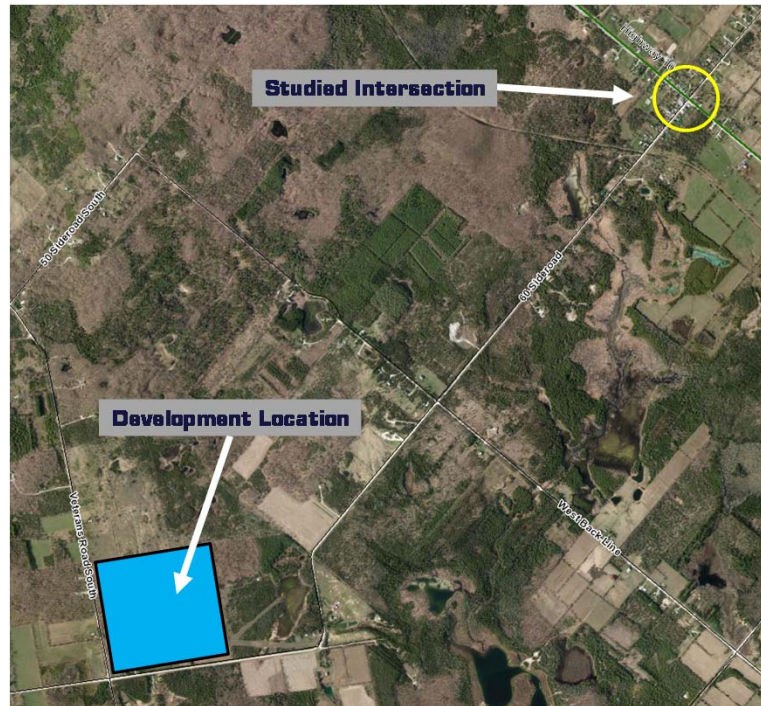




Bumstead Pit Chatsworth, ON Scoped Traffic Impact Study



**Prepared for:
GM BluePlan**

September, 2014

**Paradigm Transportation Solutions Ltd.
43 Forest Road
Cambridge ON
N1S 3B4**

✉ selkins@pts1.com
☎ 1.519.896.3163
☎ Fax: 1.866.722.5117



PROJECT SUMMARY

PROJECT NAME: **BUMSTEAD PIT**
CHATSWORTH, ONTARIO
SCOPED TRANSPORTATION IMPACT STUDY

CLIENT: **BRIAN AND PEARL BUMSTEAD**
C/O: **GAMSBY AND MANNEROW LIMITED**
1260 2ND AVENUE EAST
OWEN SOUND, ON
N4K 2J3

CLIENT PROJECT MANAGER: MR. MATTHEW NELSON, M.SC., P.ENG., P.GEO.

CONSULTANT: **PARADIGM TRANSPORTATION SOLUTIONS LIMITED**
43 FOREST ROAD
CAMBRIDGE ON N1S 3B4
PH: 519-896-3163
FAX: 1-866-722-5117

CONSULTANT PROJECT MANAGER: STEWART ELKINS, B.E.S., MITE

REPORT DATE: **SEPTEMBER 2014**
PROJECT NUMBER: **140780**



EXECUTIVE SUMMARY

CONTENT

Paradigm Transportation Solutions Limited (Paradigm) has been retained by Gamsby and Mannerow Limited, on behalf of owners Brian and Pearl Bumstead to conduct a Scoped Transportation Impact Study for the planned aggregate pit in the Township of Chatsworth. The parcel of land to be re-developed as an aggregate pit is located on the north-east corner of Side Road 60 and Veteran Road South, in the Township of Chatsworth, Ontario. The proposed development consists of an aggregate pit with a maximum annual extraction of 150,000 tonnes.

The purpose of the study is to determine the potential traffic impact of the development on the intersection of Highway 10 and Side Road 60. The scope of the study includes determination of the current traffic and site conditions in the vicinity of the development, forecasting of additional traffic that will be generated by the development, analyses of the impact of the traffic and development of recommendations on the measures required in order to accommodate this traffic in a satisfactory manner for a five and ten year planning horizon (2021 and 2026). The AM and PM peak hours were used for analysis in this report.

CONCLUSIONS

The conclusions of the report are as follows:

- ▶ currently, the intersection and all turning movements operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ by 2021 with background traffic alone, the intersection and all turning movements operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ by 2026 with background traffic alone, the intersection and all turning movements operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ the proposed development is forecasted to produce about 12 net new trips during the AM peak hour (6 in and 6 out) and 12 net new trips during the PM peak hour (6 in and 6 out);
- ▶ by 2021 with full development and occupancy of the site, the intersection and all turning movements operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ by 2026 with full development and occupancy of the site, the intersection and all turning movements operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ by 2026 with full development and occupancy of the site, traffic control signals are not warranted at the intersection of Highway 10 and Side Road 60; and
- ▶ by 2026 with full development and occupancy of the site, auxiliary turning lanes are not warranted at the intersection of Highway 10 and Side Road 60.
- ▶ Given the posted speed of 50km/h on Highway 10, the sight distances available in both the northbound and southbound directions and the relatively low volume of truck traffic there will not be the need to provide a southbound acceleration lane for trucks.



RECOMMENDATIONS

Based on the analyses contained in the report, it is recommended that:

- ▶ the reviewing agency recognize the conclusions drawn above; and
- ▶ that the proposed development be approved with no conditions related to off-site remedial transportation measures.



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1.0 INTRODUCTION

1.1 Background

Planning applications have been submitted for a new aggregate pit in the Township of Chatsworth, Ontario (**Figure 1.1**). The site is planned to have an annual extraction limit of 150,000 tonnes. It is anticipated that the trucks will leave the development site and head east towards Highway 10 in order to access the broader road network and conform with the haul route.

1.2 Purpose and Scope

Paradigm Transportation Solutions Limited (Paradigm) has been retained by Gamsby and Mannerow Limited, on behalf of owners Brian and Pearl Bumstead to conduct a Scoped Transportation Impact Study for the planned aggregate pit in the Township of Chatsworth. This study has been prepared in consideration of the Ministry of Transportation of Ontario (MTO) - Transportation Impact Study Guidelines¹ and in response to MTO comment received through application under the Aggregate Resource Act process.

The purpose of the study is to determine the impact of the additional development traffic at the intersection of Highway 10 and Side Road 60 and the improvements (if any) required to accommodate this future traffic. The scope of the study includes determination of the current traffic and site conditions in the vicinity of the development, estimates of background traffic growth in the area, estimates of the additional traffic that will be generated by the development, analyses of the impact of the traffic and recommendations on the remedial measures necessary to accommodate the future traffic in a satisfactory manner.

Based on the consultation with MTO staff, the following assumptions guided the development of this report:

- ▶ the study would assess the intersection of Highway 10 and Side Road 60;
- ▶ the analysis horizon would extend for five and ten years after construction and full occupancy of the development (i.e. 2021 and 2026, assuming 2016 opening); and
- ▶ AM and PM peak hours were analyzed to assess traffic operations.

¹ General Guidelines for the Preparation of Traffic Impact Studies, Ministry of Transportation of Ontario December 2009.

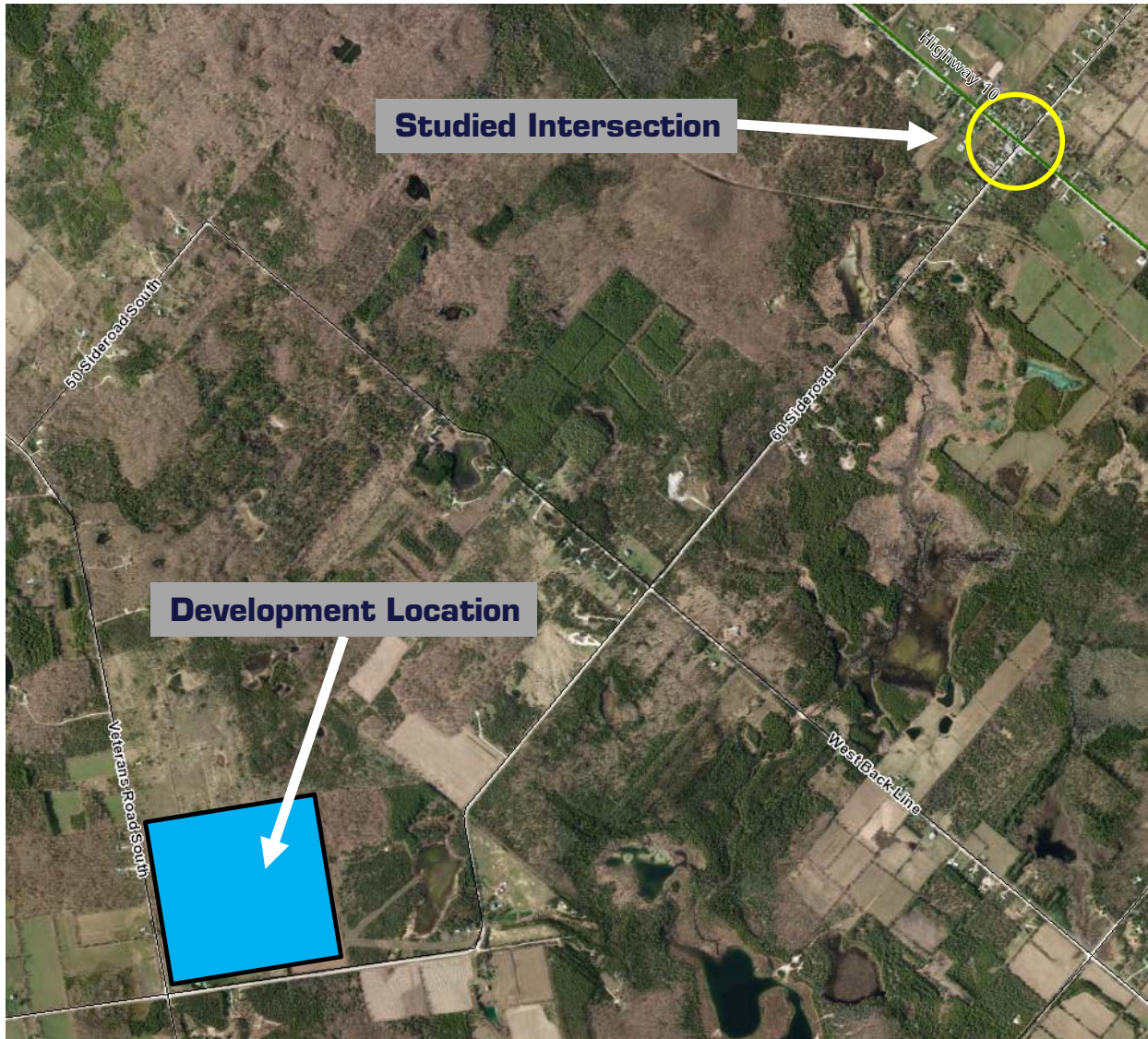


Image Source: Grey County GIS – Interactive Maps

Bumstead Pit, TIS

Figure 1.1



Location of Development



2.0 EXISTING CONDITIONS

This section documents current traffic conditions, operational deficiencies, and constraints experienced by the public traveling at the study area intersection.

2.1 Existing Roads, Transit, Cycling and Pedestrian Service

The location of the subject site in relation to the existing local area roadways is illustrated in **Figure 1.1**. The area in the immediate vicinity of the studied intersection primarily consists of residential dwellings. Extending further from the studied intersection the land use is largely agricultural. Highway 10 and Side Road 60 are both two-lane roadways with posted speed limits of 50 km/h within the study area. The intersection of Highway 10 and Side Road 60 operates under two-way stop control, with stop control along Side Road 60. There are no cycling lanes present in the study area, and sidewalks are only present along Highway 10 for approximately 200 metres north and south of Side Road 60.

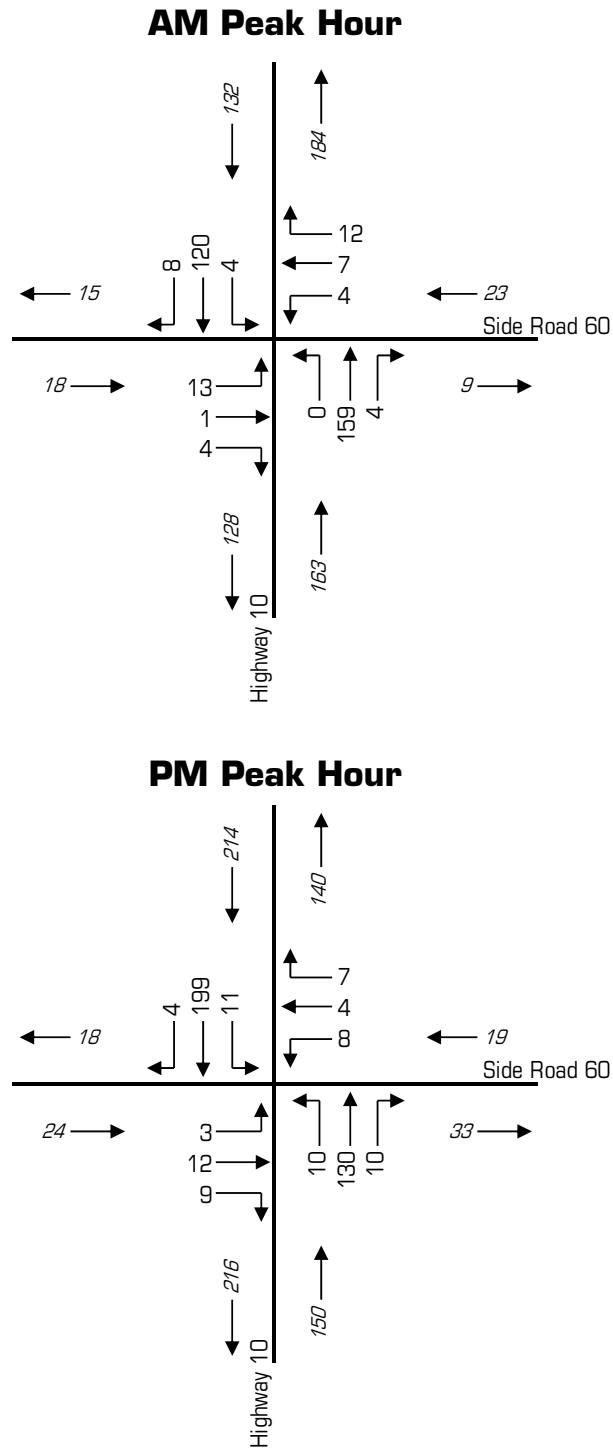
2.2 Existing Traffic Volumes

Paradigm collected turning movement counts for the intersection within the study area in June 2014.

Figure 2.1 shows the existing AM and PM peak hour traffic volumes.

From the collected traffic volumes the total two-way peak hour traffic volumes on Highway 10 near the site range from approximately 315 vehicles in the AM peak hour to 365 vehicles during the PM peak hour, both of which are well within the maximum accepted capacity for a two-lane highway (1800).

In order to design the worst case scenario for analysis, the traffic volumes were adjusted to represent the peak time of year. Utilizing the adjustment factors for “Intermediate Recreation” designated roads prepared by MTO, it was determined that the collected volumes (early June) needed to be multiplied by a factor of 1.098 in order to represent the peak yearly conditions in early August. After applying the expansion factor, it was determined that the total two-way peak hour traffic volumes on Highway 10 near the site range from approximately 350 vehicles in the AM peak hour to 400 vehicles during the PM peak hour, both of which are well within the maximum accepted capacity for a two-lane highway (1800). **Figure 2.2** shows the adjusted existing AM and PM peak hour traffic volumes.

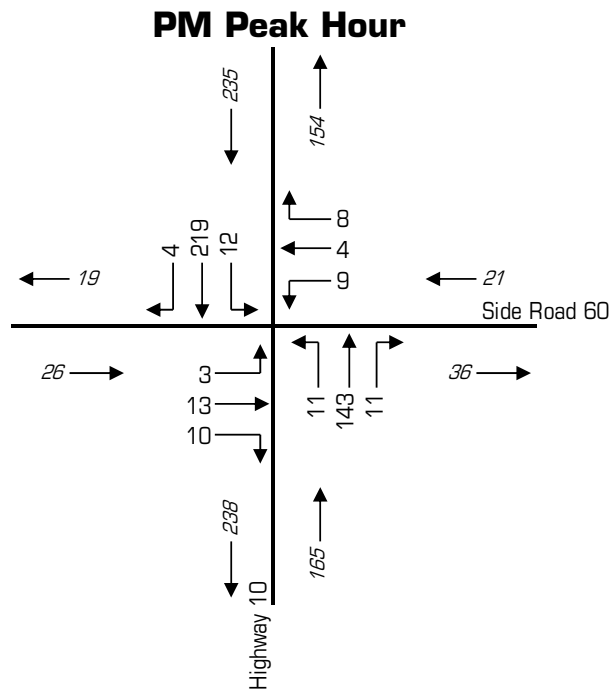
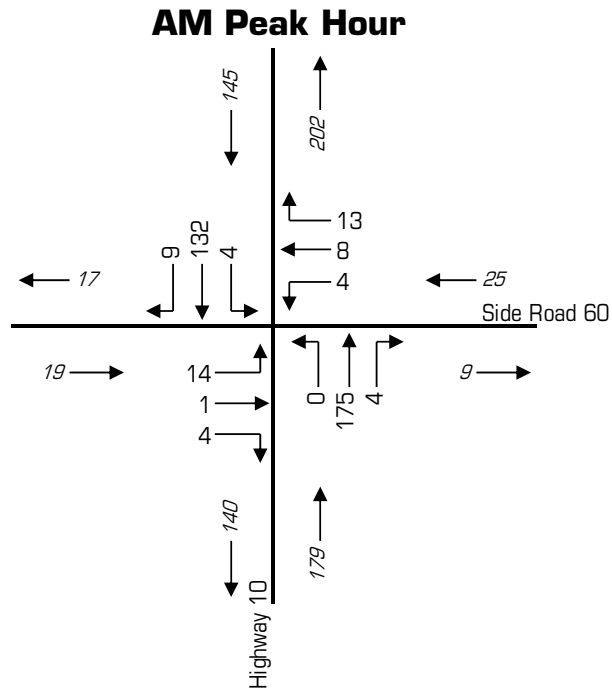


Bumstead Pit, TIS



Figure 2.1

**2014 Peak Hours
Existing Traffic Volumes**



Bumstead Pit, TIS

Figure 2.2



2014 Peak Hours Adjusted Existing Traffic Volumes



2.3 Existing Traffic Operations

Intersection level of service (LOS) is a recognized method of quantifying the delays to traffic flow at intersections. It is based on the delay experienced by individual vehicles executing the various movements. The delay is related to the number of vehicles desiring to make a particular movement, compared to the estimated capacity for that movement. The capacity is based on a number of criteria related to the opposing traffic flows and intersection geometry.

The highest possible rating is LOS A, under which the average total delay is equal or less than 10.0 seconds per vehicle. When the average delay exceeds 80 seconds for signalized intersections or 50 seconds for unsignalized intersections, the movement is classed as LOS F and remedial measures are usually implemented, if they are feasible.

The intersection analysis considered two separate measures of performance:

- ▶ the volume to capacity ratio for each intersection; and
- ▶ the level of service (LOS) for each turning movement which is based on the average control delay per vehicle.

The operation of the intersection within the study area was evaluated using Synchro v8 with the existing turning movement volumes. **Table 2.1** summarizes the operations. Based on the analysis, the following is noted:

- ▶ currently the intersection and all turning movements within the study area operate at acceptable overall levels of service during the AM and PM peak hours; and
- ▶ it is estimated that only one vehicle will be queued to turn onto Side Road 60 at a time.

Appendix A provides the detailed Synchro v8 outputs for the existing traffic operations, and adjusted existing traffic operations.

TABLE 2.1: EXISTING (2014) TRAFFIC OPERATIONS

Analysis Period	Intersection	Control Type	MDE	Direction / Movement / Approach																OVERALL	
				Eastbound				Westbound				Northbound				Southbound					
				LEFT	THROUGH	RIGHT	APPROACH	LEFT	THROUGH	RIGHT	APPROACH	LEFT	THROUGH	RIGHT	APPROACH	LEFT	THROUGH	RIGHT	APPROACH		
Existing Traffic Volumes AM Peak Hour	Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A	
			Delay	11	11	11	11	10	10	10	10	0	0	0	0	0	0	0	0	0	1
			V/C	0.03	0.03	0.03		0.04	0.04	0.04		0.00	0.00	0.00		0.00	0.00	0.01			
Existing Traffic Volumes PM Peak Hour	Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A	
			Delay	11	11	11	11	11	11	11	11	1	1	0	1	1	1	0	1	2	
			V/C	0.04	0.04	0.04		0.03	0.03	0.03		0.01	0.01	0.01		0.01	0.01	0.00			
Adjusted Existing Traffic Volumes AM Peak Hour	Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A	
			Delay	11	11	11	11	11	11	11	11	0	0	0	0	0	0	0	0	1	
			V/C	0.03	0.03	0.03		0.04	0.04	0.04		0.00	0.00	0.00		0.00	0.00	0.01			
Adjusted Existing Traffic Volumes PM Peak Hour	Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A	
			Delay	12	12	12	12	12	12	12	12	1	1	0	1	1	1	0	1	2	
			V/C	0.05	0.05	0.05		0.04	0.04	0.04		0.01	0.01	0.01		0.01	0.01	0.00			



3.0 DEVELOPMENT CONCEPT

3.1 Development Description

The parcel of land to be re-developed as an aggregate pit is located on the north-east corner of Side Road 60 and Veteran Road South, in the Township of Chatsworth, Ontario. The proposed development consists of an aggregate pit with a maximum annual extraction of 150,000 tonnes.

3.2 Development Trip Generation, Distribution and Assignment

For the purposes of forecasting traffic demand that will be generated by the proposed development calculations based on utilizing the maximum licensed extraction completed by Gamsby and Mannerow Engineers in their report titled "Road Assessment Proposed Class 'A' Gravel Pit"² in May 2013 were used.

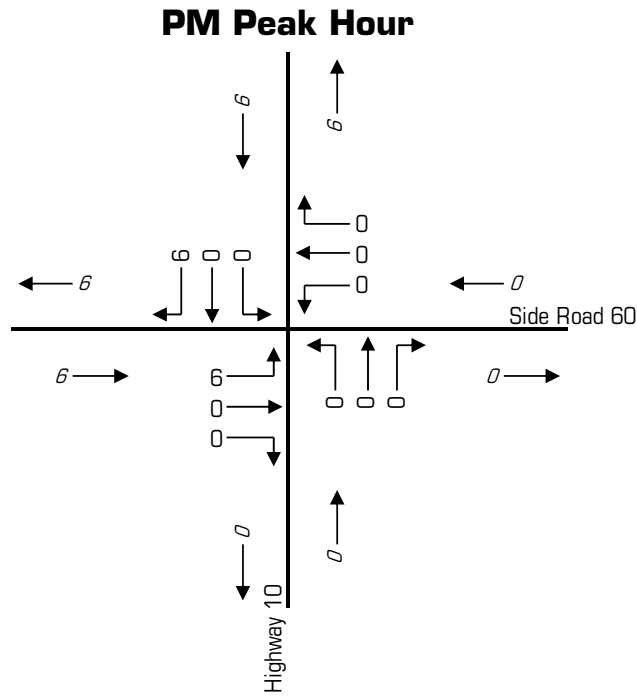
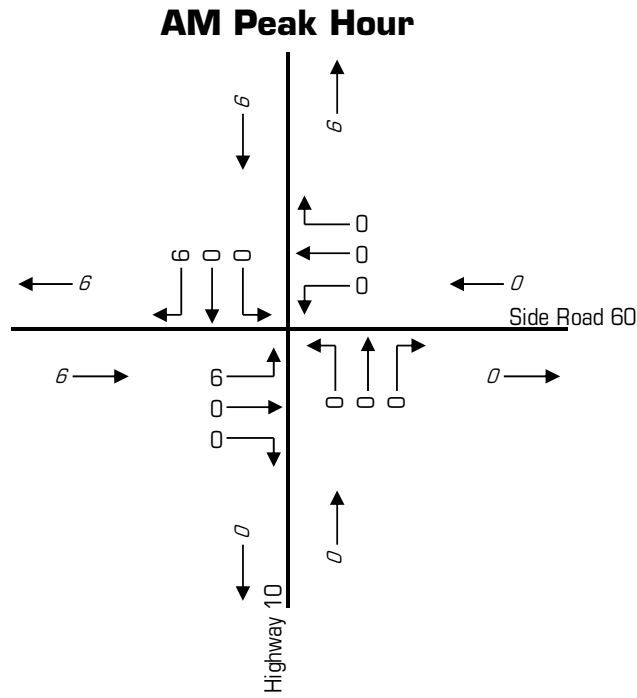
The proposed aggregate pit is licensed to extract 150,000 tonnes per year. Based upon a five day work week (170 working day season) and load capacity of 22 tonnes/load, an average of 80 trips per day (40 into the site, 40 out). Assuming an 11 hour work day, results in an estimated 7.3 trips per hour (rounded to 4 in, 4 out). It was also determined that in the event of local hauling project for road construction or a new subdivision, more trucks may be required for the project. This would be considered a peak traffic event, and an estimated 6 trucks would be running per hour, resulting in 12 trips per hour (6 in, 6 out). It should be noted that if this extraction pace were sustained, the pit would only be able to be open for 103 working days per year, before the extraction limited is reached. Extraction at this rate would exhaust the pit in 11 years.

In order to remain conservative with our assumptions and calculations, it was assumed that the worst case scenario would be to assess the traffic impacts operating under peak conditions. Therefore, the site is estimated to have site generated traffic in the amount of 12 trips per hour (6 in, 6 out).

It was determined that the trip distribution would be largely dependent upon the location of the project which requires aggregate. Given that vehicles will either travel north or south along Highway 10, it was determined that 2 scenarios should be considered; assigning all traffic to the north, and assigning all traffic to the south.

Figure 3.1 illustrates Scenario 1 in which the site generated traffic volumes are assigned to the north for the AM and PM peak hours. **Figure 3.2** illustrates Scenario 2 in which the site generated traffic volumes are assigned to the south for the AM and PM peak hours.

² Road Assessment Proposed Class "A" Gravel Pit, Gamsby and Mannerow Limited, May 2013

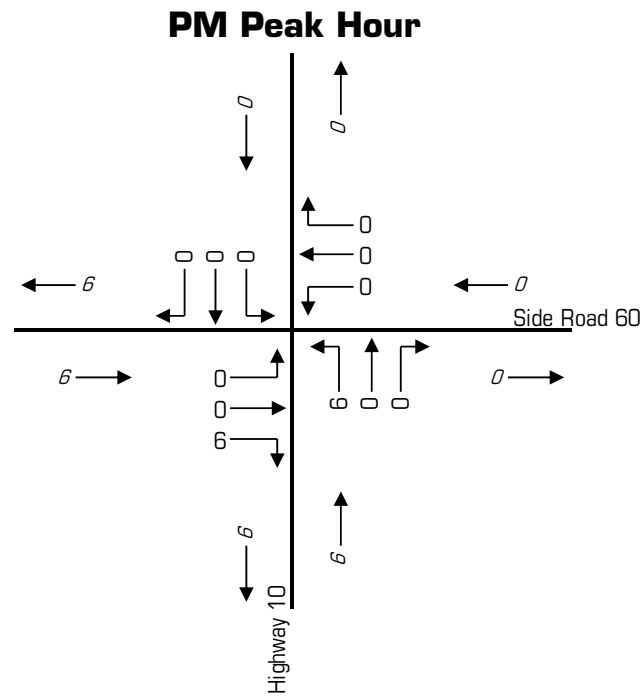
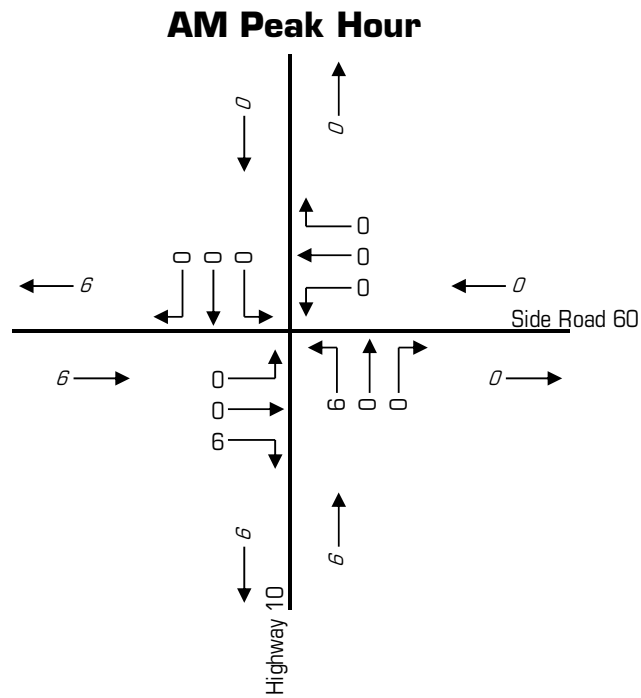


Bumstead Pit, TIS



Figure 3.1

Site Generated Traffic Volumes (Heading North)



Bumstead Pit, TIS



Figure 3.2

**Site Generated Traffic Volumes
(Heading South)**



4.0 EVALUATION OF FUTURE TRAFFIC CONDITIONS

The assessment of future traffic conditions contained in this section includes estimates of future background and total traffic and analysis for a five and ten year planning horizon beyond an assumed 2016 Opening Day, in order to adequately identify the impacts of the development. The future traffic volumes in the vicinity of the development will likely consist of increased non-site traffic volumes (background traffic) and the traffic generated by the proposed development (site traffic).

4.1 Background Traffic Growth (2021 and 2026)

The non-site traffic increase is generalized traffic growth in the vicinity of the studied intersection and as such the generalized growth is anticipated to follow the average increase in traffic within the area. Collecting traffic data from the historical volumes published within the Ministry of Transportation Provincial Highways Traffic Volumes Report³ an average growth rate could be calculated for the studied section of Highway 10. **Figure 4.1** displays the results of this data collection. It was determined that between the years 1988 and 2010 an observed growth rate of 2.1% per annum occurred for the Annual Average Daily Traffic (AADT). Therefore this growth rate (2.1% per annum) was used for the forecast background traffic.

The horizon year of 2021 was chosen based upon five years from opening of the aggregate pit, (assuming an opening date within 2016). **Figure 4.2** and **Figure 4.3** show the 2021 and 2026 background traffic for the AM and PM peak hours, respectively.

4.2 Background Traffic Operations (2021 and 2026)

Based on the forecast 2021 and 2026 background traffic volumes, LOS analyses have been conducted using Synchro v8 to determine the AM and PM peak hour conditions for the intersections within the study area. **Table 4.1** summarizes the 2021 and 2026 background traffic operations. Based on the analysis, the following is noted:

- ▶ by 2021 with background traffic alone, the intersection and all turning movements within the study area operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ by 2026 with background traffic alone, the intersection and all turning movements within the study area operate at acceptable overall levels of service during the AM and PM peak hours; and
- ▶ it is estimated that only one vehicle will be queued to turn onto Side Road 60 at a time.

Appendix B provides the detailed Synchro v8 outputs for the 2021 and 2026 background traffic operations.

³ Provincial Highways – Traffic Volumes 1988-2010, Ministry of Transportation of Ontario, Highway Standard Branch, 2010



TABLE 4.1: BACKGROUND (2021 AND 2026) TRAFFIC OPERATIONS

Analysis Period	Intersection	Control Type	MOE	Direction / Movement / Approach																OVERALL
				Eastbound				Westbound				Northbound				Southbound				
				LEFT	THROUGH	RIGHT	APPROACH	LEFT	THROUGH	RIGHT	APPROACH	LEFT	THROUGH	RIGHT	APPROACH	LEFT	THROUGH	RIGHT	APPROACH	
2021 Background Traffic Volumes AM Peak Hour	Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A
			Delay	12	12	12	12	11	11	11	11	0	0	0	0	0	0	0	0	1
			V/C	0.04	0.04	0.04		0.05	0.05	0.05		0.00	0.00	0.00		0.00	0.00	0.01		
2021 Background Traffic Volumes PM Peak Hour	Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A
			Delay	12	12	12	12	12	12	12	12	1	1	0	1	1	1	0	1	2
			V/C	0.06	0.06	0.06		0.05	0.05	0.05		0.01	0.01	0.01		0.01	0.01	0.00		
2026 Background Traffic Volumes AM Peak Hour	Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A
			Delay	12	12	12	12	11	11	11	11	0	0	0	0	0	0	0	0	2
			V/C	0.05	0.05	0.05		0.06	0.06	0.06		0.00	0.00	0.00		0.00	0.00	0.01		
2026 Background Traffic Volumes PM Peak Hour	Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A
			Delay	13	13	13	13	13	13	13	13	1	1	0	1	1	1	0	1	2
			V/C	0.07	0.07	0.07		0.06	0.06	0.06		0.01	0.01	0.01		0.01	0.01	0.00		

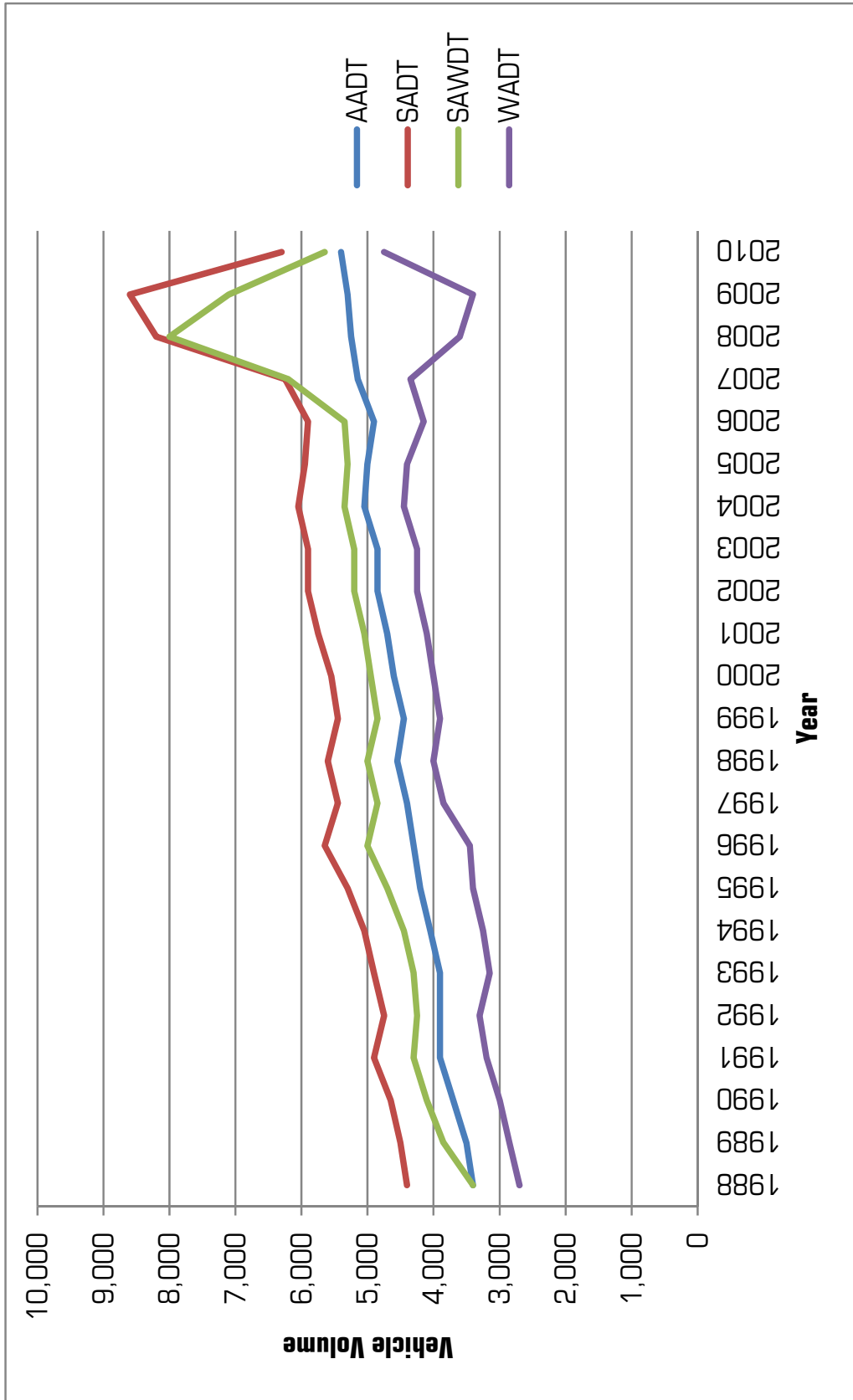
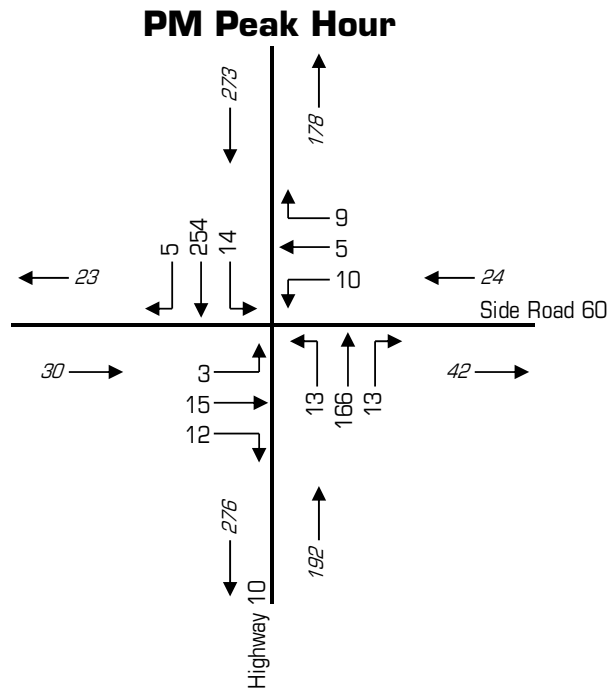
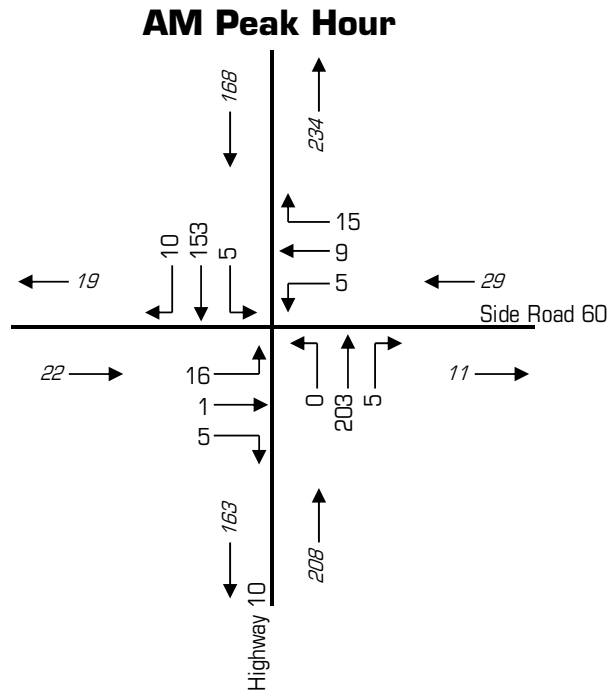


Figure 4.1

Historical Traffic Volumes

Bumstead Pit, TIS



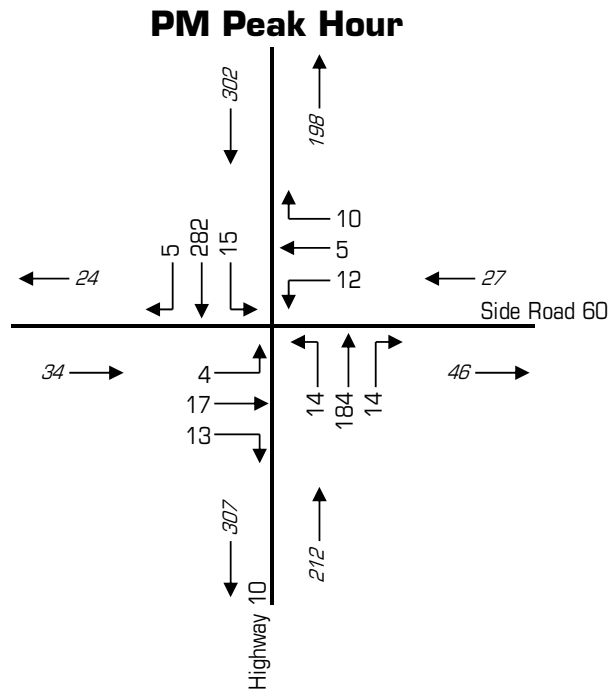
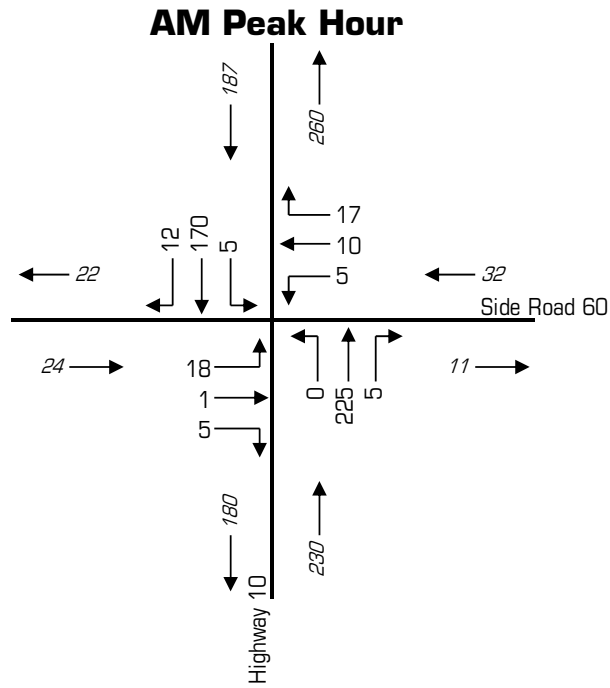


Bumstead Pit, TIS



Figure 4.2

**2021 Peak Hours
Background Traffic Volumes**



Bumstead Pit, TIS



Figure 4.3

**2026 Peak Hours
Background Traffic Volumes**



4.3 Total Traffic Operations (2021 and 2026)

Total traffic is the background volumes added to the site generated volumes. With two scenarios for the site generated traffic, total conditions were assessed for both 2021 and 2026, under both scenarios.

Figure 4.4 and **Figure 4.5** display the 2021 total traffic volumes for the AM and PM peak hour, for Scenario 1 and Scenario 2, respectively. **Figure 4.6** and **Figure 4.7** display the 2026 total traffic volumes for the AM and PM peak hour, for Scenario 1 and Scenario 2, respectively.

Based on the forecast 2021 and 2026 total traffic volumes, LOS analyses have been conducted using Synchro v8 and the AM and PM peak hour conditions for the study area. **Table 4.3** summarizes the Total Traffic LOS conditions. Based on the analyses, the following is noted:

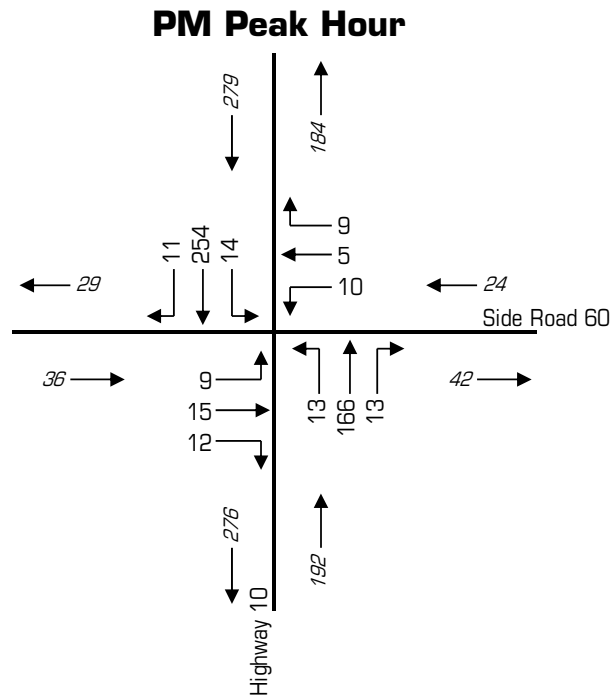
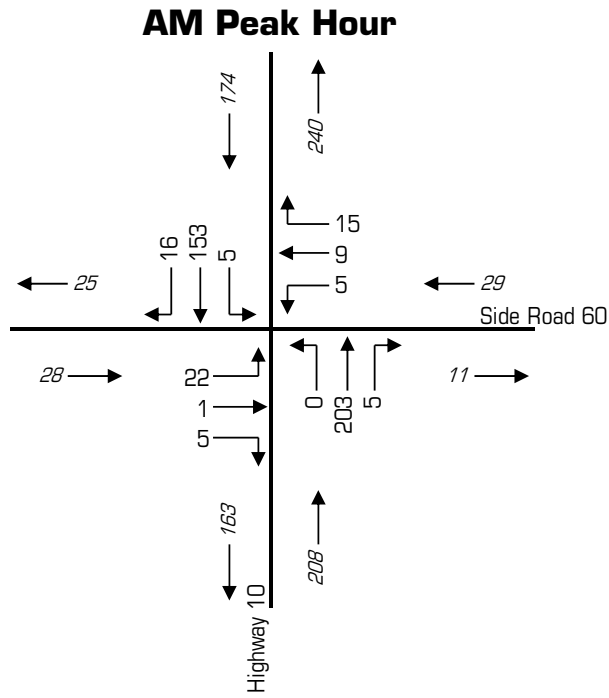
- ▶ by 2021 with full development and occupancy of the site under Scenario 1 (Heading North), the intersection and all turning movements within the study area operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ by 2021 with full development and occupancy of the site under Scenario 2 (Heading South), the intersection and all turning movements within the study area operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ by 2026 with full development and occupancy of the site under Scenario 1 (Heading North), the intersection and all turning movements within the study area operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ by 2026 with full development and occupancy of the site under Scenario 2 (Heading South), the intersection and all turning movements within the study area operate at acceptable overall levels of service during the AM and PM peak hours; and
- ▶ it is estimated that only one vehicle will be queued to turn onto Side Road 60 at a time.

Appendix C provides the detailed Synchro v8 outputs for the 2021 and 2026 total traffic operations.



TABLE 4.2: TOTAL (2021 AND 2026) TRAFFIC OPERATIONS

Analysis Period	Intersection	Control Type	MOE	Direction / Movement / Approach																OVERALL
				Eastbound				Westbound				Northbound				Southbound				
				LEFT	THROUGH	RIGHT	APPROACH	LEFT	THROUGH	RIGHT	APPROACH	LEFT	THROUGH	RIGHT	APPROACH	LEFT	THROUGH	RIGHT	APPROACH	
2021 Total Traffic Volumes	Scenario 1 Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A
			Delay	12	12	12	12	11	11	11	11	0	0	0	0	0	0	0	0	2
			V/C	0.06	0.06	0.06		0.05	0.05	0.05		0.00	0.00	0.00		0.00	0.00	0.01		
	Scenario 1 Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A
			Delay	13	13	13	13	12	12	12	12	1	1	0	1	1	1	0	1	2
			V/C	0.08	0.08	0.08		0.05	0.05	0.05		0.01	0.01	0.01		0.01	0.01	0.01		
	Scenario 2 Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A
			Delay	12	12	12	12	11	11	11	11	0	0	0	0	0	0	0	0	2
			V/C	0.05	0.05	0.05		0.05	0.05	0.05		0.01	0.01	0.00		0.00	0.00	0.01		
	Scenario 2 Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A
			Delay	12	12	12	12	12	12	12	12	1	1	0	1	1	1	0	1	2
			V/C	0.07	0.07	0.07		0.05	0.05	0.05		0.02	0.02	0.01		0.01	0.01	0.00		
2026 Total Traffic Volumes	Scenario 1 Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A
			Delay	13	13	13	13	11	11	11	11	0	0	0	0	0	0	0	0	2
			V/C	0.07	0.07	0.07		0.06	0.06	0.06		0.00	0.00	0.00		0.00	0.00	0.01		
	Scenario 1 Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A
			Delay	14	14	14	14	13	13	13	13	1	1	0	1	1	1	0	1	2
			V/C	0.10	0.10	0.10		0.06	0.06	0.06		0.01	0.01	0.01		0.01	0.01	0.01		
	Scenario 2 Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A
			Delay	12	12	12	12	11	11	11	11	0	0	0	0	0	0	0	0	2
			V/C	0.06	0.06	0.06		0.06	0.06	0.06		0.00	0.00	0.00		0.00	0.00	0.01		
	Scenario 2 Highway 10 & Side Road 60	TWSC	LOS	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A
			Delay	13	13	13	13	13	13	13	13	1	1	0	1	1	1	0	1	2
			V/C	0.09	0.09	0.09		0.06	0.06	0.06		0.02	0.02	0.01		0.01	0.01	0.00		

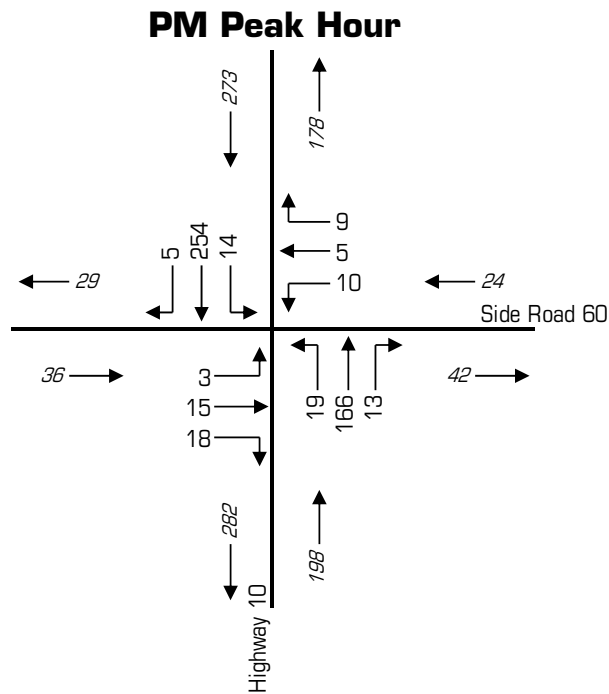
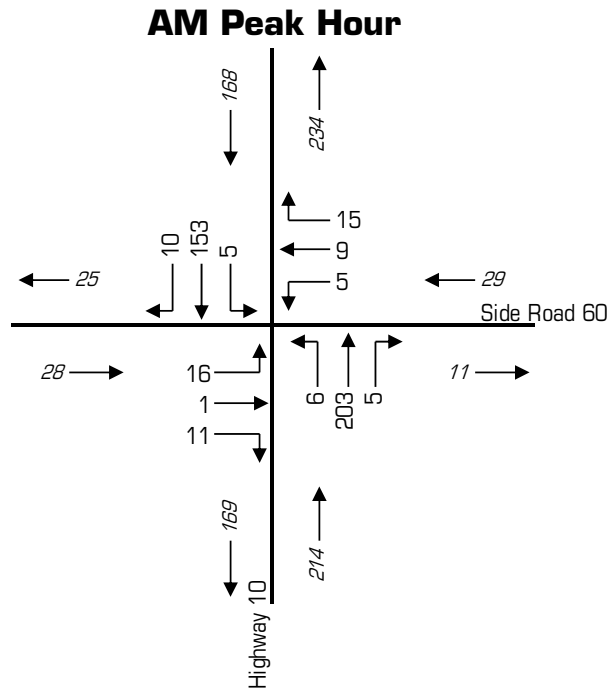


Bumstead Pit, TIS



Figure 4.4

**2021 Peak Hours
Scenario 1 Total Traffic Volumes**

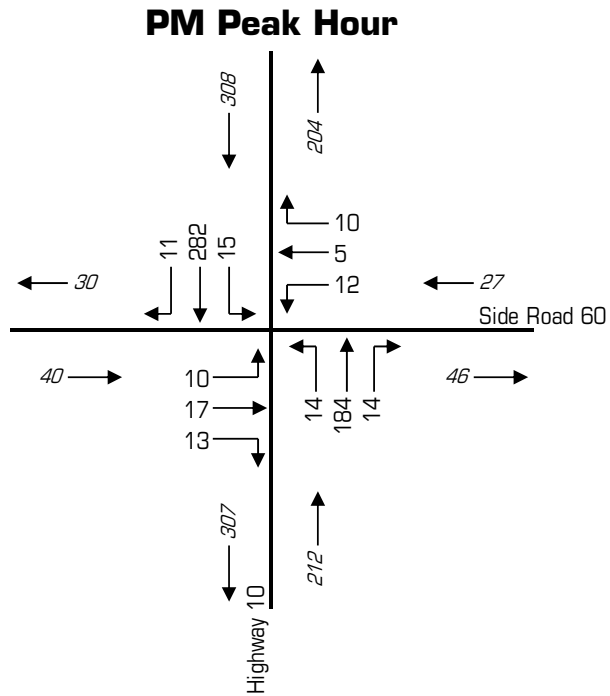
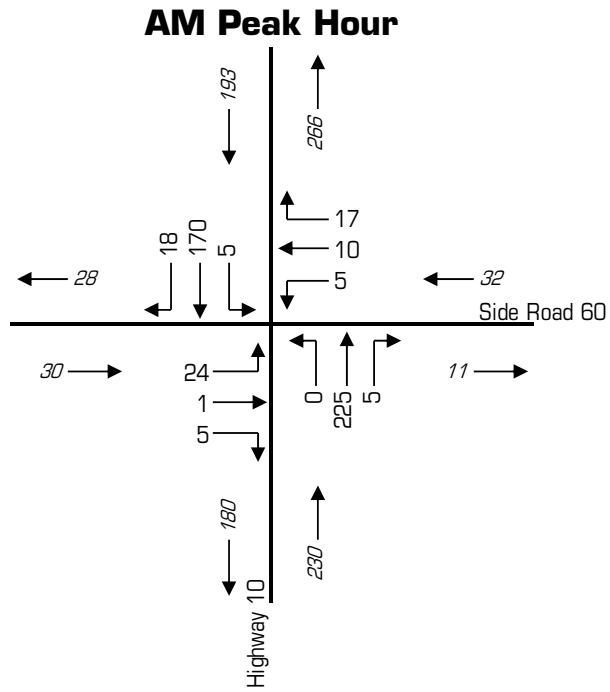


Bumstead Pit, TIS



Figure 4.5

**2021 Peak Hours
Scenario 2 Total Traffic Volumes**

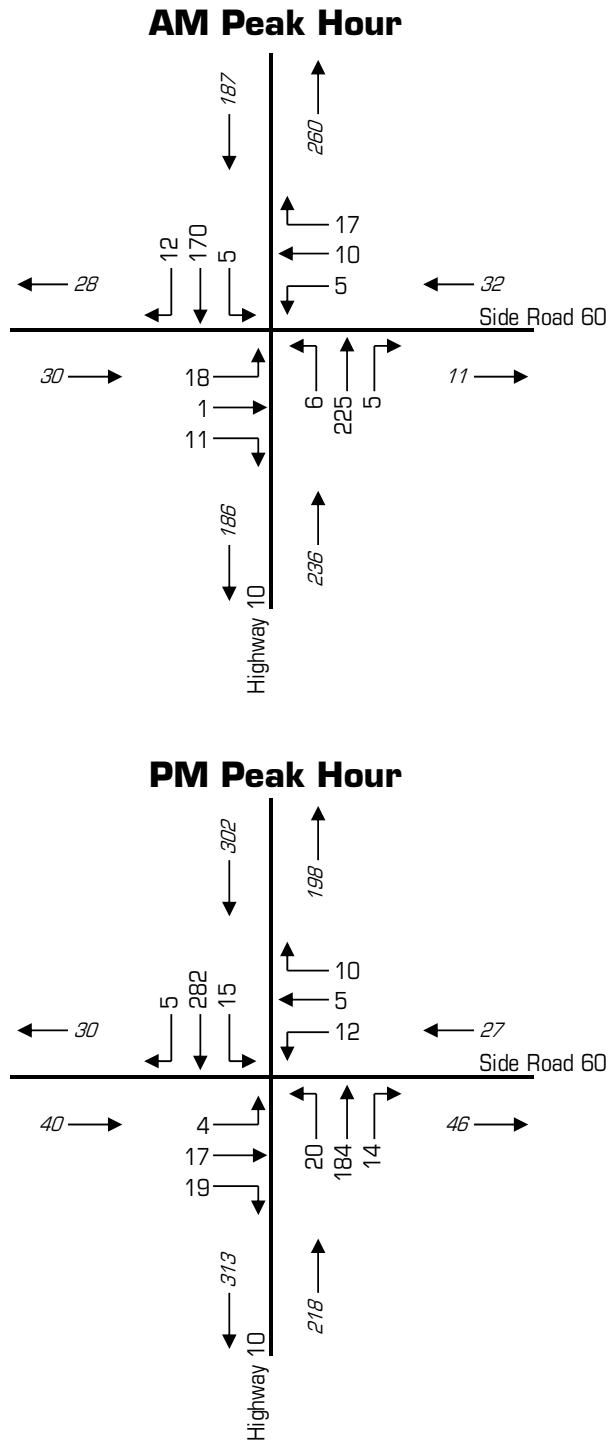


Bumstead Pit, TIS



Figure 4.6

**2026 Peak Hours
Scenario 1 Total Traffic Volumes**



Bumstead Pit, TIS



Figure 4.7

**2026 Peak Hours
Scenario 2 Total Traffic Volumes**



5.0 REMEDIAL MEASURES

The following sections review what, if any, measures should be implemented to mitigate the increases in delay resulting from the development of the site.

5.1 Traffic Control Signal Warrant

Using the OTM Book 12 Warrant System⁴ and the 2026 future total traffic conditions for both Scenario 1 and Scenario 2, a signal warrant was calculated for the intersection of Highway 10 and Side Road 60. It was found that a traffic control signal would not be warranted at any of the intersections under future total traffic conditions, based on the need to meet 120% of the warrant requirements for future forecasts.

Appendix D shows the results of these calculations.

5.2 Auxiliary Turn Lanes

Additionally, the need for turning lanes at intersections within the study area was assessed using the Ministry of Transportation procedures detailed in the Geometric Design Manual⁵. With the posted speed limit of 50 km/h, standard practice would account for a design speed of 60 km/h.

Utilizing the worst case scenario for left-turning vehicles from Highway 10 (Scenario 2 – work site in south), it was determined that a northbound left turn would be not be warranted. **Figure 5.1** displays the nomographs that represent the traffic volumes. Within these nomographs 5% of the advancing volume is assumed to be turning left for the northbound AM peak hour and 10% of the advancing volume is assumed to be turning left for the northbound PM peak hour.

Additionally, the need for a southbound left-turn lane was also assessed, and was found to not be warranted. **Figure 5.2** displays the nomographs for the southbound left-turn lane warrants.

5.3 Sight Distance Analysis

In June 2014, Paradigm staff performed a site visit, during which available sight distances were assessed at the proposed intersections. It was determined that from the west leg of the studied intersection, sightlines extended to the south for approximately 200 metres (655 ft), and to the north for greater than 400 metres (1300 ft).

In order for a passenger vehicle to turn left or right onto a two-lane roadway and attain operating speed, without causing approaching vehicles to overtake or reduce speed, a sight-distance of approximately 180 metres is required. Based upon the available sight distances which both exceed the minimum of 180 metres there is less potential for vehicle conflicts to occur. Additionally, based upon the traffic volumes and capacity analyses, it is anticipated that there should be sufficient gaps available, such that a vehicle can turn onto Highway 10 safely and without much delay. As well, the minimum decision sight distance, which is the minimum distance required for a vehicle to recognize a hazard in the road and adequately make a decision to either stop their vehicle or avoid the object is approximately 165 m. Due to the available 200 metres sight distance south of Side Road 60 and 400 metre sight distance north of Side Road 60, it can

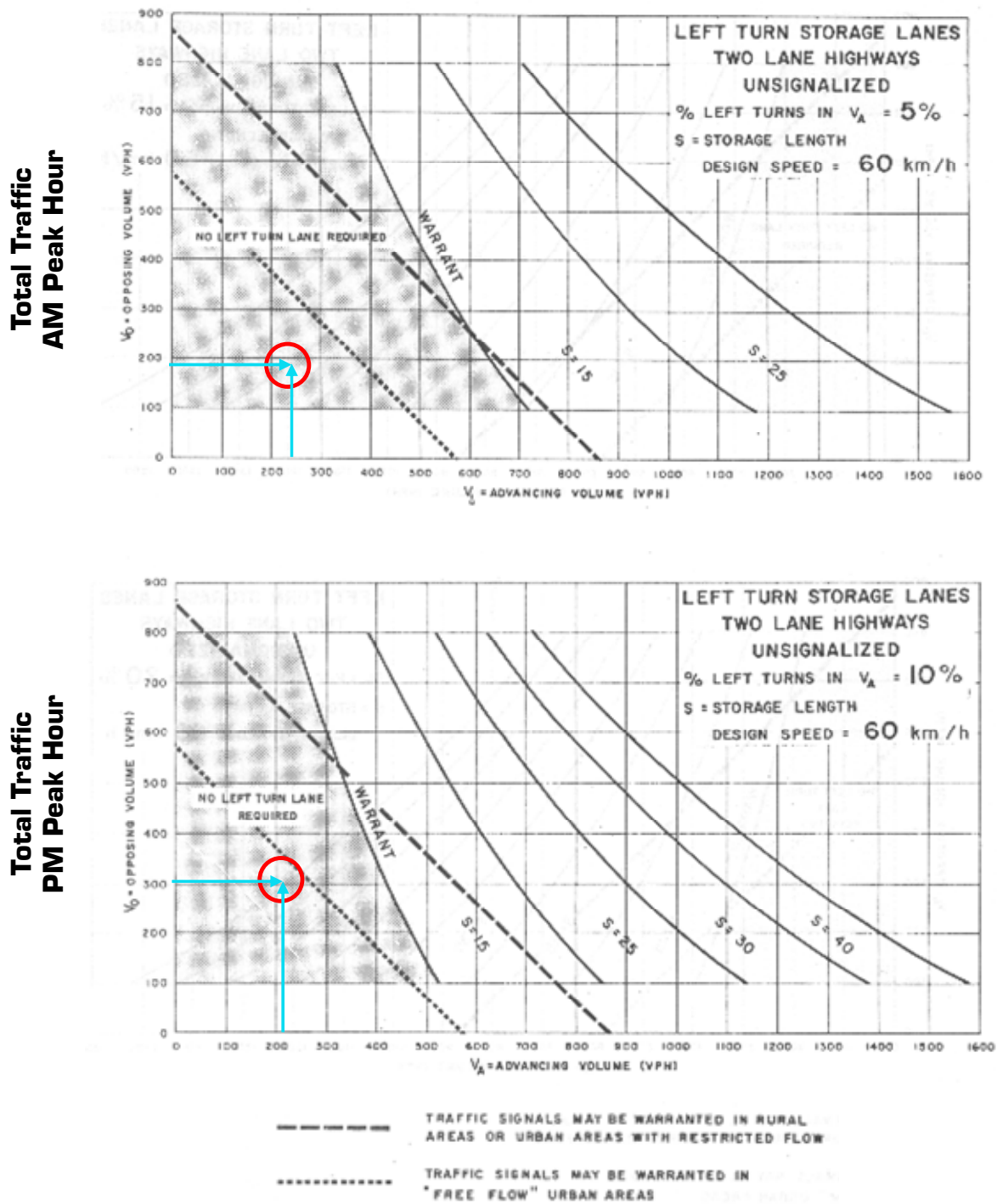
⁴ *Ontario Traffic Manual – Book 12 – Traffic Signals, Ministry of Transportation of Ontario, Queen's Printer for Ontario, 2007*

⁵ *Geometric Design Manual for Ontario Highways, Ministry of Transportation of Ontario, Queen's Printer for Ontario, 1986*



be determined that based upon the MTO guidelines, there is sufficient sight distance at the studied intersection. **Figure 5.3** displays the sight distance requirements.

Figure 5.1: Hwy 10 and Side Road 60 (Total Traffic) Northbound Left Turn Lane Warrant Analysis

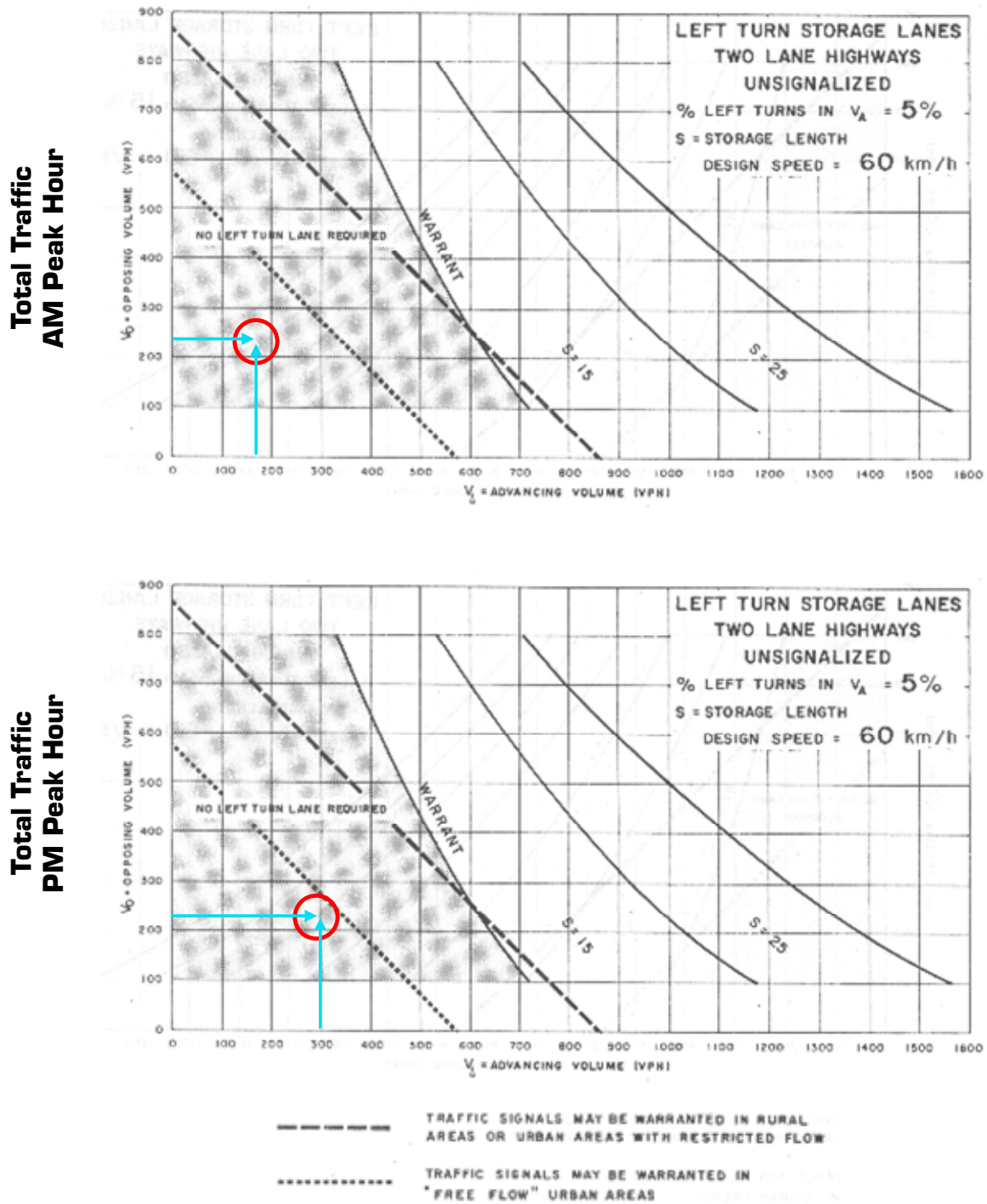


Bumstead Pit, TIS

Figure 5.1



**Hwy 10 and Side Road 60 (Total Traffic)
Northbound Left Turn Lane Warrant Analysis**



Bumstead Pit, TIS

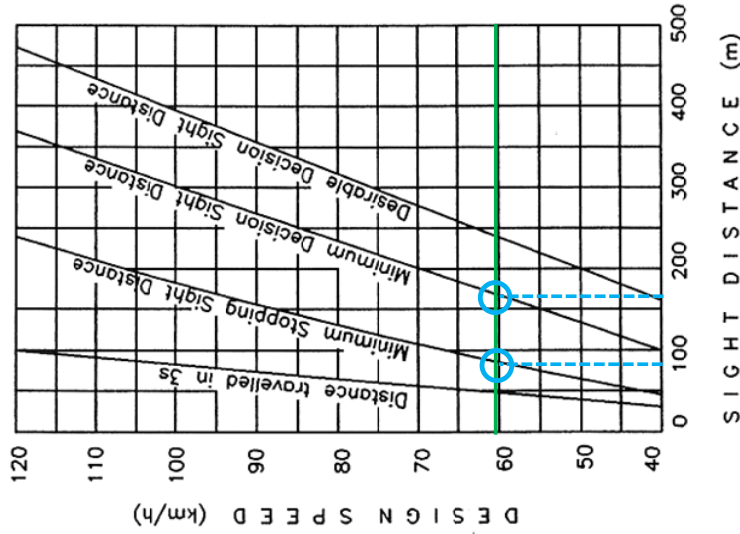
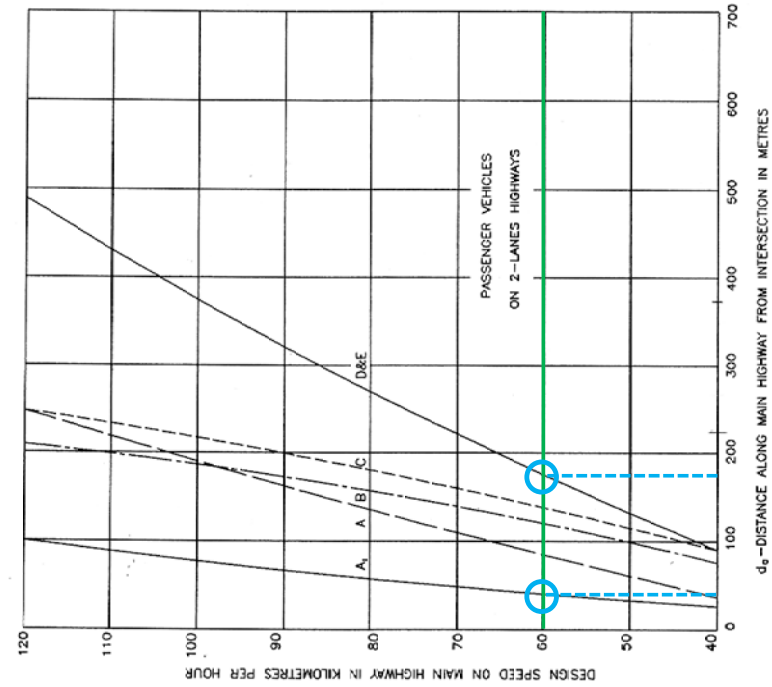
Figure 5.2



**Hwy 10 and Side Road 60 (Total Traffic)
 Southbound Left Turn Lane Warrant Analysis**



- A - Minimum Stopping Sight Distance, Table E3-1.
- A1- Distance travelled in 3 s, Table E3-2.
- B - Safe Sight Distance for P vehicle, crossing 2-lane highway from stop.
- C - Safe Sight Distance for P vehicle, turning left into 2-lane highway and attain assumed operating speed before being overtaken by P vehicle approaching in same direction at design speed.
- D - Safe Sight Distance for P vehicle to turn left into 2-lane highway and attain assumed operating speed before being overtaken by P vehicle approaching in same direction at design speed.
- E - Safe Sight Distance for P vehicle to turn right into 2-lane highway and attain assumed operating speed before being overtaken by P vehicle approaching in same direction at design speed.



Bumstead Pit, TIS



Figure 5.3

Sight Distance Requirements



6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The conclusions of the report are as follows:

- ▶ currently, the intersection and all turning movements operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ by 2021 with background traffic alone, the intersection and all turning movements operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ by 2026 with background traffic alone, the intersection and all turning movements operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ the proposed development is forecasted to produce about 12 net new trips during the AM peak hour (6 in and 6 out) and 12 net new trips during the PM peak hour (6 in and 6 out);
- ▶ by 2021 with full development and occupancy of the site, the intersection and all turning movements operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ by 2026 with full development and occupancy of the site, the intersection and all turning movements operate at acceptable overall levels of service during the AM and PM peak hours;
- ▶ by 2026 with full development and occupancy of the site, traffic control signals are not warranted at the intersection of Highway 10 and Side Road 60; and
- ▶ by 2026 with full development and occupancy of the site, auxiliary turning lanes are not warranted at the intersection of Highway 10 and Side Road 60.
- ▶ Given the posted speed of 50km/h on Highway 10, the sight distances available in both the northbound and southbound directions and the relatively low volume of traffic there will not be the need to provide a southbound acceleration lane for trucks.

6.2 Recommendations

Based on the analyses contained in the report, it is recommended that:

- ▶ the reviewing agency recognize the conclusions drawn above; and
- ▶ that the proposed development be approved with no conditions related to off-site remedial transportation measures.

Appendix A

Existing Traffic Operations Analyses

HCM Unsignalized Intersection Capacity Analysis
 1: Hwy 10 & Side Road 60

2014 Existing AM
 Bumstead Pit



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↑	↗		↑	↗
Volume (veh/h)	13	1	4	4	7	12	0	159	4	4	120	8
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	14	1	4	4	8	13	0	173	4	4	130	9
Pedestrians					4							
Lane Width (m)					3.6							
Walking Speed (m/s)					1.2							
Percent Blockage					0							
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	329	320	130	321	325	177	139			181		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	329	320	130	321	325	177	139			181		
tC, single (s)	7.1	6.5	6.2	7.1	6.8	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.3	3.3	2.2			2.2		
p0 queue free %	98	100	100	99	99	98	100			100		
cM capacity (veh/h)	609	596	925	627	548	869	1457			1402		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	20	25	173	4	135	9
Volume Left	14	4	0	0	4	0
Volume Right	4	13	0	4	0	9
cSH	658	698	1457	1700	1402	1700
Volume to Capacity	0.03	0.04	0.00	0.00	0.00	0.01
Queue Length 95th (m)	0.7	0.9	0.0	0.0	0.1	0.0
Control Delay (s)	10.6	10.4	0.0	0.0	0.3	0.0
Lane LOS	B	B			A	
Approach Delay (s)	10.6	10.4	0.0		0.3	
Approach LOS	B	B				

Intersection Summary		
Average Delay		1.4
Intersection Capacity Utilization	26.8%	ICU Level of Service
Analysis Period (min)		15
		A

HCM Unsignalized Intersection Capacity Analysis

1: Hwy 10 & Side Road 60

2014 Existing PM
Bumstead Pit



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔	↔		↔	↔
Volume (veh/h)	3	12	9	8	4	7	10	130	10	11	199	4
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	13	10	9	4	8	11	141	11	12	216	4
Pedestrians					2			3			1	
Lane Width (m)					3.6			3.6			3.6	
Walking Speed (m/s)					1.2			1.2			1.2	
Percent Blockage					0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	414	416	219	425	410	144	221			154		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	414	416	219	425	410	144	221			154		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	99	97	99	98	99	99	99			99		
cM capacity (veh/h)	536	521	823	517	525	906	1303			1436		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	26	21	152	11	228	4
Volume Left	3	9	11	0	12	0
Volume Right	10	8	0	11	0	4
cSH	606	617	1303	1700	1436	1700
Volume to Capacity	0.04	0.03	0.01	0.01	0.01	0.00
Queue Length 95th (m)	1.1	0.8	0.2	0.0	0.2	0.0
Control Delay (s)	11.2	11.0	0.6	0.0	0.5	0.0
Lane LOS	B	B	A		A	
Approach Delay (s)	11.2	11.0	0.6		0.5	
Approach LOS	B	B				



















Intersection Summary

Average Delay	1.6
Intersection Capacity Utilization	33.6%
ICU Level of Service	A
Analysis Period (min)	15

HCM Unsignalized Intersection Capacity Analysis



















1: Hwy 10 & Side Road 60

2014 Adjusted Existing AM
Bumstead Pit

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	14	1	4	4	8	13	0	175	4	4	132	9
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	15	1	4	4	9	14	0	190	4	4	143	10
Pedestrians					4							
Lane Width (m)					3.6							
Walking Speed (m/s)					1.2							
Percent Blockage					0							
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	361	351	143	351	356	194	153			199		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	361	351	143	351	356	194	153			199		
tC, single (s)	7.1	6.5	6.2	7.1	6.8	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.3	3.3	2.2			2.2		
p0 queue free %	97	100	100	99	98	98	100			100		
cM capacity (veh/h)	578	573	909	599	525	849	1440			1381		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total	21	27	190	4	148	10						
Volume Left	15	4	0	0	4	0						
Volume Right	4	14	0	4	0	10						
cSH	626	672	1440	1700	1381	1700						
Volume to Capacity	0.03	0.04	0.00	0.00	0.00	0.01						
Queue Length 95th (m)	0.8	1.0	0.0	0.0	0.1	0.0						
Control Delay (s)	10.9	10.6	0.0	0.0	0.2	0.0						
Lane LOS	B	B			A							
Approach Delay (s)	10.9	10.6	0.0		0.2							
Approach LOS	B	B										
Intersection Summary												
Average Delay			1.4									
Intersection Capacity Utilization			27.7%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
1: Hwy 10 & Side Road 60

2014 Adjusted Existing PM
Bumstead Pit

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	3	13	10	9	4	8	11	143	11	12	219	4
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	14	11	10	4	9	12	155	12	13	238	4
Pedestrians					2			3			1	
Lane Width (m)					3.6			3.6			3.6	
Walking Speed (m/s)					1.2			1.2			1.2	
Percent Blockage					0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	455	457	241	466	450	158	242			169		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	455	457	241	466	450	158	242			169		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	99	97	99	98	99	99	99			99		
cM capacity (veh/h)	502	493	801	482	497	890	1279			1418		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total	28	23	167	12	251	4						
Volume Left	3	10	12	0	13	0						
Volume Right	11	9	0	12	0	4						
cSH	580	588	1279	1700	1418	1700						
Volume to Capacity	0.05	0.04	0.01	0.01	0.01	0.00						
Queue Length 95th (m)	1.2	1.0	0.2	0.0	0.2	0.0						
Control Delay (s)	11.5	11.4	0.6	0.0	0.5	0.0						
Lane LOS	B	B	A		A							
Approach Delay (s)	11.5	11.4	0.6		0.5							
Approach LOS	B	B										
Intersection Summary												
Average Delay			1.7									
Intersection Capacity Utilization			35.7%		ICU Level of Service				A			
Analysis Period (min)			15									

Appendix B

2021 / 2026 Background Traffic Operations Analyses

HCM Unsignalized Intersection Capacity Analysis

1: Hwy 10 & Side Road 60

2021 Background AM
Bumstead Pit



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↑	↗		↖	↗
Volume (veh/h)	16	1	5	5	9	15	0	203	5	5	153	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	17	1	5	5	10	16	0	221	5	5	166	11
Pedestrians					5							
Lane Width (m)					3.6							
Walking Speed (m/s)					1.2							
Percent Blockage					0							
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	419	408	166	409	414	226	177			231		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	419	408	166	409	414	226	177			231		
tC, single (s)	7.1	6.5	6.2	7.1	6.8	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.3	3.3	2.2			2.2		
p0 queue free %	97	100	99	99	98	98	100			100		
cM capacity (veh/h)	526	531	883	547	486	815	1411			1343		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	24	32	221	5	172	11
Volume Left	17	5	0	0	5	0
Volume Right	5	16	0	5	0	11
cSH	579	629	1411	1700	1343	1700
Volume to Capacity	0.04	0.05	0.00	0.00	0.00	0.01
Queue Length 95th (m)	1.0	1.3	0.0	0.0	0.1	0.0
Control Delay (s)	11.5	11.0	0.0	0.0	0.3	0.0
Lane LOS	B	B			A	
Approach Delay (s)	11.5	11.0	0.0		0.3	
Approach LOS	B	B				

Intersection Summary		
Average Delay		1.4
Intersection Capacity Utilization	29.2%	ICU Level of Service
Analysis Period (min)		15
		A

HCM Unsignalized Intersection Capacity Analysis

1: Hwy 10 & Side Road 60

2021 Background PM
Bumstead Pit



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕	↕		↕	↕
Volume (veh/h)	3	15	12	10	5	9	13	166	13	14	254	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	16	13	11	5	10	14	180	14	15	276	5
Pedestrians					2			3			1	
Lane Width (m)					3.6			3.6			3.6	
Walking Speed (m/s)					1.2			1.2			1.2	
Percent Blockage					0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	529	531	279	541	523	183	282			197		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	529	531	279	541	523	183	282			197		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	99	96	98	97	99	99	99			99		
cM capacity (veh/h)	446	446	763	425	451	862	1236			1386		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	33	26	195	14	291	5
Volume Left	3	11	14	0	15	0
Volume Right	13	10	0	14	0	5
cSH	535	532	1236	1700	1386	1700
Volume to Capacity	0.06	0.05	0.01	0.01	0.01	0.00
Queue Length 95th (m)	1.6	1.2	0.3	0.0	0.3	0.0
Control Delay (s)	12.2	12.1	0.7	0.0	0.5	0.0
Lane LOS	B	B	A		A	
Approach Delay (s)	12.2	12.1	0.6		0.5	
Approach LOS	B	B				

Intersection Summary		
Average Delay		1.7
Intersection Capacity Utilization	40.3%	ICU Level of Service
Analysis Period (min)		15
		A

HCM Unsignalized Intersection Capacity Analysis
1: Hwy 10 & Side Road 60

2026 Background AM
Bumstead Pit



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕	↕		↕	↕
Volume (veh/h)	18	1	5	5	10	17	0	225	5	5	170	12
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	20	1	5	5	11	18	0	245	5	5	185	13
Pedestrians					5							
Lane Width (m)					3.6							
Walking Speed (m/s)					1.2							
Percent Blockage					0							
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	464	451	185	451	458	250	198			255		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	464	451	185	451	458	250	198			255		
tC, single (s)	7.1	6.5	6.2	7.1	6.8	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.3	3.3	2.2			2.2		
p0 queue free %	96	100	99	99	98	98	100			100		
cM capacity (veh/h)	488	503	863	512	457	791	1387			1316		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	26	35	245	5	190	13
Volume Left	20	5	0	0	5	0
Volume Right	5	18	0	5	0	13
cSH	537	602	1387	1700	1316	1700
Volume to Capacity	0.05	0.06	0.00	0.00	0.00	0.01
Queue Length 95th (m)	1.2	1.5	0.0	0.0	0.1	0.0
Control Delay (s)	12.0	11.3	0.0	0.0	0.3	0.0
Lane LOS	B	B			A	
Approach Delay (s)	12.0	11.3	0.0		0.2	
Approach LOS	B	B				

Intersection Summary		
Average Delay		1.5
Intersection Capacity Utilization	30.4%	ICU Level of Service
Analysis Period (min)		15
		A

HCM Unsignalized Intersection Capacity Analysis
 1: Hwy 10 & Side Road 60

2026 Background PM
 Bumstead Pit



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↑	↗		↑	↗
Volume (veh/h)	4	17	13	12	5	10	14	184	14	15	282	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	4	18	14	13	5	11	15	200	15	16	307	5
Pedestrians					3			4			1	
Lane Width (m)					3.6			3.6			3.6	
Walking Speed (m/s)					1.2			1.2			1.2	
Percent Blockage					0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	584	588	311	600	578	204	312			218		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	584	588	311	600	578	204	312			218		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	99	96	98	97	99	99	99			99		
cM capacity (veh/h)	407	413	732	384	418	839	1204			1360		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	37	29	215	15	323	5
Volume Left	4	13	15	0	16	0
Volume Right	14	11	0	15	0	5
cSH	494	489	1204	1700	1360	1700
Volume to Capacity	0.07	0.06	0.01	0.01	0.01	0.00
Queue Length 95th (m)	1.9	1.5	0.3	0.0	0.3	0.0
Control Delay (s)	12.9	12.8	0.7	0.0	0.5	0.0
Lane LOS	B	B	A		A	
Approach Delay (s)	12.9	12.8	0.6		0.5	
Approach LOS	B	B				



















Intersection Summary		
Average Delay		1.9
Intersection Capacity Utilization	43.3%	ICU Level of Service
Analysis Period (min)		15
		A

Appendix C

2021 / 2026 Total Traffic Operations Analyses



















HCM Unsignalized Intersection Capacity Analysis
1: Hwy 10 & Side Road 60

2021 Scenario 1 Total AM
Bumstead Pit

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	22	1	5	5	9	15	0	203	5	5	153	16
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	24	1	5	5	10	16	0	221	5	5	166	17
Pedestrians					5							
Lane Width (m)					3.6							
Walking Speed (m/s)					1.2							
Percent Blockage					0							
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	419	408	166	409	420	226	184			231		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	419	408	166	409	420	226	184			231		
tC, single (s)	7.4	6.5	6.2	7.1	6.8	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.7	4.0	3.3	3.5	4.3	3.3	2.2			2.2		
p0 queue free %	95	100	99	99	98	98	100			100		
cM capacity (veh/h)	482	531	883	547	481	815	1403			1343		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total	30	32	221	5	172	17						
Volume Left	24	5	0	0	5	0						
Volume Right	5	16	0	5	0	17						
cSH	527	627	1403	1700	1343	1700						
Volume to Capacity	0.06	0.05	0.00	0.00	0.00	0.01						
Queue Length 95th (m)	1.5	1.3	0.0	0.0	0.1	0.0						
Control Delay (s)	12.3	11.0	0.0	0.0	0.3	0.0						
Lane LOS	B	B			A							
Approach Delay (s)	12.3	11.0	0.0		0.3							
Approach LOS	B	B										
Intersection Summary												
Average Delay			1.6									
Intersection Capacity Utilization			29.2%		ICU Level of Service				A			
Analysis Period (min)			15									



















HCM Unsignalized Intersection Capacity Analysis
1: Hwy 10 & Side Road 60

2021 Scenario 1 Total PM
Bumstead Pit

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	9	15	12	10	5	9	13	166	13	14	254	11
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	10	16	13	11	5	10	14	180	14	15	276	12
Pedestrians					2			3			1	
Lane Width (m)					3.6			3.6			3.6	
Walking Speed (m/s)					1.2			1.2			1.2	
Percent Blockage					0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	529	531	279	541	529	183	288			197		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	529	531	279	541	529	183	288			197		
tC, single (s)	7.8	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	4.1	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	97	96	98	97	99	99	99			99		
cM capacity (veh/h)	359	446	763	425	447	862	1229			1386		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total	39	26	195	14	291	12						
Volume Left	10	11	14	0	15	0						
Volume Right	13	10	0	14	0	12						
cSH	483	531	1229	1700	1386	1700						
Volume to Capacity	0.08	0.05	0.01	0.01	0.01	0.01						
Queue Length 95th (m)	2.1	1.2	0.3	0.0	0.3	0.0						
Control Delay (s)	13.1	12.1	0.7	0.0	0.5	0.0						
Lane LOS	B	B	A		A							
Approach Delay (s)	13.1	12.1	0.6		0.5							
Approach LOS	B	B										
Intersection Summary												
Average Delay			1.9									
Intersection Capacity Utilization			39.8%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
1: Hwy 10 & Side Road 60



















2021 Scenario 2 Total AM
Bumstead Pit

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	16	1	11	5	9	15	6	203	5	5	153	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	17	1	12	5	10	16	7	221	5	5	166	11
Pedestrians					2			3			1	
Lane Width (m)					3.6			3.6			3.6	
Walking Speed (m/s)					1.2			1.2			1.2	
Percent Blockage					0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	433	418	169	428	424	224	177			228		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	433	418	169	428	424	224	177			228		
tC, single (s)	7.1	6.5	6.8	7.1	6.8	6.2	5.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.8	3.5	4.3	3.3	3.1			2.2		
p0 queue free %	97	100	98	99	98	98	99			100		
cM capacity (veh/h)	512	522	752	524	477	819	974			1350		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total	30	32	227	5	172	11						
Volume Left	17	5	7	0	5	0						
Volume Right	12	16	0	5	0	11						
cSH	586	621	974	1700	1350	1700						
Volume to Capacity	0.05	0.05	0.01	0.00	0.00	0.01						
Queue Length 95th (m)	1.3	1.3	0.2	0.0	0.1	0.0						
Control Delay (s)	11.5	11.1	0.3	0.0	0.3	0.0						
Lane LOS	B	B	A		A							
Approach Delay (s)	11.5	11.1	0.3		0.3							
Approach LOS	B	B										
Intersection Summary												
Average Delay			1.7									
Intersection Capacity Utilization			30.5%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis



















1: Hwy 10 & Side Road 60

2021 Scenario 2 Total PM
Bumstead Pit

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	3	15	18	10	5	9	19	166	13	14	254	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	16	20	11	5	10	21	180	14	15	276	5
Pedestrians					2			3			1	
Lane Width (m)					3.6			3.6			3.6	
Walking Speed (m/s)					1.2			1.2			1.2	
Percent Blockage					0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	542	544	279	561	536	183	282			197		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	542	544	279	561	536	183	282			197		
tC, single (s)	7.1	6.5	6.5	7.1	6.5	6.2	4.5			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.6	3.5	4.0	3.3	2.5			2.2		
p0 queue free %	99	96	97	97	99	99	98			99		
cM capacity (veh/h)	434	435	690	405	440	862	1100			1386		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total	39	26	201	14	291	5						
Volume Left	3	11	21	0	15	0						
Volume Right	20	10	0	14	0	5						
cSH	533	516	1100	1700	1386	1700						
Volume to Capacity	0.07	0.05	0.02	0.01	0.01	0.00						
Queue Length 95th (m)	1.9	1.3	0.5	0.0	0.3	0.0						
Control Delay (s)	12.3	12.3	1.0	0.0	0.5	0.0						
Lane LOS	B	B	A		A							
Approach Delay (s)	12.3	12.3	0.9		0.5							
Approach LOS	B	B										
Intersection Summary												
Average Delay			2.0									
Intersection Capacity Utilization			40.7%		ICU Level of Service				A			
Analysis Period (min)			15									



















HCM Unsignalized Intersection Capacity Analysis
1: Hwy 10 & Side Road 60

2026 Scenario 1 Total AM
Bumstead Pit

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	24	1	5	5	10	17	0	225	5	5	170	18
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	26	1	5	5	11	18	0	245	5	5	185	20
Pedestrians					5							
Lane Width (m)					3.6							
Walking Speed (m/s)					1.2							
Percent Blockage					0							
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	464	451	185	451	465	250	204			255		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	464	451	185	451	465	250	204			255		
tC, single (s)	7.3	6.5	6.2	7.1	6.8	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.7	4.0	3.3	3.5	4.2	3.3	2.2			2.2		
p0 queue free %	94	100	99	99	98	98	100			100		
cM capacity (veh/h)	450	503	863	512	457	791	1379			1316		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total	33	35	245	5	190	20						
Volume Left	26	5	0	0	5	0						
Volume Right	5	18	0	5	0	20						
cSH	490	602	1379	1700	1316	1700						
Volume to Capacity	0.07	0.06	0.00	0.00	0.00	0.01						
Queue Length 95th (m)	1.7	1.5	0.0	0.0	0.1	0.0						
Control Delay (s)	12.9	11.3	0.0	0.0	0.3	0.0						
Lane LOS	B	B			A							
Approach Delay (s)	12.9	11.3	0.0		0.2							
Approach LOS	B	B										
Intersection Summary												
Average Delay			1.6									
Intersection Capacity Utilization			30.4%		ICU Level of Service				A			
Analysis Period (min)			15									



















HCM Unsignalized Intersection Capacity Analysis
1: Hwy 10 & Side Road 60

2026 Scenario 1 Total PM
Bumstead Pit

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	17	13	12	5	10	14	184	14	15	282	11
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	18	14	13	5	11	15	200	15	16	307	12
Pedestrians					2			3			1	
Lane Width (m)					3.6			3.6			3.6	
Walking Speed (m/s)					1.2			1.2			1.2	
Percent Blockage					0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	584	587	310	598	584	203	318			217		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	584	587	310	598	584	203	318			217		
tC, single (s)	7.7	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	4.0	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	97	96	98	97	99	99	99			99		
cM capacity (veh/h)	333	414	733	386	415	841	1203			1362		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total	43	29	215	15	323	12						
Volume Left	11	13	15	0	16	0						
Volume Right	14	11	0	15	0	12						
cSH	450	490	1203	1700	1362	1700						
Volume to Capacity	0.10	0.06	0.01	0.01	0.01	0.01						
Queue Length 95th (m)	2.5	1.5	0.3	0.0	0.3	0.0						
Control Delay (s)	13.8	12.8	0.7	0.0	0.5	0.0						
Lane LOS	B	B	A		A							
Approach Delay (s)	13.8	12.8	0.6		0.5							
Approach LOS	B	B										
Intersection Summary												
Average Delay			2.0									
Intersection Capacity Utilization			42.4%	ICU Level of Service	A							
Analysis Period (min)			15									



















HCM Unsignalized Intersection Capacity Analysis
1: Hwy 10 & Side Road 60

2026 Scenario 2 Total AM
Bumstead Pit

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	18	1	11	5	10	17	6	225	5	5	170	12
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	20	1	12	5	11	18	7	245	5	5	185	13
Pedestrians					5							
Lane Width (m)					3.6							
Walking Speed (m/s)					1.2							
Percent Blockage					0							
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	477	464	185	471	471	250	198			255		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	477	464	185	471	471	250	198			255		
tC, single (s)	7.1	6.5	6.8	7.1	6.8	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.8	3.5	4.2	3.3	2.2			2.2		
p0 queue free %	96	100	98	99	98	98	100			100		
cM capacity (veh/h)	476	492	738	491	451	791	1381			1316		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total	33	35	251	5	190	13						
Volume Left	20	5	7	0	5	0						
Volume Right	12	18	0	5	0	13						
cSH	548	594	1381	1700	1316	1700						
Volume to Capacity	0.06	0.06	0.00	0.00	0.00	0.01						
Queue Length 95th (m)	1.5	1.5	0.1	0.0	0.1	0.0						
Control Delay (s)	12.0	11.4	0.2	0.0	0.3	0.0						
Lane LOS	B	B	A		A							
Approach Delay (s)	12.0	11.4	0.2		0.2							
Approach LOS	B	B										
Intersection Summary												
Average Delay			1.7									
Intersection Capacity Utilization			31.8%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
 1: Hwy 10 & Side Road 60

2026 Scenario 2 Total PM
 Bumstead Pit

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	4	17	19	12	5	10	20	184	14	15	282	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	4	18	21	13	5	11	22	200	15	16	307	5
Pedestrians					2			3			1	
Lane Width (m)					3.6			3.6			3.6	
Walking Speed (m/s)					1.2			1.2			1.2	
Percent Blockage					0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	597	600	310	618	590	203	312			217		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	597	600	310	618	590	203	312			217		
tC, single (s)	7.1	6.5	6.5	7.1	6.5	6.2	4.5			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.6	3.5	4.0	3.3	2.5			2.2		
p0 queue free %	99	95	97	96	99	99	98			99		
cM capacity (veh/h)	397	403	664	367	409	841	1075			1362		
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total	43	29	222	15	323	5						
Volume Left	4	13	22	0	16	0						
Volume Right	21	11	0	15	0	5						
cSH	495	475	1075	1700	1362	1700						
Volume to Capacity	0.09	0.06	0.02	0.01	0.01	0.00						
Queue Length 95th (m)	2.3	1.6	0.5	0.0	0.3	0.0						
Control Delay (s)	13.0	13.1	1.0	0.0	0.5	0.0						
Lane LOS	B	B	A		A							
Approach Delay (s)	13.0	13.1	0.9		0.5							
Approach LOS	B	B										
Intersection Summary												
Average Delay			2.1									
Intersection Capacity Utilization			43.7%	ICU Level of Service	A							
Analysis Period (min)			15									

Appendix D

Traffic Signal Warrant Analyses

Signal Warrant Calculation for Forecasted Volumes (OTM Book 12 - Justification 7)



Horizon Year: 2026 (Scenario 1)
 Region/City/Township: Township of Chatsworth

Major Street: Highway 10 North/South?: Y
 Minor Street: Side Road 60

Number of Approach Lanes: 1
 Tee Intersection?: N
 Flow Conditions: Restricted
 PM Forecast Only? N

Warrant Results		
150% Satisfied	No	Warrant for new intersections with forecast traffic
120% Satisfied	No	Warrant for existing intersections with forecast traffic

Time Period	Major Street Highway 10						Minor Street Side Road 60						Peds Crossing Main Road
	Northbound			Southbound			Eastbound			Westbound			
	Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
AM Peak Hour	0	225	5	5	170	18	24	1	5	5	10	17	0
PM Peak Hour	14	184	14	15	282	11	10	17	13	12	5	10	4

Average Hourly Volumes			
Volume	AM	PM	AHV
1A - All	485	587	268
1B - Minor	62	67	32
2A - Major	423	520	236
2B - Cross	39	43	21

Warrant 1 - Minimum Vehicular Volume

1A	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
	All Approaches	480	720	600	900	

1B	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
	Minor Street Approaches	120	170	120	170	

Warrant 2 - Delay To Cross Traffic

2A	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
	Major Street Approaches	480	720	600	900	

2B	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
	Traffic Crossing Major Street	50	75	50	75	

Signal Warrant Calculation for Forecasted Volumes (OTM Book 12 - Justification 7)



Horizon Year: 2026 (Scenario 2)
 Region/City/Township: Township of Chatsworth

Major Street: Highway 10 North/South?: Y
 Minor Street: Side Road 60

Number of Approach Lanes: 1
 Tee Intersection?: N
 Flow Conditions: Restricted
 PM Forecast Only? N

Warrant Results		
150% Satisfied	No	Warrant for new intersections with forecast traffic
120% Satisfied	No	Warrant for existing intersections with forecast traffic

Time Period	Major Street Highway 10						Minor Street Side Road 60						Peds Crossing Main Road
	Northbound			Southbound			Eastbound			Westbound			
	Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
AM Peak Hour	6	225	5	5	170	12	18	1	11	5	10	17	0
PM Peak Hour	20	184	14	15	282	5	4	17	19	12	5	10	4

Average Hourly Volumes			
Volume	AM	PM	AHV
1A - All	485	587	268
1B - Minor	62	67	32
2A - Major	423	520	236
2B - Cross	33	37	18

Warrant 1 - Minimum Vehicular Volume

1A	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
	All Approaches	480	720	600	900	

1B	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
	Minor Street Approaches	120	170	120	170	

Warrant 2 - Delay To Cross Traffic

2A	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
	Major Street Approaches	480	720	600	900	

2B	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
	Traffic Crossing Major Street	50	75	50	75	