

Winslow Drive Commercial Development

Halifax Regional Municipality

Traffic Impact Study Final Report

Prepared by:

GRIFFIN transportation group inc.

30 Bonny View Drive

Fall River, NS

B2T 1R2

www.griffininc.ca

Prepared for:

RAMAR
HOMES

June 2020

June 17, 2020

Mr. Chris Marchand, P.Eng.
Director of Development
Ramar Construction Ltd.
66 Temple Terrace
Lower Sackville, NS B4C 0A7

Dear Mr. Marchand:

RE: A Traffic Impact Assessment of the proposed Winslow Drive Commercial Development

The GRIFFIN transportation group inc. is pleased to present the results of the enclosed traffic impact study carried out in support of the planning approval process for a proposed commercial development located in two corners of the Hammonds Plains Road / Winslow Drive intersection, in the community of Upper Tantallon, Halifax Regional Municipality (HRM). It is understood that a total of 22,600 ft² of commercial space is being proposed within three separate low-rise buildings. One building will be located in the northeast quadrant of the subject intersection and two buildings will be located in the northwest quadrant. One vehicle access is proposed to serve each of the two sites, both connecting to Winslow Drive.

The results flowing from this study have identified that the site-generated traffic volumes will have an acceptable level of impact on the study area streets and intersections. Although new traffic associated with this development will be added to the study area streets and intersections, changes to the existing volumes on Hammond Plains Road and Winslow Drive can be accommodated within the capacity provided by the existing lane configurations and traffic control, beyond the 2027 planning horizon.

It has been a pleasure working with the project team in completing this study. Feel free to contact the undersigned anytime to further discuss the details of this project.

Yours truly,

Original Signed

James J. Copeland, P.Eng.
Managing Principal
GRIFFIN transportation group inc.



© GRIFFIN transportation group inc.

This document and the information contained within has been prepared exclusively for the Client identified on the cover of this report for the purpose for which it has been prepared. The GRIFFIN transportation group inc. undertakes no duty to or accepts any responsibility to any third party who may rely upon this document.

This document may not be used for any purpose other than that provided in the contract between the Owner/Client and the Engineer nor may any section or element of this document be removed, reproduced, electronically stored or transmitted in any form without the express written consent of the GRIFFIN transportation group inc.

TABLE OF CONTENTS

TABLE OF CONTENTS	II
LIST OF FIGURES	III
LIST OF TABLES	III
1. INTRODUCTION	1
1.1 Overview	1
1.2 Study Context and Scope	1
2. EXISTING CONDITIONS	3
2.1 The Roadway Network	3
2.1.1 Overview	3
2.1.2 Hammonds Plains Road	3
2.1.3 Winslow Drive	3
2.1.4 Other Study Area Streets	5
2.2 Traffic Data	5
2.3 Existing Conditions Operational Analysis	5
3. THE PROPOSED DEVELOPMENT	7
3.1 Overview	7
3.2 Transportation Land Use Type	7
3.3 Site Trip Generation	9
3.3.1 Overview	9
3.3.2 Effect of Cross-Shopping	10
3.3.3 Pass-by Trips	10
3.4 Trip Distribution and Assignment	10
3.5 New Vehicle Access Locations	12
3.5.1 Corner Clearance	12
3.5.2 Driver Sight Distance	12
4. FUTURE CONDITIONS	14
4.1 Overview	14

4.2	Traffic Volume Forecasting Process	14
4.2.1	Overview	14
4.2.2	Future Background Traffic Volumes	15
4.2.3	Future Total Traffic Volumes	16
4.3	Future 2027 Operational Analysis	17
4.3.1	Traffic Signal Warrant Review	17
4.3.2	Auxiliary Turning Lane Review	18
4.3.3	Future 2027 Intersection Capacity Analysis	18
5.	CONCLUSIONS AND RECOMMENDATIONS	21
5.1	Conclusions	21
5.2	Recommendations	22

LIST OF FIGURES

Figure 1: Key Map and Site Location	2
Figure 2: Existing Roadway Characteristics	4
Figure 3: Existing 2020 Peak Hour Volumes	6
Figure 4: Proposed Site Layout	8
Figure 5: Site-generated Peak Hour Volumes	11
Figure 6: Future Background 2027 Peak Hour Traffic Volumes	16
Figure 7: Future Total 2027 Peak Hour Traffic Volumes	17
Figure 8: Future Lane Configuration Requirements	20

LIST OF TABLES

Table 1: Existing Operational Analysis Results	6
Table 2: ITE Trip Rate Comparison (22,600 ft ²)	9
Table 3: Forecast Site Trip Generation – AM & PM Peak Hours	9
Table 4: Forecast Commercial Trip Distribution	10
Table 5: Summary of Stopping Sight Distances (SSD) at the New Access Locations	13
Table 6: Planning Horizons and Access Options	14
Table 7: Future Year Traffic Factors	15
Table 8: TAC Signal Warrant Results at the Hammonds Plains Road / Winslow Drive Intersection	17
Table 9: Summary of Auxiliary Turn Lane Assessment	18
Table 10: Future 2027 Operational Analysis Results	19

1. INTRODUCTION

1.1 Overview

At the request of *Ramar Construction Ltd. (Ramar)*, the GRIFFIN transportation group inc. has completed a traffic impact study in support of the planning approval process for the proposed Winslow Drive commercial development, located in the northeast and northwest quadrants of the Hammonds Plains Road / Winslow Drive intersection, in the community of Upper Tantallon, Halifax Regional Municipality (HRM). It is understood that up to 22,600 ft² (2,100 m²) of commercial space is proposed to be built within three separate low-rise buildings. A key map of the proposed site location is shown in *Figure 1*.

The subject lands (PID's 41249681, 41277773, and 41277765) are currently undeveloped and zoned R-1 (low density, single unit residential). They are located within the Beaver Bank, Hammonds Plains, and Upper Sackville Land Use By-Law area and outside the urban serviced area of Halifax Water. As such, the proponent will be seeking a rezoning of the subject lands and this traffic impact study will form part of the documentation accompanying that application.

Since the development will be split across two of the quadrants of the Hammonds Plains Road / Winslow Drive intersection, the development will be served by two separate vehicular access points. Following good access management practices, both of the proposed accesses will connect to the lower classification roadway fronting the subject properties – Winslow Drive. As such, the traffic operational assessment contained within this report will focus on the impacts to Hammonds Plains Road and Winslow Drive.

1.2 Study Context and Scope

Hammonds Plains Road is under the jurisdiction of the Halifax Regional Municipality (HRM) and this impact study attempts to follow their policy and guidelines. In order to initiate this study, GRIFFIN held a teleconference meeting with representatives of HRM's Planning and Traffic Management Departments on Thursday March 26th to identify the general TIS assumptions, intersections to be evaluated and other relevant assumptions to consider in the traffic assessment process. GRIFFIN has made every attempt to follow the scope parameters discussed in this meeting. Additional terms of reference applied to the study include the following:

- The HRM's *Guidelines for the Preparation of Transportation Impact Studies*;
- A conceptual site plan drawing provided by *Ramar* dated February 18th, 2020;
- A teleconference meeting with representatives of HRM's Traffic Management and Planning departments on March 26th, 2020 to establish the general scope of the TIS; and
- A set of peak hour traffic data gathered on February 26th and a site review carried out on April 8th, 2020.

The approach and technical findings of this traffic impact study are discussed in the following sections of this report.

Figure 1: Key Map and Site Location



2. EXISTING CONDITIONS

This chapter describes the roadway network, traffic volumes, operational analysis results and other notable characteristics under the baseline conditions.

2.1 The Roadway Network

2.1.1 Overview

The subject lands are located in the community of Upper Tantallon immediately east of the large commercial shopping centre adjacent to the Highway 103 interchange. The proposed development will occur on undeveloped lands located on the north side of Hammonds Plains Road, at its intersection with Winslow Drive. The Hammonds Plains Road corridor is one of the main commuter routes for this established bedroom community. It provides access to Highway 103 as well as a key connection to the east linking the communities of Bedford and Lower Sackville and the Highway 102 corridor

The main vehicular access to this new development is assumed to be via Winslow Drive. Future traffic flow patterns were discussed with HRM at the early stages of this study and HRM confirmed the following study area intersections should be explicitly evaluated in this assessment:

- Existing Hammonds Plains Road / Winslow Drive (unsignalized, stop-controlled);
- Future Winslow Drive / East Site Access; and
- Future Winslow Drive / West Access.

Driver views along Winslow Drive are provided in *Figure 2*.

2.1.2 Hammonds Plains Road

Hammonds Plains Road serves as a key commuter corridor in this area of HRM and accommodates both commuter traffic as well as HRM's Metro Transit buses. It is generally aligned in an east-west direction and appears to function as an arterial street corridor. Hammonds Plains Road has an asphalt surface with a rural cross-section that includes gravel shoulders and open ditches. At its intersection with Winslow Drive, there is an eastbound left turn auxiliary lane as well as a westbound right turn auxiliary lane. Through the study area it has a posted speed limit of 80 km/h.

2.1.3 Winslow Drive

Winslow Drive has a two-lane, two-way rural cross-section with gravel shoulders and open ditches and is generally aligned in a north-south direction. It serves as a secondary access to the Westwood Hills subdivision. Through the study area it has a varied alignment with back-to-back horizontal curves and a long vertical slope northwest of Earl Retson Drive. It has a regulatory posted speed limit of 50 km/h but vehicle operating speeds are limited due to the varied horizontal geometry.

Figure 2: Existing Roadway Characteristics



Winslow Drive – Looking North through Earl Retson Drive Intersection



Winslow Drive – Looking South through Earl Retson Drive Intersection

2.1.4 Other Study Area Streets

It should be noted that there are two other adjacent local streets in the study area – Earl Retson Drive and Stillwater Lane. Earl Retson Drive is a public cul-de-sac street that connects the few residents along Stillwater Lane with Winslow Drive. Stillwater Lane is a narrow private roadway that connects to Hammonds Plains Road; however, HRM has turning restrictions in place to only allow local residents to exit onto Hammonds Plains Road. No left or right turns are permitted from Hammonds Plains Road and all inbound traffic to these existing homes are required to use Earl Retson Drive. Since both of these roadways are considered to have a very low volume of traffic – and these streets are not expected to accommodate new traffic as a direct result of the proposed development – they have not been explicitly evaluated in this study.

2.2 Traffic Data

In order to facilitate an assessment of the existing and future traffic operations there was a need to develop a set of representative baseline traffic volumes. As such, GRIFFIN carried out recent weekday peak period traffic counts at the existing Hammonds Plains Road / Winslow Drive intersection in order to obtain current vehicle trends and patterns. These data were gathered during the weekday morning and afternoon peak periods on Wednesday February 26th, 2020. A review of these data was then carried out and it was determined that they were reasonably representative of current demands in the study area and formed the basis of the traffic analysis discussed throughout the report.

Given the notable commuter traffic peaks on a typical weekday that travel along the Hammonds Plains corridor, and commercial developments also experience peak demand during this same time, these two peak periods were selected for analysis in this study. The specific peak hours were determined using the recently recorded hourly traffic counts at the study area intersections. A summary of the Existing 2020 peak hour traffic volumes applied to the analysis are illustrated in *Figure 3*.

2.3 Existing Conditions Operational Analysis

An intersection capacity analysis process was carried out using the Existing 2020 traffic volumes (*Figure 3*) as well as the existing lane configurations and traffic control at the Hammonds Plains Road / Winslow Drive intersection. The analysis process used Trafficware's *Synchro 10* software tool following the Transportation Research Board's *Highway Capacity Manual* (HCM) methodology for the analysis of unsignalized intersections.

Following HRM TIS guidelines, the measures of effectiveness used to describe the operational performance of the intersections included the average vehicle delay, volume-to-capacity ratio (v/c ratio) and 95th percentile queue length (metres) for each movement at each of the study area intersections. The results have been summarized in *Table 1*. An expanded summary of results contained within the detailed capacity analysis reports are contained in *Appendix III*.

Figure 3: Existing 2020 Peak Hour Volumes

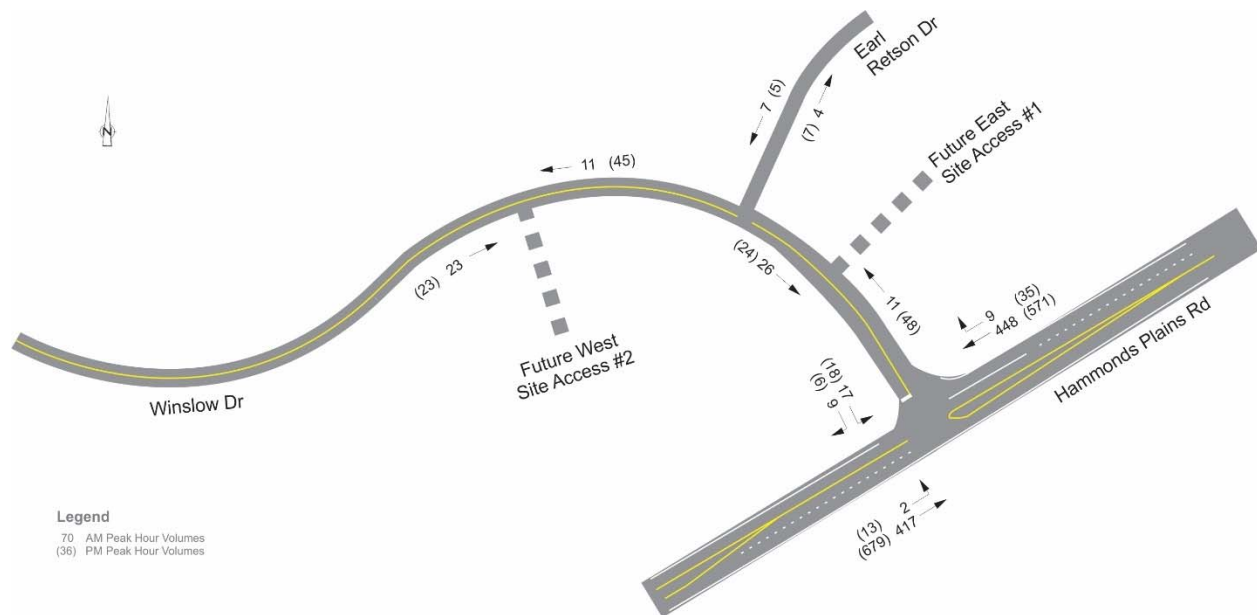


Table 1: Existing Operational Analysis Results

1. Hammonds Plains Road / Winslow Drive						
	AM Peak Hour			PM Peak Hour		
	Movement: Delay	V/C	Queue ^A	Movement: Delay	V/C	Queue ^A
Existing 2020 (stop-control)	WB Right: n/a ^B	-	-	WB Right: n/a ^B	-	-
	EB Left: 8.5s	0.01	<10m	EB Left: 9.0s	0.02	<10m
	SB Lt-Rt: 16.6s	0.08	<10m	SB Lt-Rt: 28.4s	0.15	<10m

A – Queue represents the calculated vehicle queue length in metres occurring 95% of the time (95th percentile).

B – No performance measures calculated for the eastbound and westbound through movements as they are first order priority movements with no impediments.

The analysis results contained in *Table 1* suggest the existing Hammonds Plains Road / Winslow Drive intersection operates during peak periods with average delays of 28.4 seconds per vehicle or less, volume to capacity ratios of 0.15 or less and negligible queue lengths at the stop bar. Generally, these results appeared to be consistent with the vehicle operations and queue lengths observed during the data collection task. The operational results indicate there is a notable amount of residual capacity to accommodate future traffic growth for all movements at this intersection.

3. THE PROPOSED DEVELOPMENT

This chapter describes the existing site, proposed changes to the buildings/operations, and the changes to the site generated traffic.

3.1 Overview

Based on discussions with *Ramar*, it is understood that the subject properties will be designed in a manner to accommodate a total of 22,600 ft² of gross floor of commercial space. Three low-rise buildings will be constructed, each containing about 7,533 ft² of space. One building will be located in the northeast quadrant of the Hammonds Plains Road / Winslow Drive intersection and the other two buildings will be located in the northwest quadrant. The proposed development will connect to the existing public street system in two locations:

- The single building in the northeast quadrant will be served by a new access connecting to Winslow Drive, between Hammonds Plains Road and Earl Retson Drive, and
- The other two buildings in the northwest quadrant will be served by a new access connecting to Winslow Drive north and west of Earl Retson Drive.

The general site layout is illustrated in *Figure 4*.

3.2 Transportation Land Use Type

The types of commercial business operations that could establish in this type of development can vary widely. Based on discussions with the proponent, it is anticipated that some form of office space and/or retail space (i.e. a mix of service-based businesses or shops) are likely to occupy within these new buildings. Based on our review of the transportation literature, the land use types that are most likely to be located in this proposed development are described below.

- *Small Office Building (Land Use Code 712)*: A small office building houses a single tenant and is less than or equal to 5,000 gross square feet in size. It is a location where affairs of business, commercial or industrial organization, or professional person or firm are conducted. One floor of the proposed new building is expected to be less than 3,800 ft² in size – which suggests that a business occupying an entire floor in one of the new buildings would fit the description of this land use code.
- *Shopping Centre (Land Use Code 820)*: The ITE trip generation surveys for this land use type include an integrated set of shops in one building (i.e. a mall), or peripheral out-buildings or pads. Businesses could include banks, retail stores, restaurants or small offices. In smaller developments the gross leasable area (GLA) is considered to be the same as the gross floor area (GFA). To remain conservative and evaluate a worse-than-typical situation, the GFA will be used in this study.

A corresponding comparison of vehicle trip rates for these two land uses are presented in *Table 2*.

Figure 4: Proposed Site Layout

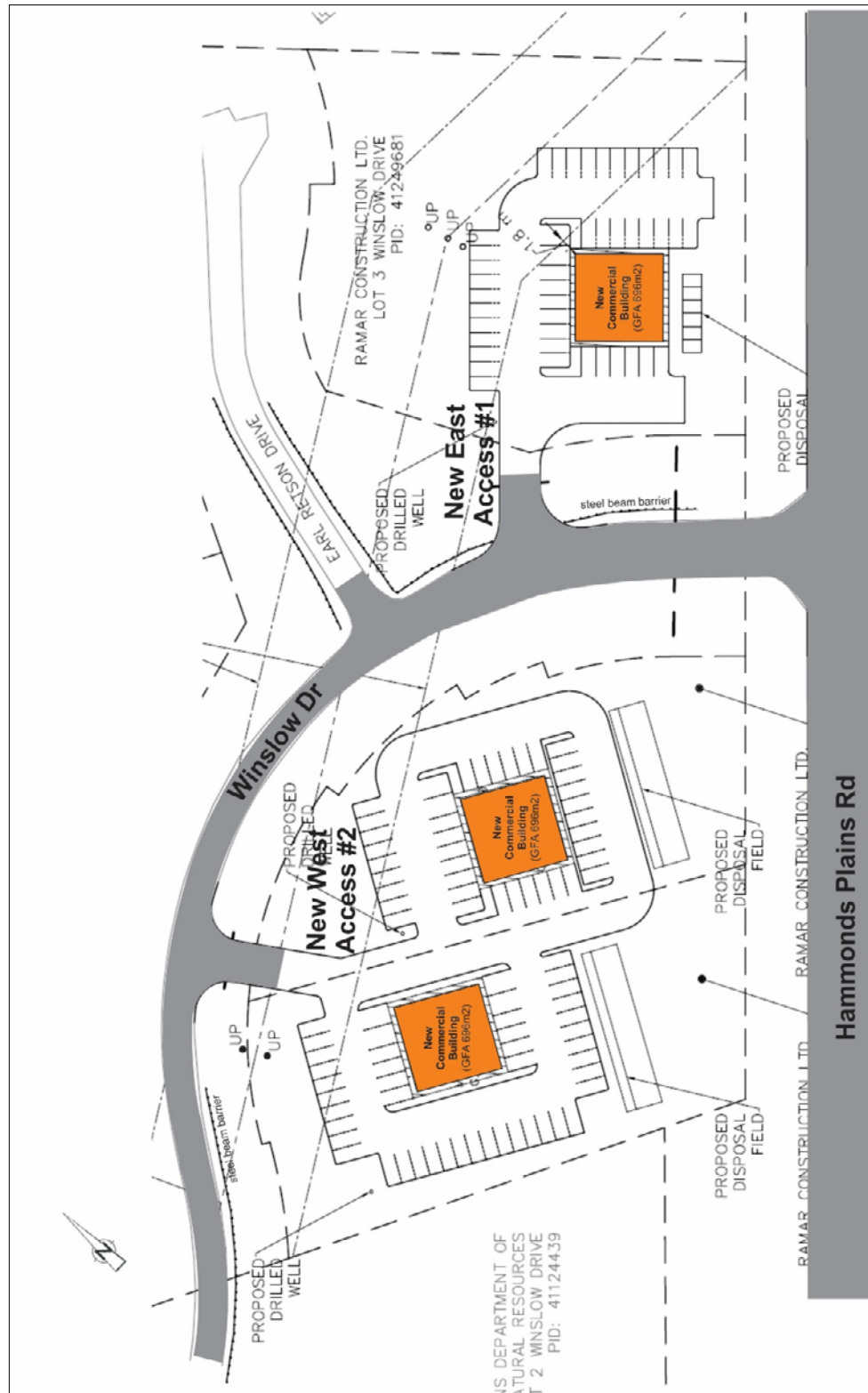


Table 2: ITE Trip Rate Comparison (22,600 ft²)

ITE Land Use	Weekday AM Peak Hour		Weekday PM Peak Hour	
	Avg. Rate	Formula Rate	Avg. Rate	Formula Rate
Small Office Building (LUC 712)	1.92 / 1,000 ft ²	<i>n/a</i>	2.45 / 1,000 ft ²	<i>n/a</i>
Shopping Centre (LUC 820)	0.94 / 1,000 ft ²	7.21 / 1,000 ft ²	3.81 / 1,000 ft ²	8.01 / 1,000 ft ²

Based on the comparison of results contained in *Table 2*, the Shopping Centre land use trip rates – using the regression formula – provide the highest and most conservative estimate of new vehicle traffic for this development. As such, GRIFFIN applied the Shopping Centre trip rate to this study.

3.3 Site Trip Generation

3.3.1 Overview

Typically, traffic engineers estimate the volume of new traffic by using trip generation rates that are published by the Institute of Transportation Engineers (ITE), and contained in the latest *Trip Generation, 10th Edition* document. Upon reviewing this publication, it was determined that the vehicle trip generation rates for retail businesses (LUC 820) provided an increased estimate of future volumes for this development – as noted in Section 3.2. The ITE regression formula was thus used to forecast the volume of traffic generated for the entire 22,600 ft² of gross floor area of commercial space. A summary of the AM and PM peak hour site trip generation results are contained in *Table 3*.

Table 3: Forecast Site Trip Generation – AM & PM Peak Hours

	Size	Trip Rate	Total Trips (in/out)	Pass-by Trips (rate)	On-site Linked Trips (rate)	New Trips (vph)
AM Peak Hour						
Commercial Retail / Shopping Centre (ITE Code 820)	22,600 ft ²	7.21/1,000ft ^{2A}	163 (62%/38%)	42 (26%) ^B	0 (0%)	121
AM Peak Vehicle Trips			163	42	0	121
PM Peak Hour						
Commercial Retail / Shopping Centre (ITE Code 820)	22,600 ft ²	8.01/1,000ft ^{2A}	181 (48%/52%)	62 (34%) ^B	0 (0%)	119
PM Peak Vehicle Trips			181	62	0	119

A – Based on ITE's regression formula for land use code 820.

B – Average pass-by rate taken from ITE Trip Generation Handbook, 3rd Edition for a mix of commercial business types including a shopping centre, discount store, and a bank.

The results contained in *Table 2* indicate the proposed development is forecast to generate new trips totaling 121 vehicles/hour (vph) (80 inbound, 41 outbound) during the weekday morning peak hour and 119 vph (56 inbound, 63 outbound) during the weekday PM peak hour.

3.3.2 *Effect of Cross-Shopping*

Typically, where commercial businesses co-locate, drivers will sometimes patronize more than one business within the development. This phenomenon is referred to as cross-shopping or on-site linked trips. These cross-shopping trips are included in the total trip generation volumes but are not considered to be new trips as drivers will make one round trip to the development and visit multiple businesses during that trip. Often it is reasonable to discount the total trip generation volume to account for cross-shopping, but in order to remain conservative in our estimates and provide a worst-case scenario, GRIFFIN has not reduced the number of new site-generated trips in this study.

3.3.3 *Pass-by Trips*

Another phenomenon that occurs is the attraction of traffic to/from the new development from the traffic stream already using the existing roads. These trips are referred to as pass-by traffic trips, and again, are part of the total site trip generation estimates but not considered to be new trips on the study area roads. For this study, a pass-by trip rate reduction factor was applied and these factors were referenced from ITE's Trip Generation Handbook, 3rd Edition document. The pass-by trip rates applied included 26% and 34% for the AM and PM peak hours, respectively. It should be noted that the pass-by trips effectively reduced the number of new vehicle trips added to the study area roads; however, the pass-by trips still increased the right and left turning volumes at the study area intersections.

3.4 **Trip Distribution and Assignment**

A review of the observed February 2020 traffic volumes and travel patterns gathered at the Hammonds Plains Road / Winslow Drive intersection was carried out to establish the existing distribution patterns of traffic flow in the study area. These existing trends were also applied to the distribution of the new site-generated trips. It was assumed that the majority of the new commercial trips would utilize the Hammonds Plains Road corridor to move in/out of the study area. The distribution percentages to/from each of the study area gateways are contained in *Table 4*.

Table 4: Forecast Commercial Trip Distribution

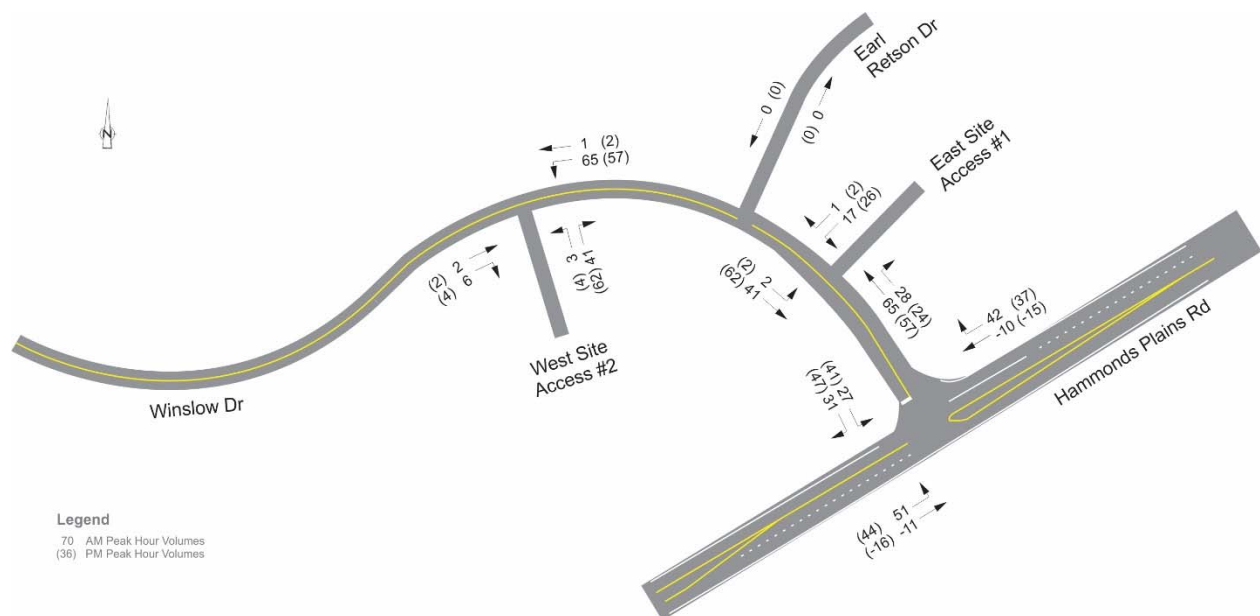
Direction	Via	AM & PM Peaks	
		Inbound	Outbound
East	Hammonds Plains Rd	40%	40%
West	Hammonds Plains Rd	50%	50%
South	n/a	-	-
North	Winslow Drive	10%	10%
Total		100%	100%

Once the volume of site-generated trips moving to/from each study area gateway was established, GRIFFIN then assigned trips to each of the two site driveways based on the amount of floor space in each quadrant of the intersection. This was carried out in the following manner:

- *East Access:* 33% of the site-generated traffic was assigned to this driveway which corresponds to the amount of floor space in the single building located in this quadrant (7,533 ft²).
- *West Access:* 67% of the site-generated traffic was assigned to this driveway which corresponds to the amount of floor space in the two buildings located in this quadrant. (15,067 ft²)

The resulting peak hour site-generated volumes are illustrated in Figure 5.

Figure 5: Site-generated Peak Hour Volumes



This space intentionally left blank

3.5 New Vehicle Access Locations

3.5.1 Corner Clearance

Corner clearance provides a sufficient separation distance between a site driveway and an adjacent intersection in order to minimize the potential for traffic operational issues that could occur between slowing / stopping / turning vehicles. GRIFFIN followed HRM design guidelines for driveway corner clearances which suggest that a new access should be located a minimum of 30m away from the end of the corner radius (eg. 30m along the tangent, beyond the corner radius) of a major intersection and a minimum of 8m away from a minor intersection with a local street. The corner clearance review identified the following:

- *East Access:* Between Hammonds Plains Road and Earl Retson Drive there is 58m of available tangent distance on the east side of Winslow Drive. This distance would provide for a 30m corner clearance from Hammonds Plains Road, an 8m corner clearance from Earl Retson Drive and would allow for an approximate 20m space within which to locate the new commercial driveway.
- *West Access:* This new access is proposed to connect to Winslow Drive a sufficient distance away from the next closest intersection – Earl Retson Drive – and provides a corner clearance of about 70m.

In conclusion, the proposed site accesses serving the new development provide sufficient corner clearances that exceed HRM's minimum guidelines.

3.5.2 Driver Sight Distance

The sight distance review was based on the guidelines contained in the latest Transportation Association of Canada's (TAC) Geometric Design Guide for Canadian Roads document (2017). At this early stage of the planning process only the minimum requirement for vehicles approaching the new access was assessed. This is referred to as stopping sight distance (SSD). The provision of adequate SSD for vehicles traveling on the main roadway – in this case Winslow Drive – ensures that drivers have sufficient forward visibility to identify a hazard in the roadway, and if needed, bring their vehicle to a stop.

To initiate this analysis step, GRIFFIN gathered existing vehicle operating speeds along Winslow Drive, in the vicinity of the existing Earl Retson Drive intersection. These data only included free-flow speeds not influenced by slowing/turning vehicles at the study area intersections. All of the speed recordings were assembled and an 85th percentile vehicle speed was calculated – determined to be 51 km/h. As such a 50 km/h design speed was chosen as the basis for the sight distance assessment discussed below.

The field measurements were carried out by GRIFFIN and followed Nova Scotia Transportation and Infrastructure Renewal (NSTIR) best practices and TAC guidelines including a driver eye height of 1.05 m and an object/hazard height of 0.60 m. The 0.60 m object was placed at the approximate

centre of the proposed new access, on the edge of Winslow Drive. A summary of the field measured sight distances relative to TAC's minimum requirements is provided in *Table 5*.

Table 5: Summary of Stopping Sight Distances (SSD) at the New Access Locations

Access Location	Travel Direction on Main Roadway	Available SSD	Minimum Required SSD ^A		Does Available Meet Required?
			Base	Slope Adjusted	
East Access (min. 30m corner clearance)	NB on Winslow	45 m	31.2m (30km/h) ^C	31.2 m (<2%) ^B	Yes
	SB Winslow	73 m	63.5m (50km/h)	67.0 m (-4%) ^B	Yes
West Access (19m east of steel barrier)	NB on Winslow	59 m	63.5m (50km/h) ^C	59.0 m (+6%) ^B	Yes
	SB on Winslow	93 m		70.0 m (-6%) ^B	Yes

A – Minimum SSD requirements referenced from TAC's Table 2.5.2, GDGCR Chapter 2 (2017).

B – An estimate of the actual slope along the study area roads. Following TAC geometric design guidelines, SSD requirements were not adjusted where slopes appeared less than 2%.

C – South terminus of Winslow Drive in close proximity, thus northbound vehicles assumed to be traveling less than 50km/h.

Based on the site conditions, the available stopping sight distances along Winslow Drive meet or exceed TAC minimum requirements for the expected vehicle operating speeds. Therefore, the two proposed accesses appear to meet the minimum design guidelines. Following the planning approval process associated with the proposed development, the site designers will need to confirm the final location of the site accesses and ensure that minimum driver sight distances, intersection corner clearances and sight triangles are provided in the final site design.

4. FUTURE CONDITIONS

This chapter summarizes the future year traffic conditions and assessment of the road network with the full build-out of the proposed development.

4.1 Overview

The future planning horizon chosen for a traffic impact study represents a milestone in the development process. Following HRM guidelines, the future planning horizon year used in the analysis for this type of development will occur 5 years beyond the full build-out/occupancy of the site. It is expected that the planning, design and construction of the proposed development will likely occur within two years (2022). This would mean a reasonable future planning horizon for analysis purposes would occur by 2027 (i.e. 2022 plus 5 years). A summary of the planning horizons and the associated development scenarios are provided in *Table 6*.

Table 6: Planning Horizons and Access Options

Planning Horizons	Development Scenario	Access Options
2020 Planning Horizon	2020 Existing Conditions (No Development)	- No site access
2027 Planning Horizon	2027 Future Background Conditions (No Development)	- No site access
	2027 Future Total Conditions (With Development)	- East Access to Winslow Drive - West Access to Winslow Drive

Following traffic impact study best practices, the analysis process carried out for the future planning horizon includes two sets of assessments. The first is referred to as the future background traffic scenario which excludes the proposed site-generated traffic. The second is referred to as the future total traffic scenario which includes the proposed site-generated traffic. It is through this process that the practitioner can identify the impacts explicitly associated with the new site-generated traffic added to the roadway network by comparing the two sets of results. The assembly of both sets of future 2027 peak hour traffic conditions and the analysis process used to identify any future roadway infrastructure changes is discussed in the following Sections.

4.2 Traffic Volume Forecasting Process

4.2.1 Overview

Using information gleaned from the discussions with HRM representatives at the scope development meeting, in addition to the available background documentation, the future year volumes were developed using the following steps identified in *Table 7*.

Table 7: Future Year Traffic Factors

Contributing Factor	Description
1. General Traffic Growth	- A review of historical NSTIR traffic volume data recorded along Hammonds Plains Road (Route 213) was undertaken to determine recent growth trends. Average Annual Daily Traffic (AADT) volumes recorded by NSTIR in Section 30 of Route 213 between 2011 and 2017 were reviewed. The data showed a 0.83% increase over this period. Therefore, a higher-than-average compounding growth rate of 1.0% per year was applied to the 2020 baseline volumes to establish the background growth out to the year 2027.
2. Future Adjacent Development	- There are no known developments in the vicinity of the study area that could notably impact traffic volumes. The assumed general growth rate described above will account for any small infill developments, should they occur.
3. Road Network Changes	- No roadway network changes were assumed in this study and the existing travel patterns and travel route choices remained the same out to the 2027 planning horizon.
4. New Site-generated Traffic	- The new traffic added to the study area streets and intersections explicitly associated with the proposed development as contained in Figure 5.

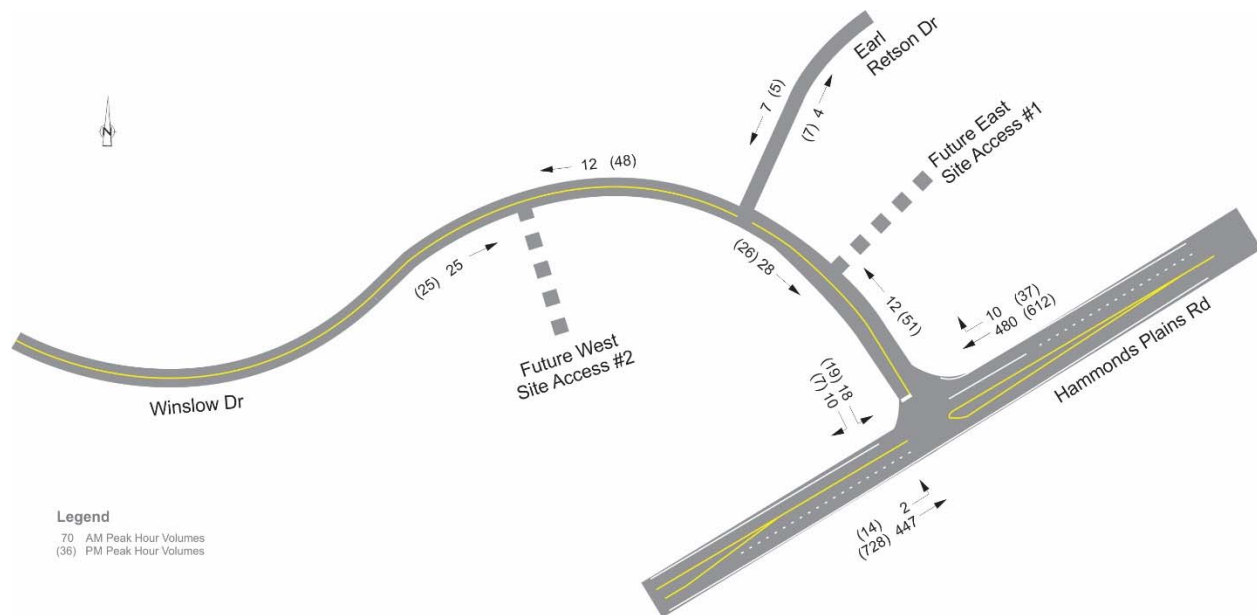
4.2.2 Future Background Traffic Volumes

A summary of the future Background 2027 peak hour traffic volumes used in the analysis are illustrated in *Figure 6*. These volumes were established using the following:

- Existing 2020 weekday peak hour traffic volumes; plus
- General traffic increases associated with population and employment growth were assumed to reflect historical trends and a 1.0% per year compounding growth rate was applied to the 2020 peak hour volumes.

This space intentionally left blank

Figure 6: Future Background 2027 Peak Hour Traffic Volumes



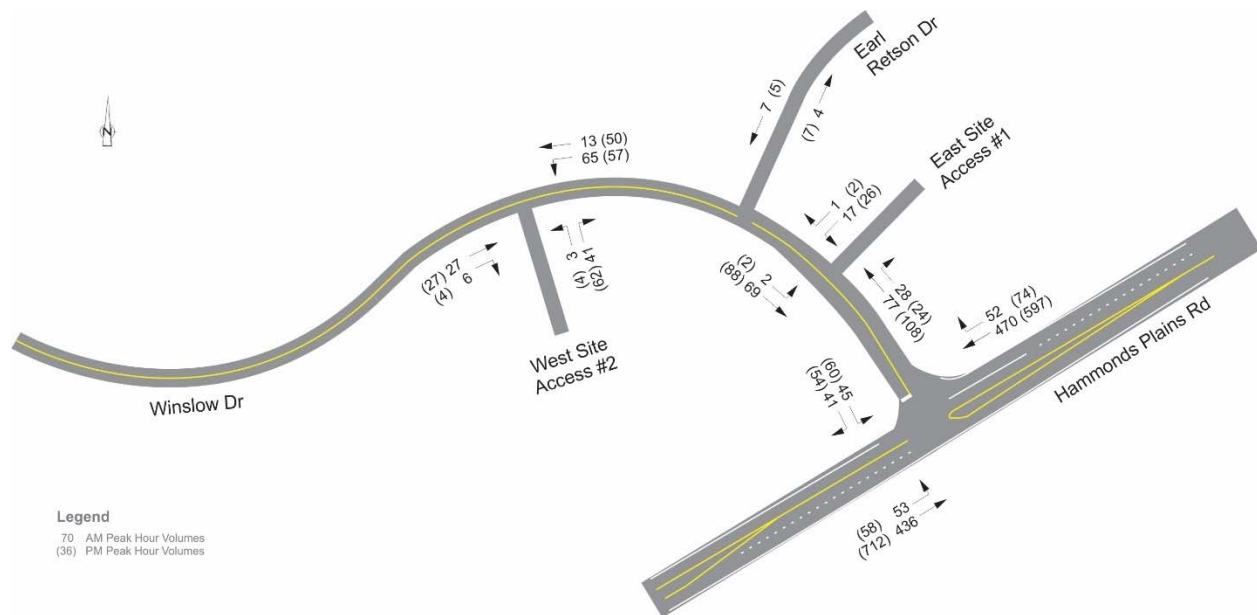
4.2.3 Future Total Traffic Volumes

The assembly of Future Total 2027 AM and PM peak hour traffic volumes is shown in *Figure 7* and was based on the following:

- Existing 2020 weekday peak hour traffic volumes; plus
- General traffic increases associated with population and employment growth were represented by a 1.0% per year compounding growth rate applied to the 2020 peak hour volumes; plus
- Site-generated traffic distributed throughout the study area as shown in *Figure 5*.

This space intentionally left blank

Figure 7: Future Total 2027 Peak Hour Traffic Volumes



4.3 Future 2027 Operational Analysis

4.3.1 Traffic Signal Warrant Review

The first step in the future conditions analysis was to determine if traffic signals would be required at the Hammonds Plains Road / Winslow Drive intersection by using the most recent version of the Transportation Association of Canada's (TAC) signal warrant procedure. This methodology is widely used by road agencies across Canada and is a recognized procedure by HRM. The TAC calculation process uses a set of average intersection volumes measured over the six highest hours of a typical day. The results of this calculation process are a number of priority points to indicate whether a traffic signal is warranted. When the minor street peak hour traffic volume exceeds 75 vehicles/hour and the number of priority points exceeds 100, the traffic signal warrant is met.

The results flowing from the signal warrant analysis under each planning horizon are contained in *Table 8*. The detailed calculation sheets are provided in *Appendix I*.

Table 8: TAC Signal Warrant Results at the Hammonds Plains Road / Winslow Drive Intersection

Scenario	TAC Priority Points	Warranted?
2020 Existing	20 points	No
2027 Background	23 points	No
2027 Total	53 points	No

Based the calculated priority points, a traffic signal warrant is not met at the Hammonds Plains Road / Winslow Drive intersection under the assumed full build-out 2027 traffic conditions.

4.3.2 Auxiliary Turning Lane Review

The second step in the analysis process included a review of the auxiliary turn lane warrants at the two new site access intersections with Winslow Drive. The left turn lane warrant review was undertaken following Ministry of Transportation of Ontario (MTO) procedures. The right turn lane warrant review followed the Ohio Department of Transportation (ODOT) methodology. A summary of the auxiliary turn lane assessment results is provided in *Table 9*. Detailed auxiliary turn lane warrant assessments are contained in *Appendix II*.

It should be noted that the auxiliary turn lane warrant review was only carried out using the peak hour volumes for the future full build-out scenario (Total 2027). Since the two proposed site accesses would not be built and open to traffic under the existing 2020 or the future Background 2027 scenarios, the analysis was not completed for these two planning horizons.

Table 9: Summary of Auxiliary Turn Lane Assessment

Scenario	Winslow Dr. Turn Lane	1. East Access	2. West Access
Total 2027	Northbound Right Turn Lane	Warrant not met ^B	Warrant not met ^B
	Southbound Left Turn Lane	Warrant not met	Warrant not met ^A

A – Left turn lane warrant not met as the opposing volume less than 100 vph.

B – Right turn lane warrant not met as the advancing volume less than 200 vph.

The warrant review results suggest that no new auxiliary turn lanes are required under the future Total 2027 scenario. This suggests that the existing roadway infrastructure at the two proposed site accesses is sufficient to accommodate the expected weekday peak hour vehicle demand. These findings were carried forward to the intersection capacity analysis discussed in the following Section.

4.3.3 Future 2027 Intersection Capacity Analysis

A capacity analysis effort was carried out for the study area intersections using both sets of future 2027 forecast traffic volumes. The analysis process used Trafficware's *Synchro 10* software tool. The results for the critical movements at the study area intersections are contained in *Table 10* and the detailed capacity reports are contained in *Appendix III*.

Table 10: Future 2027 Operational Analysis Results

1. Hammonds Plains Road / Winslow Drive (unsignalized)						
	AM Peak Hour			PM Peak Hour		
	Movement: Delay	V/C	Queue^A	Movement: Delay	V/C	Queue^A
Existing 2020 (existing lanes)	WB Right: n/a ^B EB Left: 8.5s SB Lt-Rt: 16.6s	- 0.01 0.08	- <10m <10m	WB Right: n/a ^B EB Left: 9.0s SB Lt-Rt: 28.4s	- 0.02 0.15	- <10m <10m
Background 2027 (existing lanes)	WB Right: n/a ^B EB Left: 8.6s SB Lt-Rt: 17.7s	- 0.01 0.10	- <10m <10m	WB Right: n/a ^B EB Left: 9.2s SB Lt-Rt: 32.1s	- 0.02 0.18	- <10m <10m
Total 2027 (existing lanes)	WB Right: n/a ^B EB Left: 8.9s SB Lt-Rt: 22.3s	- 0.06 0.31	- <10m 15m	WB Right: n/a ^B EB Left: 9.6s SB Lt-Rt: 65.0s	- 0.07 0.71	- <10m 35m

2. Winslow Drive / East Access 1 (unsignalized)						
	AM Peak Hour			PM Peak Hour		
	Movement: Delay	V/C	Queue^A	Movement: Delay	V/C	Queue^A
Existing 2020 (existing lanes)	-	-	-	-	-	-
Background 2027 (existing lanes)	-	-	-	-	-	-
Total 2027 (existing lanes)	NB Th-Rt: n/a ^B SB Th-Lt: 7.5s WB Lt-Rt: 9.6s	- 0.01 0.03	- <10m <10m	NB Th-Rt: n/a ^B SB Th-Lt: 7.6s WB Lt-Rt: 10.0s	- 0.01 0.04	- <10m <10m

3. Winslow Drive / West Access 2 (unsignalized)						
	AM Peak Hour			PM Peak Hour		
	Movement: Delay	V/C	Queue^A	Movement: Delay	V/C	Queue^A
Existing 2020 (existing lanes)	-	-	-	-	-	-
Background 2027 (existing lanes)	-	-	-	-	-	-
Total 2027 (existing lanes)	NB Th-Lt: 7.4s SB Th-Rt: n/a ^B EB Lt-Rt: 8.8s	0.05 - 0.05	<10m - <10m	NB Th-Lt: 7.4s SB Th-Rt: n/a ^B EB Lt-Rt: 8.9s	0.04 - 0.07	<10m - <10m

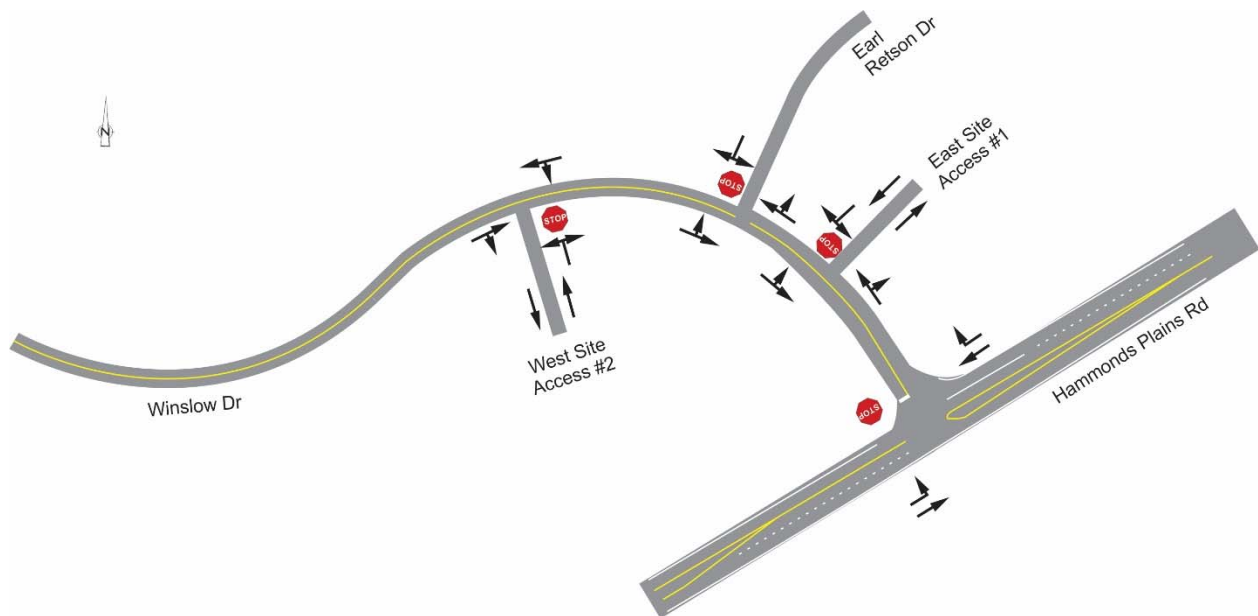
A – Queue represents the calculated vehicle queue length in metres occurring 95% of the time (95th percentile).

B – No performance measures calculated as this is a first order priority movement at the intersection.

The results contained in *Table 10* suggest that the critical stop-controlled movement is the southbound shared left-right turn at the Hammonds Plains Road / Winslow Drive intersection. Under a full build-out scenario this movement is expected to operate with 65 seconds of delay per vehicle or less, v/c ratios of 0.71 or less and less than 35m queues. Despite the notable deterioration in operational performance between the 2027 Background and Total traffic scenarios, this movement is expected to continue to operate within acceptable performance thresholds as established in HRM's TIS guidelines.

The recommended intersection lane configurations required to accommodate the peak hour vehicle demand under a full build-out scenario is contained in *Figure 8*.

Figure 8: Future Lane Configuration Requirements



5. CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the salient findings of the analysis process and identifies necessary infrastructure changes.

5.1 Conclusions

The following conclusions were gleaned from the traffic impact assessment:

- *The Proposed Development:* A total of 22,600 ft² of commercial space is proposed to be contained within three separate low-rise buildings. One building is proposed in the northeast quadrant of the Hammonds Plains Road / Winslow Drive intersection, and two buildings are proposed for northwest quadrant. A sensitivity assessment was carried out and it was determined that the use of a vehicle trip generation rate for a retail shopping centre yielded a higher volume of vehicle trips for this type of commercial development. In order to remain conservative in our traffic forecasting step this higher trip rate was applied to the study. ITE's *Trip Generation, 10th Edition* document indicates that a development of this size will generate new trips on the study area roads totaling 121 vehicles/hour (vph) (80 inbound, 41 outbound) during the weekday morning peak hour and 119 vph (56 inbound, 63 outbound) during the weekday PM peak hour.
- *Existing Intersection Operations:* The majority of the new traffic generated by the proposed development is expected to move through the Hammonds Plains Road / Winslow Drive intersection. This intersection has stop-control on the Winslow Drive approach with left and right turn auxiliary lanes on Hammonds Plains Road. Currently, this intersection operates with acceptable performance measures during typical weekday peak periods and has residual capacity to accommodate future traffic growth.
- *Future Intersection Operations:* The operating conditions at the study area intersections under future full build-out conditions are expected to continue to have some residual capacity for the critical stop-controlled movements. This includes the expected operations at the two new site accesses connecting to Winslow Drive. A traffic signal warrant assessment was also carried out to determine if there would be a need to upgrade the traffic control to signalization at the Hammonds Plains Road / Winslow Drive intersection under a full build-out scenario. A total of 53 priority points were calculated – well below the 100-point threshold. It was concluded that the existing stop-control would be sufficient to accommodate the forecast vehicle demand.

In summary, the forecast site-generated volumes associated with the proposed 22,600 ft² of new commercial space is expected to have an acceptable operational impact on the study area streets and intersections out to the 2027 planning horizon.

5.2 Recommendations

The following recommendations were developed based on the findings flowing from this study:

- That the two new site accesses be designed to have the following:
 - One outbound lane accommodating a shared left-right turn exiting movement, with a sufficient throat length to accommodate queue storage for two vehicles at the stop sign (i.e. about 15m). Stop signs are to be installed following TAC guidelines.
 - One inbound lane for vehicles entering the site.
 - *East Access #1*: Following HRM corner clearance design guidelines, this access should allow for a minimum tangent distance (i.e. beyond the corner radius) along Winslow Drive in the following locations:
 - 30m between the access and Hammonds Plains Road.
 - 8m between the access and Earl Retson Drive.
 - *West Access #2*: Given the existing driver visibility limitations and TAC's minimum stopping sight distance requirements, this access should be located about 19m east of the steel beam barrier, as shown in *Figure 4*. In this location, HRM's minimum corner clearance design guidelines are met.
- That the design process for any new and/or changes to the roadway infrastructure follow the most recent HRM and TAC design guidelines. In addition, minimum required driver sight distances, corner sight triangles and corner clearances should be confirmed and maintained throughout the design and construction phases of the project.
- That all new signage and pavement markings associated with any necessary roadway upgrades be installed in accordance with the latest version of the Transportation Association of Canada's (TAC) *Manual of Uniform Traffic Control Devices of Canada* (MUTCDC).

APPENDIX I

Traffic Signal Warrant Results



HRM / NSTIR - Traffic Signal Warrant Analysis

Main Street (name) **Hammonds Plains Rd (Rte 213)**
Side Street (name) **Winslow Drive**
Quadrant / Int # **1**
CHECK SHEET

for Warrant Calculation
Results, please hit 'Page
Down'

Comments

Direction (EW or NS) **EW**
Direction (EW or NS) **NS**
Existing 2020 Volumes
Existing Road Network

Road Authority: **HRM / NSTIR**
City: **Tantallon**
Analysis Date: **2020 Feb 27, Thu**
Count Date: **2020 Feb 26, Wed**
Date Entry Format: **(yyyy-mm-dd)**

Lane Configuration		Excl LT	Th & LT	Through	Th+RT+LT	Th & RT	Excl RT	UpStream Signal (m)	# of Thru Lanes
Hammonds Plains Rd (Rte 213)	WB			1			1	2,000	1
Hammonds Plains Rd (Rte 213)	EB	1		1				320	1
Winslow Drive	NB								
Winslow Drive	SB				1				

Are the Winslow Drive SB right turns significantly impeded by through movements? (y/n) **n**

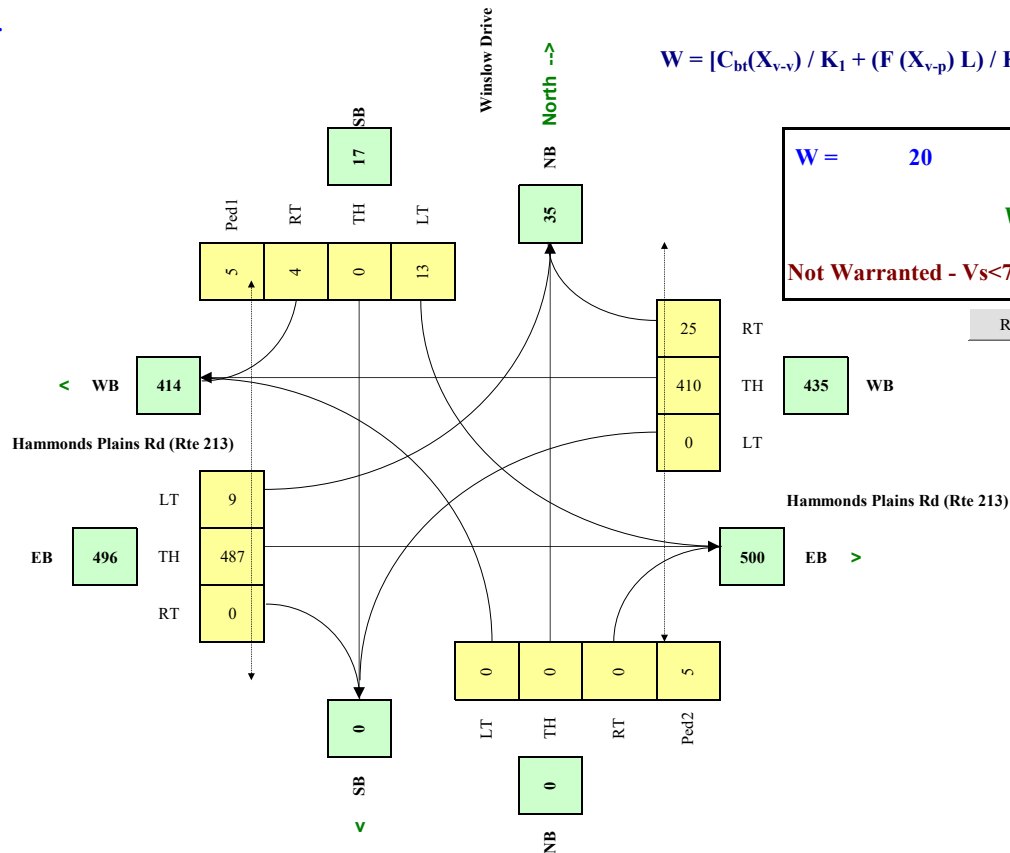
Other input		Speed (Km/h)	Truck %	Bus Rt (y/n)	Median (m)
Hammonds Plains Rd (Rte 213)	EW	80	5.0%	n	0.0
Winslow Drive	NS		5.0%	n	

Demographics		
Elem. School/Mobility Challenged	(y/n)	n
Senior's Complex	(y/n)	n
Pathway to School	(y/n)	n
Metro Area Population	(#)	30,000
Central Business District	(y/n)	n

Set Peak Hours														Ped1	Ped2	Ped3	Ped4
Traffic Input														NS	NS	EW	EW
	NB			SB			WB			EB				W Side	E Side	N Side	S Side
	LT	Th	RT	LT	Th	RT	LT	Th	RT	LT	Th	RT					
7:00 - 8:00	0	0	0	14	0	5	0	457	28	10	543	0	5	5	5	5	5
8:00 - 9:00	0	0	0	13	0	4	0	400	25	9	475	0	5	5	5	5	5
12:00 - 13:00	0	0	0	9	0	3	0	286	18	7	340	0	5	5	5	5	5
13:00 - 14:00	0	0	0	9	0	3	0	286	18	7	340	0	5	5	5	5	5
16:00 - 17:00	0	0	0	14	0	5	0	457	28	10	543	0	5	5	5	5	5
17:00 - 18:00	0	0	0	18	0	6	0	571	35	13	679	0	5	5	5	5	5
Total (6-hour peak)	0	0	0	77	0	26	0	2,457	152	56	2,920	0	30	30	30	30	30
Average (6-hour peak)	0	0	0	13	0	4	0	410	25	9	487	0	5	5	5	5	5

Average 6-hour
Peak Turning
Movements

$$W = [C_{bt}(X_{v-v}) / K_1 + (F(X_{v-p}) L) / K_2] \times C_i$$



W = 20 10 10
Veh Ped
Not Warranted - Vs<75

RESET SHEET



HRM / NSTIR - Traffic Signal Warrant Analysis

Main Street (name) **Hammonds Plains Rd (Rte 213)**
Side Street (name) **Winslow Drive**
Quadrant / Int # **1**
CHECK SHEET

Comments

Direction (EW or NS) **EW**
Direction (EW or NS) **NS**
Background 2027 Volumes
Existing Road Network

Road Authority: **HRM / NSTIR**
City: **Tantallon**
Analysis Date: **2020 Feb 27, Thu**
Count Date: **2020 Feb 26, Wed**
Date Entry Format: (yyyy-mm-dd)

Lane Configuration		Excl LT	Th & LT	Through	Th+RT+LT	Th & RT	Excl RT	UpStream Signal (m)	# of Thru Lanes
Hammonds Plains Rd (Rte 213)	WB			1			1	2,000	1
Hammonds Plains Rd (Rte 213)	EB	1		1				320	1
Winslow Drive	NB								
Winslow Drive	SB				1				

Are the Winslow Drive SB right turns significantly impeded by through movements? (y/n) **n**

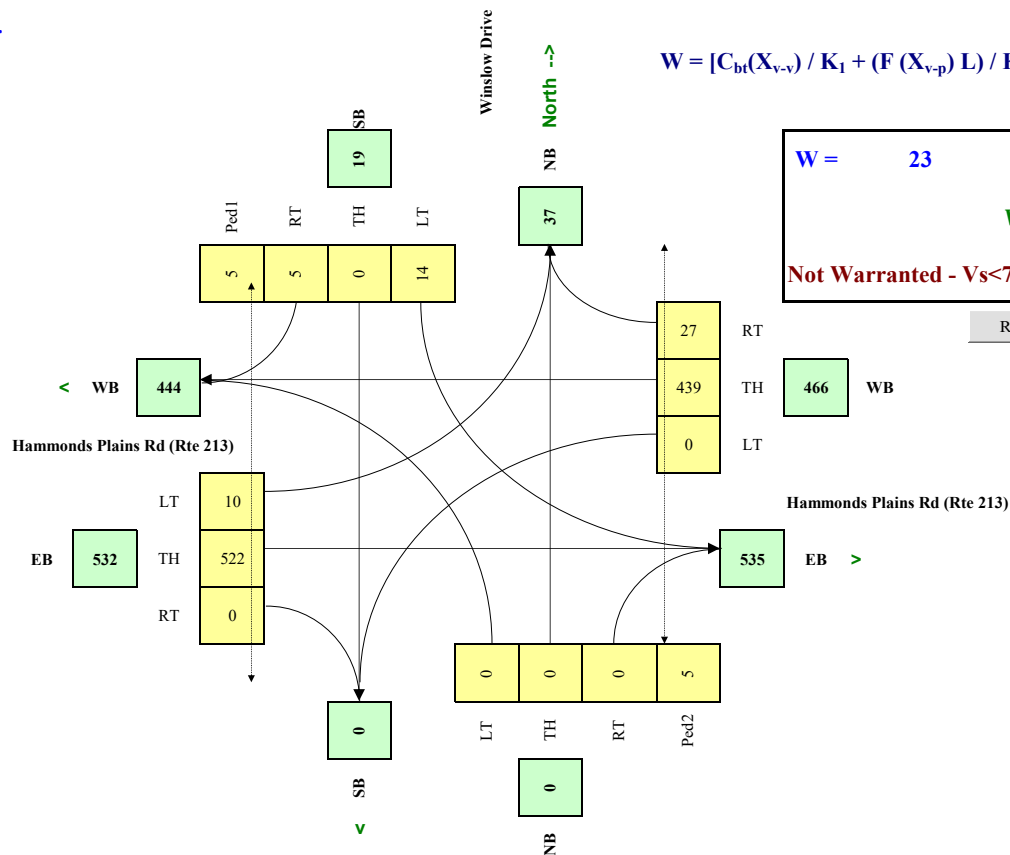
Other input		Speed (Km/h)	Truck %	Bus Rt (y/n)	Median (m)
Hammonds Plains Rd (Rte 213)	EW	80	5.0%	n	0.0
Winslow Drive	NS		5.0%	n	

Demographics		
Elem. School/Mobility Challenged	(y/n)	n
Senior's Complex	(y/n)	n
Pathway to School	(y/n)	n
Metro Area Population	(#)	30,000
Central Business District	(y/n)	n

Set Peak Hours														Ped1	Ped2	Ped3	Ped4
Traffic Input														NS	NS	EW	EW
	NB			SB			WB			EB				W Side	E Side	N Side	S Side
	LT	Th	RT	LT	Th	RT	LT	Th	RT	LT	Th	RT					
7:00 - 8:00	0	0	0	15	0	6	0	490	30	11	582	0	5	5	5	5	5
8:00 - 9:00	0	0	0	13	0	5	0	428	26	10	510	0	5	5	5	5	5
12:00 - 13:00	0	0	0	10	0	4	0	306	19	7	364	0	5	5	5	5	5
13:00 - 14:00	0	0	0	10	0	4	0	306	19	7	364	0	5	5	5	5	5
16:00 - 17:00	0	0	0	15	0	6	0	490	30	11	582	0	5	5	5	5	5
17:00 - 18:00	0	0	0	19	0	7	0	612	37	14	728	0	5	5	5	5	5
Total (6-hour peak)	0	0	0	82	0	32	0	2,632	161	60	3,130	0	30	30	30	30	30
Average (6-hour peak)	0	0	0	14	0	5	0	439	27	10	522	0	5	5	5	5	5

Average 6-hour
Peak Turning
Movements

$$W = [C_{bt}(X_{v-v}) / K_1 + (F(X_{v-p}) L) / K_2] \times C_i$$



W = 23 11 12
Veh Ped
Not Warranted - Vs<75

RESET SHEET



HRM / NSTIR - Traffic Signal Warrant Analysis

Main Street (name) **Hammonds Plains Rd (Rte 213)**
Side Street (name) **Winslow Drive**
Quadrant / Int # **1**

for Warrant Calculation
Results, please hit 'Page
Down'

CHECK SHEET

Comments

Direction (EW or NS) **EW**
Direction (EW or NS) **NS**
Total 2027 Volumes
Existing Road Network

Road Authority: **HRM / NSTIR**
City: **Tantallon**
Analysis Date: **2020 Feb 27, Thu**
Count Date: **2020 Feb 26, Wed**
Date Entry Format: **(yyyy-mm-dd)**

Lane Configuration		Excl LT	Th & LT	Through	Th+RT+LT	Th & RT	Excl RT	UpStream Signal (m)	# of Thru Lanes
Hammonds Plains Rd (Rte 213)	WB			1			1	2,000	1
Hammonds Plains Rd (Rte 213)	EB	1		1				320	1
Winslow Drive	NB								
Winslow Drive	SB				1				

Are the Winslow Drive SB right turns significantly impeded by through movements? (y/n) **n**

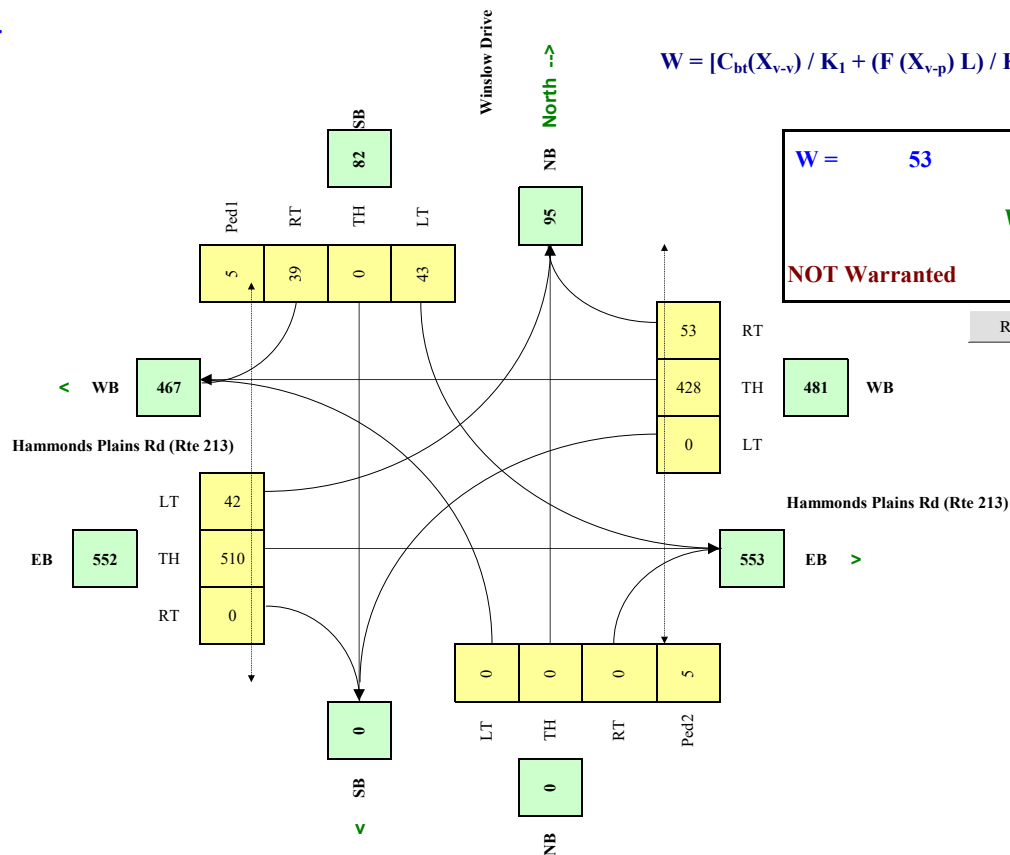
Other input		Speed (Km/h)	Truck %	Bus Rt (y/n)	Median (m)
Hammonds Plains Rd (Rte 213)	EW	80	5.0%	n	0.0
Winslow Drive	NS		5.0%	n	

Demographics		
Elem. School/Mobility Challenged	(y/n)	n
Senior's Complex	(y/n)	n
Pathway to School	(y/n)	n
Metro Area Population	(#)	30,000
Central Business District	(y/n)	n

Set Peak Hours														Ped1	Ped2	Ped3	Ped4
Traffic Input														NS	NS	EW	EW
	NB			SB			WB			EB				W Side	E Side	N Side	S Side
	LT	Th	RT	LT	Th	RT	LT	Th	RT	LT	Th	RT					
7:00 - 8:00	0	0	0	48	0	43	0	478	59	46	570	0	5	5	5	5	5
8:00 - 9:00	0	0	0	42	0	38	0	418	52	41	498	0	5	5	5	5	5
12:00 - 13:00	0	0	0	30	0	27	0	299	37	29	356	0	5	5	5	5	5
13:00 - 14:00	0	0	0	30	0	27	0	299	37	29	356	0	5	5	5	5	5
16:00 - 17:00	0	0	0	48	0	43	0	478	59	46	570	0	5	5	5	5	5
17:00 - 18:00	0	0	0	60	0	54	0	597	74	58	712	0	5	5	5	5	5
Total (6-hour peak)	0	0	0	258	0	232	0	2,569	318	249	3,062	0	30	30	30	30	30
Average (6-hour peak)	0	0	0	43	0	39	0	428	53	42	510	0	5	5	5	5	5

Average 6-hour
Peak Turning
Movements

$$W = [C_{bt}(X_{v-v}) / K_1 + (F(X_{v-p}) L) / K_2] \times C_i$$



APPENDIX II

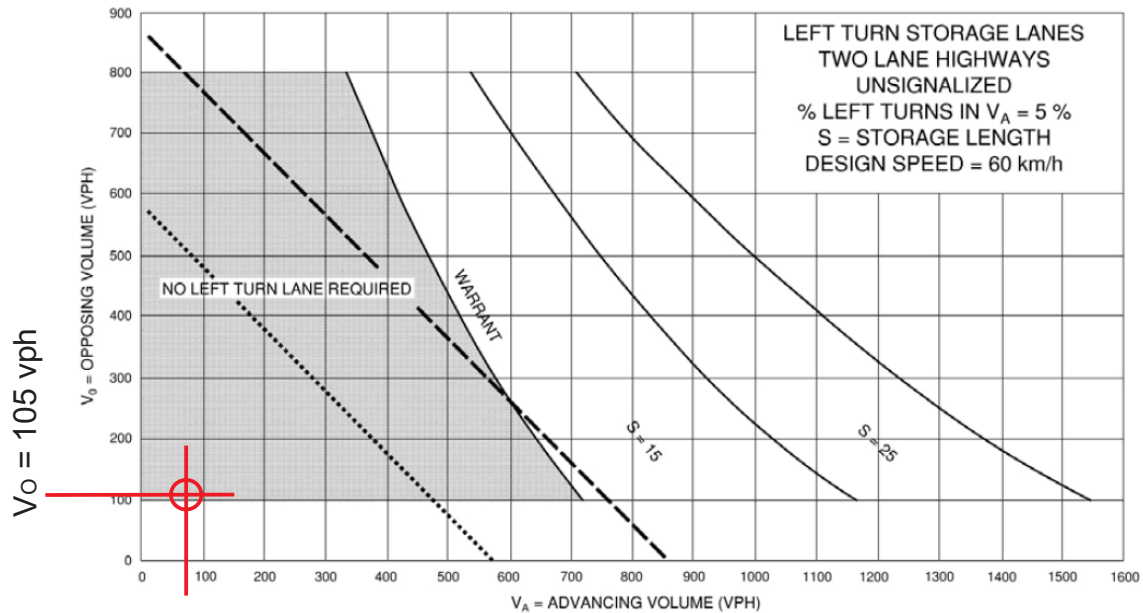
Auxiliary Turn Lane Warrant Results

Left Turn Lane Warrant Analysis

Total 2027 Traffic Volumes

East Access #1 - Southbound Left Turn

Weekday AM Peak Hour - MTO 2017 Design Supplement Exhibit 9A-6:



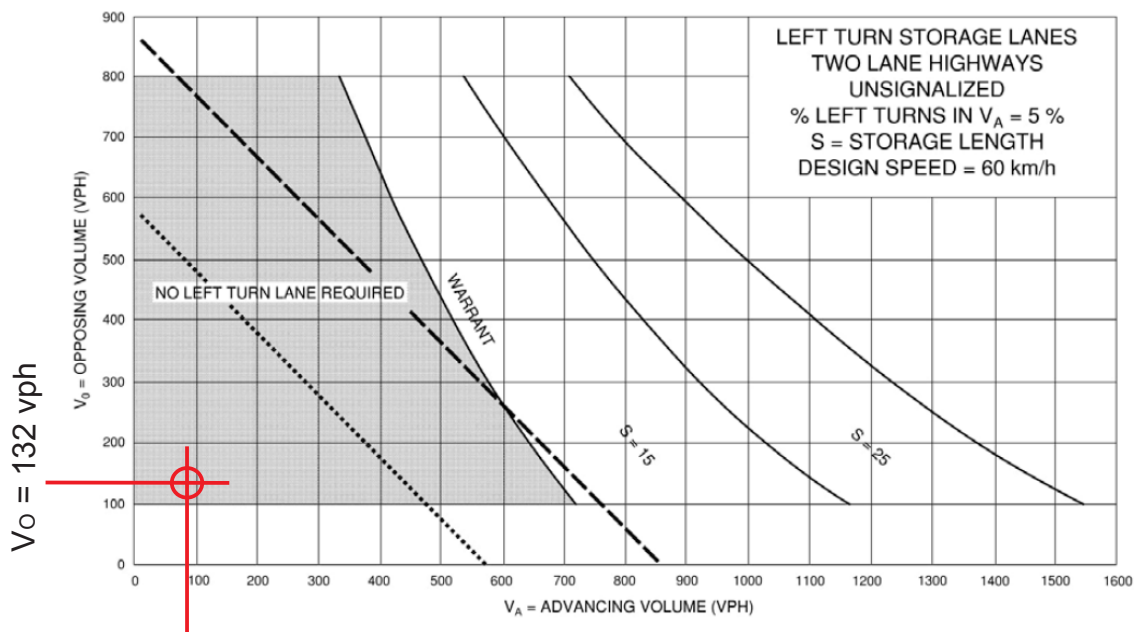
Advancing Traffic:

$V_A = 71$ vph

$V_L = 2$ vph

Left turns = 2.8%

Weekday PM Peak Hour - MTO 2017 Design Supplement Exhibit 9A-6:



Advancing Traffic:

$V_A = 90$ vph

$V_L = 2$ vph

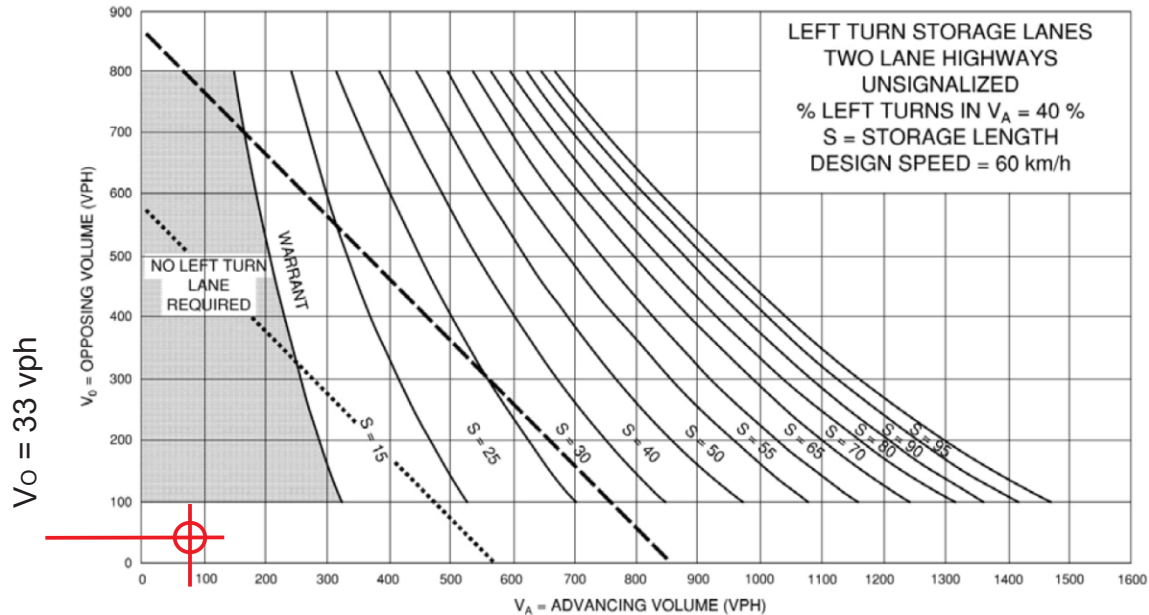
Left turns = 2.2%

Left Turn Lane Warrant Analysis

Total 2027 Traffic Volumes

West Access #2 - Northbound Left Turn

Weekday AM Peak Hour - MTO 2017 Design Supplement Exhibit 9A-9:



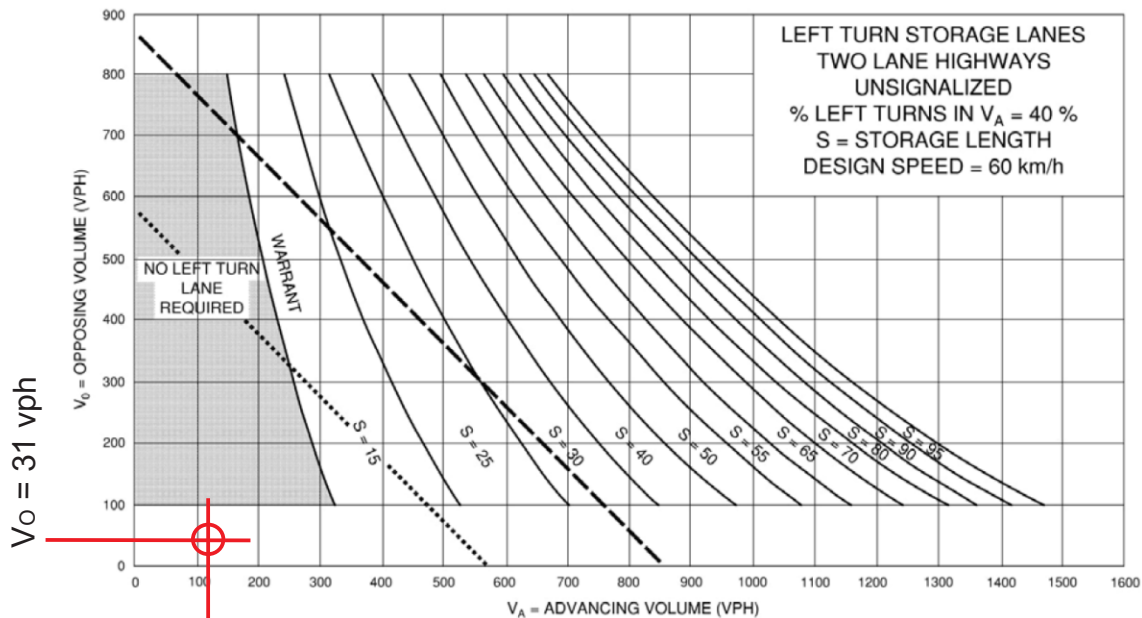
Advancing Traffic:

$V_A = 78$ vph

$V_L = 65$ vph

Left turns = 83.3%

Weekday PM Peak Hour - MTO 2017 Design Supplement Exhibit 9A-9:



Advancing Traffic:

$V_A = 107$ vph

$V_L = 57$ vph

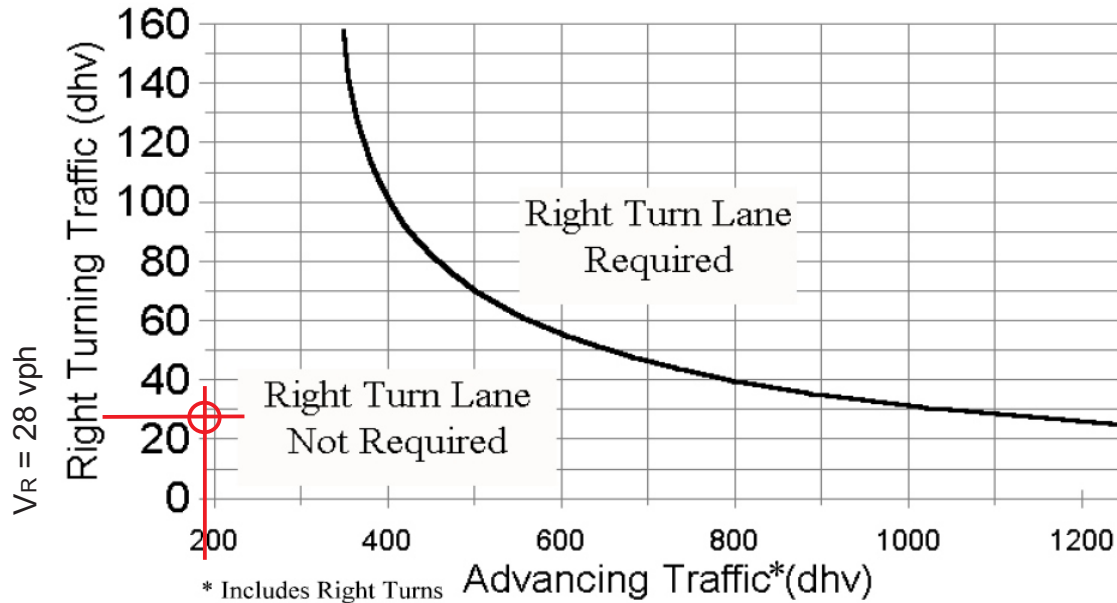
Left turns = 53.3%

Right Turn Lane Warrant Analysis

Total 2027 Traffic Volumes

East Access #1 - Northbound Right Turn

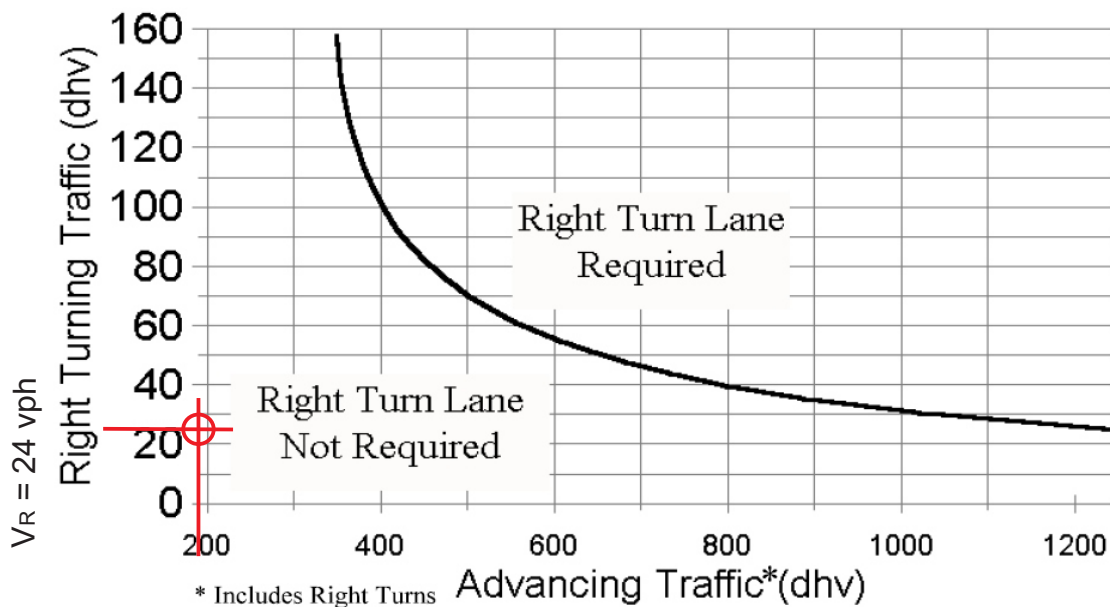
Weekday AM Peak Hour:



Advancing Traffic:

$V_A = 105$ vph

Weekday PM Peak Hour:



Advancing Traffic:

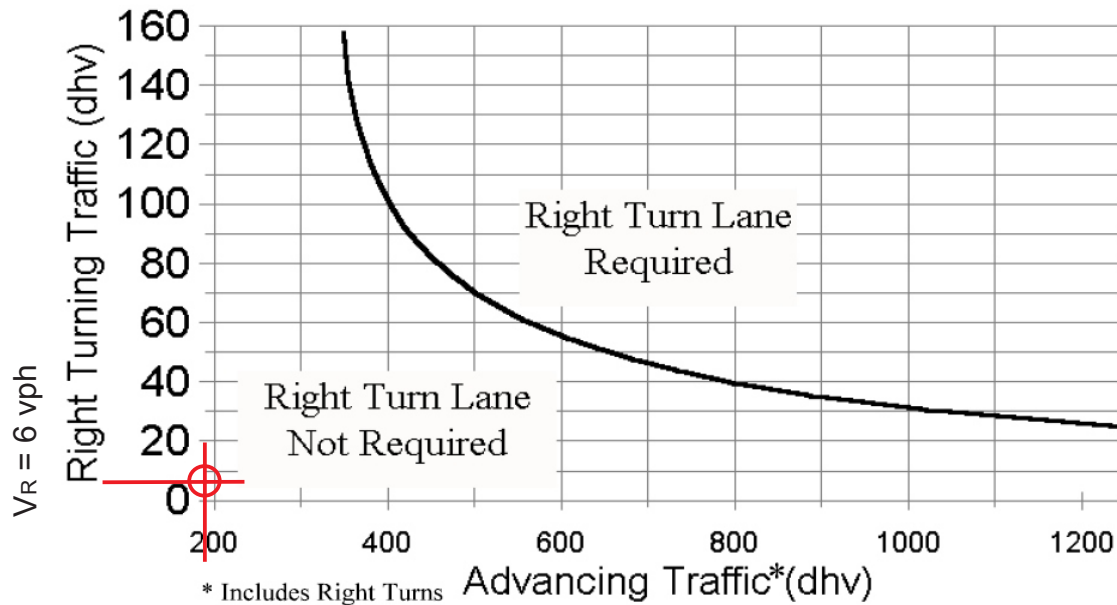
$V_A = 132$ vph

Right Turn Lane Warrant Analysis

Total 2027 Traffic Volumes

West Access #2 - Southbound Right Turn

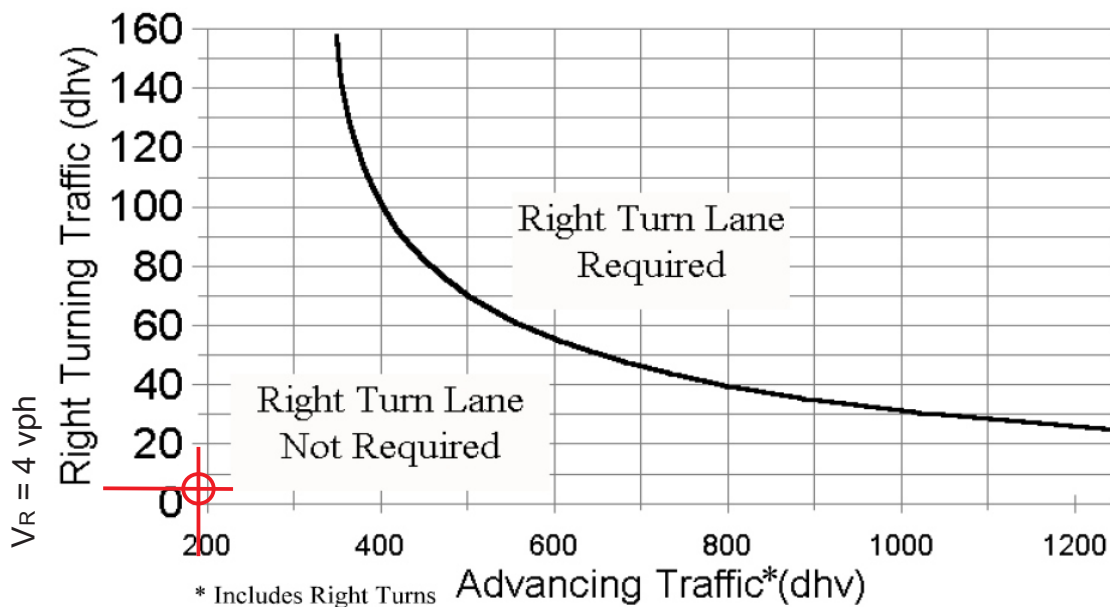
Weekday AM Peak Hour:



Advancing Traffic:

$V_A = 33$ vph

Weekday PM Peak Hour:



Advancing Traffic:

$V_A = 31$ vph

APPENDIX III

Intersection Capacity Analysis Results

DEFINITION OF LEVELS OF SERVICE

Automobile Mode

UNSIGNALIZED INTERSECTIONS

Analysis of the Level of Service for unsignalized intersections is based on the **Highway Capacity Manual (HCM 2010)** procedures using Trafficware's *Synchro 8* for unsignalized intersections. The Level of Service for intersections is based on *Control Delay*. At two way stop controlled intersections (TWSC) and All way stop controlled intersections (AWSC), *Control Delay* is the total elapsed time from a vehicle joining the queue until its departure from the stopped position at the head of the queue. The *Control Delay* also includes the time required to decelerate from a stop and to accelerate to the free-flow speed.

The analysis of individual movements at TWSC and AWSC intersections can also include the estimate of the ratio of volume or demand to available capacity for the movements. This is commonly known as the (v/c) ratio. The v/c ratio provides some indication of how well these individual intersection movements will function during peak hour periods.

Level of Service definitions for unsignalized intersections as defined by the **Highway Capacity Manual** are summarized in the table below.

Definition of Level of Service for Unsignalized Intersections (see Exhibit 19-1, Highway Capacity Manual 2010)

Level of Service	Average Delay (seconds)
A	0 - 10
B	>10-15
C	>15-25
D	>25-35
E	>35-50
F	More than 50s and/or v/c > 1

Level of Service (LoS) for TWSC and AWSC intersections is determined by the computed or measured *Control Delay* and is defined for each minor movement at the intersection. LoS is not defined for the major street approaches or the intersection as a whole. LoS "F" is considered to be undesirable for design or planning purposes. However, many individual turning movements at TWSC and AWSC intersections and commercial entrances along urban arterial corridors operate at LoS "F" during peak hour periods.

Existing 2020 Results

HCM 6th TWSC
1: Hamm. Plns Rd & Winslow

2020 Existing - AM Peak Hour

Intersection						
Int Delay, s/veh	0.5					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	2	417	448	9	17	9
Future Vol, veh/h	2	417	448	9	17	9
Conflicting Peds, #/hr	5	0	0	5	5	5
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	400	-	-	600	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	5	5
Mvmt Flow	2	453	487	10	18	10
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	502	0	-	0	954	497
Stage 1	-	-	-	-	492	-
Stage 2	-	-	-	-	462	-
Critical Hdwy	4.15	-	-	-	6.45	6.25
Critical Hdwy Stg 1	-	-	-	-	5.45	-
Critical Hdwy Stg 2	-	-	-	-	5.45	-
Follow-up Hdwy	2.245	-	-	-	3.545	3.345
Pot Cap-1 Maneuver	1047	-	-	-	283	567
Stage 1	-	-	-	-	608	-
Stage 2	-	-	-	-	628	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1043	-	-	-	280	562
Mov Cap-2 Maneuver	-	-	-	-	280	-
Stage 1	-	-	-	-	604	-
Stage 2	-	-	-	-	625	-
Approach	EB	WB		SB		
HCM Control Delay, s	0	0		16.6		
HCM LOS	C					
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1043	-	-	-	339	
HCM Lane V/C Ratio	0.002	-	-	-	0.083	
HCM Control Delay (s)	8.5	-	-	-	16.6	
HCM Lane LOS	A	-	-	-	C	
HCM 95th %tile Q(veh)	0	-	-	-	0.3	

HCM 6th TWSC
1: Hamm. Plns Rd & Winslow

2020 Existing - PM Peak Hour

Intersection						
Int Delay, s/veh	0.6					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	13	679	571	35	18	6
Future Vol, veh/h	13	679	571	35	18	6
Conflicting Peds, #/hr	5	0	0	5	5	5
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	400	-	-	600	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	5	5
Mvmt Flow	14	738	621	38	20	7
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	664	0	-	0	1397	631
Stage 1	-	-	-	-	626	-
Stage 2	-	-	-	-	771	-
Critical Hdwy	4.15	-	-	-	6.45	6.25
Critical Hdwy Stg 1	-	-	-	-	5.45	-
Critical Hdwy Stg 2	-	-	-	-	5.45	-
Follow-up Hdwy	2.245	-	-	-	3.545	3.345
Pot Cap-1 Maneuver	911	-	-	-	153	476
Stage 1	-	-	-	-	527	-
Stage 2	-	-	-	-	451	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	907	-	-	-	149	472
Mov Cap-2 Maneuver	-	-	-	-	149	-
Stage 1	-	-	-	-	517	-
Stage 2	-	-	-	-	449	-
Approach	EB	WB		SB		
HCM Control Delay, s	0.2	0		28.4		
HCM LOS	D					
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	907	-	-	-	180	
HCM Lane V/C Ratio	0.016	-	-	-	0.145	
HCM Control Delay (s)	9	-	-	-	28.4	
HCM Lane LOS	A	-	-	-	D	
HCM 95th %tile O(veh)	0	-	-	-	0.5	

Background 2027 Results

HCM 6th TWSC
1: Hamm. Plns Rd & Winslow

2027 Bkgd - AM Peak Hour

Intersection						
Int Delay, s/veh	0.5					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	2	447	480	10	18	10
Future Vol, veh/h	2	447	480	10	18	10
Conflicting Peds, #/hr	5	0	0	5	5	5
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	400	-	-	600	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	5	5
Mvmt Flow	2	486	522	11	20	11
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	538	0	-	0	1022	532
Stage 1	-	-	-	-	527	-
Stage 2	-	-	-	-	495	-
Critical Hdwy	4.15	-	-	-	6.45	6.25
Critical Hdwy Stg 1	-	-	-	-	5.45	-
Critical Hdwy Stg 2	-	-	-	-	5.45	-
Follow-up Hdwy	2.245	-	-	-	3.545	3.345
Pot Cap-1 Maneuver	1015	-	-	-	258	542
Stage 1	-	-	-	-	586	-
Stage 2	-	-	-	-	606	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1011	-	-	-	255	537
Mov Cap-2 Maneuver	-	-	-	-	255	-
Stage 1	-	-	-	-	582	-
Stage 2	-	-	-	-	604	-
Approach	EB	WB		SB		
HCM Control Delay, s	0	0		17.7		
HCM LOS	C					
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1011	-	-	-	314	
HCM Lane V/C Ratio	0.002	-	-	-	0.097	
HCM Control Delay (s)	8.6	-	-	-	17.7	
HCM Lane LOS	A	-	-	-	C	
HCM 95th %tile Q(veh)	0	-	-	-	0.3	

HCM 6th TWSC
1: Hamm. Plns Rd & Winslow

2027 Bkgd - PM Peak Hour

Intersection

Int Delay, s/veh 0.7

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	14	728	612	37	19	7
Future Vol, veh/h	14	728	612	37	19	7
Conflicting Peds, #/hr	5	0	0	5	5	5
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	400	-	-	600	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	5	5
Mvmt Flow	15	791	665	40	21	8

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	710	0	0 1496 675
Stage 1	-	-	- 670 -
Stage 2	-	-	- 826 -
Critical Hdwy	4.15	-	- 6.45 6.25
Critical Hdwy Stg 1	-	-	- 5.45 -
Critical Hdwy Stg 2	-	-	- 5.45 -
Follow-up Hdwy	2.245	-	- 3.545 3.345
Pot Cap-1 Maneuver	875	-	- 133 449
Stage 1	-	-	- 503 -
Stage 2	-	-	- 425 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	871	-	- 130 445
Mov Cap-2 Maneuver	-	-	- 130 -
Stage 1	-	-	- 492 -
Stage 2	-	-	- 423 -

Approach	EB	WB	SB
HCM Control Delay, s	0.2	0	32.1
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	871	-	-	-	161
HCM Lane V/C Ratio	0.017	-	-	-	0.176
HCM Control Delay (s)	9.2	-	-	-	32.1
HCM Lane LOS	A	-	-	-	D
HCM 95th %tile Q(veh)	0.1	-	-	-	0.6

Total 2027 Results

HCM 6th TWSC
1: Hamm. Plns Rd & Winslow

2027 Total - AM Peak Hour

Intersection

Int Delay, s/veh 2.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	53	436	470	52	45	41
Future Vol, veh/h	53	436	470	52	45	41
Conflicting Peds, #/hr	5	0	0	5	5	5
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	400	-	-	600	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	5	5
Mvmt Flow	58	474	511	57	49	45

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	573	0	0 1111 521
Stage 1	-	-	- 516 -
Stage 2	-	-	- 595 -
Critical Hdwy	4.15	-	- 6.45 6.25
Critical Hdwy Stg 1	-	-	- 5.45 -
Critical Hdwy Stg 2	-	-	- 5.45 -
Follow-up Hdwy	2.245	-	- 3.545 3.345
Pot Cap-1 Maneuver	985	-	- 228 550
Stage 1	-	-	- 593 -
Stage 2	-	-	- 545 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	981	-	- 213 545
Mov Cap-2 Maneuver	-	-	- 213 -
Stage 1	-	-	- 556 -
Stage 2	-	-	- 543 -

Approach	EB	WB	SB
HCM Control Delay, s	1	0	22.3
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	981	-	-	-	300
HCM Lane V/C Ratio	0.059	-	-	-	0.312
HCM Control Delay (s)	8.9	-	-	-	22.3
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0.2	-	-	-	1.3

HCM 6th TWSC
1: Hamm. Plns Rd & Winslow

2027 Total - PM Peak Hour

Intersection

Int Delay, s/veh 5.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	58	712	597	74	60	54
Future Vol, veh/h	58	712	597	74	60	54
Conflicting Peds, #/hr	5	0	0	5	5	5
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	400	-	-	600	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	5	5
Mvmt Flow	63	774	649	80	65	59

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	734	0	0 1559 659
Stage 1	-	-	- 654 -
Stage 2	-	-	- 905 -
Critical Hdwy	4.15	-	- 6.45 6.25
Critical Hdwy Stg 1	-	-	- 5.45 -
Critical Hdwy Stg 2	-	-	- 5.45 -
Follow-up Hdwy	2.245	-	- 3.545 3.345
Pot Cap-1 Maneuver	857	-	- 122 458
Stage 1	-	-	- 512 -
Stage 2	-	-	- 390 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	853	-	- 112 454
Mov Cap-2 Maneuver	-	-	- 112 -
Stage 1	-	-	- 472 -
Stage 2	-	-	- 388 -

Approach	EB	WB	SB
HCM Control Delay, s	0.7	0	65
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	853	-	-	-	174
HCM Lane V/C Ratio	0.074	-	-	-	0.712
HCM Control Delay (s)	9.6	-	-	-	65
HCM Lane LOS	A	-	-	-	F
HCM 95th %tile Q(veh)	0.2	-	-	-	4.4

HCM 6th TWSC

2: Winslow & East Access #1

2027 Total - AM Peak Hour

Intersection						
Int Delay, s/veh	1					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	17	1	77	28	2	69
Future Vol, veh/h	17	1	77	28	2	69
Conflicting Peds, #/hr	5	5	0	5	5	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	5	5
Mvmt Flow	18	1	84	30	2	75
Major/Minor	Minor1	Major1	Major2			
Conflicting Flow All	188	109	0	0	119	0
Stage 1	104	-	-	-	-	-
Stage 2	84	-	-	-	-	-
Critical Hdwy	6.45	6.25	-	-	4.15	-
Critical Hdwy Stg 1	5.45	-	-	-	-	-
Critical Hdwy Stg 2	5.45	-	-	-	-	-
Follow-up Hdwy	3.545	3.345	-	-	2.245	-
Pot Cap-1 Maneuver	794	937	-	-	1451	-
Stage 1	913	-	-	-	-	-
Stage 2	932	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	787	929	-	-	1445	-
Mov Cap-2 Maneuver	787	-	-	-	-	-
Stage 1	908	-	-	-	-	-
Stage 2	928	-	-	-	-	-
Approach	WB	NB		SB		
HCM Control Delay, s	9.6	0		0.2		
HCM LOS	A					
Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT		
Capacity (veh/h)	-	-	794	1445	-	
HCM Lane V/C Ratio	-	-	0.025	0.002	-	
HCM Control Delay (s)	-	-	9.6	7.5	0	
HCM Lane LOS	-	-	A	A	A	
HCM 95th %tile Q(veh)	-	-	0.1	0	-	

HCM 6th TWSC

2: Winslow & East Access #1

2027 Total - PM Peak Hour

Intersection

Int Delay, s/veh 1.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	26	2	108	24	2	88
Future Vol, veh/h	26	2	108	24	2	88
Conflicting Peds, #/hr	5	5	0	5	5	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	5	5
Mvmt Flow	28	2	117	26	2	96

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	240	140	0
Stage 1	135	-	-
Stage 2	105	-	-
Critical Hdwy	6.45	6.25	-
Critical Hdwy Stg 1	5.45	-	-
Critical Hdwy Stg 2	5.45	-	-
Follow-up Hdwy	3.545	3.345	-
Pot Cap-1 Maneuver	742	900	-
Stage 1	884	-	-
Stage 2	912	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	735	892	-
Mov Cap-2 Maneuver	735	-	-
Stage 1	880	-	-
Stage 2	908	-	-

Approach	WB	NB	SB
HCM Control Delay, s	10	0	0.2
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	-	744	1409
HCM Lane V/C Ratio	-	-	0.041	0.002
HCM Control Delay (s)	-	-	10	7.6
HCM Lane LOS	-	-	B	A
HCM 95th %tile Q(veh)	-	-	0.1	0

HCM 6th TWSC

3: West Access #2 & Winslow

2027 Total - AM Peak Hour

Intersection

Int Delay, s/veh 5.6

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	27	6	65	13	3	41
Future Vol, veh/h	27	6	65	13	3	41
Conflicting Peds, #/hr	0	5	5	0	5	5
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	5	5
Mvmt Flow	29	7	71	14	3	45

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	41
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.15
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.245
Pot Cap-1 Maneuver	-	-	1549
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	1542
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	6.2	8.8
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	986	-	-	1542	-
HCM Lane V/C Ratio	0.049	-	-	0.046	-
HCM Control Delay (s)	8.8	-	-	7.4	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.2	-	-	0.1	-

HCM 6th TWSC
5: West Access #2 & Winslow

2027 Total - PM Peak Hour

Intersection

Int Delay, s/veh 5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	27	4	57	50	4	62
Future Vol, veh/h	27	4	57	50	4	62
Conflicting Peds, #/hr	0	5	5	0	5	5
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	5	5
Mvmt Flow	29	4	62	54	4	67

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	38
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.15
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.245
Pot Cap-1 Maneuver	-	-	1553
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	1546
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	4	8.9
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	989	-	-	1546	-
HCM Lane V/C Ratio	0.073	-	-	0.04	-
HCM Control Delay (s)	8.9	-	-	7.4	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.2	-	-	0.1	-