



Springbrook Corners Residential Development Hamilton, Ontario Transportation Impact Assessment

Paradigm Transportation Solutions Limited

September 2020
200224



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Executive Summary

Content

Springbrook West Developments LTD retained Paradigm Transportation Solutions Limited (Paradigm) to conduct this Transportation Impact Assessment for the proposed residential development located in the northeast corner of Springbrook Avenue at Garner Road in the City of Hamilton (Ancaster).

The report documents the additional traffic that is expected to occur as a result of the development and assesses the impact of the traffic on the surrounding road network.

The findings, conclusions, and recommendations of this study are summarized below and outlined in detail in the body of the report.

Development Concept

The proposed development will consist of 80 townhouse units with 206 parking spaces. It is expected to be completed in a single phase at or before 2022. Vehicular access to the site will be provided by three driveways: two on Springbrook Avenue and one on Garner Road.

The proposed development is projected to generate approximately 39 trips in the weekday AM peak hour and 48 trips in the PM peak hour.

Conclusions

Based on the investigations carried out, it is concluded that:

Base Year Traffic Operations

The study area intersections are operating well with no specific problem movements.

2027 Background Traffic Operations

The analysis results indicate that the intersection of Garner Road and Raymond Road will operate with a v/c ratio of approximately 0.91 during the PM peak hour. The remaining study area intersections are forecast to operate at overall acceptable levels with the following critical movements:

Garner Road at Springbrook Avenue

- ▶ AM Peak Hour



- The northbound movement is forecast to operate at LOS E with a v/c ratio of 0.05;
- The southbound movement is forecast to operate at LOS E with a v/c ratio of 0.68; and
- ▶ PM Peak Hour
 - The southbound movement is forecast to operate at LOS F with a v/c ratio of 1.26.

Garner Road at Raymond Road

- ▶ PM Peak Hour
 - The eastbound through movement is forecast to operate at LOS C with a v/c ratio of 0.92; and
 - The westbound movement is forecast to operate at LOS C with a v/c ratio of 0.85.

2027 Total Traffic Operations

The study area intersections are forecast to operate similar to background conditions. Inclusion of the site-generated traffic volumes shows minimal increase in delay at all three study area intersections. The greatest increase occurs at Garner Road at Kitty Murray Lane/ Smith Road where the delay increases by one second during each peak hour.

Remedial Measures

Traffic Signal Warrant

A traffic signal is not warranted at the intersection of Springbrook Avenue at Garner Road under the 2027 total horizon.

Left-Turn Lane Warrant

A southbound left-turn lane is not warranted on Springbrook Avenue at Driveway A or Driveway B and an eastbound left-turn lane is not warranted on Garner Road at Driveway C under future background or future total conditions with or without the planned roadway widening.

However, an eastbound left-turn lane with 40 metres storage is warranted on Garner Road at Springbrook Avenue both with the existing lane configuration and with the planned roadway widening along Garner Road.



Planned Roadway Improvements

Garner Road is planned to undergo an expansion to a five-lane cross-section with two lanes in each direction and a centre left-turn lane by 2031. Left and right-turn auxiliary lanes will be provided on Garner Road at the study area intersections.

2027 Total Traffic Operations – with Improvements

The study area intersections are forecast to operate with acceptable delays and within capacity with no specific problem movements with the applied remedial measures.

Recommendations

Based on the findings of this study, the following are recommended:

- ▶ The City permit the development to proceed as planned;
- ▶ The City monitor the traffic volumes at the intersection of Garner Road at Springbrook Avenue to provide a traffic signal if one is warranted in the near future;
- ▶ The signalized intersections along the Garner Road Corridor be monitored by the local road authorities to provide optimized signal timings for future traffic conditions; and
- ▶ The City implement the expansion of Garner Road as outlined in the *Garner Road/Rymal Road and Garth Street Improvements Municipal Class Environmental Assessment Study*.



Contents

- 1 Introduction 1**
- 1.1 Overview 1
- 1.2 Study Area 1
- 2 Existing Conditions 3**
- 2.1 Roadway Network 3
- 2.2 Traffic Volumes 5
- 2.2.1 Historic Comparison 5
- 2.2.2 Adjustments..... 5
- 2.2.3 Base Year Volumes..... 6
- 2.3 Traffic Operations 9
- 3 Development Concept 12**
- 3.1 Development Description 12
- 3.2 Development Trip Generation 14
- 3.3 Development Trip Distribution and Assignment 14
- 4 Future Traffic 17**
- 4.1 Background Traffic Growth 17
- 4.1.1 General Growth Rate 17
- 4.1.2 Approved Developments 17
- 4.1.3 Growth Summary 18
- 4.2 Background Traffic Operations..... 25
- 4.3 Total Traffic Projections 27
- 4.4 Total Traffic Operations 30
- 5 Remedial Measures..... 33**
- 5.1 Garner Road EA Planned Improvements 33
- 5.2 Traffic Signal Warrant Analysis 36
- 5.3 Left-Turn Lane Warrant..... 36
- 6 Conclusions..... 38**
- 6.1 Conclusions 38
- 6.2 Recommendations 39



Appendices

Appendix A	Pre-Study Consultation
Appendix B	Traffic Count Data
Appendix C	Base Year (2020) Traffic Operational Conditions
Appendix D	2027 Background Traffic Operational Conditions
Appendix E	2027 Total Traffic Operational Conditions
Appendix F	2027 Total Traffic Operational Conditions with Improvements
Appendix G	OTM Signal Justification 7 Warrant Analysis
Appendix H	Left-Turn Lane Warrant Analysis

Figures

Figure 1.1:	Subject Site Location and Study Area	2
Figure 2.1:	Existing Traffic Controls and Lane Configurations	4
Figure 2.2a:	Base Year (2020) Traffic Volumes – AM Peak Hour	7
Figure 2.2b:	Base Year (2020) Traffic Volumes – PM Peak Hour	8
Figure 3.1:	Concept Site Plan	13
Figure 3.2a:	Site Traffic Volumes – AM Peak Hour	15
Figure 3.2b:	Site Traffic Volumes – PM Peak Hour	16
Figure 4.1:	Approved Background Developments	20
Figure 4.2a:	Background Development Traffic Volumes – AM Peak Hour	21
Figure 4.2b:	Background Development Traffic Volumes – PM Peak Hour	22
Figure 4.3a:	2027 Background Traffic Volumes – AM Peak Hour	23
Figure 4.3b:	2027 Background Traffic Volumes – PM Peak Hour	24
Figure 4.4a:	2027 Total Traffic Volumes – AM Peak Hour	28
Figure 4.4b:	2027 Total Traffic Volumes – PM Peak Hour	29

Tables

Table 2.1:	Traffic Data	5
Table 2.2:	Garner Road at Sprinbrook (2012 vs 2016)	5
Table 2.3:	Base Year (2020) Peak Hour Traffic Operations	11
Table 3.1:	Trip Generation	14
Table 3.2:	Estimated Peak Hour Trip Distribution	14
Table 4.1:	Trip Generation	19
Table 4.2:	2027 Background Traffic Operational Conditions	26
Table 4.3:	2027 Total Traffic Operational Conditions	32
Table 5.1:	2027 Total Traffic Sensitivity Analysis	35
Table 5.2:	OTM Signal Warrant Analysis Summary	36



1 Introduction

1.1 Overview

Paradigm Transportation Solutions Limited (Paradigm) prepared a traffic assessment for the proposed development located in the City of Hamilton in June 2012¹; however, this report is outdated as it is more than three years old. As a result, Springbrook West Developments LTD retained Paradigm to conduct an updated Transportation Impact Assessment to examine the impacts of the proposed development traffic.

This study has been carried out in general accordance with the City's Traffic Impact Study (TIS) Guidelines².

Appendix A contains correspondence regarding the study terms of reference.

1.2 Study Area

The following intersections define the study area:

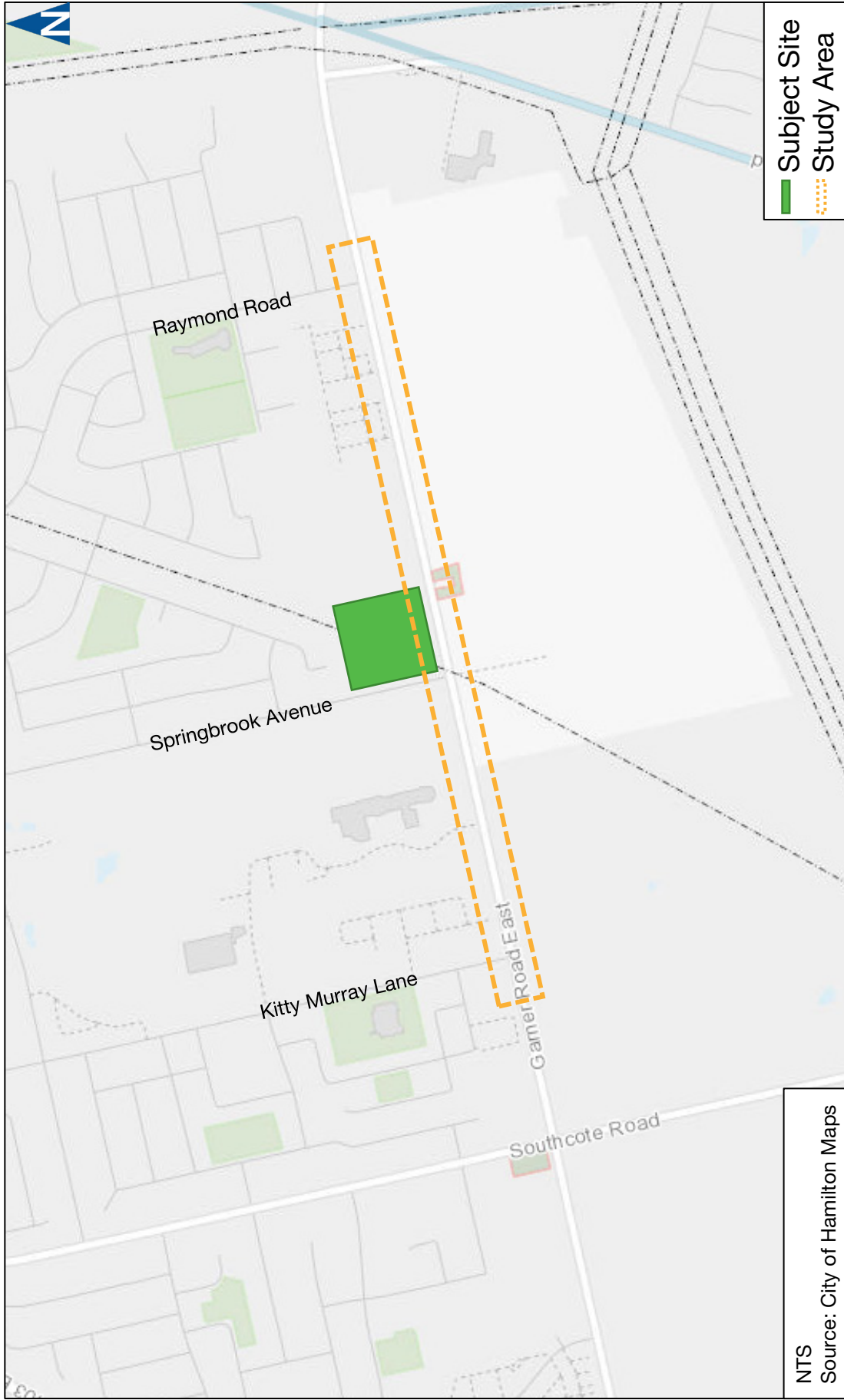
- ▶ Garner Road at Kitty Murray Lane (signalized);
- ▶ Garner Road at Springbrook Avenue (unsignalized);
- ▶ Garner Road at Raymond Road (signalized); and
- ▶ Up to three new street connections (future, unsignalized).

Figure 1.1 illustrates the subject development location and study area.

¹ "Springbrook Corners Residential Development Traffic Impact Study", Hamilton ON, Paradigm, June 2012.

² "Traffic Impact Study Guidelines", City of Hamilton, July 2009.





Subject Site Location and Study Area

2 Existing Conditions

2.1 Roadway Network

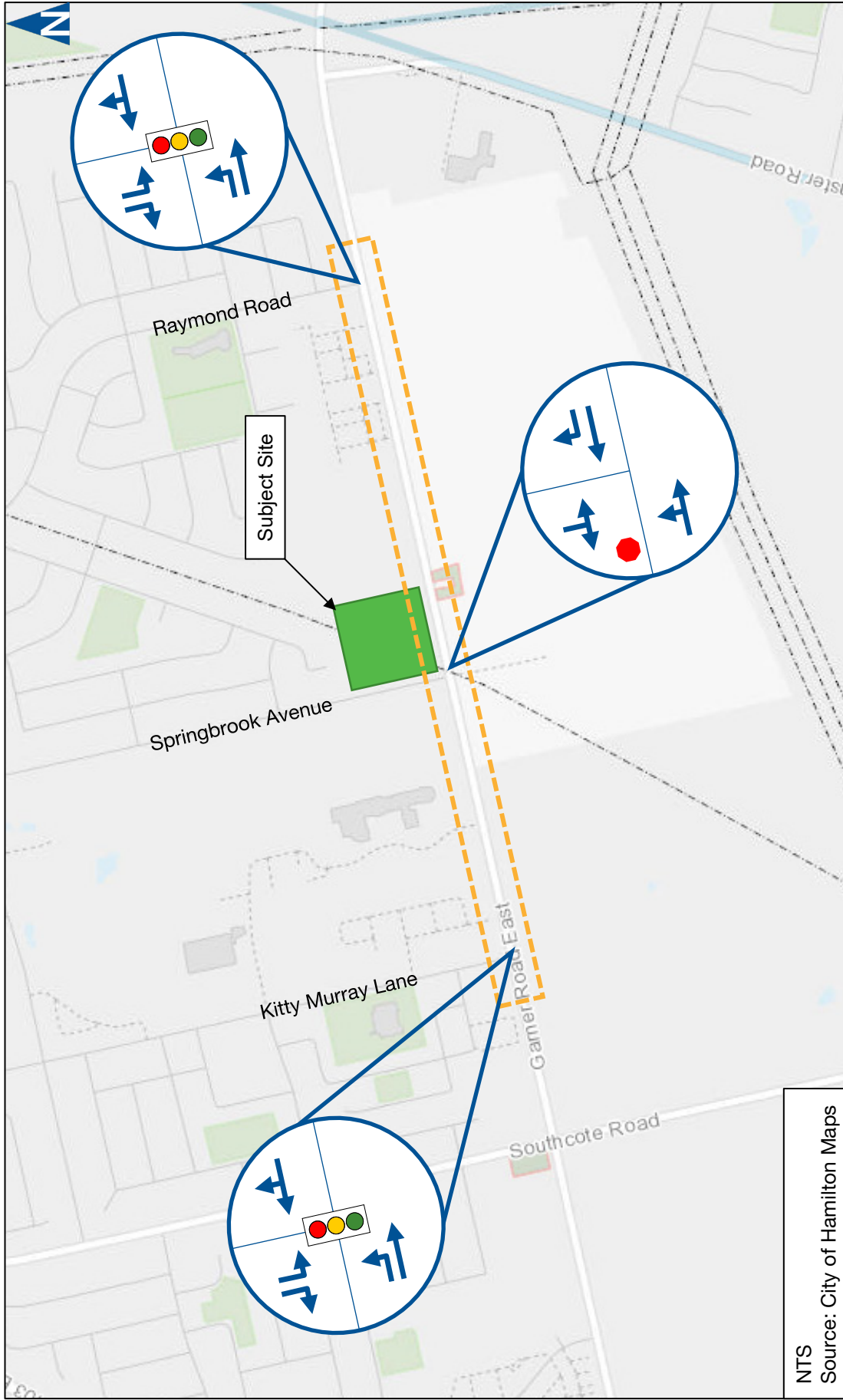
The roadways near the subject site considered in assessing the traffic impacts of the development include:

- ▶ **Garner Road** is an east-west major arterial³ roadway with a two-lane rural cross-section and a posted speed limit of 60 km/h. A 2.5-metre gravel shoulder is provided along both sides of the roadway throughout the study area. Parking and/or stopping is prohibited intermittently along both sides of the roadway.
- ▶ **Springbrook Avenue** is a north-south local roadway with a two-lane rural cross-section and a posted speed limit of 50 km/h. A narrow shoulder (less than one-metre-wide) is provided along both sides of the roadway. Springbrook Avenue has a posted restriction of 5 tonnes per axel from March 1 to April 30.
- ▶ **Kitty Murray Lane** is a north-south collector³ roadway with a two-lane urban cross-section and a posted speed limit of 50 km/h. Sidewalks are provided along both sides of the roadway throughout the study area. Immaculate Conception Catholic Elementary School is located along Kitty Murray Lane approximately 250 metres north of Garner Road. School zone signs are posted along the roadway with a 40 km/h speed limit and a “When Flashing” tab.
- ▶ **Raymond Road** is a north-south local roadway with a two-lane urban cross-section and a posted speed limit of 40 km/h. A sidewalk is provided along the east side of the roadway throughout the study area. Tiffany Hill Elementary School is located along Raymond Road approximately 300 metres north of Garner Road. School zone signs are posted along the roadway within study area.

Figure 2.1 illustrates the traffic controls and lane configurations at the study area intersections.

³ *City of Hamilton Official Plan*, Schedule C: Functional Road Classification, 9 July 2009.





Existing Traffic Controls and Lane Configurations

Figure 2.1

2.2 Traffic Volumes

This update was initiated and authored during the COVID-19 global pandemic. As a result, typical traffic volumes and travel patterns were significantly impacted from their norm and collecting new traffic data would not provide an accurate reflection of typical conditions. Therefore, pre-pandemic traffic data has been used to develop 2020 base year traffic estimates. **Table 2.1** summarizes the date and source of each turning movement count referenced in this study. **Appendix B** contains the traffic data used in this report.

TABLE 2.1: TRAFFIC DATA

Intersection	Date	Conducted By
Garner Road at Springbrook Avenue	April 2016 June 2012	City of Hamilton Paradigm
Garner Road at Raymond Road	October 2019	City of Hamilton
Garner Road at Kitty Murray Lane	October 2019	City of Hamilton

2.2.1 Historic Comparison

Base year traffic volumes (2020) at the intersection of Garner Road and Springbrook Avenue have been established through a review of turning movement count data at a number of area intersections. Comparison of historic counts at this intersection between 2012 and 2016 indicates a growth of 2.3% in the AM peak hour and 1.9% during the PM peak hour as outlined in **Table 2.2**.

TABLE 2.2: GARNER ROAD AT SPRINBROOK (2012 VS 2016)

		Garner Road at Springbrook Avenue												
Peak Hour	TMC Year	Movement												Total
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
AM	2016	14	430	1	0	470	9	3	1	0	12	0	52	992
	2012	16	389	0	0	440	9	0	0	0	14	0	41	909
	Difference	-2	41	1	0	30	0	3	1	0	-2	0	11	83
PM	2016	32	615	2	1	573	19	0	0	1	13	1	16	1273
	2012	43	585	0	0	490	30	0	0	0	15	0	21	1184
	Difference	-11	30	2	1	83	-11	0	0	1	-2	1	-5	89

2.2.2 Adjustments

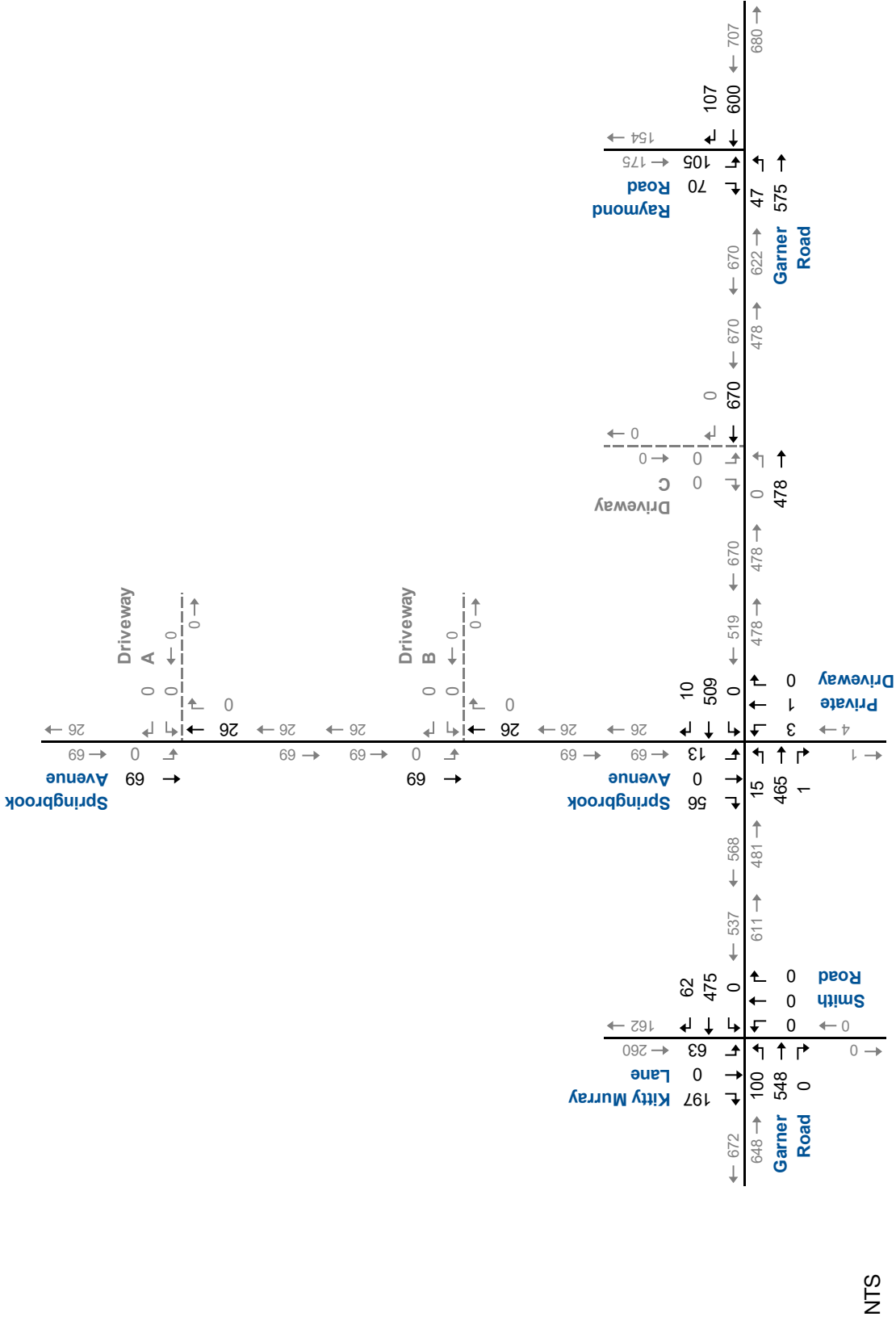
To remain conservative with the analysis and account for any growth that may have occurred between the count year and 2020, the turning movement counts have been factored using a 2% per annum growth rate. The growth rate is also consistent with the City's standard growth rate outlined in the *Traffic Impact Study Guidelines*.



2.2.3 Base Year Volumes

Figure 2.2a and **Figure 2.2b** illustrate the respective weekday AM and PM peak hour base year traffic volumes.





Base Year (2020) Traffic Volumes AM Peak Hour



Figure 2.2a

2.3 Traffic Operations

Intersection level of service (LOS) is a recognized method of quantifying the average delay experienced by drivers 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 intending 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 to or less than 10 seconds per vehicle. When the average delay exceeds 80 seconds for signalized intersections, 50 seconds for unsignalized intersections or when the volume to capacity ratio is greater than 1.0, the movement is classified as LOS F and remedial measures are usually implemented if they are feasible. LOS E is usually used as a guideline for the determination of road improvement needs on through lanes, while LOS F may be acceptable for left-turn movements at peak times, depending on delays.

The operations of intersections in the study area were evaluated with the existing turning movement volumes using Synchro 9 with HCM procedures. The following parameters were used:

- ▶ Signal timings provided by the City of Hamilton;
- ▶ Truck percentages derived from the provided traffic data;
- ▶ Calculated peak hour factors (PHF) from the provided traffic data;
- ▶ The level of service for each turning movement, which is based on the average control delay per vehicle; and
- ▶ The 95th percentile queue length estimated using Synchro.

The City's TIS Guidelines identify the following critical measures of performance:

- ▶ **Signalized Intersections**
 - Volume to capacity (v/c) ratios for through movements or shared through/turning movements will operate at 0.85 or greater (0.85 is considered the maximum acceptable level of service for these movements);
 - V/C ratios for exclusive turning movements increase to 0.90 or greater (0.90 is considered the maximum acceptable level of service for these movements);



- Queues for an individual movement are projected to exceed available turning lane storage at 95th percentile volumes;
- ▶ **Unsignalized Intersections**
 - Level of service, based on average delay per vehicle or individual movements is LOS “D” or greater; and
 - The estimated 95th percentile queue length for an individual movement exceeds the available queue storage.

Table 2.3 summarizes the 2020 base year intersection operations. All intersections operate within acceptable levels with no specific problem movements.

Appendix C contains the detailed Synchro 9 reports.



TABLE 2.3: BASE YEAR (2020) PEAK HOUR TRAFFIC OPERATIONS

Analysis Period	Intersection	Control Type	MOE	Direction / Movement / Approach																
				Eastbound				Westbound				Northbound				Southbound				OVERALL
				Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	
AM Peak Hour	Garner Road & Kitty Murray Lane/ Smith Road	TCS	LOS	A	A	>	A	<	B	>	B	<	A	>	A	C	C	>	C	B
			Delay	7	7	>	7	<	20	>	20	<	0	>	0	25	24	>	24	15
			V/C	0.23	0.53	>	<	0.73	>	<	0.00	>	<	0.32	0.14	>	<	0.61		
			95th	8	58	>	<	96	>	<	0	>	19	0	>	<	24	15		
	Storage	55	-	>	<	-	>	<	-	>	30	-	>	<	-	>	<	-	>	
	Avail.	47	-	>	<	-	>	<	-	>	11	-	>	<	-	>	<	-	>	
Garner Road & Springbrook Avenue	SC	LOS	<	A	>	<	A	A	<	D	>	<	C	>	<	16	>	<	>	
		Delay	<	1	>	<	0	0	<	25	>	<	0.17	>	<	5	>	<	>	
Garner Road & Raymond Road	TCS	LOS	A	A	>	A	<	B	>	B	<	D	C	>	C	C	>	C	B	
		Delay	6	6	>	6	<	13	>	13	<	37	31	>	35	12				
		V/C	0.15	0.49	>	<	0.69	>	<	0.58	0.05	<	0.67							
		95th	5	70	>	<	156	>	<	32	11	>	<	35	12					
Storage	35	-	>	<	-	>	<	40	-	>	<	-	>	<	-	>	<	-		
Avail.	30	-	>	<	-	>	<	8	-	>	<	-	>	<	-	>	<	-		
PM Peak Hour	Garner Road & Kitty Murray Lane/ Smith Road	TCS	LOS	A	A	>	A	<	C	>	C	<	A	>	A	C	C	>	C	B
			Delay	10	7	>	8	<	23	>	23	<	0	>	0	25	23	>	24	16
			V/C	0.37	0.54	>	<	0.81	>	<	0.00	>	<	0.34	0.08	>	<	0.66		
			95th	11	66	>	<	139	>	<	0	>	20	0	>	<	24	16		
	Storage	55	-	>	<	-	>	<	-	>	30	-	>	<	-	>	<	-	>	
	Avail.	44	-	>	<	-	>	<	-	>	10	-	>	<	-	>	<	-	>	
Garner Road & Springbrook Avenue	SC	LOS	<	A	>	<	A	A	<	B	>	<	D	>	<	29	>	<	>	
		Delay	<	1	>	<	0	0	<	13	>	<	0.19	>	<	5	>	<	>	
Garner Road & Raymond Road	TCS	LOS	A	B	>	B	<	B	>	B	<	C	C	>	C	C	>	C	B	
		Delay	8	13	>	12	<	19	>	19	<	28	26	>	28	16				
		V/C	0.25	0.81	>	<	0.83	>	<	0.44	0.03	<	0.79							
		95th	6	194	>	<	184	>	<	24	8	>	<	28	16					
Storage	35	-	>	<	-	>	<	40	-	>	<	-	>	<	-	>	<	-		
Avail.	29	-	>	<	-	>	<	16	-	>	<	-	>	<	-	>	<	-		

MOE - Measure of Effectiveness

LOS - Level of Service

V/C - Volume to Capacity Ratio

95th - 95th Percentile Queue Length

TCS - Traffic Control Signal

SC - Stop Control

Avail. - Available Storage (m)

Storage - Existing Storage (m)

> - Shared Right-Turn Lane

< - Shared Left-Turn Lane



3 Development Concept

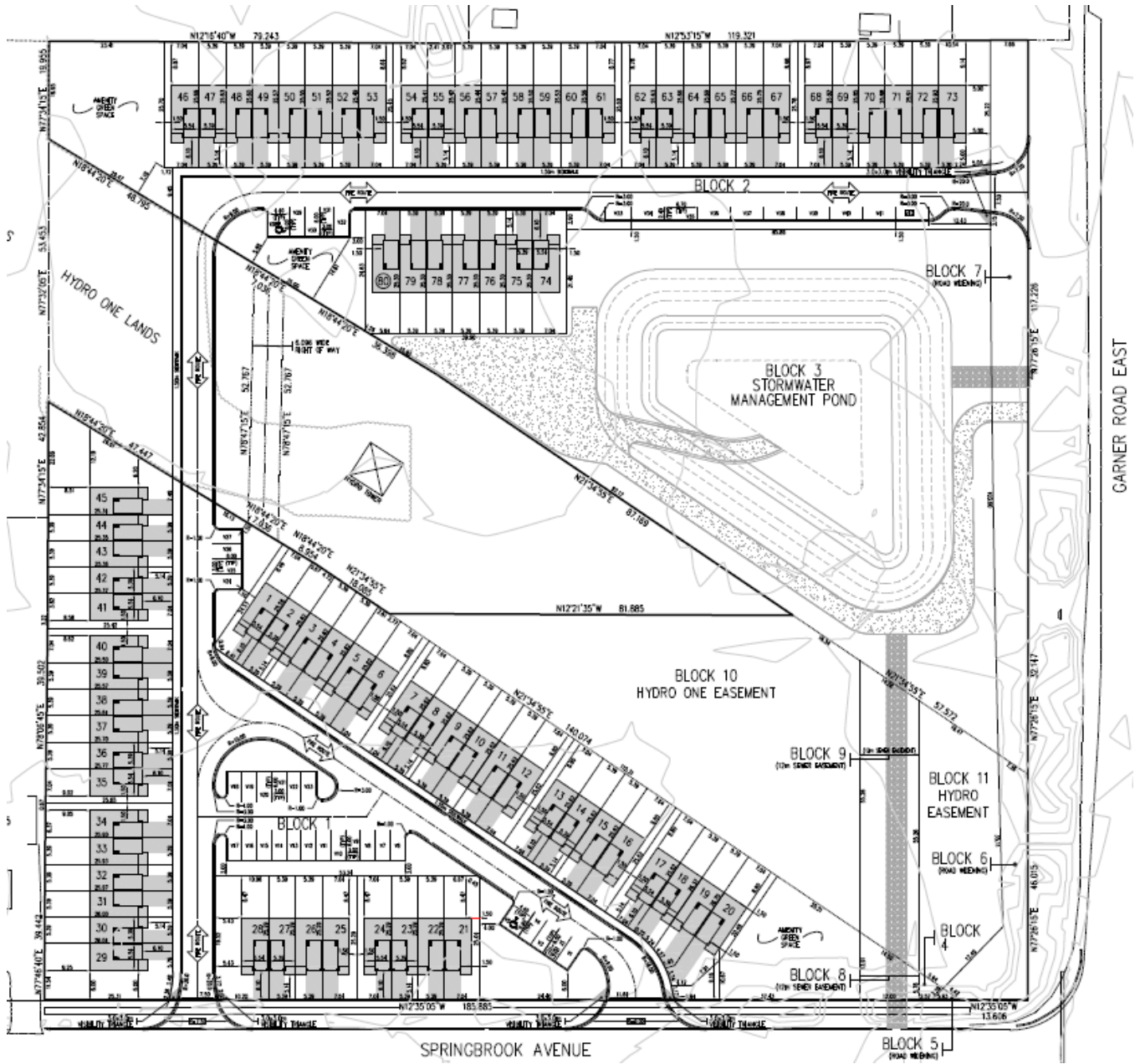
3.1 Development Description

The subject site is located on a vacant parcel of land on the north side of Garner Road and east of Springbrook Avenue in the City of Hamilton. The property owner is proposing to include 80 townhouse units with 206 parking spaces.

Access for the development will be provided via two new driveway connections to Springbrook Avenue as well as one new driveway connection to Garner Road.

Figure 3.1 illustrates the proposed site plan.





NTS



Concept Site Plan

Springbrook Corners Residential Development
200224

Figure 3.1

3.2 Development Trip Generation

The Institute of Transportation Engineers' (ITE) *Trip Generation Manual*⁴ provides rates and equations used to estimate the peak hour traffic volumes generated by the proposed development. Land Use Code (LUC) 220 (Multifamily Housing (Low-Rise)) was used to estimate the anticipated vehicular trips generated by the subject development.

Table 3.1 summarizes the forecast number of net new trips generated by the proposed development. As shown, the development is anticipated to generate approximately 39 new trips during the AM peak hour and 48 new trips during the PM peak hour.

TABLE 3.1: TRIP GENERATION

Land Use	Units	AM Peak Hour			PM Peak Hour				
		Rate	In	Out	Total	Rate	In	Out	Total
Multifamily Housing (Low-Rise) - LUC 220	80	Eq ¹	9	30	39	Eq ²	30	18	48
Total Trip Generation			9	30	39		30	18	48

$${}^1\text{Ln}(T) = 0.95\text{Ln}(X) - 0.51$$

$${}^2\text{Ln}(T) = 0.89\text{Ln}(X) - 0.02$$

3.3 Development Trip Distribution and Assignment

The trip distribution and assignment were based on existing travel patterns of the study area since the proposed development is similar to the type of development within the surrounding area. **Table 3.2** summarizes the breakdown of trip distributions used in this study.

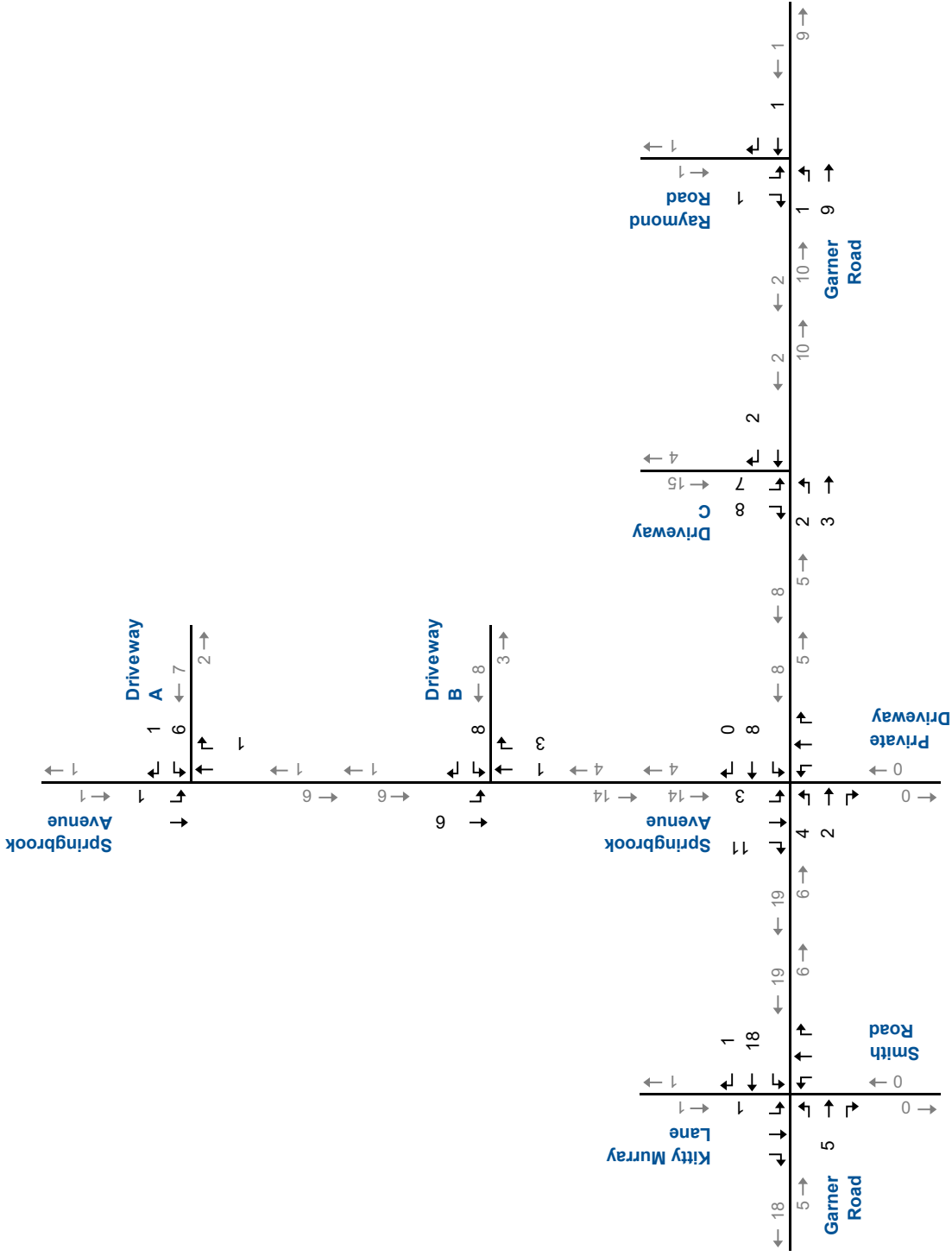
TABLE 3.2: ESTIMATED PEAK HOUR TRIP DISTRIBUTION

Direction (To/From)	AM Peak Hour		PM Peak Hour	
	In	Out	In	Out
North via Springbrook Avenue	5%	2%	2%	3%
North via Kitty Murray Lane	5%	5%	5%	5%
North via Raymond Road	5%	4%	3%	4%
West via Garner Road	40%	40%	43%	32%
East via Garner Road	45%	49%	47%	56%
Total	100%	100%	100%	100%

Figure 3.2a and **Figure 3.2b** illustrate the weekday AM and PM peak hour site trip assignments.

⁴ Institute of Transportation Engineers, *Trip Generation Manual, Tenth Edition*, Washington D.C., 2017.



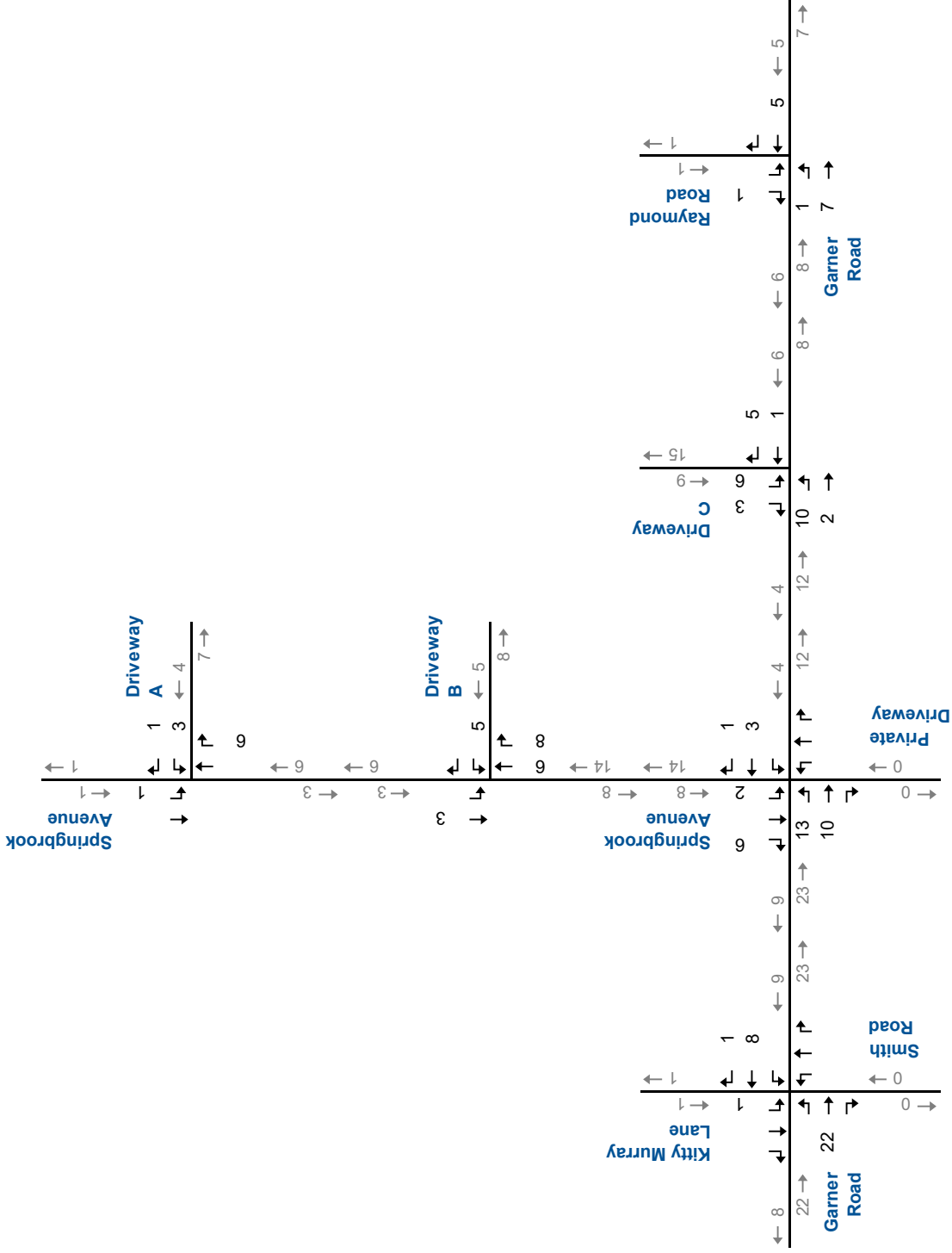


NTS



Site Traffic Volumes AM Peak Hour

Figure 3.2a



NTS



Site Traffic Volumes PM Peak Hour

Figure 3.2b

4 Future Traffic

The development is assumed to be completed at or before 2022. The assessment of future traffic conditions includes background and total traffic five years after Opening Day (2027) to conform with the City of Hamilton's *Traffic Impact Study Guidelines*.

4.1 Background Traffic Growth

Future background traffic volume increases in the study area will consist of growth due to general increases in roadway traffic as well as traffic generated by other proposed and approved new developments in the area.

4.1.1 General Growth Rate

A 2% per annum growth rate, as discussed in Section 2.2, was applied to the existing traffic volumes to derive the 2027 general background traffic volumes. The rate was compounded for seven years, resulting in total growth of 14.9%.

4.1.2 Approved Developments

The City's online development application tool⁵ and the City's *Staging of Development Report*⁶ indicate that there are six approved residential developments that should be included as part of background traffic projections, corresponding to the 2027 horizon. All developments have the number and type of units listed in either resource. Where there were discrepancies in the number of units, the units listed in the *Staging of Development Report* were used.

The ITE's *Trip Generation Manual* was used to estimate the trips generated by the background developments using the following LUCs:

- ▶ LUC 210 (Single-Family Detached Housing);
- ▶ LUC 220 (Multifamily Housing (Low-Rise)); and
- ▶ LUC 221 (Multifamily Housing (Mid-Rise)).

Table 4.1 summarizes the forecast number of net new trips generated by the background developments. As shown, the developments are anticipated to generate approximately 264 new trips during the AM peak hour and 335 new trips during the PM peak hour.

⁵ <http://map.hamilton.ca/>

⁶ City of Hamilton, *Staging of Development Report 2019 – 2022*.



The background trip distribution follows the same as **Table 3.2** for the base year peak hour volume distribution.

Figure 4.1 illustrates the general location of these approved developments, and **Figure 4.2a** and **Figure 4.2b** illustrate the trips estimated to be generated by the background developments during the weekday AM and PM peak hours, respectively.

4.1.3 Growth Summary

In summary, the background traffic volumes for the 2027 horizon within the study area are estimated to consist of:

- ▶ Generalized background traffic growth of 2% per annum (compounded); and
- ▶ Traffic related to the nearby, approved developments.

Figure 4.3a and **Figure 4.3b** respectively illustrate the weekday AM and PM peak hour background traffic forecasts for the 2027 horizon.



TABLE 4.1: TRIP GENERATION

Development	Land Use	Units	AM Peak Hour				PM Peak Hour			
			Rate	In	Out	Total	Rate	In	Out	Total
Garner Estates (1049-1109 Garner Road)	Multifamily Housing (Low-Rise) - LUC 220	114	Eq ¹	12	42	54	Eq ²	42	24	66
Cortland (1035 Garner Road)	Multifamily Housing (Low-Rise) - LUC 220	70	Eq ¹	8	26	34	Eq ²	27	16	43
	Multifamily Housing (Mid-Rise) - LUC 221	24	Eq ³	2	6	8	Eq ⁴	7	4	11
961-989 Garner Rd	Multifamily Housing (Low-Rise) - LUC 220	54	Eq ¹	6	21	27	Eq ²	21	13	34
	Multifamily Housing (Mid-Rise) - LUC 221	57	Eq ³	5	15	20	Eq ⁴	16	10	26
Fields of Springbrook	Single-Family Detached Housing - LUC 210	92	Eq ⁵	18	52	70	Eq ⁶	59	35	94
Springbrook Meadows West (296 Springbrook Avenue)	Single-Family Detached Housing - LUC 210	42	Eq ⁵	9	26	35	Eq ⁶	28	16	44
Star Meadows (275 Springbrook Avenue)	Single-Family Detached Housing - LUC 210	16	Eq ⁵	4	12	16	Eq ⁶	11	6	17
Total Trip Generation				64	200	264		211	124	335

¹Ln(T) = 0.95Ln(X) - 0.51

³Ln(T) = 0.98Ln(X) - 0.98

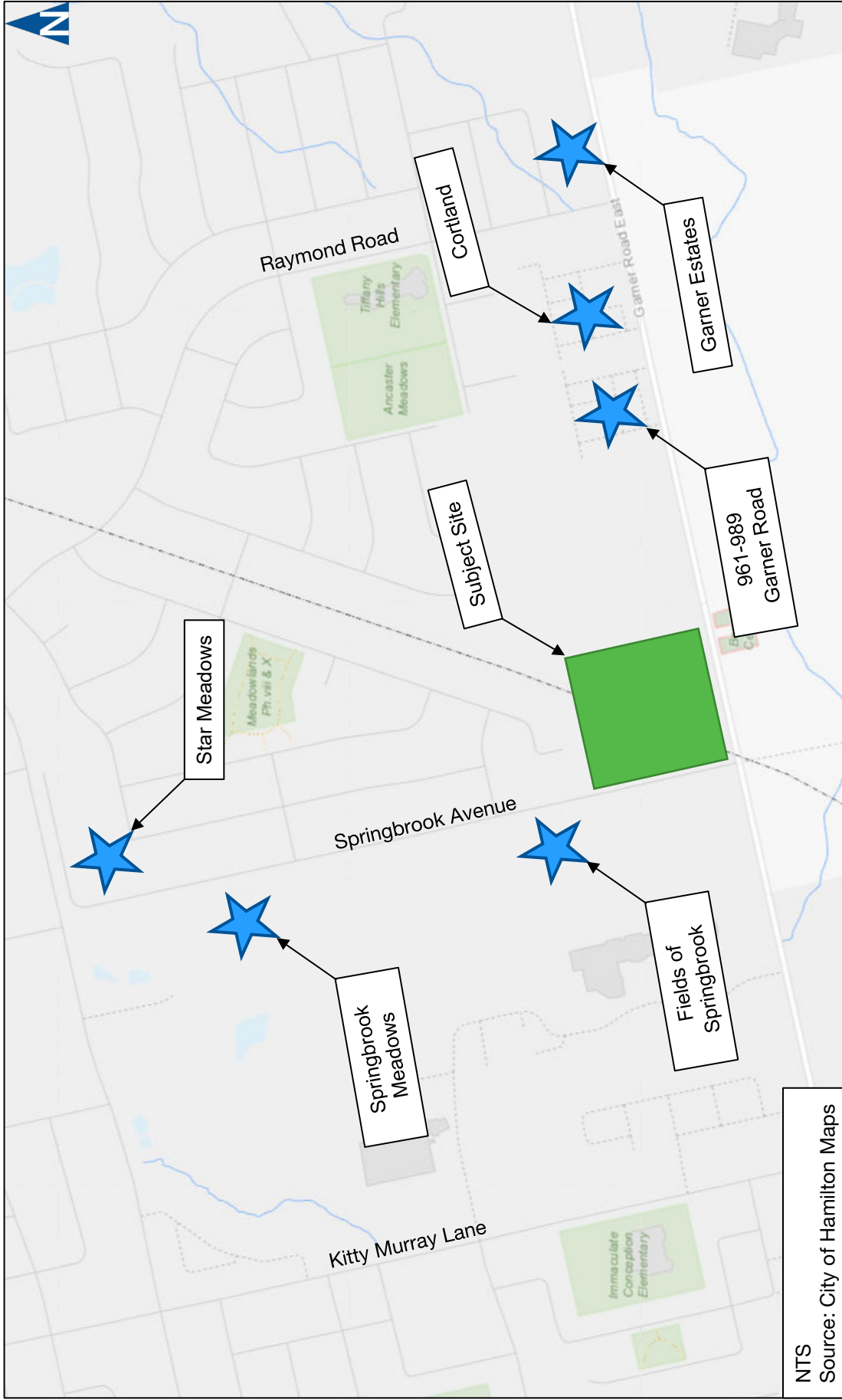
⁵T = 0.71(X) + 4.80

²Ln(T) = 0.89Ln(X) - 0.02

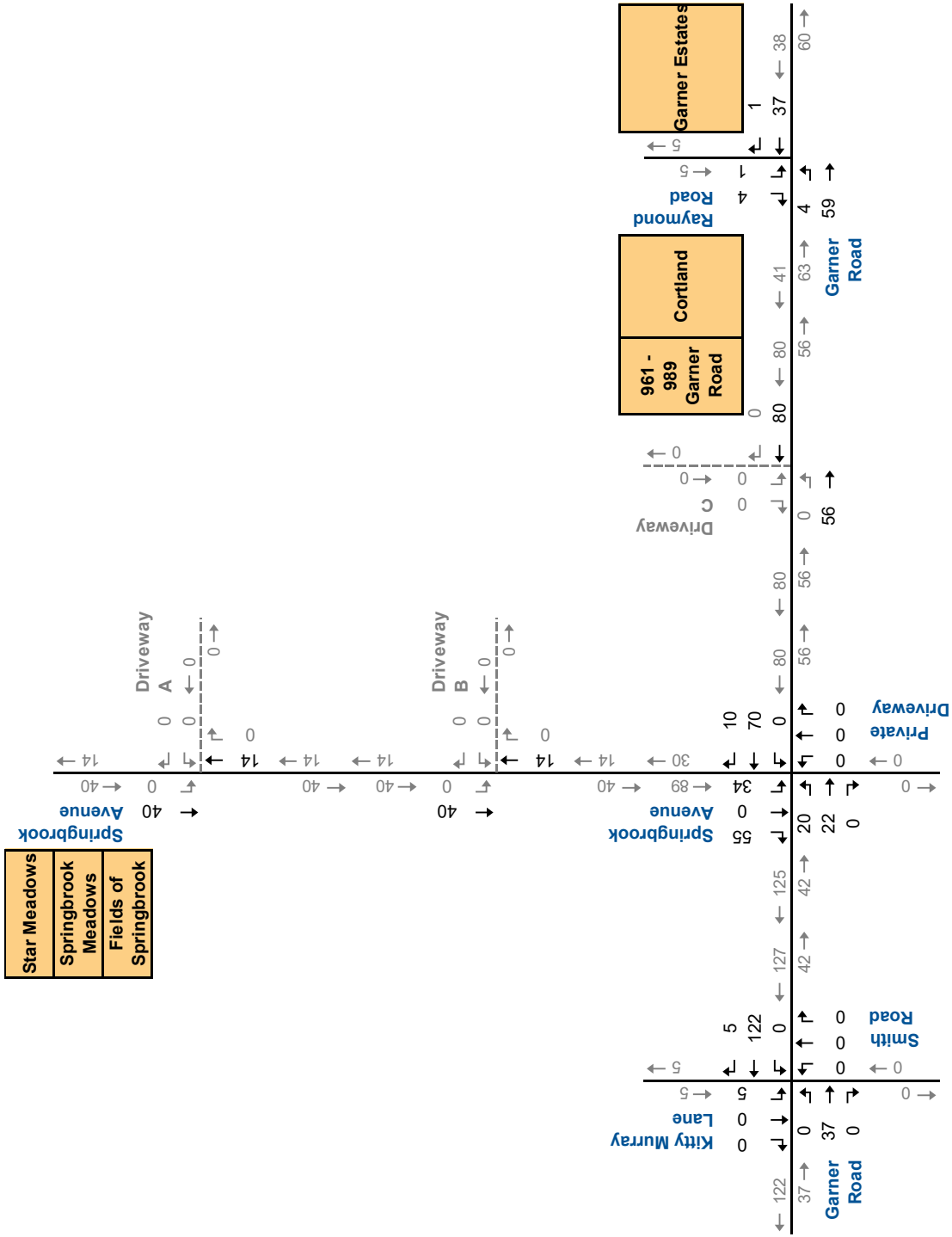
⁴Ln(T) = 0.96Ln(X) - 0.63

⁶Ln(T) = 0.96Ln(X) + 0.20





Approved Background Developments

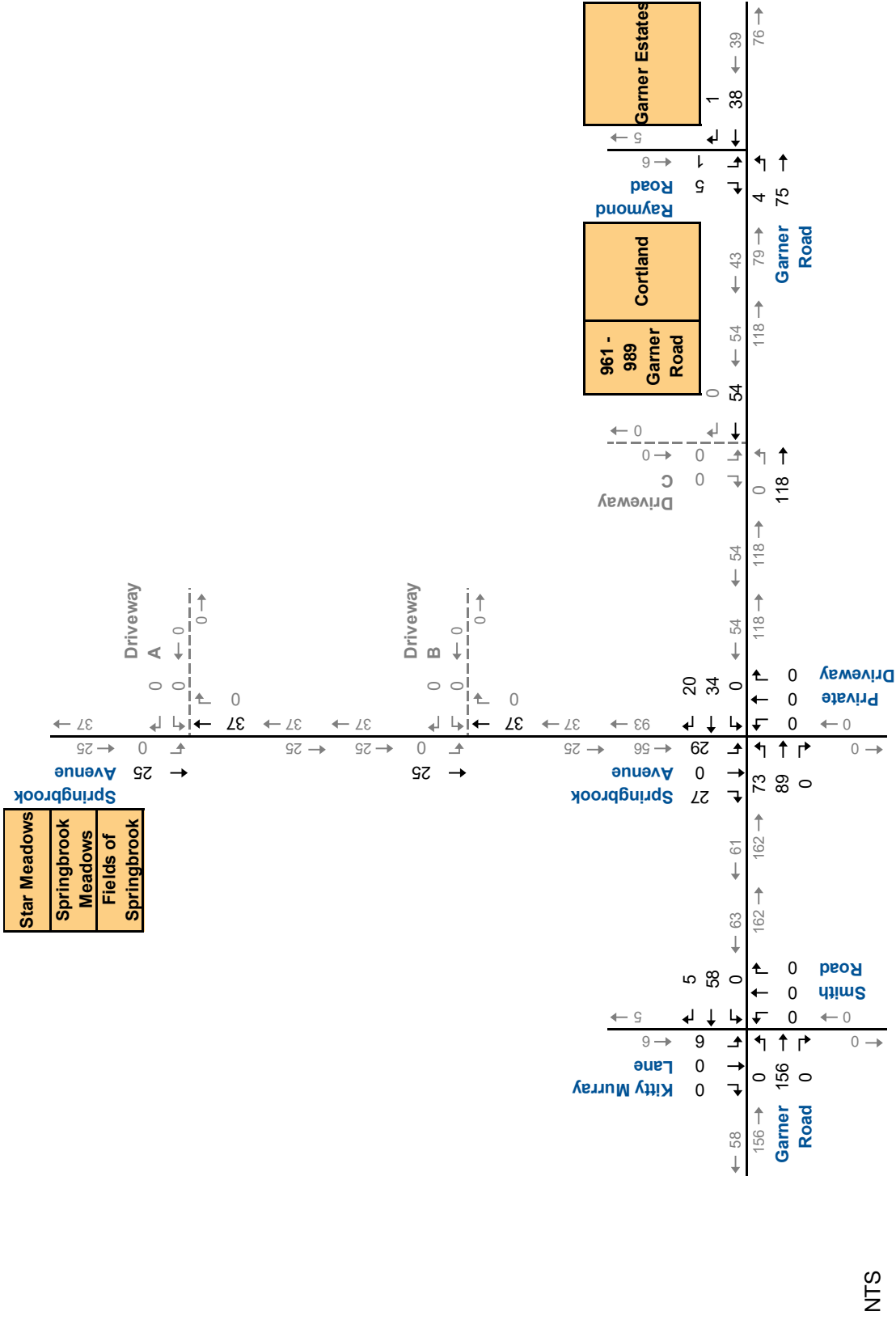


NTS



Background Development Traffic Volumes AM Peak Hour

Figure 4.2a

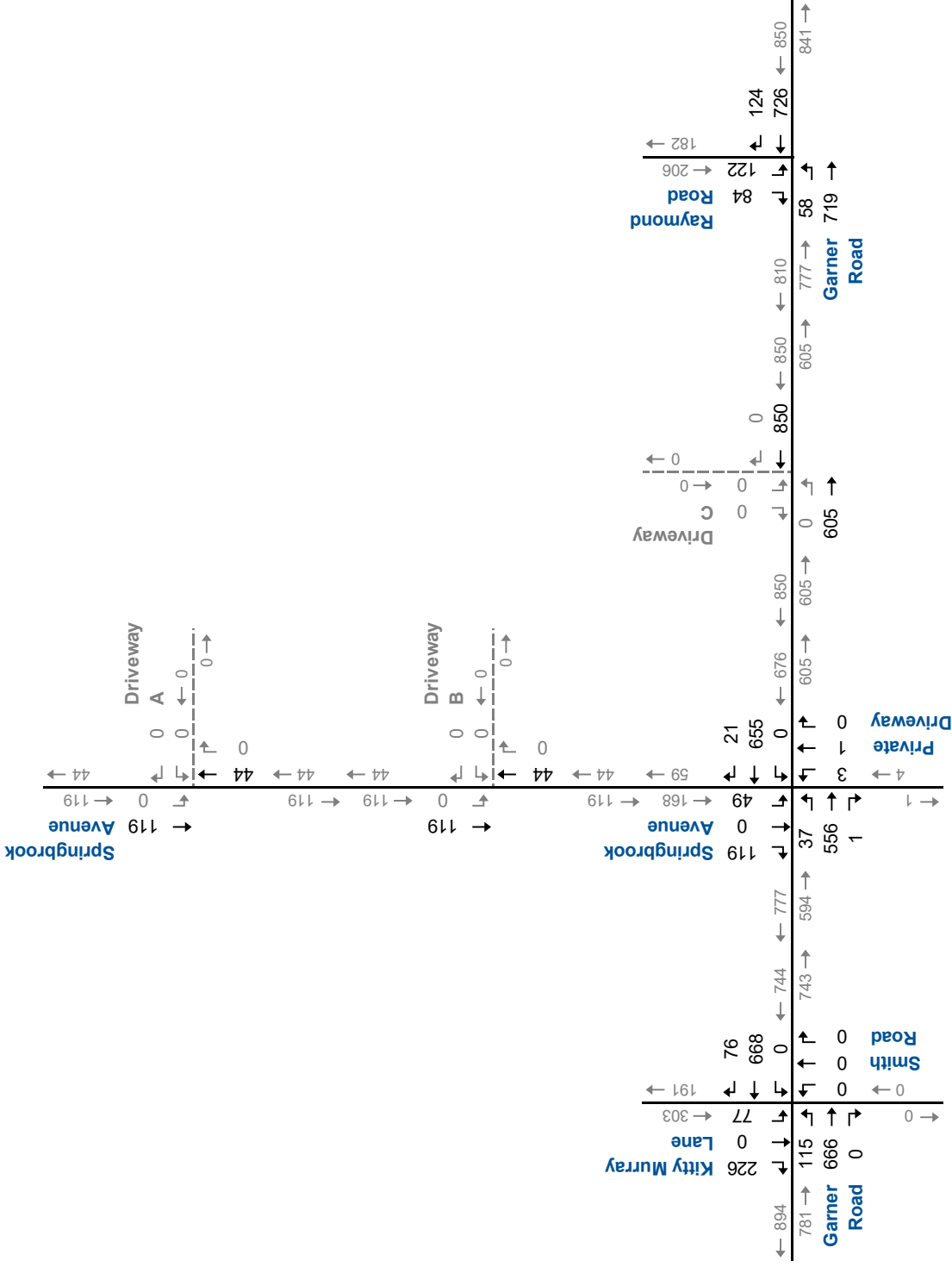


NTS



Background Development Traffic Volumes PM Peak Hour

Figure 4.2b



NTS



2027 Background Traffic Volumes AM Peak Hour

Figure 4.3a

4.2 Background Traffic Operations

Based on the estimated background traffic projections, level of service analyses has been conducted using Synchro 9 with HCM 2000 procedures for the weekday AM and PM peak hour conditions at the study area intersections. The same parameters as in the analysis of existing conditions were used with the exception of optimizing signal timing splits and cycle lengths.

Table 4.2 summarizes the results of the 2027 background horizon operations. The results indicate that the intersection of Garner Road and Raymond Road will operate with a v/c ratio of approximately 0.91 during the PM peak hour. The remaining study area intersections are forecast to operate at overall acceptable levels with the following critical movements:

Garner Road at Springbrook Avenue

- ▶ AM Peak Hour
 - The northbound movement is forecast to operate at LOS E with a v/c ratio of 0.05;
 - The southbound movement is forecast to operate at LOS E with a v/c ratio of 0.68; and
- ▶ PM Peak Hour
 - The southbound movement is forecast to operate at LOS F with a v/c ratio of 1.26.

Garner Road at Raymond Road

- ▶ PM Peak Hour
 - The eastbound through movement is forecast to operate at LOS C with a v/c ratio of 0.92; and
 - The westbound movement is forecast to operate at LOS C with a v/c ratio of 0.85.

Appendix D contains the detailed Synchro reports.



TABLE 4.2: 2027 BACKGROUND TRAFFIC OPERATIONAL CONDITIONS

Analysis Period	Intersection	Control Type	MOE	Direction / Movement / Approach																
				Eastbound				Westbound				Northbound				Southbound				OVERALL
				Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	
AM Peak Hour	Garner Road & Kitty Murray Lane/ Smith Road	TCS	LOS	B	A	>	A	<	B	>	B	<	A	>	A	C	C	>	C	B
			Delay	13	8	>	9	<	18	>	18	<	0	>	0	30	28	>	29	16
			V/C	0.42	0.61	>	<	0.80	>	<	0.00	>	0.42	0.23	>	0.72				
			95th	10	86	>	<	156	>	<	0	>	25	21	>					
	Storage	55	-	>	<	-	>	<	-	>	30	-	>							
	Avail.	45	-	>	<	-	>	<	-	>	5	-	>							
Garner Road & Springbrook Avenue	SC	LOS	<	A	>	<	A	A	<	E	>	<	E	>	<	E	>	<	<	
		Delay	<	1	>	<	0	0	<	49	>	<	44	>	<	68	>	<	<	
Garner Road & Raymond Road	TCS	LOS	B	A	>	A	<	B	>	B	<				D		C	D	B	
		Delay	11	9	>	9	<	19	>	19	<				39		33	36	17	
		V/C	0.28	0.62	>	<	0.83	>	0.06	0.77										
		95th	7	111	>	<	232	>	40	13										
Storage	35	-	>	<	-	>	40	-												
Avail.	29	-	>	<	-	>	0	-												
PM Peak Hour	Garner Road & Kitty Murray Lane/ Smith Road	TCS	LOS	B	B	>	B	<	B	>	B	<	A	>	A	C	C	>	C	B
			Delay	19	11	>	12	<	20	>	20	<	0	>	0	30	27	>	28	17
			V/C	0.61	0.73	>	<	0.82	>	<	0.00	>	0.44	0.09	>	0.75				
			95th	20	137	>	<	188	>	<	0	>	26	0	>					
	Storage	55	-	>	<	-	>	<	-	>	30	-	>							
	Avail.	35	-	>	<	-	>	<	-	>	4	-	>							
Garner Road & Springbrook Avenue	SC	LOS	<	A	>	<	A	A	<	C	>	<	F	>	<	F	>	<	<	
		Delay	<	4	>	<	0	0	<	16	>	<	279	>	<	1.26	>	<	<	
Garner Road & Raymond Road	TCS	LOS	B	B	>	B	<	B	>	B	<				D		C	D	C	
		Delay	13	19	>	19	<	18	>	18	<				41		34	39	20	
		V/C	0.38	0.92	>	<	0.85	>	0.04	0.91										
		95th	8	317	>	<	257	>	34	11										
Storage	35	-	>	<	-	>	40	-												
Avail.	27	-	>	<	-	>	6	-												

MOE - Measure of Effectiveness

LOS - Level of Service

V/C - Volume to Capacity Ratio

95th - 95th Percentile Queue Length

TCS - Traffic Control Signal

SC - Stop Control

Avail. - Available Storage (m)

Storage - Existing Storage (m)

> - Shared Right-Turn Lane

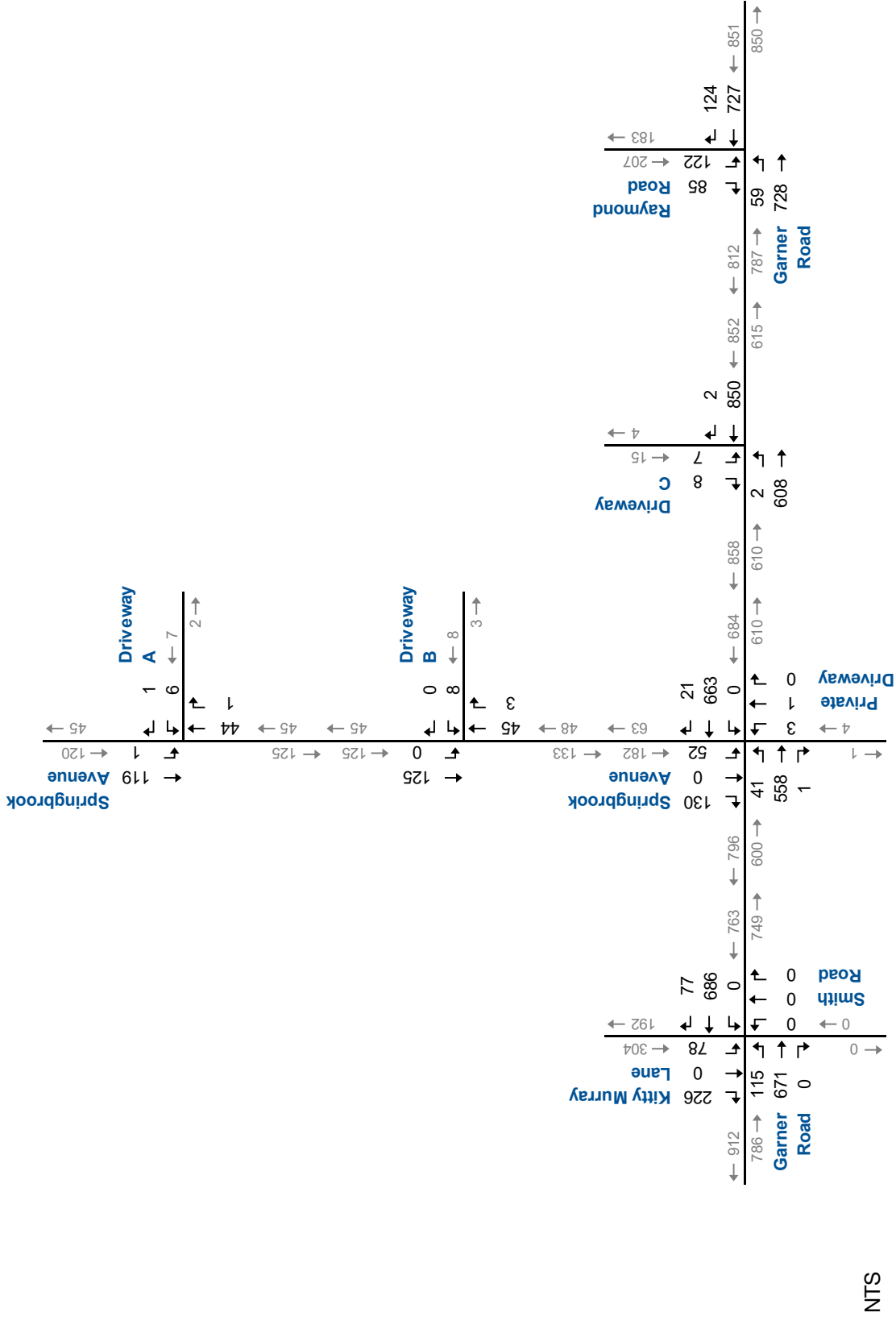
< - Shared Left-Turn Lane



4.3 Total Traffic Projections

Total traffic volumes include the background forecasts as well as the site-generated forecasts. **Figure 4.4a** and **Figure 4.4b** illustrate the respective weekday AM and PM peak hour total traffic forecasts for the 2027 horizon.



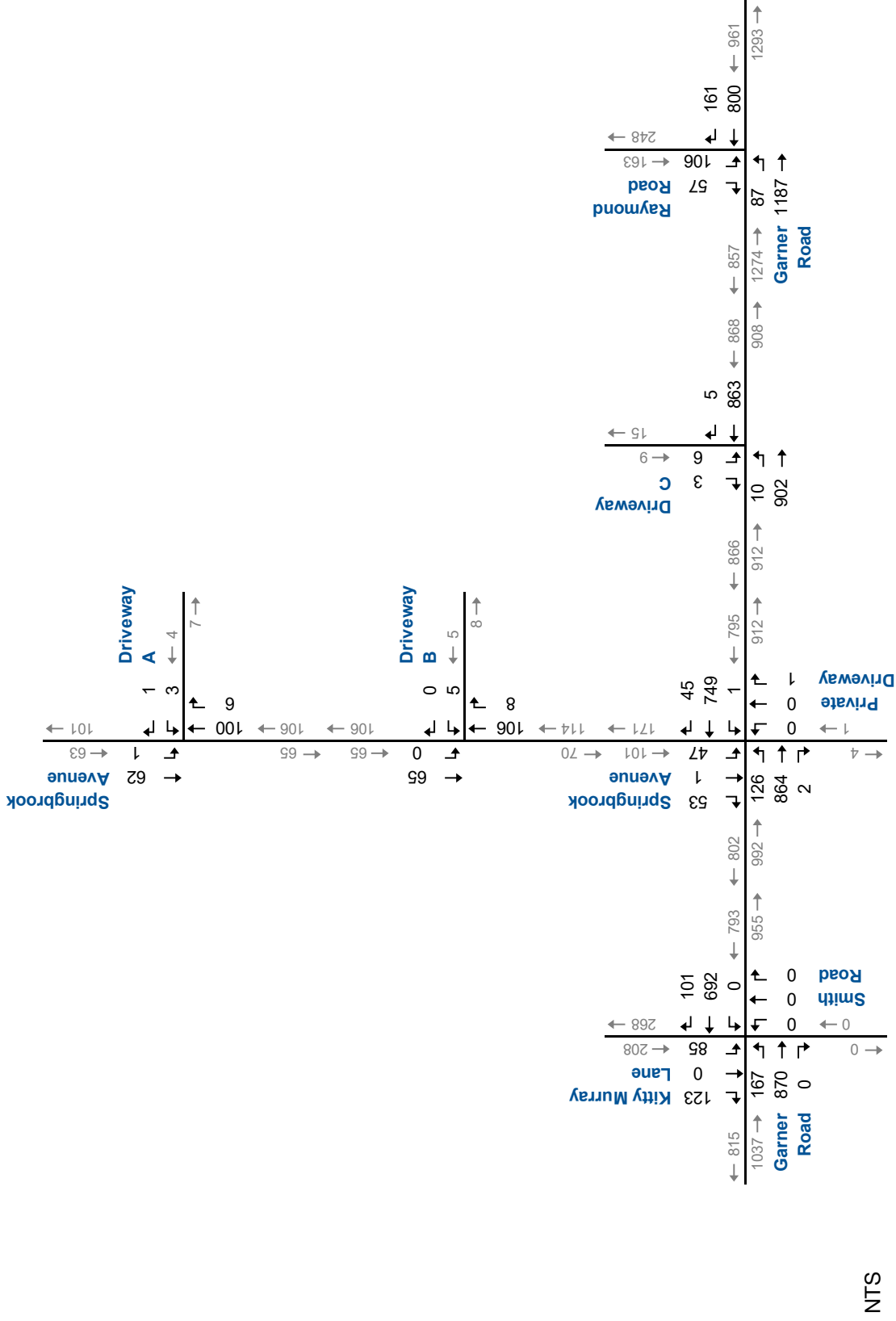


NTS



2027 Total Traffic Volumes AM Peak Hour

Figure 4.3a



NTS



2027 Total Traffic Volumes PM Peak Hour

Figure 4.3b

4.4 Total Traffic Operations

Based on the estimated total traffic projections, level of service analyses has been conducted using Synchro 9 with HCM 2000 procedures for the weekday AM and PM peak hour conditions at the study area intersections. The same parameters as in the analysis of background traffic conditions were used including optimizing the signal timing splits and cycle lengths.

Table 4.3 summarizes the results of the 2027 total horizon operations. The results indicate that the intersection of Garner Road and Raymond Road will operate with a v/c ratio of approximately 0.89 during the PM peak hour. The remaining study area intersections are forecast to operate at overall acceptable levels with the following critical movements:

Garner Road at Springbrook Avenue

- ▶ AM Peak Hour
 - The northbound movement is forecast to operate at LOS F with a v/c ratio of 0.05;
 - The southbound movement is forecast to operate at LOS F with a v/c ratio of 0.75; and
- ▶ PM Peak Hour
 - The southbound movement is forecast to operate at LOS F with a v/c ratio of 1.42.

Garner Road at Raymond Road

- ▶ PM Peak Hour
 - The eastbound through movement is forecast to operate at LOS C with a v/c ratio of 0.92.

Garner Road at Driveway C

- ▶ AM Peak Hour
 - The southbound movement is forecast to operate at LOS D with a v/c ratio of 0.10; and
- ▶ PM Peak Hour
 - The southbound movement is forecast to operate at LOS E with a v/c ratio of 0.11.



Overall, inclusion of the site-generated traffic increases delay at the study area intersections by one second or less during both the AM and PM peak hours.

Appendix E contains the detailed Synchro reports.



TABLE 4.3: 2027 TOTAL TRAFFIC OPERATIONAL CONDITIONS

Analysis Period	Intersection	Control Type	MOE	Direction / Movement / Approach																	
				Eastbound				Westbound				Northbound				Southbound				OVERALL	
				Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach		
AM Peak Hour	Gamer Road & Kitty Murray Lane/ Smith Road	TCS	LOS	B	A	>	A	<	B	>	B	<	A	>	A	<	C	C	>	C	B
			Delay	14	8	>	9	<	19	>	19	<	0	>	0	<	30	29	>	29	17
			V/C	0.44	0.62	>		<	0.82	>		<	0.00	>		<	0.43	0.26	>		0.74
	95th	10	88	>		<	178	>		<	0	>		<	25	22	>				
	Storage	55	-	>		<	-	>		<	-	>		<	30	-	>				
	Avail.	45	-	>		<	-	>		<	-	>		<	5	-	>				
	Gamer Road & Springbrook Avenue	SC	LOS	<	A	>		<	A	A		<	F	>		<	F	>			
			Delay	<	1	>		<	0	0		<	53	>		<	52	>			
			V/C	<	0.05	>		<	0.00	0.01		<	0.05	>		<	0.75	>			
	95th	<	1	>		<	0	0		<	1	>		<	42	>					
Gamer Road & Raymond Road	TCS	LOS	B	A	>	A	<	B	>	B	<				D	C	>	D	B		
		Delay	11	9	>	9	<	19	>	19	<				39		33	36	17		
		V/C	0.28	0.63	>		<	0.83	>						0.56		0.06		0.78		
95th	7	114	>		<	232	>						40		13						
Storage	35	-	>		<	-	>						40		-						
Avail.	29	-	>		<	-	>						0		-						
Springbrook Avenue & Driveway A	SC	LOS					A		>			A	>		<	A					
		Delay					9		>			0	>		<	0					
		V/C					0.01		>			0.03	>		<	0.00					
95th					0		>			0	>		<	0							
Springbrook Avenue & Driveway B	SC	LOS					A		>			A	>		<	A					
		Delay					10		>			0	>		<	0					
		V/C					0.01		>			0.03	>		<	0.00					
95th					0		>			0	>		<	0							
Gamer Road & Driveway C	SC	LOS	<	A	>			A	>						D		>				
		Delay	<	0	>			0	>						27		>				
		V/C	<	0.00	>			0.54	>						0.10		>				
95th	<	0	>			0	>						3		>						
PM Peak Hour	Gamer Road & Kitty Murray Lane/ Smith Road	TCS	LOS	C	B	>	B	<	C	>	C	<	A	>	A	C	C	>	C	B	
			Delay	21	11	>	13	<	20	>	20	<	0	>	0	<	30	27	>	28	17
			V/C	0.62	0.75	>		<	0.83	>		<	0.00	>		<	0.45	0.09	>		0.76
	95th	25	146	>		<	192	>		<	0	>		<	27	0	>				
	Storage	55	-	>		<	-	>		<	-	>		<	30	-	>				
	Avail.	30	-	>		<	-	>		<	-	>		<	3	-	>				
	Gamer Road & Springbrook Avenue	SC	LOS	<	A	>		<	A	A		<	C	>		<	F	>			
			Delay	<	5	>		<	0	0		<	16	>		<	345	>			
			V/C	<	0.17	>		<	0.00	0.03		<	0.00	>		<	1.42	>			
	95th	<	5	>		<	0	0		<	0	>		<	69	>					
Gamer Road & Raymond Road	TCS	LOS	B	C	>	B	<	B	>	B	<				D	D	>	D	C		
		Delay	14	20	>	20	<	18	>	18	<				43		38	41	21		
		V/C	0.39	0.92	>		<	0.84	>						0.52		0.04		0.89		
95th	8	342	>		<	272	>						38		11						
Storage	35	-	>		<	-	>						40		-						
Avail.	27	-	>		<	-	>						2		-						
Springbrook Avenue & Driveway A	SC	LOS					A		>			A	>		<	A					
		Delay					9		>			0	>		<	0					
		V/C					0.00		>			0.07	>		<	0.00					
95th					0		>			0	>		<	0							
Springbrook Avenue & Driveway B	SC	LOS					A		>			A	>		<	A					
		Delay					10		>			0	>		<	0					
		V/C					0.01		>			0.07	>		<	0.00					
95th					0		>			0	>		<	0							
Gamer Road & Driveway C	SC	LOS	<	A	>			A	>						E		>				
		Delay	<	1	>			0	>						49		>				
		V/C	<	0.02	>			0.55	>						0.11		>				
95th	<	0	>			0	>						3		>						

MOE - Measure of Effectiveness
 LOS - Level of Service
 V/C - Volume to Capacity Ratio
 95th - 95th Percentile Queue Length

TCS - Traffic Control Signal
 SC - Stop Control
 Avail. - Available Storage (m)

Storage - Existing Storage (m)
 > - Shared Right-Turn Lane
 < - Shared Left-Turn Lane



5 Remedial Measures

Based on the analyses, several problem movements were identified under future total conditions. The following sections discuss what, if any, measures should be implemented to mitigate traffic impacts.

5.1 Garner Road EA Planned Improvements

The City of Hamilton has completed an Environmental Assessment (EA)⁷ in 2014 for the Garner Road corridor between Highway 6 and West 5th Street to address capacity issues within the corridor. A review of this EA identified that the preferred option includes the widening of Garner Road to two travel lanes in each direction, inclusion of off-road bike lanes, two-way centre turn lane and auxiliary right turn lanes at strategic locations. As to how the improvements relate to the study area, the following has been identified:

Garner Road at Kitty Murray Lane

- ▶ Four Through Lanes;
- ▶ Left turn lane for all approaches;
- ▶ Right turn lane for southbound and eastbound approaches;
- ▶ Traffic Control Signals

Garner Road at Springbrook Avenue

- ▶ Four Through Lanes;
- ▶ Left turn lane for southbound, eastbound, and westbound approaches;

Garner Road at Raymond Road

- ▶ Four Through Lanes
- ▶ Left turn lane for eastbound and westbound approaches

A sensitivity analysis to assess the identified improvements noted above at the study area intersections have been undertaken for the 2027 Total conditions. **Table 5.1** summarizes the results of the sensitivity analysis. The results indicate that all previously identified critical conditions improve to acceptable thresholds with all overall intersection operations improving to a v/c ratio of 0.55 or better and

⁷ Garner Road/Rymal Road and Garth Street Improvements, Municipal Class Environmental Assessment Study, SNC Lavalin, 2011.



LOS B or better. Also, all movements are forecast to operate with a v/c ratio of 0.53 or better and LOS C or better.

Appendix F contains the detailed Synchro reports.



TABLE 5.1: 2027 TOTAL TRAFFIC SENSITIVY ANALYSIS

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			
AM Peak Hour	Gamer Road & Kitty Murray Lane/ Smith Road	TCS	LOS	A	A	>	A	<	B	>	B	<	A	>	A	>	C	A	>	C	B	
			Delay	6	5	>	5	<	11	>	11	<	0	>	0	>	24	0	>	23	11	
			V/C	0.28	0.35	>	<	0.46	>	<	0.00	>	<	0.00	>	0.38	0.00	>	0.38	0.00	>	0.43
			95th Storage Avail.	10	29	>	<	46	>	<	0	>	<	0	>	21	0	>	30	-	>	9
	Gamer Road & Springbrook Avenue	SC	LOS	B	A	>	A	A	>	<	C	>	<	C	B	>	<	B	>	<	<	
			Delay	10	0	>	0	0	>	<	17	>	<	17	13	>	17	13	>	4	7	
	Gamer Road & Raymond Road	TCS	LOS	A	A	>	A	A	>	A	>	<	C	>	C	C	>	C	C	C	A	
			Delay	5	5	>	5	9	>	9	>	<	33	>	29	31	10	0.47				
			V/C	0.19	0.34	>	<	0.46	>	<	0.01	>	<	0.15	0.22	>	0.53	0.06	>	0.53	0.06	
			95th Storage Avail.	7	37	>	61	>	35	-	>	29	-	>	35	12	>	40	-	>	5	
Springbrook Avenue & Driveway A	SC	LOS			>	A		>		A	>	<	A		>	<	A					
		Delay			>	9		>	0		0	>	<	0		<	0					
Springbrook Avenue & Driveway B	SC	LOS			>	A		>		A	>	<	A		>	<	A					
		Delay			>	10		>	0		0	>	<	0		<	0					
Gamer Road & Driveway C	SC	LOS	A	A	>		A	>					B		>		B					
		Delay	10	0	>		0	>						14		>		14				
PM Peak Hour	Gamer Road & Kitty Murray Lane/ Smith Road	TCS	LOS	A	A	>	A	<	B	>	B	<	A	>	A	>	C	A	>	C	A	
			Delay	7	6	>	6	<	12	>	11	<	0	>	0	>	25	0	>	23	10	
			V/C	0.37	0.42	>	<	0.45	>	<	0.00	>	<	0.00	>	0.40	0.00	>	0.40	0.00	>	0.44
			95th Storage Avail.	14	41	>	<	48	>	<	0	>	<	0	>	23	0	>	30	-	>	7
	Gamer Road & Springbrook Avenue	SC	LOS	B	A	>	A	A	>	<	B	>	<	C	B	>	<	B	>	<	<	
			Delay	10	0	>	10	0	>	<	12	>	<	12	12	>	24	12	>	6	3	
	Gamer Road & Raymond Road	TCS	LOS	A	A	>	A	A	>	A	>	<	C	C	C	C	>	C	C	C	A	
			Delay	5	6	>	6	10	>	10	>	<	28	>	25	27	9	0.55				
			V/C	0.25	0.53	>	<	0.53	>	<	0.00	>	<	0.48	0.04	>	0.21	0.10	>	0.21	0.10	
			95th Storage Avail.	8	61	>	65	>	35	-	>	27	-	>	40	-	>	14	-	>	14	
Springbrook Avenue & Driveway A	SC	LOS			>	A		>		A	>	<	A		>	<	A					
		Delay			>	9		>	0		0	>	<	0		<	0					
Springbrook Avenue & Driveway B	SC	LOS			>	A		>		A	>	<	A		>	<	A					
		Delay			>	10		>	0		0	>	<	0		<	0					
Gamer Road & Driveway C	SC	LOS	B	A	>		A	>					C		>		C					
		Delay	10	0	>		0	>						16		>		16				

MOE - Measure of Effectiveness
 LOS - Level of Service
 V/C - Volume to Capacity Ratio
 95th - 95th Percentile Queue Length

TCS - Traffic Control Signal
 SC - Stop Control
 Avail. - Available Storage (m)

Storage - Existing Storage (m)
 > - Shared Right-Turn Lane
 < - Shared Left-Turn Lane



5.2 Traffic Signal Warrant Analysis

The study intersection of Garner Road at Springbrook Avenue was assessed using the Ontario Traffic Manual (OTM Book 12 – Justification 7) signal warrant⁸ procedures. **Table 5.2** summarizes the warrant analysis for the 2027 total traffic conditions.

Based on the warrant analysis, the criteria necessary to warrant the installation of a traffic control signal is not satisfied for the intersection of Garner Road at Springbrook Avenue. **Appendix G** contains the warrant analysis.

TABLE 5.2: OTM SIGNAL WARRANT ANALYSIS SUMMARY

Intersection 2027 Total Traffic Conditions	Warrant	Percent Fulfilled	Warranted
Garner Road at Springbrook Avenue	1A	122.0%	No
	1B	43.4%	
	2A	111.8%	No
	2B	35.7%	

5.3 Left-Turn Lane Warrant

The need for an auxiliary left turning lane along Garner Road at the site driveway follows the requirements and procedures for a four-lane roadway detailed in the Transportation Association of Canada (TAC) *Geometric Design Guide for Canadian Roads*⁹. The warrant nomograph is used to determine if a left-turn lane is needed based on criteria such as design speed, advancing volume, opposing volumes and percent of advancing vehicles performing a left-turn maneuver.

Auxiliary turn lanes are usually provided on roadways where traffic intending to complete a left turn against approaching traffic incurs significant delay due to opposing traffic volumes. In instances where this left-turn movement is being made from a through traffic lane, this delay is passed onto other motorists travelling in the same direction. The need for an exclusive left-turn lane is usually determined by comparing the percentage of left-turning traffic against the opposing traffic stream.

Left-turn lane warrants were examined for the study area intersections and proposed development driveways. All warrants were assessed assuming the existing lane configurations are maintained at least

⁸ Ministry of Transportation of Ontario, *Ontario Traffic Manual Book 12*, July 2001.

⁹ Ministry of Transportation of Ontario, *MTO Design Supplement for TAC Geometric Design Guide for Canadian Roads*, June 2017.



through the horizon year 2027. In assessing the requirement for a left-turn lane, a minimum threshold of 2.5% of advancing vehicles making a left-turn maneuver is used as the left-turning vehicle percentage is rounded to the nearest 5%. **Appendix H** contains the left-turn lane warrant nomographs and indicates the following:

- ▶ A left-turn lane is not warranted along Springbrook Avenue at Driveway A. The advancing volume is noted to be less than 2.5%.
- ▶ A left-turn lane is not warranted along Springbrook Avenue at Driveway B. The advancing volume is noted to be less than 2.5%.
- ▶ A left-turn lane is not warranted along Garner Road at Driveway C. The advancing volume is noted to be less than 2.5%.
- ▶ An eastbound left-turn lane with 40 metres of storage is warranted along Garner Road at Springbrook Avenue under the 2027 horizon (with or without the development).

With the implementation of the Class EA identified roadway improvements along Garner Road, the centre lane would develop into a two-way left-turn lane. The left-turn lane warrant nomographs were assessed assuming the five-lane cross-section and indicate the following:

- ▶ A left-turn lane is not warranted along Garner Road at Driveway C.
- ▶ A left-turn lane with 40 metres of storage is warranted along Garner Road at Springbrook Avenue under the 2027 horizon (with or without the development).



6 Conclusions

6.1 Conclusions

Based on the investigations carried out, it is concluded that:

Base Year Traffic Operations

The study area intersections are operating well with no specific problem movements.

2027 Background Traffic Operations

The analysis results indicate that the intersection of Garner Road and Raymond Road will operate with a v/c ratio of approximately 0.91 during the PM peak hour. The remaining study area intersections are forecast to operate at overall acceptable levels with the following critical movements:

Garner Road at Springbrook Avenue

- ▶ AM Peak Hour
 - The northbound movement is forecast to operate at LOS E with a v/c ratio of 0.05;
 - The southbound movement is forecast to operate at LOS E with a v/c ratio of 0.68; and
- ▶ PM Peak Hour
 - The southbound movement is forecast to operate at LOS F with a v/c ratio of 1.26.

Garner Road at Raymond Road

- ▶ PM Peak Hour
 - The eastbound through movement is forecast to operate at LOS C with a v/c ratio of 0.92; and
 - The westbound movement is forecast to operate at LOS C with a v/c ratio of 0.85.

2027 Total Traffic Operations

The study area intersections are forecast to operate similar to background conditions. Inclusion of the site-generated traffic volumes shows minimal increase in delay at all three study area intersections. The greatest increase occurs at Garner Road at Kitty Murray Lane/



Smith Road where the delay increases by one second during each peak hour.

Remedial Measures

Traffic Signal Warrant

A traffic signal is not warranted at the intersection of Springbrook Avenue at Garner Road under the 2027 total horizon.

Left-Turn Lane Warrant

A southbound left-turn lane is not warranted on Springbrook Avenue at Driveway A or Driveway B and an eastbound left-turn lane is not warranted on Garner Road at Driveway C under future background or future total conditions with or without the planned roadway widening.

However, an eastbound left-turn lane with 40 metres storage is warranted on Garner Road at Springbrook Avenue both with the existing lane configuration and with the planned roadway widening along Garner Road.

Planned Roadway Improvements

Garner Road is planned to undergo an expansion to a five-lane cross-section with two lanes in each direction and a centre left-turn lane by 2031. Left and right-turn auxiliary lanes will be provided on Garner Road at the study area intersections.

2027 Total Traffic Operations – with Improvements

The study area intersections are forecast to operate with acceptable delays and within capacity with no specific problem movements with the applied remedial measures.

6.2 Recommendations

Based on the findings of this study, the following are recommended:

- ▶ The City permit the development to proceed as planned;
- ▶ The City monitor the traffic volumes at the intersection of Garner Road at Springbrook Avenue to provide a traffic signal if one is warranted in the near future;
- ▶ The signalized intersections along the Garner Road Corridor be monitored by the local road authorities to provide optimized signal timings for future traffic conditions; and



- ▶ The City implement the expansion of Garner Road as outlined in the *Garner Road/Rymal Road and Garth Street Improvements Municipal Class Environmental Assessment Study*.



Appendix A

Pre-Study Consultation



From: Transportation Planning <Transportation.Planning@hamilton.ca>

Sent: 2-Jun-20 8:15 AM

To: Adam Makarewicz <amakarewicz@ptsl.com>

Subject: RE: 200244: Springbrook Corner (TIS) - Terms of Reference

Hello,

Transportation Planning has reviewed the submitted Terms of Reference below, and have approved with the revisions noted in red below.

Please ensure these are dealt with in the submitted TIS report.

Thank you,

Bart Brosseau

Transportation Planning Technologist

Transportation Planning

COVID-19 UPDATE: Flexibility and patience is asked of ourselves, clients, contractors and customers working with the City of Hamilton. Most staff are working remotely with limited access to voicemail, so please send emails. All in-person meetings that are required will become conference calls or another form of virtual meetings. The City is making adjustments to ensure staff are connected to office tools and project files while we protect ourselves and our communities during this time. Please note that while we are trying to maintain time frames for comments on applications and dealing with responding information, we may not always achieve these goals.

From: Adam Makarewicz <amakarewicz@ptsl.com>
Sent: Monday, April 13, 2020 4:23 PM
To: Transportation Planning <Transportation.Planning@hamilton.ca>
Subject: 200244: Springbrook Corner (TIS) - Terms of Reference

This email provides our proposed scope of work for a Transportation Impact Study (TIS) for a proposed residential development within the northeast corner of Garner Road East and Springbrook Avenue in the City of Hamilton. Paradigm has previously carried out a Traffic Impact Study in 2012 [can you supply a copy of the previous study showing the proposed development at the time] which assessed these lands. The study is referred to as “Springbrook Corners Residential and Commercial Development”. In this study the subdivision included 41 residential units and 45,059 square feet of speciality retail. The latest subdivision plan (enclosed) indicates the development program is solely residential uses with 80 units proposed. Vehicle access is proposed driveway connections to Springbrook Avenue and Garner Road East.

The TIS will examine the proposed development’s anticipated impact on the study area’s traffic operations and identify any necessary road improvements required to accommodate the generated traffic. The proposed scope of work, outlined was developed based on the City of Hamilton Traffic Impact Study Guidelines (2009).

Scope of Work

1. **Development Study Area:** We will comment on existing transportation facilities within 500 metres of the subject site. Existing key roadways, major intersections, transit services, and pedestrian facilities will be discussed, as appropriate. [as a minimum the intersection of Garner Road East at Raymond Road; Garner Road East at Kitty Murray Lane; Garner Road East and Springbrook Avenue along with the site entrances]

2. **Analysis Time Periods and Intersections:** Based on the proposed development’s land use, size, and proximity, we plan to analyze the following intersections during the weekday AM and PM peak periods:
 - Garner Road East at Springbrook Avenue
 - Up to three (3) driveway connections

[Plus add these intersections in

- Garner Road East at Raymond Road;
- Garner Road East at Kitty Murray Lane.]

3. **2020 Existing Conditions:** With the recent school closures due to COVID-19 and social distancing measures, we recognize conducting traffic counts will not represent typical volumes for the study area intersections. As none of us knows how long this situation will last, and when traffic demands and travel patterns will return to pre-pandemic levels, we are proposing the following methodology to develop reasonable traffic data estimates for baseline conditions:

- a. Paradigm will obtain the April 2016 Turning Movement Count (TMC) at Garner Road East and Springbrook Avenue from the city
- b. Paradigm has on File a June 2012 TMC at Garner Road East and Springbrook Avenue
- c. The 2012 count will be compared to the 2016 count to derive a historic factor
- d. Factor will be applied to the 2016 TMC to develop baseline 2020 volumes
- e. Paradigm will also obtain the October 2019 TMC at Garner Road East and Raymond Road. Link volumes along Garner Road East will be checked and adjusted if necessary
- f) Estimated 2020 Baseline volumes will be provided to the City for approval before carrying out the Transportation Impact Assessment

The 2020 existing traffic operations at the aforementioned intersections will be analyzed using the software program Synchro (version 9) for the weekday AM and PM peak hours.

4. **2027 Future Background Traffic Conditions:** The background traffic volumes will be determined for the study area intersections, five years from anticipated build-out (2022 assumed **[this maybe an optimistic full build-out date under current conditions]**). We will identify an applicable background traffic growth rate and other area developments that may introduce traffic into the study area,

based on our previous assumptions and discussions with the City. Planned road improvements and other approved developments within close proximity will be taken into consideration. The 2027 background traffic operations will be analyzed for the weekday AM and PM peak hours. Specific assumptions are noted:

- General Background Growth will be developed based on historic growth documented in Task 3.
- City to provide background developments to be included (if any).

[Please find a link to the City's website which allows you to determine which sites have development applications which may affect the TIS study area and background traffic volumes. It is searchable by address, toggle aerial photos on/off, etc. This may be of assistance when requesting development application information from the City Planner on file. The planner will offer general information regarding the land use, number of proposed units, GFA associated with the application, etc. <http://map.hamilton.ca/> Access the Development Applications and pick the pins associated with the site.

It is up to the Transportation consultant to ascertain the traffic volumes associated with each development. Trip distribution for each development shall also be determined by the Transportation consultant based on their analysis.]

5. **Site Traffic Generation and Trip Distribution:** The size and nature of the proposed subject site will be documented based on the received site drawings and statistics, and will be used to estimate the number of automobile and non-automobile trips likely to be produced during the weekday AM and PM peak hours. The estimation will be based on information from the Institute of Transportation Engineers (ITE) publication, Trip Generation, 10th Edition. The trip distribution for the proposed site will be based on a review of the 2016 Transportation Tomorrow Survey (TTS). The forecast site traffic for the development will be added to the road network based on the trip distribution and assigned to the network based on existing travel patterns, logical travel routes, and available traffic capacity.
6. **2027 Future Total Traffic Conditions:** The estimated site traffic volumes will be combined with the future background traffic volumes to determine the 2027 total traffic volumes for the study area intersections. Intersection operations analysis will be undertaken for the weekday AM and PM peak hours. Any necessary road improvements required to accommodate total traffic volumes will be identified if necessary, such as additional turning lanes, storage length modifications, intersection reconfigurations and, signal installation.

7. **Traffic Signal Warrant Analysis:** Ontario Traffic Manual (OTM) Book 12 will be referenced with regards to signal warrant guidelines to determine if the installation of a traffic signal at the unsignalized intersections that experience operational issues.

8. **Road Improvements (Left Turn Storage Lane):** Left turn storage lane assessment will be conducted to determine if site traffic volumes will be high enough to warrant a left turn lane provision upon full buildout of the subject site at the unsignalized intersections. The assessment will be based on the methodology outlined in the Transportation Association of Canada (TAC) Geometric Design Guide.

If we could receive a response back by end of the week that we can proceed with our scope of work it would be greatly appreciated.

Regards,

Adam J. Makarewicz
Senior Project Manager



Paradigm Transportation Solutions Limited

5A-150 Pinebush Road, Cambridge ON N1R 8J8
p: 905.381.2229 x303
e: amakarewicz@ptsl.com
w: www.ptsl.com

In these very uncertain times, we want to take this opportunity to assure you that our unique “work at home” business model enables us to offer uninterrupted support to our clients, ensuring we can continue to offer the high-quality service and work product we always have. We are fully operational and our staff are diligently working on our assignments with you.

As social distancing is imperative to stop the spread of the COVID-19 virus, we will not be conducting in-person meetings until we are advised by the proper authorities that it is safe to do so. In the meantime, we have the technology to host on-line meetings in various forms and will be using it to communicate with you.

Let’s stay safe and look out for each other. We will get through this together.

Appendix B

Traffic Count Data



Intersection: **Garner Rd E**
 Direction: (East/West)
 Road Condition: Wet
 Comments:

at **Raymond Rd**
 (North/South)

Total Vehicles: 8,764
 M.V.E./Year: 5.960
 AWDT Factor: 2

Date: Wednesday
 Oct 30, 2019
 Period: 7 hours

Weather: Overcast

15 mins. Ending (Pk.Hr.*)	TOTAL VEHICLES												Pedestrians				
	North Bd. on N/S			East Bd. on E/W			South Bd. on N/S			West Bd. on E/W			Total Veh's	N side	E side	S side	W side
	L	S	R	L	S	R	L	S	R	L	S	R					
7:15	0	0	0	3	39	0	11	0	2	0	65	6	126	0	0	0	0
7:30	0	0	0	7	97	0	22	0	9	0	100	12	247	0	0	0	0
7:45	0	0	0	6	97	0	18	0	15	0	85	9	230	0	0	0	0
8:00	0	0	0	9	106	0	19	0	17	0	113	23	287	0	0	0	0
8:15	0	0	0	9	131	0	23	0	20	0	105	22	310	0	0	0	2
8:30 *	0	0	0	21	159	0	26	0	25	0	156	28	415	0	0	0	1
8:45 *	0	0	0	10	160	0	19	0	5	0	136	28	358	1	0	0	0
9:00 *	0	0	0	9	129	0	29	0	22	0	143	26	358	2	0	0	0
9:15 *	0	0	0	6	116	0	29	0	17	0	153	23	344	0	0	0	0
9:30	0	0	0	11	83	0	4	0	8	0	96	21	223	1	0	0	1
9:45	0	0	0	7	94	0	12	0	8	0	63	11	195	0	0	0	0
10:00	0	0	0	4	92	0	11	0	4	0	64	11	186	0	0	0	1
13:45	0	0	0	9	92	0	15	0	10	0	93	22	241	0	0	0	0
14:00	0	0	0	1	66	0	10	0	1	0	81	8	167	0	0	0	0
14:15	0	0	0	2	95	0	13	0	4	0	93	12	219	0	0	0	0
14:30	0	0	0	4	83	0	9	0	4	0	83	12	195	0	1	0	0
14:45 *	0	0	0	9	127	0	14	0	18	0	102	16	286	0	0	0	0
15:00 *	0	0	0	8	95	0	10	0	6	0	118	9	246	0	0	0	0
15:15 *	0	0	0	7	100	0	8	0	0	0	107	18	240	0	0	0	0
15:30 *	0	0	0	9	179	0	21	0	5	0	195	68	477	1	0	0	0
16:15	0	0	0	5	169	0	29	0	7	0	158	26	394	0	1	0	0
16:30	0	0	0	12	246	0	36	0	10	0	155	31	490	0	0	0	0
16:45 *	0	0	0	23	237	0	25	0	14	0	132	43	474	0	0	0	0
17:00 *	0	0	0	15	229	0	29	0	9	0	187	34	503	0	0	0	0
17:15 *	0	0	0	14	232	0	11	0	11	0	128	29	425	0	0	0	0
17:30 *	0	0	0	18	245	0	24	0	9	0	199	30	525	0	0	0	0
17:45	0	0	0	8	127	0	23	0	8	0	104	16	286	0	0	0	0
18:00	0	0	0	14	127	0	27	0	13	0	109	27	317	0	0	0	0
TOTAL	0	0	0	260	3,752	0	527	0	281	0	3,323	621		5	2	0	5
APPR.		0			4,012			808			3,944		8,764				12

15 mins. Ending (Pk.Hr.*)	TRUCKS & BUSES												Total		
	North Bd. on N/S			East Bd. on E/W			South Bd. on N/S			West Bd. on E/W					
	L	S	R	L	S	R	L	S	R	L	S	R			
7:15	0	0	0	0	5	0	0	0	0	0	0	0	4	0	9
7:30	0	0	0	1	4	0	0	0	0	0	0	0	5	0	12
7:45	0	0	0	1	3	0	0	0	0	0	0	0	4	1	9
8:00	0	0	0	1	9	0	0	0	0	0	1	0	8	0	19
8:15	0	0	0	0	12	0	0	0	0	0	1	0	5	0	18
8:30 *	0	0	0	6	5	0	2	0	4	0	0	0	8	0	25
8:45 *	0	0	0	0	12	0	1	0	0	0	0	0	4	3	20
9:00 *	0	0	0	0	8	0	0	0	1	0	0	0	7	1	17
9:15 *	0	0	0	0	10	0	3	0	1	0	0	0	6	1	21
9:30	0	0	0	0	11	0	0	0	0	0	0	0	7	1	19
9:45	0	0	0	1	5	0	0	0	1	0	0	0	1	3	11
10:00	0	0	0	0	2	0	0	0	0	0	0	0	3	2	7
13:45	0	0	0	1	5	0	0	0	0	0	0	0	4	0	10
14:00	0	0	0	0	7	0	1	0	0	0	0	0	6	0	14
14:15	0	0	0	0	3	0	1	0	0	0	0	0	11	0	15
14:30	0	0	0	1	4	0	0	0	0	0	0	0	7	1	13
14:45 *	0	0	0	0	7	0	0	0	0	0	0	0	8	0	15
15:00 *	0	0	0	0	3	0	0	0	0	0	0	0	2	0	5
15:15 *	0	0	0	0	6	0	0	0	0	0	0	0	3	2	11
15:30 *	0	0	0	3	3	0	2	0	0	0	0	0	2	0	10
16:15	0	0	0	1	1	0	2	0	0	0	0	0	9	0	13
16:30	0	0	0	0	4	0	1	0	0	0	0	0	4	0	9
16:45 *	0	0	0	0	8	0	0	0	0	0	0	0	5	0	13
17:00 *	0	0	0	0	4	0	0	0	1	0	0	0	1	0	6
17:15 *	0	0	0	0	2	0	0	0	0	0	0	0	3	0	5
17:30 *	0	0	0	0	4	0	0	0	0	0	0	0	8	0	12
17:45	0	0	0	0	1	0	0	0	0	0	0	0	1	0	2
18:00	0	0	0	0	1	0	1	0	1	0	0	0	3	0	6
TOTAL	0	0	0	16	149	0	14	0	11	0	139	17			346
APPR.		0			165			25			156				346

15 mins. Ending (Pk.Hr.*)	TRUCKS												Total		
	North Bd. on N/S			East Bd. on E/W			South Bd. on N/S			West Bd. on E/W					
	L	S	R	L	S	R	L	S	R	L	S	R			
7:15	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3
7:30	0	0	0	0	2	0	0	0	0	0	0	0	4	0	6
7:45	0	0	0	1	3	0	0	0	0	0	0	0	2	0	6
8:00	0	0	0	0	3	0	0	0	0	0	0	0	3	0	6
8:15	0	0	0	0	6	0	0	0	1	0	0	0	4	0	11
8:30 *	0	0	0	1	1	0	0	0	0	0	0	0	7	0	9
8:45 *	0	0	0	0	7	0	0	0	0	0	0	0	3	1	11
9:00 *	0	0	0	0	5	0	0	0	0	0	0	0	4	0	9
9:15 *	0	0	0	0	6	0	0	0	0	0	0	0	4	0	10
9:30	0	0	0	0	9	0	0	0	0	0	0	0	4	0	13
9:45	0	0	0	1	4	0	0	0	1	0	0	0	0	3	9
10:00	0	0	0	0	1	0	0	0	0	0	0	0	1	2	4
13:45	0	0	0	1	5	0	0	0	0	0	0	0	3	0	9
14:00	0	0	0	0	6	0	1	0	0	0	0	0	3	0	10
14:15	0	0	0	0	2	0	1	0	0	0	0	0	5	0	8
14:30	0	0	0	0	3	0	0	0	0	0	0	0	3	1	7
14:45 *	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3
15:00 *	0	0	0	0	2	0	0	0	0	0	0	0	2	0	4
15:15 *	0	0	0	0	4	0	0	0	0	0	0	0	2	0	6
15:30 *	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
16:15	0	0	0	0	1	0	0	0	0	0	0	0	3	0	4
16:30	0	0	0	0	2	0	0	0	0	0	0	0	2	0	4
16:45 *	0	0	0	0	2	0	0	0	0	0	0	0	4	0	6
17:00 *	0	0	0	0	2	0	0	0	1	0	0	0	1	0	4
17:15 *	0	0	0	0	1	0	0	0	0	0	0	0	2	0	3
17:30 *	0	0	0	0	4	0	0	0	0	0	0	0	2	0	6
17:45	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
18:00	0	0	0	0	0	0	1	0	1	0	0	0	3	0	5
TOTAL	0	0	0	4	84	0	3	0	4	0	77	7			179
APPR.		0			88			7			84				179

Intersection: **Garner Rd**
 Direction: (East/West)
 Road Condition: Dry
 Comments:

at **Springbrook Ave**
 (North/South)
 Weather: Clear

Total Vehicles: 6,950
 M.V.E./Year: 4.679
 AWDT Factor: 1.98

Date: Friday
 Apr 22, 2016
 Period: 7 hours

TOTAL VEHICLES																	
15 mins. Ending (Pk.Hr.*)	North Bd. on N/S			East Bd. on E/W			South Bd. on N/S			West Bd. on E/W			Total Veh's	Pedestrians			
	L	S	R	L	S	R	L	S	R	L	S	R		N side	E side	S side	W side
7:15	0	0	0	2	49	0	1	0	5	0	65	1	123	0	0	0	0
7:30	0	0	0	1	88	0	2	0	6	0	82	2	181	0	0	0	0
7:45	0	0	0	1	84	0	6	0	6	0	108	2	207	0	0	0	0
8:00 *	1	0	0	3	103	0	2	0	17	0	126	3	255	0	0	0	0
8:15 *	1	0	0	2	110	1	4	0	11	0	108	3	240	0	0	0	0
8:30 *	0	0	0	5	108	0	0	0	11	0	117	1	242	0	0	0	0
8:45 *	1	1	0	4	109	0	6	0	13	0	119	2	255	0	0	0	0
9:00	0	0	0	3	88	0	4	0	12	0	115	3	225	0	0	0	0
9:15	0	0	0	6	95	0	2	0	12	0	101	3	219	0	0	0	0
9:30	0	0	0	6	67	0	4	0	9	0	94	4	184	1	0	0	0
9:45	0	0	1	2	79	1	3	0	3	0	90	1	180	0	0	0	0
10:00	0	0	0	4	76	0	2	0	7	0	77	1	167	1	0	0	0
13:45	0	0	0	7	87	0	2	0	5	0	103	5	209	0	1	0	0
14:00	0	0	0	6	99	0	0	0	6	0	114	1	226	0	0	0	0
14:15	0	0	0	4	101	0	0	0	2	0	124	3	234	0	0	0	1
14:30	0	0	0	3	123	0	2	0	3	0	129	5	265	0	0	0	0
14:45 *	0	0	0	6	112	0	1	0	5	0	132	3	259	0	0	0	0
15:00 *	0	0	0	4	116	0	3	0	6	0	105	1	235	0	0	0	0
15:15 *	0	0	0	8	122	1	3	0	4	0	148	5	291	0	0	0	0
15:30 *	0	0	0	5	131	0	8	0	7	0	121	6	278	1	0	0	0
16:15	0	0	0	8	151	0	1	0	6	0	136	3	305	0	0	0	0
16:30	0	0	0	11	152	0	2	0	3	0	148	2	318	0	0	0	0
16:45	0	0	0	7	143	0	1	0	7	0	141	2	301	0	0	0	0
17:00 *	0	0	0	6	149	0	3	0	4	1	136	2	301	1	0	0	0
17:15 *	0	0	1	11	160	1	5	1	5	0	150	4	338	0	0	0	2
17:30 *	0	0	0	9	160	0	1	0	4	0	145	10	329	0	0	0	0
17:45 *	0	0	0	6	146	1	4	0	3	0	142	3	305	0	0	0	0
18:00	1	0	1	7	133	0	1	0	3	0	128	4	278	0	2	0	0
TOTAL	4	1	3	147	3,141	5	73	1	185	1	3,304	85		4	3	0	3
APPR.		8			3,293			259			3,390		6,950				10

TRUCKS & BUSES																
15 mins. Ending (Pk.Hr.*)	North Bd. on N/S			East Bd. on E/W			South Bd. on N/S			West Bd. on E/W			Total			
	L	S	R	L	S	R	L	S	R	L	S	R				
7:15	0	0	0	0	4	0	0	0	0	0	3	0	7			
7:30	0	0	0	1	4	0	0	0	0	6	0	0	11			
7:45	0	0	0	1	10	0	1	0	1	0	11	2	26			
8:00 *	0	0	0	0	12	0	0	0	3	0	10	0	25			
8:15 *	0	0	0	0	10	0	0	0	0	4	1	0	15			
8:30 *	0	0	0	1	11	0	0	0	1	0	9	0	22			
8:45 *	0	0	0	3	7	0	0	0	2	0	2	1	15			
9:00	0	0	0	1	4	0	0	0	4	0	4	0	13			
9:15	0	0	0	0	8	0	0	0	0	0	8	0	16			
9:30	0	0	0	0	3	0	0	0	0	0	6	0	9			
9:45	0	0	1	0	3	0	0	0	0	0	0	0	4			
10:00	0	0	0	0	4	0	1	0	0	0	1	0	6			
13:45	0	0	0	0	7	0	0	0	0	0	6	0	13			
14:00	0	0	0	0	2	0	0	0	0	0	8	0	10			
14:15	0	0	0	0	5	0	0	0	0	0	5	0	10			
14:30	0	0	0	0	6	0	0	0	0	0	5	1	12			
14:45 *	0	0	0	1	7	0	0	0	0	0	7	0	15			
15:00 *	0	0	0	0	3	0	0	0	0	0	2	0	5			
15:15 *	0	0	0	1	2	0	0	0	0	0	6	0	9			
15:30 *	0	0	0	1	3	0	2	0	2	0	2	0	10			
16:15	0	0	0	0	4	0	0	0	1	0	4	0	9			
16:30	0	0	0	1	3	0	0	0	1	0	4	0	9			
16:45	0	0	0	0	3	0	0	0	0	0	1	0	4			
17:00 *	0	0	0	0	4	0	0	0	0	0	2	0	6			
17:15 *	0	0	0	0	2	0	0	0	0	0	1	0	3			
17:30 *	0	0	0	0	1	0	0	0	0	0	3	0	4			
17:45 *	0	0	0	0	3	0	0	0	0	0	0	0	3			
18:00	0	0	0	0	1	0	0	0	0	0	3	1	5			
TOTAL	0	0	1	11	136	0	4	0	15	0	123	6				
APPR.		1			147			19			129		296			

TRUCKS																
15 mins. Ending (Pk.Hr.*)	North Bd. on N/S			East Bd. on E/W			South Bd. on N/S			West Bd. on E/W			Total			
	L	S	R	L	S	R	L	S	R	L	S	R				
7:15	0	0	0	0	4	0	0	0	0	0	1	0	5			
7:30	0	0	0	0	2	0	0	0	0	0	1	0	3			
7:45	0	0	0	0	6	0	1	0	0	0	3	0	10			
8:00 *	0	0	0	0	4	0	0	0	1	0	5	0	10			
8:15 *	0	0	0	0	3	0	0	0	0	0	3	0	6			
8:30 *	0	0	0	0	4	0	0	0	0	0	5	0	9			
8:45 *	0	0	0	0	2	0	0	0	0	0	1	0	3			
9:00	0	0	0	1	1	0	0	0	0	0	1	0	3			
9:15	0	0	0	0	3	0	0	0	0	0	8	0	11			
9:30	0	0	0	0	1	0	0	0	0	0	5	0	6			
9:45	0	0	1	0	2	0	0	0	0	0	0	0	3			
10:00	0	0	0	0	4	0	0	0	0	0	0	0	4			
13:45	0	0	0	0	4	0	0	0	0	0	5	0	9			
14:00	0	0	0	0	2	0	0	0	0	0	4	0	6			
14:15	0	0	0	0	2	0	0	0	0	0	1	0	3			
14:30	0	0	0	0	4	0	0	0	0	0	2	1	7			
14:45 *	0	0	0	0	2	0	0	0	0	0	6	0	8			
15:00 *	0	0	0	0	1	0	0	0	0	0	0	0	1			
15:15 *	0	0	0	1	0	0	0	0	0	0	2	0	3			
15:30 *	0	0	0	0	1	0	0	0	0	0	0	0	1			
16:15	0	0	0	0	1	0	0	0	0	0	3	0	4			
16:30	0	0	0	1	1	0	0	0	0	0	2	0	4			
16:45	0	0	0	0	3	0	0	0	0	0	1	0	4			
17:00 *	0	0	0	0	1	0	0	0	0	0	0	0	1			
17:15 *	0	0	0	0	2	0	0	0	0	0	1	0	3			
17:30 *	0	0	0	0	0	0	0	0	0	0	2	0	2			
17:45 *	0	0	0	0	3	0	0	0	0	0	0	0	3			
18:00	0	0	0	0	0	0	0	0	0	0	2	0	2			
TOTAL	0	0	1	3	63	0	1	0	1	0	64	1				
APPR.		1			66			2			65		134			

Intersection: **Garner Rd E**
 Direction: (East/West)
 Road Condition: Dry
 Comments:

at **Kitty Murray Ln**
 (North/South)

Weather: Clear

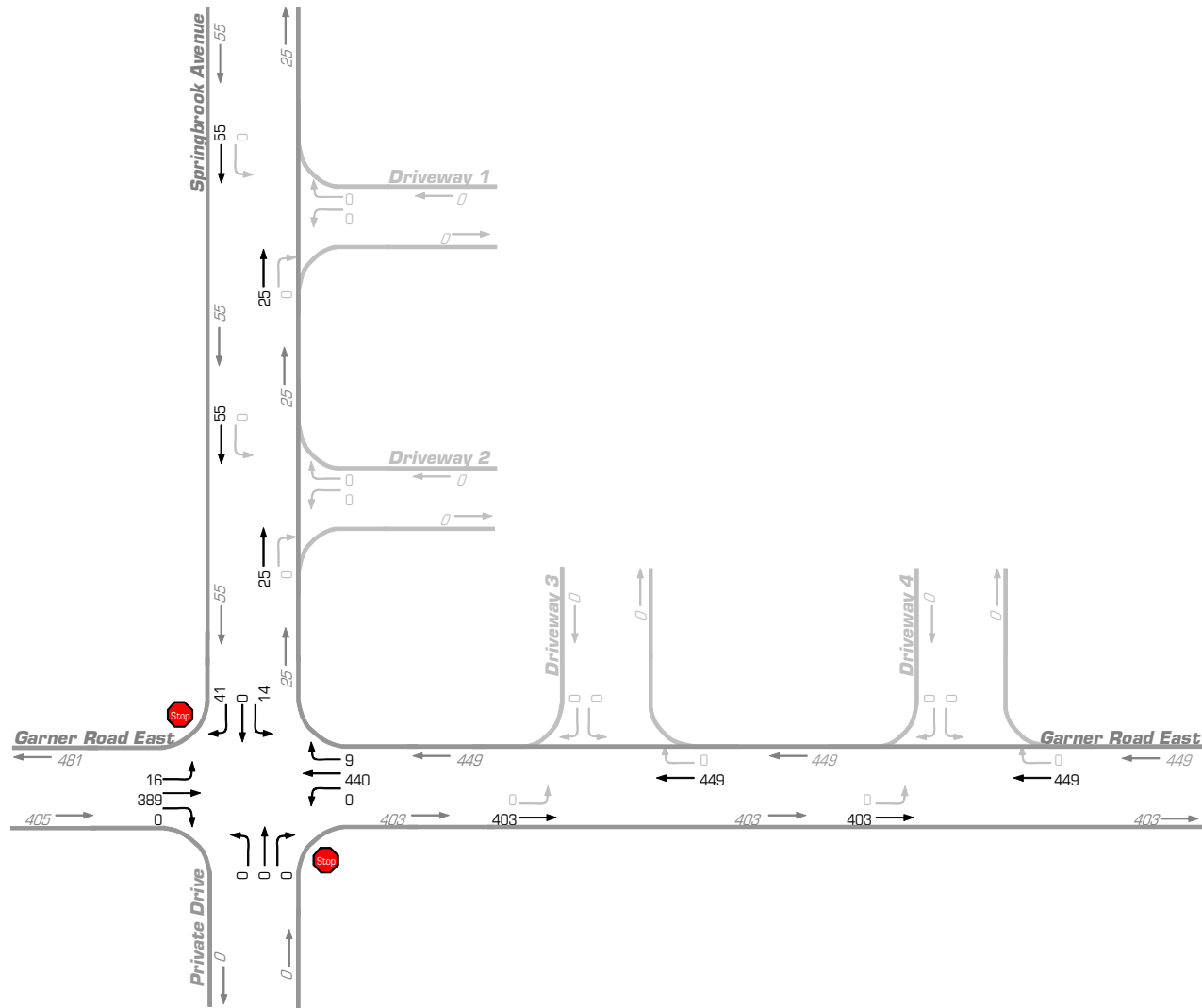
Total Vehicles: 7,785
 M.V.E./Year: 5.426
 AWDT Factor: 2.05

Date: Monday
 Oct 28, 2019
 Period: 7 hours

15 mins. Ending (Pk.Hr.*)	TOTAL VEHICLES												Pedestrians				
	North Bd. on N/S			East Bd. on E/W			South Bd. on N/S			West Bd. on E/W			Total Veh's	N side	E side	S side	W side
	L	S	R	L	S	R	L	S	R	L	S	R					
7:15	0	0	0	7	44	0	5	0	13	0	57	3	129	0	0	0	0
7:30	0	0	0	10	96	0	10	0	20	0	70	2	208	0	0	0	0
7:45	0	0	0	10	81	0	7	0	26	0	73	7	204	0	0	0	0
8:00 *	0	0	0	12	98	0	16	0	63	0	121	14	324	0	0	0	2
8:15 *	0	0	0	40	135	0	19	0	61	0	133	15	403	1	0	0	1
8:30 *	0	0	0	21	130	0	10	0	43	0	112	16	332	0	0	0	0
8:45 *	0	0	0	25	174	0	17	0	26	0	100	16	358	0	0	0	2
9:00	0	0	0	18	136	0	17	0	20	0	107	17	315	2	0	0	1
9:15	0	0	0	30	93	0	31	0	32	0	89	35	310	2	0	0	1
9:30	0	0	0	15	81	0	27	0	20	0	79	12	234	0	0	0	0
9:45	0	0	0	12	69	0	6	0	12	0	62	5	166	1	0	0	0
10:00	0	0	0	12	90	0	12	0	18	0	87	6	225	2	0	0	0
13:45	0	0	0	5	66	0	9	0	6	0	72	7	165	0	0	0	0
14:00	0	0	0	8	49	0	3	0	3	0	42	8	113	0	0	0	0
14:15	0	0	0	3	42	0	4	0	4	0	46	1	100	0	0	0	0
14:30	0	0	0	22	77	0	6	0	19	0	115	9	248	0	0	0	0
14:45 *	0	0	0	20	115	0	10	0	22	0	96	14	277	0	0	0	24
15:00 *	0	0	0	20	104	0	13	0	31	0	113	14	295	1	0	0	0
15:15 *	0	0	0	21	74	0	9	0	10	0	63	10	187	0	0	0	0
15:30 *	0	0	0	30	132	0	14	0	10	0	134	24	344	1	0	1	0
16:15	0	0	0	17	115	0	23	0	22	0	105	6	288	0	0	0	0
16:30	0	0	0	26	138	0	22	0	35	0	118	14	353	3	0	0	1
16:45	0	0	0	31	134	0	13	0	18	0	111	26	333	1	0	0	0
17:00 *	0	0	0	35	155	0	24	0	27	0	150	29	420	0	0	0	0
17:15 *	0	0	0	35	179	0	11	0	24	0	143	15	407	0	0	0	1
17:30 *	0	0	0	27	142	0	10	0	28	0	128	21	356	0	0	0	0
17:45 *	0	0	0	45	114	0	22	0	26	0	113	16	336	0	0	0	0
18:00	0	0	0	25	141	0	21	0	29	0	128	11	355	0	0	0	0
TOTAL	0	0	0	582	3,004	0	391	0	668	0	2,767	373		14	0	1	33
APPR.		0			3,586			1,059			3,140		7,785				48

15 mins. Ending (Pk.Hr.*)	TRUCKS & BUSES												Total		
	North Bd. on N/S			East Bd. on E/W			South Bd. on N/S			West Bd. on E/W					
	L	S	R	L	S	R	L	S	R	L	S	R			
7:15	0	0	0	2	6	0	1	0	0	0	0	1	0	0	10
7:30	0	0	0	1	8	0	0	0	0	0	0	0	1	0	10
7:45	0	0	0	0	4	0	0	0	1	0	0	0	1	2	8
8:00 *	0	0	0	1	11	0	1	0	1	0	0	0	11	2	27
8:15 *	0	0	0	1	7	0	1	0	1	0	0	0	5	3	18
8:30 *	0	0	0	1	9	0	0	0	1	0	0	0	2	0	13
8:45 *	0	0	0	1	17	0	0	0	1	0	0	0	4	0	23
9:00	0	0	0	1	14	0	1	0	1	0	0	0	8	3	28
9:15	0	0	0	3	4	0	3	0	3	0	0	0	8	1	22
9:30	0	0	0	0	6	0	0	0	0	0	0	0	5	0	11
9:45	0	0	0	1	5	0	0	0	0	0	0	0	6	0	12
10:00	0	0	0	0	5	0	1	0	0	0	0	0	6	0	12
13:45	0	0	0	0	5	0	1	0	0	0	0	0	7	1	14
14:00	0	0	0	0	7	0	0	0	0	0	0	0	5	0	12
14:15	0	0	0	0	0	0	1	0	0	0	0	0	4	0	5
14:30	0	0	0	1	2	0	1	0	0	0	0	0	7	0	11
14:45 *	0	0	0	1	13	0	0	0	1	0	0	0	4	0	19
15:00 *	0	0	0	0	11	0	0	0	2	0	0	0	10	0	23
15:15 *	0	0	0	0	6	0	1	0	0	0	0	0	8	0	15
15:30 *	0	0	0	2	6	0	2	0	1	0	0	0	12	2	25
16:15	0	0	0	0	5	0	3	0	0	0	0	0	7	0	15
16:30	0	0	0	0	2	0	0	0	1	0	0	0	4	0	7
16:45	0	0	0	0	6	0	1	0	0	0	0	0	6	0	13
17:00 *	0	0	0	1	7	0	0	0	0	0	0	0	2	0	10
17:15 *	0	0	0	0	5	0	0	0	0	0	0	0	5	0	10
17:30 *	0	0	0	1	2	0	1	0	0	0	0	0	5	0	9
17:45 *	0	0	0	0	1	0	2	0	0	0	0	0	1	0	4
18:00	0	0	0	0	1	0	2	0	0	0	0	0	2	0	5
TOTAL	0	0	0	18	175	0	23	0	14	0	147	14			
APPR.		0			193			37			161				391

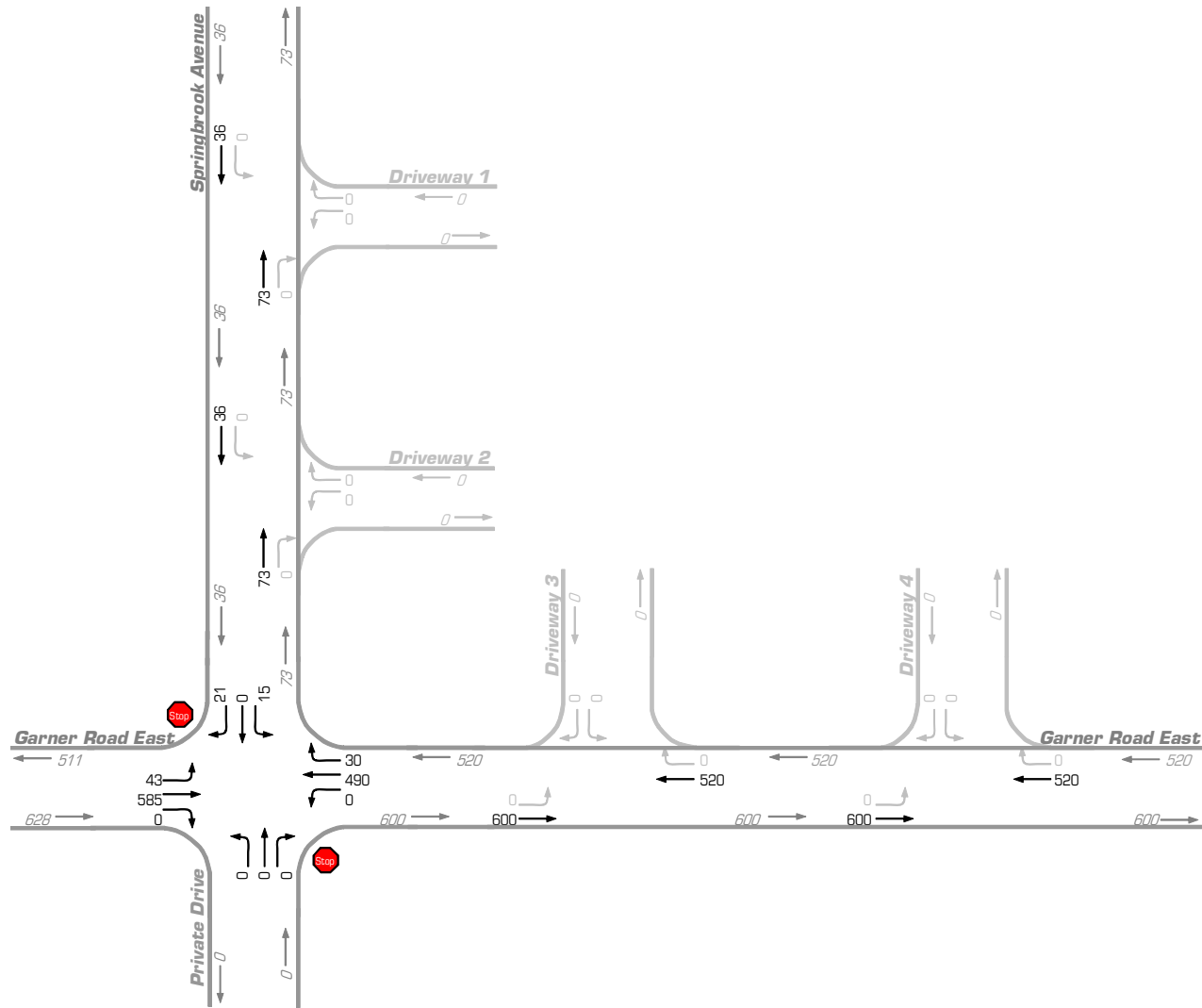
15 mins. Ending (Pk.Hr.*)	TRUCKS												Total		
	North Bd. on N/S			East Bd. on E/W			South Bd. on N/S			West Bd. on E/W					
	L	S	R	L	S	R	L	S	R	L	S	R			
7:15	0	0	0	1	5	0	1	0	0	0	0	0	0	0	7
7:30	0	0	0	0	5	0	0	0	0	0	0	0	0	0	5
7:45	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
8:00 *	0	0	0	0	4	0	1	0	0	0	0	0	2	0	7
8:15 *	0	0	0	1	1	0	0	0	0	0	0	0	1	3	6
8:30 *	0	0	0	0	3	0	0	0	0	0	0	0	2	0	5
8:45 *	0	0	0	0	11	0	0	0	1	0	0	0	3	0	15
9:00	0	0	0	0	7	0	0	0	0	0	0	0	6	0	13
9:15	0	0	0	1	3	0	0	0	0	0	0	0	7	0	11
9:30	0	0	0	0	5	0	0	0	0	0	0	0	3	0	8
9:45	0	0	0	1	5	0	0	0	0	0	0	0	5	0	11
10:00	0	0	0	0	4	0	1	0	0	0	0	0	5	0	10
13:45	0	0	0	0	5	0	1	0	0	0	0	0	7	1	14
14:00	0	0	0	0	6	0	0	0	0	0	0	0	4	0	10
14:15	0	0	0	0	0	0	1	0	0	0	0	0	2	0	3
14:30	0	0	0	0	2	0	1	0	0	0	0	0	4	0	7
14:45 *	0	0	0	0	6	0	0	0	1	0	0	0	4	0	11
15:00 *	0	0	0	0	8	0	0	0	1	0	0	0	7	0	16
15:15 *	0	0	0	0	5	0	0	0	0	0	0	0	7	0	12
15:30 *	0	0	0	1	2	0	0	0	0	0	0	0	7	0	10
16:15	0	0	0	0	3	0	1	0	0	0	0	0	1	0	5
16:30	0	0	0	0	2	0	0	0	0	0	0	0	2	0	4
16:45	0	0	0	0	4	0	1	0	0	0	0	0	3	0	8
17:00 *	0	0	0	1	4	0	0	0	0	0	0	0	2	0	7
17:15 *	0	0	0	0	3	0	0	0	0	0	0	0	3	0	6
17:30 *	0	0	0	1	2	0	1	0	0	0	0	0	1	0	5
17:45 *	0	0	0	0	0	0	2	0	0	0	0	0	1	0	3
18:00	0	0	0	0	0	0	2	0	0	0	0	0	1	0	3
TOTAL	0	0	0	7	106	0	13	0	3	0	90	4			
APPR.		0			113			16			94				223



Springbrook Corners Traffic Impact Study



Figure 2.2a
Existing AM Peak Hour
Traffic Volumes



Springbrook Corners Traffic Impact Study



Figure 2.2b
Existing PM Peak Hour
Traffic Volumes

Appendix C

Base Year (2020) Traffic Operational Conditions



Timings
1: Smith Road/Kitty Murray Lane & Garner Road

Base Year 2020 AM Peak Hour
200224

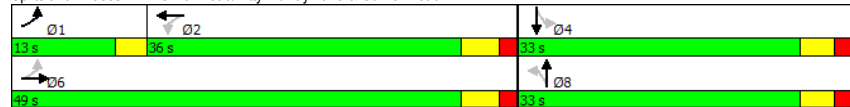
	↖	→	←	↙	↓	Ø8
Lane Group	EBL	EBT	WBT	SBL	SBT	Ø8
Lane Configurations	↖	↖	↖	↖	↖	
Traffic Volume (vph)	100	548	475	63	0	
Future Volume (vph)	100	548	475	63	0	
Turn Type	pm+pt	NA	NA	Perm	NA	
Protected Phases	1	6	2		4	8
Permitted Phases	6			4		
Detector Phase	1	6	2	4	4	
Switch Phase						
Minimum Initial (s)	5.0	30.0	30.0	10.0	10.0	10.0
Minimum Split (s)	8.0	35.5	35.5	32.6	32.6	32.6
Total Split (s)	13.0	49.0	36.0	33.0	33.0	33.0
Total Split (%)	15.9%	59.8%	43.9%	40.2%	40.2%	40%
Yellow Time (s)	3.0	3.7	3.7	3.3	3.3	3.3
All-Red Time (s)	0.0	1.8	1.8	2.3	2.3	2.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	5.5	5.5	5.6	5.6	
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?	Yes		Yes			
Recall Mode	Max	Max	Max	Min	Min	Min
Act Effct Green (s)	46.0	43.5	30.5	10.4	10.4	
Actuated g/C Ratio	0.71	0.67	0.47	0.16	0.16	
v/c Ratio	0.22	0.53	0.73	0.32	0.39	
Control Delay	4.2	7.6	20.5	28.5	1.9	
Queue Delay	0.0	0.0	0.0	0.0	0.0	
Total Delay	4.2	7.6	20.5	28.5	1.9	
LOS	A	A	C	C	A	
Approach Delay		7.1	20.5		8.4	
Approach LOS		A	C		A	

Intersection Summary

Cycle Length: 82
 Actuated Cycle Length: 65
 Natural Cycle: 80
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.73
 Intersection Signal Delay: 12.3
 Intersection Capacity Utilization 79.9%
 Analysis Period (min) 15

Intersection LOS: B
 ICU Level of Service D

Splits and Phases: 1: Smith Road/Kitty Murray Lane & Garner Road



Queues
1: Smith Road/Kitty Murray Lane & Garner Road

Base Year 2020 AM Peak Hour
200224

	↖	→	←	↙	↓
Lane Group	EBL	EBT	WBT	SBL	SBT
Lane Group Flow (vph)	114	623	610	72	224
v/c Ratio	0.22	0.53	0.73	0.32	0.39
Control Delay	4.2	7.6	20.5	28.5	1.9
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	4.2	7.6	20.5	28.5	1.9
Queue Length 50th (m)	3.4	32.3	57.1	8.2	0.0
Queue Length 95th (m)	7.9	57.6	96.4	18.7	0.0
Internal Link Dist (m)		75.7	599.0		166.9
Turn Bay Length (m)	55.0			30.0	
Base Capacity (vph)	507	1177	834	588	893
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.22	0.53	0.73	0.12	0.25

Intersection Summary

HCM Signalized Intersection Capacity Analysis
1: Smith Road/Kitty Murray Lane & Garner Road

Base Year 2020 AM Peak Hour
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↔	↔		↔	↔			↔		↔	↔	
Traffic Volume (vph)	100	548	0	0	475	62	0	0	0	63	0	197
Future Volume (vph)	100	548	0	0	475	62	0	0	0	63	0	197
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	5.5			5.5					5.6	5.6	
Lane Util. Factor	1.00	1.00			1.00					1.00	1.00	
Flpb, ped/bikes	1.00	1.00			1.00					1.00	1.00	
Flpb, ped/bikes	1.00	1.00			1.00					1.00	1.00	
Frt	1.00	1.00			0.98					1.00	0.85	
Fit Protected	0.95	1.00			1.00					0.95	1.00	
Satd. Flow (prot)	1735	1759			1768					1752	1583	
Fit Permitted	0.24	1.00			1.00					0.76	1.00	
Satd. Flow (perm)	433	1759			1768					1397	1583	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	114	623	0	0	540	70	0	0	0	72	0	224
RTOR Reduction (vph)	0	0	0	0	5	0	0	0	0	0	188	0
Lane Group Flow (vph)	114	623	0	0	605	0	0	0	0	72	36	0
Confl. Peds. (#/hr)	1				1							
Heavy Vehicles (%)	4%	8%	0%	0%	5%	8%	0%	0%	0%	3%	0%	2%
Turn Type	pm+pt	NA		Perm	NA					Perm	NA	
Protected Phases	1	6			2			8			4	
Permitted Phases	6			2			8			4		
Actuated Green, G (s)	43.5	43.5			30.5					10.4	10.4	
Effective Green, g (s)	43.5	43.5			30.5					10.4	10.4	
Actuated g/C Ratio	0.67	0.67			0.47					0.16	0.16	
Clearance Time (s)	3.0	5.5			5.5					5.6	5.6	
Vehicle Extension (s)	3.0	3.0			3.0					3.0	3.0	
Lane Grp Cap (vph)	490	1177			829					223	253	
v/s Ratio Prot	0.04	c0.35			c0.34						0.02	
v/s Ratio Perm	0.12									c0.05		
v/c Ratio	0.23	0.53			0.73					0.32	0.14	
Uniform Delay, d1	5.9	5.5			13.9					24.2	23.5	
Progression Factor	1.00	1.00			1.00					1.00	1.00	
Incremental Delay, d2	1.1	1.7			5.6					0.8	0.3	
Delay (s)	7.0	7.2			19.5					25.0	23.7	
Level of Service	A	A			B					C	C	
Approach Delay (s)		7.2			19.5			0.0			24.0	
Approach LOS		A			B			A			C	
Intersection Summary												
HCM 2000 Control Delay		14.8			HCM 2000 Level of Service					B		
HCM 2000 Volume to Capacity ratio		0.61										
Actuated Cycle Length (s)		65.0			Sum of lost time (s)					14.1		
Intersection Capacity Utilization		79.9%			ICU Level of Service					D		
Analysis Period (min)		15										

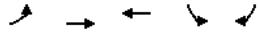
HCM Unsignalized Intersection Capacity Analysis
2: Private Driveway/Springbrook Avenue & Garner Road

Base Year 2020 AM Peak Hour
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (veh/h)	15	465	1	0	509	10	3	1	0	13	0	56
Future Volume (Veh/h)	15	465	1	0	509	10	3	1	0	13	0	56
Sign Control	Free			Free			Stop			Stop		
Grade	0%			0%			0%			0%		
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	15	479	1	0	525	10	3	1	0	13	0	58
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type	None			None								
Median storage (veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	535			480			1092	1044	480	1035	1035	525
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	535			480			1092	1044	480	1035	1035	525
tC, single (s)	4.4			4.1			7.1	6.5	6.2	7.1	6.5	6.3
tC, 2 stage (s)												
tF (s)	2.5			2.2			3.5	4.0	3.3	3.5	4.0	3.4
p0 queue free %	98			100			98	100	100	94	100	89
cM capacity (veh/h)	910			1093			170	227	590	209	230	533
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1							
Volume Total	495	525	10	4	71							
Volume Left	15	0	0	3	13							
Volume Right	1	0	10	0	58							
cSH	910	1093	1700	182	415							
Volume to Capacity	0.02	0.00	0.01	0.02	0.17							
Queue Length 95th (m)	0.4	0.0	0.0	0.5	4.9							
Control Delay (s)	0.5	0.0	0.0	25.3	15.5							
Lane LOS	A			D	C							
Approach Delay (s)	0.5	0.0		25.3	15.5							
Approach LOS				D	C							
Intersection Summary												
Average Delay				1.3								
Intersection Capacity Utilization				47.3%		ICU Level of Service				A		
Analysis Period (min)				15								

Timings
3: Garner Road & Raymond Road

Base Year 2020 AM Peak Hour
200224



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations	↘	↗	↘	↘	↘
Traffic Volume (vph)	47	575	600	105	70
Future Volume (vph)	47	575	600	105	70
Turn Type	pm+pt	NA	NA	Prot	Prot
Protected Phases	5	2	6	8	8
Permitted Phases	2				
Detector Phase	5	2	6	8	8
Switch Phase					
Minimum Initial (s)	5.0	40.0	40.0	10.0	10.0
Minimum Split (s)	8.0	46.0	46.0	22.9	22.9
Total Split (s)	13.0	59.0	46.0	31.0	31.0
Total Split (%)	14.4%	65.6%	51.1%	34.4%	34.4%
Yellow Time (s)	3.0	3.5	3.5	3.3	3.3
All-Red Time (s)	0.0	2.5	2.5	2.6	2.6
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.0	6.0	5.9	5.9
Lead/Lag	Lead		Lag		
Lead-Lag Optimize?	Yes		Yes		
Recall Mode	None	Max	Max	None	None
Act Effct Green (s)	59.2	57.5	51.8	11.4	11.4
Actuated g/C Ratio	0.78	0.75	0.68	0.15	0.15
v/c Ratio	0.13	0.48	0.65	0.46	0.27
Control Delay	3.9	6.8	14.8	35.9	10.1
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	3.9	6.8	14.8	35.9	10.1
LOS	A	A	B	D	B
Approach Delay		6.6	14.8	25.6	
Approach LOS		A	B	C	

Intersection Summary

Cycle Length: 90
 Actuated Cycle Length: 76.3
 Natural Cycle: 80
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.65
 Intersection Signal Delay: 12.6
 Intersection Capacity Utilization 57.5%
 Analysis Period (min) 15

Intersection LOS: B
 ICU Level of Service B

Splits and Phases: 3: Garner Road & Raymond Road



Queues
3: Garner Road & Raymond Road

Base Year 2020 AM Peak Hour
200224



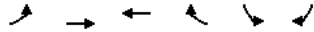
Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	53	646	794	118	79
v/c Ratio	0.13	0.48	0.65	0.46	0.27
Control Delay	3.9	6.8	14.8	35.9	10.1
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	3.9	6.8	14.8	35.9	10.1
Queue Length 50th (m)	1.6	37.0	79.6	16.6	0.0
Queue Length 95th (m)	5.0	70.1	#156.4	31.7	10.9
Internal Link Dist (m)		365.4	90.6	133.1	
Turn Bay Length (m)	35.0			15.0	
Base Capacity (vph)	462	1349	1213	560	540
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.11	0.48	0.65	0.21	0.15

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis
3: Garner Road & Raymond Road

Base Year 2020 AM Peak Hour
200224



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↔	↔	↔	↔	↔	↔
Traffic Volume (vph)	47	575	600	107	105	70
Future Volume (vph)	47	575	600	107	105	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	6.0	6.0		5.9	5.9
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.98		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1597	1792	1780		1703	1482
Flt Permitted	0.23	1.00	1.00		0.95	1.00
Satd. Flow (perm)	394	1792	1780		1703	1482
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	53	646	674	120	118	79
RTOR Reduction (vph)	0	0	5	0	0	70
Lane Group Flow (vph)	53	646	789	0	118	9
Confl. Peds. (#/hr)	3			3		1
Heavy Vehicles (%)	13%	6%	4%	5%	6%	9%
Turn Type	pm+pt	NA	NA		Prot	Prot
Protected Phases	5	2	6		8	8
Permitted Phases	2					
Actuated Green, G (s)	57.5	57.5	50.6		9.4	9.4
Effective Green, g (s)	57.5	57.5	50.6		9.4	9.4
Actuated g/C Ratio	0.73	0.73	0.64		0.12	0.12
Clearance Time (s)	3.0	6.0	6.0		5.9	5.9
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	347	1307	1142		203	176
v/s Ratio Prot	0.01	c0.36	c0.44		c0.07	0.01
v/s Ratio Perm	0.10					
v/c Ratio	0.15	0.49	0.69		0.58	0.05
Uniform Delay, d1	5.6	4.5	9.1		32.8	30.8
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.2	1.3	3.4		4.2	0.1
Delay (s)	5.8	5.8	12.5		37.0	30.9
Level of Service	A	A	B		D	C
Approach Delay (s)		5.8	12.5		34.6	
Approach LOS		A	B		C	

Intersection Summary			
HCM 2000 Control Delay		12.3	HCM 2000 Level of Service B
HCM 2000 Volume to Capacity ratio		0.67	
Actuated Cycle Length (s)		78.8	Sum of lost time (s) 14.9
Intersection Capacity Utilization		57.5%	ICU Level of Service B
Analysis Period (min)		15	

c Critical Lane Group

Timings
1: Smith Road/Kitty Murray Lane & Garner Road

Base Year 2020 PM Peak Hour
200224

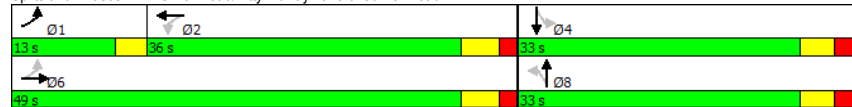
	↖	→	←	↙	↓	
Lane Group	EBL	EBT	WBT	SBL	SBT	Ø8
Lane Configurations	↖	↗	↖	↗	↘	
Traffic Volume (vph)	145	602	545	68	0	
Future Volume (vph)	145	602	545	68	0	
Turn Type	pm+pt	NA	NA	Perm	NA	
Protected Phases	1	6	2		4	8
Permitted Phases	6			4		
Detector Phase	1	6	2	4	4	
Switch Phase						
Minimum Initial (s)	5.0	30.0	30.0	10.0	10.0	10.0
Minimum Split (s)	8.0	35.5	35.5	32.6	32.6	32.6
Total Split (s)	13.0	49.0	36.0	33.0	33.0	33.0
Total Split (%)	15.9%	59.8%	43.9%	40.2%	40.2%	40%
Yellow Time (s)	3.0	3.7	3.7	3.3	3.3	3.3
All-Red Time (s)	0.0	1.8	1.8	2.3	2.3	2.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	5.5	5.5	5.6	5.6	
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?	Yes		Yes			
Recall Mode	Max	Max	Max	Min	Min	Min
Act Effct Green (s)	46.0	43.5	30.5	10.5	10.5	
Actuated g/C Ratio	0.71	0.67	0.47	0.16	0.16	
v/c Ratio	0.36	0.54	0.81	0.34	0.21	
Control Delay	5.5	7.8	24.4	28.9	0.9	
Queue Delay	0.0	0.0	0.0	0.0	0.0	
Total Delay	5.5	7.8	24.4	28.9	0.9	
LOS	A	A	C	C	A	
Approach Delay		7.4	24.4		11.8	
Approach LOS		A	C		B	

Intersection Summary

Cycle Length: 82
 Actuated Cycle Length: 65.1
 Natural Cycle: 80
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.81
 Intersection Signal Delay: 14.8
 Intersection Capacity Utilization 79.3%
 Analysis Period (min) 15

Intersection LOS: B
ICU Level of Service D

Splits and Phases: 1: Smith Road/Kitty Murray Lane & Garner Road



Queues
1: Smith Road/Kitty Murray Lane & Garner Road

Base Year 2020 PM Peak Hour
200224

	↖	→	←	↙	↓
Lane Group	EBL	EBT	WBT	SBL	SBT
Lane Group Flow (vph)	161	669	698	76	119
v/c Ratio	0.36	0.54	0.81	0.34	0.21
Control Delay	5.5	7.8	24.4	28.9	0.9
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	5.5	7.8	24.4	28.9	0.9
Queue Length 50th (m)	5.0	35.3	69.1	8.7	0.0
Queue Length 95th (m)	11.2	66.0	#138.6	19.9	0.0
Internal Link Dist (m)		75.7	599.0		166.9
Turn Bay Length (m)	55.0			30.0	
Base Capacity (vph)	449	1232	863	581	876
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.36	0.54	0.81	0.13	0.14

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis
1: Smith Road/Kitty Murray Lane & Garner Road

Base Year 2020 PM Peak Hour
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations	↔	↔		↔	↔			↔		↔	↔		
Traffic Volume (vph)	145	602	0	0	545	83	0	0	0	68	0	107	
Future Volume (vph)	145	602	0	0	545	83	0	0	0	68	0	107	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Total Lost time (s)	3.0	5.5			5.5					5.6	5.6		
Lane Util. Factor	1.00	1.00			1.00					1.00	1.00		
Frb, ped/bikes	1.00	1.00			1.00					1.00	0.98		
Flpb, ped/bikes	1.00	1.00			1.00					1.00	1.00		
Frt	1.00	1.00			0.98					1.00	0.85		
Fit Protected	0.95	1.00			1.00					0.95	1.00		
Satd. Flow (prot)	1787	1845			1831					1736	1581		
Fit Permitted	0.17	1.00			1.00					0.76	1.00		
Satd. Flow (perm)	316	1845			1831					1383	1581		
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
Adj. Flow (vph)	161	669	0	0	606	92	0	0	0	76	0	119	
RTOR Reduction (vph)	0	0	0	0	6	0	0	0	0	0	100	0	
Lane Group Flow (vph)	161	669	0	0	692	0	0	0	0	76	19	0	
Confl. Peds. (#/hr)							1					1	
Heavy Vehicles (%)	1%	3%	0%	0%	2%	0%	0%	0%	0%	4%	0%	0%	
Turn Type	pm+pt	NA		Perm	NA					Perm	NA		
Protected Phases	1	6			2			8			4		
Permitted Phases	6			2			8			4			
Actuated Green, G (s)	43.5	43.5			30.5					10.5	10.5		
Effective Green, g (s)	43.5	43.5			30.5					10.5	10.5		
Actuated g/C Ratio	0.67	0.67			0.47					0.16	0.16		
Clearance Time (s)	3.0	5.5			5.5					5.6	5.6		
Vehicle Extension (s)	3.0	3.0			3.0					3.0	3.0		
Lane Grp Cap (vph)	437	1232			857					223	255		
v/s Ratio Prot	0.06	c0.36			c0.38						0.01		
v/s Ratio Perm	0.19									c0.05			
v/c Ratio	0.37	0.54			0.81					0.34	0.08		
Uniform Delay, d1	7.6	5.6			14.8					24.2	23.2		
Progression Factor	1.00	1.00			1.00					1.00	1.00		
Incremental Delay, d2	2.4	1.7			8.1					0.9	0.1		
Delay (s)	10.0	7.3			22.9					25.1	23.3		
Level of Service	B	A			C					C	C		
Approach Delay (s)		7.9			22.9			0.0			24.0		
Approach LOS		A			C			A			C		
Intersection Summary													
HCM 2000 Control Delay		15.8			HCM 2000 Level of Service						B		
HCM 2000 Volume to Capacity ratio		0.66											
Actuated Cycle Length (s)		65.1			Sum of lost time (s)						14.1		
Intersection Capacity Utilization		79.3%									ICU Level of Service		D
Analysis Period (min)		15											

HCM Unsignalized Intersection Capacity Analysis
2: Private Driveway/Springbrook Avenue & Garner Road

Base Year 2020 PM Peak Hour
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR				
Lane Configurations		↔			↔	↔		↔			↔	↔				
Traffic Volume (veh/h)	35	666	2	1	620	21	0	0	1	14	1	17				
Future Volume (Veh/h)	35	666	2	1	620	21	0	0	1	14	1	17				
Sign Control	Free			Free			Stop			Stop						
Grade	0%			0%			0%			0%						
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94				
Hourly flow rate (vph)	37	709	2	1	660	22	0	0	1	15	1	18				
Pedestrians	2															
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	683			711			1466			1469			710	1448	1448	663
vC1, stage 1 conf vol																
vC2, stage 2 conf vol																
vCu, unblocked vol	683			711			1466			1469			710	1448	1448	663
tC, single (s)	4.1			4.1			7.1			6.5			6.2	7.1	6.5	6.2
tC, 2 stage (s)																
tF (s)	2.2			2.2			3.5			4.0			3.3	3.5	4.0	3.3
p0 queue free %	96			100			100			100			86	99	96	
cM capacity (veh/h)	919			898			99			123			437	106	127	464
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1											
Volume Total	748	661	22	1	34											
Volume Left	37	1	0	0	15											
Volume Right	2	0	22	1	18											
cSH	919	898	1700	437	181											
Volume to Capacity	0.04	0.00	0.01	0.00	0.19											
Queue Length 95th (m)	1.0	0.0	0.0	0.1	5.4											
Control Delay (s)	1.0	0.0	0.0	13.3	29.4											
Lane LOS	A	A		B	D											
Approach Delay (s)	1.0	0.0		13.3	29.4											
Approach LOS				B	D											
Intersection Summary																
Average Delay				1.2												
Intersection Capacity Utilization				79.3%			ICU Level of Service			D						
Analysis Period (min)				15												

Timings
3: Garner Road & Raymond Road

Base Year 2020 PM Peak Hour
200224

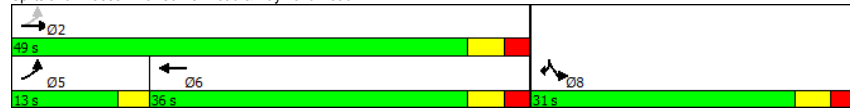
	↖	→	←	↘	↙
Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations	↘	↖	↖	↘	↘
Traffic Volume (vph)	71	962	659	91	44
Future Volume (vph)	71	962	659	91	44
Turn Type	pm+pt	NA	NA	Prot	Prot
Protected Phases	5	2	6	8	8
Permitted Phases	2				
Detector Phase	5	2	6	8	8
Switch Phase					
Minimum Initial (s)	5.0	30.0	30.0	10.0	10.0
Minimum Split (s)	8.0	36.0	36.0	22.9	22.9
Total Split (s)	13.0	49.0	36.0	31.0	31.0
Total Split (%)	16.3%	61.3%	45.0%	38.8%	38.8%
Yellow Time (s)	3.0	3.5	3.5	3.3	3.3
All-Red Time (s)	0.0	2.5	2.5	2.6	2.6
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.0	6.0	5.9	5.9
Lead/Lag	Lead		Lag		
Lead-Lag Optimize?	Yes		Yes		
Recall Mode	None	Max	Max	None	None
Act Effct Green (s)	49.0	47.3	39.6	10.4	10.4
Actuated g/C Ratio	0.75	0.73	0.61	0.16	0.16
v/c Ratio	0.21	0.77	0.78	0.34	0.16
Control Delay	4.5	14.1	21.5	28.1	9.6
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	4.5	14.1	21.5	28.1	9.6
LOS	A	B	C	C	A
Approach Delay		13.4	21.5	22.1	
Approach LOS		B	C	C	

Intersection Summary

Cycle Length: 80
 Actuated Cycle Length: 65.1
 Natural Cycle: 75
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.78
 Intersection Signal Delay: 17.3
 Intersection Capacity Utilization 68.9%
 Analysis Period (min) 15

Intersection LOS: B
ICU Level of Service C

Splits and Phases: 3: Garner Road & Raymond Road



Queues
3: Garner Road & Raymond Road

Base Year 2020 PM Peak Hour
200224

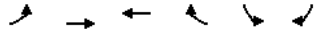
	↖	→	←	↘	↙
Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	77	1046	867	99	48
v/c Ratio	0.21	0.77	0.78	0.34	0.16
Control Delay	4.5	14.1	21.5	28.1	9.6
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	4.5	14.1	21.5	28.1	9.6
Queue Length 50th (m)	2.3	84.5	91.3	11.4	0.0
Queue Length 95th (m)	6.0	#194.0	#184.0	24.1	8.1
Internal Link Dist (m)		365.4	90.6	133.1	
Turn Bay Length (m)	35.0			15.0	
Base Capacity (vph)	445	1352	1108	695	639
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.17	0.77	0.78	0.14	0.08

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis
3: Garner Road & Raymond Road

Base Year 2020 PM Peak Hour
200224



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↘	↗	↘		↘	↗
Traffic Volume (vph)	71	962	659	139	91	44
Future Volume (vph)	71	962	659	139	91	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	6.0	6.0		5.9	5.9
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Flt	1.00	1.00	0.98		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1805	1863	1810		1805	1583
Flt Permitted	0.15	1.00	1.00		0.95	1.00
Satd. Flow (perm)	281	1863	1810		1805	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	77	1046	716	151	99	48
RTOR Reduction (vph)	0	0	6	0	0	42
Lane Group Flow (vph)	77	1046	861	0	99	6
Heavy Vehicles (%)	0%	2%	3%	0%	0%	2%
Turn Type	pm+pt	NA	NA		Prot	Prot
Protected Phases	5	2	6		8	8
Permitted Phases	2					
Actuated Green, G (s)	46.6	46.6	38.4		8.4	8.4
Effective Green, g (s)	46.6	46.6	38.4		8.4	8.4
Actuated g/C Ratio	0.70	0.70	0.57		0.13	0.13
Clearance Time (s)	3.0	6.0	6.0		5.9	5.9
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	314	1297	1038		226	198
v/s Ratio Prot	0.02	c0.56	0.48		c0.05	0.00
v/s Ratio Perm	0.15					
v/c Ratio	0.25	0.81	0.83		0.44	0.03
Uniform Delay, d1	7.9	7.0	11.6		27.1	25.7
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.4	5.4	7.7		1.4	0.1
Delay (s)	8.3	12.5	19.2		28.4	25.7
Level of Service	A	B	B		C	C
Approach Delay (s)		12.2	19.2		27.5	
Approach LOS		B	B		C	
Intersection Summary						
HCM 2000 Control Delay		16.1		HCM 2000 Level of Service		B
HCM 2000 Volume to Capacity ratio		0.79				
Actuated Cycle Length (s)		66.9		Sum of lost time (s)		14.9
Intersection Capacity Utilization		68.9%		ICU Level of Service		C
Analysis Period (min)		15				
c Critical Lane Group						

Appendix D

2027 Background Traffic Operational Conditions



Timings
1: Smith Road/Kitty Murray Lane & Garner Road

2027 Background AM Peak Hour
200224

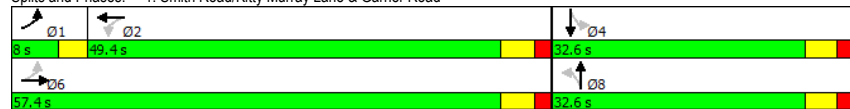
	↖	→	←	↙	↓	Ø8
Lane Group	EBL	EBT	WBT	SBL	SBT	Ø8
Lane Configurations	↖	↖	↖	↖	↖	
Traffic Volume (vph)	115	666	668	77	0	
Future Volume (vph)	115	666	668	77	0	
Turn Type	pm+pt	NA	NA	Perm	NA	
Protected Phases	1	6	2		4	8
Permitted Phases	6			4		
Detector Phase	1	6	2	4	4	
Switch Phase						
Minimum Initial (s)	5.0	30.0	30.0	10.0	10.0	10.0
Minimum Split (s)	8.0	35.5	35.5	32.6	32.6	32.6
Total Split (s)	8.0	57.4	49.4	32.6	32.6	32.6
Total Split (%)	8.9%	63.8%	54.9%	36.2%	36.2%	36%
Yellow Time (s)	3.0	3.7	3.7	3.3	3.3	3.3
All-Red Time (s)	0.0	1.8	1.8	2.3	2.3	2.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	5.5	5.5	5.6	5.6	
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?	Yes		Yes			
Recall Mode	Max	Max	Max	Min	Min	Min
Act Effect Green (s)	54.5	52.0	43.9	11.1	11.1	
Actuated g/C Ratio	0.73	0.70	0.59	0.15	0.15	
v/c Ratio	0.41	0.61	0.80	0.42	0.59	
Control Delay	6.9	8.8	19.7	35.1	11.4	
Queue Delay	0.0	0.0	0.0	0.0	0.0	
Total Delay	6.9	8.8	19.7	35.1	11.4	
LOS	A	A	B	D	B	
Approach Delay		8.6	19.7		17.5	
Approach LOS		A	B		B	

Intersection Summary

Cycle Length: 90
 Actuated Cycle Length: 74.2
 Natural Cycle: 90
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.80
 Intersection Signal Delay: 14.6
 Intersection Capacity Utilization 87.9%
 Analysis Period (min) 15

Intersection LOS: B
 ICU Level of Service E

Splits and Phases: 1: Smith Road/Kitty Murray Lane & Garner Road



Queues
1: Smith Road/Kitty Murray Lane & Garner Road

2027 Background AM Peak Hour
200224

	↖	→	←	↙	↓
Lane Group	EBL	EBT	WBT	SBL	SBT
Lane Group Flow (vph)	131	757	845	88	257
v/c Ratio	0.41	0.61	0.80	0.42	0.59
Control Delay	6.9	8.8	19.7	35.1	11.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	6.9	8.8	19.7	35.1	11.4
Queue Length 50th (m)	4.0	44.7	81.9	11.9	2.6
Queue Length 95th (m)	9.9	86.4	#156.0	24.6	20.7
Internal Link Dist (m)		75.7	599.0		166.9
Turn Bay Length (m)	55.0			30.0	
Base Capacity (vph)	321	1231	1053	508	727
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.41	0.61	0.80	0.17	0.35

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis
1: Smith Road/Kitty Murray Lane & Garner Road

2027 Background AM Peak Hour
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↔	↔		↔	↔			↔		↔	↔	
Traffic Volume (vph)	115	666	0	0	668	76	0	0	0	77	0	226
Future Volume (vph)	115	666	0	0	668	76	0	0	0	77	0	226
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	5.5			5.5					5.6	5.6	
Lane Util. Factor	1.00	1.00			1.00					1.00	1.00	
Frb, ped/bikes	1.00	1.00			1.00					1.00	1.00	
Flpb, ped/bikes	1.00	1.00			1.00					1.00	1.00	
Frt	1.00	1.00			0.98					1.00	0.85	
Fit Protected	0.95	1.00			1.00					0.95	1.00	
Satd. Flow (prot)	1736	1759			1773					1752	1583	
Fit Permitted	0.17	1.00			1.00					0.76	1.00	
Satd. Flow (perm)	308	1759			1773					1397	1583	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	131	757	0	0	759	86	0	0	0	88	0	257
RTOR Reduction (vph)	0	0	0	0	4	0	0	0	0	0	201	0
Lane Group Flow (vph)	131	757	0	0	841	0	0	0	0	88	56	0
Confl. Peds. (#/hr)	1				1							
Heavy Vehicles (%)	4%	8%	0%	0%	5%	8%	0%	0%	0%	3%	0%	2%
Turn Type	pm+pt	NA		Perm	NA					Perm	NA	
Protected Phases	1	6			2			8			4	
Permitted Phases	6			2			8			4		
Actuated Green, G (s)	51.9	51.9			43.9					11.1	11.1	
Effective Green, g (s)	51.9	51.9			43.9					11.1	11.1	
Actuated g/C Ratio	0.70	0.70			0.59					0.15	0.15	
Clearance Time (s)	3.0	5.5			5.5					5.6	5.6	
Vehicle Extension (s)	3.0	3.0			3.0					3.0	3.0	
Lane Grp Cap (vph)	312	1232			1050					209	237	
v/s Ratio Prot	0.03	c0.43			c0.47						0.04	
v/s Ratio Perm	0.27									c0.06		
v/c Ratio	0.42	0.61			0.80					0.42	0.23	
Uniform Delay, d1	8.6	5.8			11.7					28.6	27.8	
Progression Factor	1.00	1.00			1.00					1.00	1.00	
Incremental Delay, d2	4.1	2.3			6.4					1.4	0.5	
Delay (s)	12.7	8.1			18.2					30.0	28.3	
Level of Service	B	A			B					C	C	
Approach Delay (s)		8.8			18.2			0.0			28.7	
Approach LOS		A			B			A			C	
Intersection Summary												
HCM 2000 Control Delay		15.9			HCM 2000 Level of Service						B	
HCM 2000 Volume to Capacity ratio		0.72										
Actuated Cycle Length (s)		74.1			Sum of lost time (s)						14.1	
Intersection Capacity Utilization		87.9%			ICU Level of Service						E	
Analysis Period (min)		15										

HCM Unsignalized Intersection Capacity Analysis
2: Private Driveway/Springbrook Avenue & Garner Road

2027 Background AM Peak Hour
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (veh/h)	37	556	1	0	655	21	3	1	0	49	0	119
Future Volume (Veh/h)	37	556	1	0	655	21	3	1	0	49	0	119
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	38	573	1	0	675	22	3	1	0	51	0	123
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	697			574			1448	1346	574	1325	1325	675
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	697			574			1448	1346	574	1325	1325	675
tC, single (s)	4.4			4.1			7.1	6.5	6.2	7.1	6.5	6.3
tC, 2 stage (s)												
tF (s)	2.5			2.2			3.5	4.0	3.3	3.5	4.0	3.4
p0 queue free %	95			100			96	99	100	60	100	72
cM capacity (veh/h)	786			1009			76	145	522	128	150	437
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1							
Volume Total	612	675	22	4	174							
Volume Left	38	0	0	3	51							
Volume Right	1	0	22	0	123							
cSH	786	1009	1700	87	256							
Volume to Capacity	0.05	0.00	0.01	0.05	0.68							
Queue Length 95th (m)	1.2	0.0	0.0	1.1	35.4							
Control Delay (s)	1.3	0.0	0.0	48.6	44.2							
Lane LOS	A			E	E							
Approach Delay (s)	1.3	0.0		48.6	44.2							
Approach LOS				E	E							
Intersection Summary												
Average Delay		5.8										
Intersection Capacity Utilization		76.1%			ICU Level of Service						D	
Analysis Period (min)		15										

Timings
3: Garner Road & Raymond Road

2027 Background AM Peak Hour
200224

	↖	→	←	↘	↙
Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations	↘	↖	↘	↘	↘
Traffic Volume (vph)	58	719	726	122	84
Future Volume (vph)	58	719	726	122	84
Turn Type	pm+pt	NA	NA	Prot	Prot
Protected Phases	5	2	6	8	8
Permitted Phases	2				
Detector Phase	5	2	6	8	8
Switch Phase					
Minimum Initial (s)	5.0	40.0	40.0	10.0	10.0
Minimum Split (s)	8.0	46.0	46.0	22.9	22.9
Total Split (s)	8.0	67.0	59.0	23.0	23.0
Total Split (%)	8.9%	74.4%	65.6%	25.6%	25.6%
Yellow Time (s)	3.0	3.5	3.5	3.3	3.3
All-Red Time (s)	0.0	2.5	2.5	2.6	2.6
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.0	6.0	5.9	5.9
Lead/Lag	Lead		Lag		
Lead-Lag Optimize?	Yes		Yes		
Recall Mode	None	Max	Max	None	None
Act Effct Green (s)	67.0	63.9	57.4	12.7	12.7
Actuated g/C Ratio	0.76	0.72	0.65	0.14	0.14
v/c Ratio	0.25	0.62	0.82	0.56	0.32
Control Delay	5.7	9.5	21.0	43.5	10.3
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	5.7	9.5	21.0	43.5	10.3
LOS	A	A	C	D	B
Approach Delay		9.2	21.0	30.0	
Approach LOS		A	C	C	

Intersection Summary

Cycle Length: 90
 Actuated Cycle Length: 88.6
 Natural Cycle: 90
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.82
 Intersection Signal Delay: 17.0
 Intersection Capacity Utilization 66.6%
 Analysis Period (min) 15

Intersection LOS: B
 ICU Level of Service C

Splits and Phases: 3: Garner Road & Raymond Road



Queues
3: Garner Road & Raymond Road

2027 Background AM Peak Hour
200224

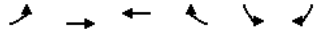
	↖	→	←	↘	↙
Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	65	808	955	137	94
v/c Ratio	0.25	0.62	0.82	0.56	0.32
Control Delay	5.7	9.5	21.0	43.5	10.3
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	5.7	9.5	21.0	43.5	10.3
Queue Length 50th (m)	2.3	58.6	116.3	22.2	0.0
Queue Length 95th (m)	6.5	111.3	#232.3	39.8	12.6
Internal Link Dist (m)		365.4	90.6	133.1	
Turn Bay Length (m)	35.0			15.0	
Base Capacity (vph)	258	1293	1159	329	362
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.25	0.62	0.82	0.42	0.26

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis
3: Garner Road & Raymond Road

2027 Background AM Peak Hour
200224



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↘	↗	↘		↘	↗
Traffic Volume (vph)	58	719	726	124	122	84
Future Volume (vph)	58	719	726	124	122	84
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	6.0	6.0		5.9	5.9
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.98		1.00	0.85
Fit Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1597	1792	1782		1703	1482
Fit Permitted	0.14	1.00	1.00		0.95	1.00
Satd. Flow (perm)	241	1792	1782		1703	1482
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	65	808	816	139	137	94
RTOR Reduction (vph)	0	0	6	0	0	81
Lane Group Flow (vph)	65	808	949	0	137	13
Confl. Peds. (#/hr)	3			3		1
Heavy Vehicles (%)	13%	6%	4%	5%	6%	9%
Turn Type	pm+pt	NA	NA		Prot	Prot
Protected Phases	5	2	6		8	8
Permitted Phases	2					
Actuated Green, G (s)	64.4	64.4	57.3		12.7	12.7
Effective Green, g (s)	64.4	64.4	57.3		12.7	12.7
Actuated g/C Ratio	0.72	0.72	0.64		0.14	0.14
Clearance Time (s)	3.0	6.0	6.0		5.9	5.9
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	236	1296	1147		243	211
v/s Ratio Prot	0.01	c0.45	c0.53		c0.08	0.01
v/s Ratio Perm	0.19					
v/c Ratio	0.28	0.62	0.83		0.56	0.06
Uniform Delay, d1	10.4	6.2	12.1		35.6	33.0
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.6	2.3	6.9		3.0	0.1
Delay (s)	11.1	8.5	19.0		38.5	33.1
Level of Service	B	A	B		D	C
Approach Delay (s)		8.7	19.0		36.3	
Approach LOS		A	B		D	

Intersection Summary			
HCM 2000 Control Delay	16.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	89.0	Sum of lost time (s)	14.9
Intersection Capacity Utilization	66.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Timings
1: Smith Road/Kitty Murray Lane & Garner Road

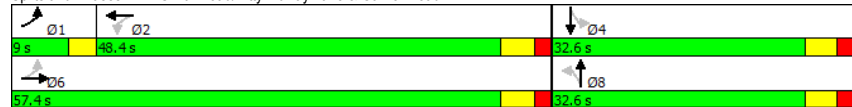
2027 Background PM Peak Hour
200224

	↖	→	←	↙	↓	Ø8
Lane Group	EBL	EBT	WBT	SBL	SBT	Ø8
Lane Configurations	↖	↗	↖	↗	↘	
Traffic Volume (vph)	167	848	684	84	0	
Future Volume (vph)	167	848	684	84	0	
Turn Type	pm+pt	NA	NA	Perm	NA	
Protected Phases	1	6	2		4	8
Permitted Phases	6			4		
Detector Phase	1	6	2	4	4	
Switch Phase						
Minimum Initial (s)	5.0	30.0	30.0	10.0	10.0	10.0
Minimum Split (s)	8.0	35.5	35.5	32.6	32.6	32.6
Total Split (s)	9.0	57.4	48.4	32.6	32.6	32.6
Total Split (%)	10.0%	63.8%	53.8%	36.2%	36.2%	36%
Yellow Time (s)	3.0	3.7	3.7	3.3	3.3	3.3
All-Red Time (s)	0.0	1.8	1.8	2.3	2.3	2.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	5.5	5.5	5.6	5.6	
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?	Yes		Yes			
Recall Mode	Max	Max	Max	Min	Min	Min
Act Effect Green (s)	54.4	51.9	42.9	11.3	11.3	
Actuated g/C Ratio	0.73	0.70	0.58	0.15	0.15	
v/c Ratio	0.59	0.73	0.82	0.44	0.30	
Control Delay	12.8	11.7	21.4	35.7	1.7	
Queue Delay	0.0	0.0	0.0	0.0	0.0	
Total Delay	12.8	11.7	21.4	35.7	1.7	
LOS	B	B	C	D	A	
Approach Delay		11.9	21.4		15.4	
Approach LOS		B	C		B	

Intersection Summary

Cycle Length: 90
 Actuated Cycle Length: 74.4
 Natural Cycle: 90
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.82
 Intersection Signal Delay: 16.0
 Intersection Capacity Utilization 92.3%
 Analysis Period (min) 15
 Intersection LOS: B
 ICU Level of Service F

Splits and Phases: 1: Smith Road/Kitty Murray Lane & Garner Road



Queues
1: Smith Road/Kitty Murray Lane & Garner Road

2027 Background PM Peak Hour
200224

	↖	→	←	↙	↓
Lane Group	EBL	EBT	WBT	SBL	SBT
Lane Group Flow (vph)	186	942	871	93	137
v/c Ratio	0.59	0.73	0.82	0.44	0.30
Control Delay	12.8	11.7	21.4	35.7	1.7
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	12.8	11.7	21.4	35.7	1.7
Queue Length 50th (m)	5.9	65.6	88.6	12.6	0.0
Queue Length 95th (m)	#20.3	136.7	#187.5	26.4	0.0
Internal Link Dist (m)		75.7	599.0		166.9
Turn Bay Length (m)	55.0			30.0	
Base Capacity (vph)	315	1288	1062	502	733
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.59	0.73	0.82	0.19	0.19

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis
1: Smith Road/Kitty Murray Lane & Garner Road

2027 Background PM Peak Hour
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations	↔	↔		↔	↔			↔		↔	↔		
Traffic Volume (vph)	167	848	0	0	684	100	0	0	0	84	0	123	
Future Volume (vph)	167	848	0	0	684	100	0	0	0	84	0	123	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Total Lost time (s)	3.0	5.5			5.5					5.6	5.6		
Lane Util. Factor	1.00	1.00			1.00					1.00	1.00		
Frb, ped/bikes	1.00	1.00			1.00					1.00	0.98		
Flpb, ped/bikes	1.00	1.00			1.00					1.00	1.00		
Frt	1.00	1.00			0.98					1.00	0.85		
Fit Protected	0.95	1.00			1.00					0.95	1.00		
Satd. Flow (prot)	1787	1845			1832					1736	1581		
Fit Permitted	0.14	1.00			1.00					0.76	1.00		
Satd. Flow (perm)	264	1845			1832					1383	1581		
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
Adj. Flow (vph)	186	942	0	0	760	111	0	0	0	93	0	137	
RTOR Reduction (vph)	0	0	0	0	5	0	0	0	0	0	116	0	
Lane Group Flow (vph)	186	942	0	0	866	0	0	0	0	93	21	0	
Confl. Peds. (#/hr)							1					1	
Heavy Vehicles (%)	1%	3%	0%	0%	2%	0%	0%	0%	0%	4%	0%	0%	
Turn Type	pm+pt	NA		Perm	NA					Perm	NA		
Protected Phases	1	6			2			8			4		
Permitted Phases	6			2			8			4			
Actuated Green, G (s)	51.9	51.9			42.9					11.3	11.3		
Effective Green, g (s)	51.9	51.9			42.9					11.3	11.3		
Actuated g/C Ratio	0.70	0.70			0.58					0.15	0.15		
Clearance Time (s)	3.0	5.5			5.5					5.6	5.6		
Vehicle Extension (s)	3.0	3.0			3.0					3.0	3.0		
Lane Grp Cap (vph)	307	1288			1057					210	240		
v/s Ratio Prot	0.05	c0.51			c0.47						0.01		
v/s Ratio Perm	0.37									c0.07			
v/c Ratio	0.61	0.73			0.82					0.44	0.09		
Uniform Delay, d1	10.7	6.9			12.6					28.6	27.1		
Progression Factor	1.00	1.00			1.00					1.00	1.00		
Incremental Delay, d2	8.6	3.7			7.1					1.5	0.2		
Delay (s)	19.3	10.6			19.7					30.1	27.2		
Level of Service	B	B			B					C	C		
Approach Delay (s)		12.0			19.7			0.0			28.4		
Approach LOS		B			B			A			C		
Intersection Summary													
HCM 2000 Control Delay		16.7			HCM 2000 Level of Service						B		
HCM 2000 Volume to Capacity ratio		0.75											
Actuated Cycle Length (s)		74.3			Sum of lost time (s)						14.1		
Intersection Capacity Utilization		92.3%			ICU Level of Service						F		
Analysis Period (min)		15											

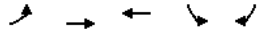
HCM Unsignalized Intersection Capacity Analysis
2: Private Driveway/Springbrook Avenue & Garner Road

2027 Background PM Peak Hour
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR												
Lane Configurations		↔			↔	↔		↔			↔	↔												
Traffic Volume (veh/h)	113	854	2	1	746	44	0	0	1	45	1	47												
Future Volume (Veh/h)	113	854	2	1	746	44	0	0	1	45	1	47												
Sign Control	Free			Free			Stop			Stop														
Grade	0%			0%			0%			0%														
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94												
Hourly flow rate (vph)	120	909	2	1	794	47	0	0	1	48	1	50												
Pedestrians	2																							
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	842			911			1998			1994			910			1948			1948			797		
vC1, stage 1 conf vol																								
vC2, stage 2 conf vol																								
vCu, unblocked vol	842			911			1998			1994			910			1948			1948			797		
tC, single (s)	4.1			4.1			7.1			6.5			6.2			7.1			6.5			6.2		
tC, 2 stage (s)																								
tF (s)	2.2			2.2			3.5			4.0			3.3			3.5			4.0			3.3		
p0 queue free %	85			100			100			100			100			0			98			87		
cM capacity (veh/h)	802			756			34			52			336			43			55			389		
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1																			
Volume Total	1031	795	47	1	99																			
Volume Left	120	1	0	0	48																			
Volume Right	2	0	47	1	50																			
cSH	802	756	1700	336	79																			
Volume to Capacity	0.15	0.00	0.03	0.00	1.26																			
Queue Length 95th (m)	4.2	0.0	0.0	0.1	59.8																			
Control Delay (s)	4.1	0.0	0.0	15.8	278.5																			
Lane LOS	A	A		C	F																			
Approach Delay (s)	4.1	0.0		15.8	278.5																			
Approach LOS				C	F																			
Intersection Summary																								
Average Delay	16.2																							
Intersection Capacity Utilization	112.9%			ICU Level of Service			H																	
Analysis Period (min)	15																							

Timings
3: Garner Road & Raymond Road

2027 Background PM Peak Hour
200224



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations	↔	↕	↔	↔	↕
Traffic Volume (vph)	86	1180	795	106	56
Future Volume (vph)	86	1180	795	106	56
Turn Type	pm+pt	NA	NA	Prot	Prot
Protected Phases	5	2	6	8	8
Permitted Phases	2				
Detector Phase	5	2	6	8	8
Switch Phase					
Minimum Initial (s)	5.0	30.0	30.0	10.0	10.0
Minimum Split (s)	8.0	36.0	36.0	22.9	22.9
Total Split (s)	8.0	67.1	59.1	22.9	22.9
Total Split (%)	8.9%	74.6%	65.7%	25.4%	25.4%
Yellow Time (s)	3.0	3.5	3.5	3.3	3.3
All-Red Time (s)	0.0	2.5	2.5	2.6	2.6
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.0	6.0	5.9	5.9
Lead/Lag	Lead		Lag		
Lead-Lag Optimize?	Yes		Yes		
Recall Mode	None	Max	Max	None	None
Act Effct Green (s)	67.2	65.5	59.1	11.5	11.5
Actuated g/C Ratio	0.80	0.78	0.70	0.14	0.14
v/c Ratio	0.34	0.89	0.82	0.47	0.23
Control Delay	6.2	20.4	19.9	40.2	11.3
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	6.2	20.4	19.9	40.2	11.3
LOS	A	C	B	D	B
Approach Delay		19.4	19.9	30.2	
Approach LOS		B	B	C	

Intersection Summary

Cycle Length: 90
 Actuated Cycle Length: 84.4
 Natural Cycle: 90
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.89
 Intersection Signal Delay: 20.3
 Intersection Capacity Utilization 80.4%
 Analysis Period (min) 15

Intersection LOS: C
 ICU Level of Service D

Splits and Phases: 3: Garner Road & Raymond Road



Queues
3: Garner Road & Raymond Road

2027 Background PM Peak Hour
200224



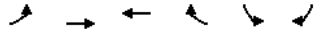
Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	93	1283	1039	115	61
v/c Ratio	0.34	0.89	0.82	0.47	0.23
Control Delay	6.2	20.4	19.9	40.2	11.3
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	6.2	20.4	19.9	40.2	11.3
Queue Length 50th (m)	2.9	151.5	129.9	18.3	0.0
Queue Length 95th (m)	7.7	#316.5	#257.3	34.4	10.6
Internal Link Dist (m)		365.4	90.6	133.1	
Turn Bay Length (m)	35.0			15.0	
Base Capacity (vph)	275	1444	1273	363	367
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.34	0.89	0.82	0.32	0.17

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis
3: Garner Road & Raymond Road

2027 Background PM Peak Hour
200224



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↘	↗	↘		↘	↗
Traffic Volume (vph)	86	1180	795	161	106	56
Future Volume (vph)	86	1180	795	161	106	56
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	6.0	6.0		5.9	5.9
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.98		1.00	0.85
Fit Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1805	1863	1812		1805	1583
Fit Permitted	0.12	1.00	1.00		0.95	1.00
Satd. Flow (perm)	228	1863	1812		1805	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	93	1283	864	175	115	61
RTOR Reduction (vph)	0	0	7	0	0	54
Lane Group Flow (vph)	93	1283	1032	0	115	7
Heavy Vehicles (%)	0%	2%	3%	0%	0%	2%
Turn Type	pm+pt	NA	NA		Prot	Prot
Protected Phases	5	2	6		8	8
Permitted Phases	2					
Actuated Green, G (s)	64.9	64.9	57.9		9.5	9.5
Effective Green, g (s)	64.9	64.9	57.9		9.5	9.5
Actuated g/C Ratio	0.75	0.75	0.67		0.11	0.11
Clearance Time (s)	3.0	6.0	6.0		5.9	5.9
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	244	1401	1215		198	174
v/s Ratio Prot	0.02	c0.69	0.57		c0.06	0.00
v/s Ratio Perm	0.27					
v/c Ratio	0.38	0.92	0.85		0.58	0.04
Uniform Delay, d1	11.7	8.5	10.9		36.5	34.3
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	1.0	10.9	7.5		4.3	0.1
Delay (s)	12.7	19.4	18.4		40.8	34.4
Level of Service	B	B	B		D	C
Approach Delay (s)	18.9	18.4	18.4		38.6	
Approach LOS	B	B	B		D	
Intersection Summary						
HCM 2000 Control Delay		20.1		HCM 2000 Level of Service		C
HCM 2000 Volume to Capacity ratio		0.91				
Actuated Cycle Length (s)		86.3		Sum of lost time (s)		14.9
Intersection Capacity Utilization		80.4%		ICU Level of Service		D
Analysis Period (min)		15				
c Critical Lane Group						

Appendix E

2027 Total Traffic Operational Conditions

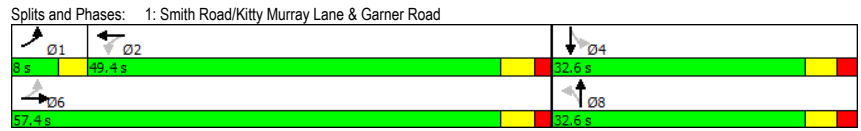


Timings 2027 Total AM Peak Hour
 1: Smith Road/Kitty Murray Lane & Garner Road 200224

	↖	→	←	↘	↓	
Lane Group	EBL	EBT	WBT	SBL	SBT	Ø8
Lane Configurations	↘	↘	↘	↘	↘	
Traffic Volume (vph)	115	671	686	78	0	
Future Volume (vph)	115	671	686	78	0	
Turn Type	pm+pt	NA	NA	Perm	NA	
Protected Phases	1	6	2		4	8
Permitted Phases	6			4		
Detector Phase	1	6	2	4	4	
Switch Phase						
Minimum Initial (s)	5.0	30.0	30.0	10.0	10.0	10.0
Minimum Split (s)	8.0	35.5	35.5	32.6	32.6	32.6
Total Split (s)	8.0	57.4	49.4	32.6	32.6	32.6
Total Split (%)	8.9%	63.8%	54.9%	36.2%	36.2%	36%
Yellow Time (s)	3.0	3.7	3.7	3.3	3.3	3.3
All-Red Time (s)	0.0	1.8	1.8	2.3	2.3	2.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	5.5	5.5	5.6	5.6	
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?	Yes		Yes			
Recall Mode	Max	Max	Max	Min	Min	Min
Act Effct Green (s)	54.5	52.0	43.9	11.1	11.1	
Actuated g/C Ratio	0.73	0.70	0.59	0.15	0.15	
v/c Ratio	0.43	0.62	0.82	0.43	0.59	
Control Delay	7.5	9.0	21.1	35.3	12.3	
Queue Delay	0.0	0.0	0.0	0.0	0.0	
Total Delay	7.5	9.0	21.1	35.3	12.3	
LOS	A	A	C	D	B	
Approach Delay		8.7	21.1		18.2	
Approach LOS		A	C		B	

Intersection Summary

Cycle Length: 90
 Actuated Cycle Length: 74.2
 Natural Cycle: 90
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.82
 Intersection Signal Delay: 15.4 Intersection LOS: B
 Intersection Capacity Utilization 88.1% ICU Level of Service E
 Analysis Period (min) 15



Queues 2027 Total AM Peak Hour
 1: Smith Road/Kitty Murray Lane & Garner Road 200224

	↖	→	←	↘	↓
Lane Group	EBL	EBT	WBT	SBL	SBT
Lane Group Flow (vph)	131	763	868	89	257
v/c Ratio	0.43	0.62	0.82	0.43	0.59
Control Delay	7.5	9.0	21.1	35.3	12.3
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	7.5	9.0	21.1	35.3	12.3
Queue Length 50th (m)	4.0	45.4	86.3	12.0	3.6
Queue Length 95th (m)	9.9	87.6	#178.4	24.9	22.1
Internal Link Dist (m)		75.7	599.0		166.9
Turn Bay Length (m)	55.0			30.0	
Base Capacity (vph)	305	1231	1053	508	722
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.43	0.62	0.82	0.18	0.36

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis
1: Smith Road/Kitty Murray Lane & Garner Road

2027 Total AM Peak Hour
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↔	↔		↔	↔			↔		↔	↔	
Traffic Volume (vph)	115	671	0	0	686	77	0	0	0	78	0	226
Future Volume (vph)	115	671	0	0	686	77	0	0	0	78	0	226
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	5.5			5.5					5.6	5.6	
Lane Util. Factor	1.00	1.00			1.00					1.00	1.00	
Flpb, ped/bikes	1.00	1.00			1.00					1.00	1.00	
Flpb, ped/bikes	1.00	1.00			1.00					1.00	1.00	
Frt	1.00	1.00			0.98					1.00	0.85	
Fit Protected	0.95	1.00			1.00					0.95	1.00	
Satd. Flow (prot)	1736	1759			1773					1752	1583	
Fit Permitted	0.15	1.00			1.00					0.76	1.00	
Satd. Flow (perm)	283	1759			1773					1397	1583	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	131	762	0	0	780	88	0	0	0	89	0	257
RTOR Reduction (vph)	0	0	0	0	4	0	0	0	0	0	195	0
Lane Group Flow (vph)	131	763	0	0	864	0	0	0	0	89	62	0
Confl. Peds. (#/hr)	1				1							
Heavy Vehicles (%)	4%	8%	0%	0%	5%	8%	0%	0%	0%	3%	0%	2%
Turn Type	pm+pt	NA		Perm	NA					Perm	NA	
Protected Phases	1	6			2			8			4	
Permitted Phases	6			2			8			4		
Actuated Green, G (s)	51.9	51.9			43.9					11.1	11.1	
Effective Green, g (s)	51.9	51.9			43.9					11.1	11.1	
Actuated g/C Ratio	0.70	0.70			0.59					0.15	0.15	
Clearance Time (s)	3.0	5.5			5.5					5.6	5.6	
Vehicle Extension (s)	3.0	3.0			3.0					3.0	3.0	
Lane Grp Cap (vph)	296	1232			1050					209	237	
v/s Ratio Prot	0.03	c0.43			c0.49						0.04	
v/s Ratio Perm	0.28									c0.06		
v/c Ratio	0.44	0.62			0.82					0.43	0.26	
Uniform Delay, d1	9.2	5.9			12.0					28.6	27.9	
Progression Factor	1.00	1.00			1.00					1.00	1.00	
Incremental Delay, d2	4.7	2.3			7.3					1.4	0.6	
Delay (s)	13.9	8.2			19.3					30.0	28.5	
Level of Service	B	A			B					C	C	
Approach Delay (s)		9.1			19.3			0.0			28.9	
Approach LOS		A			B			A			C	
Intersection Summary												
HCM 2000 Control Delay		16.5			HCM 2000 Level of Service			B				
HCM 2000 Volume to Capacity ratio		0.74										
Actuated Cycle Length (s)		74.1			Sum of lost time (s)			14.1				
Intersection Capacity Utilization		88.1%			ICU Level of Service			E				
Analysis Period (min)		15										

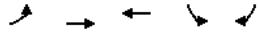
HCM Unsignalized Intersection Capacity Analysis
2: Private Driveway/Springbrook Avenue & Garner Road

2027 Total AM Peak Hour
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔	↔		↔			↔	↔
Traffic Volume (veh/h)	41	558	1	0	663	21	3	1	0	52	0	130
Future Volume (Veh/h)	41	558	1	0	663	21	3	1	0	52	0	130
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	42	575	1	0	684	22	3	1	0	54	0	134
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	706			576			1478	1366	576	1344	1344	684
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	706			576			1478	1366	576	1344	1344	684
tC, single (s)	4.4			4.1			7.1	6.5	6.2	7.1	6.5	6.3
tC, 2 stage (s)												
tF (s)	2.5			2.2			3.5	4.0	3.3	3.5	4.0	3.4
p0 queue free %	95			100			96	99	100	56	100	69
cM capacity (veh/h)	780			1007			70	141	521	124	145	432
Direction, Lane #												
Volume Total	618	684		22		4	188					
Volume Left	42	0		0	3	54						
Volume Right	1	0		22	0	134						
cSH	780	1007		1700		80	252					
Volume to Capacity	0.05	0.00		0.01	0.05	0.75						
Queue Length 95th (m)	1.4	0.0		0.0	1.2	42.3						
Control Delay (s)	1.4	0.0		0.0	52.6	51.8						
Lane LOS	A				F	F						
Approach Delay (s)	1.4	0.0			52.6	51.8						
Approach LOS					F	F						
Intersection Summary												
Average Delay		7.1										
Intersection Capacity Utilization		80.4%			ICU Level of Service			D				
Analysis Period (min)		15										

Timings
3: Garner Road & Raymond Road

2027 Total AM Peak Hour
200224



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations	↔	↑	↔	↔	↔
Traffic Volume (vph)	59	728	727	122	85
Future Volume (vph)	59	728	727	122	85
Turn Type	pm+pt	NA	NA	Prot	Prot
Protected Phases	5	2	6	8	8
Permitted Phases	2				
Detector Phase	5	2	6	8	8
Switch Phase					
Minimum Initial (s)	5.0	40.0	40.0	10.0	10.0
Minimum Split (s)	8.0	46.0	46.0	22.9	22.9
Total Split (s)	8.0	67.0	59.0	23.0	23.0
Total Split (%)	8.9%	74.4%	65.6%	25.6%	25.6%
Yellow Time (s)	3.0	3.5	3.5	3.3	3.3
All-Red Time (s)	0.0	2.5	2.5	2.6	2.6
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.0	6.0	5.9	5.9
Lead/Lag	Lead		Lag		
Lead-Lag Optimize?	Yes		Yes		
Recall Mode	None	Max	Max	None	None
Act Effct Green (s)	67.0	63.9	57.4	12.7	12.7
Actuated g/C Ratio	0.76	0.72	0.65	0.14	0.14
v/c Ratio	0.26	0.63	0.82	0.56	0.33
Control Delay	5.7	9.6	21.1	43.5	10.2
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	5.7	9.6	21.1	43.5	10.2
LOS	A	A	C	D	B
Approach Delay		9.4	21.1	29.8	
Approach LOS		A	C	C	

Intersection Summary

Cycle Length: 90
 Actuated Cycle Length: 88.6
 Natural Cycle: 90
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.82
 Intersection Signal Delay: 17.1
 Intersection Capacity Utilization 67.5%
 Analysis Period (min) 15

Intersection LOS: B
 ICU Level of Service C

Splits and Phases: 3: Garner Road & Raymond Road



Queues
3: Garner Road & Raymond Road

2027 Total AM Peak Hour
200224



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	66	818	956	137	96
v/c Ratio	0.26	0.63	0.82	0.56	0.33
Control Delay	5.7	9.6	21.1	43.5	10.2
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	5.7	9.6	21.1	43.5	10.2
Queue Length 50th (m)	2.3	59.9	116.6	22.2	0.0
Queue Length 95th (m)	6.5	114.0	#232.3	39.8	12.6
Internal Link Dist (m)		365.4	90.6	133.1	
Turn Bay Length (m)	35.0			40.0	
Base Capacity (vph)	258	1293	1159	329	364
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.26	0.63	0.82	0.42	0.26

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis
3: Garner Road & Raymond Road

2027 Total AM Peak Hour
200224



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↔	↕	↔	↔	↔	↕
Traffic Volume (vph)	59	728	727	124	122	85
Future Volume (vph)	59	728	727	124	122	85
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	6.0	6.0		5.9	5.9
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.98		1.00	0.85
Fit Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1597	1792	1782		1703	1482
Fit Permitted	0.14	1.00	1.00		0.95	1.00
Satd. Flow (perm)	240	1792	1782		1703	1482
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	66	818	817	139	137	96
RTOR Reduction (vph)	0	0	6	0	0	82
Lane Group Flow (vph)	66	818	950	0	137	14
Confl. Peds. (#/hr)	3			3		1
Heavy Vehicles (%)	13%	6%	4%	5%	6%	9%
Turn Type	pm+pt	NA	NA	Prot	Prot	
Protected Phases	5	2	6		8	8
Permitted Phases	2					
Actuated Green, G (s)	64.4	64.4	57.3		12.7	12.7
Effective Green, g (s)	64.4	64.4	57.3		12.7	12.7
Actuated g/C Ratio	0.72	0.72	0.64		0.14	0.14
Clearance Time (s)	3.0	6.0	6.0		5.9	5.9
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	236	1296	1147		243	211
v/s Ratio Prot	0.01	c0.46	c0.53		c0.08	0.01
v/s Ratio Perm	0.19					
v/c Ratio	0.28	0.63	0.83		0.56	0.06
Uniform Delay, d1	10.5	6.3	12.1		35.6	33.0
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.7	2.3	6.9		3.0	0.1
Delay (s)	11.1	8.6	19.0		38.5	33.1
Level of Service	B	A	B		D	C
Approach Delay (s)		8.8	19.0		36.3	
Approach LOS		A	B		D	

Intersection Summary			
HCM 2000 Control Delay	16.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	89.0	Sum of lost time (s)	14.9
Intersection Capacity Utilization	67.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
4: Springbrook Avenue & Driveway A

2027 Total AM Peak Hour
200224



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↔	↔	↕	↔	↔	↕
Traffic Volume (veh/h)	6	1	44	1	1	119
Future Volume (Veh/h)	6	1	44	1	1	119
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	7	1	48	1	1	129
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	180	48			49	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	180	48			49	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	100			100	
cM capacity (veh/h)	810	1020			1558	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	8	49	130
Volume Left	7	0	1
Volume Right	1	1	0
cSH	831	1700	1558
Volume to Capacity	0.01	0.03	0.00
Queue Length 95th (m)	0.2	0.0	0.0
Control Delay (s)	9.4	0.0	0.1
Lane LOS	A		A
Approach Delay (s)	9.4	0.0	0.1
Approach LOS	A		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	17.1%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
5: Springbrook Avenue & Driveway B

2027 Total AM Peak Hour
200224

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↔		↔		↔	↔
Traffic Volume (veh/h)	8	0	45	3	0	125
Future Volume (Veh/h)	8	0	45	3	0	125
Sign Control	Stop		Free		Free	
Grade	0%		0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	9	0	49	3	0	136
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None		None	
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	186	50			52	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	186	50			52	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	100			100	
cM capacity (veh/h)	803	1018			1554	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	9	52	136			
Volume Left	9	0	0			
Volume Right	0	3	0			
cSH	803	1700	1554			
Volume to Capacity	0.01	0.03	0.00			
Queue Length 95th (m)	0.3	0.0	0.0			
Control Delay (s)	9.5	0.0	0.0			
Lane LOS	A					
Approach Delay (s)	9.5	0.0	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay		0.4				
Intersection Capacity Utilization		16.6%		ICU Level of Service	A	
Analysis Period (min)		15				

HCM Unsignalized Intersection Capacity Analysis
6: Garner Road & Driveway C

2027 Total AM Peak Hour
200224

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔		↔	↔
Traffic Volume (veh/h)	2	608	850	2	7	8
Future Volume (Veh/h)	2	608	850	2	7	8
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	661	924	2	8	9
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	926				1590	925
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	926				1590	925
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				93	97
cM capacity (veh/h)	738				118	326
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	663	926	17			
Volume Left	2	0	8			
Volume Right	0	2	9			
cSH	738	1700	178			
Volume to Capacity	0.00	0.54	0.10			
Queue Length 95th (m)	0.1	0.0	2.5			
Control Delay (s)	0.1	0.0	27.3			
Lane LOS	A		D			
Approach Delay (s)	0.1	0.0	27.3			
Approach LOS			D			
Intersection Summary						
Average Delay			0.3			
Intersection Capacity Utilization		54.9%		ICU Level of Service	A	
Analysis Period (min)		15				

Timings
1: Smith Road/Kitty Murray Lane & Garner Road

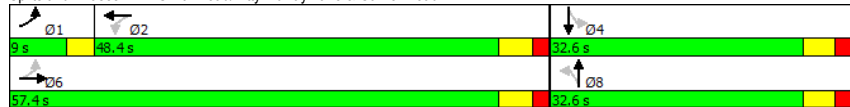
2027 Total PM Peak Hour
200224

	↖	→	←	↙	↓	Ø8
Lane Group	EBL	EBT	WBT	SBL	SBT	Ø8
Lane Configurations	↖	↖	↖	↖	↖	
Traffic Volume (vph)	167	870	692	85	0	
Future Volume (vph)	167	870	692	85	0	
Turn Type	pm+pt	NA	NA	Perm	NA	
Protected Phases	1	6	2		4	8
Permitted Phases	6			4		
Detector Phase	1	6	2	4	4	
Switch Phase						
Minimum Initial (s)	5.0	30.0	30.0	10.0	10.0	10.0
Minimum Split (s)	8.0	35.5	35.5	32.6	32.6	32.6
Total Split (s)	9.0	57.4	48.4	32.6	32.6	32.6
Total Split (%)	10.0%	63.8%	53.8%	36.2%	36.2%	36%
Yellow Time (s)	3.0	3.7	3.7	3.3	3.3	3.3
All-Red Time (s)	0.0	1.8	1.8	2.3	2.3	2.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	5.5	5.5	5.6	5.6	
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?	Yes		Yes			
Recall Mode	Max	Max	Max	Min	Min	Min
Act Effect Green (s)	54.4	51.9	42.9	11.4	11.4	
Actuated g/C Ratio	0.73	0.70	0.58	0.15	0.15	
v/c Ratio	0.60	0.75	0.83	0.45	0.30	
Control Delay	14.0	12.4	22.0	35.7	1.7	
Queue Delay	0.0	0.0	0.0	0.0	0.0	
Total Delay	14.0	12.4	22.0	35.7	1.7	
LOS	B	B	C	D	A	
Approach Delay		12.6	22.0		15.6	
Approach LOS		B	C		B	

Intersection Summary

Cycle Length: 90
 Actuated Cycle Length: 74.4
 Natural Cycle: 90
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.83
 Intersection Signal Delay: 16.6
 Intersection Capacity Utilization 93.4%
 Analysis Period (min) 15
 Intersection LOS: B
 ICU Level of Service F

Splits and Phases: 1: Smith Road/Kitty Murray Lane & Garner Road



Queues
1: Smith Road/Kitty Murray Lane & Garner Road

2027 Total PM Peak Hour
200224

	↖	→	←	↙	↓
Lane Group	EBL	EBT	WBT	SBL	SBT
Lane Group Flow (vph)	186	967	881	94	137
v/c Ratio	0.60	0.75	0.83	0.45	0.30
Control Delay	14.0	12.4	22.0	35.7	1.7
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	14.0	12.4	22.0	35.7	1.7
Queue Length 50th (m)	5.9	69.3	90.4	12.8	0.0
Queue Length 95th (m)	#24.8	146.4	#191.7	26.6	0.0
Internal Link Dist (m)		75.7	599.0		166.9
Turn Bay Length (m)	55.0			30.0	
Base Capacity (vph)	308	1287	1061	502	731
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.60	0.75	0.83	0.19	0.19

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis
1: Smith Road/Kitty Murray Lane & Garner Road

2027 Total PM Peak Hour
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	167	870	0	0	692	101	0	0	0	85	0	123
Future Volume (vph)	167	870	0	0	692	101	0	0	0	85	0	123
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	5.5			5.5					5.6	5.6	
Lane Util. Factor	1.00	1.00			1.00					1.00	1.00	
Frb, ped/bikes	1.00	1.00			1.00					1.00	0.98	
Flpb, ped/bikes	1.00	1.00			1.00					1.00	1.00	
Frt	1.00	1.00			0.98					1.00	0.85	
Fit Protected	0.95	1.00			1.00					0.95	1.00	
Satd. Flow (prot)	1787	1845			1832					1736	1581	
Fit Permitted	0.13	1.00			1.00					0.76	1.00	
Satd. Flow (perm)	251	1845			1832					1383	1581	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	186	967	0	0	769	112	0	0	0	94	0	137
RTOR Reduction (vph)	0	0	0	0	5	0	0	0	0	0	116	0
Lane Group Flow (vph)	186	967	0	0	876	0	0	0	0	94	21	0
Confl. Peds. (#/hr)							1					1
Heavy Vehicles (%)	1%	3%	0%	0%	2%	0%	0%	0%	0%	4%	0%	0%
Turn Type	pm+pt	NA		Perm	NA					Perm	NA	
Protected Phases	1	6		2				8			4	
Permitted Phases	6			2			8			4		
Actuated Green, G (s)	51.9	51.9			42.9					11.4	11.4	
Effective Green, g (s)	51.9	51.9			42.9					11.4	11.4	
Actuated g/C Ratio	0.70	0.70			0.58					0.15	0.15	
Clearance Time (s)	3.0	5.5			5.5					5.6	5.6	
Vehicle Extension (s)	3.0	3.0			3.0					3.0	3.0	
Lane Grp Cap (vph)	298	1287			1056					211	242	
v/s Ratio Prot	0.05	c0.52			c0.48						0.01	
v/s Ratio Perm	0.38									c0.07		
v/c Ratio	0.62	0.75			0.83					0.45	0.09	
Uniform Delay, d1	11.1	7.1			12.8					28.6	27.0	
Progression Factor	1.00	1.00			1.00					1.00	1.00	
Incremental Delay, d2	9.5	4.1			7.6					1.5	0.2	
Delay (s)	20.6	11.2			20.4					30.1	27.2	
Level of Service	C	B			C					C	C	
Approach Delay (s)		12.7			20.4			0.0			28.4	
Approach LOS		B			C			A			C	

Intersection Summary			
HCM 2000 Control Delay	17.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	74.4	Sum of lost time (s)	14.1
Intersection Capacity Utilization	93.4%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
2: Private Driveway/Springbrook Avenue & Garner Road

2027 Total PM Peak Hour
200224

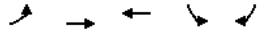
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	126	864	2	1	749	45	0	0	1	47	1	53
Future Volume (Veh/h)	126	864	2	1	749	45	0	0	1	47	1	53
Sign Control	Free											
Grade	0%											
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	134	919	2	1	797	48	0	0	1	50	1	56
Pedestrians	1											
Lane Width (m)	3.6											
Walking Speed (m/s)	1.2											
Percent Blockage	0											
Right turn flare (veh)												
Median type	None											
Median storage (veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	846			921			2044	2036	920	1989	1989	798
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	846			921			2044	2036	920	1989	1989	798
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	83			100			100	100	100	0	98	86
cM capacity (veh/h)	799			750			31	48	331	40	51	389

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	1055	798	48	1	107
Volume Left	134	1	0	0	50
Volume Right	2	0	48	1	56
cSH	799	750	1700	331	75
Volume to Capacity	0.17	0.00	0.03	0.00	1.42
Queue Length 95th (m)	4.8	0.0	0.0	0.1	68.8
Control Delay (s)	4.6	0.0	0.0	15.9	344.9
Lane LOS	A	A		C	F
Approach Delay (s)	4.6	0.0		15.9	344.9
Approach LOS				C	F

Intersection Summary			
Average Delay	20.8		
Intersection Capacity Utilization	114.6%	ICU Level of Service	H
Analysis Period (min)	15		

Timings
3: Garner Road & Raymond Road

2027 Total PM Peak Hour
200224



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations	↔	↑	↔	↔	↔
Traffic Volume (vph)	87	1187	800	106	57
Future Volume (vph)	87	1187	800	106	57
Turn Type	pm+pt	NA	NA	Prot	Prot
Protected Phases	5	2	6	8	8
Permitted Phases	2				
Detector Phase	5	2	6	8	8
Switch Phase					
Minimum Initial (s)	5.0	30.0	30.0	10.0	10.0
Minimum Split (s)	8.0	36.0	36.0	22.9	22.9
Total Split (s)	8.0	77.1	69.1	22.9	22.9
Total Split (%)	8.0%	77.1%	69.1%	22.9%	22.9%
Yellow Time (s)	3.0	3.5	3.5	3.3	3.3
All-Red Time (s)	0.0	2.5	2.5	2.6	2.6
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.0	6.0	5.9	5.9
Lead/Lag	Lead		Lag		
Lead-Lag Optimize?	Yes		Yes		
Recall Mode	None	Max	Max	None	None
Act Effct Green (s)	77.1	74.1	67.5	12.1	12.1
Actuated g/C Ratio	0.79	0.76	0.69	0.12	0.12
v/c Ratio	0.36	0.92	0.84	0.52	0.25
Control Delay	6.4	22.8	20.1	47.7	12.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	6.4	22.8	20.1	47.7	12.4
LOS	A	C	C	D	B
Approach Delay		21.7	20.1	35.3	
Approach LOS		C	C	D	

Intersection Summary

Cycle Length: 100
 Actuated Cycle Length: 98.1
 Natural Cycle: 90
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.92
 Intersection Signal Delay: 22.0
 Intersection Capacity Utilization 80.7%
 Analysis Period (min) 15
 Intersection LOS: C
 ICU Level of Service D

Splits and Phases: 3: Garner Road & Raymond Road



Queues
3: Garner Road & Raymond Road

2027 Total PM Peak Hour
200224



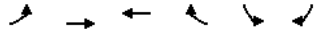
Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	95	1290	1045	115	62
v/c Ratio	0.36	0.92	0.84	0.52	0.25
Control Delay	6.4	22.8	20.1	47.7	12.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	6.4	22.8	20.1	47.7	12.4
Queue Length 50th (m)	3.2	161.0	135.3	21.0	0.0
Queue Length 95th (m)	8.0	#342.4	#272.3	38.3	11.4
Internal Link Dist (m)		365.4	90.6	133.1	
Turn Bay Length (m)	35.0			15.0	
Base Capacity (vph)	267	1406	1251	313	326
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.36	0.92	0.84	0.37	0.19

Intersection Summary

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

HCM Signalized Intersection Capacity Analysis
3: Garner Road & Raymond Road

2027 Total PM Peak Hour
200224



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↔	↕	↔	↔	↔	↕
Traffic Volume (vph)	87	1187	800	161	106	57
Future Volume (vph)	87	1187	800	161	106	57
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	6.0	6.0		5.9	5.9
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.98		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1805	1863	1812		1805	1583
Flt Permitted	0.12	1.00	1.00		0.95	1.00
Satd. Flow (perm)	237	1863	1812		1805	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	95	1290	870	175	115	62
RTOR Reduction (vph)	0	0	6	0	0	54
Lane Group Flow (vph)	95	1290	1039	0	115	8
Heavy Vehicles (%)	0%	2%	3%	0%	0%	2%
Turn Type	pm+pt	NA	NA		Prot	Prot
Protected Phases	5	2	6		8	8
Permitted Phases	2					
Actuated Green, G (s)	74.6	74.6	67.5		12.1	12.1
Effective Green, g (s)	74.6	74.6	67.5		12.1	12.1
Actuated g/C Ratio	0.76	0.76	0.68		0.12	0.12
Clearance Time (s)	3.0	6.0	6.0		5.9	5.9
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	244	1409	1240		221	194
v/s Ratio Prot	0.02	c0.69	0.57		c0.06	0.00
v/s Ratio Perm	0.28					
v/c Ratio	0.39	0.92	0.84		0.52	0.04
Uniform Delay, d1	12.9	9.5	11.5		40.5	38.1
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	1.0	10.8	6.8		2.2	0.1
Delay (s)	13.9	20.3	18.3		42.7	38.2
Level of Service	B	C	B		D	D
Approach Delay (s)	19.9		18.3		41.1	
Approach LOS	B		B		D	

Intersection Summary			
HCM 2000 Control Delay	20.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	98.6	Sum of lost time (s)	14.9
Intersection Capacity Utilization	80.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
4: Springbrook Avenue & Driveway A

2027 Total PM Peak Hour
200224



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↔	↔	↕	↕	↔	↕
Traffic Volume (veh/h)	3	1	100	6	1	62
Future Volume (Veh/h)	3	1	100	6	1	62
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	1	109	7	1	67
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	182	112			116	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	182	112			116	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	807	940			1473	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	4	116	68
Volume Left	3	0	1
Volume Right	1	7	0
cSH	837	1700	1473
Volume to Capacity	0.00	0.07	0.00
Queue Length 95th (m)	0.1	0.0	0.0
Control Delay (s)	9.3	0.0	0.1
Lane LOS	A		A
Approach Delay (s)	9.3	0.0	0.1
Approach LOS	A		

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	15.6%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
5: Springbrook Avenue & Driveway B

2027 Total PM Peak Hour
200224

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↔		↔			↔
Traffic Volume (veh/h)	5	0	106	8	0	65
Future Volume (Veh/h)	5	0	106	8	0	65
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	0	115	9	0	71
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None		None	
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	190	120			124	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	190	120			124	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	100			100	
cM capacity (veh/h)	798	932			1463	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	5	124	71			
Volume Left	5	0	0			
Volume Right	0	9	0			
cSH	798	1700	1463			
Volume to Capacity	0.01	0.07	0.00			
Queue Length 95th (m)	0.2	0.0	0.0			
Control Delay (s)	9.5	0.0	0.0			
Lane LOS	A					
Approach Delay (s)	9.5	0.0	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay		0.2				
Intersection Capacity Utilization		16.1%	ICU Level of Service	A		
Analysis Period (min)		15				

HCM Unsignalized Intersection Capacity Analysis
6: Garner Road & Driveway C

2027 Total PM Peak Hour
200224

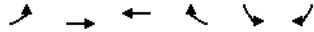
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔		↔	
Traffic Volume (veh/h)	10	902	863	5	6	3
Future Volume (Veh/h)	10	902	863	5	6	3
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	980	938	5	7	3
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	943				1942	940
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	943				1942	940
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				90	99
cM capacity (veh/h)	727				70	319
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	991	943	10			
Volume Left	11	0	7			
Volume Right	0	5	3			
cSH	727	1700	92			
Volume to Capacity	0.02	0.55	0.11			
Queue Length 95th (m)	0.4	0.0	2.8			
Control Delay (s)	0.5	0.0	48.9			
Lane LOS	A		E			
Approach Delay (s)	0.5	0.0	48.9			
Approach LOS			E			
Intersection Summary						
Average Delay		0.5				
Intersection Capacity Utilization		65.4%	ICU Level of Service	C		
Analysis Period (min)		15				

Appendix F

2027 Total Traffic Operational Conditions with Improvements



Timings 2027 Total AM Peak Hour - Remedial
1: Smith Road/Kitty Murray Lane & Garner Road 200224



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR	Ø8
Lane Configurations	↘	↗	↗	↘	↘	↗	
Traffic Volume (vph)	115	671	686	77	78	226	
Future Volume (vph)	115	671	686	77	78	226	
Turn Type	pm+pt	NA	NA	Perm	Perm	Perm	
Protected Phases	1	6	2				8
Permitted Phases	6			2	4	4	
Detector Phase	1	6	2	2	4	4	
Switch Phase							
Minimum Initial (s)	5.0	30.0	30.0	30.0	10.0	10.0	10.0
Minimum Split (s)	8.0	35.5	35.5	35.5	32.6	32.6	32.6
Total Split (s)	10.0	47.0	37.0	37.0	33.0	33.0	33.0
Total Split (%)	12.5%	58.8%	46.3%	46.3%	41.3%	41.3%	41%
Yellow Time (s)	3.0	3.7	3.7	3.7	3.3	3.3	3.3
All-Red Time (s)	0.0	1.8	1.8	1.8	2.3	2.3	2.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	5.5	5.5	5.5	5.6	5.6	
Lead/Lag	Lead		Lag	Lag			
Lead-Lag Optimize?	Yes		Yes	Yes			
Recall Mode	Max	Max	Max	Max	Min	Min	Min
Act Effct Green (s)	44.0	41.5	31.5	31.5	10.7	10.7	
Actuated g/C Ratio	0.69	0.65	0.50	0.50	0.17	0.17	
v/c Ratio	0.26	0.35	0.46	0.11	0.38	0.53	
Control Delay	4.8	5.5	11.6	2.9	28.4	7.8	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	4.8	5.5	11.6	2.9	28.4	7.8	
LOS	A	A	B	A	C	A	
Approach Delay		5.4	10.7				
Approach LOS		A	B				

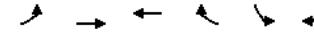
Intersection Summary

Cycle Length: 80
 Actuated Cycle Length: 63.4
 Natural Cycle: 80
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.53
 Intersection Signal Delay: 8.9 Intersection LOS: A
 Intersection Capacity Utilization 72.2% ICU Level of Service C
 Analysis Period (min) 15

Splits and Phases: 1: Smith Road/Kitty Murray Lane & Garner Road



Queues 2027 Total AM Peak Hour - Remedial
1: Smith Road/Kitty Murray Lane & Garner Road 200224



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Group Flow (vph)	131	763	780	88	89	257
v/c Ratio	0.26	0.35	0.46	0.11	0.38	0.53
Control Delay	4.8	5.5	11.6	2.9	28.4	7.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	4.8	5.5	11.6	2.9	28.4	7.8
Queue Length 50th (m)	4.0	17.5	29.6	0.0	9.8	0.0
Queue Length 95th (m)	9.7	29.0	45.6	6.0	21.4	15.4
Internal Link Dist (m)		75.7	599.0			
Turn Bay Length (m)	55.0			40.0	30.0	
Base Capacity (vph)	495	2190	1709	771	604	833
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.26	0.35	0.46	0.11	0.15	0.31

Intersection Summary

HCM Signalized Intersection Capacity Analysis
1: Smith Road/Kitty Murray Lane & Garner Road

2027 Total AM Peak Hour - Remedial
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔
Traffic Volume (vph)	115	671	0	0	686	77	0	0	0	78	0	226
Future Volume (vph)	115	671	0	0	686	77	0	0	0	78	0	226
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	5.5			5.5	5.5				5.6		5.6
Lane Util. Factor	1.00	0.95			0.95	1.00				1.00		1.00
Frb, ped/bikes	1.00	1.00			1.00	0.98				1.00		1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00				1.00		1.00
Frt	1.00	1.00			1.00	0.85				1.00		0.85
Fit Protected	0.95	1.00			1.00	1.00				0.95		1.00
Satd. Flow (prot)	1735	3343			3438	1464				1752		1583
Fit Permitted	0.29	1.00			1.00	1.00				0.76		1.00
Satd. Flow (perm)	521	3343			3438	1464				1397		1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	131	762	0	0	780	88	0	0	0	89	0	257
RTOR Reduction (vph)	0	0	0	0	0	44	0	0	0	0	0	214
Lane Group Flow (vph)	131	763	0	0	780	44	0	0	0	89	0	43
Confl. Peds. (#/hr)	1				1							
Heavy Vehicles (%)	4%	8%	0%	0%	5%	8%	0%	0%	0%	3%	0%	2%
Turn Type	pm+pt	NA	Perm	Perm	NA	Perm	Perm	Perm	Perm	Perm	Perm	Perm
Protected Phases	1	6			2			8			4	
Permitted Phases	6		6	2		2		8		4		4
Actuated Green, G (s)	41.5	41.5			31.5	31.5				10.7		10.7
Effective Green, g (s)	41.5	41.5			31.5	31.5				10.7		10.7
Actuated g/C Ratio	0.66	0.66			0.50	0.50				0.17		0.17
Clearance Time (s)	3.0	5.5			5.5	5.5				5.6		5.6
Vehicle Extension (s)	3.0	3.0			3.0	3.0				3.0		3.0
Lane Grp Cap (vph)	475	2191			1710	728				236		267
v/s Ratio Prot	0.03	c0.23			c0.23							
v/s Ratio Perm	0.15					0.03				c0.06		0.03
v/c Ratio	0.28	0.35			0.46	0.06				0.38		0.16
Uniform Delay, d1	4.5	4.9			10.3	8.2				23.3		22.5
Progression Factor	1.00	1.00			1.00	1.00				1.00		1.00
Incremental Delay, d2	1.4	0.4			0.9	0.2				1.0		0.3
Delay (s)	6.0	5.3			11.2	8.4				24.4		22.8
Level of Service	A	A			B	A				C		C
Approach Delay (s)		5.4			10.9		0.0				23.2	
Approach LOS		A			B		A				C	
Intersection Summary												
HCM 2000 Control Delay		10.6			HCM 2000 Level of Service					B		
HCM 2000 Volume to Capacity ratio		0.43										
Actuated Cycle Length (s)		63.3			Sum of lost time (s)				14.1			
Intersection Capacity Utilization		72.2%			ICU Level of Service				C			
Analysis Period (min)		15										

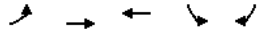
HCM Unsignalized Intersection Capacity Analysis
2: Private Driveway/Springbrook Avenue & Garner Road

2027 Total AM Peak Hour - Remedial
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔
Traffic Volume (veh/h)	41	558	1	0	663	21	3	1	0	52	0	130
Future Volume (Veh/h)	41	558	1	0	663	21	3	1	0	52	0	130
Sign Control	Free			Free			Stop			Stop		
Grade	0%			0%			0%			0%		
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	42	575	1	0	684	22	3	1	0	54	0	134
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type	TWLTL			TWLTL								
Median storage (veh)	2			2								
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	706			576			1136	1366	288	1067	1355	353
vC1, stage 1 conf vol							660	660		695	695	
vC2, stage 2 conf vol							476	706		372	660	
vCu, unblocked vol	706			576			1136	1366	288	1067	1355	353
tC, single (s)	4.7			4.1			7.5	6.5	6.9	7.5	6.5	7.1
tC, 2 stage (s)							6.5	5.5		6.5	5.5	
tF (s)	2.5			2.2			3.5	4.0	3.3	3.5	4.0	3.4
p0 queue free %	94			100			99	100	100	85	100	78
cM capacity (veh/h)	730			1007			293	317	715	356	334	615
Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1	SB 2			
Volume Total	42	383	193	0	456	250	4	54	134			
Volume Left	42	0	0	0	0	0	3	54	0			
Volume Right	0	0	1	0	0	22	0	0	134			
cSH	730	1700	1700	1700	1700	1700	299	356	615			
Volume to Capacity	0.06	0.23	0.11	0.00	0.27	0.15	0.01	0.15	0.22			
Queue Length 95th (m)	1.5	0.0	0.0	0.0	0.0	0.0	0.3	4.2	6.6			
Control Delay (s)	10.2	0.0	0.0	0.0	0.0	0.0	17.2	16.9	12.5			
Lane LOS	B						C	C	B			
Approach Delay (s)	0.7			0.0			17.2	13.7				
Approach LOS							C	B				
Intersection Summary												
Average Delay		2.0										
Intersection Capacity Utilization		40.4%			ICU Level of Service				A			
Analysis Period (min)		15										

Timings
3: Garner Road & Raymond Road

2027 Total AM Peak Hour - Remedial
200224



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations	↘	↕	↕	↘	↘
Traffic Volume (vph)	59	728	727	122	85
Future Volume (vph)	59	728	727	122	85
Turn Type	pm+pt	NA	NA	Prot	Prot
Protected Phases	5	2	6	8	8
Permitted Phases	2				
Detector Phase	5	2	6	8	8
Switch Phase					
Minimum Initial (s)	5.0	40.0	40.0	10.0	10.0
Minimum Split (s)	8.0	46.0	46.0	22.9	22.9
Total Split (s)	9.0	57.0	48.0	23.0	23.0
Total Split (%)	11.3%	71.3%	60.0%	28.8%	28.8%
Yellow Time (s)	3.0	3.5	3.5	3.3	3.3
All-Red Time (s)	0.0	2.5	2.5	2.6	2.6
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.0	6.0	5.9	5.9
Lead/Lag	Lead		Lag		
Lead-Lag Optimize?	Yes		Yes		
Recall Mode	None	Max	Max	None	None
Act Effct Green (s)	56.9	53.9	48.4	12.1	12.1
Actuated g/C Ratio	0.73	0.69	0.62	0.16	0.16
v/c Ratio	0.17	0.35	0.45	0.52	0.31
Control Delay	4.5	5.7	9.4	36.5	9.2
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	4.5	5.7	9.4	36.5	9.2
LOS	A	A	A	D	A
Approach Delay		5.6	9.4	25.2	
Approach LOS		A	A	C	

Intersection Summary

Cycle Length: 80
 Actuated Cycle Length: 78
 Natural Cycle: 80
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.52
 Intersection Signal Delay: 9.6
 Intersection Capacity Utilization 59.3%
 Analysis Period (min) 15
 Intersection LOS: A
 ICU Level of Service B

Splits and Phases: 3: Garner Road & Raymond Road



Queues
3: Garner Road & Raymond Road

2027 Total AM Peak Hour - Remedial
200224

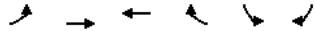


Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	66	818	956	137	96
v/c Ratio	0.17	0.35	0.45	0.52	0.31
Control Delay	4.5	5.7	9.4	36.5	9.2
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	4.5	5.7	9.4	36.5	9.2
Queue Length 50th (m)	2.2	21.5	38.8	18.9	0.0
Queue Length 95th (m)	6.5	37.0	61.3	35.0	11.6
Internal Link Dist (m)		580.1	90.6	133.1	
Turn Bay Length (m)	35.0			40.0	
Base Capacity (vph)	394	2353	2109	375	401
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.17	0.35	0.45	0.37	0.24

Intersection Summary

HCM Signalized Intersection Capacity Analysis
3: Garner Road & Raymond Road

2027 Total AM Peak Hour - Remedial
200224



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↘	↗	↗		↘	↗
Traffic Volume (vph)	59	728	727	124	122	85
Future Volume (vph)	59	728	727	124	122	85
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	6.0	6.0		5.9	5.9
Lane Util. Factor	1.00	0.95	0.95		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.98		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1597	3406	3379		1703	1482
Flt Permitted	0.25	1.00	1.00		0.95	1.00
Satd. Flow (perm)	416	3406	3379		1703	1482
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	66	818	817	139	137	96
RTOR Reduction (vph)	0	0	14	0	0	81
Lane Group Flow (vph)	66	818	942	0	137	15
Confl. Peds. (#/hr)	3			3		1
Heavy Vehicles (%)	13%	6%	4%	5%	6%	9%
Turn Type	pm+pt	NA	NA	Prot	Prot	
Protected Phases	5	2	6		8	8
Permitted Phases	2					
Actuated Green, G (s)	55.1	55.1	48.4		12.1	12.1
Effective Green, g (s)	55.1	55.1	48.4		12.1	12.1
Actuated g/C Ratio	0.70	0.70	0.61		0.15	0.15
Clearance Time (s)	3.0	6.0	6.0		5.9	5.9
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	345	2372	2067		260	226
v/s Ratio Prot	0.01	c0.24	c0.28		c0.08	0.01
v/s Ratio Perm	0.12					
v/c Ratio	0.19	0.34	0.46		0.53	0.06
Uniform Delay, d1	4.4	4.8	8.3		30.9	28.7
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.3	0.4	0.7		1.9	0.1
Delay (s)	4.6	5.2	9.0		32.8	28.8
Level of Service	A	A	A		C	C
Approach Delay (s)		5.2	9.0		31.1	
Approach LOS		A	A		C	

Intersection Summary			
HCM 2000 Control Delay	9.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	79.1	Sum of lost time (s)	14.9
Intersection Capacity Utilization	59.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
4: Springbrook Avenue & Driveway A

2027 Total AM Peak Hour - Remedial
200224



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↘		↗		↘	↗
Traffic Volume (veh/h)	6	1	44	1	1	119
Future Volume (Veh/h)	6	1	44	1	1	119
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	7	1	48	1	1	129
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	180	48			49	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	180	48			49	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	100			100	
cM capacity (veh/h)	810	1020			1558	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	8	49	130
Volume Left	7	0	1
Volume Right	1	1	0
cSH	831	1700	1558
Volume to Capacity	0.01	0.03	0.00
Queue Length 95th (m)	0.2	0.0	0.0
Control Delay (s)	9.4	0.0	0.1
Lane LOS	A		A
Approach Delay (s)	9.4	0.0	0.1
Approach LOS	A		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	17.1%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
5: Springbrook Avenue & Driveway B

2027 Total AM Peak Hour - Remedial
200224

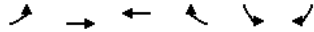
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	8	0	45	3	0	125
Future Volume (Veh/h)	8	0	45	3	0	125
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	9	0	49	3	0	136
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None		None	
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	186	50			52	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	186	50			52	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	100			100	
cM capacity (veh/h)	803	1018			1554	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	9	52	136			
Volume Left	9	0	0			
Volume Right	0	3	0			
cSH	803	1700	1554			
Volume to Capacity	0.01	0.03	0.00			
Queue Length 95th (m)	0.3	0.0	0.0			
Control Delay (s)	9.5	0.0	0.0			
Lane LOS	A					
Approach Delay (s)	9.5	0.0	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay		0.4				
Intersection Capacity Utilization		16.6%	ICU Level of Service	A		
Analysis Period (min)		15				

HCM Unsignalized Intersection Capacity Analysis
6: Garner Road & Driveway C

2027 Total AM Peak Hour - Remedial
200224

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	2	608	850	2	7	8
Future Volume (Veh/h)	2	608	850	2	7	8
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	661	924	2	8	9
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		TWLTL	TWLTL			
Median storage (veh)		2	2			
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume		926			1260	463
vC1, stage 1 conf vol					925	
vC2, stage 2 conf vol					334	
vCu, unblocked vol		926			1260	463
tC, single (s)		4.1			6.8	6.9
tC, 2 stage (s)					5.8	
tF (s)		2.2			3.5	3.3
p0 queue free %		100			98	98
cM capacity (veh/h)		734			324	546
Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1
Volume Total	2	330	330	616	310	17
Volume Left	2	0	0	0	0	8
Volume Right	0	0	0	0	2	9
cSH	734	1700	1700	1700	1700	412
Volume to Capacity	0.00	0.19	0.19	0.36	0.18	0.04
Queue Length 95th (m)	0.1	0.0	0.0	0.0	0.0	1.0
Control Delay (s)	9.9	0.0	0.0	0.0	0.0	14.1
Lane LOS	A					B
Approach Delay (s)	0.0			0.0		14.1
Approach LOS						B
Intersection Summary						
Average Delay			0.2			
Intersection Capacity Utilization			33.6%	ICU Level of Service	A	
Analysis Period (min)			15			

Timings 2027 Total PM Peak Hour - Remedial
1: Smith Road/Kitty Murray Lane & Garner Road 200224

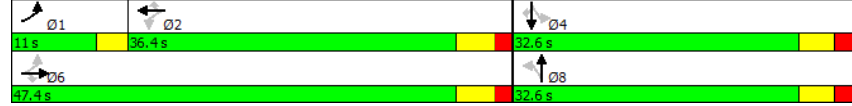


Lane Group	EBL	EBT	WBT	WBR	SBL	SBR	Ø8
Lane Configurations	↘	↗	↗	↘	↘	↗	
Traffic Volume (vph)	167	870	692	101	85	123	
Future Volume (vph)	167	870	692	101	85	123	
Turn Type	pm+pt	NA	NA	Perm	Perm	Perm	
Protected Phases	1	6	2				8
Permitted Phases	6			2	4	4	
Detector Phase	1	6	2	2	4	4	
Switch Phase							
Minimum Initial (s)	5.0	30.0	30.0	30.0	10.0	10.0	10.0
Minimum Split (s)	8.0	35.5	35.5	35.5	32.6	32.6	32.6
Total Split (s)	11.0	47.4	36.4	36.4	32.6	32.6	32.6
Total Split (%)	13.8%	59.3%	45.5%	45.5%	40.8%	40.8%	41%
Yellow Time (s)	3.0	3.7	3.7	3.7	3.3	3.3	3.3
All-Red Time (s)	0.0	1.8	1.8	1.8	2.3	2.3	2.3
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	5.5	5.5	5.5	5.6	5.6	
Lead/Lag	Lead		Lag	Lag			
Lead-Lag Optimize?	Yes		Yes	Yes			
Recall Mode	Max	Max	Max	Max	Min	Min	Min
Act Effct Green (s)	44.4	41.9	30.9	30.9	10.9	10.9	
Actuated g/C Ratio	0.69	0.66	0.48	0.48	0.17	0.17	
v/c Ratio	0.35	0.42	0.45	0.13	0.40	0.27	
Control Delay	5.5	6.1	12.1	2.8	29.0	1.3	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	5.5	6.1	12.1	2.8	29.0	1.3	
LOS	A	A	B	A	C	A	
Approach Delay		6.0	11.0				
Approach LOS		A	B				

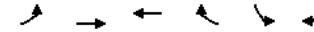
Intersection Summary

Cycle Length: 80
 Actuated Cycle Length: 63.9
 Natural Cycle: 80
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.45
 Intersection Signal Delay: 8.6 Intersection LOS: A
 Intersection Capacity Utilization 72.6% ICU Level of Service C
 Analysis Period (min) 15

Splits and Phases: 1: Smith Road/Kitty Murray Lane & Garner Road



Queues 2027 Total PM Peak Hour - Remedial
1: Smith Road/Kitty Murray Lane & Garner Road 200224



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Group Flow (vph)	186	967	769	112	94	137
v/c Ratio	0.35	0.42	0.45	0.13	0.40	0.27
Control Delay	5.5	6.1	12.1	2.8	29.0	1.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	5.5	6.1	12.1	2.8	29.0	1.3
Queue Length 50th (m)	5.8	23.6	30.0	0.0	10.6	0.0
Queue Length 95th (m)	13.9	40.5	48.0	7.3	23.0	0.0
Internal Link Dist (m)		75.7	599.0			
Turn Bay Length (m)	55.0			40.0	30.0	30.0
Base Capacity (vph)	528	2298	1710	838	584	838
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.35	0.42	0.45	0.13	0.16	0.16

Intersection Summary

HCM Signalized Intersection Capacity Analysis
1: Smith Road/Kitty Murray Lane & Garner Road

2027 Total PM Peak Hour - Remedial
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔
Traffic Volume (vph)	167	870	0	0	692	101	0	0	0	85	0	123
Future Volume (vph)	167	870	0	0	692	101	0	0	0	85	0	123
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	5.5			5.5	5.5				5.6		5.6
Lane Util. Factor	1.00	0.95			0.95	1.00				1.00		1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00				1.00		0.99
Flpb, ped/bikes	1.00	1.00			1.00	1.00				1.00		1.00
Frt	1.00	1.00			1.00	0.85				1.00		0.85
Fit Protected	0.95	1.00			1.00	1.00				0.95		1.00
Satd. Flow (prot)	1787	3505			3539	1615				1736		1594
Fit Permitted	0.29	1.00			1.00	1.00				0.76		1.00
Satd. Flow (perm)	536	3505			3539	1615				1383		1594
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	186	967	0	0	769	112	0	0	0	94	0	137
RTOR Reduction (vph)	0	0	0	0	0	58	0	0	0	0	0	114
Lane Group Flow (vph)	186	967	0	0	769	54	0	0	0	94	0	23
Confl. Peds. (#/hr)							1					1
Heavy Vehicles (%)	1%	3%	0%	0%	2%	0%	0%	0%	0%	4%	0%	0%
Turn Type	pm+pt	NA	Perm	Perm	NA	Perm	Perm	Perm	Perm	Perm	Perm	Perm
Protected Phases	1	6			2			8			4	
Permitted Phases	6		6	2		2		8		4		4
Actuated Green, G (s)	41.9	41.9			30.9	30.9				10.9		10.9
Effective Green, g (s)	41.9	41.9			30.9	30.9				10.9		10.9
Actuated g/C Ratio	0.66	0.66			0.48	0.48				0.17		0.17
Clearance Time (s)	3.0	5.5			5.5	5.5				5.6		5.6
Vehicle Extension (s)	3.0	3.0			3.0	3.0				3.0		3.0
Lane Grp Cap (vph)	508	2298			1711	780				235		271
v/s Ratio Prot	0.05	c0.28			0.22							
v/s Ratio Perm	0.19					0.03				c0.07		0.01
v/c Ratio	0.37	0.42			0.45	0.07				0.40		0.09
Uniform Delay, d1	4.8	5.2			10.9	8.8				23.6		22.3
Progression Factor	1.00	1.00			1.00	1.00				1.00		1.00
Incremental Delay, d2	2.0	0.6			0.9	0.2				1.1		0.1
Delay (s)	6.8	5.8			11.7	9.0				24.7		22.4
Level of Service	A	A			B	A				C		C
Approach Delay (s)		6.0			11.4			0.0				23.4
Approach LOS		A			B			A				C
Intersection Summary												
HCM 2000 Control Delay		9.8			HCM 2000 Level of Service					A		
HCM 2000 Volume to Capacity ratio		0.44										
Actuated Cycle Length (s)		63.9			Sum of lost time (s)				14.1			
Intersection Capacity Utilization		72.6%			ICU Level of Service				C			
Analysis Period (min)		15										

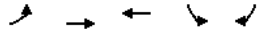
HCM Unsignalized Intersection Capacity Analysis
2: Private Driveway/Springbrook Avenue & Garner Road

2027 Total PM Peak Hour - Remedial
200224

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔
Traffic Volume (veh/h)	126	864	2	1	749	45	0	0	1	47	1	53
Future Volume (Veh/h)	126	864	2	1	749	45	0	0	1	47	1	53
Sign Control	Free			Free			Stop			Stop		
Grade	0%			0%			0%			0%		
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	134	919	2	1	797	48	0	0	1	50	1	56
Pedestrians												1
Lane Width (m)												3.6
Walking Speed (m/s)												1.2
Percent Blockage												0
Right turn flare (veh)												
Median type	TWLTL			TWLTL								
Median storage (veh)	2			2								
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	846			921			1645	2036	460	1552	2013	424
vC1, stage 1 conf vol							1188	1188		824	824	
vC2, stage 2 conf vol							457	848		728	1189	
vCu, unblocked vol	846			921			1645	2036	460	1552	2013	424
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)							6.5	5.5		6.5	5.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	83			100			100	100	100	79	99	90
cM capacity (veh/h)	799			750			155	166	553	235	190	584
Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1	SB 2			
Volume Total	134	613	308	1	531	314	1	50	57			
Volume Left	134	0	0	1	0	0	0	50	0			
Volume Right	0	0	2	0	0	48	1	0	56			
cSH	799	1700	1700	750	1700	1700	553	235	564			
Volume to Capacity	0.17	0.36	0.18	0.00	0.31	0.18	0.00	0.21	0.10			
Queue Length 95th (m)	4.8	0.0	0.0	0.0	0.0	0.0	0.0	6.3	2.7			
Control Delay (s)	10.4	0.0	0.0	9.8	0.0	0.0	11.5	24.4	12.1			
Lane LOS	B			A			B	C	B			
Approach Delay (s)	1.3			0.0			11.5	17.8				
Approach LOS							B	C				
Intersection Summary												
Average Delay							1.7					
Intersection Capacity Utilization							48.4%		ICU Level of Service		A	
Analysis Period (min)							15					

Timings
3: Garner Road & Raymond Road

2027 Total PM Peak Hour - Remedial
200224



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations	↘	↕	↕	↘	↘
Traffic Volume (vph)	87	1187	800	106	57
Future Volume (vph)	87	1187	800	106	57
Turn Type	pm+pt	NA	NA	Prot	Prot
Protected Phases	5	2	6	8	8
Permitted Phases	2				
Detector Phase	5	2	6	8	8
Switch Phase					
Minimum Initial (s)	5.0	30.0	30.0	10.0	10.0
Minimum Split (s)	8.0	36.0	36.0	22.9	22.9
Total Split (s)	9.0	47.0	38.0	23.0	23.0
Total Split (%)	12.9%	67.1%	54.3%	32.9%	32.9%
Yellow Time (s)	3.0	3.5	3.5	3.3	3.3
All-Red Time (s)	0.0	2.5	2.5	2.6	2.6
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	3.0	6.0	6.0	5.9	5.9
Lead/Lag	Lead		Lag		
Lead-Lag Optimize?	Yes		Yes		
Recall Mode	None	Max	Max	None	None
Act Effct Green (s)	47.1	45.3	38.1	10.7	10.7
Actuated g/C Ratio	0.74	0.71	0.60	0.17	0.17
v/c Ratio	0.22	0.51	0.50	0.38	0.19
Control Delay	4.7	6.6	10.7	27.4	8.7
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	4.7	6.6	10.7	27.4	8.7
LOS	A	A	B	C	A
Approach Delay		6.5	10.7	20.9	
Approach LOS		A	B	C	

Intersection Summary

Cycle Length: 70
 Actuated Cycle Length: 63.4
 Natural Cycle: 70
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.51
 Intersection Signal Delay: 9.2
 Intersection Capacity Utilization 53.7%
 Analysis Period (min) 15

Intersection LOS: A
 ICU Level of Service A

Splits and Phases: 3: Garner Road & Raymond Road



Queues
3: Garner Road & Raymond Road

2027 Total PM Peak Hour - Remedial
200224

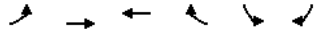


Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	95	1290	1045	115	62
v/c Ratio	0.22	0.51	0.50	0.38	0.19
Control Delay	4.7	6.6	10.7	27.4	8.7
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	4.7	6.6	10.7	27.4	8.7
Queue Length 50th (m)	2.9	37.7	41.4	12.8	0.0
Queue Length 95th (m)	7.6	61.1	64.7	26.3	8.8
Internal Link Dist (m)		582.4	90.6	133.1	
Turn Bay Length (m)	35.0			40.0	
Base Capacity (vph)	428	2527	2082	486	472
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.22	0.51	0.50	0.24	0.13

Intersection Summary

HCM Signalized Intersection Capacity Analysis
3: Garner Road & Raymond Road

2027 Total PM Peak Hour - Remedial
200224



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↘	↗↗	↗↗		↘	↗
Traffic Volume (vph)	87	1187	800	161	106	57
Future Volume (vph)	87	1187	800	161	106	57
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	6.0	6.0		5.9	5.9
Lane Util. Factor	1.00	0.95	0.95		1.00	1.00
Frt	1.00	1.00	0.97		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1805	3539	3434		1805	1583
Flt Permitted	0.21	1.00	1.00		0.95	1.00
Satd. Flow (perm)	397	3539	3434		1805	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	95	1290	870	175	115	62
RTOR Reduction (vph)	0	0	19	0	0	54
Lane Group Flow (vph)	95	1290	1026	0	115	8
Heavy Vehicles (%)	0%	2%	3%	0%	0%	2%
Turn Type	pm+pt	NA	NA		Prot	Prot
Protected Phases	5	2	6		8	8
Permitted Phases	2					
Actuated Green, G (s)	44.7	44.7	36.9		8.7	8.7
Effective Green, g (s)	44.7	44.7	36.9		8.7	8.7
Actuated g/C Ratio	0.68	0.68	0.57		0.13	0.13
Clearance Time (s)	3.0	6.0	6.0		5.9	5.9
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	375	2422	1940		240	210
v/s Ratio Prot	0.02	c0.36	0.30		c0.06	0.01
v/s Ratio Perm	0.15					
v/c Ratio	0.25	0.53	0.53		0.48	0.04
Uniform Delay, d1	4.3	5.1	8.8		26.2	24.7
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.4	0.8	1.0		1.5	0.1
Delay (s)	4.6	6.0	9.8		27.7	24.7
Level of Service	A	A	A		C	C
Approach Delay (s)	5.9		9.8		26.7	
Approach LOS	A		A		C	

Intersection Summary			
HCM 2000 Control Delay	8.9	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	65.3	Sum of lost time (s)	14.9
Intersection Capacity Utilization	53.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
4: Springbrook Avenue & Driveway A

2027 Total PM Peak Hour - Remedial
200224



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↘		↗		↘	↗
Traffic Volume (veh/h)	3	1	100	6	1	62
Future Volume (Veh/h)	3	1	100	6	1	62
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	1	109	7	1	67
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	182	112			116	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	182	112			116	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	807	940			1473	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	4	116	68
Volume Left	3	0	1
Volume Right	1	7	0
cSH	837	1700	1473
Volume to Capacity	0.00	0.07	0.00
Queue Length 95th (m)	0.1	0.0	0.0
Control Delay (s)	9.3	0.0	0.1
Lane LOS	A		A
Approach Delay (s)	9.3	0.0	0.1
Approach LOS	A		

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	15.6%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
5: Springbrook Avenue & Driveway B

2027 Total PM Peak Hour - Remedial
200224

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↔		↔			↔
Traffic Volume (veh/h)	5	0	106	8	0	65
Future Volume (Veh/h)	5	0	106	8	0	65
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	0	115	9	0	71
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None		None	
Median storage (veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	190	120			124	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	190	120			124	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	100			100	
cM capacity (veh/h)	798	932			1463	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	5	124	71			
Volume Left	5	0	0			
Volume Right	0	9	0			
cSH	798	1700	1463			
Volume to Capacity	0.01	0.07	0.00			
Queue Length 95th (m)	0.2	0.0	0.0			
Control Delay (s)	9.5	0.0	0.0			
Lane LOS	A					
Approach Delay (s)	9.5	0.0	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay		0.2				
Intersection Capacity Utilization		16.1%	ICU Level of Service	A		
Analysis Period (min)		15				

HCM Unsignalized Intersection Capacity Analysis
6: Garner Road & Driveway C

2027 Total PM Peak Hour - Remedial
200224

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↔	↕	↕	↔	↔	↔
Traffic Volume (veh/h)	10	902	863	5	6	3
Future Volume (Veh/h)	10	902	863	5	6	3
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	980	938	5	7	3
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		TWLTL	TWLTL			
Median storage (veh)		2	2			
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	943				1452	472
vC1, stage 1 conf vol					940	
vC2, stage 2 conf vol					512	
vCu, unblocked vol	943				1452	472
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)					5.8	
tF (s)	2.2				3.5	3.3
p0 queue free %	98				98	99
cM capacity (veh/h)	723				301	539
Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1
Volume Total	11	490	490	625	318	10
Volume Left	11	0	0	0	0	7
Volume Right	0	0	0	0	5	3
cSH	723	1700	1700	1700	1700	347
Volume to Capacity	0.02	0.29	0.29	0.37	0.19	0.03
Queue Length 95th (m)	0.4	0.0	0.0	0.0	0.0	0.7
Control Delay (s)	10.1	0.0	0.0	0.0	0.0	15.7
Lane LOS	B					C
Approach Delay (s)	0.1			0.0		15.7
Approach LOS						C
Intersection Summary						
Average Delay		0.1				
Intersection Capacity Utilization		34.9%	ICU Level of Service	A		
Analysis Period (min)		15				

Appendix G

OTM Signal Justification 7 Warrant Analysis



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



Horizon Year: 2027
 Region/City/Township: Hamilton

Major Street: Garner Road East North/South?: N
 Minor Street: Springbrook Avenue

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

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

Time Period	Major Street Garner Road East						Minor Street Springbrook Avenue						Peds Crossing Main Road
	Eastbound			Westbound			Northbound			Southbound			
	Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
AM Peak Hour	41	558	1	0	663	21	3	1	0	52	0	130	0
PM Peak Hour	126	864	2	1	749	45	0	0	1	47	1	53	2
Average Hourly Volume	42	356	1	0	353	17	1	0	0	25	0	46	1

Warrant	AHV
1A - All	840
1B - Minor	72
2A - Major	768
2B - Cross	26

Warrant 1 - Minimum Vehicular Volume

1A	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
		480	720	600	900	840
	All Approaches	% Fulfilled				116.6%

1B	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
	Minor Street Approaches	120	170	120	170	72
		% Fulfilled				42.4%

Warrant 2 - Delay To Cross Traffic

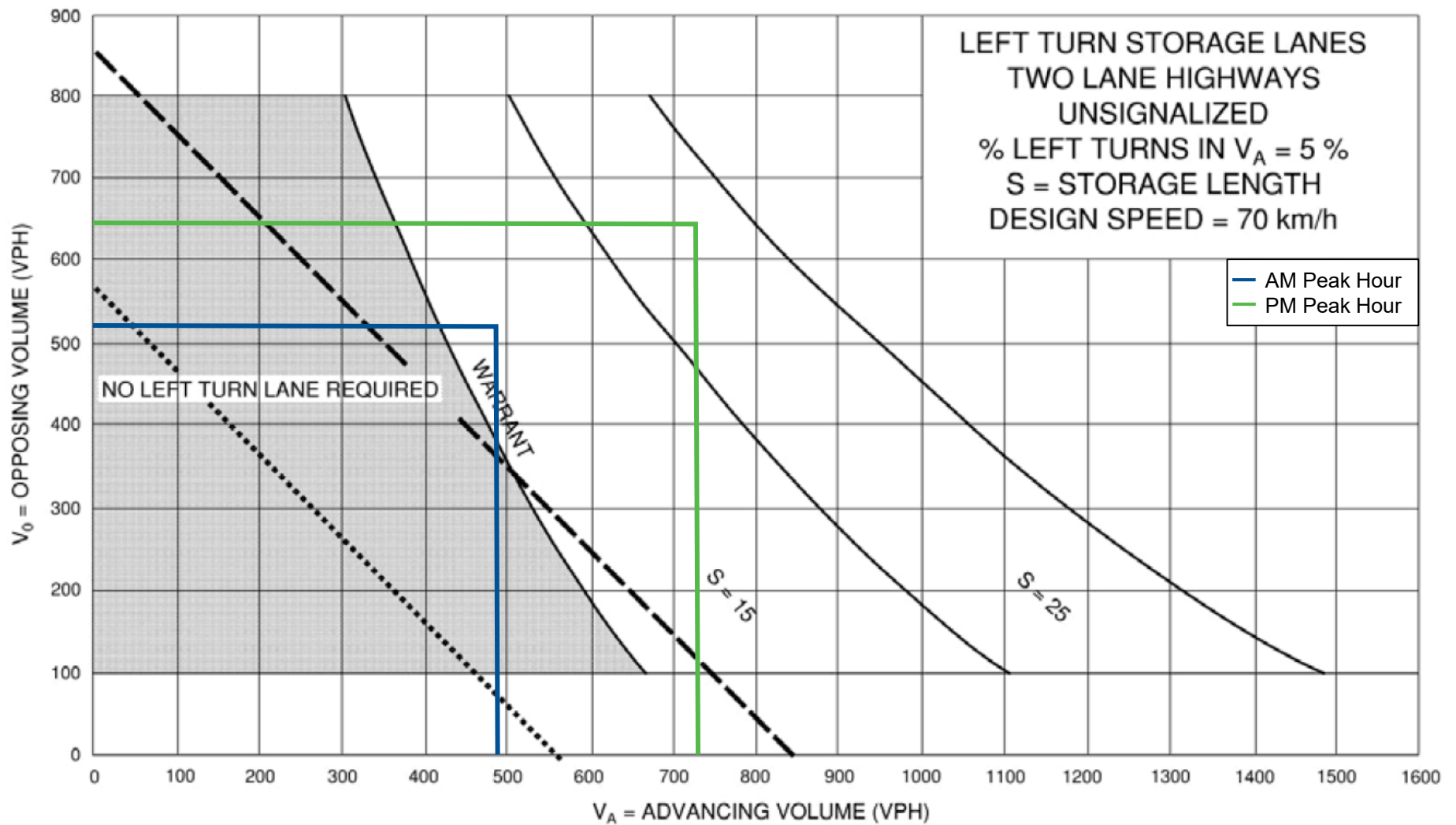
2A	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
	Major Street Approaches	480	720	600	900	768
		% Fulfilled				106.6%

2B	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
	Traffic Crossing Major Street	50	75	50	75	26
		% Fulfilled				35.0%

Appendix H

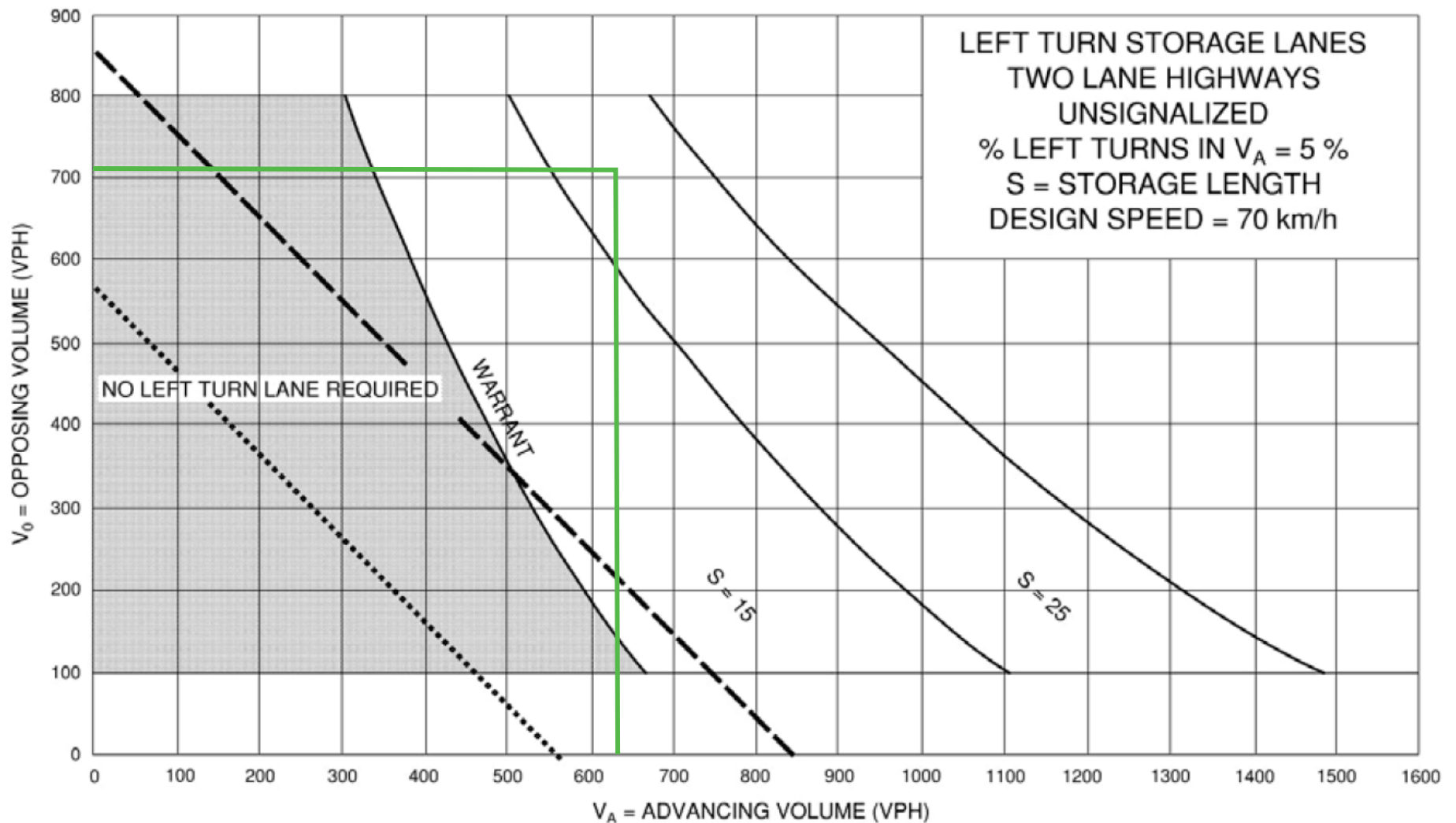
Left-Turn Lane Warrant Nomographs





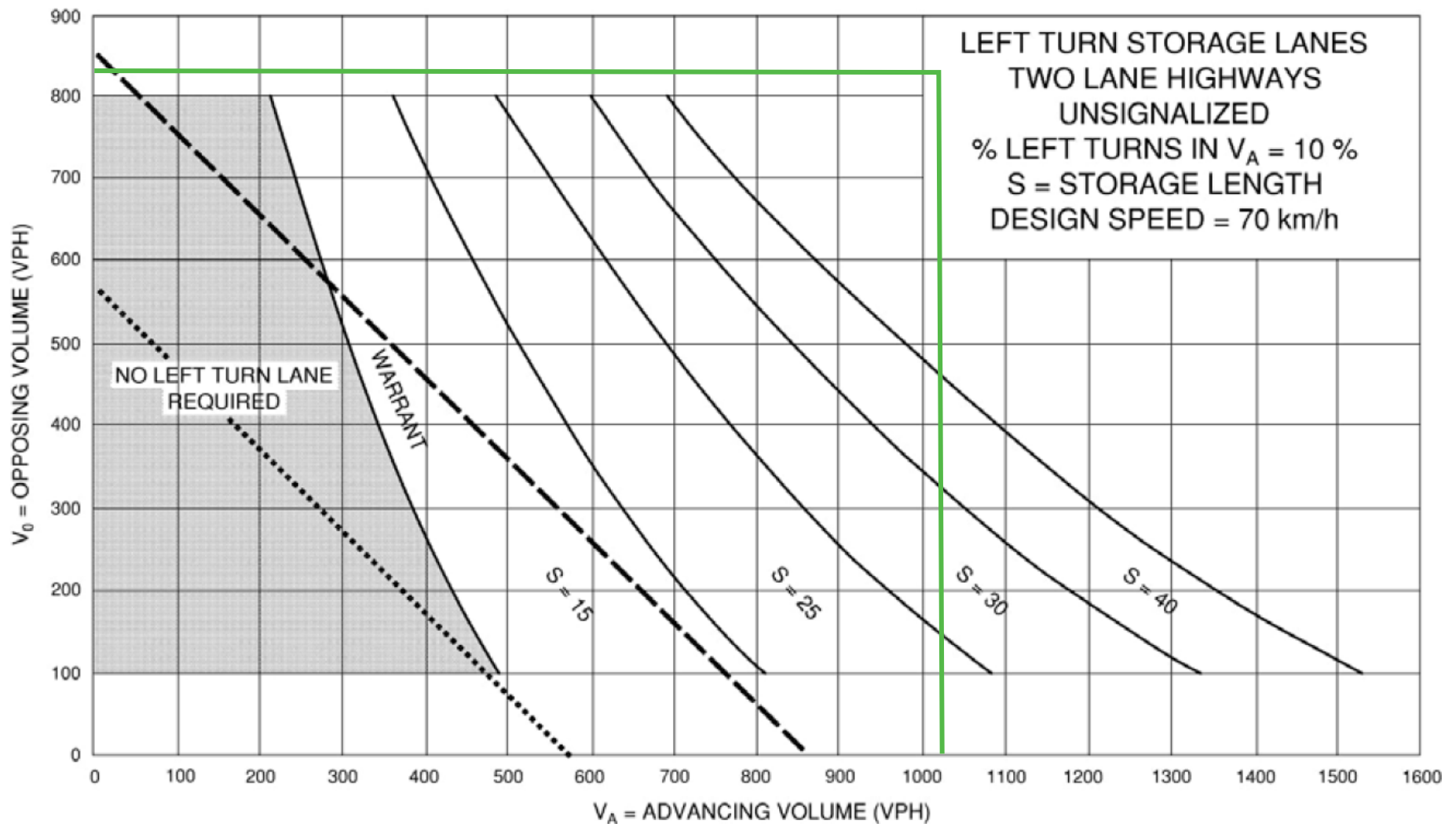
Location:
Direction:
Horizon Year:

Garner Road at Springbrook Avenue
Eastbound Left-Turn Lane
Base Year (2020)



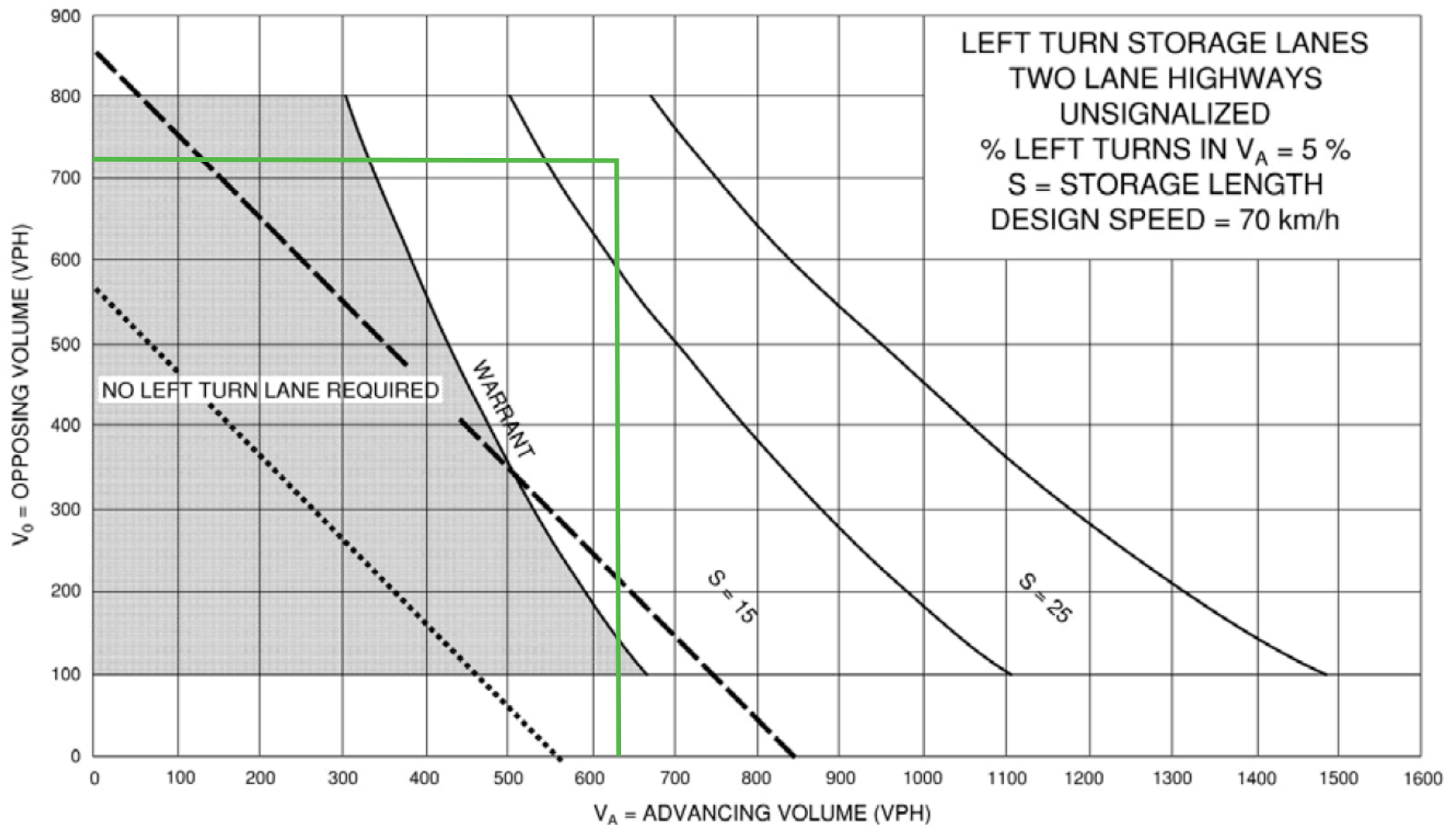
Location:
Direction:
Horizon Year:

Garner Road at Springbrook Avenue
Eastbound Left-Turn Lane
Background 5 Years (2027) – AM Peak Hour



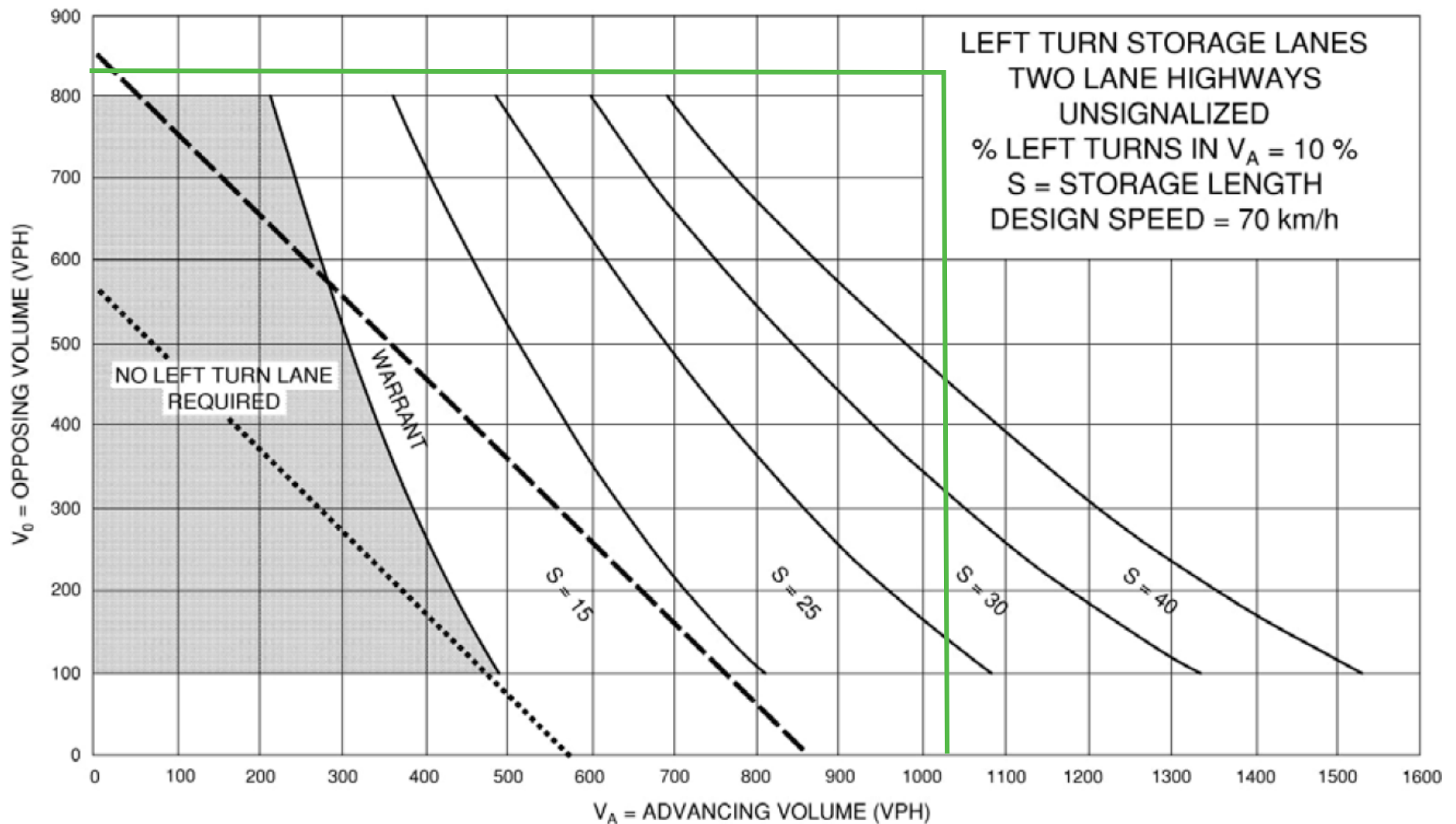
Location:
Direction:
Horizon Year:

Garner Road at Springbrook Avenue
Eastbound Left-Turn Lane
Background 5 Years (2027) – PM Peak Hour



Location:
Direction:
Horizon Year:

Garner Road at Springbrook Avenue
Eastbound Left-Turn Lane
Total 5 Years (2027) – AM Peak Hour



Location:
Direction:
Horizon Year:

**Garner Road at Springbrook Avenue
Eastbound Left-Turn Lane
Total 5 Years (2027) – PM Peak Hour**