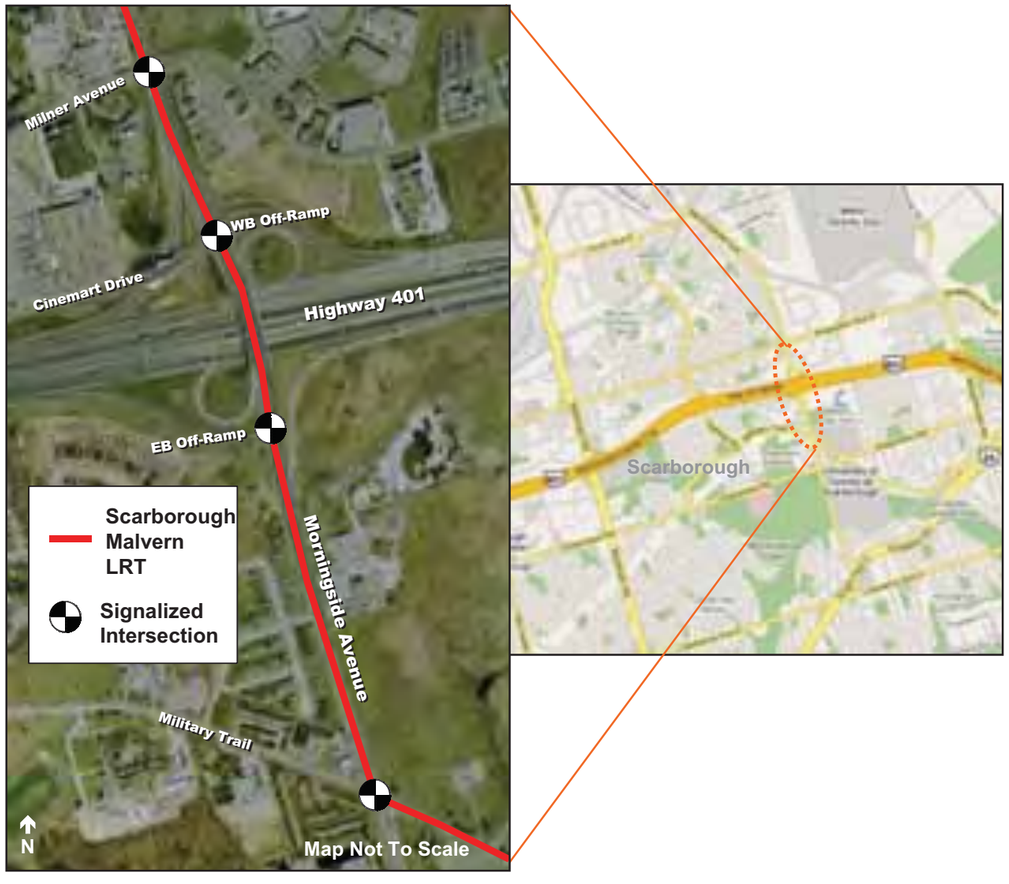
Exhibit 2-1: Morningside Avenue Looking North at Highway 401 Westbound Off-Ramp

3. STUDY AREA

3.1 Study Area Road Network

The Study Area for this TIS includes the road network bounded by Military Trail to the south, Milner Avenue to the north and both sides of Morningside Avenue. Exhibit 3-1 shows a map is the Study Area.

Exhibit 3-1: Study Area of Traffic Impact Study



Morningside Avenue is major north-south arterial that connects Guildwood Parkway/Greyabbey Trail in the south (Scarborough Bluffs) with Oasis Boulevard in the north (Town of Markham boundary). In the vicinity of the Study Area, Morningside Avenue has three northbound and three southbound travel lanes separated by a 2.5 metre centre median. There are exclusive northbound and southbound left-turn lanes at all signalized intersections in which left-turns are allowed. Some signalized intersections also have exclusive or channelized northbound and southbound right-turn lanes.

Military Trail is an east-west street that connects Kingston Road in the southeast with Ellesmere Road in the northwest. From Kingston Road to Morningside Avenue, Military Trail is oriented northwest-southeast and is classified as a collector roadway. From Morningside Avenue to Ellesmere Road, Military Trail is oriented east-west and northeast-southwest and is classified as a minor roadway. At its intersection with Morningside Avenue, both the eastbound and westbound approaches of Military Trail has three travel lanes, respectively – one dedicated left-turn lane, one though lane and one shared through/right-turn lane.

The Highway 401 Eastbound Off-Ramp at Morningside Avenue (Exit 387) is 0.50 km long (including tapers) and connects the eastbound collector lanes of Highway 401 with the west side of Morningside Avenue approximately 180 metres south of the Highway 401 centreline. This off-ramp begins with two travel lanes and widens to three travel lanes (two left-turn lanes and one right-turn lane) at approximately the 0.35 km point.

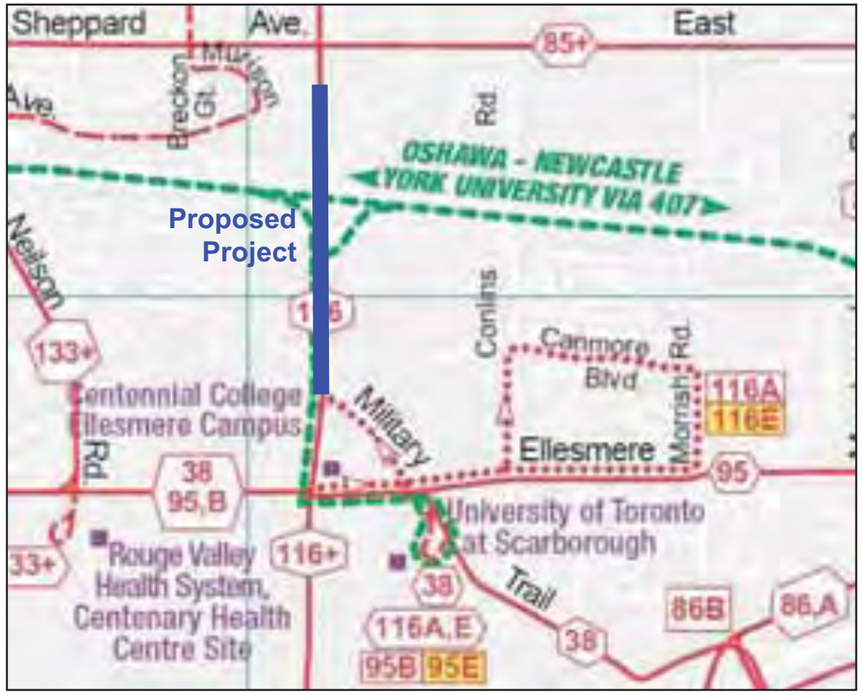
The Highway 401 Westbound Off-Ramp at Morningside Avenue (Exit 387) is 0.50 km long (including tapers) and connects the westbound collector lanes of Highway 401 with the east side of Morningside Avenue approximately 190 metres north of the Highway 401 centreline. This off-ramp begins with two travel lanes and widens to four travel lanes (two left-turn lanes and two right-turn lanes) at approximately the 0.36 km point.

Milner Avenue is an east-west street that connects McCowan Road in the west with Conlins Road in the east. From McCowan Road to Morningside Avenue, Milner Avenue is classified as a minor arterial roadway and from Morningside Avenue to McCowan Road, Milner Avenue is classified as a collector roadway. At its intersection with Morningside Avenue, both the eastbound and westbound approaches of Milner Avenue has three travel lanes, respectively – one dedicated left-turn lane, one though lane and one shared through/right-turn lane.

3.2 Transit Services and Operations

A brief description of transit services operating near the Proposed Project is provided below, and a summary map is provided in Exhibit 3-2. In the vicinity of the Proposed Development, TTC operates one main bus route along Morningside Avenue, and GO Transit also offers service to the nearby University of Toronto Scarborough Campus via Highway 401 and Morningside Avenue.

Exhibit 3-2: Existing Transit Services Map



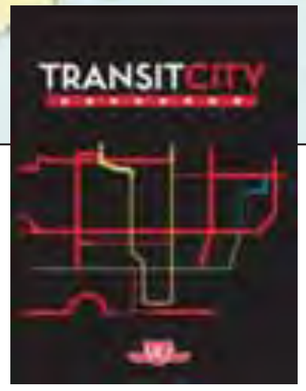
- Bus Route 116: Morningside – TTC Route 116 is a north-south bus route that travels between the Kennedy Subway Station (Bloor-Danforth Subway Line) and Old Finch Avenue via Eglinton Avenue East, Guildwood Parkway and Morningside Avenue. In the vicinity of the Proposed Development, Route 116 buses operate along Morningside Avenue with Route 116A and Route 116E buses short turning at Ellesmere Road and Military Trail.

- Highway 407 East GO Bus – GO Transit Route Highway 407 East is a regional bus route that connects York University in the west with the Oshawa Bus Terminal in the east via Highway 407, Highway 404 and Highway 401. In the vicinity of the Proposed Development, Route 407 East buses operate along Highway 401, Morningside Avenue, Ellesmere Road and Military Trail, with the primary stop being in the University of Toronto Scarborough Campus.

4. THE PROPOSED PROJECT

The TTC Scarborough Malvern LRT is one of seven light rail lines proposed in the *Toronto Transit City – Light Rail Plan*, a high-level plan for light rail for Toronto. This plan was released in March 2007, and consolidates the various light rail plans and studies undertaken by the City from 2002-2006. The core of the Transit City Plan calls for the development of a network of light rail lines (electric) across Toronto that offer seamless interconnections between each other and with the City's existing and proposed rapid transit lines. A map of the proposed LRT lines in the Toronto Transit City Light Rail Plan is shown below.

Exhibit 4-1: Toronto Transit City Light Rail Plan



The preliminary preferred alignment for the TTC Scarborough Malvern LRT (as of September 2008) is a follows: east along Eglinton Avenue (from Kennedy Station), northeast on Kingston Road, and north on Morningside Avenue and Military Trail to Sheppard Avenue where it would interline with the proposed TTC Sheppard East LRT. It would proceed westerly to Neilson Road, and north along Neilson Road to the Malvern Town Centre. The LRT route would provide service to University of Toronto Scarborough Campus and Centennial College Ellesmere Campus.

The proposed LRT will consist of electric powered "light rail" vehicles that operate in exclusive right-of-way (dedicated lanes/reserved lanes), generally in the centre of the existing road right-of-way. Throughout the entire alignment, two through traffic lanes and traffic crossings at signalized intersections will be maintained. Preliminary evaluations propose a total of 25 far side LRT stations.

Exhibit 4-2: Typical Cross Section and Rendering of the Proposed Scarborough Malvern LRT

4.1 Project Development Size

The approximate length of the entire TTC Scarborough Malvern LRT alignment is 15.0 km and its average width (non-station section) is 7.0-7.5 metres. In the Study Area, the length of the TTC Scarborough Malvern LRT on Morningside Avenue (from Military Trail to Milner Avenue) is 1.3 km, with one LRT station proposed at Morningside Avenue and Military Trail.

4.2 Planned Road Improvements

Construction of the LRT alignment will bring changes to the existing Morningside Avenue roadway configuration. A dedicated two-lane transitway with station platforms, bicycle lanes, upgraded sidewalks and new landscaping will all be added to the Study Area alignment. In general, two through traffic lanes will be removed for LRT operations. **Exhibit 4-3** shows the existing and future lane configurations along Morningside Avenue.

Exhibit 4-3: Existing and Future Morningside Avenue Roadway Configurations

The following provides intersection-by-intersection details of the proposed road improvements.

4.2.1 MORNINGSIDE AVENUE AND MILITARY TRAIL

Morningside Avenue from Military Trail north 0.3 km currently consists of two northbound and two southbound travel lanes with dedicated northbound and southbound left-turn lanes and a dedicated right-turn lane at the Morningside Avenue and Military Trail intersection. The westbound approach of Military Trail consists of individual left-turn, through and right-turn lanes. With the LRT alignment in place, the northbound, eastbound approaches will remain unchanged. For the southbound approach, two northbound and two southbound travel lanes, and one southbound left-turn lane will be maintained.

4.2.2 MORNINGSIDE AVENUE AND HIGHWAY 401 EASTBOUND OFF-RAMP

Morningside Avenue, 0.3 km north of Military Trail to the Highway 401 Eastbound Off-Ramp currently consists of three northbound and three southbound travel lanes. With the LRT alignment in place, two existing northbound and two existing southbound travel lanes will be maintained with one travel lane removed in each direction. The lane configuration of the Highway 401 Eastbound Off-Ramp (two left-turn lanes and one right-turn lane) will remain unchanged.

4.2.3 MORNINGSIDE AVENUE AND HIGHWAY 401 WESTBOUND OFF-RAMP/CINEMART DRIVE

Morningside Avenue, from the Highway 401 Eastbound Off-Ramp to Highway 401 Westbound Off-Ramp/Cinemart Drive intersection currently consists of three northbound and three southbound travel lanes with a dedicated northbound left-turn lane. With the LRT alignment in place, two existing northbound and two existing southbound travel lanes will be maintained with one travel lane removed in each direction. The northbound protected left-turn lane at the Morningside Avenue and Highway 401 Westbound Off-Ramp/Cinemart Drive intersection will be maintained. The lane configuration of the Highway 401 Westbound Off-Ramp (one right turn lane, one right-turn/through lane, one left-turn lane and one left-turn/through lane) will remain unchanged. The lane configuration of Cinemart Drive (one right-turn lane) will remain unchanged.

4.2.4 MORNINGSIDE AVENUE AND MILNER AVENUE

Morningside Avenue, from the Highway 401 Westbound Off-Ramp/Cinemart Drive intersection to the Milner Avenue intersection currently consists of two northbound and three southbound travel lanes with a dedicated northbound right-turn lane and dedicated northbound and southbound left-turn lanes. With the LRT alignment in place, two existing northbound and two existing southbound travel lanes will be maintained with one travel lane removed in each direction. The dedicated right-turn lane at this intersection will be converted to a shared through/right-turn lane. The northbound and southbound left-turn lanes will also be maintained but will be converted from permissive/ protected and permissive lanes, respectively, to fully protected lanes. The lane configurations for the eastbound and westbound Milner Avenue approaches (one left turn lane, one through lane, and one right-turn/through lane) will remain unchanged.

IBI GROUP TRAFFIC IMPACT STUDY

TORONTO TRANSIT COMMISSION
TTC SCARBOROUGH MALVERN LRT
HIGHWAY 401 & MORNINGSIDE AVENUE TRAFFIC IMPACT STUDY

5. EXISTING CONDITIONS

5.1 Study Horizons

As prescribed by the MTO's *General Guidelines for the Preparation of Traffic Impact Studies (2008)*, the following horizon years are recommended: open year, 5 years after opening and 10 years after opening. Therefore, the following periods (conditions) were analysed as part of this study:

- 2008 (Existing condition)
- 2018 (Projected opening year)
- 2023 (5 years after opening)
- 2028 (10 years after opening)

Impacts on the road network were analyzed during the AM and PM peak hours, which correspond to the peak hours for the Proposed Project.

5.2 Turning Movement Counts

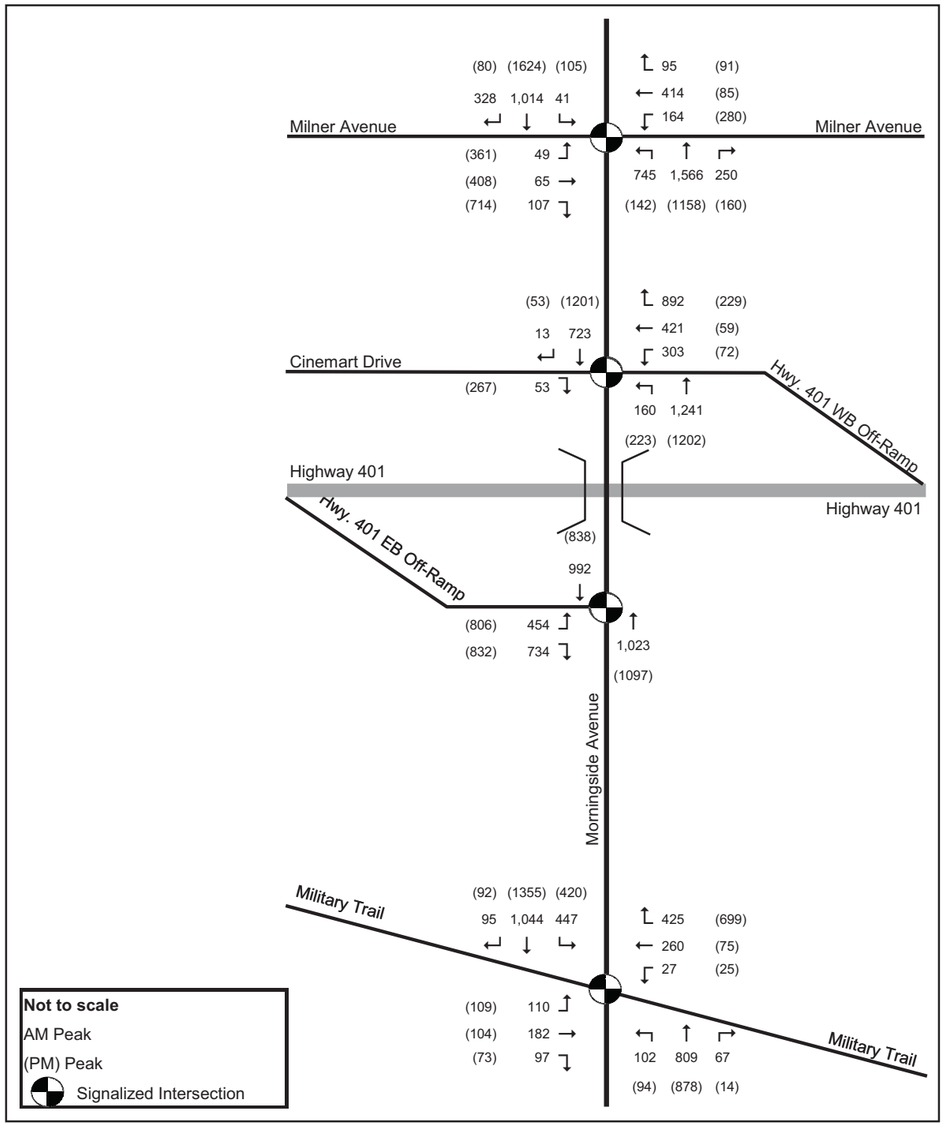
Morning and afternoon peak hour counts of traffic at the four Study Area signalized intersections were obtained from the City of Toronto, or where City of Toronto counts were unavailable, traffic counts were undertaken by IBI Group. The location, source and date of count information are listed in Exhibit 5-1. These represent the most recent counts available from the City for each intersection.

Exhibit 5-1: Traffic Count Information Used in Study

No.	Intersection		Source	Count Date
	East-West Street	North-South Street		
1	Military Trail	Morningside Avenue	City of Toronto	November 9, 2006
2	Highway 401 Eastbound Off-Ramp	Morningside Avenue	City of Toronto	April 3, 2007
3	Highway 401 Westbound Off-Ramp/Cinemart Drive	Morningside Avenue	IBI Group	June 26, 2008
			iTrans	January, 2002
4	Milner Avenue	Morningside Avenue	City of Toronto	May 1, 2002

Demographic data, namely traffic zone population and employment projections (from the City of Toronto) for the Study Area were analyzed to determine the growth rate in the Study Area. The analysis determined that from 2002-2008, there has been a 1.95% average annual growth rate. This growth rate was applied on a compounded annual basis to the turning movement counts to create the 2008 existing condition traffic volumes. The 2008 existing AM and PM peak hour volumes are illustrated in Exhibit 5-2.

Exhibit 5-2: 2008 Existing Condition Traffic Volumes



5.3 Signal Timings and Intersection Configurations

Current signal phasing and splits for the signalized study intersections were obtained from the City of Toronto. Intersection lane configurations were obtained through aerial photography, and field studies undertaken by IBI Group staff.

5.4 Traffic Analysis Parameters

5.4.1 CAPACITY AND LEVEL OF SERVICE

An intersection's overall operating conditions are typically characterized by two standard measures: the volume to capacity ratio (V/C) and the level of service (LOS). Taken together, they provide an indication of delay and the number of vehicles that can be accommodated through an intersection.

The V/C ratio is an indication of the volume of traffic attempting to make a specific movement through an intersection (i.e., northbound left, westbound straight through), versus the theoretical capacity of that movement given the lane configurations, operating conditions and signal timings provided at the intersection. A V/C ratio of 1.0 represents a condition where all available capacity for a particular movement is being used.

The level of service (LOS) of the overall intersection of a particular movement is a measure of the average vehicle delay experienced by the motorists attempting to travel through the intersection. LOS is measured from "A" to "F" with peak hour LOS in the "A" to "D" range being considered acceptable by most and a LOS of F representing unacceptable delays.

The MTO's *General Guidelines for the Preparation of Traffic Impact Studies (2008)* and the City of Toronto's *Guidelines for Using Synchro Software v.5.0 (2004)* were consulted for the base parameters of this study. Existing intersection capacity analyses were undertaken using the Highway Capacity Manual (HCM) methodology, and specifically the Synchro 6.0 Traffic Signal Coordination Software package by Trafficware. The analysis reflects 2008 traffic volumes, current signal timings, and existing lane configurations. Critical movements were identified as those operating with a volume-to-capacity (V/C) ratio of 0.85 or higher and/or the poorest level of service (LOS).

5.4.2 QUEUE LENGTHS

A queue length for a turning movement that exceeds the length of the available turning bay (left-turns) or creates back-ups (right-turns) is a concern, particularly at a signalized intersection. These turning vehicles can potentially block through vehicles during a green light, which reduces the intersection efficiency. Of greater concern are queues that extend beyond the available storage space on Highway 401 off-ramps. Vehicles queued on Highway 401 are a significant safety concern given the speed differential between the queued vehicles and the highways section. Preventing queue spillback on the Highway 401 off-ramps is the objective of the queue length analysis.

The Synchro 6.0 Traffic Signal Coordination Software measures both the 50th percentile and 95th percentile maximum queue lengths. The 50th percentile queue (the median) is the maximum back of queue length during a typical traffic cycle. The 95th percentile queue is the maximum back of queue length during a typical traffic cycle with 95th percentile traffic volumes. The 95th percentile queue measures the queue length that 95 percent of the sample lies below.

Critical queue lengths were identified as movements that surpassed the estimated length of the storage bay.

5.5 2008 Existing Condition

5.5.1 TRAFFIC ANALYSIS RESULTS

Capacity and Level of Service

The AM and PM peak hour analysis results are included in Exhibit 5-3. Full analysis summaries are included in Appendix A.

Exhibit 5-3: 2008 Existing Intersection Operations

Intersection	Overall	Critical		
	LOS	Movement	V/C	LOS
AM PEAK PERIOD				
Military Trail & Morningside Avenue	F	Eastbound Left-Turn	1.10	F
Hwy. 401 EB Off-Ramp & Morningside Avenue	F	Eastbound Right-Turn	2.16	F
Hwy. 401 WB Off-Ramp/Cinemart Dr. & Morningside Avenue	D	Westbound Through	0.99	D
Milner Avenue & Morningside Avenue	E	Northbound Left-Turn	1.83	F
PM PEAK PERIOD				
Military Trail & Morningside Avenue	F	Westbound Right-Turn	1.13	F
Hwy. 401 EB Off-Ramp & Morningside Avenue	F	Eastbound Right-Turn	1.57	F
Hwy. 401 WB Off-Ramp/Cinemart Dr. & Morningside Avenue	D	Eastbound Right-Turn	0.81	D
Milner Avenue & Morningside Avenue	F	Westbound Left-Turn	1.39	F

Notes:
Critical movement(s) defined as V/C >0.85 and/or poorest LOS.

At the Military Trail and Morningside Avenue intersection, the intersection is operating at LOS C during the AM and PM peak hours. During the AM peak hour, the eastbound left-turn turn movement is operating above capacity and the eastbound through movement is operating just below capacity. The southbound left-turn movement is operating at capacity. During the PM peak hour, the westbound right-turn movement is operating well above capacity, and the southbound left-turn movement is operating just below capacity.

At the Highway 401 Eastbound Off-Ramp and Morningside Avenue intersection, the intersection is operating at LOS F during the AM and PM peak hours. During the AM and PM peak hours, the eastbound right-turn turn movement is operating well above capacity.

At the Highway 401 Westbound Off-Ramp/Cinemart Drive and Morningside Avenue intersection, the intersection is operating at LOS C during the AM and PM peak hours. During the AM peak

hour, the westbound through and right-turn movements are operating at capacity. During the PM peak hour, the eastbound right-turn movement is operating just below capacity.

At the Milner Avenue and Morningside Avenue intersection, the intersection is operating at LOS F during the AM peak hour and LOS E during the PM peak hour. During the AM peak hour, the northbound right-turn turn movement is operating well above capacity. The Southbound through movement is operating close to capacity. During the PM peak hour, the westbound left-turn movement is operating well above capacity. The eastbound left-turn and through movements are operating just below/at capacity and the southbound left-turn and through movements are operating above capacity.

Queue Lengths

The AM and PM peak hour analysis results are included in Exhibit 5-4. Full analysis summaries are included in Appendix A.

Exhibit 5-4: 2008 Existing Intersection Queues

Intersection	App-roach	Lane Group	Storage		Queue Lengths (m)			
					AM Peak Hour		PM Peak Hour	
			Length (m)	No. Lanes	50th %tile	95th %tile	50th %tile	95th %tile
Military Trail & Morningside Avenue	East	Left-Turn	72.3	1	~21.8	#53.4	17.1	32.7
		Through	-	1S	43.6	#89.8	22.7	43.2
		Right-turn	-	1S				
	West	Left-Turn	82.2	1	4.2	#15.7	3.8	11.2
		Through	-	1	43.1	#78.5	11.2	22.9
		Right-turn	74.5	1	36.8	72	~123.8	#190.0
	North	Left-Turn	184.0	1	7.7	18	8.9	24.8
		Through	-	2	33	43.7	43.3	57.2
		Right-turn	-	1	1.7	6.2	0	2.4
	South	Left-Turn	182.5	1	~17.3	m#19.2	27.2	m33.8
		Through	-	2	8.9	m10.1	40.5	m40.1
		Right-turn	54.4	1	0	m0.0	0.4	m1.1
Hwy. 401 EB Off-Ramp & Morningside Avenue	East	Left-Turn	500.0	2	39	#60.0	69.1	#98.7
		Through	500.0	0				
		Right-turn	500.0	1	~163.6	#230.5	~174.2	#243.7
	West	Left-Turn	-	0				
		Through	-	0				
		Right-turn	-	0				
	North	Left-Turn	-	0				
		Through	-	3	26.9	m35.1	32.7	m34.9
		Right-turn	-	0				
	South	Left-Turn	-	0				
		Through	-	3	27.1	34	2.8	3.4
		Right-turn	-	0				

Exhibit 5-4: 2008 Existing Intersection Queues (Continued)

Intersection	App-roach	Lane Group	Storage		Queue Lengths (m)			
					AM Peak Hour		PM Peak Hour	
			Length (m)	No. Lanes	50th %tile	95th %tile	50th %tile	95th %tile
Hwy. 401 WB Off-Ramp/ Cinemart Drive & Morningside Avenue	East	Left-Turn	-	0				
		Through	-	0				
		Right-turn	-	1	8.9	20.4	43.8	#80.5
	West	Left-Turn	500.0	1+1S	49.3	79.1	10.1	21.3
		Through	500.0	2S	79.3	#122.7	7.2	15.6
		Right-turn	500.0	1+1S	72.7	#139.7	5.4	19.2
	North	Left-Turn	83.0	1	12.3	m17.7	25.7	m41.3
		Through	-	3	43	49.5	39.4	47.6
		Right-turn	-	0				
	South	Left-Turn	-	0				
		Through	-	2+1S	6.1	m8.3	65.8	81.2
		Right-turn	-	1S				
Milner Avenue & Morningside Avenue	East	Left-Turn	112.0	1	5.8	14.4	61.2	#111.7
		Through	-	1+1S	3.8	10.4	80	#119.3
		Right-turn	-	1S				
	West	Left-Turn	90.0	1	21.1	38.5	~54.7	#103.4
		Through	-	1+1S	33	46.5	7.5	13.3
		Right-turn	-	1S				
	North	Left-Turn	140.0	1	~188.5	m#238.1	15	28.2
		Through	-	2	99.4	m124.6	89.3	114.3
		Right-turn	-	1	9	m16.1	0	10.3
	South	Left-Turn	38.4	1	5.7	#20.8	~22.8	#55.2
		Through	-	2	73.6	91.9	~131.5	#164.6
		Right-turn	112.0	1				

Notes:
S Shared Lane
~ Volume exceeds capacity, queue is theoretically infinite. Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after two cycles.
M Volume for 95th percentile queue is metered by upstream signal.

At the Military Trail and Morningside Avenue intersection, during the AM peak hour, the 95th percentile queue for the westbound right-turn lane is approaching its estimated lane length. During the PM peak period, the 95th percentile queue for the westbound right-turn lane surpasses its estimated lane length creating spillbacks onto the westbound through lane of Military Trail.

At the Highway 401 Eastbound Off-Ramp and Morningside Avenue intersection, during the AM and PM peak hours, the 50th and 95th percentile queues for the eastbound right-turn lane are estimated to be 160 metres and 230 metres (AM) and 170 metres and 240 metres (PM), respectively. AM peak hour field observations indicate that eastbound off-ramp vehicular queues extend to an average of 150-200 metres (which correlates well with Synchro's estimate of 160 metres) and are easily accommodated by the ramp's 500 metre length. Similarly, during the PM peak hour, the observed eastbound off-ramp queue extended around 175 metres.

At the Highway 401 Westbound Off-Ramp/Cinemart Drive and Morningside Avenue intersection, during the AM peak hour, the 95th percentile queue for the westbound right-turn lane is estimated

to be 140 metres. AM peak hour field observations indicate that vehicular queues extend to an average of 100-150 metres per traffic cycle along the westbound off-ramp, and are easily accommodated by the ramp's 500 metre length.

At the Milner Avenue and Morningside Avenue intersection, during the AM peak hour, the 50th and 95th percentile queues for the northbound left-turn lane surpasses its estimated lane length creating spillbacks onto the northbound through lanes of Morningside Avenue. During the PM peak period, the 95th percentile queue for the westbound left-turn lane surpasses its estimated lane length creating spillbacks onto the westbound through lanes of Milner Avenue. The 95th percentile queue for the southbound left-turn lane surpasses its estimated lane length creating spillbacks onto the southbound through lanes of Morningside Avenue

6. FUTURE CONDITIONS

6.1 Background Traffic Forecasts (Non-Site Traffic)

To undertake a transportation assessment of the opening year (2018) and 5-year (2023) and 10-year (2028) time horizons within the study, it was necessary to establish a future background condition. Based on the existing conditions and field observations, the majority of major intersections outside the Study Area are operating near or at capacity during the peak hours.

Normally, a background growth rate would reflect the following conditions:

- Future traffic growth on the Study Area roadways resulting from development in Scarborough and the City of Toronto; and
- Planned development within and adjacent to the Study Area.

Research indicates that no major current and future residential and commercial developments are planned for the Study Area. Demographic data, namely traffic zone population and employment projections (from the City of Toronto) for the Study Area were analyzed to determine the growth rate in the Study Area. The analysis determined that from 2008-2018, there is a projected 0.53% average annual growth rate. This growth rate was applied on a compounded annual basis to the turning movement counts to create the 2018 background traffic volumes.

6.2 Trip Generation

The Proposed Project is not projected to generate any new vehicular trips in the Study Area. In fact, the Proposed Project has the potential to remove vehicles from Study Area streets through improved public transit. However, a reduction in overall traffic volumes was not explored in this study.

6.3 Trip Distribution / Assignment

No new vehicular trips were assigned to the Study Area traffic network.

6.4 2018 Opening Year

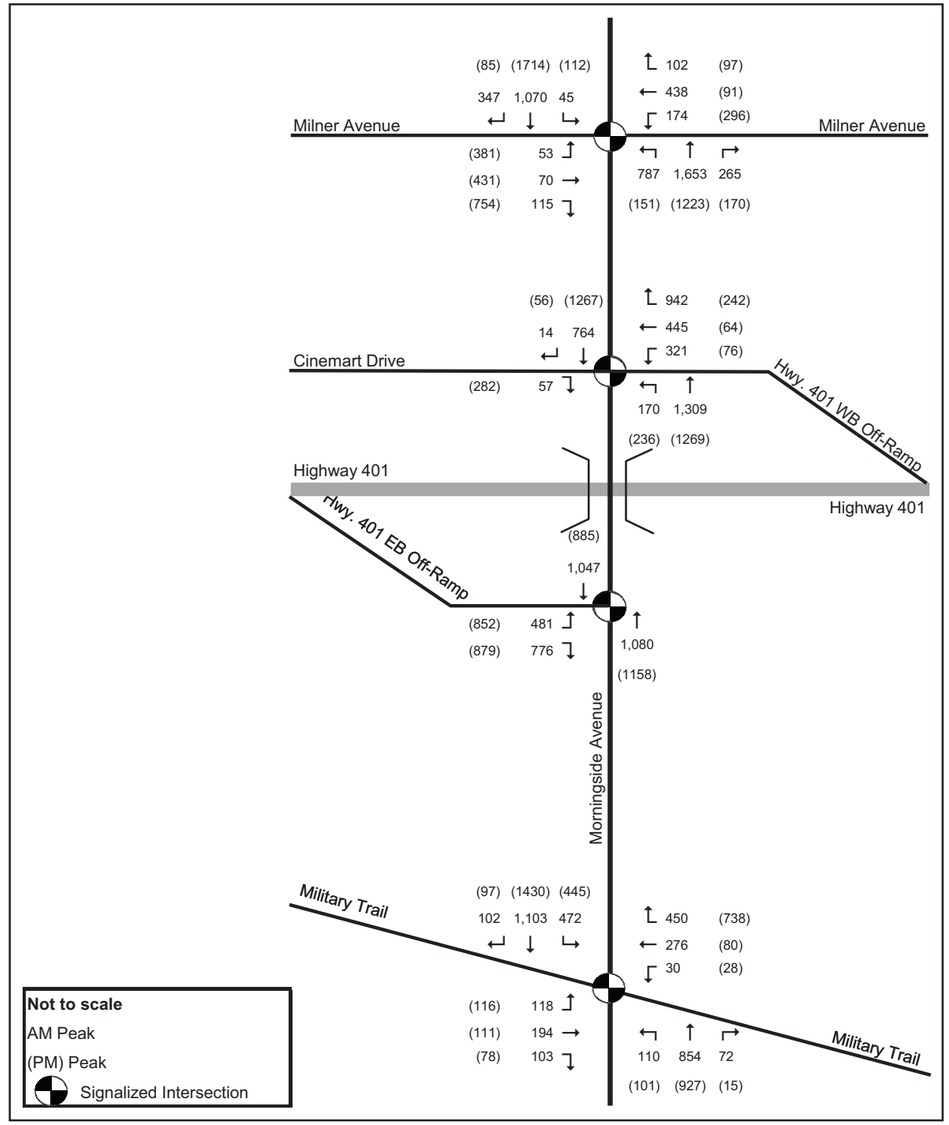
6.4.1 TOTAL TRAFFIC VOLUMES

The 2018 opening year traffic volumes were developed by adding the background traffic volumes with the project-generated traffic volumes for the weekday AM and PM peak hours. Exhibit 6-1 shows the 2018 opening year total traffic volumes during the AM and PM peak hours.

IBI GROUP TRAFFIC IMPACT STUDY

TORONTO TRANSIT COMMISSION
TTC SCARBOROUGH MALVERN LRT
HIGHWAY 401 & MORNINGSIDE AVENUE TRAFFIC IMPACT STUDY

Exhibit 6-1: 2018 Opening Year Traffic Volumes



6.4.2 TRAFFIC ANALYSIS PARAMETERS

The 2018 opening year intersection capacity analyses were undertaken using the Highway Capacity Manual (HCM) methodology, and specifically the Synchro 6.0 Traffic Signal Coordination Software package by Trafficware. The analysis reflects 2018 opening year traffic volumes. Roadway configurations were adjusted to reflect the new configurations with the Proposed Project in place. Signal timings were adjusted to reflect the conversion of protected/permissive left-turn lanes along Morningside Avenue to fully protected left-turn lanes.

6.4.3 TRAFFIC ANALYSIS RESULTS

Capacity and Level of Service

The AM and PM peak hour analysis results are included in Exhibit 6-2. Full analysis summaries are included in Appendix B.

Exhibit 6-2: 2018 Opening Year Intersection Operations

Intersection	Overall	Critical		
	LOS	Movement	V/C	LOS
AM PEAK PERIOD				
Military Trail & Morningside Avenue	C	Eastbound Left-Turn	1.34	F
Hwy. 401 EB Off-Ramp & Morningside Avenue	F	Eastbound Right-Turn	2.37	F
Hwy. 401 WB Off-Ramp/Cinemart Dr. & Morningside Avenue	D	Northbound Left-Turn	1.30	F
Milner Avenue & Morningside Avenue	F	Northbound Left-Turn	2.20	F
PM PEAK PERIOD				
Military Trail & Morningside Avenue	D	Westbound Right-Turn	1.24	F
Hwy. 401 EB Off-Ramp & Morningside Avenue	F	Eastbound Right-Turn	1.68	F
Hwy. 401 WB Off-Ramp/Cinemart Dr. & Morningside Avenue	D	Southbound Through	1.03	E
Milner Avenue & Morningside Avenue	F	Southbound Through	1.72	F

Notes:
Critical movement(s) defined as V/C >0.85 and/or poorest LOS.

At the Military Trail and Morningside Avenue intersection, the intersection is projected to operate at LOS C during the AM peak hour and LOS D during the PM peak hour. During the AM peak hour, the eastbound left-turn turn movement is projected to operate well above capacity and the eastbound through movement is projected to operate at capacity. The southbound left-turn movement is projected to operate above capacity. During the PM peak hour, the westbound right-turn movement is projected to operate above capacity and the southbound left-turn movement is projected to operate at capacity.

At the Highway 401 Eastbound Off-Ramp and Morningside Avenue intersection, the intersection is project to operate at LOS F during the AM and PM peak hours. During the AM and PM peak hours,

the eastbound right-turn turn movement is projected to operate well above capacity and the left-turn movement is projected to operate just below capacity.

At the Highway 401 Westbound Off-Ramp/Cinemart Drive and Morningside Avenue intersection, the intersection is project to operate at LOS D during the AM and PM peak hours. During the AM peak hour, the westbound through and right-turn movements are projected to operate at capacity. The northbound left-turn turn movement is projected to operate above capacity. During the PM peak hour, the southbound through movement is project to operate at capacity.

At the Milner Avenue and Morningside Avenue intersection, the intersection is project to operate at LOS F during the AM peak and PM peak hours. During the AM peak hour, the northbound left-turn and through movements are projected to operate well above capacity. The northbound left-turn turn movement is projected to operate well above capacity. During the PM peak hour, each approach is projected to have at least one movement operating at or above capacity.

Queue Lengths

The AM and PM peak hour analysis results are included in Exhibit 6-3. Full analysis summaries are included in Appendix B.

Exhibit 6-3: 2018 Opening Year Intersection Queues

Intersection	App-roach	Lane Group	Storage		Queue Lengths (m)			
					AM Peak Hour		PM Peak Hour	
			Length (m)	No. Lanes	50th %tile	95th %tile	50th %tile	95th %tile
Military Trail & Morningside Avenue	East	Left-Turn	72.3	1	~26.9	#59.6	18.3	34.5
		Through	-	1S	47.4	#97.5	24.6	45.5
		Right-turn	-	1S				
	West	Left-Turn	82.2	1	4.8	#18.8	4.2	12.2
		Through	-	1	46.2	#86.0	12	24.1
		Right-turn	74.5	1	45.3	#94.0	~119.7	#190.3
	North	Left-Turn	184.0	1	9	23	10.9	#39.0
		Through	-	2	35.5	46.8	46.1	60.5
		Right-turn	-	1	2.5	7.3	0	2.4
	South	Left-Turn	182.5	1	~22.2	m#21.1	34.3	m#35.5
		Through	-	1+1S	9.3	m11.3	69.7	m62.4
		Right-turn	54.4	1S				

Exhibit 6-3: 2018 Opening Year Intersection Queues (Continued)

Intersection	App-roach	Lane Group	Storage		Queue Lengths (m)			
					AM Peak Hour		PM Peak Hour	
			Length (m)	No. Lanes	50th %tile	95th %tile	50th %tile	95th %tile
Hwy. 401 EB Off-Ramp & Morningside Avenue	East	Left-Turn	500.0	2	41.8	#65.6	72.3	#104.6
		Through	500.0	0				
		Right-turn	500.0	1	~184.9	#252.9	~195.1	#265.3
	West	Left-Turn	-	0				
		Through	-	0				
		Right-turn	-	0				
	North	Left-Turn	-	0				
		Through	-	2	44.3	m58.0	64.2	m57.4
		Right-turn	-	0				
	South	Left-Turn	-	0				
		Through	-	2	47.7	57.9	4.2	m4.3
		Right-turn	-	0				
Hwy. 401 WB Off-Ramp/ Cinemart Drive & Morningside Avenue	East	Left-Turn	-	0				
		Through	-	0				
		Right-turn	-	1	9.6	#23.1	46.9	#87.0
	West	Left-Turn	500.0	1	53	84.1	10.7	22.3
		Through	500.0	1+1S	~90.6	#135.5	8.9	17.7
		Right-turn	500.0	1+1S	~90.3	#154.0	7.9	22.3
	North	Left-Turn	83.0	1	~39.5	m#69.8	42.4	m58.2
		Through	-	2	110.2	133.8	65.2	m77.3
		Right-turn	-	0				
	South	Left-Turn	-	0				
		Through	-	1+1S	9.1	m9.1	~131.6	#172.3
		Right-turn	-	1S				
Milner Avenue & Morningside Avenue	East	Left-Turn	112.0	1	6.4	15.6	66.4	#121.1
		Through	-	1+1S	4.1	11	89.3	#133.7
		Right-turn	-	1S				
	West	Left-Turn	90.0	1	22.7	41.2	~61.0	#110.9
		Through	-	1+1S	34.4	48.5	4.6	10.5
		Right-turn	-	1S				
	North	Left-Turn	140.0	1	~210.2	m#250.1	27.6	#60.6
		Through	-	1+1S	~263.3	m#286.0	~177.4	#219.0
		Right-turn	-	1S				
	South	Left-Turn	38.4	1	6.7	16.1	20.1	#43.2
		Through	-	1+1S	~165.1	#206.4	~261.8	#304.6
		Right-turn	112.0	1S				

Notes:
S Shared Lane
~ Volume exceeds capacity, queue is theoretically infinite. Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after two cycles.
M Volume for 95th percentile queue is metered by upstream signal.

At the Military Trail and Morningside Avenue intersection, during the AM peak hour, the 95th percentile queue for the westbound right-turn lane is projected to surpass its estimated lane length creating spillbacks onto the westbound through lane of Military Trail. During the PM peak hour, the

50th and 95th percentile queues for the westbound right-turn lane are projected to surpass its estimated lane length creating spillbacks onto the westbound through lane of Military Trail.

At the Highway 401 Eastbound Off-Ramp and Morningside Avenue intersection, during the AM and PM peak hour, there are no projected queue length issues.

At the Highway 401 Westbound Off-Ramp/Cinemart Drive and Morningside Avenue intersection, during the AM and PM peak hour, there are no projected queue length issues.

At the Milner Avenue and Morningside Avenue intersection, during the AM peak hour, the 50th and 95th percentile queues for the northbound left-turn lane are projected to surpass its estimated lane length creating spillbacks onto the northbound through lanes of Morningside Avenue. During the PM peak hour, the 95th percentile queue for the eastbound left-turn lane is projected to surpass its estimated lane length creating spillbacks onto the westbound through lanes of Milner Avenue. The 95th percentile queue for the westbound left-turn lane is projected to surpass its estimated lane length creating spillbacks onto the westbound through lanes of Milner Avenue. The 95th percentile queue for the southbound left-turn lane is projected to surpass its estimated lane length creating spillbacks onto the southbound through lanes of Morningside Avenue.

6.5 2023 5-Year Horizon

6.5.1 TOTAL TRAFFIC VOLUMES

Demographic data, namely traffic zone population and employment projections (from the City of Toronto) for the Study Area were analyzed to determine the growth rate in the Study Area. The analysis determined that from 2018-2023, there is a projected 0.25% average annual growth rate. The 2023 5-year horizon traffic volumes were developed by applying this growth rate to the 2018 background AM and PM peak traffic volumes hour over a five-year period. The site-generated traffic volumes were then added to these 2023 background traffic volumes to develop the 2023 5-year horizon traffic volumes. Exhibit 6-4 shows the 2023 5-year horizon total traffic volumes during the AM and PM peak hours.

6.5.2 TRAFFIC ANALYSIS PARAMETERS

The 2023 5-year horizon intersection capacity analyses were undertaken using the Highway Capacity Manual (HCM) methodology and specifically the Synchro 6.0 Traffic Signal Coordination Software package by Trafficware. The analysis reflects 2023 5-year horizon traffic volumes. There were no adjustments to roadway configurations or traffic signal timing.

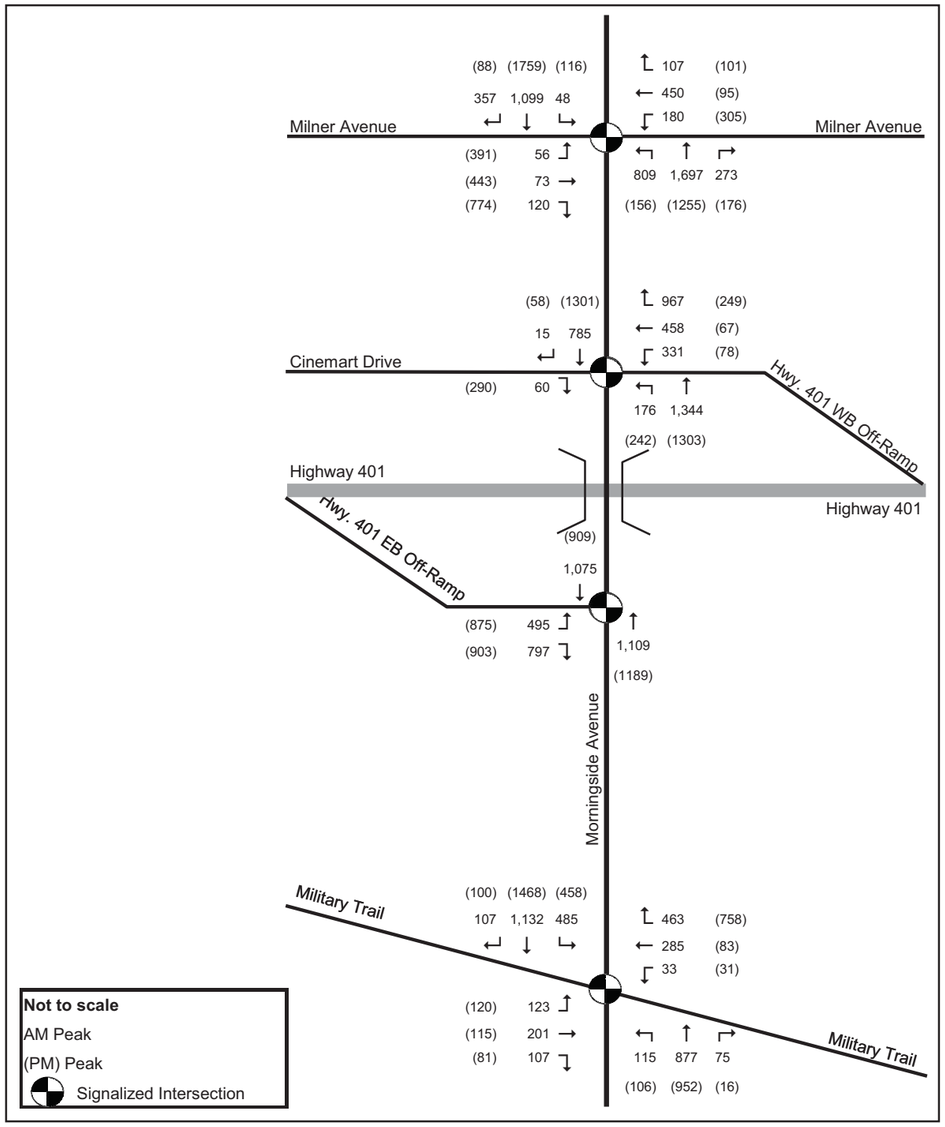
6.5.3 TRAFFIC ANALYSIS RESULTS

Capacity and Level of Service

The AM and PM peak hour analysis results are included in Exhibit 6-5. Full analysis summaries are included in Appendix C.

TORONTO TRANSIT COMMISSION
TTC SCARBOROUGH MALVERN LRT
HIGHWAY 401 & MORNINGSIDE AVENUE TRAFFIC IMPACT STUDY

Exhibit 6-4: 2023 5-Year Horizon Traffic Volumes



TORONTO TRANSIT COMMISSION
TTC SCARBOROUGH MALVERN LRT
HIGHWAY 401 & MORNINGSIDE AVENUE TRAFFIC IMPACT STUDY

Exhibit 6-5: 2023 5-Year Horizon Intersection Operations

Intersection	Overall	Critical		
	LOS	Movement	V/C	LOS
AM PEAK PERIOD				
Military Trail & Morningside Avenue	D	Eastbound Left-Turn	1.52	F
Hwy. 401 EB Off-Ramp & Morningside Avenue	F	Eastbound Right-Turn	2.47	F
Hwy. 401 WB Off-Ramp/Cinemart Dr. & Morningside Avenue	D	Northbound Left-Turn	1.34	F
Milner Avenue & Morningside Avenue	F	Northbound Left-Turn	2.49	F
PM PEAK PERIOD				
Military Trail & Morningside Avenue	D	Westbound Right-Turn	1.29	F
Hwy. 401 EB Off-Ramp & Morningside Avenue	F	Eastbound Right-Turn	1.76	F
Hwy. 401 WB Off-Ramp/Cinemart Dr. & Morningside Avenue	D	Southbound Through	1.08	E
Milner Avenue & Morningside Avenue	F	Southbound Through	1.80	F

Notes:
Critical movement(s) defined as V/C >0.85 and/or poorest LOS.

At the Military Trail and Morningside Avenue intersection, the intersection is projected to operate at LOS D during the AM and PM peak hours. All traffic impacts identified in the 2018 opening year condition remain. During the AM peak hour, the westbound through movement is projected to operate close to capacity.

At the Highway 401 Eastbound Off-Ramp and Morningside Avenue intersection, the intersection is projected to operate at LOS F during the AM and PM peak hours. All traffic impacts identified in the 2018 opening year condition remain.

At the Highway 401 Westbound Off-Ramp/Cinemart Drive and Morningside Avenue intersection, the intersection is projected to operate at LOS D during the AM and PM peak hours. All traffic impacts identified in the 2018 opening year condition remain.

At the Milner Avenue and Morningside Avenue intersection, the intersection is projected to operate at LOS F during the AM and PM peak hours. All traffic impacts identified in the 2018 opening year condition remain.

Queue Lengths

The AM and PM peak hour analysis results are included in Exhibit 6-6. Full analysis summaries are included in Appendix C.

Exhibit 6-6: 2023 5-Year Horizon Intersection Queues

Intersection	App-roach	Lane Group	Storage		Queue Lengths (m)			
					AM Peak Hour		PM Peak Hour	
			Length (m)	No. Lanes	50th %tile	95th %tile	50th %tile	95th %tile
Military Trail & Morningside Avenue	East	Left-Turn	72.3	1	~30.0	#63.1	18.9	35.8
		Through	-	1S	~51.4	#102.9	25.7	47.6
		Right-turn	-	1S				
	West	Left-Turn	82.2	1	5.3	#21.1	4.7	13.2
		Through	-	1	48.1	#90.0	12.4	24.7
		Right-turn	74.5	1	49.6	#101.3	~131.0	#200.0
	North	Left-Turn	184.0	1	9.8	26.2	12.5	#43.6
		Through	-	2	36.8	48.6	47.7	62.7
		Right-turn	-	1	2.9	7.8	0	2.5
	South	Left-Turn	182.5	1	~31.6	m#27.4	~34.4	m#41.1
		Through	-	1+1S	9.5	m12.6	74.4	m64.6
		Right-turn	54.4	1S				
Hwy. 401 EB Off-Ramp & Morningside Avenue	East	Left-Turn	500.0	2	43.2	#68.4	75	#109.3
		Through	500.0	0				
		Right-turn	500.0	1	~195.2	#263.9	~207.3	#278.2
	West	Left-Turn	-	0				
		Through	-	0				
		Right-turn	-	0				
	North	Left-Turn	-	0				
		Through	-	2	45.3	m59.2	69.4	m59.2
		Right-turn	-	0				
	South	Left-Turn	-	0				
		Through	-	2	49.1	59.2	4.3	m4.2
		Right-turn	-	0				
Hwy. 401 WB Off-Ramp/ Cinemart Drive & Morningside Avenue	East	Left-Turn	-	0				
		Through	-	0				
		Right-turn	-	1	10.2	#25.1	48.5	#90.3
	West	Left-Turn	500.0	1	55.3	87.6	11	22.7
		Through	500.0	1+1S	~100.2	#141.9	9.7	18.8
		Right-turn	500.0	1+1S	~97.1	#161.6	9.2	24.1
	North	Left-Turn	83.0	1	~41.9	m#71.9	43.5	m59.1
		Through	-	2	114.2	138.1	67.4	m78.7
		Right-turn	-	0				
	South	Left-Turn	-	0				
		Through	-	1+1S	9.6	m9.5	~141.0	#182.1
		Right-turn	-	1S				

Exhibit 6-6: 2023 5-Year Horizon Intersection Queues (Continued)

Intersection	App-roach	Lane Group	Storage		Queue Lengths (m)			
					AM Peak Hour		PM Peak Hour	
			Length (m)	No. Lanes	50th %tile	95th %tile	50th %tile	95th %tile
Milner Avenue & Morningside Avenue	East	Left-Turn	112.0	1	6.8	16.5	69.3	#125.9
		Through	-	1+1S	4.3	11.2	94.3	#140.9
		Right-turn	-	1S				
	West	Left-Turn	90.0	1	23.6	42.5	~64.5	#115.2
		Through	-	1+1S	35.8	49.8	4.8	10.8
		Right-turn	-	1S				
	North	Left-Turn	140.0	1	~243.3	m#283.7	28.6	#63.3
		Through	-	1+1S	~273.5	m#294.4	~185.2	#226.9
		Right-turn	-	1S				
	South	Left-Turn	38.4	1	6.9	16.4	20.8	#44.9
		Through	-	1+1S	~172.6	#214.1	~273.2	#316.0
		Right-turn	112.0	1S				

Notes:
S Shared Lane
~ Volume exceeds capacity, queue is theoretically infinite. Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after two cycles.
M Volume for 95th percentile queue is metered by upstream signal.

At the Military Trail and Morningside Avenue intersection, during the AM peak hour, the 95th percentile queue for the westbound right-turn lane is projected to surpass its estimated lane length creating spillbacks onto the westbound through lane of Military Trail. During the PM peak hour, the 50th and 95th percentile queues for the westbound right-turn lane are projected to surpass its estimated lane length creating spillbacks onto the westbound through lane of Military Trail.

At the Highway 401 Eastbound Off-Ramp and Morningside Avenue intersection, during the AM and PM peak hour, there are no projected queue length issues.

At the Highway 401 Westbound Off-Ramp/Cinemart Drive and Morningside Avenue intersection, during the AM and PM peak hour, there are no projected queue length issues.

At the Milner Avenue and Morningside Avenue intersection, during the AM peak hour, the 50th and 95th percentile queues for the northbound left-turn lane are projected to surpass its estimated lane length creating spillbacks onto the northbound through lanes of Morningside Avenue. During the PM peak hour, the 95th percentile queue for the eastbound left-turn lane is projected to surpass its estimated lane length creating spillbacks onto the westbound through lanes of Milner Avenue. The 95th percentile queue for the westbound left-turn lane is projected to surpass its estimated lane length creating spillbacks onto the westbound through lanes of Milner Avenue. The 95th percentile queue for the southbound left-turn lane is projected to surpass its estimated lane length creating spillbacks onto the southbound through lanes of Morningside Avenue.

6.6 2028 10-Year Horizon

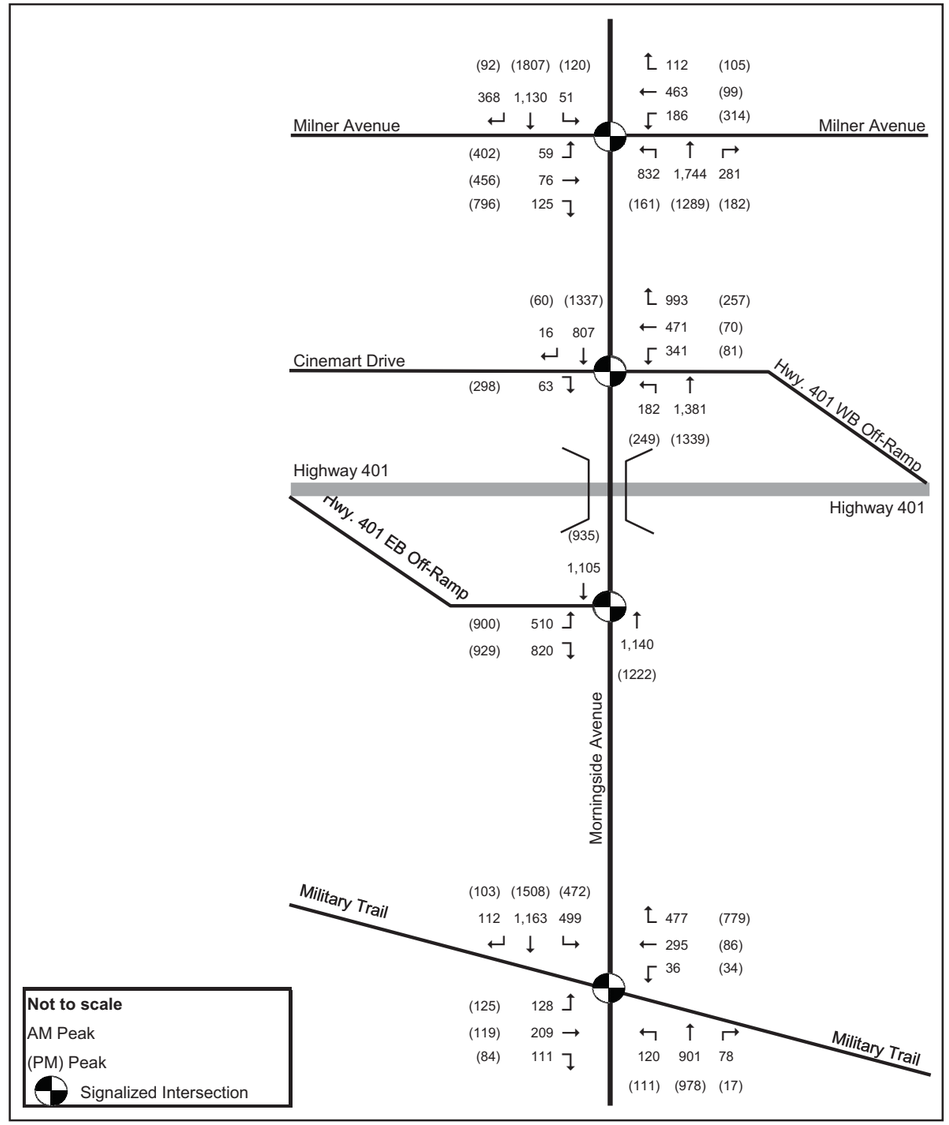
6.6.1 TOTAL TRAFFIC VOLUMES

Demographic data, namely traffic zone population and employment projections (from the City of Toronto) for the Study Area were analyzed to determine the growth rate in the Study Area. The analysis determined that from 2018-2028, there is a projected 0.26% average annual growth rate. The 2028 10-year horizon traffic volumes were developed by applying this growth rate to the 2018 background AM and PM peak traffic volumes hour over a five-year period. The site-generated traffic volumes were then added to these 2028 background traffic volumes to develop the 2028 5-year horizon traffic volumes. Exhibit 6-7 shows the 2028 10-year horizon total traffic volumes during the AM and PM peak hours.

6.6.2 TOTAL TRAFFIC VOLUMES

The 2028 10-year horizon intersection capacity analyses were undertaken using the Highway Capacity Manual (HCM) methodology and specifically the Synchro 6.0 Traffic Signal Coordination Software package by Trafficware. The analysis reflects 2028 10-year horizon traffic volumes. There were no adjustments to roadway configurations or traffic signal timing.

Exhibit 6-7: 2028 10-Year Horizon Traffic Volumes



6.6.3 TRAFFIC ANALYSIS RESULTS

Capacity and Level of Service

The AM and PM peak hour analysis results are included in Exhibit 6-8. Full analysis summaries are included in Appendix D.

Exhibit 6-8: 2028 10-Year Horizon Intersection Operations

Intersection	Overall	Critical		
	LOS	Movement	V/C	LOS
AM PEAK PERIOD				
Military Trail & Morningside Avenue	D	Eastbound Left-Turn	1.71	F
Hwy. 401 EB Off-Ramp & Morningside Avenue	F	Eastbound Right-Turn	2.58	F
Hwy. 401 WB Off-Ramp/Cinemart Dr. & Morningside Avenue	D	Northbound Left-Turn	1.40	F
Milner Avenue & Morningside Avenue	F	Northbound Left-Turn	2.58	F
PM PEAK PERIOD				
Military Trail & Morningside Avenue	D	Westbound Right-Turn	1.34	F
Hwy. 401 EB Off-Ramp & Morningside Avenue	F	Eastbound Right-Turn	1.83	F
Hwy. 401 WB Off-Ramp/Cinemart Dr. & Morningside Avenue	D	Southbound Through	1.09	F
Milner Avenue & Morningside Avenue	F	Southbound Through	1.83	F

Notes:
Critical movement(s) defined as V/C >0.85 and/or poorest LOS.

At the Military Trail and Morningside Avenue intersection, the intersection is projected to operate at LOS D during the AM and PM peak hours. All traffic impacts identified in the 2018 opening year condition and 2023 5-year horizon remain.

At the Highway 401 Eastbound Off-Ramp and Morningside Avenue intersection, the intersection is projected to operate at LOS F during the AM and PM peak hours. All traffic impacts identified in the 2018 opening year condition and 2023 5-year horizon remain. During the AM peak hour, the eastbound left-turn movement is projected to operate close to capacity.

At the Highway 401 Westbound Off-Ramp/Cinemart Drive and Morningside Avenue intersection, the intersection is projected to operate at LOS D during the AM and PM peak hours. All traffic impacts identified in the 2018 opening year condition and 2023 5-year horizon remain.

At the Milner Avenue and Morningside Avenue intersection, the intersection is projected to operate at LOS F during the AM and PM peak hours. All traffic impacts identified in the 2018 opening year condition and 2023 5-year horizon remain.

Exhibit 6-9: 2028 10-Year Horizon Intersection Queues

Intersection	App-roach	Lane Group	Storage		Queue Lengths (m)			
					AM Peak Hour		PM Peak Hour	
			Length (m)	No. Lanes	50th %tile	95th %tile	50th %tile	95th %tile
Military Trail & Morningside Avenue	East	Left-Turn	72.3	1	~32.9	#66.7	19.6	37.1
		Through	-	1S	~58.0	#108.2	26.8	49.4
		Right-turn	-	1S				
	West	Left-Turn	82.2	1	5.9	#22.6	5.2	14.5
		Through	-	1	50.2	#94.9	12.8	25.4
		Right-turn	74.5	1	54.6	#109.7	~142.4	#210.4
	North	Left-Turn	184.0	1	10.7	30.7	14.5	#48.2
		Through	-	2	38.3	50.4	49.6	65.1
		Right-turn	-	1	3.3	8.4	0	2.6
	South	Left-Turn	182.5	1	~45.0	m#36.6	~48.4	m#49.5
		Through	-	1+1S	9.7	m12.6	77.5	m68.1
		Right-turn	54.4	1S				
Hwy. 401 EB Off-Ramp & Morningside Avenue	East	Left-Turn	500.0	2	44.8	#71.8	77.9	#114.2
		Through	500.0	0				
		Right-turn	500.0	1	~206.5	#275.7	~219.4	#290.7
	West	Left-Turn	-	0				
		Through	-	0				
		Right-turn	-	0				
	North	Left-Turn	-	0				
		Through	-	2	46.6	m59.8	74.2	m61.4
		Right-turn	-	0				
	South	Left-Turn	-	0				
		Through	-	2	50.4	60.4	4.5	m4.3
		Right-turn	-	0				
Hwy. 401 WB Off-Ramp/ Cinemart Drive & Morningside Avenue	East	Left-Turn	-	0				
		Through	-	0				
		Right-turn	-	1	10.7	#26.7	50.1	#93.9
	West	Left-Turn	500.0	1	57.3	#91.6	11.5	23.5
		Through	500.0	1+1S	~106.6	#148.7	10.7	20
		Right-turn	500.0	1+1S	~103.9	#168.9	10.5	25.9
	North	Left-Turn	83.0	1	~44.3	m#73.7	44.9	m60.0
		Through	-	2	118.6	m141.4	69.6	m80.2
		Right-turn	-	0				
	South	Left-Turn	-	0				
		Through	-	1+1S	10.2	m9.6	~146.1	#187.2
		Right-turn	-	1S				

Exhibit 6-9: 2028 10-Year Horizon Intersection Queues (Continued)

Intersection	App-roach	Lane Group	Storage		Queue Lengths (m)			
					AM Peak Hour		PM Peak Hour	
			Length (m)	No. Lanes	50th %tile	95th %tile	50th %tile	95th %tile
Milner Avenue & Morningside Avenue	East	Left-Turn	112.0	1	7.2	17.2	72.4	#131.5
		Through	-	1+1S	4.5	11.4	100.1	#149.2
		Right-turn	-	1S				
	West	Left-Turn	90.0	1	24.7	43.8	~68.1	#119.1
		Through	-	1+1S	37.3	51.1	5.1	11.2
		Right-turn	-	1S				
	North	Left-Turn	140.0	1	~252.4	m#291.6	29.7	#65.6
		Through	-	1+1S	~284.5	m#302.5	~193.7	#235.4
		Right-turn	-	1S				
	South	Left-Turn	38.4	1	7.7	17.7	21.7	#47.7
		Through	-	1+1S	~181.8	#223.5	~282.4	#325.2
		Right-turn	112.0	1S				

Notes:
S Shared Lane
~ Volume exceeds capacity, queue is theoretically infinite. Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after two cycles.
M Volume for 95th percentile queue is metered by upstream signal.

Queue Lengths

At the Military Trail and Morningside Avenue intersection, during the AM peak hour, the 95th percentile queue for the westbound right-turn lane is projected to surpass its estimated lane length creating spillbacks onto the westbound through lane of Military Trail. During the PM peak hour, the 50th and 95th percentile queues for the westbound right-turn lane are projected to surpass its estimated lane length creating spillbacks onto the westbound through lane of Military Trail.

At the Highway 401 Eastbound Off-Ramp and Morningside Avenue intersection, during the AM and PM peak hour, there are no projected queue length issues.

At the Highway 401 Westbound Off-Ramp/Cinemart Drive and Morningside Avenue intersection, during the AM and PM peak hour, there are no projected queue length issues.

At the Milner Avenue and Morningside Avenue intersection, during the AM peak hour, the 50th and 95th percentile queues for the northbound left-turn lane are projected to surpass its estimated lane length creating spillbacks onto the northbound through lanes of Morningside Avenue. During the PM peak hour, the 95th percentile queue for the eastbound left-turn lane is projected to surpass its estimated lane length creating spillbacks onto the westbound through lanes of Milner Avenue. The 95th percentile queue for the westbound left-turn lane is projected to surpass its estimated lane length creating spillbacks onto the westbound through lanes of Milner Avenue. The 95th percentile queue for the southbound left-turn lane is projected to surpass its estimated lane length creating spillbacks onto the southbound through lanes of Morningside Avenue.

IBI GROUP TRAFFIC IMPACT STUDY

TORONTO TRANSIT COMMISSION
TTC SCARBOROUGH MALVERN LRT
HIGHWAY 401 & MORNINGSIDE AVENUE TRAFFIC IMPACT STUDY

7. FUTURE CONDITIONS MITIGATION

7.1 Mitigation Measures

Mitigation measures were examined that would reduce critical movements in the 2028 10-Year Horizon Intersection Operations. These measures included simple mitigation and geometrical improvements.

7.1.1 SIMPLE MITIGATION

Simple mitigation measures included the following:

- Changing intersection signal timing: (i.e. shifting green signal time from one movement to another, increasing the overall cycle length); and
- Converting lane turn types (i.e. permitted to protected and permitted).

7.1.2 GEOMETRICAL IMPROVEMENTS

Geometrical Improvements included the following:

- Increasing turning lane (bay) storage lengths; and.
- Adding additional lanes (where feasible).

7.2 Proposed Mitigation Measures

7.2.1 MORNINGSIDE AVENUE AND MILITARY TRAIL

Simple Mitigation

AM Peak Hour

- Shift 18 seconds of green time from the northbound movements to the southbound left-turn movement; and
- Shift 5 seconds of green time from the northbound and southbound through movements to all the eastbound and westbound movements.

PM Peak Hour

- Convert the northbound left-turn lane turn type from permitted to protected and permitted; and
- Shift 5 seconds of green time from the northbound and southbound through movements to the northbound and southbound left-turn movements.

Geometrical Improvements

- Increase the length of the westbound right-turn lane (75 metres) by 100 metres for a total of length of 175 metres.

7.2.2 MORNINGSIDE AVENUE AND HIGHWAY 401 EASTBOUND OFF-RAMP

Simple Mitigation

AM Peak Hour

- Shift 14 seconds of green time from the northbound and southbound through movements to all eastbound movements.

PM Peak Hour

- Shift 5 seconds of green time from the northbound and southbound through movements to all eastbound movements.

Geometrical Improvements

- Add an additional eastbound right-turn lane for a total of two eastbound right-turn lanes.

7.2.3 MORNINGSIDE AVENUE AND HIGHWAY 401 WESTBOUND OFF-RAMP/CINEMART DRIVE

Simple Mitigation

AM Peak Hour

- Shift 5 seconds of green time from the northbound and southbound through movements to the northbound left-turn movement; and
- Shift 10 seconds of green time from the northbound and southbound through movements to all westbound movements.

PM Peak Hour

- No simple mitigation measures were applied.

Geometrical Improvements

- No geometrical improvements were applied.

7.2.4 MORNINGSIDE AVENUE AND MILNER AVENUE

Simple Mitigation

AM Peak Hour

- Shift 5 seconds of green time from all eastbound and westbound movements to the northbound and southbound left-turn movements; and
- Shift 5 seconds of green time from all eastbound and westbound movements to the northbound and southbound through movements;
- Increase the cycle length from 90 seconds to 100 seconds by adding 10 seconds of green time to the northbound and southbound left-turn phases.

PM Peak Hour

- Increase the cycle length from 95 seconds to 110 seconds by adding 5 seconds of green time to the northbound and southbound left-turn phases, 5 second to the westbound left-turn phase and 5 seconds to the eastbound and westbound through/right-turn phases.

Geometrical Improvements

- Add one through lane to the northbound movement and one through lane to the southbound movement.
- Increase the length of the eastbound left-turn lane (112.0 metres) by 40.0 metres for a total of length of 152.0 metres;
- Increase the length of the westbound left-turn lane (90.0 metres) by 34.0 metres for a total of length of 130.0 metres;
- Increase the length of the northbound left-turn lane (140.0 metres) by 60.0 metres for a total of length of 200.0 metres; and
- Increase the length of the southbound left-turn lane (38.4 metres) by 10.0 metres for a total of length of 48.4 metres.

7.3 Mitigation Analysis and Results

7.3.1 TOTAL TRAFFIC VOLUMES

The 2028 10-year horizon traffic volumes were used to analyze mitigation measures, because they represent the worst case traffic scenario.

7.3.2 TRAFFIC ANALYSIS PARAMETERS

The 2028 10-year horizon mitigation intersection capacity analyses were undertaken using the Highway Capacity Manual (HCM) methodology and specifically the Synchro 6.0 Traffic Signal Coordination Software package by Trafficware. The analysis reflects 2028 10-year horizon traffic volumes with mitigation adjustments to roadway configurations or traffic signal timing in place.

7.3.3 TRAFFIC ANALYSIS RESULTS

Capacity and Level of Service

The AM and PM peak hour analysis results are included in Exhibit 7-1. Full analysis summaries are included in Appendix E.

Exhibit 7-1: 2028 10-Year Horizon Intersection Operations (Mitigated)

Intersection	Overall	Critical		
	LOS	Movement	V/C	LOS
AM PEAK PERIOD				
Military Trail & Morningside Avenue	C	Eastbound Left-Turn	0.94	F
Hwy. 401 EB Off-Ramp & Morningside Avenue	C	Eastbound Right-Turn	0.82	C
Hwy. 401 WB Off-Ramp/Cinemart Dr. & Morningside Avenue	C	Westbound Right-Turn	0.88	D
Milner Avenue & Morningside Avenue	E	Northbound Left-Turn	1.54	F
PM PEAK PERIOD				
Military Trail & Morningside Avenue	D	Westbound Right-Turn	1.13	F
Hwy. 401 EB Off-Ramp & Morningside Avenue	C	Eastbound Right-Turn	0.84	C
Hwy. 401 WB Off-Ramp/Cinemart Dr. & Morningside Avenue	D	Southbound Through	1.09	F
Milner Avenue & Morningside Avenue	F	Southbound Through	1.46	F

Notes:
Critical movement(s) defined as V/C >0.85 and/or poorest LOS.

At the Military Trail and Morningside Avenue intersection with the proposed mitigation measures in place, the intersection V/C ratio is projected to decrease from 1.32 to 0.90 during the AM peak hour and from 1.18 to 1.01 during the PM peak hour. During the AM peak hour, the V/C ratio for the eastbound left-turn movement is projected to decrease from 1.71 to 0.94 and the V/C ratio for the southbound left-turn movement is projected to decrease from 1.24 to 0.90. The V/C ratio for the northbound left-turn movement is projected to increase from 0.54 to 0.89. During the PM peak hour, the V/C ratio for the westbound right-turn movement is projected to decrease from 1.34 to 1.13 and the V/C ratio for the southbound left-turn movement is projected to decrease from 1.13 to 0.95.

At the Highway 401 Eastbound Off-Ramp and Morningside Avenue intersection, the intersection V/C ratio is projected to decrease from 0.87 to 0.66 during the AM peak hour and from 0.97 to 0.71 during the PM peak hour. During the AM peak hour, the V/C ratio for the eastbound right-turn movement is projected to decrease from 2.58 to 0.82 and the V/C ratio for the eastbound left-turn movement is projected to decrease from 0.89 to 0.48. During the PM peak hour, the V/C ratio for the eastbound right-turn movement is projected to decrease from 1.83 to 0.84.

At the Highway 401 Westbound Off-Ramp/Cinemart Drive and Morningside Avenue intersection, the intersection V/C ratio is projected to decrease from 0.88 to 0.84 during the AM peak hour and remain unchanged at 0.75 during the PM peak hour. During the AM peak hour, the V/C ratio for the westbound through movement is projected to decrease from 1.09 to 0.77 and the V/C ratio for the westbound right-turn movement is projected to decrease from 1.15 to 0.88. The V/C ratio for the northbound left-turn movement is projected to decrease from 1.40 to 0.83. During the PM peak hour, the V/C ratios remain unchanged, because no mitigation measures were applied.

IBI GROUP TRAFFIC IMPACT STUDY

TORONTO TRANSIT COMMISSION
TTC SCARBOROUGH MALVERN LRT
HIGHWAY 401 & MORNINGSIDE AVENUE TRAFFIC IMPACT STUDY

At the Milner Avenue and Morningside Avenue intersection, the intersection V/C ratio is projected to decrease from 1.27 to 1.06 during the AM peak hour and from 1.55 to 1.22 during the PM peak hour. During the AM peak hour, the V/C ratio for the northbound left-turn movement is projected to decrease from 2.58 to 1.54 and the V/C ratio for the northbound through movement is projected to decrease from 1.45 to 0.88. The V/C ratio for the southbound through movement is projected to decrease from 1.41 to 1.16. During the PM peak hour, the V/C ratio for the eastbound through movement is projected to decrease from 1.14 to 1.08. The V/C ratio for the westbound left-turn movement is projected to decrease from 2.57 to 1.26. The V/C ratio for the northbound left-turn movement is projected to decrease from 0.90 to 0.71 and the V/C ratio for the northbound through movement is projected to decrease from 1.42 to 1.12. The V/C ratio for the southbound through movement is projected to decrease from 1.83 to 1.46.

Queue Lengths

The AM and PM peak hour analysis results are included in Exhibit 7-2. Full analysis summaries are included in Appendix E.

Exhibit 7-2: 2028 10-Year Horizon Intersection Queues (Mitigated)

Intersection	App-roach	Lane Group	Storage		Queue Lengths (m)			
					AM Peak Hour		PM Peak Hour	
			Length (m)	No. Lanes	50th %tile	95th %tile	50th %tile	95th %tile
Military Trail & Morningside Avenue	East	Left-Turn	72.3	1	21.7	#55.2	19.6	37.1
		Through		1S	48.3	#92.1	26.8	49.4
		Right-turn		1S				
	West	Left-Turn	82.2	1	5.3	#17.3	5.2	14.5
		Through		1	46.4	73.9	12.8	25.4
		Right-turn	174.5	1	46.6	74.5	~107.4	#175.5
	North	Left-Turn	184.0	1	19.2	#52.2	4.8	17.1
		Through		2	69.7	91.6	60.4	79.3
		Right-turn		1	0	8.5	0	3.1
	South	Left-Turn	182.5	1	62.7	m#110.0	45.7	m#90.0
		Through		1+1S	48.5	62.6	118.1	#178.2
		Right-turn	54.4	1S				
Hwy. 401 EB Off-Ramp & Morningside Avenue	East	Left-Turn	500.0	2	35.6	49.7	71.1	93.6
		Through	500.0	0				
		Right-turn	500.0	2	60.9	#89.3	66.2	#104.5
	West	Left-Turn	-	0				
		Through	-	0				
		Right-turn	-	0				
	North	Left-Turn	-	0				
		Through	-	2	72.6	m88.2	79.3	m71.8
		Right-turn	-	0				
	South	Left-Turn	-	0				
		Through	-	2	99.3	119.4	12.8	m12.4
		Right-turn	-	0				

Exhibit 7-2: 2028 10-Year Horizon Intersection Queues (Mitigated) (Continued)

Intersection	App-roach	Lane Group	Storage		Queue Lengths (m)			
					AM Peak Hour		PM Peak Hour	
			Length (m)	No. Lanes	50th %tile	95th %tile	50th %tile	95th %tile
Hwy. 401 WB Off-Ramp/ Cinemart Drive & Morningside Avenue	East	Left-Turn		0				
		Through		0				
		Right-turn		1	10	21.8	50.1	#93.9
	West	Left-Turn	500.0	1	47.3	74.9	11.5	23.5
		Through	500.0	1+1S	81.9	110.4	10.7	20
		Right-turn	500.0	1+1S	81.2	#146.4	10.5	25.9
	North	Left-Turn	83.0	1	33.9	#67.6	45.8	m65.3
		Through		2	61.2	73.7	73.3	86.4
		Right-turn		0				
	South	Left-Turn		0				
		Through		1+1S	66.2	87.5	~146.1	#187.2
		Right-turn		1S				
Milner Avenue & Morningside Avenue	East	Left-Turn	**132.0**	1	10.5	#32.1	85.4	#147.8
		Through		1+1S	6.1	15.3	110.4	#159.3
		Right-turn		1S				
	West	Left-Turn	**120.0**	1	34	#68.7	~70.0	#124.3
		Through		1+1S	52.1	70.8	5.6	11.8
		Right-turn		1S				
	North	Left-Turn	**200.0**	1	~228.5	#298.7	33.5	#60.9
		Through		1+1S	~173.3	#203.2	~131.3	#164.7
		Right-turn		1S				
	South	Left-Turn	**48.4**	1	8.3	18.6	24.7	43.2
		Through		1+1S	43.9	53.6	~206.8	#237.1
		Right-turn		1S			85.4	#147.8

Notes:
S Shared Lane
~ Volume exceeds capacity, queue is theoretically infinite. Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after two cycles.
M Volume for 95th percentile queue is metered by upstream signal.

At the Military Trail and Morningside Avenue intersection, during the AM and PM peak hours, the 50th and 95th percentile queue for the westbound right-turn lane is projected to be accommodated by the increased lane length, creating no spillbacks onto the westbound through lanes of Military Trail.

At the Milner Avenue and Morningside Avenue intersection, during the AM peak hour, the 50th and 95th percentile queues for the northbound left-turn lane are projected to surpass the increased lane length creating spillbacks onto the northbound through lanes of Morningside Avenue. During the PM peak hour, the 95th percentile queue for the eastbound right-turn lane is projected to be accommodated by the increased lane length, creating no spillbacks onto the eastbound lanes of Milner Avenue. The 95th percentile queue for the westbound right-turn lane is projected to be accommodated by the increased lane length, creating no spillbacks onto the westbound lanes of Milner Avenue. The 95th percentile queue for the southbound right-turn lane is projected to be accommodated by the increased lane length, creating no spillbacks onto the southbound lanes of Morningside Avenue.

IBI GROUP TRAFFIC IMPACT STUDY

TORONTO TRANSIT COMMISSION
TTC SCARBOROUGH MALVERN LRT
HIGHWAY 401 & MORNINGSIDE AVENUE TRAFFIC IMPACT STUDY

8. CONCLUSIONS AND RECOMMENDATIONS

Intersection analyses of existing traffic volumes indicate that each of the four Study Area intersections have some movements that operate with capacity issues or at unacceptable levels of service. The Proposed Project is not expected to add new vehicular trips to the boundary road system. Intersection analyses of the 2018 opening year and 2023 and 2028 horizon year traffic volumes, with the Proposed Project in place, indicate that the some of these traffic impacts will remain, while some new traffic impacts will also be introduced. High traffic volumes at the Milner Avenue and Morningside Avenue intersection causes it to experience unacceptable levels of delay, queue lengths and operate with demand exceeding the capacity of the intersection.

The Proposed Project will have no impact on the traffic operations of the Highway 401 Eastbound and Westbound Off-Ramps at Morningside Avenue. For the 2008 Existing Condition, at the Eastbound Off-Ramp, right-turn traffic volumes are high during the AM and PM peak periods and increase in future years (due to background growth). Therefore, it is recommended that a second right-turn lane be added to alleviate capacity, delay and queuing issues. At the Westbound Off-Ramp, right-turn traffic volumes are high during the AM peak period and increase in future years (due to background growth). Therefore, it is recommend that 10 seconds of green time be shifted from the northbound and southbound through movements to all westbound movements.

It is concluded that many of the traffic impacts identified in Future Years already occur in the Existing Condition or are due to an increase in background traffic. Some impacts also arise from the implementation of the Proposed Development, due to the reconfiguration of traffic lanes in the Study Area. Proposed signal timing and roadway configuration measures will mitigate the majority of traffic impacts at three Study Area intersections: Military Trail and Morningside Avenue, Highway 401 Eastbound Off-Ramp and Morningside Avenue, and Highway 401 Westbound Off-Ramp/Cinemart Drive and Morningside Avenue. Some geometrical improvements are required to mitigate traffic impacts at the Milner Avenue and Morningside Avenue intersection.

Although the recommended signal and roadway improvements do not mitigate all critical movements at study intersections, overall, Study Area intersections are still projected to operate at acceptable levels of service during the AM and PM peak hours. Further mitigation measures are not recommended given the constraints of the surrounding lane use and roadway network.

During future years, the removal of two travel lanes on Morningside Avenue to accommodate the Proposed Project will have no adverse impacts to the traffic operations along Morningside Avenue and at the Study Area signalized intersections. No vehicular queuing and safety issues are projected to occur along the Highway 401 eastbound and westbound off-ramps at Morningside Avenue.

APPENDIX A

2008 EXISTING CONDITION CAPACITY ANALYSIS

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	110	279	27	260	425	102	809	67	447	1044	95
v/c Ratio	1.10	0.91	0.45	0.77	0.74	0.34	0.38	0.07	1.00	0.43	0.09
Control Delay	158.0	68.3	58.7	51.4	24.6	12.1	9.1	3.7	40.5	2.1	0.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	158.0	68.3	58.7	51.4	24.6	12.1	9.1	3.7	40.5	2.1	0.2
Queue Length 50th (m)	~21.8	43.6	4.2	43.1	36.8	7.7	33.0	1.7	~17.3	8.9	0.0
Queue Length 95th (m)	#53.4	#89.8	#15.7	#78.5	72.0	18.0	43.7	6.2m	#19.2	m10.1	m0.0
Internal Link Dist (m)		321.8		300.5			425.0			158.5	
Turn Bay Length (m)	72.3		82.2		74.5	184.0			182.5		54.4
Base Capacity (vph)	100	305	60	338	577	299	2116	950	446	2456	1033
Starvation Cap Reductn	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
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.10	0.91	0.45	0.77	0.74	0.34	0.38	0.07	1.00	0.43	0.09

Intersection Summary

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

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

m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.89		1.00	1.00	1.00	1.00	1.00	0.97	1.00	1.00	0.94
Flpb, ped/bikes	1.00	1.00		0.85	1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1653	1501		1137	1789	1536	1669	3400	1503	1749	3400	1394
Flt Permitted	0.31	1.00		0.26	1.00	1.00	0.27	1.00	1.00	0.29	1.00	1.00
Satd. Flow (perm)	531	1501		315	1789	1536	482	3400	1503	525	3400	1394
Volume (vph)	110	182	97	27	260	425	102	809	67	447	1044	95
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	110	182	97	27	260	425	102	809	67	447	1044	95
RTOR Reduction (vph)	0	21	0	0	0	142	0	0	15	0	0	26
Lane Group Flow (vph)	110	258	0	27	260	283	102	809	52	447	1044	69
Confl. Peds. (#/hr)			219	219			43		12	12		43
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	8%	4%	7%	34%	5%	4%	6%	5%	3%	2%	5%	8%
Turn Type	Perm			Perm		pm+ov	Perm		Perm	pm+pt		Perm
Protected Phases		4			8	1		2		1	6	
Permitted Phases	4			8		8	2		2	6		6
Actuated Green, G (s)	15.0	15.0		15.0	15.0	22.0	54.0	54.0	54.0	63.0	63.0	63.0
Effective Green, g (s)	17.0	17.0		17.0	17.0	22.0	56.0	56.0	56.0	65.0	65.0	65.0
Actuated g/C Ratio	0.19	0.19		0.19	0.19	0.24	0.62	0.62	0.62	0.72	0.72	0.72
Clearance Time (s)	6.0	6.0		6.0	6.0	2.0	6.0	6.0	6.0	2.0	6.0	6.0
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
Lane Grp Cap (vph)	100	284		60	338	444	300	2116	935	447	2456	1007
v/s Ratio Prot		0.17			0.15	0.04		0.24		c0.06	0.31	
v/s Ratio Perm	c0.21			0.09		0.15	0.21		0.03	c0.67		0.05
v/c Ratio	1.10	0.91		0.45	0.77	0.64	0.34	0.38	0.06	1.00	0.43	0.07
Uniform Delay, d1	36.5	35.7		32.4	34.6	30.4	8.1	8.4	6.7	12.0	5.0	3.7
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	0.94	0.37	0.10
Incremental Delay, d2	119.5	30.3		5.3	10.1	3.0	3.1	0.5	0.1	27.7	0.2	0.1
Delay (s)	156.0	66.1		37.6	44.7	33.4	11.2	9.0	6.8	39.0	2.1	0.4
Level of Service	F	E		D	D	C	B	A	A	D	A	A
Approach Delay (s)		91.5			37.7			9.0			12.4	
Approach LOS		F			D			A			B	

Intersection Summary

HCM Average Control Delay	24.8	HCM Level of Service	C
HCM Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	137.4%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT
Lane Group Flow (vph)	454	734	1023	992
v/c Ratio	0.79	1.74	0.28	0.27
Control Delay	46.7	362.2	5.2	7.3
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	46.7	362.2	5.2	7.3
Queue Length 50th (m)	39.0	~163.6	26.9	27.1
Queue Length 95th (m)	#60.0	#230.5	m35.1	34.0
Internal Link Dist (m)	99.0		340.6	333.0
Turn Bay Length (m)				
Base Capacity (vph)	575	423	3617	3617
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.79	1.74	0.28	0.27

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	1.00		0.91	0.91	
Frpb, ped/bikes	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	
Frt	1.00	0.85		1.00	1.00	
Flt Protected	0.95	1.00		1.00	1.00	
Satd. Flow (prot)	3236	1521		4932	4932	
Flt Permitted	0.95	1.00		1.00	1.00	
Satd. Flow (perm)	3236	1521		4932	4932	
Volume (vph)	454	734	0	1023	992	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	454	734	0	1023	992	0
RTOR Reduction (vph)	0	152	0	0	0	0
Lane Group Flow (vph)	454	582	0	1023	992	0
Confl. Bikes (#/hr)						4
Heavy Vehicles (%)	7%	5%	0%	4%	4%	0%
Turn Type		Perm				
Protected Phases	4			2	6	
Permitted Phases		4				
Actuated Green, G (s)	15.0	15.0		65.0	65.0	
Effective Green, g (s)	16.0	16.0		66.0	66.0	
Actuated g/C Ratio	0.18	0.18		0.73	0.73	
Clearance Time (s)	5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	575	270		3617	3617	
v/s Ratio Prot	0.14			c0.21	0.20	
v/s Ratio Perm		c0.38				
v/c Ratio	0.79	2.16		0.28	0.27	
Uniform Delay, d1	35.4	37.0		4.0	4.0	
Progression Factor	1.00	1.00		1.25	1.77	
Incremental Delay, d2	7.1	532.0		0.2	0.2	
Delay (s)	42.5	569.0		5.2	7.3	
Level of Service	D	F		A	A	
Approach Delay (s)	367.8			5.2	7.3	
Approach LOS	F			A	A	

Intersection Summary

HCM Average Control Delay	140.3	HCM Level of Service	F
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	105.4%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBR	WBL	WBT	WBR	NBL	NBT	SBT
Lane Group Flow (vph)	53	303	867	446	160	1241	736
v/c Ratio	0.46	0.63	0.99dr	0.99	0.39	0.42	0.30
Control Delay	52.9	34.1	51.2	67.6	10.2	10.4	4.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	52.9	34.1	51.2	67.6	10.2	10.4	4.2
Queue Length 50th (m)	8.9	49.3	79.3	72.7	12.3	43.0	6.1
Queue Length 95th (m)	20.4	79.1	#122.7	#139.7	m17.7	49.5	m8.3
Internal Link Dist (m)			61.0			333.0	273.1
Turn Bay Length (m)					83.0		
Base Capacity (vph)	119	482	904	452	418	2957	2418
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.45	0.63	0.96	0.99	0.38	0.42	0.30

Intersection Summary

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.0	4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor			1.00	0.91	0.86	0.91	1.00	0.91			0.91	
Frpb, ped/bikes			1.00	1.00	0.99	0.99	1.00	1.00			1.00	
Flpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	
Frt			0.86	1.00	0.92	0.85	1.00	1.00			1.00	
Flt Protected			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)			1533	1608	2844	1339	1700	4839			4921	
Flt Permitted			1.00	0.95	1.00	1.00	0.30	1.00			1.00	
Satd. Flow (perm)			1533	1608	2844	1339	537	4839			4921	
Volume (vph)	0	0	53	303	421	892	160	1241	0	0	723	13
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	53	303	421	892	160	1241	0	0	723	13
RTOR Reduction (vph)	0	0	0	0	50	50	0	0	0	0	2	0
Lane Group Flow (vph)	0	0	53	303	817	396	160	1241	0	0	734	0
Confl. Peds. (#/hr)	2					2	4		1	1		4
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	0%	0%	6%	1%	1%	7%	5%	6%	0%	0%	4%	0%
Turn Type			Over	pm+pt		Perm	pm+pt					
Protected Phases			5	3	8		5	2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)			7.8	25.0	25.0	25.0	53.0	53.0			42.2	
Effective Green, g (s)			6.8	27.0	27.0	27.0	55.0	55.0			44.2	
Actuated g/C Ratio			0.08	0.30	0.30	0.30	0.61	0.61			0.49	
Clearance Time (s)			3.0	6.0	6.0	6.0	3.0	6.0			6.0	
Vehicle Extension (s)			3.0	3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)			116	482	853	402	416	2957			2417	
v/s Ratio Prot			0.03	0.19	0.29		0.03	c0.26			0.15	
v/s Ratio Perm						c0.30	0.21					
v/c Ratio			0.46	0.63	0.99dr	0.98	0.38	0.42			0.30	
Uniform Delay, d1			39.8	27.2	30.9	31.3	8.0	9.2			13.7	
Progression Factor			1.00	1.00	1.00	1.00	1.01	1.08			0.29	
Incremental Delay, d2			2.8	2.6	20.9	40.4	0.5	0.4			0.2	
Delay (s)			42.7	29.7	51.8	71.7	8.6	10.3			4.2	
Level of Service			D	C	D	E	A	B			A	
Approach Delay (s)	42.7				53.1			10.1			4.2	
Approach LOS	D				D			B			A	

Intersection Summary

HCM Average Control Delay	27.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	87.0%	ICU Level of Service	E
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	49	172	164	509	745	1566	250	41	1342
v/c Ratio	0.20	0.15	0.41	0.42	1.83	0.82	0.26	0.51	0.85
Control Delay	23.0	8.6	25.8	22.3	404.3	26.4	6.7	51.2	32.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	23.0	8.6	25.8	22.3	404.3	26.4	6.7	51.2	32.8
Queue Length 50th (m)	5.8	3.8	21.1	33.0	~188.5	99.4	9.0	5.7	73.6
Queue Length 95th (m)	14.4	10.4	38.5	46.5m	#238.1m	124.6	m16.1	#20.8	91.9
Internal Link Dist (m)		302.5		198.6		273.1			176.1
Turn Bay Length (m)	112.0		90.0		140.0			38.4	
Base Capacity (vph)	249	1161	410	1257	408	1907	948	80	1575
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.20	0.15	0.40	0.40	1.83	0.82	0.26	0.51	0.85

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95	1.00	1.00	0.91	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.91		1.00	0.97		1.00	1.00	0.85	1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1694	2980		1653	3391		1733	3433	1506	1699	4689	
Flt Permitted	0.38	1.00		0.64	1.00		0.12	1.00	1.00	0.14	1.00	
Satd. Flow (perm)	669	2980		1119	3391		221	3433	1506	247	4689	
Volume (vph)	49	65	107	164	414	95	745	1566	250	41	1014	328
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	49	65	107	164	414	95	745	1566	250	41	1014	328
RTOR Reduction (vph)	0	69	0	0	14	0	0	0	111	0	65	0
Lane Group Flow (vph)	49	103	0	164	495	0	745	1566	139	41	1277	0
Confl. Peds. (#/hr)	9					9	2		6	6		2
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	5%	8%	9%	8%	1%	6%	3%	4%	4%	5%	6%	2%
Turn Type	Perm			Perm			pm+pt		Perm	Perm		
Protected Phases		4			8		5	2			6	
Permitted Phases	4			8			2		2	6		
Actuated Green, G (s)	30.0	30.0		30.0	30.0		49.0	49.0	49.0	28.0	28.0	
Effective Green, g (s)	32.0	32.0		32.0	32.0		50.0	50.0	50.0	29.0	29.0	
Actuated g/C Ratio	0.36	0.36		0.36	0.36		0.56	0.56	0.56	0.32	0.32	
Clearance Time (s)	6.0	6.0		6.0	6.0		3.0	5.0	5.0	5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	238	1060		398	1206		408	1907	837	80	1511	
v/s Ratio Prot		0.03			0.15		c0.34	0.46			0.27	
v/s Ratio Perm	0.07			c0.15			c0.67		0.09	0.17		
v/c Ratio	0.21	0.10		0.41	0.41		1.83	0.82	0.17	0.51	0.85	
Uniform Delay, d1	20.2	19.4		21.9	21.9		25.9	16.3	9.8	24.8	28.4	
Progression Factor	1.00	1.00		1.00	1.00		1.36	1.36	4.35	1.00	1.00	
Incremental Delay, d2	0.4	0.0		0.7	0.2		379.8	3.5	0.4	21.5	6.0	
Delay (s)	20.6	19.4		22.6	22.1		415.1	25.7	43.0	46.3	34.4	
Level of Service	C	B		C	C		F	C	D	D	C	
Approach Delay (s)		19.7			22.2			140.7			34.7	
Approach LOS		B			C			F			C	

Intersection Summary

HCM Average Control Delay	88.4	HCM Level of Service	F
HCM Volume to Capacity ratio	1.24		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	131.6%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	109	177	25	75	699	94	878	14	420	1355	92
v/c Ratio	0.46	0.60	0.25	0.22	1.12	0.48	0.47	0.02	0.89	0.53	0.08
Control Delay	39.8	36.2	38.5	33.1	97.5	21.5	12.3	4.1	27.1	4.9	0.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	39.8	36.2	38.5	33.1	97.5	21.5	12.3	4.1	27.1	4.9	0.6
Queue Length 50th (m)	17.1	22.7	3.8	11.2	~123.8	8.9	43.3	0.0	27.2	40.5	0.4
Queue Length 95th (m)	32.7	43.2	11.2	22.9	#190.0	24.8	57.2	2.4	m33.8	m40.1	m1.1
Internal Link Dist (m)		321.8		300.5			425.0			158.5	
Turn Bay Length (m)	72.3		82.2		74.5	184.0			182.5		54.4
Base Capacity (vph)	246	305	104	355	626	197	1874	891	470	2551	1119
Starvation Cap Reductn	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
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.44	0.58	0.24	0.21	1.12	0.48	0.47	0.02	0.89	0.53	0.08

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.86		1.00	1.00	1.00	1.00	1.00	0.97	1.00	1.00	0.94
Flpb, ped/bikes	1.00	1.00		0.78	1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.94		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1750	1467		1058	1879	1581	1627	3275	1546	1732	3500	1501
Flt Permitted	0.71	1.00		0.49	1.00	1.00	0.20	1.00	1.00	0.25	1.00	1.00
Satd. Flow (perm)	1305	1467		543	1879	1581	344	3275	1546	448	3500	1501
Volume (vph)	109	104	73	25	75	699	94	878	14	420	1355	92
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	109	104	73	25	75	699	94	878	14	420	1355	92
RTOR Reduction (vph)	0	29	0	0	0	96	0	0	6	0	0	25
Lane Group Flow (vph)	109	148	0	25	75	603	94	878	8	420	1355	67
Confl. Peds. (#/hr)			219	219			43		12	12		43
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	2%	3%	5%	32%	0%	1%	9%	9%	0%	3%	2%	0%
Turn Type	Perm			Perm		pm+ov	Perm		Perm	pm+pt		Perm
Protected Phases		4			8	1		2		1	6	
Permitted Phases	4			8		8	2		2	6		6
Actuated Green, G (s)	14.4	14.4		14.4	14.4	26.0	49.5	49.5	49.5	63.6	63.6	63.6
Effective Green, g (s)	16.4	16.4		16.4	16.4	26.5	51.5	51.5	51.5	65.6	65.6	65.6
Actuated g/C Ratio	0.18	0.18		0.18	0.18	0.29	0.57	0.57	0.57	0.73	0.73	0.73
Clearance Time (s)	6.0	6.0		6.0	6.0	2.5	6.0	6.0	6.0	2.5	6.0	6.0
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
Lane Grp Cap (vph)	238	267		99	342	536	197	1874	885	471	2551	1094
v/s Ratio Prot		0.10			0.04	c0.13		0.27		0.10	0.39	
v/s Ratio Perm	0.08			0.05		0.26	0.27		0.01	c0.55		0.04
v/c Ratio	0.46	0.56		0.25	0.22	1.13	0.48	0.47	0.01	0.89	0.53	0.06
Uniform Delay, d1	32.8	33.5		31.5	31.3	31.7	11.3	11.3	8.3	7.8	5.4	3.5
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.69	0.80	0.59
Incremental Delay, d2	1.4	2.5		1.3	0.3	78.1	8.1	0.8	0.0	12.8	0.5	0.1
Delay (s)	34.2	36.0		32.9	31.7	109.8	19.4	12.1	8.3	25.9	4.8	2.1
Level of Service	C	D		C	C	F	B	B	A	C	A	A
Approach Delay (s)		35.3			100.1			12.7			9.4	
Approach LOS		D			F			B			A	

Intersection Summary

HCM Average Control Delay	30.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.96		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	121.6%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT
Lane Group Flow (vph)	826	832	1097	838
v/c Ratio	0.85	1.44	0.36	0.27
Control Delay	40.2	230.6	9.5	1.4
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	40.2	230.6	9.5	1.4
Queue Length 50th (m)	69.1	~174.2	32.7	2.8
Queue Length 95th (m)	#98.7	#243.7	m34.9	3.4
Internal Link Dist (m)	99.0		340.6	333.0
Turn Bay Length (m)				
Base Capacity (vph)	971	578	3069	3069
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.85	1.44	0.36	0.27

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	1.00		0.91	0.91	
Frpb, ped/bikes	1.00	0.98		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	
Frt	1.00	0.85		1.00	1.00	
Flt Protected	0.95	1.00		1.00	1.00	
Satd. Flow (prot)	3362	1540		4932	4932	
Flt Permitted	0.95	1.00		1.00	1.00	
Satd. Flow (perm)	3362	1540		4932	4932	
Volume (vph)	826	832	0	1097	838	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	826	832	0	1097	838	0
RTOR Reduction (vph)	0	133	0	0	0	0
Lane Group Flow (vph)	826	699	0	1097	838	0
Confl. Peds. (#/hr)	1	4				
Heavy Vehicles (%)	3%	2%	0%	4%	4%	0%
Turn Type		Perm				
Protected Phases	4			2	6	
Permitted Phases		4				
Actuated Green, G (s)	25.0	25.0		55.0	55.0	
Effective Green, g (s)	26.0	26.0		56.0	56.0	
Actuated g/C Ratio	0.29	0.29		0.62	0.62	
Clearance Time (s)	5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	971	445		3069	3069	
v/s Ratio Prot	0.25			c0.22	0.17	
v/s Ratio Perm		c0.45				
v/c Ratio	0.85	1.57		0.36	0.27	
Uniform Delay, d1	30.2	32.0		8.3	7.7	
Progression Factor	1.00	1.00		1.11	0.16	
Incremental Delay, d2	7.2	267.6		0.2	0.2	
Delay (s)	37.4	299.6		9.4	1.4	
Level of Service	D	F		A	A	
Approach Delay (s)	169.0			9.4	1.4	
Approach LOS	F			A	A	

Intersection Summary

HCM Average Control Delay	81.2	HCM Level of Service	F
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	79.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBR	WBL	WBT	WBR	NBL	NBT	SBT
Lane Group Flow (vph)	267	72	173	115	223	1202	1254
v/c Ratio	0.81	0.15	0.20	0.26	0.50	0.39	0.67
Control Delay	54.7	25.0	14.4	11.9	26.3	13.7	25.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	54.7	25.0	14.4	11.9	26.3	13.7	25.7
Queue Length 50th (m)	43.8	10.1	7.2	5.4	25.7	39.4	65.8
Queue Length 95th (m)	#80.5	21.3	15.6	19.2	m41.3	47.6	81.2
Internal Link Dist (m)			61.0			333.0	273.1
Turn Bay Length (m)					83.0		
Base Capacity (vph)	336	487	889	465	453	3099	1865
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.79	0.15	0.19	0.25	0.49	0.39	0.67

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.0	4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor			1.00	0.91	0.86	0.91	1.00	0.91			0.91	
Frpb, ped/bikes			1.00	1.00	0.99	0.98	1.00	1.00			1.00	
Flpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	
Frt			0.86	1.00	0.90	0.85	1.00	1.00			0.99	
Flt Protected			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)			1625	1624	2788	1374	1785	4980			4951	
Flt Permitted			1.00	0.95	1.00	1.00	0.11	1.00			1.00	
Satd. Flow (perm)			1625	1624	2788	1374	199	4980			4951	
Volume (vph)	0	0	267	72	59	229	223	1202	0	0	1201	53
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	267	72	59	229	223	1202	0	0	1201	53
RTOR Reduction (vph)	0	0	0	0	53	53	0	0	0	0	5	0
Lane Group Flow (vph)	0	0	267	72	120	62	223	1202	0	0	1249	0
Confl. Peds. (#/hr)	4					4	8		11	11		8
Confl. Bikes (#/hr)									5			
Heavy Vehicles (%)	0%	0%	0%	0%	2%	4%	0%	3%	0%	0%	3%	0%
Turn Type			Over	pm+pt		Perm	pm+pt					
Protected Phases			5	3	8		5	2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)			19.2	24.0	24.0	24.0	54.0	54.0			31.8	
Effective Green, g (s)			18.2	26.0	26.0	26.0	56.0	56.0			33.8	
Actuated g/C Ratio			0.20	0.29	0.29	0.29	0.62	0.62			0.38	
Clearance Time (s)			3.0	6.0	6.0	6.0	3.0	6.0			6.0	
Vehicle Extension (s)			3.0	3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)			329	469	805	397	445	3099			1859	
v/s Ratio Prot			c0.16	0.04	0.04		0.10	0.24			c0.25	
v/s Ratio Perm						c0.04	0.21					
v/c Ratio			0.81	0.15	0.15	0.16	0.50	0.39			0.67	
Uniform Delay, d1			34.3	23.8	23.8	23.8	13.6	8.5			23.5	
Progression Factor			1.00	1.00	1.00	1.00	1.81	1.56			1.00	
Incremental Delay, d2			14.1	0.2	0.1	0.2	0.7	0.3			2.0	
Delay (s)			48.3	24.0	23.9	24.0	25.4	13.5			25.4	
Level of Service			D	C	C	C	C	B			C	
Approach Delay (s)	48.3				23.9			15.4			25.4	
Approach LOS	D				C			B			C	

Intersection Summary

HCM Average Control Delay	22.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	71.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	361	1122	280	176	142	1158	160	105	1704
v/c Ratio	0.88	1.00dr	1.40	0.12	0.57	0.74	0.21	1.15	1.11
Control Delay	52.9	32.1	230.3	12.0	25.7	25.0	3.3	174.8	91.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	52.9	32.1	230.3	12.0	25.7	25.0	3.3	174.8	91.6
Queue Length 50th (m)	61.2	80.0	~54.7	7.5	15.0	89.3	0.0	~22.8	~131.5
Queue Length 95th (m)	#111.7	#119.3	#103.4	13.3	28.2	114.3	10.3	#55.2	#164.6
Internal Link Dist (m)		302.5		198.6		273.1			176.1
Turn Bay Length (m)	112.0		90.0		140.0			38.4	
Base Capacity (vph)	415	1273	200	1432	257	1561	773	91	1534
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.87	0.88	1.40	0.12	0.55	0.74	0.21	1.15	1.11

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95	1.00	1.00	0.91	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes	0.99	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.90		1.00	0.92		1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3169		1700	3054		1716	3433	1508	1606	4876	
Flt Permitted	0.64	1.00		0.11	1.00		0.12	1.00	1.00	0.17	1.00	
Satd. Flow (perm)	1194	3169		195	3054		214	3433	1508	287	4876	
Volume (vph)	361	408	714	280	85	91	142	1158	160	105	1624	80
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	361	408	714	280	85	91	142	1158	160	105	1624	80
RTOR Reduction (vph)	0	172	0	0	18	0	0	0	87	0	5	0
Lane Group Flow (vph)	361	950	0	280	158	0	142	1158	73	105	1699	0
Confl. Peds. (#/hr)	11		1	1		11	2		5	5		2
Confl. Bikes (#/hr)			1									
Heavy Vehicles (%)	0%	1%	1%	5%	5%	8%	4%	4%	4%	11%	4%	12%
Turn Type	Perm			pm+pt			pm+pt		Perm	Perm		
Protected Phases		4		3	8		5	2			6	
Permitted Phases	4			8			2		2	6		
Actuated Green, G (s)	30.8	30.8		41.8	41.8		42.2	42.2	42.2	28.8	28.8	
Effective Green, g (s)	32.8	32.8		43.8	43.8		43.2	43.2	43.2	29.8	29.8	
Actuated g/C Ratio	0.35	0.35		0.46	0.46		0.45	0.45	0.45	0.31	0.31	
Clearance Time (s)	6.0	6.0		3.0	6.0		3.0	5.0	5.0	5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	412	1094		201	1408		246	1561	686	90	1530	
v/s Ratio Prot		0.30		c0.10	0.05		0.06	c0.34			0.35	
v/s Ratio Perm	0.30			c0.54			0.21		0.05	c0.37		
v/c Ratio	0.88	1.00dr		1.39	0.11		0.58	0.74	0.11	1.17	1.11	
Uniform Delay, d1	29.2	29.1		22.3	14.6		21.4	21.3	14.8	32.6	32.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	18.4	7.5		204.3	0.0		3.3	3.2	0.3	146.6	59.4	
Delay (s)	47.6	36.5		226.6	14.6		24.7	24.5	15.1	179.2	92.0	
Level of Service	D	D		F	B		C	C	B	F	F	
Approach Delay (s)		39.2			144.8			23.5			97.1	
Approach LOS		D			F			C			F	

Intersection Summary

HCM Average Control Delay	64.2	HCM Level of Service	E
HCM Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	95.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	129.2%	ICU Level of Service	H
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

APPENDIX B

2018 OPENING YEAR CAPACITY ANALYSIS

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	118	297	30	276	450	110	854	72	472	1205
v/c Ratio	1.34	0.98	0.57	0.82	0.80	0.44	0.40	0.08	1.11	0.50
Control Delay	245.0	82.5	75.5	56.7	30.2	15.9	9.3	4.6	65.4	1.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	245.0	82.5	75.5	56.7	30.2	15.9	9.3	4.6	65.4	1.9
Queue Length 50th (m)	~26.9	47.4	4.8	46.2	45.3	9.0	35.5	2.5	~22.2	9.3
Queue Length 95th (m)	#59.6	#97.5	#18.8	#86.0	#94.0	23.0	46.8	7.3m	#21.1	m11.3
Internal Link Dist (m)		321.8		300.5			425.0			629.8
Turn Bay Length (m)	72.3		82.2		74.5	184.0			182.5	
Base Capacity (vph)	88	303	53	335	565	248	2116	929	427	2412
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.34	0.98	0.57	0.82	0.80	0.44	0.40	0.08	1.11	0.50

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	0.89		1.00	1.00	1.00	1.00	1.00	0.97	1.00	1.00	
Flpb, ped/bikes	1.00	1.00		0.87	1.00	1.00	0.99	1.00	1.00	1.00	1.00	
Frt	1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1638	1492		1127	1773	1536	1641	3400	1474	1749	3330	
Flt Permitted	0.27	1.00		0.24	1.00	1.00	0.23	1.00	1.00	0.27	1.00	
Satd. Flow (perm)	465	1492		279	1773	1536	399	3400	1474	495	3330	
Volume (vph)	118	194	103	30	276	450	110	854	72	472	1103	102
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	118	194	103	30	276	450	110	854	72	472	1103	102
RTOR Reduction (vph)	0	21	0	0	0	129	0	0	12	0	8	0
Lane Group Flow (vph)	118	276	0	30	276	321	110	854	60	472	1197	0
Confl. Peds. (#/hr)			219	219			43		12	12		43
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	9%	5%	7%	37%	6%	4%	8%	5%	5%	2%	5%	9%
Turn Type	Perm			Perm		pm+ov	Perm		Perm	pm+pt		
Protected Phases		4			8	1		2		1	6	
Permitted Phases	4			8		8	2		2	6		
Actuated Green, G (s)	15.0	15.0		15.0	15.0	22.0	54.0	54.0	54.0	63.0	63.0	
Effective Green, g (s)	17.0	17.0		17.0	17.0	22.0	56.0	56.0	56.0	65.0	65.0	
Actuated g/C Ratio	0.19	0.19		0.19	0.19	0.24	0.62	0.62	0.62	0.72	0.72	
Clearance Time (s)	6.0	6.0		6.0	6.0	2.0	6.0	6.0	6.0	2.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	88	282		53	335	444	248	2116	917	427	2405	
v/s Ratio Prot		0.18			0.16	0.04		0.25		c0.06	0.36	
v/s Ratio Perm	c0.25			0.11		0.17	0.28		0.04	c0.74		
v/c Ratio	1.34	0.98		0.57	0.82	0.72	0.44	0.40	0.07	1.11	0.50	
Uniform Delay, d1	36.5	36.3		33.1	35.1	31.2	8.9	8.6	6.7	12.0	5.4	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.07	0.33	
Incremental Delay, d2	211.7	47.1		13.1	15.0	5.7	5.7	0.6	0.1	51.1	0.1	
Delay (s)	248.2	83.4		46.3	50.1	36.9	14.5	9.2	6.8	64.0	1.9	
Level of Service	F	F		D	D	D	B	A	A	E	A	
Approach Delay (s)		130.3			42.1			9.6			19.4	
Approach LOS		F			D			A			B	

Intersection Summary

HCM Average Control Delay	33.0	HCM Level of Service	C
HCM Volume to Capacity ratio	1.14		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	138.4%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT
Lane Group Flow (vph)	481	776	1080	1047
v/c Ratio	0.84	1.90	0.43	0.42
Control Delay	50.2	436.0	6.6	8.6
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	50.2	436.0	6.6	8.6
Queue Length 50th (m)	41.8	~184.9	44.3	47.7
Queue Length 95th (m)	#65.6	#252.9	m58.0	57.9
Internal Link Dist (m)	99.0		629.8	333.0
Turn Bay Length (m)				
Base Capacity (vph)	575	408	2518	2518
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.84	1.90	0.43	0.42

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	1.00		0.95	0.95	
Frt	1.00	0.85		1.00	1.00	
Flt Protected	0.95	1.00		1.00	1.00	
Satd. Flow (prot)	3236	1521		3433	3433	
Flt Permitted	0.95	1.00		1.00	1.00	
Satd. Flow (perm)	3236	1521		3433	3433	
Volume (vph)	481	776	0	1080	1047	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	481	776	0	1080	1047	0
RTOR Reduction (vph)	0	137	0	0	0	0
Lane Group Flow (vph)	481	639	0	1080	1047	0
Heavy Vehicles (%)	7%	5%	0%	4%	4%	0%
Turn Type		Perm				
Protected Phases	4			2	6	
Permitted Phases		4				
Actuated Green, G (s)	15.0	15.0		65.0	65.0	
Effective Green, g (s)	16.0	16.0		66.0	66.0	
Actuated g/C Ratio	0.18	0.18		0.73	0.73	
Clearance Time (s)	5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	575	270		2518	2518	
v/s Ratio Prot	0.15			c0.31	0.31	
v/s Ratio Perm		c0.42				
v/c Ratio	0.84	2.37		0.43	0.42	
Uniform Delay, d1	35.7	37.0		4.7	4.6	
Progression Factor	1.00	1.00		1.29	1.73	
Incremental Delay, d2	10.2	625.8		0.4	0.4	
Delay (s)	46.0	662.8		6.5	8.4	
Level of Service	D	F		A	A	
Approach Delay (s)	426.8			6.5	8.4	
Approach LOS	F			A	A	

Intersection Summary

HCM Average Control Delay	163.2	HCM Level of Service	F
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	108.0%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBR	WBL	WBT	WBR	NBL	NBT	SBT
Lane Group Flow (vph)	57	321	916	471	170	1309	778
v/c Ratio	0.49	0.67	1.06dr	1.06	1.30	0.64	0.46
Control Delay	54.4	35.5	66.1	87.9	210.3	15.1	4.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	54.4	35.5	66.1	87.9	210.3	15.1	4.1
Queue Length 50th (m)	9.6	53.0	~90.6	~90.3	~39.5	110.2	9.1
Queue Length 95th (m)	#23.1	84.1	#135.5	#154.0m	#69.8	133.8	m9.1
Internal Link Dist (m)			61.0			333.0	273.1
Turn Bay Length (m)					83.0		
Base Capacity (vph)	117	482	897	445	131	2058	1675
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.49	0.67	1.02	1.06	1.30	0.64	0.46

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.0	4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor			1.00	0.91	0.86	0.91	1.00	0.95			0.95	
Frpb, ped/bikes			1.00	1.00	0.99	0.99	1.00	1.00			1.00	
Flpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	
Frt			0.86	1.00	0.92	0.85	1.00	1.00			1.00	
Flt Protected			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)			1505	1608	2844	1339	1684	3368			3425	
Flt Permitted			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (perm)			1505	1608	2844	1339	1684	3368			3425	
Volume (vph)	0	0	57	321	445	942	170	1309	0	0	764	14
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	57	321	445	942	170	1309	0	0	764	14
RTOR Reduction (vph)	0	0	0	0	43	43	0	0	0	0	2	0
Lane Group Flow (vph)	0	0	57	321	873	428	170	1309	0	0	776	0
Confl. Peds. (#/hr)	2					2	4		1	1		4
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	0%	0%	8%	1%	1%	7%	6%	6%	0%	0%	4%	0%
Turn Type			Over	pm+pt		Perm	Prot					
Protected Phases			5	3	8		5	2			6	
Permitted Phases				8		8						
Actuated Green, G (s)			8.0	27.0	27.0	25.0	8.0	53.0			42.0	
Effective Green, g (s)			7.0	27.0	27.0	27.0	7.0	55.0			44.0	
Actuated g/C Ratio			0.08	0.30	0.30	0.30	0.08	0.61			0.49	
Clearance Time (s)			3.0	4.0	6.0	6.0	3.0	6.0			6.0	
Vehicle Extension (s)			3.0	3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)			117	482	853	402	131	2058			1674	
v/s Ratio Prot			0.04	0.20	0.31		c0.10	c0.39			0.23	
v/s Ratio Perm						c0.32						
v/c Ratio			0.49	0.67	1.06dr	1.06	1.30	0.64			0.46	
Uniform Delay, d1			39.8	27.6	31.5	31.5	41.5	11.1			15.2	
Progression Factor			1.00	1.00	1.00	1.00	1.05	1.21			0.26	
Incremental Delay, d2			3.2	3.5	36.8	62.8	172.9	1.3			0.1	
Delay (s)			43.0	31.0	68.3	94.3	216.4	14.8			4.1	
Level of Service			D	C	E	F	F	B			A	
Approach Delay (s)	43.0				68.4			37.9			4.1	
Approach LOS	D				E			D			A	

Intersection Summary

HCM Average Control Delay	44.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	89.1%	ICU Level of Service	E
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	53	185	174	540	720	1918	45	1417
v/c Ratio	0.24	0.16	0.44	0.44	2.20	1.32	0.16	1.30
Control Delay	23.9	8.6	26.6	22.0	571.6	177.2	33.9	171.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	23.9	8.6	26.6	22.0	571.6	177.2	33.9	171.7
Queue Length 50th (m)	6.4	4.1	22.7	34.4	~210.2	~263.3	6.7	~165.1
Queue Length 95th (m)	15.6	11.0	41.2	48.5m	#250.1m	#286.0	16.1	#206.4
Internal Link Dist (m)		302.5		198.6		273.1		176.1
Turn Bay Length (m)	112.0		90.0		140.0		38.4	
Base Capacity (vph)	232	1156	405	1263	327	1449	297	1086
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.23	0.16	0.43	0.43	2.20	1.32	0.15	1.30

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.91		1.00	0.97		1.00	0.98		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1678	2953		1653	3383		1733	3352		1668	3263	
Flt Permitted	0.35	1.00		0.64	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	625	2953		1105	3383		1733	3352		1668	3263	
Volume (vph)	53	70	115	174	438	102	720	1653	265	45	1070	347
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	53	70	115	174	438	102	720	1653	265	45	1070	347
RTOR Reduction (vph)	0	74	0	0	23	0	0	12	0	0	35	0
Lane Group Flow (vph)	53	111	0	174	517	0	720	1906	0	45	1382	0
Confl. Peds. (#/hr)	9					9	2		6	6		2
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	6%	9%	10%	8%	1%	7%	3%	4%	4%	7%	6%	2%
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	30.0	30.0		30.0	30.0		18.0	36.4		9.6	28.0	
Effective Green, g (s)	32.0	32.0		32.0	32.0		17.0	37.4		8.6	29.0	
Actuated g/C Ratio	0.36	0.36		0.36	0.36		0.19	0.42		0.10	0.32	
Clearance Time (s)	6.0	6.0		6.0	6.0		3.0	5.0		3.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	222	1050		393	1203		327	1393		159	1051	
v/s Ratio Prot		0.04			0.15		c0.42	c0.57		0.03	0.42	
v/s Ratio Perm	0.08			c0.16								
v/c Ratio	0.24	0.11		0.44	0.43		2.20	1.37		0.28	1.32	
Uniform Delay, d1	20.4	19.4		22.2	22.1		36.5	26.3		37.8	30.5	
Progression Factor	1.00	1.00		1.00	1.00		1.17	1.19		1.00	1.00	
Incremental Delay, d2	0.6	0.0		0.8	0.2		548.0	169.0		1.0	148.7	
Delay (s)	21.0	19.5		23.0	22.3		590.6	200.4		38.8	179.2	
Level of Service	C	B		C	C		F	F		D	F	
Approach Delay (s)		19.8			22.5			306.9			174.9	
Approach LOS		B			C			F			F	

Intersection Summary

HCM Average Control Delay	215.0	HCM Level of Service	F
HCM Volume to Capacity ratio	1.15		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	143.9%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	116	189	28	80	738	101	927	15	445	1527
v/c Ratio	0.49	0.60	0.26	0.23	1.35	0.65	0.49	0.02	1.00	0.60
Control Delay	41.1	35.9	38.5	33.3	195.0	36.9	12.3	3.9	42.5	6.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	41.1	35.9	38.5	33.3	195.0	36.9	12.3	3.9	42.5	6.9
Queue Length 50th (m)	18.3	24.6	4.2	12.0	~119.7	10.9	46.1	0.0	34.3	69.7
Queue Length 95th (m)	34.5	45.5	12.2	24.1	#190.3	#39.0	60.5	2.4	m#35.5	m62.4
Internal Link Dist (m)		321.8		300.5			425.0			629.8
Turn Bay Length (m)	72.3		82.2		74.5	184.0			182.5	
Base Capacity (vph)	243	327	111	355	545	155	1892	929	446	2526
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.48	0.58	0.25	0.23	1.35	0.65	0.49	0.02	1.00	0.60

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	0.94		1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00		0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.94		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1733	1583		1200	1879	1563	1617	3275	1597	1733	3460	
Flt Permitted	0.70	1.00		0.46	1.00	1.00	0.16	1.00	1.00	0.23	1.00	
Satd. Flow (perm)	1286	1583		579	1879	1563	276	3275	1597	420	3460	
Volume (vph)	116	111	78	28	80	738	101	927	15	445	1430	97
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	116	111	78	28	80	738	101	927	15	445	1430	97
RTOR Reduction (vph)	0	29	0	0	0	93	0	0	6	0	5	0
Lane Group Flow (vph)	116	160	0	28	80	645	101	927	9	445	1522	0
Confl. Peds. (#/hr)			69	69			31					31
Confl. Bikes (#/hr)						8						
Heavy Vehicles (%)	3%	4%	6%	36%	0%	1%	10%	9%	0%	3%	2%	0%
Turn Type	Perm			Perm		pm+ov	Perm		Perm	pm+pt		
Protected Phases		4			8	1		2		1	6	
Permitted Phases	4			8		8	2		2	6		
Actuated Green, G (s)	14.4	14.4		14.4	14.4	26.0	50.0	50.0	50.0	63.6	63.6	
Effective Green, g (s)	16.4	16.4		16.4	16.4	26.0	52.0	52.0	52.0	65.6	65.6	
Actuated g/C Ratio	0.18	0.18		0.18	0.18	0.29	0.58	0.58	0.58	0.73	0.73	
Clearance Time (s)	6.0	6.0		6.0	6.0	2.0	6.0	6.0	6.0	2.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	234	288		106	342	521	159	1892	923	446	2522	
v/s Ratio Prot		0.10			0.04	c0.13		0.28		0.11	0.44	
v/s Ratio Perm	0.09			0.05		0.28	0.37		0.01	c0.62		
v/c Ratio	0.50	0.56		0.26	0.23	1.24	0.64	0.49	0.01	1.00	0.60	
Uniform Delay, d1	33.1	33.5		31.6	31.4	32.0	12.7	11.2	8.1	10.7	5.9	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.48	1.06	
Incremental Delay, d2	1.7	2.3		1.3	0.4	122.7	17.8	0.9	0.0	28.4	0.5	
Delay (s)	34.7	35.8		33.0	31.8	154.7	30.5	12.1	8.1	44.3	6.7	
Level of Service	C	D		C	C	F	C	B	A	D	A	
Approach Delay (s)		35.4			139.0			13.8			15.2	
Approach LOS		D			F			B			B	

Intersection Summary

HCM Average Control Delay	41.5	HCM Level of Service	D
HCM Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	124.1%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT
Lane Group Flow (vph)	852	879	1158	885
v/c Ratio	0.89	1.53	0.54	0.41
Control Delay	43.2	272.2	12.3	1.5
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	43.2	272.2	12.3	1.5
Queue Length 50th (m)	72.3	~195.1	64.2	4.2
Queue Length 95th (m)	#104.6	#265.3	m57.4	m4.3
Internal Link Dist (m)	99.0		629.8	333.0
Turn Bay Length (m)				
Base Capacity (vph)	962	573	2136	2157
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.89	1.53	0.54	0.41

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	1.00		0.95	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	
Frt	1.00	0.85		1.00	1.00	
Flt Protected	0.95	1.00		1.00	1.00	
Satd. Flow (prot)	3330	1566		3433	3466	
Flt Permitted	0.95	1.00		1.00	1.00	
Satd. Flow (perm)	3330	1566		3433	3466	
Volume (vph)	852	879	0	1158	885	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	852	879	0	1158	885	0
RTOR Reduction (vph)	0	120	0	0	0	0
Lane Group Flow (vph)	852	759	0	1158	885	0
Confl. Peds. (#/hr)			2			
Heavy Vehicles (%)	4%	2%	0%	4%	3%	0%
Turn Type		Perm				
Protected Phases	4			2	6	
Permitted Phases		4				
Actuated Green, G (s)	25.0	25.0		55.0	55.0	
Effective Green, g (s)	26.0	26.0		56.0	56.0	
Actuated g/C Ratio	0.29	0.29		0.62	0.62	
Clearance Time (s)	5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	962	452		2136	2157	
v/s Ratio Prot	0.26			c0.34	0.26	
v/s Ratio Perm		c0.48				
v/c Ratio	0.89	1.68		0.54	0.41	
Uniform Delay, d1	30.6	32.0		9.7	8.6	
Progression Factor	1.00	1.00		1.19	0.15	
Incremental Delay, d2	9.8	315.0		0.5	0.2	
Delay (s)	40.4	347.0		12.0	1.5	
Level of Service	D	F		B	A	
Approach Delay (s)	196.1			12.0	1.5	
Approach LOS	F			B	A	

Intersection Summary

HCM Average Control Delay	94.0	HCM Level of Service	F
HCM Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	106.1%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBR	WBL	WBT	WBR	NBL	NBT	SBT
Lane Group Flow (vph)	282	76	185	121	236	1269	1323
v/c Ratio	0.84	0.16	0.22	0.28	0.64	0.59	1.03
Control Delay	57.8	25.1	16.3	14.4	45.7	15.0	62.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	57.8	25.1	16.3	14.4	45.7	15.0	62.1
Queue Length 50th (m)	46.9	10.7	8.9	7.9	42.4	65.2	~131.6
Queue Length 95th (m)	#87.0	22.3	17.7	22.3	m58.2	m77.3	#172.3
Internal Link Dist (m)			61.0			333.0	273.1
Turn Bay Length (m)					83.0		
Base Capacity (vph)	338	487	872	454	371	2157	1286
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.83	0.16	0.21	0.27	0.64	0.59	1.03

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.0	4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor			1.00	0.91	0.86	0.91	1.00	0.95			0.95	
Frpb, ped/bikes			1.00	1.00	0.99	0.98	1.00	1.00			1.00	
Flpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	
Frt			0.86	1.00	0.90	0.85	1.00	1.00			0.99	
Flt Protected			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)			1625	1624	2755	1361	1785	3466			3445	
Flt Permitted			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (perm)			1625	1624	2755	1361	1785	3466			3445	
Volume (vph)	0	0	282	76	64	242	236	1269	0	0	1267	56
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	282	76	64	242	236	1269	0	0	1267	56
RTOR Reduction (vph)	0	0	0	0	46	46	0	0	0	0	4	0
Lane Group Flow (vph)	0	0	282	76	139	75	236	1269	0	0	1319	0
Confl. Peds. (#/hr)	4					4	8		11	11		8
Confl. Bikes (#/hr)									5			
Heavy Vehicles (%)	0%	0%	0%	0%	4%	5%	0%	3%	0%	0%	3%	0%
Turn Type			Over	pm+pt		Perm	Prot					
Protected Phases			5	3	8		5	2			6	
Permitted Phases				8		8						
Actuated Green, G (s)			19.5	24.0	24.0	24.0	19.5	54.0			31.5	
Effective Green, g (s)			18.5	26.0	26.0	26.0	18.5	56.0			33.5	
Actuated g/C Ratio			0.21	0.29	0.29	0.29	0.21	0.62			0.37	
Clearance Time (s)			3.0	6.0	6.0	6.0	3.0	6.0			6.0	
Vehicle Extension (s)			3.0	3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)			334	469	796	393	367	2157			1282	
v/s Ratio Prot			c0.17	0.05	0.05		0.13	0.37			c0.38	
v/s Ratio Perm						c0.05						
v/c Ratio			0.84	0.16	0.17	0.19	0.64	0.59			1.03	
Uniform Delay, d1			34.4	23.9	24.0	24.1	32.7	10.1			28.2	
Progression Factor			1.00	1.00	1.00	1.00	1.19	1.36			1.00	
Incremental Delay, d2			17.4	0.2	0.1	0.2	2.8	0.8			32.9	
Delay (s)			51.8	24.0	24.1	24.3	41.8	14.7			61.1	
Level of Service			D	C	C	C	D	B			E	
Approach Delay (s)	51.8				24.1			18.9			61.1	
Approach LOS	D				C			B			E	

Intersection Summary

HCM Average Control Delay	38.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	84.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	381	1185	296	188	151	1393	112	1799
v/c Ratio	0.92	1.06dr	1.48	0.13	0.85	1.33	0.69	1.72
Control Delay	60.9	38.1	262.3	7.4	81.0	184.0	63.4	353.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	60.9	38.1	262.3	7.4	81.0	184.0	63.4	353.1
Queue Length 50th (m)	66.4	89.3	~61.0	4.6	27.6	~177.4	20.1	~261.8
Queue Length 95th (m)	#121.1	#133.7	#110.9	10.5	#60.6	#219.0	#43.2	#304.6
Internal Link Dist (m)		302.5		198.6		273.1		176.1
Turn Bay Length (m)	112.0		90.0		140.0		38.4	
Base Capacity (vph)	412	1266	200	1459	181	1048	169	1047
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.92	0.94	1.48	0.13	0.83	1.33	0.66	1.72

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.90		1.00	0.92		1.00	0.98		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1780	3151		1700	3037		1716	3355		1608	3393	
Flt Permitted	0.63	1.00		0.11	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1186	3151		193	3037		1716	3355		1608	3393	
Volume (vph)	381	431	754	296	91	97	151	1223	170	112	1714	85
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	381	431	754	296	91	97	151	1223	170	112	1714	85
RTOR Reduction (vph)	0	171	0	0	52	0	0	11	0	0	3	0
Lane Group Flow (vph)	381	1014	0	296	136	0	151	1382	0	112	1796	0
Confl. Peds. (#/hr)	4		11	11		4	5		20	20		5
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	0%	1%	1%	5%	6%	9%	4%	4%	4%	11%	4%	12%
Turn Type	Perm			pm+pt			Prot			Prot		
Protected Phases		4		3	8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	31.0	31.0		42.0	42.0		10.8	28.3		10.7	28.2	
Effective Green, g (s)	33.0	33.0		44.0	44.0		9.8	29.3		9.7	29.2	
Actuated g/C Ratio	0.35	0.35		0.46	0.46		0.10	0.31		0.10	0.31	
Clearance Time (s)	6.0	6.0		3.0	6.0		3.0	5.0		3.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	412	1095		200	1407		177	1035		164	1043	
v/s Ratio Prot		0.32		c0.11	0.04		c0.09	0.41		0.07	c0.53	
v/s Ratio Perm	0.32			c0.57								
v/c Ratio	0.92	1.06dr		1.48	0.10		0.85	1.34		0.68	1.72	
Uniform Delay, d1	29.8	29.8		22.7	14.3		41.9	32.8		41.2	32.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	26.3	12.9		240.9	0.0		30.7	157.5		11.1	328.7	
Delay (s)	56.1	42.8		263.6	14.4		72.6	190.3		52.3	361.6	
Level of Service	E	D		F	B		E	F		D	F	
Approach Delay (s)		46.0			166.8			178.8			343.5	
Approach LOS		D			F			F			F	

Intersection Summary

HCM Average Control Delay	197.1	HCM Level of Service	F
HCM Volume to Capacity ratio	1.47		
Actuated Cycle Length (s)	95.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	131.0%	ICU Level of Service	H
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

APPENDIX C

2023 5-YEAR HORIZON CAPACITY ANALYSIS

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	123	308	33	285	463	115	877	75	485	1239
v/c Ratio	1.52	1.02	0.63	0.85	0.83	0.49	0.42	0.08	1.16	0.51
Control Delay	316.7	92.4	86.0	59.8	33.4	18.1	9.4	4.9	91.4	1.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	316.7	92.4	86.0	59.8	33.4	18.1	9.4	4.9	91.4	1.9
Queue Length 50th (m)	~30.0	~51.4	5.3	48.1	49.6	9.8	36.8	2.9	~31.6	9.5
Queue Length 95th (m)	#63.1	#102.9	#21.1	#90.0	#101.3	26.2	48.6	7.8m	#27.4	m12.6
Internal Link Dist (m)		321.8		300.5			425.0			629.8
Turn Bay Length (m)	72.3		82.2		74.5	184.0			182.5	
Base Capacity (vph)	81	302	52	335	560	235	2096	919	417	2408
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.52	1.02	0.63	0.85	0.83	0.49	0.42	0.08	1.16	0.51

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	0.89		1.00	1.00	1.00	1.00	1.00	0.97	1.00	1.00	
Flpb, ped/bikes	1.00	1.00		0.87	1.00	1.00	0.99	1.00	1.00	1.00	1.00	
Frt	1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1623	1487		1112	1773	1536	1627	3368	1460	1749	3323	
Flt Permitted	0.25	1.00		0.24	1.00	1.00	0.22	1.00	1.00	0.26	1.00	
Satd. Flow (perm)	427	1487		275	1773	1536	378	3368	1460	480	3323	
Volume (vph)	123	201	107	33	285	463	115	877	75	485	1132	107
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	123	201	107	33	285	463	115	877	75	485	1132	107
RTOR Reduction (vph)	0	21	0	0	0	123	0	0	11	0	8	0
Lane Group Flow (vph)	123	287	0	33	285	340	115	877	64	485	1231	0
Confl. Peds. (#/hr)			219	219			43		12	12		43
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	10%	5%	8%	40%	6%	4%	9%	6%	6%	2%	5%	11%
Turn Type	Perm			Perm		pm+ov	Perm		Perm	pm+pt		
Protected Phases		4			8	1		2		1	6	
Permitted Phases	4			8		8	2		2	6		
Actuated Green, G (s)	15.0	15.0		15.0	15.0	22.0	54.0	54.0	54.0	63.0	63.0	
Effective Green, g (s)	17.0	17.0		17.0	17.0	22.0	56.0	56.0	56.0	65.0	65.0	
Actuated g/C Ratio	0.19	0.19		0.19	0.19	0.24	0.62	0.62	0.62	0.72	0.72	
Clearance Time (s)	6.0	6.0		6.0	6.0	2.0	6.0	6.0	6.0	2.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	81	281		52	335	444	235	2096	908	417	2400	
v/s Ratio Prot		0.19			0.16	0.04		0.26		c0.06	0.37	
v/s Ratio Perm	c0.29			0.12		0.18	0.30		0.04	c0.78		
v/c Ratio	1.52	1.02		0.63	0.85	0.77	0.49	0.42	0.07	1.16	0.51	
Uniform Delay, d1	36.5	36.5		33.6	35.3	31.6	9.2	8.7	6.7	11.9	5.5	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.17	0.34	
Incremental Delay, d2	286.4	59.2		22.6	18.3	7.7	7.1	0.6	0.2	76.1	0.1	
Delay (s)	322.9	95.7		56.3	53.6	39.3	16.4	9.3	6.9	90.1	1.9	
Level of Service	F	F		E	D	D	B	A	A	F	A	
Approach Delay (s)		160.5			45.2			9.9			26.7	
Approach LOS		F			D			A			C	

Intersection Summary

HCM Average Control Delay	40.2	HCM Level of Service	D
HCM Volume to Capacity ratio	1.22		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	139.0%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT
Lane Group Flow (vph)	495	797	1109	1075
v/c Ratio	0.86	1.99	0.44	0.43
Control Delay	52.4	473.9	6.6	8.6
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	52.4	473.9	6.6	8.6
Queue Length 50th (m)	43.2	~195.2	45.3	49.1
Queue Length 95th (m)	#68.4	#263.9	m59.2	59.2
Internal Link Dist (m)	99.0		629.8	333.0
Turn Bay Length (m)				
Base Capacity (vph)	575	401	2518	2518
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.86	1.99	0.44	0.43

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	1.00		0.95	0.95	
Frt	1.00	0.85		1.00	1.00	
Flt Protected	0.95	1.00		1.00	1.00	
Satd. Flow (prot)	3236	1521		3433	3433	
Flt Permitted	0.95	1.00		1.00	1.00	
Satd. Flow (perm)	3236	1521		3433	3433	
Volume (vph)	495	797	0	1109	1075	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	495	797	0	1109	1075	0
RTOR Reduction (vph)	0	131	0	0	0	0
Lane Group Flow (vph)	495	666	0	1109	1075	0
Heavy Vehicles (%)	7%	5%	0%	4%	4%	0%
Turn Type		Perm				
Protected Phases	4			2	6	
Permitted Phases		4				
Actuated Green, G (s)	15.0	15.0		65.0	65.0	
Effective Green, g (s)	16.0	16.0		66.0	66.0	
Actuated g/C Ratio	0.18	0.18		0.73	0.73	
Clearance Time (s)	5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	575	270		2518	2518	
v/s Ratio Prot	0.15			c0.32	0.31	
v/s Ratio Perm		c0.44				
v/c Ratio	0.86	2.47		0.44	0.43	
Uniform Delay, d1	35.9	37.0		4.7	4.7	
Progression Factor	1.00	1.00		1.29	1.72	
Incremental Delay, d2	12.5	671.5		0.4	0.5	
Delay (s)	48.4	708.5		6.5	8.5	
Level of Service	D	F		A	A	
Approach Delay (s)	455.6			6.5	8.5	
Approach LOS	F			A	A	

Intersection Summary

HCM Average Control Delay	174.0	HCM Level of Service	F
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	109.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBR	WBL	WBT	WBR	NBL	NBT	SBT
Lane Group Flow (vph)	60	331	941	484	176	1344	800
v/c Ratio	0.52	0.69	1.09dr	1.10	1.34	0.65	0.48
Control Delay	56.6	36.7	75.7	99.9	226.9	15.6	4.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	56.6	36.7	75.7	99.9	226.9	15.6	4.2
Queue Length 50th (m)	10.2	55.3	~100.2	~97.1	~41.9	114.2	9.6
Queue Length 95th (m)	#25.1	87.6	#141.9	#161.6m	#71.9	138.1	m9.5
Internal Link Dist (m)			61.0			333.0	273.1
Turn Bay Length (m)					83.0		
Base Capacity (vph)	116	478	893	442	131	2058	1660
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.52	0.69	1.05	1.10	1.34	0.65	0.48

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.0	4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor			1.00	0.91	0.86	0.91	1.00	0.95			0.95	
Frpb, ped/bikes			1.00	1.00	0.99	0.99	1.00	1.00			1.00	
Flpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	
Frt			0.86	1.00	0.92	0.85	1.00	1.00			1.00	
Flt Protected			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)			1491	1592	2845	1339	1684	3368			3392	
Flt Permitted			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (perm)			1491	1592	2845	1339	1684	3368			3392	
Volume (vph)	0	0	60	331	458	967	176	1344	0	0	785	15
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	60	331	458	967	176	1344	0	0	785	15
RTOR Reduction (vph)	0	0	0	0	40	40	0	0	0	0	2	0
Lane Group Flow (vph)	0	0	60	331	901	444	176	1344	0	0	798	0
Confl. Peds. (#/hr)	2					2	4		1	1		4
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	0%	0%	9%	2%	1%	7%	6%	6%	0%	0%	5%	0%
Turn Type			Over	pm+pt		Perm	Prot					
Protected Phases			5	3	8		5	2			6	
Permitted Phases				8		8						
Actuated Green, G (s)			8.0	25.0	25.0	25.0	8.0	53.0			42.0	
Effective Green, g (s)			7.0	27.0	27.0	27.0	7.0	55.0			44.0	
Actuated g/C Ratio			0.08	0.30	0.30	0.30	0.08	0.61			0.49	
Clearance Time (s)			3.0	6.0	6.0	6.0	3.0	6.0			6.0	
Vehicle Extension (s)			3.0	3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)			116	478	854	402	131	2058			1658	
v/s Ratio Prot			0.04	0.21	0.32		c0.10	c0.40			0.24	
v/s Ratio Perm						c0.33						
v/c Ratio			0.52	0.69	1.09dr	1.10	1.34	0.65			0.48	
Uniform Delay, d1			39.9	27.8	31.5	31.5	41.5	11.3			15.4	
Progression Factor			1.00	1.00	1.00	1.00	1.04	1.23			0.27	
Incremental Delay, d2			3.9	4.3	46.4	76.3	190.6	1.4			0.1	
Delay (s)			43.7	32.1	77.9	107.8	234.0	15.2			4.2	
Level of Service			D	C	E	F	F	B			A	
Approach Delay (s)	43.7				77.5			40.6			4.2	
Approach LOS	D				E			D			A	

Intersection Summary			
HCM Average Control Delay	49.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	90.1%	ICU Level of Service	E
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	56	193	180	557	809	1970	46	1456
v/c Ratio	0.26	0.17	0.46	0.46	2.49	1.36	0.17	1.34
Control Delay	24.6	8.5	27.0	22.2	697.3	193.9	34.0	187.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.6	8.5	27.0	22.2	697.3	193.9	34.0	187.1
Queue Length 50th (m)	6.8	4.3	23.6	35.8	~243.3	~273.5	6.9	~172.6
Queue Length 95th (m)	16.5	11.2	42.5	49.8m	#283.7m	#294.4	16.4	#214.1
Internal Link Dist (m)		302.5		198.6		273.1		176.1
Turn Bay Length (m)	112.0		90.0		140.0		38.4	
Base Capacity (vph)	221	1149	402	1248	325	1446	291	1086
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.25	0.17	0.45	0.45	2.49	1.36	0.16	1.34

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.91		1.00	0.97		1.00	0.98		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1647	2926		1653	3342		1733	3352		1638	3263	
Flt Permitted	0.34	1.00		0.63	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	595	2926		1097	3342		1733	3352		1638	3263	
Volume (vph)	56	73	120	180	450	107	809	1697	273	46	1099	357
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	56	73	120	180	450	107	809	1697	273	46	1099	357
RTOR Reduction (vph)	0	77	0	0	23	0	0	12	0	0	35	0
Lane Group Flow (vph)	56	116	0	180	534	0	809	1958	0	46	1421	0
Confl. Peds. (#/hr)	9					9	2		6	6		2
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	8%	10%	11%	8%	2%	9%	3%	4%	4%	9%	6%	2%
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	30.1	30.1		30.1	30.1		17.9	36.3		9.6	28.0	
Effective Green, g (s)	32.1	32.1		32.1	32.1		16.9	37.3		8.6	29.0	
Actuated g/C Ratio	0.36	0.36		0.36	0.36		0.19	0.41		0.10	0.32	
Clearance Time (s)	6.0	6.0		6.0	6.0		3.0	5.0		3.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	212	1044		391	1192		325	1389		157	1051	
v/s Ratio Prot		0.04			0.16		c0.47	c0.58		0.03	0.44	
v/s Ratio Perm	0.09			c0.16								
v/c Ratio	0.26	0.11		0.46	0.45		2.49	1.41		0.29	1.35	
Uniform Delay, d1	20.6	19.4		22.3	22.2		36.6	26.4		37.9	30.5	
Progression Factor	1.00	1.00		1.00	1.00		1.16	1.18		1.00	1.00	
Incremental Delay, d2	0.7	0.0		0.9	0.3		676.7	187.4		1.0	164.6	
Delay (s)	21.2	19.4		23.1	22.4		719.1	218.4		38.9	195.1	
Level of Service	C	B		C	C		F	F		D	F	
Approach Delay (s)		19.8			22.6			364.2			190.4	
Approach LOS		B			C			F			F	

Intersection Summary

HCM Average Control Delay	250.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	150.0%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	120	196	31	83	758	106	952	16	458	1568
v/c Ratio	0.52	0.62	0.30	0.24	1.40	0.74	0.50	0.02	1.05	0.62
Control Delay	41.8	37.1	40.4	33.3	216.5	48.0	12.5	3.9	57.9	7.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	41.8	37.1	40.4	33.3	216.5	48.0	12.5	3.9	57.9	7.2
Queue Length 50th (m)	18.9	25.7	4.7	12.4	~131.0	12.5	47.7	0.0	~34.4	74.4
Queue Length 95th (m)	35.8	47.6	13.2	24.7	#200.0	#43.6	62.7	2.5	m#41.1	m64.6
Internal Link Dist (m)		321.8		300.5			425.0			629.8
Turn Bay Length (m)	72.3		82.2		74.5	184.0			182.5	
Base Capacity (vph)	240	324	106	355	540	144	1892	929	435	2521
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.50	0.60	0.29	0.23	1.40	0.74	0.50	0.02	1.05	0.62

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	0.94		1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00		0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.94		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1716	1567		1177	1879	1563	1589	3275	1597	1733	3460	
Flt Permitted	0.70	1.00		0.44	1.00	1.00	0.15	1.00	1.00	0.22	1.00	
Satd. Flow (perm)	1270	1567		549	1879	1563	254	3275	1597	405	3460	
Volume (vph)	120	115	81	31	83	758	106	952	16	458	1468	100
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	120	115	81	31	83	758	106	952	16	458	1468	100
RTOR Reduction (vph)	0	29	0	0	0	88	0	0	7	0	5	0
Lane Group Flow (vph)	120	167	0	31	83	670	106	952	9	458	1563	0
Confl. Peds. (#/hr)			69	69			31					31
Confl. Bikes (#/hr)						8						
Heavy Vehicles (%)	4%	5%	7%	39%	0%	1%	12%	9%	0%	3%	2%	0%
Turn Type	Perm			Perm		pm+ov	Perm		Perm	pm+pt		
Protected Phases		4			8	1		2		1	6	
Permitted Phases	4			8		8	2		2	6		
Actuated Green, G (s)	14.5	14.5		14.5	14.5	26.0	50.0	50.0	50.0	63.5	63.5	
Effective Green, g (s)	16.5	16.5		16.5	16.5	26.0	52.0	52.0	52.0	65.5	65.5	
Actuated g/C Ratio	0.18	0.18		0.18	0.18	0.29	0.58	0.58	0.58	0.73	0.73	
Clearance Time (s)	6.0	6.0		6.0	6.0	2.0	6.0	6.0	6.0	2.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	233	287		101	344	521	147	1892	923	435	2518	
v/s Ratio Prot		0.11			0.04	c0.14		0.29		0.11	0.45	
v/s Ratio Perm	0.09			0.06		0.29	0.42		0.01	c0.66		
v/c Ratio	0.52	0.58		0.31	0.24	1.29	0.72	0.50	0.01	1.05	0.62	
Uniform Delay, d1	33.1	33.6		31.8	31.4	32.0	13.8	11.3	8.1	11.3	6.1	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.46	1.09	
Incremental Delay, d2	1.9	3.0		1.7	0.4	142.6	26.2	1.0	0.0	42.5	0.5	
Delay (s)	35.1	36.6		33.5	31.8	174.6	39.9	12.3	8.1	59.1	7.1	
Level of Service	D	D		C	C	F	D	B	A	E	A	
Approach Delay (s)		36.0			156.0			14.9			18.8	
Approach LOS		D			F			B			B	

Intersection Summary

HCM Average Control Delay	47.0	HCM Level of Service	D
HCM Volume to Capacity ratio	1.12		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	126.6%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT
Lane Group Flow (vph)	875	903	1189	909
v/c Ratio	0.91	1.61	0.56	0.42
Control Delay	45.8	304.2	12.5	1.5
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	45.8	304.2	12.5	1.5
Queue Length 50th (m)	75.0	~207.3	69.4	4.3
Queue Length 95th (m)	#109.3	#278.2	m59.2	m4.2
Internal Link Dist (m)	99.0		629.8	333.0
Turn Bay Length (m)				
Base Capacity (vph)	962	562	2136	2157
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.91	1.61	0.56	0.42

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	1.00		0.95	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	
Frt	1.00	0.85		1.00	1.00	
Flt Protected	0.95	1.00		1.00	1.00	
Satd. Flow (prot)	3330	1551		3433	3466	
Flt Permitted	0.95	1.00		1.00	1.00	
Satd. Flow (perm)	3330	1551		3433	3466	
Volume (vph)	875	903	0	1189	909	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	875	903	0	1189	909	0
RTOR Reduction (vph)	0	114	0	0	0	0
Lane Group Flow (vph)	875	789	0	1189	909	0
Confl. Peds. (#/hr)			2			
Heavy Vehicles (%)	4%	3%	0%	4%	3%	0%
Turn Type		Perm				
Protected Phases	4			2	6	
Permitted Phases		4				
Actuated Green, G (s)	25.0	25.0		55.0	55.0	
Effective Green, g (s)	26.0	26.0		56.0	56.0	
Actuated g/C Ratio	0.29	0.29		0.62	0.62	
Clearance Time (s)	5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	962	448		2136	2157	
v/s Ratio Prot	0.26			c0.35	0.26	
v/s Ratio Perm		c0.51				
v/c Ratio	0.91	1.76		0.56	0.42	
Uniform Delay, d1	30.9	32.0		9.8	8.7	
Progression Factor	1.00	1.00		1.20	0.15	
Incremental Delay, d2	12.2	351.8		0.5	0.1	
Delay (s)	43.0	383.8		12.3	1.4	
Level of Service	D	F		B	A	
Approach Delay (s)	216.1			12.3	1.4	
Approach LOS	F			B	A	

Intersection Summary

HCM Average Control Delay	103.2	HCM Level of Service	F
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	107.6%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBR	WBL	WBT	WBR	NBL	NBT	SBT
Lane Group Flow (vph)	290	78	191	125	242	1303	1359
v/c Ratio	0.86	0.17	0.23	0.29	0.66	0.60	1.08
Control Delay	60.3	25.2	17.3	15.7	45.8	15.0	78.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	60.3	25.2	17.3	15.7	45.8	15.0	78.4
Queue Length 50th (m)	48.5	11.0	9.7	9.2	43.5	67.4	~141.0
Queue Length 95th (m)	#90.3	22.7	18.8	24.1	m59.1	m78.7	#182.1
Internal Link Dist (m)			61.0			333.0	273.1
Turn Bay Length (m)					83.0		
Base Capacity (vph)	339	487	867	450	373	2157	1260
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.86	0.16	0.22	0.28	0.65	0.60	1.08

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.0	4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor			1.00	0.91	0.86	0.91	1.00	0.95			0.95	
Frpb, ped/bikes			1.00	1.00	0.99	0.98	1.00	1.00			1.00	
Flpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	
Frt			0.86	1.00	0.90	0.85	1.00	1.00			0.99	
Flt Protected			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)			1625	1624	2748	1361	1785	3466			3382	
Flt Permitted			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (perm)			1625	1624	2748	1361	1785	3466			3382	
Volume (vph)	0	0	290	78	67	249	242	1303	0	0	1301	58
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	290	78	67	249	242	1303	0	0	1301	58
RTOR Reduction (vph)	0	0	0	0	43	43	0	0	0	0	4	0
Lane Group Flow (vph)	0	0	290	78	148	82	242	1303	0	0	1355	0
Confl. Peds. (#/hr)	4					4	8		11	11		8
Confl. Bikes (#/hr)									5			
Heavy Vehicles (%)	0%	0%	0%	0%	5%	5%	0%	3%	0%	0%	5%	0%
Turn Type			Over	pm+pt		Perm	Prot					
Protected Phases			5	3	8		5	2			6	
Permitted Phases				8		8						
Actuated Green, G (s)			19.6	24.0	24.0	24.0	19.6	54.0			31.4	
Effective Green, g (s)			18.6	26.0	26.0	26.0	18.6	56.0			33.4	
Actuated g/C Ratio			0.21	0.29	0.29	0.29	0.21	0.62			0.37	
Clearance Time (s)			3.0	6.0	6.0	6.0	3.0	6.0			6.0	
Vehicle Extension (s)			3.0	3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)			336	469	794	393	369	2157			1255	
v/s Ratio Prot			c0.18	0.05	0.05		0.14	0.38			c0.40	
v/s Ratio Perm						c0.06						
v/c Ratio			0.86	0.17	0.19	0.21	0.66	0.60			1.08	
Uniform Delay, d1			34.5	23.9	24.1	24.2	32.8	10.3			28.3	
Progression Factor			1.00	1.00	1.00	1.00	1.19	1.34			1.00	
Incremental Delay, d2			19.8	0.2	0.1	0.3	2.9	0.9			49.9	
Delay (s)			54.3	24.1	24.2	24.5	41.8	14.7			78.2	
Level of Service			D	C	C	C	D	B			E	
Approach Delay (s)	54.3				24.3			19.0			78.2	
Approach LOS	D				C			B			E	

Intersection Summary

HCM Average Control Delay	44.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	85.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	391	1217	305	196	156	1431	116	1847
v/c Ratio	0.96	1.09dr	1.52	0.13	0.88	1.37	0.69	1.79
Control Delay	67.1	43.1	281.2	7.4	86.0	200.2	63.9	386.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	67.1	43.1	281.2	7.4	86.0	200.2	63.9	386.9
Queue Length 50th (m)	69.3	94.3	~64.5	4.8	28.6	~185.2	20.8	~273.2
Queue Length 95th (m)	#125.9	#140.9	#115.2	10.8	#63.3	#226.9	#44.9	#316.0
Internal Link Dist (m)		302.5		198.6		273.1		176.1
Turn Bay Length (m)	112.0		90.0		140.0		38.4	
Base Capacity (vph)	409	1261	200	1455	179	1047	172	1029
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.96	0.97	1.53	0.13	0.87	1.37	0.67	1.79

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.90		1.00	0.92		1.00	0.98		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1780	3140		1700	3023		1700	3354		1638	3347	
Flt Permitted	0.63	1.00		0.11	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1177	3140		193	3023		1700	3354		1638	3347	
Volume (vph)	391	443	774	305	95	101	156	1255	176	116	1759	88
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	391	443	774	305	95	101	156	1255	176	116	1759	88
RTOR Reduction (vph)	0	170	0	0	54	0	0	12	0	0	3	0
Lane Group Flow (vph)	391	1047	0	305	142	0	156	1419	0	116	1844	0
Confl. Peds. (#/hr)	4		11	11		4	5		20	20		5
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	0%	2%	1%	5%	7%	9%	5%	4%	4%	9%	6%	2%
Turn Type	Perm			pm+pt			Prot			Prot		
Protected Phases		4		3	8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	31.0	31.0		42.0	42.0		10.9	28.3		10.7	28.1	
Effective Green, g (s)	33.0	33.0		44.0	44.0		9.9	29.3		9.7	29.1	
Actuated g/C Ratio	0.35	0.35		0.46	0.46		0.10	0.31		0.10	0.31	
Clearance Time (s)	6.0	6.0		3.0	6.0		3.0	5.0		3.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	409	1091		200	1400		177	1034		167	1025	
v/s Ratio Prot		0.33		c0.11	0.05		c0.09	0.42		0.07	c0.55	
v/s Ratio Perm	0.33			c0.59								
v/c Ratio	0.96	1.09dr		1.52	0.10		0.88	1.37		0.69	1.80	
Uniform Delay, d1	30.3	30.3		22.9	14.4		42.0	32.8		41.2	33.0	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	33.0	18.0		260.0	0.0		36.3	173.8		11.8	363.3	
Delay (s)	63.3	48.4		282.9	14.4		78.3	206.7		53.0	396.2	
Level of Service	E	D		F	B		E	F		D	F	
Approach Delay (s)		52.0			177.9			194.1			375.9	
Approach LOS		D			F			F			F	

Intersection Summary

HCM Average Control Delay	215.4	HCM Level of Service	F
HCM Volume to Capacity ratio	1.52		
Actuated Cycle Length (s)	95.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	132.6%	ICU Level of Service	H
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

APPENDIX D

2028 10-YEAR HORIZON CAPACITY ANALYSIS

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	128	320	36	295	477	120	901	78	499	1275
v/c Ratio	1.71	1.07	0.69	0.89	0.86	0.54	0.43	0.09	1.24	0.53
Control Delay	395.9	105.3	95.8	65.3	37.9	21.0	9.6	5.3	127.0	1.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	395.9	105.3	95.8	65.3	37.9	21.0	9.6	5.3	127.0	1.9
Queue Length 50th (m)	~32.9	~58.0	5.9	50.2	54.6	10.7	38.3	3.3	~45.0	9.7
Queue Length 95th (m)	#66.7	#108.2	#22.6	#94.9	#109.7	30.7	50.4	8.4	m#36.6	m12.6
Internal Link Dist (m)		321.8		300.5			425.0			629.8
Turn Bay Length (m)	72.3		82.2		74.5	184.0			182.5	
Base Capacity (vph)	75	300	52	332	553	222	2096	909	402	2405
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.71	1.07	0.69	0.89	0.86	0.54	0.43	0.09	1.24	0.53

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	0.89		1.00	1.00	1.00	1.00	1.00	0.97	1.00	0.99	
Flpb, ped/bikes	1.00	1.00		0.88	1.00	1.00	0.99	1.00	1.00	1.00	1.00	
Frt	1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1608	1474		1106	1756	1536	1612	3368	1446	1732	3319	
Flt Permitted	0.24	1.00		0.24	1.00	1.00	0.21	1.00	1.00	0.25	1.00	
Satd. Flow (perm)	398	1474		274	1756	1536	357	3368	1446	460	3319	
Volume (vph)	128	209	111	36	295	477	120	901	78	499	1163	112
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	128	209	111	36	295	477	120	901	78	499	1163	112
RTOR Reduction (vph)	0	21	0	0	0	116	0	0	9	0	8	0
Lane Group Flow (vph)	128	299	0	36	295	361	120	901	69	499	1267	0
Confl. Peds. (#/hr)			219	219			43		12	12		43
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	11%	6%	9%	42%	7%	4%	10%	6%	7%	3%	5%	12%
Turn Type	Perm			Perm		pm+ov	Perm		Perm	pm+pt		
Protected Phases		4			8	1		2		1	6	
Permitted Phases	4			8		8	2		2	6		
Actuated Green, G (s)	15.0	15.0		15.0	15.0	22.0	54.0	54.0	54.0	63.0	63.0	
Effective Green, g (s)	17.0	17.0		17.0	17.0	22.0	56.0	56.0	56.0	65.0	65.0	
Actuated g/C Ratio	0.19	0.19		0.19	0.19	0.24	0.62	0.62	0.62	0.72	0.72	
Clearance Time (s)	6.0	6.0		6.0	6.0	2.0	6.0	6.0	6.0	2.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	75	278		52	332	444	222	2096	900	403	2397	
v/s Ratio Prot		0.20			0.17	0.05		0.27		c0.07	0.38	
v/s Ratio Perm	c0.32			0.13		0.19	0.34		0.05	c0.83		
v/c Ratio	1.71	1.08		0.69	0.89	0.81	0.54	0.43	0.08	1.24	0.53	
Uniform Delay, d1	36.5	36.5		34.1	35.6	32.1	9.7	8.8	6.7	11.9	5.6	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.27	0.33	
Incremental Delay, d2	368.1	75.4		33.0	23.7	10.8	9.1	0.6	0.2	109.2	0.1	
Delay (s)	404.6	111.9		67.0	59.3	42.9	18.8	9.4	6.9	124.3	1.9	
Level of Service	F	F		E	E	D	B	A	A	F	A	
Approach Delay (s)		195.5			49.9			10.3			36.4	
Approach LOS		F			D			B			D	

Intersection Summary

HCM Average Control Delay	49.3	HCM Level of Service	D
HCM Volume to Capacity ratio	1.32		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	139.7%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT
Lane Group Flow (vph)	510	820	1140	1105
v/c Ratio	0.89	2.08	0.45	0.44
Control Delay	55.3	515.5	6.7	8.7
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	55.3	515.5	6.7	8.7
Queue Length 50th (m)	44.8	~206.5	46.6	50.4
Queue Length 95th (m)	#71.8	#275.7	m59.8	60.4
Internal Link Dist (m)	99.0		629.8	333.0
Turn Bay Length (m)				
Base Capacity (vph)	575	394	2518	2518
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.89	2.08	0.45	0.44

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	1.00		0.95	0.95	
Frt	1.00	0.85		1.00	1.00	
Flt Protected	0.95	1.00		1.00	1.00	
Satd. Flow (prot)	3236	1521		3433	3433	
Flt Permitted	0.95	1.00		1.00	1.00	
Satd. Flow (perm)	3236	1521		3433	3433	
Volume (vph)	510	820	0	1140	1105	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	510	820	0	1140	1105	0
RTOR Reduction (vph)	0	123	0	0	0	0
Lane Group Flow (vph)	510	697	0	1140	1105	0
Heavy Vehicles (%)	7%	5%	0%	4%	4%	0%
Turn Type		Perm				
Protected Phases	4			2	6	
Permitted Phases		4				
Actuated Green, G (s)	15.0	15.0		65.0	65.0	
Effective Green, g (s)	16.0	16.0		66.0	66.0	
Actuated g/C Ratio	0.18	0.18		0.73	0.73	
Clearance Time (s)	5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	575	270		2518	2518	
v/s Ratio Prot	0.16			c0.33	0.32	
v/s Ratio Perm		c0.46				
v/c Ratio	0.89	2.58		0.45	0.44	
Uniform Delay, d1	36.1	37.0		4.8	4.7	
Progression Factor	1.00	1.00		1.29	1.71	
Incremental Delay, d2	15.3	721.8		0.4	0.5	
Delay (s)	51.4	758.8		6.6	8.5	
Level of Service	D	F		A	A	
Approach Delay (s)	487.6			6.6	8.5	
Approach LOS	F			A	A	

Intersection Summary

HCM Average Control Delay	186.1	HCM Level of Service	F
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	110.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBR	WBL	WBT	WBR	NBL	NBT	SBT
Lane Group Flow (vph)	63	341	967	497	182	1381	823
v/c Ratio	0.55	0.71	1.13dr	1.13	1.40	0.67	0.50
Control Delay	58.9	37.8	86.7	114.0	248.2	16.1	4.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	58.9	37.8	86.7	114.0	248.2	16.1	4.3
Queue Length 50th (m)	10.7	57.3	~106.6	~103.9	~44.3	118.6	10.2
Queue Length 95th (m)	#26.7	#91.6	#148.7	#168.9m	#73.7m	141.4	m9.6
Internal Link Dist (m)			61.0			333.0	273.1
Turn Bay Length (m)					83.0		
Base Capacity (vph)	115	478	890	438	130	2058	1660
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.55	0.71	1.09	1.13	1.40	0.67	0.50

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.0	4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor			1.00	0.91	0.86	0.91	1.00	0.95			0.95	
Frpb, ped/bikes			1.00	1.00	0.99	0.99	1.00	1.00			1.00	
Flpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	
Frt			0.86	1.00	0.92	0.85	1.00	1.00			1.00	
Flt Protected			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)			1477	1592	2845	1339	1668	3368			3392	
Flt Permitted			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (perm)			1477	1592	2845	1339	1668	3368			3392	
Volume (vph)	0	0	63	341	471	993	182	1381	0	0	807	16
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	63	341	471	993	182	1381	0	0	807	16
RTOR Reduction (vph)	0	0	0	0	36	36	0	0	0	0	2	0
Lane Group Flow (vph)	0	0	63	341	931	461	182	1381	0	0	821	0
Confl. Peds. (#/hr)	2					2	4		1	1		4
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	0%	0%	10%	2%	1%	7%	7%	6%	0%	0%	5%	0%
Turn Type			Over	pm+pt		Perm	Prot					
Protected Phases			5	3	8		5	2			6	
Permitted Phases				8		8						
Actuated Green, G (s)			8.0	25.0	25.0	25.0	8.0	53.0			42.0	
Effective Green, g (s)			7.0	27.0	27.0	27.0	7.0	55.0			44.0	
Actuated g/C Ratio			0.08	0.30	0.30	0.30	0.08	0.61			0.49	
Clearance Time (s)			3.0	6.0	6.0	6.0	3.0	6.0			6.0	
Vehicle Extension (s)			3.0	3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)			115	478	854	402	130	2058			1658	
v/s Ratio Prot			0.04	0.21	0.33		c0.11	c0.41			0.24	
v/s Ratio Perm						c0.34						
v/c Ratio			0.55	0.71	1.13dr	1.15	1.40	0.67			0.50	
Uniform Delay, d1			40.0	28.1	31.5	31.5	41.5	11.5			15.5	
Progression Factor			1.00	1.00	1.00	1.00	1.04	1.24			0.27	
Incremental Delay, d2			5.3	5.0	58.1	91.0	213.3	1.4			0.1	
Delay (s)			45.2	33.1	89.6	122.5	256.3	15.8			4.3	
Level of Service			D	C	F	F	F	B			A	
Approach Delay (s)	45.2				88.0			43.8			4.3	
Approach LOS	D				F			D			A	

Intersection Summary

HCM Average Control Delay	54.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	91.2%	ICU Level of Service	F
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	59	201	186	575	832	2025	51	1498
v/c Ratio	0.29	0.18	0.48	0.47	2.58	1.40	0.19	1.39
Control Delay	25.3	8.4	27.5	22.3	735.3	211.8	34.4	209.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	25.3	8.4	27.5	22.3	735.3	211.8	34.4	209.3
Queue Length 50th (m)	7.2	4.5	24.7	37.3	~252.4	~284.5	7.7	~181.8
Queue Length 95th (m)	17.2	11.4	43.8	51.1m	#291.6m	#302.5	17.7	#223.5
Internal Link Dist (m)		302.5		198.6		273.1		176.1
Turn Bay Length (m)	112.0		90.0		140.0		38.4	
Base Capacity (vph)	212	1143	396	1246	323	1442	289	1076
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.28	0.18	0.47	0.46	2.58	1.40	0.18	1.39

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.91		1.00	0.97		1.00	0.98		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1632	2900		1638	3333		1733	3352		1623	3232	
Flt Permitted	0.33	1.00		0.63	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	570	2900		1078	3333		1733	3352		1623	3232	
Volume (vph)	59	76	125	186	463	112	832	1744	281	51	1130	368
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	59	76	125	186	463	112	832	1744	281	51	1130	368
RTOR Reduction (vph)	0	80	0	0	24	0	0	12	0	0	35	0
Lane Group Flow (vph)	59	121	0	186	551	0	832	2013	0	51	1463	0
Confl. Peds. (#/hr)	9					9	2		6	6		2
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	9%	11%	12%	9%	2%	10%	3%	4%	4%	10%	7%	3%
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	30.2	30.2		30.2	30.2		17.8	36.2		9.6	28.0	
Effective Green, g (s)	32.2	32.2		32.2	32.2		16.8	37.2		8.6	29.0	
Actuated g/C Ratio	0.36	0.36		0.36	0.36		0.19	0.41		0.10	0.32	
Clearance Time (s)	6.0	6.0		6.0	6.0		3.0	5.0		3.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	204	1038		386	1192		323	1385		155	1041	
v/s Ratio Prot		0.04			0.17		c0.48	c0.60		0.03	0.45	
v/s Ratio Perm	0.10			c0.17								
v/c Ratio	0.29	0.12		0.48	0.46		2.58	1.45		0.33	1.41	
Uniform Delay, d1	20.7	19.4		22.4	22.2		36.6	26.4		38.0	30.5	
Progression Factor	1.00	1.00		1.00	1.00		1.16	1.16		1.00	1.00	
Incremental Delay, d2	0.8	0.1		1.0	0.3		715.4	206.8		1.2	188.1	
Delay (s)	21.5	19.4		23.4	22.5		757.7	237.5		39.3	218.6	
Level of Service	C	B		C	C		F	F		D	F	
Approach Delay (s)		19.9			22.7			389.0			212.7	
Approach LOS		B			C			F			F	

Intersection Summary

HCM Average Control Delay	269.6	HCM Level of Service	F
HCM Volume to Capacity ratio	1.27		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	152.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	125	203	34	86	779	111	978	17	472	1611
v/c Ratio	0.54	0.64	0.35	0.25	1.46	0.83	0.52	0.02	1.13	0.64
Control Delay	42.5	38.3	43.0	33.4	240.5	65.7	12.7	3.8	84.1	7.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	42.5	38.3	43.0	33.4	240.5	65.7	12.7	3.8	84.1	7.5
Queue Length 50th (m)	19.6	26.8	5.2	12.8	~142.4	14.5	49.6	0.0	~48.4	77.5
Queue Length 95th (m)	37.1	49.4	14.5	25.4	#210.4	#48.2	65.1	2.6	m#49.5	m68.1
Internal Link Dist (m)		321.8		300.5			425.0			629.8
Turn Bay Length (m)	72.3		82.2		74.5	184.0			182.5	
Base Capacity (vph)	239	322	100	355	534	133	1892	930	419	2518
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.52	0.63	0.34	0.24	1.46	0.83	0.52	0.02	1.13	0.64

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	0.94		1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00		0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.94		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1716	1552		1155	1879	1563	1575	3275	1597	1716	3460	
Flt Permitted	0.70	1.00		0.43	1.00	1.00	0.14	1.00	1.00	0.21	1.00	
Satd. Flow (perm)	1267	1552		520	1879	1563	234	3275	1597	385	3460	
Volume (vph)	125	119	84	34	86	779	111	978	17	472	1508	103
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	125	119	84	34	86	779	111	978	17	472	1508	103
RTOR Reduction (vph)	0	29	0	0	0	82	0	0	7	0	5	0
Lane Group Flow (vph)	125	174	0	34	86	697	111	978	10	472	1606	0
Confl. Peds. (#/hr)			69	69			31					31
Confl. Bikes (#/hr)						8						
Heavy Vehicles (%)	4%	6%	8%	42%	0%	1%	13%	9%	0%	4%	2%	0%
Turn Type	Perm			Perm		pm+ov	Perm			Perm	pm+pt	
Protected Phases		4			8	1		2			1	6
Permitted Phases	4			8		8	2		2	6		
Actuated Green, G (s)	14.6	14.6		14.6	14.6	26.0	50.0	50.0	50.0	63.4	63.4	
Effective Green, g (s)	16.6	16.6		16.6	16.6	26.0	52.0	52.0	52.0	65.4	65.4	
Actuated g/C Ratio	0.18	0.18		0.18	0.18	0.29	0.58	0.58	0.58	0.73	0.73	
Clearance Time (s)	6.0	6.0		6.0	6.0	2.0	6.0	6.0	6.0	2.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	234	286		96	347	521	135	1892	923	419	2514	
v/s Ratio Prot		0.11			0.05	c0.14		0.30		0.12	0.46	
v/s Ratio Perm	0.10			0.07		0.31	0.47		0.01	c0.70		
v/c Ratio	0.53	0.61		0.35	0.25	1.34	0.82	0.52	0.01	1.13	0.64	
Uniform Delay, d1	33.2	33.7		32.0	31.4	32.0	15.3	11.4	8.1	11.9	6.3	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.38	1.10	
Incremental Delay, d2	2.3	3.7		2.2	0.4	164.2	40.8	1.0	0.0	67.7	0.4	
Delay (s)	35.5	37.4		34.3	31.7	196.2	56.1	12.5	8.1	84.1	7.3	
Level of Service	D	D		C	C	F	E	B	A	F	A	
Approach Delay (s)		36.7			174.4			16.8			24.7	
Approach LOS		D			F			B			C	

Intersection Summary

HCM Average Control Delay	54.1	HCM Level of Service	D
HCM Volume to Capacity ratio	1.18		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	129.1%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT
Lane Group Flow (vph)	900	929	1222	935
v/c Ratio	0.94	1.67	0.57	0.44
Control Delay	49.4	333.8	12.8	1.4
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	49.4	333.8	12.8	1.4
Queue Length 50th (m)	77.9	~219.4	74.2	4.5
Queue Length 95th (m)	#114.2	#290.7	m61.4	m4.3
Internal Link Dist (m)	99.0		629.8	333.0
Turn Bay Length (m)				
Base Capacity (vph)	962	555	2136	2136
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.94	1.67	0.57	0.44

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	1.00		0.95	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	
Frt	1.00	0.85		1.00	1.00	
Flt Protected	0.95	1.00		1.00	1.00	
Satd. Flow (prot)	3330	1551		3433	3433	
Flt Permitted	0.95	1.00		1.00	1.00	
Satd. Flow (perm)	3330	1551		3433	3433	
Volume (vph)	900	929	0	1222	935	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	900	929	0	1222	935	0
RTOR Reduction (vph)	0	107	0	0	0	0
Lane Group Flow (vph)	900	822	0	1222	935	0
Confl. Peds. (#/hr)			2			
Heavy Vehicles (%)	4%	3%	0%	4%	4%	0%
Turn Type		Perm				
Protected Phases	4			2	6	
Permitted Phases		4				
Actuated Green, G (s)	25.0	25.0		55.0	55.0	
Effective Green, g (s)	26.0	26.0		56.0	56.0	
Actuated g/C Ratio	0.29	0.29		0.62	0.62	
Clearance Time (s)	5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	962	448		2136	2136	
v/s Ratio Prot	0.27			c0.36	0.27	
v/s Ratio Perm		c0.53				
v/c Ratio	0.94	1.83		0.57	0.44	
Uniform Delay, d1	31.2	32.0		10.0	8.8	
Progression Factor	1.00	1.00		1.21	0.15	
Incremental Delay, d2	15.7	383.9		0.4	0.1	
Delay (s)	46.8	415.9		12.5	1.4	
Level of Service	D	F		B	A	
Approach Delay (s)	234.3			12.5	1.4	
Approach LOS	F			B	A	

Intersection Summary

HCM Average Control Delay	111.7	HCM Level of Service	F
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	109.2%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBR	WBL	WBT	WBR	NBL	NBT	SBT
Lane Group Flow (vph)	298	81	198	129	249	1339	1397
v/c Ratio	0.89	0.17	0.24	0.30	0.67	0.62	1.09
Control Delay	63.7	25.2	18.3	16.9	46.1	15.1	81.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	63.7	25.2	18.3	16.9	46.1	15.1	81.8
Queue Length 50th (m)	50.1	11.5	10.7	10.5	44.9	69.6	~146.1
Queue Length 95th (m)	#93.9	23.5	20.0	25.9	m60.0	m80.2	#187.2
Internal Link Dist (m)			61.0			333.0	273.1
Turn Bay Length (m)					83.0		
Base Capacity (vph)	339	487	861	447	373	2157	1283
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.88	0.17	0.23	0.29	0.67	0.62	1.09

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.0	4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor			1.00	0.91	0.86	0.91	1.00	0.95			0.95	
Frpb, ped/bikes			1.00	1.00	0.99	0.98	1.00	1.00			1.00	
Flpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	
Frt			0.86	1.00	0.90	0.85	1.00	1.00			0.99	
Flt Protected			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)			1625	1624	2741	1361	1785	3466			3445	
Flt Permitted			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (perm)			1625	1624	2741	1361	1785	3466			3445	
Volume (vph)	0	0	298	81	70	257	249	1339	0	0	1337	60
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	298	81	70	257	249	1339	0	0	1337	60
RTOR Reduction (vph)	0	0	0	0	39	39	0	0	0	0	4	0
Lane Group Flow (vph)	0	0	298	81	159	90	249	1339	0	0	1393	0
Confl. Peds. (#/hr)	4					4	8		11	11		8
Confl. Bikes (#/hr)									5			
Heavy Vehicles (%)	0%	0%	0%	0%	6%	5%	0%	3%	0%	0%	3%	0%
Turn Type			Over	pm+pt		Perm	Prot					
Protected Phases			5	3	8		5	2			6	
Permitted Phases				8		8						
Actuated Green, G (s)			19.6	24.0	24.0	24.0	19.6	54.0			31.4	
Effective Green, g (s)			18.6	26.0	26.0	26.0	18.6	56.0			33.4	
Actuated g/C Ratio			0.21	0.29	0.29	0.29	0.21	0.62			0.37	
Clearance Time (s)			3.0	6.0	6.0	6.0	3.0	6.0			6.0	
Vehicle Extension (s)			3.0	3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)			336	469	792	393	369	2157			1278	
v/s Ratio Prot			c0.18	0.05	0.06		0.14	0.39			c0.40	
v/s Ratio Perm						c0.07						
v/c Ratio			0.89	0.17	0.20	0.23	0.67	0.62			1.09	
Uniform Delay, d1			34.7	24.0	24.2	24.4	32.9	10.5			28.3	
Progression Factor			1.00	1.00	1.00	1.00	1.18	1.32			1.00	
Incremental Delay, d2			23.3	0.2	0.1	0.3	3.3	0.9			53.5	
Delay (s)			58.0	24.1	24.3	24.7	42.2	14.8			81.8	
Level of Service			E	C	C	C	D	B			F	
Approach Delay (s)	58.0				24.4			19.1			81.8	
Approach LOS	E				C			B			F	

Intersection Summary

HCM Average Control Delay	46.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	87.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	402	1252	314	204	161	1471	120	1899
v/c Ratio	0.99	1.14dr	1.57	0.14	0.90	1.41	0.73	1.83
Control Delay	75.2	50.7	300.2	7.4	89.3	219.9	67.5	400.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	75.2	50.7	300.2	7.4	89.3	219.9	67.5	400.9
Queue Length 50th (m)	72.4	100.1	~68.1	5.1	29.7	~193.7	21.7	~282.4
Queue Length 95th (m)	#131.5	#149.2	#119.1	11.2	#65.6	#235.4	#47.7	#325.2
Internal Link Dist (m)		302.5		198.6		273.1		176.1
Turn Bay Length (m)	112.0		90.0		140.0		38.4	
Base Capacity (vph)	406	1254	200	1444	179	1042	168	1039
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.99	1.00	1.57	0.14	0.90	1.41	0.71	1.83

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.90		1.00	0.92		1.00	0.98		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1780	3121		1700	2996		1700	3350		1594	3389	
Flt Permitted	0.62	1.00		0.11	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1168	3121		193	2996		1700	3350		1594	3389	
Volume (vph)	402	456	796	314	99	105	161	1289	182	120	1807	92
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	402	456	796	314	99	105	161	1289	182	120	1807	92
RTOR Reduction (vph)	0	170	0	0	56	0	0	12	0	0	4	0
Lane Group Flow (vph)	402	1082	0	314	148	0	161	1459	0	120	1895	0
Confl. Peds. (#/hr)	4		11	11		4	5		20	20		5
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	0%	2%	2%	5%	8%	10%	5%	4%	5%	12%	4%	14%
Turn Type	Perm			pm+pt			Prot			Prot		
Protected Phases		4		3	8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	31.0	31.0		42.0	42.0		11.0	28.2		10.8	28.0	
Effective Green, g (s)	33.0	33.0		44.0	44.0		10.0	29.2		9.8	29.0	
Actuated g/C Ratio	0.35	0.35		0.46	0.46		0.11	0.31		0.10	0.31	
Clearance Time (s)	6.0	6.0		3.0	6.0		3.0	5.0		3.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	406	1084		200	1388		179	1030		164	1035	
v/s Ratio Prot		0.35		c0.12	0.05		c0.09	0.44		0.08	c0.56	
v/s Ratio Perm	0.34			c0.61								
v/c Ratio	0.99	1.14dr		1.57	0.11		0.90	1.42		0.73	1.83	
Uniform Delay, d1	30.8	31.0		23.2	14.4		42.0	32.9		41.3	33.0	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	41.9	26.7		279.3	0.0		39.5	193.3		15.4	377.6	
Delay (s)	72.8	57.7		302.5	14.4		81.6	226.2		56.8	410.6	
Level of Service	E	E		F	B		F	F		E	F	
Approach Delay (s)		61.4			189.1			211.9			389.6	
Approach LOS		E			F			F			F	

Intersection Summary

HCM Average Control Delay	228.7	HCM Level of Service	F
HCM Volume to Capacity ratio	1.55		
Actuated Cycle Length (s)	95.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	134.3%	ICU Level of Service	H
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

APPENDIX E

2028 10-YEAR HORIZON CAPACITY ANALYSIS (MITIGATED)

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	128	320	36	295	477	120	901	78	499	1275
v/c Ratio	0.93	0.84	0.45	0.69	0.56	0.89	0.73	0.14	0.90	0.57
Control Delay	98.5	50.4	49.1	40.7	15.4	84.2	28.9	5.4	43.3	10.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	98.5	50.4	49.1	40.7	15.4	84.2	28.9	5.4	43.3	10.4
Queue Length 50th (m)	21.7	48.3	5.3	46.4	46.6	19.2	69.7	0.0	62.7	48.5
Queue Length 95th (m)	#55.2	#92.1	#17.3	73.9	74.5	#52.2	91.6	8.5m	#110.0	62.6
Internal Link Dist (m)		321.8		300.5			425.0			629.8
Turn Bay Length (m)	72.3		82.2		174.5	184.0			182.5	
Base Capacity (vph)	138	384	81	429	853	135	1235	574	552	2221
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.93	0.83	0.44	0.69	0.56	0.89	0.73	0.14	0.90	0.57

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	0.89		1.00	1.00	1.00	1.00	1.00	0.96	1.00	0.99	
Flpb, ped/bikes	1.00	1.00		0.86	1.00	1.00	0.99	1.00	1.00	1.00	1.00	
Frt	1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1608	1486		1082	1756	1536	1603	3368	1432	1732	3309	
Flt Permitted	0.33	1.00		0.29	1.00	1.00	0.22	1.00	1.00	0.14	1.00	
Satd. Flow (perm)	560	1486		327	1756	1536	367	3368	1432	259	3309	
Volume (vph)	128	209	111	36	295	477	120	901	78	499	1163	112
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	128	209	111	36	295	477	120	901	78	499	1163	112
RTOR Reduction (vph)	0	21	0	0	0	18	0	0	49	0	8	0
Lane Group Flow (vph)	128	299	0	36	295	459	120	901	29	499	1267	0
Confl. Peds. (#/hr)			219	219			43		12	12		43
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	11%	6%	9%	42%	7%	4%	10%	6%	7%	3%	5%	12%
Turn Type	Perm			Perm		pm+ov	Perm		Perm	pm+pt		
Protected Phases		4			8	1		2		1	6	
Permitted Phases	4			8		8	2		2	6		
Actuated Green, G (s)	19.8	19.8		19.8	19.8	45.0	31.0	31.0	31.0	58.2	58.2	
Effective Green, g (s)	21.8	21.8		21.8	21.8	45.0	33.0	33.0	33.0	60.2	60.2	
Actuated g/C Ratio	0.24	0.24		0.24	0.24	0.50	0.37	0.37	0.37	0.67	0.67	
Clearance Time (s)	6.0	6.0		6.0	6.0	2.0	6.0	6.0	6.0	2.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	136	360		79	425	836	135	1235	525	553	2213	
v/s Ratio Prot		0.20			0.17	0.14		0.27		c0.23	0.38	
v/s Ratio Perm	c0.23			0.11		0.16	0.33		0.02	c0.37		
v/c Ratio	0.94	0.83		0.46	0.69	0.55	0.89	0.73	0.05	0.90	0.57	
Uniform Delay, d1	33.5	32.3		29.0	31.1	15.5	26.8	24.6	18.4	21.8	8.0	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.31	1.19	
Incremental Delay, d2	59.2	14.6		4.1	4.9	0.7	52.2	3.8	0.2	14.0	0.8	
Delay (s)	92.6	46.9		33.2	35.9	16.2	79.0	28.5	18.6	42.6	10.3	
Level of Service	F	D		C	D	B	E	C	B	D	B	
Approach Delay (s)		60.0			24.2			33.3			19.4	
Approach LOS		E			C			C			B	

Intersection Summary

HCM Average Control Delay	28.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	120.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT
Lane Group Flow (vph)	510	820	1140	1105
v/c Ratio	0.48	0.84	0.57	0.55
Control Delay	25.8	31.6	10.3	26.2
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	25.8	31.6	10.3	26.2
Queue Length 50th (m)	35.6	60.9	72.6	99.3
Queue Length 95th (m)	49.7	#89.3	m88.2	119.4
Internal Link Dist (m)	99.0		629.8	333.0
Turn Bay Length (m)				
Base Capacity (vph)	1079	993	1999	1999
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.47	0.83	0.57	0.55

Intersection Summary

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	0.88		0.95	0.95	
Frt	1.00	0.85		1.00	1.00	
Flt Protected	0.95	1.00		1.00	1.00	
Satd. Flow (prot)	3236	2677		3433	3433	
Flt Permitted	0.95	1.00		1.00	1.00	
Satd. Flow (perm)	3236	2677		3433	3433	
Volume (vph)	510	820	0	1140	1105	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	510	820	0	1140	1105	0
RTOR Reduction (vph)	0	101	0	0	0	0
Lane Group Flow (vph)	510	719	0	1140	1105	0
Heavy Vehicles (%)	7%	5%	0%	4%	4%	0%
Turn Type		Perm				
Protected Phases	4			2	6	
Permitted Phases		4				
Actuated Green, G (s)	28.6	28.6		51.4	51.4	
Effective Green, g (s)	29.6	29.6		52.4	52.4	
Actuated g/C Ratio	0.33	0.33		0.58	0.58	
Clearance Time (s)	5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	1064	880		1999	1999	
v/s Ratio Prot	0.16			c0.33	0.32	
v/s Ratio Perm		c0.27				
v/c Ratio	0.48	0.82		0.57	0.55	
Uniform Delay, d1	24.1	27.7		11.8	11.6	
Progression Factor	1.00	1.00		0.78	2.14	
Incremental Delay, d2	0.3	5.9		0.8	0.8	
Delay (s)	24.4	33.6		10.0	25.6	
Level of Service	C	C		B	C	
Approach Delay (s)	30.1			10.0	25.6	
Approach LOS	C			B	C	

Intersection Summary

HCM Average Control Delay	22.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	77.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBR	WBL	WBT	WBR	NBL	NBT	SBT
Lane Group Flow (vph)	63	341	967	497	182	1381	823
v/c Ratio	0.32	0.52	0.88dr	0.88	0.83	0.82	0.74
Control Delay	40.5	23.6	30.0	42.9	75.5	16.6	31.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	40.5	23.6	30.0	42.9	75.5	16.6	31.9
Queue Length 50th (m)	10.0	47.3	81.9	81.2	33.9	61.2	66.2
Queue Length 95th (m)	21.8	74.9	110.4	#146.4	#67.6	73.7	87.5
Internal Link Dist (m)			61.0			333.0	273.1
Turn Bay Length (m)					83.0		
Base Capacity (vph)	197	654	1185	566	222	1691	1109
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.32	0.52	0.82	0.88	0.82	0.82	0.74

Intersection Summary

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.0	4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor			1.00	0.91	0.86	0.91	1.00	0.95			0.95	
Frpb, ped/bikes			1.00	1.00	0.99	0.99	1.00	1.00			1.00	
Flpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	
Frt			0.86	1.00	0.92	0.85	1.00	1.00			1.00	
Flt Protected			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)			1477	1592	2846	1340	1668	3368			3392	
Flt Permitted			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (perm)			1477	1592	2846	1340	1668	3368			3392	
Volume (vph)	0	0	63	341	471	993	182	1381	0	0	807	16
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	63	341	471	993	182	1381	0	0	807	16
RTOR Reduction (vph)	0	0	0	0	15	15	0	0	0	0	1	0
Lane Group Flow (vph)	0	0	63	341	952	482	182	1381	0	0	822	0
Confl. Peds. (#/hr)	2					2	4		1	1		4
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	0%	0%	10%	2%	1%	7%	7%	6%	0%	0%	5%	0%
Turn Type			Over	pm+pt		Perm	Prot					
Protected Phases			5	3	8		5	2			6	
Permitted Phases				8		8						
Actuated Green, G (s)			12.8	34.8	34.8	34.8	12.8	43.2			27.4	
Effective Green, g (s)			11.8	36.8	36.8	36.8	11.8	45.2			29.4	
Actuated g/C Ratio			0.13	0.41	0.41	0.41	0.13	0.50			0.33	
Clearance Time (s)			3.0	6.0	6.0	6.0	3.0	6.0			6.0	
Vehicle Extension (s)			3.0	3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)			194	651	1164	548	219	1691			1108	
v/s Ratio Prot			0.04	0.21	0.33		0.11	c0.41			0.24	
v/s Ratio Perm						c0.36						
v/c Ratio			0.32	0.52	0.88dr	0.88	0.83	0.82			0.74	
Uniform Delay, d1			35.5	20.0	23.6	24.5	38.1	18.9			26.9	
Progression Factor			1.00	1.00	1.00	1.00	1.27	0.66			1.00	
Incremental Delay, d2			1.0	0.8	4.6	14.8	19.8	3.8			4.5	
Delay (s)			36.5	20.8	28.2	39.4	68.4	16.3			31.4	
Level of Service			D	C	C	D	E	B			C	
Approach Delay (s)	36.5				29.9			22.3			31.4	
Approach LOS	D				C			C			C	

Intersection Summary

HCM Average Control Delay	27.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	86.1%	ICU Level of Service	E
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	59	201	186	575	832	2025	51	1498
v/c Ratio	0.69	0.27	0.78	0.74	1.54	0.86	0.12	1.16dr
Control Delay	76.8	13.7	60.4	40.5	279.9	31.4	26.5	25.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	76.8	13.7	60.4	40.5	279.9	31.4	26.5	25.3
Queue Length 50th (m)	10.5	6.1	34.0	52.1	~228.5	~173.3	8.3	43.9
Queue Length 95th (m)	#32.1	15.3	#68.7	70.8	#298.7	#203.2	18.6	53.6
Internal Link Dist (m)		302.5		198.6		273.1		176.1
Turn Bay Length (m)	152.0		130.0		200.0		48.4	
Base Capacity (vph)	86	763	239	787	541	2367	433	1701
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.69	0.26	0.78	0.73	1.54	0.86	0.12	0.88

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.91		0.86	0.86	
Frpb, ped/bikes	1.00	1.00		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.91		1.00	0.97		1.00	0.98		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1630	2900		1638	3330		1733	4817		1396	4389	
Flt Permitted	0.21	1.00		0.60	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	367	2900		1039	3330		1733	4817		1396	4389	
Volume (vph)	59	76	125	186	463	112	832	1744	281	51	1130	368
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	59	76	125	186	463	112	832	1744	281	51	1130	368
RTOR Reduction (vph)	0	97	0	0	21	0	0	17	0	0	32	0
Lane Group Flow (vph)	59	105	0	186	554	0	832	2008	0	51	1466	0
Confl. Peds. (#/hr)	9					9	2		6	6		2
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	9%	11%	12%	9%	2%	10%	3%	4%	4%	10%	7%	3%
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	20.8	20.8		20.8	20.8		32.2	46.6		18.6	51.6	
Effective Green, g (s)	22.8	22.8		22.8	22.8		31.2	47.6		17.6	51.6	
Actuated g/C Ratio	0.23	0.23		0.23	0.23		0.31	0.48		0.18	0.52	
Clearance Time (s)	6.0	6.0		6.0	6.0		3.0	5.0		3.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	84	661		237	759		541	2293		246	2265	
v/s Ratio Prot		0.04			0.17		c0.48	c0.42		0.04	0.11	
v/s Ratio Perm	0.16			c0.18							0.22	
v/c Ratio	0.70	0.16		0.78	0.73		1.54	0.88		0.21	1.16dr	
Uniform Delay, d1	35.5	30.9		36.3	35.8		34.4	23.5		35.2	17.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	23.3	0.1		15.6	3.6		251.2	5.1		0.4	0.6	
Delay (s)	58.7	31.0		51.9	39.4		285.6	28.6		35.7	18.2	
Level of Service	E	C		D	D		F	C		D	B	
Approach Delay (s)		37.3			42.4			103.5			18.8	
Approach LOS		D			D			F			B	

Intersection Summary

HCM Average Control Delay	67.6	HCM Level of Service	E
HCM Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	119.4%	ICU Level of Service	H
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	125	203	34	86	779	111	978	17	472	1611
v/c Ratio	0.54	0.64	0.35	0.25	1.24	0.33	0.60	0.02	0.94	0.83
Control Delay	42.5	38.3	43.0	33.4	147.7	11.3	18.0	5.4	38.2	23.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	42.5	38.3	43.0	33.4	147.7	11.3	18.0	5.4	38.2	23.7
Queue Length 50th (m)	19.6	26.8	5.2	12.8	~107.4	4.8	60.4	0.0	45.7	118.1
Queue Length 95th (m)	37.1	49.4	14.5	25.4	#175.5	17.1	79.3	3.1m	#90.0	#178.2
Internal Link Dist (m)		321.8		300.5			425.0			629.8
Turn Bay Length (m)	72.3		82.2		174.5	184.0			182.5	
Base Capacity (vph)	239	322	100	355	626	355	1638	807	503	1934
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.52	0.63	0.34	0.24	1.24	0.31	0.60	0.02	0.94	0.83

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	0.94		1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00		0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.94		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1716	1552		1155	1879	1568	1579	3275	1597	1716	3459	
Flt Permitted	0.70	1.00		0.43	1.00	1.00	0.09	1.00	1.00	0.19	1.00	
Satd. Flow (perm)	1267	1552		520	1879	1568	148	3275	1597	335	3459	
Volume (vph)	125	119	84	34	86	779	111	978	17	472	1508	103
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	125	119	84	34	86	779	111	978	17	472	1508	103
RTOR Reduction (vph)	0	29	0	0	0	51	0	0	9	0	5	0
Lane Group Flow (vph)	125	174	0	34	86	728	111	978	9	472	1606	0
Confl. Peds. (#/hr)			69	69			31					31
Confl. Bikes (#/hr)						8						
Heavy Vehicles (%)	4%	6%	8%	42%	0%	1%	13%	9%	0%	4%	2%	0%
Turn Type	Perm			Perm		pm+ov	pm+pt		Perm	pm+pt		
Protected Phases		4			8	1	5	2		1	6	
Permitted Phases	4			8		8	2		2	6		
Actuated Green, G (s)	14.6	14.6		14.6	14.6	32.0	55.8	43.0	43.0	63.4	47.6	
Effective Green, g (s)	16.6	16.6		16.6	16.6	33.0	56.8	45.0	45.0	65.4	49.6	
Actuated g/C Ratio	0.18	0.18		0.18	0.18	0.37	0.63	0.50	0.50	0.73	0.55	
Clearance Time (s)	6.0	6.0		6.0	6.0	3.0	3.0	6.0	6.0	3.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	234	286		96	347	645	281	1638	799	495	1906	
v/s Ratio Prot		0.11			0.05	c0.21	0.05	0.30		0.17	0.46	
v/s Ratio Perm	0.10			0.07		0.26	0.20		0.01	c0.52		
v/c Ratio	0.53	0.61		0.35	0.25	1.13	0.40	0.60	0.01	0.95	0.84	
Uniform Delay, d1	33.2	33.7		32.0	31.4	28.5	12.5	16.0	11.3	17.8	16.9	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	0.81	1.08	
Incremental Delay, d2	2.3	3.7		2.2	0.4	76.3	0.9	1.6	0.0	25.1	3.8	
Delay (s)	35.5	37.4		34.3	31.7	104.8	13.4	17.7	11.3	39.5	22.2	
Level of Service	D	D		C	C	F	B	B	B	D	C	
Approach Delay (s)		36.7			95.1			17.1			26.1	
Approach LOS		D			F			B			C	

Intersection Summary

HCM Average Control Delay	38.7	HCM Level of Service	D
HCM Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	104.9%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT
Lane Group Flow (vph)	900	929	1222	935
v/c Ratio	0.79	0.86	0.63	0.48
Control Delay	32.7	30.8	15.4	4.7
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	32.7	30.8	15.4	4.7
Queue Length 50th (m)	71.1	66.2	79.3	12.8
Queue Length 95th (m)	93.6	#104.5	m71.8	m12.4
Internal Link Dist (m)	99.0		629.8	333.0
Turn Bay Length (m)				
Base Capacity (vph)	1147	1082	1953	1953
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.78	0.86	0.63	0.48

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	0.88		0.95	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	
Frt	1.00	0.85		1.00	1.00	
Flt Protected	0.95	1.00		1.00	1.00	
Satd. Flow (prot)	3330	2729		3433	3433	
Flt Permitted	0.95	1.00		1.00	1.00	
Satd. Flow (perm)	3330	2729		3433	3433	
Volume (vph)	900	929	0	1222	935	0
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	900	929	0	1222	935	0
RTOR Reduction (vph)	0	143	0	0	0	0
Lane Group Flow (vph)	900	786	0	1222	935	0
Confl. Peds. (#/hr)			2			
Heavy Vehicles (%)	4%	3%	0%	4%	4%	0%
Turn Type		Perm				
Protected Phases	4			2	6	
Permitted Phases		4				
Actuated Green, G (s)	29.8	29.8		50.2	50.2	
Effective Green, g (s)	30.8	30.8		51.2	51.2	
Actuated g/C Ratio	0.34	0.34		0.57	0.57	
Clearance Time (s)	5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	1140	934		1953	1953	
v/s Ratio Prot	0.27			c0.36	0.27	
v/s Ratio Perm		c0.29				
v/c Ratio	0.79	0.84		0.63	0.48	
Uniform Delay, d1	26.7	27.3		13.0	11.5	
Progression Factor	1.00	1.00		1.10	0.39	
Incremental Delay, d2	3.7	7.0		0.7	0.1	
Delay (s)	30.4	34.3		15.0	4.6	
Level of Service	C	C		B	A	
Approach Delay (s)	32.4			15.0	4.6	
Approach LOS	C			B	A	

Intersection Summary

HCM Average Control Delay	20.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	80.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBR	WBL	WBT	WBR	NBL	NBT	SBT
Lane Group Flow (vph)	298	81	198	129	249	1339	1397
v/c Ratio	0.89	0.17	0.24	0.30	0.67	0.62	1.09
Control Delay	63.7	25.2	18.3	16.9	48.0	15.7	81.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	63.7	25.2	18.3	16.9	48.0	15.7	81.8
Queue Length 50th (m)	50.1	11.5	10.7	10.5	45.8	73.3	~146.1
Queue Length 95th (m)	#93.9	23.5	20.0	25.9	m65.3	86.4	#187.2
Internal Link Dist (m)			61.0			333.0	273.1
Turn Bay Length (m)					83.0		
Base Capacity (vph)	339	487	861	447	373	2157	1283
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.88	0.17	0.23	0.29	0.67	0.62	1.09

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.0	4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor			1.00	0.91	0.86	0.91	1.00	0.95			0.95	
Frpb, ped/bikes			1.00	1.00	0.99	0.98	1.00	1.00			1.00	
Flpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	
Frt			0.86	1.00	0.90	0.85	1.00	1.00			0.99	
Flt Protected			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)			1625	1624	2741	1361	1785	3466			3445	
Flt Permitted			1.00	0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (perm)			1625	1624	2741	1361	1785	3466			3445	
Volume (vph)	0	0	298	81	70	257	249	1339	0	0	1337	60
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	298	81	70	257	249	1339	0	0	1337	60
RTOR Reduction (vph)	0	0	0	0	39	39	0	0	0	0	4	0
Lane Group Flow (vph)	0	0	298	81	159	90	249	1339	0	0	1393	0
Confl. Peds. (#/hr)	4					4	8		11	11		8
Confl. Bikes (#/hr)									5			
Heavy Vehicles (%)	0%	0%	0%	0%	6%	5%	0%	3%	0%	0%	3%	0%
Turn Type			Over	pm+pt		Perm	Prot					
Protected Phases			5	3	8		5	2			6	
Permitted Phases				8		8						
Actuated Green, G (s)			19.6	24.0	24.0	24.0	19.6	54.0			31.4	
Effective Green, g (s)			18.6	26.0	26.0	26.0	18.6	56.0			33.4	
Actuated g/C Ratio			0.21	0.29	0.29	0.29	0.21	0.62			0.37	
Clearance Time (s)			3.0	6.0	6.0	6.0	3.0	6.0			6.0	
Vehicle Extension (s)			3.0	3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)			336	469	792	393	369	2157			1278	
v/s Ratio Prot			c0.18	0.05	0.06		0.14	0.39			c0.40	
v/s Ratio Perm						c0.07						
v/c Ratio			0.89	0.17	0.20	0.23	0.67	0.62			1.09	
Uniform Delay, d1			34.7	24.0	24.2	24.4	32.9	10.5			28.3	
Progression Factor			1.00	1.00	1.00	1.00	1.23	1.38			1.00	
Incremental Delay, d2			23.3	0.2	0.1	0.3	3.4	1.0			53.5	
Delay (s)			58.0	24.1	24.3	24.7	43.9	15.4			81.8	
Level of Service			E	C	C	C	D	B			F	
Approach Delay (s)	58.0				24.4			19.9			81.8	
Approach LOS	E				C			B			F	

Intersection Summary

HCM Average Control Delay	46.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	87.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	402	1252	314	204	161	1471	120	1899
v/c Ratio	1.00	1.08dr	1.26	0.13	0.72	1.12	0.58	1.45
Control Delay	80.8	46.0	170.9	7.6	64.1	102.0	56.8	239.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	80.8	46.0	170.9	7.6	64.1	102.0	56.8	239.8
Queue Length 50th (m)	85.4	110.4	~70.0	5.6	33.5	~131.3	24.7	~206.8
Queue Length 95th (m)	#147.8	#159.3	#124.3	11.8	#60.9	#164.7	43.2	#237.1
Internal Link Dist (m)		302.5		198.6		273.1		176.1
Turn Bay Length (m)	152.0		130.0		200.0		48.4	
Base Capacity (vph)	404	1289	250	1525	232	1313	217	1307
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.00	0.97	1.26	0.13	0.69	1.12	0.55	1.45

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.91		1.00	0.91	
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.90		1.00	0.92		1.00	0.98		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1780	3121		1700	2996		1700	4811		1594	4869	
Flt Permitted	0.62	1.00		0.10	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1169	3121		170	2996		1700	4811		1594	4869	
Volume (vph)	402	456	796	314	99	105	161	1289	182	120	1807	92
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	402	456	796	314	99	105	161	1289	182	120	1807	92
RTOR Reduction (vph)	0	210	0	0	53	0	0	17	0	0	5	0
Lane Group Flow (vph)	402	1042	0	314	151	0	161	1454	0	120	1894	0
Confl. Peds. (#/hr)	4		11	11		4	5		20	20		5
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	0%	2%	2%	5%	8%	10%	5%	4%	5%	12%	4%	14%
Turn Type	Perm			pm+pt			Prot			Prot		
Protected Phases		4		3	8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	36.0	36.0		52.0	52.0		15.6	28.7		15.3	28.4	
Effective Green, g (s)	38.0	38.0		54.0	54.0		14.6	29.7		14.3	29.4	
Actuated g/C Ratio	0.35	0.35		0.49	0.49		0.13	0.27		0.13	0.27	
Clearance Time (s)	6.0	6.0		3.0	6.0		3.0	5.0		3.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	404	1078		250	1471		226	1299		207	1301	
v/s Ratio Prot		0.33		c0.14	0.05		c0.09	0.30		0.08	c0.39	
v/s Ratio Perm	0.34			c0.48								
v/c Ratio	1.00	1.08dr		1.26	0.10		0.71	1.12		0.58	1.46	
Uniform Delay, d1	35.9	35.4		32.8	15.0		45.7	40.1		45.0	40.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	43.2	19.6		143.5	0.0		10.1	64.6		3.9	209.4	
Delay (s)	79.1	55.0		176.3	15.0		55.8	104.7		48.9	249.7	
Level of Service	E	D		F	B		E	F		D	F	
Approach Delay (s)		60.8			112.8			99.9			237.8	
Approach LOS		E			F			F			F	

Intersection Summary

HCM Average Control Delay	137.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.22		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	129.5%	ICU Level of Service	H
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group