



## TRAFFIC STUDY

# Asbury Road Corridor City of Asbury, IA



Prepared for:  
City of Asbury



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**MSA**

January 2020

TRAFFIC STUDY FOR:

Asbury Road Corridor  
CITY OF ASBURY, IOWA

DATE SUBMITTED:

January 2020

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# Chapter 1 – INTRODUCTION & EXISTING CONDITIONS

## PART A – INTRODUCTION

At the request of the City of Asbury, MSA Professional Services (MSA) has conducted a traffic study for a portion of the Asbury Road corridor. Asbury Road is the primary east-west corridor through the City of Asbury (City), as shown in Figure 1-1.

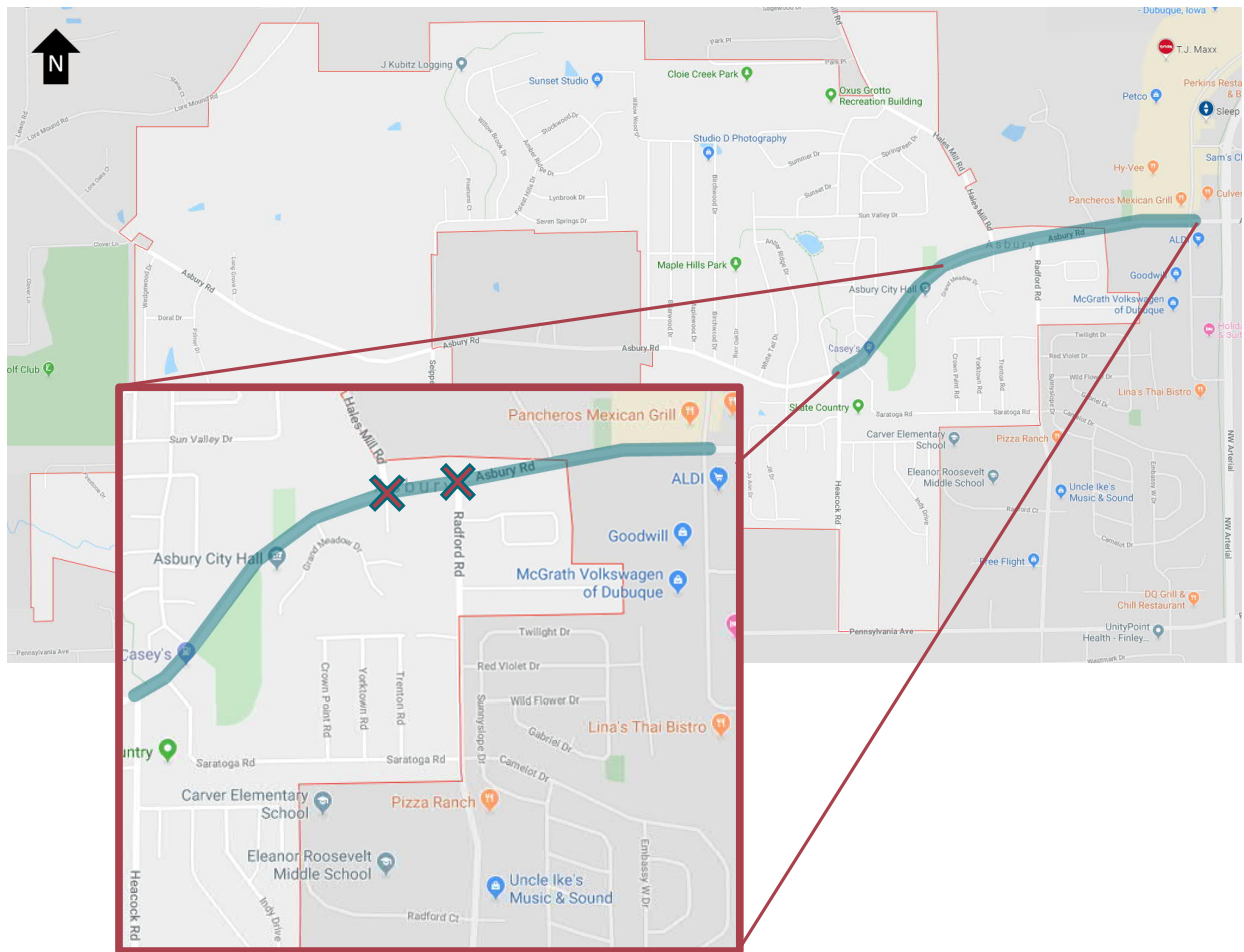


Figure 1-1, City of Asbury and Asbury Road corridor overview

The limits of the original study were from Heacock Road on the western end to Holiday Drive on the eastern end, as highlighted in Figure 1-1. After further review and discussion with the City, the focus of the study was narrowed to a portion of Asbury Road between the intersections with Hales Mill Road and Radford Road, denoted by the 'X's in Figure 1-1. The corridor experiences significant congestion during the peak hours, with queues that back into adjacent intersections and block numerous driveways, in addition to exceeding the dedicated storage at Radford Road. The poor operations cause drivers to accept smaller gaps, which create additional safety issues.

## PART B – EXISTING CONDITIONS

Asbury Road is a two-lane urban roadway with a center two-way left-turn lane (TWLTL) and a posted speed of 35-mph.

### B1. Hales Mill Road

Hales Mill Road is an urban two-lane roadway with a posted speed of 35-mph. At the intersection with Asbury Road, it widens to include a dedicated left and right turn lane, with an approximate turn lane lengths of 150-feet. The TWLTL along Asbury Road transitions into a dedicated eastbound left-turn lane with an approximate turn lane length of 50-feet. The intersection with Asbury Road is controlled by a stop sign on Hales Mill Road, a one way stop control (OWSC).

### B2. Radford Road

Radford Road is an urban two-lane roadway with bike lanes in both directions and a posted speed of 35-mph. At the intersection with Asbury Road, it widens to include a dedicated left and right turn lane, with an approximate turn lane length of 150-feet. The TWLTL along Asbury Road transitions into a dedicated westbound left-turn lane with an approximate turn lane length of 75-feet. The intersection with Asbury Road is controlled by a OWSC, with Radford Road stopping.

## PART C - TRAFFIC

Traffic counts were collected at the study intersections on Wednesday, May 15<sup>th</sup>, 2019. Twelve-hours of traffic volumes were collected at each of the study intersections, in order to cover the peak hours (7 – 8 AM, noon – 1 PM, and 4 – 5 PM) and cover the required number of hours to complete traffic signal warrants. Full traffic volume data is included in Appendix A.

To account for growth and analyze future traffic needs, background volumes were grown linearly from the 2019 counts. Growth rates were established based on data provided by the East Central Intergovernmental Association (ECIA). The following rates were used:

Asbury Road	
West of Radford Road	1.5%
Radford Road – Holiday Drive	1.0%
Hales Mill Road	3.0%
Radford Road	0.5%

Growth horizons of 2029 and 2039 were used to assess future conditions. Forecasted traffic counts are included in Appendix A.

## PART D - CRASHES

MSA worked with ECIA to gather crash data for the corridor. Per communications received from ECIA, the number of crashes that have occurred is low and would not be high enough to trigger any safety-based projects or funding. Based on that information, no further safety analysis was completed.

## PART E – OPERATIONAL ANALYSIS

Traffic volumes were analyzed using Synchro/SimTraffic 10 software, utilizing Highway Capacity Manual (HCM) 6<sup>th</sup> Edition thresholds. Queue lengths are reported at the 95<sup>th</sup> percentile. Full operational output is included in Appendix B. This type of analysis assigns a Level of Service (LOS) to each movement or lane, depending on the geometric configuration. LOS is a quantitative measure that refers to the overall quality of flow at an intersection ranging from very good, LOS “A,” to very poor, LOS “F,” as shown in

Table 1-1. The delay is measured in seconds per vehicle, which can be used to determine the LOS for the intersection. LOS is not necessarily tied solely to delay. Since an intersection has other influences outside the method of control, other factors may cause excessive congestion. In cases where there is excessive congestion not directly correlated to the control method of the intersection, the approach will automatically be assigned LOS F.

Table 1-1, HCM LOS Definitions

LOS	Unsignalized Average Control Delay (seconds/vehicle)	Signalized Average Control Delay (seconds/vehicle)
A "best"	0–10	0–10
B	>10–15	>10–20
C	>15–25	>20–35
D	>25–35	>35–55
E	>35–50	>55–80
F "worst"	>50	>80

## E1. 2019 Traffic Volumes

Table 1-2 shows a summary of the traffic analysis results for the 2019 volumes with the existing corridor geometries. Both intersections are unsignalized, with stop control on the side streets (Radford Road, Hales Mills Road).

Table 1-2, 2019 Existing Operations, Existing Configuration

Intersection	Peak Hour	Parameters	West Approach			East Approach			South Approach			North Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Radford Road		Lanes	1-Shared			1	1		1		1			
	AM	LOS	A			B	A		F		F			
		Delay (s)	0.0			13.1	0.0		75.8		81.1			
		Queue (ft)	0			25	0		25		225			
	PM	LOS	A			A	A		F		C			
		Delay (s)	0.0			9.8	0.0		81.4		19.0			
		Queue (ft)	0			25	0		25		75			
Hales Mill Road		Lanes	1	1		1-Shared						1		1
	AM	LOS	A	A		A						F		A
		Delay (s)	7.9	0.0		0.0						141.2		9.9
		Queue (ft)	0	0		0						325		25
	PM	LOS	A	A		A						F		B
		Delay (s)	9.7	0		0.0						60.2		14.1
		Queue (ft)	25	0		0						100		25

LOS source: HCM 6<sup>th</sup> Edition, Unsignalized Intersections  
Queue represents 95<sup>th</sup> percentile queue per lane, 25-feet per vehicle

### Asbury Road at Radford Road

As shown in Table 1-2, the lanes of the northbound approach operate at LOS F in the AM peak hour; the left lane operates at LOS F in the PM peak hour.

### Asbury Road at Hales Mill Road

The left lane of the southbound approach operates at LOS F for both peak hours.

For both intersections, the delays on the stop controlled side road are excessive and require intersection improvements to operate at an acceptable level.

## E2. 2029 Traffic Volumes

Table 1-3 shows a summary of the traffic analysis results for the 2029 volumes with the existing corridor geometries. Both intersections are unsignalized, with stop control on the side streets (Radford Road, Hales Mills Road). The operations were showing unacceptable LOS and delay for the stop-controlled side roads for the 2019 analysis and further deterioration occurs quickly if not addressed.

Table 1-3, 2029 Projected Operations, Existing Configuration

Intersection	Peak Hour	Parameters	West Approach			East Approach			South Approach			North Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Radford Road		Lanes	1-Shared			1	1		1		1			
	AM	LOS	A			C	A		F		F			
		Delay (s)	0.0			16.3	0.0		157.6		202.6			
		Queue (ft)	0			50	0		25		375			
	PM	LOS	A			B	A		F		C			
		Delay (s)	0.0			10.6	0.0		148.4		24.6			
Queue (ft)		0			25	0		25		100				
Hales Mill Road		Lanes	1	1		1-Shared						1	1	
	AM	LOS	A	A		A						F	A	
		Delay (s)	8.1	0.0		0.0						431.4	10.2	
		Queue (ft)	25	0		0						650	25	
	PM	LOS	B	A		A						F	C	
		Delay (s)	10.3	0		0.0						195.5	16.0	
		Queue (ft)	25	0		0						225	25	
LOS source: HCM 6 <sup>th</sup> Edition, Unsignalized Intersections														
Queue represents 95 <sup>th</sup> percentile queue per lane, 25-feet per vehicle														

## Chapter 2 – RADFORD ROAD INTERSECTION ALTERNATIVE DEVELOPMENT

Initial focus was placed on correcting operational issues at the Radford Road intersection with Asbury Road. This intersection was the initial focus, due to proposed development north of the intersection.

### PART A – METHODOLOGY

Several alternatives were identified as potential options to improve operations at the Radford Road intersection:

- Alternative 1: Traffic signal with existing lanes/geometry
- Alternative 2: Traffic signal with two eastbound lanes
- Alternative 3: Mini roundabout
- Alternative 4: Single-lane roundabout
- Alternative 5: Multilane roundabout

These alternatives were first analyzed at the Asbury Road at Radford Road intersection for the 2019, 2029, and 2039 horizons. If the alternative did not operate at acceptable levels in a horizon year subsequent horizon years were not evaluated.

Traffic volumes for signalized intersection controls were analyzed using Synchro/SimTraffic 10 software, utilizing HCM 6<sup>th</sup> Edition thresholds. Queue lengths are reported at the 95<sup>th</sup> percentile. For roundabout alternatives, ARCADY software was used, with HCM 6<sup>th</sup> Edition LOS thresholds and 95<sup>th</sup> percentile queues. SIDRA and HCS software was used for comparison purposes. SIDRA analyses were completed with HCM 6<sup>th</sup> Edition thresholds but without geometric delay parameters. The SIDRA computational engine was used to establish delay and queue results. HCS was used when possible, as HCS is not currently capable of mini roundabout analysis. SIDRA and HCS roundabout results are included in Appendix C.

Full operational analysis results are included in Appendix C.

### PART B – ALTERNATIVE ANALYSIS

#### B1. Alternative 1, Traffic Signal with Existing Lanes/Geometry

This alternative would add traffic signal controls to the intersection of Asbury Road at Radford Road, while maintaining the existing pavement and lane configurations. No geometric or operational improvements would be realized at the Hales Mill Road intersection under this alternative.

A summary of the operational analysis is shown in Table 2-1.

Table 2-1, Projected Operations, Existing Configuration with Traffic Signals at Radford Road

Year	Peak Hour	Parameters	West Approach			East Approach			South Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT
2019		Lanes	1-Shared			1	1		1		1
	AM	LOS	C			D	A		C		D
		Delay (s)	32.4			36.0	4.1		32.4		53.0
		Queue (ft)	800			175	75		25		150
		PM	LOS	C			B	B		B	
	Delay (s)		21.2			11.6	10.2		17.6		16.5
	Queue (ft)		350			50	300		25		50
2029		Lanes	1-Shared			1	1		1		1
	AM	LOS		F		E	A		D		E
		Delay (s)		47.4		75.1	2.6		50.8		77.4
		Queue (ft)		1200		275	75		25		225
		PM	LOS	C			B	B		C	
	Delay (s)		24.0			14.4	12.4		20.1		20.5
	Queue (ft)			450		75	400		25		75
LOS source: HCM 6 <sup>th</sup> Edition, Signalized Intersections											
Queue represents 95 <sup>th</sup> percentile queue per lane, 25-feet per vehicle											

Under existing 2019 traffic, all approaches are expected to operate at LOS D or better in the AM peak hour. Expected eastbound queues would reach 800-feet, during this peak hour, which would extend several hundred feet beyond the Hales Mill Road intersection. All approaches are expected to operate at LOS C or better in the PM peak hour. Expected eastbound queues would still reach the Hales Mill Road intersection.

Using projected 2029 traffic, the eastbound approach is expected to operate at LOS F and overcapacity during the AM peak hour. The left lane of the westbound approach and the right lane of the northbound approach is expected to operate at LOS E. The right lane of the westbound approach is expected to operate at LOS A; the left lane of the northbound approach is expected to operate at LOS D during the AM peak hour. Expected eastbound queues would reach 1,200-feet, during this peak hour, which would extend several hundred feet upstream of the Hales Mill Road intersection. All approaches are expected to operate at LOS C or better in the PM peak hour. Expected eastbound queues would still reach the Hales Mill Road intersection.

## B2. Alternative 2, Traffic Signal with Two Eastbound Lanes

This alternative would add traffic signal controls to the intersection of Asbury Road at Radford Road, as well as an additional eastbound through lane. The additional lane would begin downstream of the Hales Mill Road intersection; therefore, the lane addition would have negligible impact on operations at the Asbury Road at Hales Mill Road intersection. A lane schematic of this improvement alternative is shown in Figure 2-1.

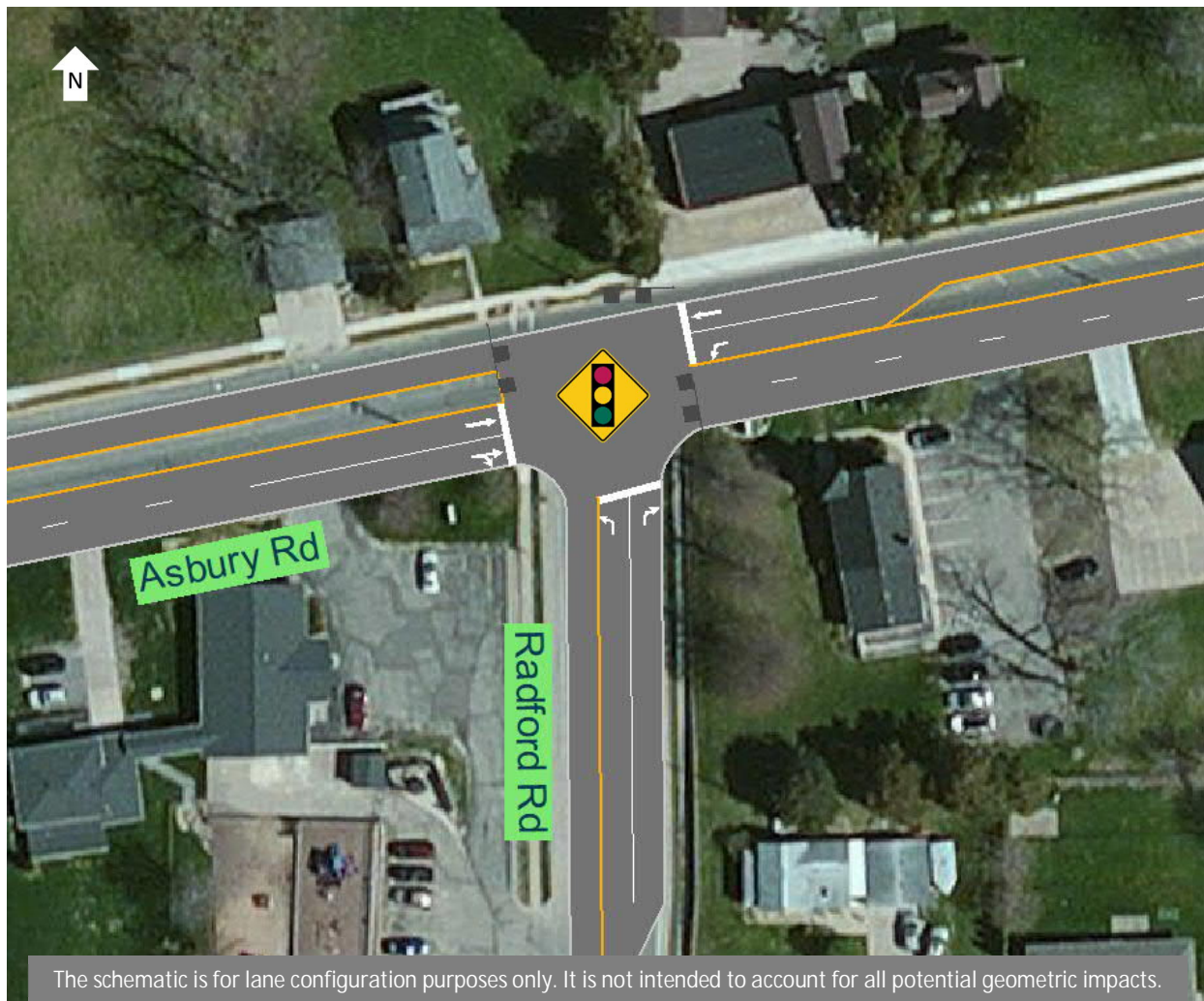


Figure 2-1, Traffic Signal with two eastbound lanes at Radford Road

A summary of the operational analysis is shown in Table 2-2.

Table 2-2, Projected Operations, Two Eastbound Lanes with Traffic Signals at Radford Road

Year	Peak Hour	Parameters	West Approach			East Approach			South Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT
2019		Lanes	1 TH, 1 TH/RT			1	1		1		1
	AM	LOS	B		B	B	A		B		C
		Delay (s)	17.7	17.6	10.5	5.3		19.4		24.7	
		Queue (ft)	225	225	75	75		25		100	
	PM	LOS	B		B	A	B		B		B
		Delay (s)	13.8	13.8	8.7	12.6		14.9		13.2	
Queue (ft)		125	125	50	300		25		50		
2029		Lanes	1 TH, 1 TH/RT			1	1		1		1
	AM	LOS	C		C	B	A		B		C
		Delay (s)	22.5	22.3	13.5	5.5		19.5		21.6	
		Queue (ft)	275	275	100	75		25		125	
	PM	LOS	B		B	A	B		B		B
		Delay (s)	12.1	12.1	8.1	11.2		19.1		19.0	
Queue (ft)		150	150	50	375		25		75		
2039		Lanes	1 TH, 1 TH/RT			1	1		1		1
	AM	LOS	C		C	B	A		C		C
		Delay (s)	21.8	21.8	18.1	5.0		23.6		31.4	
		Queue (ft)	375	375	125	100		25		150	
	PM	LOS	B		B	A	B		C		C
		Delay (s)	11.4	11.4	8.0	13.5		23.7		26.2	
Queue (ft)		175	175	50	500		25		125		
LOS source: HCM 6 <sup>th</sup> Edition, Signalized Intersections											
Queue represents 95 <sup>th</sup> percentile queue per lane, 25-feet per vehicle											

Under existing 2019 and projected 2029 traffic, all approaches are expected to operate at LOS C or better in both peak hours.

Using projected 2039 traffic, all approaches are expected to operate at LOS C or better in both peak hours. Expected eastbound queues would reach 375-feet, during this peak hour, which would begin to encroach on the Hales Mill Road intersection.

### B3. Alternative 3, Mini Roundabout

This alternative would convert the existing intersection of Asbury Road at Radford Road into a mini roundabout. A mini roundabout is smaller than a traditional roundabout with a circle diameter of 90 – 110-feet, with a central island that is fully traversable to allow truck movements. No geometric improvements would be completed at the Hales Mill Road intersection under this alternative; however, minor operational changes may be noticed.

Table 2-3 shows the traffic analyses for the 2019 volumes.

Table 2-3, 2019 Projected Operations, Mini Roundabout at Radford Road

Year	Peak Hour	Parameters	West Approach			East Approach			South Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT
2019		Lanes	1-Shared			1-Shared			1-Shared		
	AM	LOS	F			A			B		
		Delay (s)	81.1			7.1			12.3		
		Queue (ft)	1950			50			100		
	PM	LOS	B			F			A		
		Delay (s)	10.9			150.2			7.7		
		Queue (ft)	125			2700			75		
LOS source: HCM 6 <sup>th</sup> Edition, Unsignalized Intersections											
Queue represents 95 <sup>th</sup> percentile queue per lane, 25-feet per vehicle											

Under existing traffic, the eastbound approach is expected to operate at LOS F, with a queue that would extend over a thousand feet beyond the Hales Mill Road intersection, in the AM peak hour. All other approaches are expected to operate at LOS B or better for the AM peak hour. The westbound approach is expected to operate at LOS F and overcapacity in the PM peak hour. All other approaches are expected to operate at LOS B or better in the PM peak hour.

#### B4. Alternative 4, Single-lane Roundabout

This alternative would convert the existing intersection of Asbury Road at Radford Road into a single-lane roundabout. Due to the larger size of approximately 120 – 140-feet diameter, single-lane roundabouts are better able to accommodate traffic than mini roundabouts. No geometric improvements would be completed at the Hales Mill Road intersection under this alternative; however, minor operational changes may be noticed.

Table 2-4 shows the traffic analyses for the 2019 volumes.

Table 2-4, 2019 Projected Operations, Single-lane Roundabout at Radford Road

Year	Peak Hour	Parameters	West Approach			East Approach			South Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT
2019		Lanes	1-Shared			1-Shared			1-Shared		
	AM	LOS	F			A			B		
		Delay (s)	52.8			6.2			11.2		
		Queue (ft)	1625			50			100		
	PM	LOS	A			F			A		
		Delay (s)	9.8			75.6			7.1		
		Queue (ft)	75			2075			75		
LOS source: HCM 6 <sup>th</sup> Edition, Unsignalized Intersections											
Queue represents 95 <sup>th</sup> percentile queue per lane, 25-feet per vehicle											

Under existing traffic, the eastbound approach is expected to operate at LOS F, with a queue that would extend several hundred feet upstream of the Hales Mill Road intersection, in the AM peak hour. All other approaches are expected to operate at LOS B or better for the AM peak hour. The westbound

approach is expected to operate at LOS F. All other approaches are expected to operate at LOS A in the PM peak hour.

#### B5. Alternative 5, Multilane Roundabout

This alternative would convert the existing intersection of Asbury Road at Radford Road into a multilane roundabout. Existing eastbound and westbound lanes along Asbury Road would flare from one lane into two lanes upstream of the proposed roundabout. The lanes would merge back to one lane downstream of the roundabout. No geometric improvements would be completed at the Hales Mill Road intersection under this alternative; however, minor operational changes may be noticed. A lane schematic of this improvement alternative is shown in Figure 2-2.

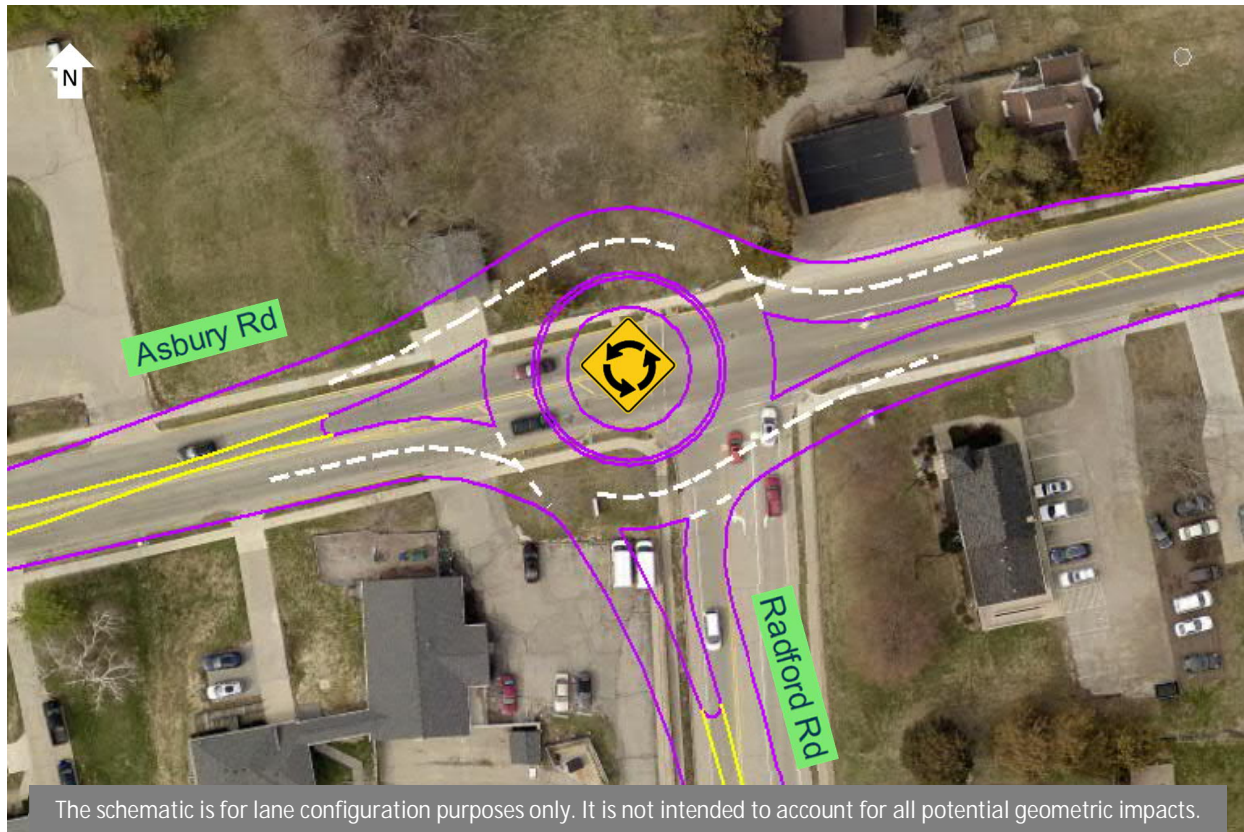


Figure 2-2, Multilane roundabout at Radford Road

A summary of the operational analysis is shown in Table 2-5.

Table 2-5, Projected Operations, Multilane Roundabout at Radford Road

Year	Peak Hour	Parameters	West Approach			East Approach			South Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT
2019		Lanes	1 TH, 1 TH/RT			1 LT/TH, 1 TH			1-Shared		
	AM	LOS	A	A	A	A	B				
		Delay (s)	5.3	5.3	2.9	2.9	10.7				
		Queue (ft)	25	25	25	25	100				
		LOS	A	A	A	A	A				
	PM	Delay (s)	3.6	3.6	5.2	5.2	6.8				
		Queue (ft)	50	50	50	50	75				
2029			Lanes	1 TH, 1 TH/RT			1 LT/TH, 1 TH			1-Shared	
	AM	LOS	A	A	A	A	B				
		Delay (s)	6.3	6.3	2.8	2.8	12.5				
		Queue (ft)	50	50	25	25	100				
		LOS	A	A	A	A	A				
	PM	Delay (s)	3.7	3.7	5.7	5.7	6.9				
		Queue (ft)	25	25	50	50	75				
2039			Lanes	1 TH, 1 TH/RT			1 LT/TH, 1 TH			1-Shared	
	AM	LOS	A	A	A	A	C				
		Delay (s)	9.8	9.8	3.0	3.0	20.7				
		Queue (ft)	175	175	50	50	200				
		LOS	A	A	A	A	A				
	PM	Delay (s)	4.4	4.4	7.6	7.6	8.3				
		Queue (ft)	25	25	100	100	75				
LOS source: HCM 6 <sup>th</sup> Edition, Unsignalized Intersections											
Queue represents 95 <sup>th</sup> percentile queue per lane, 25-feet per vehicle											

Under existing 2019 and projected 2029 traffic, all approaches are expected to operate at LOS B or better for both peak hours. Using projected 2039 traffic, all approaches are expected to operate at LOS C or better for both peak hours.

## PART C – ALTERNATIVES DISCUSSION

Alternatives that failed to improve operations to an acceptable level (LOS D or better) through the 2029 design year and/or did not reduce queue spillback from the Radford Road intersection into the Hales Mill Road intersection were removed from further analysis consideration. Based on these criteria, the following alternatives will not be considered viable and will not be analyzed any further:

- Alternative 1: Traffic Signal with Existing Lanes/Geometry
- Alternative 3: Mini Roundabout
- Alternative 4: Single-lane Roundabout

The following intersection alternatives are projected to improve operations to an acceptable level, and will be considered for further analysis:

- Alternative 2: Traffic Signal with Two Eastbound Lanes
- Alternative 5: Multilane Roundabout.

## Chapter 3 – HALES MILL ROAD INTERSECTION ALTERNATIVE DEVELOPMENT

Since the Radford Road at Asbury Road intersection has lower volumes than the Asbury Road at Hales Mill Road intersection, it was assumed that any Radford Road intersection alternative that did not operate at acceptable levels would not operate better at the Hales Mill Road intersection. Therefore, scenarios were not reanalyzed for the Hales Mill Road intersection, knowing that improvements that are more substantial would be necessary in order to improve operations. Since the alternatives that were acceptable to move forward for further consideration at Radford Road were all significant improvements that would require substantial planning by the City, the study next focused on some possible short term and long-term improvements for both intersections.

## Chapter 4 – SHORT-TERM & LONG-TERM CORRIDOR ALTERNATIVES

### PART A – ALTERNATIVE REFINEMENT

Since the alternatives that were acceptable to move forward for further consideration at Radford Road were all significant improvements that would require substantial planning by the City, the study next focused on some possible short term and long term improvements for both intersections. Short term improvements that were low in cost but would improve operations for 5-10 years were analyzed and larger improvements such as those described in Chapter 2 for Asbury Road were investigated. Based on those criteria, the following alternatives were investigated further:

#### Short-Term

- Traffic Signal at Hales Mill Road with Minor Geometric Improvements
- Traffic Signals at Both Intersections with Existing Lanes/Geometry

#### Long-Term

- Two Eastbound Lanes on Asbury Road with
  - Traffic Signal at Hales Mill Road
  - Traffic Signal at Radford Road
  - Traffic Signal at Both Intersections
- Realign Hales Mill Road and Radford Road into One Intersection with
  - Multilane Roundabout
  - Traffic Signal with Two Eastbound Lanes on Asbury Road

Traffic volumes for signalized intersection controls were analyzed using Synchro/SimTraffic 10 software, utilizing HCM 6<sup>th</sup> Edition thresholds. Queue lengths are reported at the 95<sup>th</sup> percentile. For roundabout alternatives, ARCADY software was used, with HCM 6<sup>th</sup> Edition LOS thresholds and 95<sup>th</sup> percentile queues. Full operational analysis results are included in Appendix D.

### PART B – SHORT-TERM ALTERNATIVE ANALYSIS

Short-term alternatives are intended to be changes that could be made for a lower cost, would have a lower geometric impact, but would only improve the operations for a short time, likely less than 10-years. These alternatives could also be implemented in a relatively quick timeframe. They are not intended to be complete solutions to all corridor issues, and would likely require addition work within the next 10-years.

#### B1. Alternative ST1, Traffic Signal at Hales Mill Road with Minor Geometric Improvements

This alternative would add traffic signal controls to the intersection of Asbury Road at Hales Mill Road, as well as a westbound right-turn lane. In Chapter 3, it was stated that a signal with little geometric improvements was not analyzed at this intersection, since it would likely not operate better than a similar improvement at Radford Road as analyzed in Chapter 2. However, many of the operational issues experienced with the Radford Road signal alternative included queues for eastbound traffic that extended through the Hales Mill Road intersection; therefore, causing increased problems at the Hales Mill Road intersection. By instead adding the signal at Hales Mill Road as a short-term solution, the queues would still be expected to be extensive but they would not interfere with adjacent intersections. Since this analysis was focused on incremental improvements for both intersections, an extension of the

westbound left-turn lane to 300-feet at Radford Road is also recommended to be included. A lane schematic of this improvement alternative is shown in Figure 4-1 and Figure 4-2.

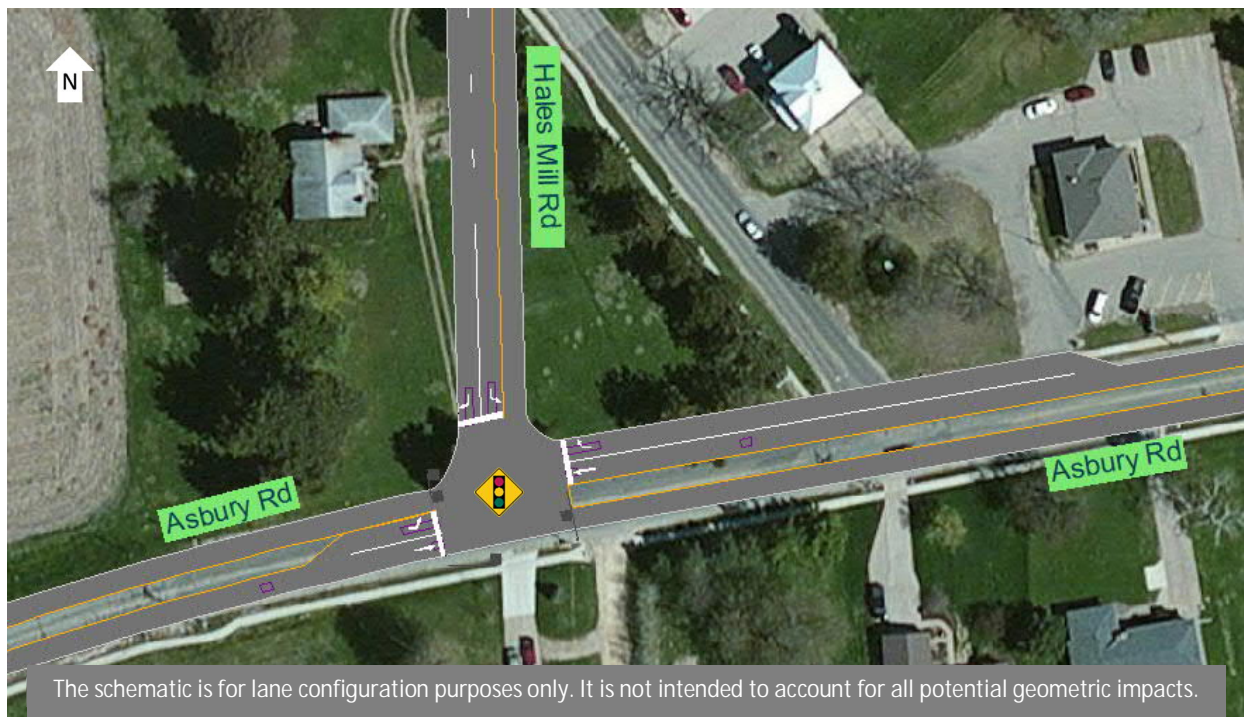


Figure 4-1, Traffic Signal with westbound right-turn lane at Hales Mill Road

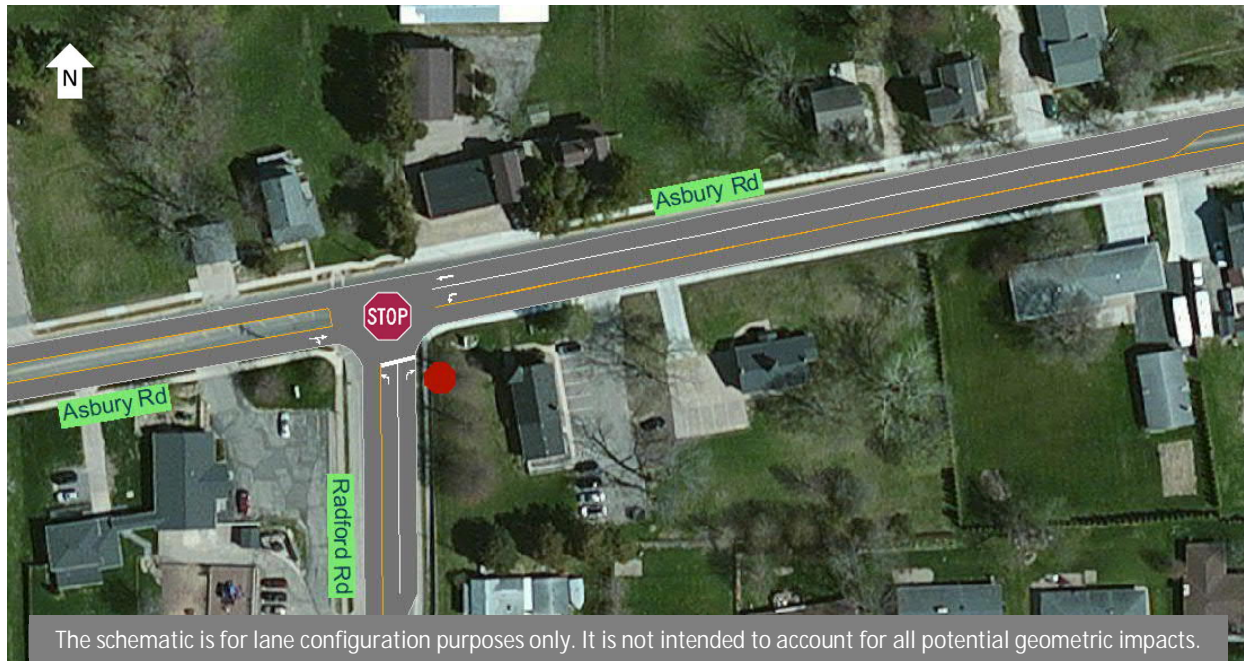


Figure 4-2, Extension of westbound left-turn lane at Radford Road

The addition of the westbound right-turn lane at the Hales Mill Road intersection and the extension of the westbound left-turn lane at the Radford Road intersection are expected to increase capacity and improve safety by removing slower traffic from the through-lanes of traffic.

A traffic signal warrant analysis was completed for the intersection of Hales Mills Road at Asbury Road, using 2019 traffic count data. The Manual on Uniform Traffic Control Devices (MUTCD) contains nine warrants that can be utilized to support the installation of a traffic signal:

- Warrant 1, Eight-Hour Vehicular Volume
- Warrant 2, Four-Hour Vehicular Volume
- Warrant 3, Peak Hour
- Warrant 4, Pedestrian Volume
- Warrant 5, School Crossing
- Warrant 6, Coordinated Signal System
- Warrant 7, Crash Experience
- Warrant 8, Roadway Network
- Warrant 9, Intersection Near a Grade Crossing

The warrant analyses focused on the volume-based warrants: Warrants 1 and 2. Warrant 3 can be another warrant of volume-based focus; however, use of that warrant is reserved for developments that attract or discharge a large number of vehicles in a short period of time (e.g., schools, manufacturing/industrial complexes). Since there is no proposed development that will not include those land uses, Warrant 3 was not investigated.

The traffic signal warrant analyses were performed using the 100-percent volume thresholds, given the 35-mph posted speed limit of Asbury Road. Right-turn volumes were only included for the westbound approach (at 100-percent inclusion), as the southbound approach has a separate lane for right-turning traffic. Right-turning traffic is generally not included when a separate and/or channelized right-turn lane is present.

Based on this analysis, no signal warrants are currently met; however, volumetric warrants may be met if any new development occurs near the intersection as the numbers are very close to meeting the Warrant 1, Condition B.

While warrants are not met, a change in traffic control is the only alternative that would have the ability to improve operations. Additional lanes along Hales Mill Road would not be feasible and an all-way stop control (AWSC) would only further degrade operations along Asbury Road. The full traffic signal warrant analysis is included in Appendix E.

Table 4-1 shows the traffic analysis for the projected 2029 volumes.

Table 4-1, 2029 Projected Operations, Traffic Signal at Hales Mill Road with Minor Geometric Improvements

Intersection	Peak Hour	Parameters	West Approach			East Approach			South Approach			North Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Radford Road <sup>1</sup>		Lanes	1-Shared			1	1		1		1			
	AM	LOS	A			C	A		F		F			
		Delay (s)	0.0			16.3	0.0		157.6		202.6			
		Queue (ft)	0			50	0		25		375			
	PM	LOS	A			B	A		F		C			
		Delay (s)	0.0			10.6	0.0		148.4		24.6			
Queue (ft)		0			25	0		50		100				
Hales Mill Road <sup>2</sup>		Lanes	1	1		1	1					1	1	
	AM	LOS	A	C		A	A					C	B	
		Delay (s)	8.2	22.8		6.9	5.9					25.9	14.4	
		Queue (ft)	25	550		100	25					225	25	
	PM	LOS	B	A		A	A					B	B	
		Delay (s)	13.7	7.8		9.4	6.2					13.7	12.3	
Queue (ft)		25	175		250	25					100	25		

<sup>1</sup> LOS source: HCM 6<sup>th</sup> Edition, Unsignalized Intersections

<sup>2</sup> LOS source: HCM 6<sup>th</sup> Edition, Signalized Intersections

Queue represents 95<sup>th</sup> percentile queue per lane, 25-feet per vehicle

Under projected traffic for 2029, all approaches are expected to operate at LOS C or better in both peak hours at the Hales Mill Road intersection. The eastbound approach is nearing capacity in the AM peak hour.

Expected operations at the Radford Road see slight improvements, but not enough to appreciably change the poor operations for the Radford Road approach. Depending on the ultimate timing of the proposed signal, additional benefits may be observed at the Radford Road intersection due to the ability to create gaps in traffic along Asbury Road.

## B2. Alternative ST2, Traffic Signals at Both Intersections with Existing Lanes/Geometry

This alternative would add traffic signal controls to both the Hales Mill Road and Radford Road intersections with Asbury Road. Due to the proximity of the intersections, both signals would need to operate in a coordinated fashion. The signal phasing includes protected/permissive left-turns along Asbury Road. No geometric lane changes are proposed as part of this alternative. A lane schematic of this improvement alternative is shown in Figure 4-3.



Figure 4-3, Traffic Signals at both intersections with existing lanes/geometry

Table 4-2 shows the traffic analysis for the projected 2029 volumes.

Table 4-2, 2029 Projected Operations, Traffic Signal at Both Intersections with Existing Lanes/Geometry

Intersection	Peak Hour	Parameters	West Approach			East Approach			South Approach			North Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Radford Road		Lanes	1-Shared			1	1		1	1				
	AM	LOS		F*		F	A		D	E				
		Delay (s)		27.6		97.1	4.0		46.3	61.0				
		Queue (ft)		1150		200	100		25	225				
	PM	LOS	A			A	B		D	D				
		Delay (s)	2.1			5.6	10.8		42.5	50.1				
Queue (ft)		125			50	300		25	100					
Hales Mill Road		Lanes	1	1		1-Shared						1	1	
	AM	LOS	A	B		A						D	D	
		Delay (s)	6.2	14.0		0.7						54.2	36.4	
		Queue (ft)	25	650		200						325	25	
	PM	LOS	A	A		A						E	D	
		Delay (s)	2.7	4.2		2.2						60.8	49.3	
Queue (ft)		25	225		600						200	25		
LOS source: HCM 6 <sup>th</sup> Edition, Signalized Intersections														
Queue represents 95 <sup>th</sup> percentile queue per lane, 25-feet per vehicle														
* LOS F due to operations exceeding capacity (excessive queue shown)														

Under projected traffic for 2029 at the Radford Road intersection, all approaches are expected to operate at LOS D or better for both peak hours, except for the eastbound approach and westbound left lane (LOS F), and the northbound right lane (LOS E) in the AM peak hour. Expected eastbound queues would reach 1,150-feet, during this peak hour, which would extend several hundred feet upstream of the Hales Mill Road intersection.

At the Hales Mill Road intersection, all approaches are expected to operate at LOS B or better in both peak hours, except for the southbound left and right lanes. The southbound left lane is expected to operate at LOS D in the AM peak hour and LOS E in the PM peak hour. The southbound right lane is expected to operate at LOS D in both peak hours.

The additional signal at the Radford Road intersection improves the operations for those on Radford Road, but similar to the results from Chapter 2, there is excessive queuing west that will cause problems at the Hales Mill Road intersection.

## PART C – LONG-TERM ALTERNATIVES

Long-term alternatives are intended to be changes that would have higher costs, due to larger geometric impacts and subsequent impact to a longer stretch of the Asbury Road corridor, not just the two study intersections. However, these alternatives would target the 2029 horizon year and beyond.

### C1. Alternative LT1, Two Eastbound Lanes on Asbury Road

#### C1-1. Traffic Signal at Hales Mill Road

This alternative would add traffic signal controls to the intersection of Asbury Road at Hales Mill Road, in addition to the second eastbound lane along Asbury Road through both study intersections. The Radford Road intersection would remain with its current one-way stop control. A lane schematic of this improvement alternative is shown in Figure 4-4.

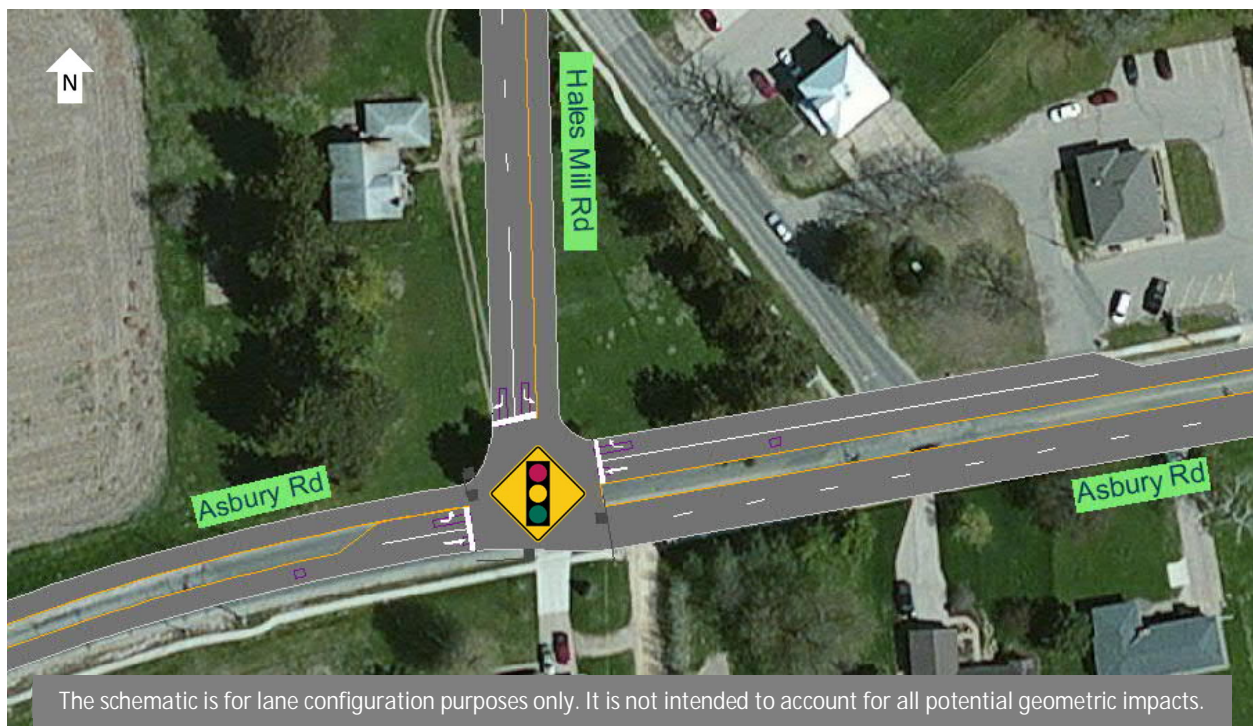


Figure 4-4, Traffic signal at Hales Mill Road with two eastbound lanes on Asbury Road

Table 4-3 shows the traffic analysis for the projected 2029 volumes.

Table 4-3, 2029 Projected Operations, Traffic Signal at Hales Mill Road Intersection with Two Eastbound Lanes on Asbury Road

Intersection	Peak Hour	Parameters	West Approach			East Approach			South Approach			North Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Radford Road <sup>1</sup>		Lanes	1 TH,1 TH/RT			1	1		1		1			
	AM	LOS	A	A		C	A		F		D			
		Delay (s)	0.0	0.0		16.5	0.0		186.1		28.8			
		Queue (ft)	0	0		50	0		25		125			
	PM	LOS	A	A		B	A		F		B			
		Delay (s)	0.0	0.0		10.6	0.0		179.8		14.5			
		Queue (ft)	0	0		25	0		50		50			
Hales Mill Road <sup>2</sup>		Lanes	1	1		1-Shared						1	1	
	AM	LOS	A	B		A						C	B	
		Delay (s)	9.6	20.0		7.5						27.2	15.2	
		Queue (ft)	25	550		150						250	25	
	PM	LOS	C	A		B						C	B	
		Delay (s)	20.3	5.9		15.1						21.4	18.9	
		Queue (ft)	25	175		575						100	25	
<sup>1</sup> LOS source: HCM 6 <sup>th</sup> Edition, Unsignalized Intersections														
<sup>2</sup> LOS source: HCM 6 <sup>th</sup> Edition, Signalized Intersections														
Queue represents 95 <sup>th</sup> percentile queue per lane, 25-feet per vehicle														

Under projected traffic for 2029, all approaches are expected to operate at LOS C or better in both peak hours at the Hales Mill Road intersection. Expected operations at the Radford Road intersection likely will see slight improvements, but not enough to effectively improve the poor operations along Radford Road. Depending on the ultimate timing of the proposed signal, additional benefits may be observed at the Radford Road intersection, due to the ability to create gaps in traffic along Asbury Road. The configuration would allow Hales Mill Road to be expended to dual left-turn lanes, should growth warrant the additional capacity.

#### C1-2. Traffic Signal at Radford Road

This alternative would add traffic signal controls to the intersection of Asbury Road at Radford Road, in addition to the second eastbound lane along Asbury Road through both study intersections. The Hales Mill Road intersection would remain with its current one-way stop control. A lane schematic of this improvement alternative is shown in Figure 4-5.



Figure 4-5, Traffic signal at Radford Road with two eastbound lanes on Asbury Road

Table 4-4 shows the traffic analysis for the projected 2029 volumes.

Table 4-4, 2029 Projected Operations, Traffic Signal at Radford Road Intersection with Two Eastbound Lanes on Asbury Road

Intersection	Peak Hour	Parameters	West Approach			East Approach			South Approach			North Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Radford Road <sup>1</sup>		Lanes	1 TH,1 TH/RT			1	1		1	1				
	AM	LOS	C		C	B	A		B	C				
		Delay (s)	22.5	22.3	13.5	5.5		19.5	21.6					
		Queue (ft)	275	275	100	75		25	125					
	PM	LOS	B		B	A	B		B	B				
		Delay (s)	12.1	12.1	8.1	11.2		19.1	19.0					
Queue (ft)		150	150	50	375		25	75						
Hales Mill Road <sup>2</sup>		Lanes	1	1	1-Shared						1	1		
	AM	LOS	A	A	A						F	B		
		Delay (s)	8.1	0.0	0.0						431.4	10.2		
		Queue (ft)	25	0	0						650	25		
	PM	LOS	B	A	A						F	C		
		Delay (s)	10.3	0.0	0.0						195.5	16.0		
Queue (ft)		25	0	0						225	25			
<sup>1</sup> LOS source: HCM 6 <sup>th</sup> Edition, Signalized Intersections														
<sup>2</sup> LOS source: HCM 6 <sup>th</sup> Edition, Unsignalized Intersections														
Queue represents 95 <sup>th</sup> percentile queue per lane, 25-feet per vehicle														

Under projected traffic for 2029, all approaches are expected to operate at LOS C or better in both peak hours at the Radford Road intersection. Expected queue lengths are not projected to impact adjacent intersections.

Expected operations at the Hales Mill Road intersection may see slight improvements, but not enough to effectively improve the poor operations along Hales Mill Road. Depending on the ultimate timing of the proposed signal at Radford Road, additional benefits may be observed at the Hales Mill Road intersection, due to the ability to create gaps in traffic along Asbury Road.

The addition of the second eastbound lane, improved the operations so that queues are no longer extending from the Radford Road intersection to the Hales Mill Road intersection.

### C1-3. Traffic Signal at Both Intersections

This alternative would add traffic signal controls to both of the Hales Mill Road and Radford Road intersections with Asbury Road, in addition to the second eastbound lane along Asbury Road. Due to the proximity of the intersections, both signals would need to operate in a coordinated fashion. The signal phasing plan would include protected/permissive left-turns along Asbury Road. No lane changes are proposed. A lane schematic of this improvement alternative is shown in Figure 4-7.



Figure 4-7, Traffic signal at both intersections with two eastbound lanes on Asbury Road

Table 4-5 shows the traffic analysis for the projected 2029 volumes.

Table 4-5, 2029 Projected Operations, Traffic Signal at Radford Road and Hales Mill Road Intersections with Two Eastbound Lanes on Asbury Road

Intersection	Peak Hour	Parameters	West Approach			East Approach			South Approach			North Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Radford Road		Lanes	1 TH, 1 TH/RT			1	1		1	1				
	AM	LOS	A	A		A	A		D	D				
		Delay (s)	0.9	0.9		6.9	6.0		40.7	49.6				
		Queue (ft)	350	350		75	100		25	225				
	PM	LOS	A	A		A	B		D	D				
		Delay (s)	0.6	0.6		5.8	11.2		42.1	48.6				
Queue (ft)		125	125		50	300		25	100					
Hales Mill Road		Lanes	1	1		1-Shared						1	1	
	AM	LOS	A	B		A						C	B	
		Delay (s)	5.5	15.6		1.0						32.6	17.6	
		Queue (ft)	25	450		100						200	25	
	PM	LOS	A	A		A						E	D	
		Delay (s)	2.7	4.2		2.2						60.8	49.3	
		Queue (ft)	25	225		600						175	25	
LOS source: HCM 6 <sup>th</sup> Edition, Signalized Intersections														
Queue represents 95 <sup>th</sup> percentile queue per lane, 25-feet per vehicle														

Under projected traffic for 2029 at the Radford Road intersection, all approaches are expected to operate at LOS B or better, except for the northbound left and right lanes, which are expected to operate at LOS D in both peak hours. Queues are not expected to cause spillback issues between the intersections.

At the Hales Mill Road intersection, all approaches are expected to operate at LOS C or better in both peak hours, except for the southbound left and right lanes in the PM peak hour. The southbound left-turn movement is expected to operate at LOS E and the right-turn at LOS D. Queues are not expected to cause spillback issues between the intersections.

## C2. Alternative LT2, Realign Hales Mill Road and Radford Road into One Intersection

These long-term alternatives are meant to be changes that would have the highest costs, due to the most significant geometric impacts. Solutions would target the 2039 horizon year and beyond.

These alternatives involve realigning Radford Road, Hales Mills Road, or both, as they intersect Asbury Road, as shown in Figure 4-8, Figure 4-9, and Figure 4-10. Control options considered for the realigned intersections include a traffic signal and a multilane roundabout.

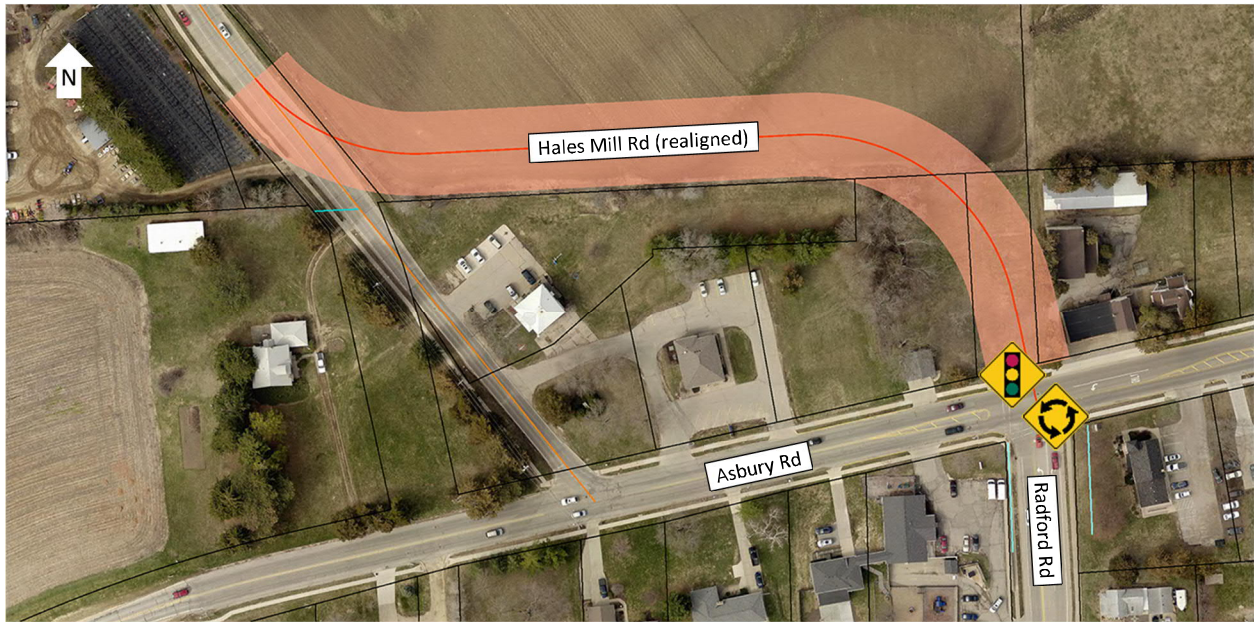


Figure 4-8, Realignment of Hales Mill Road, Alternative 1



Figure 4-9, Realignment of Hales Mill Road and Radford Road, Alternative 2

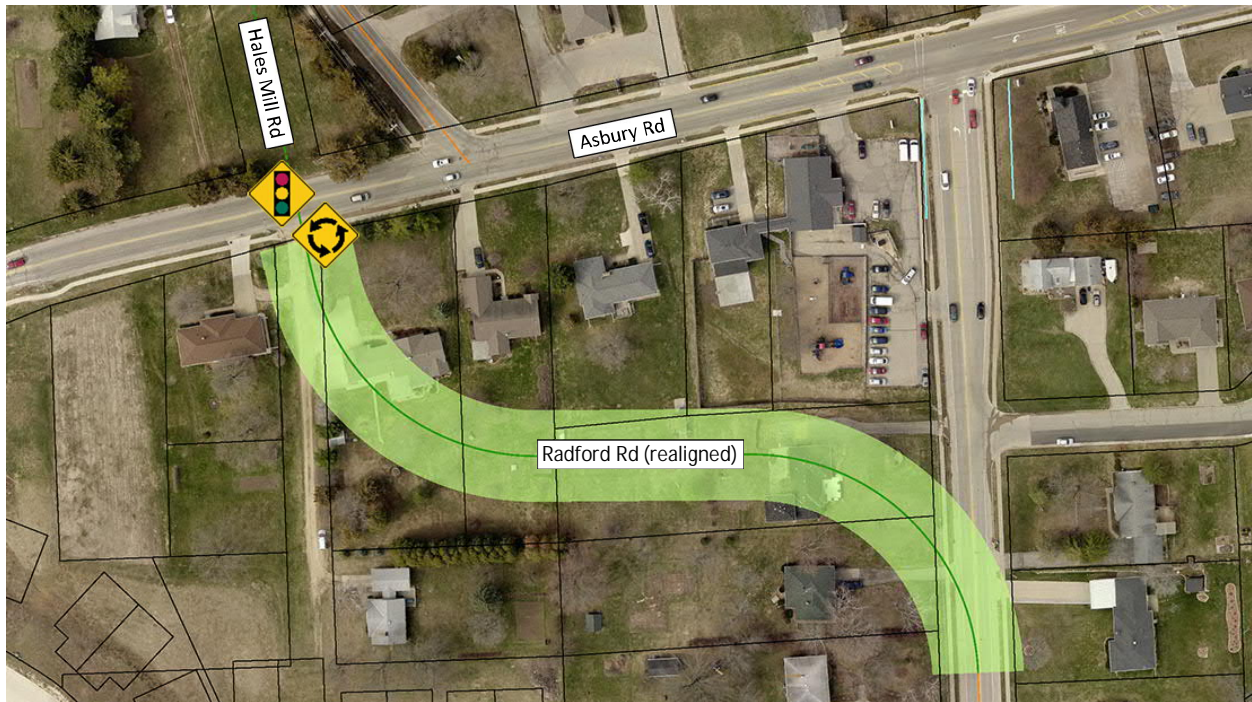


Figure 4-10, Realignment of Radford Road, Alternative 3

Cost estimates were assembled for each of the three realignment alternatives. Table 4-6 shows the anticipated costs for each realignment alternative. These costs included real estate costs based on current appraisal values plus inflation along with expected road construction costs. Expecting that this large of an improvement may take years for the City to implement, costs were established in 2029 dollars, using a 3% inflation rate.

Table 4-6, Realignment Cost Estimate

Realignment Alternative	Real Estate Cost	Construction Cost	Total Cost
Realign Hales Mill Road (Alt. 1)	\$ 0.6M – 1.6M	\$ 1.4M – 1.8M	\$ 2.0M – 3.4M
Realign Hales Mill Road and Radford Road (Alt. 2)	\$ 2.2M – 2.7M	\$ 1.8M – 2.3M	\$ 4.0M – 5.0M
Realign Radford Road (Alt. 3)	\$ 1.0M – 1.7M	\$ 1.3M – 1.8M	\$ 2.3M – 3.5M

The City should develop more accurate cost estimates if choosing to further pursue one of the realignment options.

#### C2-1. Realignment with Multilane Roundabout

This alternative would create a multilane roundabout at the intersection one of the three realignment alternatives shown earlier in this section. The design is versatile to allow expansion of the Asbury Road approaches into two lanes when operations warrant, allowing for the smallest impacts along the Asbury Road corridor.

Two approach lanes would enter the roundabout from the east and west, along Asbury Road. The approaches from Hales Mill Road and Radford Road would only need to be single-lane approaches, utilizing traffic projections to 2039 and beyond.

A summary of the operational analysis is shown in Table 4-7.

Table 4-7, Projected Operations, Multilane Roundabout with Realigned Roadways

Year	Peak Hour	Parameters	West Approach			East Approach			South Approach			North Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
2029		Lanes	1 LT/TH	1 TH/RT		1 LT/TH	1 TH/RT		1-Shared			1-Shared		
	AM	LOS	A	A		A	A		B			A		
		Delay (s)	5.5	5.5		2.8	2.8		12.8			6.5		
		Queue (ft)	25	25		25	25		100			75		
	PM	LOS	A	A		A	A		A			A		
		Delay (s)	3.7	3.7		5.9	5.9		7.1			8.1		
Queue (ft)		50	50		50	50		75			50			
2039		Lanes	1 LT/TH	1 TH/RT		1 LT/TH	1 TH/RT		1-Shared			1-Shared		
	AM	LOS	A	A		A	A		C			A		
		Delay (s)	7.7	7.7		3.0	3.0		21.8			8.4		
		Queue (ft)	50	50		50	50		200			75		
	PM	LOS	A	A		A	A		A			B		
		Delay (s)	4.2	4.2		7.9	7.9		8.6			11.0		
Queue (ft)		25	25		125	125		75			100			
LOS source: HCM 6 <sup>th</sup> Edition, Unsignalized Intersections														
Queue represents 95 <sup>th</sup> percentile queue per lane, 25-feet per vehicle														

Under projected 2029 traffic, all approaches are expected to operate at LOS B or better in for both peak hours. No significant queues are anticipated in either peak period.

Using projected 2039 traffic, all approaches are expected to operate at LOS C or better in for both peak hours. No significant queues are anticipated in either peak period.

#### C2-2, Realignment with Traffic Signal with Two Eastbound Lanes

This alternative would implement a traffic signal at the intersection one of the three realignment alternatives shown earlier in this section. This control option requires two eastbound lanes along Asbury Road. Dedicated turn lanes would need to be provided for the eastbound, westbound, and southbound left-turn movements, and the northbound and westbound right-turn movements. Protected/permissive phasing would be used for left-turn movements along Asbury. A lane schematic of this improvement alternative is shown in Figure 4-11.



Figure 4-11, Traffic signal with realigned roadways and two eastbound lanes on Asbury Road

If the City chose to pursue this alternative, consideration should be given to expanding to two westbound lanes as well as two eastbound lanes. For traffic operations as analyzed in this study, two westbound lanes are not necessary. However, when undertaking a construction project of this magnitude the City would be prudent to consider other unknowns. Further, while costs were shown above for the realignment options, costs have not been determined for the expansion of Asbury Road. There are too many variables to consider that are outside the scope of this study. Asbury Road could be widened north, south, or on both sides which all will require differing costs based on the real estate impacts. If this alternative is considered further, the City should look at all alternatives to determine the most cost effective solution.

A summary of the operational analysis is shown in Table 4-8.

Table 4-8, Projected Operations, Traffic Signal with Realigned Roadways and Two Eastbound Lanes on Asbury Road

Year	Peak Hour	Parameters	West Approach			East Approach			South Approach			North Approach		
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
2029	AM	Lanes	1	1 TH, 1 TH/RT		1	1	1	1-Shared		1	1	1-Shared	
		LOS	B	C	C	C	B	A	C	C	C	B		
		Delay (s)	16.4	27.2	27.0	23.2	11.3	6.6	21.2	21.1	25.0	13.4		
		Queue (ft)	25	200	200	125	100	25	25	100	225	25		
	PM	LOS	C	B	B	B	B	A	B	B	B	B		
		Delay (s)	23.2	19.8	19.7	14.1	18.7	7.2	19.4	18.1	15.3	12.3		
		Queue (ft)	25	125	125	75	350	25	25	50	75	25		
2039	AM	Lanes	1	1 TH, 1 TH/RT		1	1	1	1-Shared		1	1	1-Shared	
		LOS	B	C	C	D	B	A	C	C	C	B		
		Delay (s)	19.6	34.3	34.1	41.9	14.0	6.6	27.0	28.2	33.3	16.0		
		Queue (ft)	25	275	275	200	125	25	25	175	350	25		
	PM	LOS	C	B	B	B	C	A	C	C	B	B		
		Delay (s)	28.7	19.6	19.6	16.3	23.8	7.4	22.3	22.0	18.1	14.6		
		Queue (ft)	25	150	150	100	475	25	25	75	100	25		
LOS source: HCM 6 <sup>th</sup> Edition, Signalized Intersections														
Queue represents 95 <sup>th</sup> percentile queue per lane, 25-feet per vehicle														

Under projected 2029 traffic, all approaches are expected to operate at LOS C or better in for both peak hours. Queues are expected to be acceptable in both peak periods.

Using projected 2039 traffic, all approaches are expected to operate at LOS C or better in for both peak hours, with the exception of the westbound left-turn movement in the AM peak hour. That movement is expected to operate at LOS D. Queues are expected to be acceptable in both peak periods.

## Chapter 5 – CONCLUSION & RECOMMENDATIONS

Improvement alternatives established for the Radford Road at Asbury Road intersection by themselves will not solve all the issues identified in the corridor. Instead, many of these alternatives create unintended additional issues with operation at the Hales Mill Road intersection. With modifications, alternatives do exist, which are able to address the operational concerns at both of the study intersections.

Alternatives that address the corridor are split into short and long-term improvement horizons. Short-term improvements can be implemented faster and for generally less cost, but will require the corridor to be readdressed at a later date. The short-term alternatives are summarized in Table 5-1.

Table 5-1, Short-term Improvements

Alternative		Pros/Cons	Expected Longevity	Cost
1	Traffic Signal at Hales Mill Road with Minor Geometric Improvements	<ul style="list-style-type: none"> <li>• Better overall corridor operations than a traffic signal alone at Radford Road</li> <li>• Has the ability to create gaps for Radford traffic</li> <li>• Does not solve operational issues at Radford</li> <li>• Improved operations for westbound through movement</li> <li>• Eastbound approach to Hales Mill Road intersection nearing capacity</li> </ul>	2029	Low
2	Traffic Signals at Both Intersections with Existing Lanes/Geometry	<ul style="list-style-type: none"> <li>• Slight operational improvements for both intersections</li> <li>• Signals must be coordinated which limits timing options</li> <li>• Operations and queues worsen along Asbury Road</li> </ul>	2029	Low

Long-term improvements will require more planning and time to implement. They will come with a higher cost, due to the length of the project and expected ROW costs, but should allow the corridor to operate acceptably for a significantly longer period of time. Long-term alternatives are summarized in Table 5-2.

Table 5-2, Long-term Improvements

Alternative		Pros/Cons	Expected Longevity	Cost
1A*	Traffic Signal at Hales Mill Road	<ul style="list-style-type: none"> <li>Improvements to corridor operations – acceptable operations and queue lengths</li> <li>Has the ability to create gaps for Radford Traffic</li> <li>Does not solve operational issues at Radford Road</li> </ul>	2035 – 2040	Med – High
1B*	Traffic Signal at Radford Road	<ul style="list-style-type: none"> <li>Improvements to corridor operations – acceptable operations and queue lengths</li> <li>Does not solve operational issues at Hales Mill Road</li> </ul>	2035 – 2040	Med – High
1C*	Traffic Signal at Both Intersections	<ul style="list-style-type: none"> <li>Improvements to corridor operations – acceptable operations and queue lengths</li> <li>Signals must be coordinated which limits timing options</li> </ul>	2035 – 2040	High
2A	Combined Intersection with Multilane Roundabout	<ul style="list-style-type: none"> <li>Improvements to corridor operations – acceptable operations and queue lengths</li> <li>Requires ROW acquisition and relocations</li> <li>Highest expected longevity due to built-in capacity</li> <li>Could accommodate single or two-lane approaches along Asbury Road, as volumes warrant</li> </ul>	2040 – 2050 +	High
2B*	Combined Intersection with Traffic Signal	<ul style="list-style-type: none"> <li>Improvements to corridor operations – acceptable operations and queue lengths</li> <li>Requires ROW acquisition and relocations</li> <li>Highest expected longevity due to built-in capacity</li> <li>Needs the most amount of lanes</li> </ul>	2050 +	Highest

\* Includes second eastbound lane along Asbury Road

Based on the summary, the best and lowest cost alternative in the short-term is to install a traffic signal at the Hales Mill Road intersection when warrants are met, as this intersection has the worst overall intersection operations. Radford Road would also gain some operational benefit as well via gaps created by the traffic signal. In the interest of long-term growth and capacity, realigning the intersections into a single intersection creates the most long-term capacity, but it does come at the highest price due to ROW needs. It also has the greatest opportunity for safety benefits, as it significantly reduces the number of conflict points by combining the two intersections into a single intersection.

Of the long-term alternatives, the realignment to combine the Hales Mill Road and Radford Road intersections into one intersection is the best alternative to allow for future traffic growth. The roundabout has the most flexibility, as it does not require immediate expansion to additional lanes along Asbury Road. However, when undertaking a project of the magnitude necessary, it may be best to expand Asbury Road at the same time. If Asbury Road is expanded to four-lanes, the traffic signal will likely provide better operations farther into the future than the roundabout. The City should make a decision on a realignment alternative, or do a more in-depth study of the realignment alternatives, to determine which is the most cost effective. Further, that study should also explore the alternatives of expanding Asbury Road to 4-lanes and the costs and impacts associated with that improvement. After

the completion of that study, the City should move forward with pursuing a long term plan for realignment into a single intersection with a multi-lane roundabout or a traffic signal. Either control option will provide acceptable operations well into the future.

## Appendix A

### Traffic Volumes



MSA Professional Services, Inc.  
2901 International Lane  
Suite 300  
Madison, Wisconsin, United States 53704  
608.242.7779 ejordan@msa-ps.com

Count Name: Hales Mill Road  
Site Code:  
Start Date: 05/15/2019  
Page No: 1

## Turning Movement Data

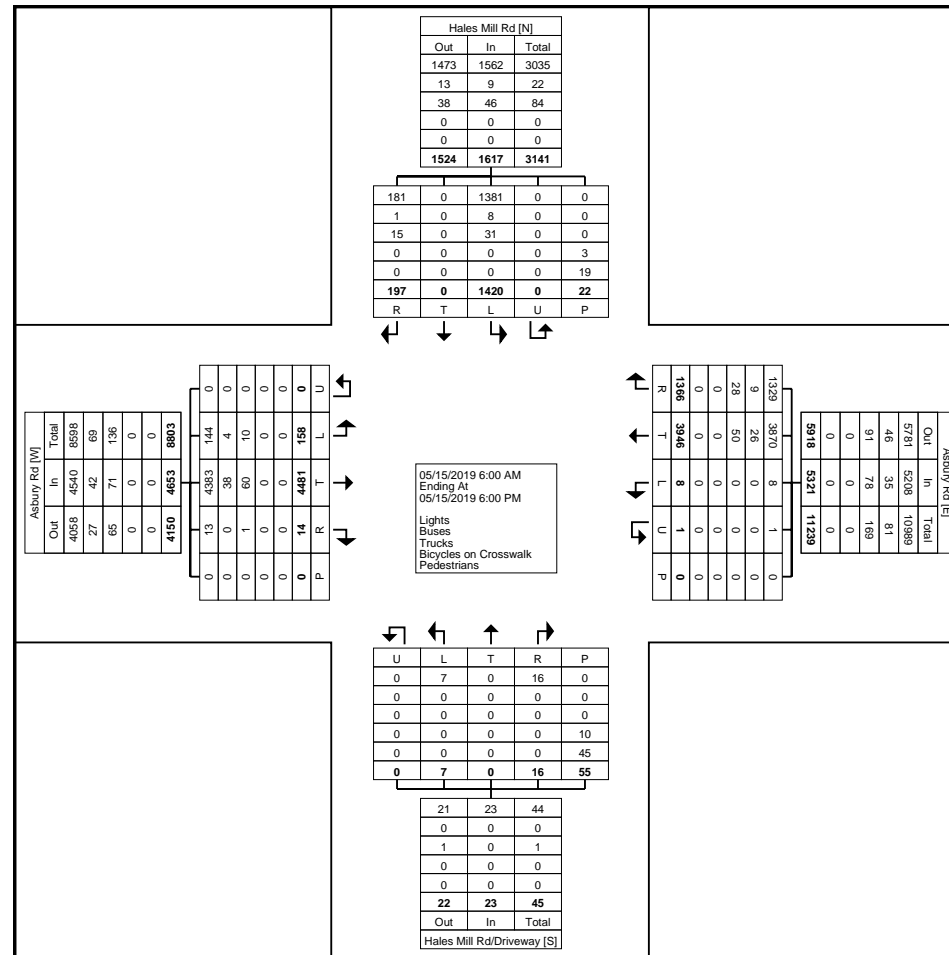
Start Time	Hales Mill Rd Southbound						Asbury Rd Westbound						Hales Mill Rd/Driveway Northbound						Asbury Rd Eastbound						Int. Total
	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	
6:00 AM	2	0	14	0	0	16	4	24	0	0	0	28	0	0	0	0	6	0	0	37	0	0	0	37	81
6:15 AM	2	0	29	0	0	31	3	30	0	0	0	33	0	0	0	0	0	0	0	60	2	0	0	62	126
6:30 AM	3	0	39	0	0	42	11	41	1	0	0	53	1	0	0	0	3	1	1	110	1	0	0	112	208
6:45 AM	2	0	60	0	0	62	12	39	1	0	0	52	1	0	0	0	3	1	1	111	0	0	0	112	227
Hourly Total	9	0	142	0	0	151	30	134	2	0	0	166	2	0	0	0	12	2	2	318	3	0	0	323	642
7:00 AM	2	0	66	0	1	68	16	38	0	0	0	54	1	0	1	0	0	2	0	130	2	0	0	132	256
7:15 AM	4	0	62	0	0	66	13	64	0	0	0	77	1	0	0	0	0	1	0	185	4	0	0	189	333
7:30 AM	3	0	65	0	0	68	20	47	0	0	0	67	0	0	0	0	0	0	1	171	1	0	0	173	308
7:45 AM	8	0	57	0	0	65	15	51	0	0	0	66	0	0	1	0	0	1	0	147	1	0	0	148	280
Hourly Total	17	0	250	0	1	267	64	200	0	0	0	264	2	0	2	0	0	4	1	633	8	0	0	642	1177
8:00 AM	2	0	38	0	1	40	19	49	0	0	0	68	0	0	0	0	1	0	0	122	6	0	0	128	236
8:15 AM	2	0	39	0	0	41	20	69	0	0	0	89	0	0	0	0	3	0	0	103	6	0	0	109	239
8:30 AM	0	0	32	0	0	32	21	57	0	0	0	78	0	0	0	0	0	0	1	107	4	0	0	112	222
8:45 AM	2	0	31	0	1	33	21	57	0	0	0	78	0	0	0	0	0	0	0	84	5	0	0	89	200
Hourly Total	6	0	140	0	2	146	81	232	0	0	0	313	0	0	0	0	4	0	1	416	21	0	0	438	897
9:00 AM	3	0	26	0	1	29	9	49	0	1	0	59	0	0	0	0	0	0	0	72	3	0	0	75	163
9:15 AM	6	0	14	0	0	20	19	52	0	0	0	71	0	0	0	0	3	0	0	69	5	0	0	74	165
9:30 AM	2	0	20	0	0	22	20	45	0	0	0	65	1	0	0	0	4	1	0	77	4	0	0	81	169
9:45 AM	5	0	23	0	0	28	16	53	0	0	0	69	0	0	0	0	1	0	0	71	4	0	0	75	172
Hourly Total	16	0	83	0	1	99	64	199	0	1	0	264	1	0	0	0	8	1	0	289	16	0	0	305	669
10:00 AM	4	0	24	0	0	28	23	53	0	0	0	76	0	0	0	0	0	0	1	60	5	0	0	66	170
10:15 AM	2	0	23	0	0	25	15	67	0	0	0	82	0	0	0	0	0	0	0	59	1	0	0	60	167
10:30 AM	2	0	23	0	0	25	14	58	0	0	0	72	1	0	0	0	1	1	0	75	1	0	0	76	174
10:45 AM	3	0	15	0	0	18	7	58	0	0	0	65	0	0	0	0	2	0	2	64	3	0	0	69	152
Hourly Total	11	0	85	0	0	96	59	236	0	0	0	295	1	0	0	0	3	1	3	258	10	0	0	271	663
11:00 AM	10	0	24	0	0	34	16	76	1	0	0	93	3	0	0	0	0	3	1	84	1	0	0	86	216
11:15 AM	5	0	18	0	1	23	32	68	2	0	0	102	0	0	1	0	0	1	0	78	2	0	0	80	206
11:30 AM	5	0	19	0	0	24	27	73	0	0	0	100	1	0	0	0	0	1	1	82	2	0	0	85	210
11:45 AM	4	0	17	0	0	21	35	76	0	0	0	111	1	0	0	0	1	1	0	85	1	0	0	86	219
Hourly Total	24	0	78	0	1	102	110	293	3	0	0	406	5	0	1	0	1	6	2	329	6	0	0	337	851
12:00 PM	2	0	25	0	0	27	23	75	0	0	0	98	0	0	0	0	0	0	0	85	3	0	0	88	213
12:15 PM	3	0	25	0	0	28	28	89	0	0	0	117	0	0	0	0	1	0	0	66	1	0	0	67	212
12:30 PM	4	0	28	0	2	32	27	88	0	0	0	115	0	0	0	0	0	0	0	81	2	0	0	83	230
12:45 PM	4	0	29	0	1	33	29	89	1	0	0	119	0	0	0	0	1	0	0	79	3	0	0	82	234
Hourly Total	13	0	107	0	3	120	107	341	1	0	0	449	0	0	0	0	2	0	0	311	9	0	0	320	889
1:00 PM	3	0	27	0	1	30	22	97	0	0	0	119	0	0	0	0	3	0	0	62	0	0	0	62	211
1:15 PM	8	0	14	0	0	22	24	90	0	0	0	114	0	0	0	0	2	0	0	62	3	0	0	65	201

1:30 PM	6	0	22	0	0	28	27	75	0	0	0	102	0	0	0	0	0	2	72	1	0	0	75	205	
1:45 PM	1	0	22	0	0	23	34	90	0	0	0	124	0	0	0	0	0	0	75	7	0	0	82	229	
Hourly Total	18	0	85	0	1	103	107	352	0	0	0	459	0	0	0	0	5	0	2	271	11	0	0	284	846
2:00 PM	7	0	35	0	1	42	21	109	0	0	0	130	2	0	0	0	4	2	0	80	7	0	0	87	261
2:15 PM	3	0	24	0	0	27	29	69	0	0	0	98	0	0	0	0	2	0	0	68	4	0	0	72	197
2:30 PM	1	0	28	0	0	29	28	85	0	0	0	113	0	0	0	0	0	0	0	92	4	0	0	96	238
2:45 PM	2	0	20	0	0	22	39	94	0	0	0	133	0	0	1	0	0	1	0	87	2	0	0	89	245
Hourly Total	13	0	107	0	1	120	117	357	0	0	0	474	2	0	1	0	6	3	0	327	17	0	0	344	941
3:00 PM	4	0	26	0	0	30	44	102	1	0	0	147	1	0	0	0	1	1	1	103	8	0	0	112	290
3:15 PM	5	0	25	0	0	30	45	125	0	0	0	170	2	0	1	0	0	3	0	96	4	0	0	100	303
3:30 PM	6	0	25	0	3	31	39	110	0	0	0	149	0	0	0	0	1	0	0	117	6	0	0	123	303
3:45 PM	5	0	36	0	2	41	61	131	0	0	0	192	0	0	0	0	0	0	0	102	6	0	0	108	341
Hourly Total	20	0	112	0	5	132	189	468	1	0	0	658	3	0	1	0	2	4	1	418	24	0	0	443	1237
4:00 PM	12	0	24	0	0	36	59	140	1	0	0	200	0	0	0	0	0	0	0	113	3	0	0	116	352
4:15 PM	4	0	32	0	0	36	61	120	0	0	0	181	0	0	0	0	0	0	0	94	4	0	0	98	315
4:30 PM	8	0	28	0	1	36	54	146	0	0	0	200	0	0	0	0	2	0	0	101	7	0	0	108	344
4:45 PM	7	0	33	0	0	40	56	156	0	0	0	212	0	0	0	0	0	0	0	116	4	0	0	120	372
Hourly Total	31	0	117	0	1	148	230	562	1	0	0	793	0	0	0	0	2	0	0	424	18	0	0	442	1383
5:00 PM	6	0	27	0	0	33	47	159	0	0	0	206	0	0	0	0	0	0	0	119	4	0	0	123	362
5:15 PM	4	0	28	0	2	32	66	140	0	0	0	206	0	0	1	0	3	1	0	124	3	0	0	127	366
5:30 PM	5	0	22	0	4	27	49	129	0	0	0	178	0	0	0	0	4	0	0	128	2	0	0	130	335
5:45 PM	4	0	37	0	0	41	46	144	0	0	0	190	0	0	1	0	3	1	2	116	6	0	0	124	356
Hourly Total	19	0	114	0	6	133	208	572	0	0	0	780	0	0	2	0	10	2	2	487	15	0	0	504	1419
Grand Total	197	0	1420	0	22	1617	1366	3946	8	1	0	5321	16	0	7	0	55	23	14	4481	158	0	0	4653	11614
Approach %	12.2	0.0	87.8	0.0	-	-	25.7	74.2	0.2	0.0	-	-	69.6	0.0	30.4	0.0	-	-	0.3	96.3	3.4	0.0	-	-	-
Total %	1.7	0.0	12.2	0.0	-	13.9	11.8	34.0	0.1	0.0	-	45.8	0.1	0.0	0.1	0.0	-	0.2	0.1	38.6	1.4	0.0	-	40.1	-
Lights	181	0	1381	0	-	1562	1329	3870	8	1	-	5208	16	0	7	0	-	23	13	4383	144	0	-	4540	11333
% Lights	91.9	-	97.3	-	-	96.6	97.3	98.1	100.0	100.0	-	97.9	100.0	-	100.0	-	-	100.0	92.9	97.8	91.1	-	-	97.6	97.6
Buses	1	0	8	0	-	9	9	26	0	0	-	35	0	0	0	0	-	0	0	38	4	0	-	42	86
% Buses	0.5	-	0.6	-	-	0.6	0.7	0.7	0.0	0.0	-	0.7	0.0	-	0.0	-	-	0.0	0.0	0.8	2.5	-	-	0.9	0.7
Trucks	15	0	31	0	-	46	28	50	0	0	-	78	0	0	0	0	-	0	1	60	10	0	-	71	195
% Trucks	7.6	-	2.2	-	-	2.8	2.0	1.3	0.0	0.0	-	1.5	0.0	-	0.0	-	-	0.0	7.1	1.3	6.3	-	-	1.5	1.7
Bicycles on Crosswalk	-	-	-	-	3	-	-	-	-	-	0	-	-	-	-	-	10	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	13.6	-	-	-	-	-	-	-	-	-	-	-	18.2	-	-	-	-	-	-	-	-
Pedestrians	-	-	-	-	19	-	-	-	-	-	0	-	-	-	-	-	45	-	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	86.4	-	-	-	-	-	-	-	-	-	-	-	81.8	-	-	-	-	-	-	-	-



MSA Professional Services, Inc.  
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Madison, Wisconsin, United States 53704  
608.242.7779 ejordan@msa-ps.com

Count Name: Hales Mill Road  
Site Code:  
Start Date: 05/15/2019  
Page No: 3



MSA Professional Services, Inc.  
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Madison, Wisconsin, United States 53704  
608.242.7779 ejordan@msa-ps.com

Count Name: Hales Mill Road  
Site Code:  
Start Date: 05/15/2019  
Page No: 4

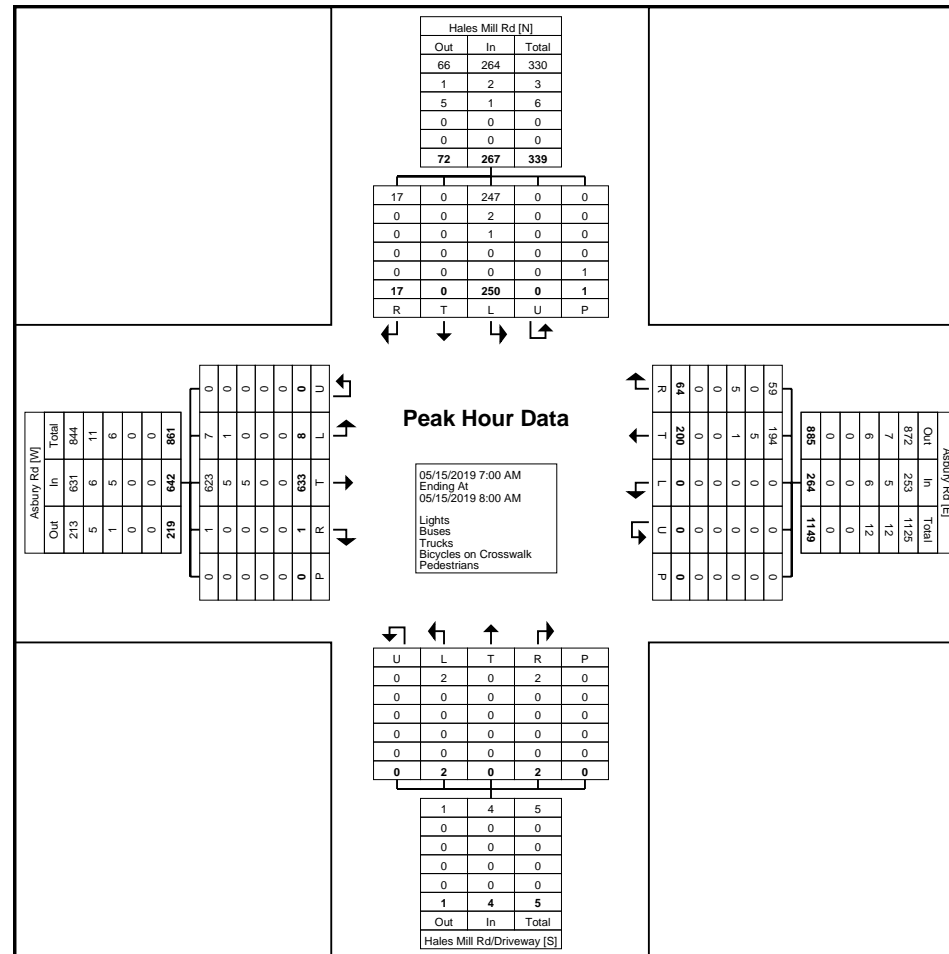
### Turning Movement Peak Hour Data (7:00 AM)

[illegible]



MSA Professional Services, Inc.  
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608.242.7779 ejordan@msa-ps.com

Count Name: Hales Mill Road  
Site Code:  
Start Date: 05/15/2019  
Page No: 5



Turning Movement Peak Hour Data Plot (7:00 AM)

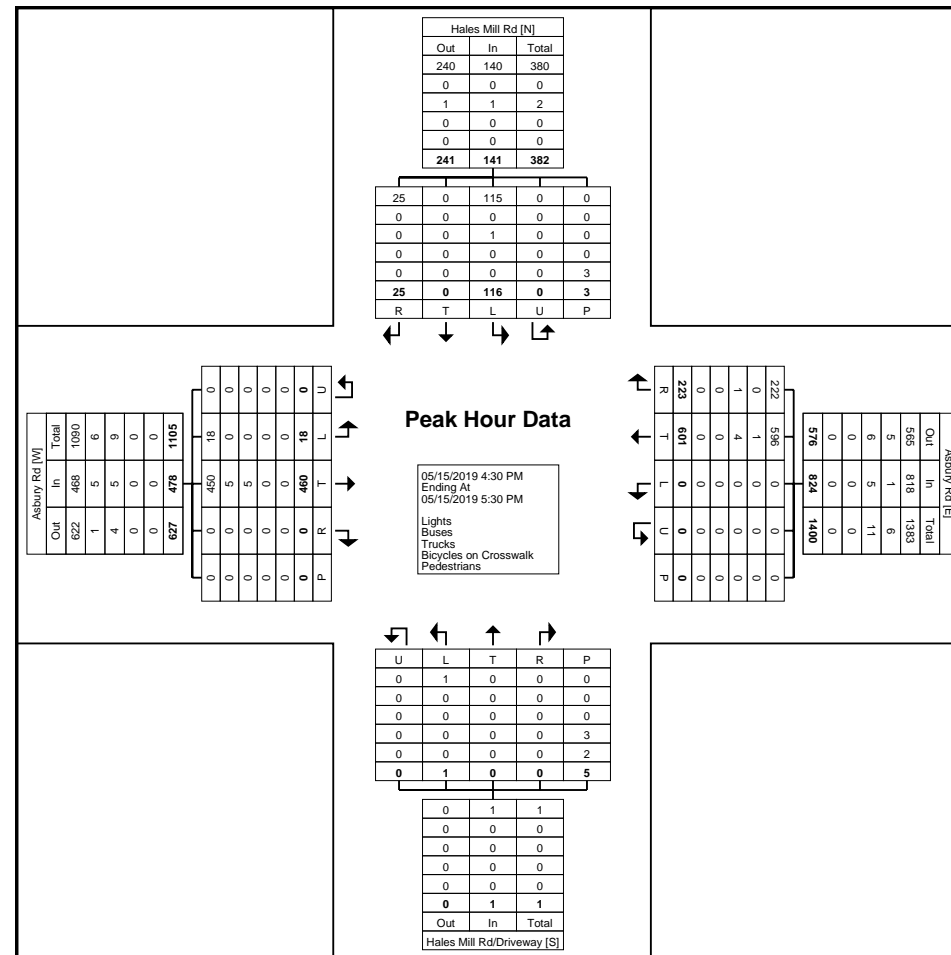


MSA Professional Services, Inc.  
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Count Name: Hales Mill Road  
Site Code:  
Start Date: 05/15/2019  
Page No: 6

### Turning Movement Peak Hour Data (4:30 PM)

Start Time	Hales Mill Rd Southbound						Asbury Rd Westbound						Hales Mill Rd/Driveway Northbound						Asbury Rd Eastbound						Int. Total
	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	
4:30 PM	8	0	28	0	1	36	54	146	0	0	0	200	0	0	0	0	2	0	0	101	7	0	0	108	344
4:45 PM	7	0	33	0	0	40	56	156	0	0	0	212	0	0	0	0	0	0	0	116	4	0	0	120	372
5:00 PM	6	0	27	0	0	33	47	159	0	0	0	206	0	0	0	0	0	0	0	119	4	0	0	123	362
5:15 PM	4	0	28	0	2	32	66	140	0	0	0	206	0	0	1	0	3	1	0	124	3	0	0	127	366
Total	25	0	116	0	3	141	223	601	0	0	0	824	0	0	1	0	5	1	0	460	18	0	0	478	1444
Approach %	17.7	0.0	82.3	0.0	-	-	27.1	72.9	0.0	0.0	-	-	0.0	0.0	100.0	0.0	-	-	0.0	96.2	3.8	0.0	-	-	-
Total %	1.7	0.0	8.0	0.0	-	9.8	15.4	41.6	0.0	0.0	-	57.1	0.0	0.0	0.1	0.0	-	0.1	0.0	31.9	1.2	0.0	-	33.1	-
PHF	0.781	0.000	0.879	0.000	-	0.881	0.845	0.945	0.000	0.000	-	0.972	0.000	0.000	0.250	0.000	-	0.250	0.000	0.927	0.643	0.000	-	0.941	0.970
Lights	25	0	115	0	-	140	222	596	0	0	-	818	0	0	1	0	-	1	0	450	18	0	-	468	1427
% Lights	100.0	-	99.1	-	-	99.3	99.6	99.2	-	-	-	99.3	-	-	100.0	-	-	100.0	-	97.8	100.0	-	-	97.9	98.8
Buses	0	0	0	0	-	0	0	1	0	0	-	1	0	0	0	0	-	0	0	5	0	0	-	5	6
% Buses	0.0	-	0.0	-	-	0.0	0.0	0.2	-	-	-	0.1	-	-	0.0	-	-	0.0	-	1.1	0.0	-	-	1.0	0.4
Trucks	0	0	1	0	-	1	1	4	0	0	-	5	0	0	0	0	-	0	0	5	0	0	-	5	11
% Trucks	0.0	-	0.9	-	-	0.7	0.4	0.7	-	-	-	0.6	-	-	0.0	-	-	0.0	-	1.1	0.0	-	-	1.0	0.8
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	3	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	60.0	-	-	-	-	-	-	-	-
Pedestrians	-	-	-	-	3	-	-	-	-	-	0	-	-	-	-	-	2	-	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	100.0	-	-	-	-	-	-	-	-	-	-	-	40.0	-	-	-	-	-	-	-	-



### Turning Movement Peak Hour Data Plot (4:30 PM)



MSA Professional Services, Inc.  
2901 International Lane  
Suite 300  
Madison, Wisconsin, United States 53704  
608.242.7779 ejordan@msa-ps.com

Count Name: Radford Rd  
Site Code:  
Start Date: 05/15/2019  
Page No: 1

## Turning Movement Data

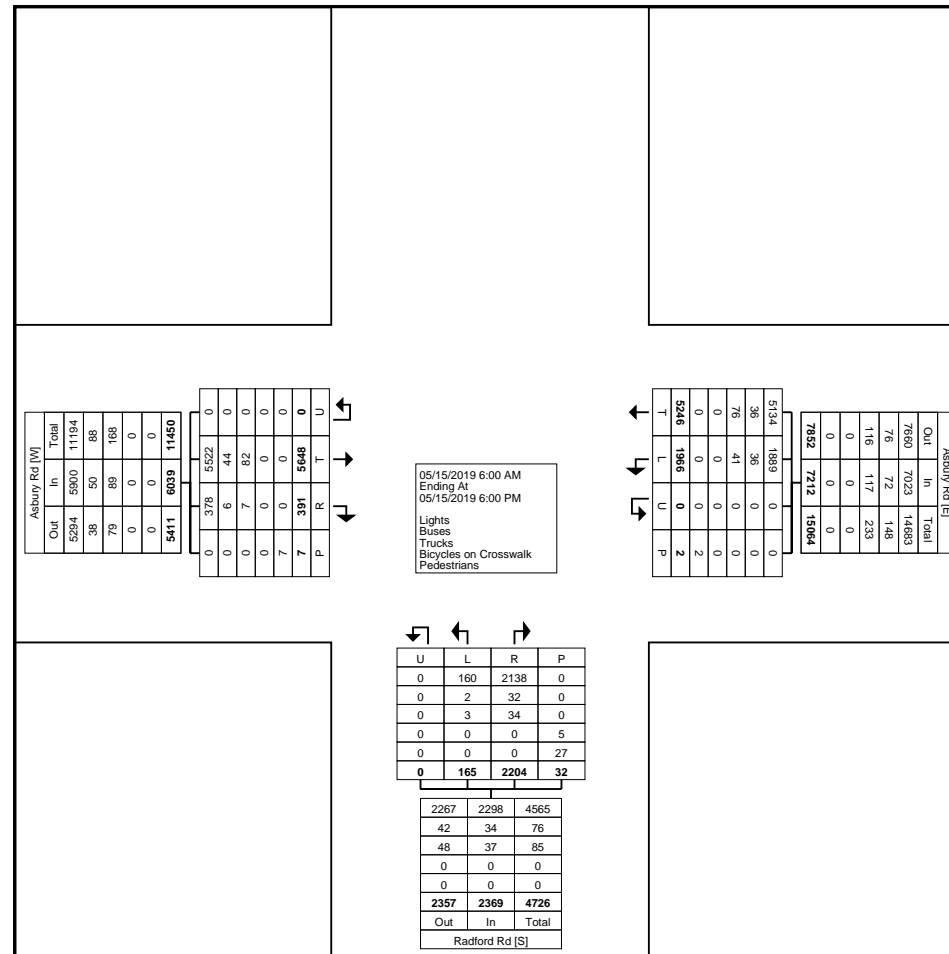
Start Time	Asbury Rd Westbound					Radford Rd Northbound					Asbury Rd Eastbound					Int. Total
	Thru	Left	U-Turn	Peds	App. Total	Right	Left	U-Turn	Peds	App. Total	Right	Thru	U-Turn	Peds	App. Total	
6:00 AM	28	11	0	0	39	13	0	0	5	13	1	51	0	0	52	104
6:15 AM	33	24	0	0	57	19	0	0	0	19	10	82	0	0	92	168
6:30 AM	50	26	0	0	76	22	2	0	2	24	6	142	0	0	148	248
6:45 AM	54	47	0	0	101	41	1	0	0	42	12	159	0	0	171	314
Hourly Total	165	108	0	0	273	95	3	0	7	98	29	434	0	0	463	834
7:00 AM	56	52	0	0	108	50	1	0	0	51	11	188	0	0	199	358
7:15 AM	81	59	0	0	140	68	2	0	0	70	17	236	0	0	253	463
7:30 AM	65	53	0	0	118	78	3	0	0	81	11	226	0	0	237	436
7:45 AM	72	28	0	0	100	46	3	0	0	49	11	199	0	0	210	359
Hourly Total	274	192	0	0	466	242	9	0	0	251	50	849	0	0	899	1616
8:00 AM	75	25	0	0	100	37	0	0	1	37	8	152	0	0	160	297
8:15 AM	88	51	0	0	139	38	3	0	2	41	6	141	0	0	147	327
8:30 AM	84	29	0	0	113	34	3	0	0	37	9	130	0	0	139	289
8:45 AM	76	31	0	0	107	36	3	0	0	39	7	108	0	0	115	261
Hourly Total	323	136	0	0	459	145	9	0	3	154	30	531	0	0	561	1174
9:00 AM	61	27	0	0	88	28	0	0	0	28	9	92	0	0	101	217
9:15 AM	67	18	0	0	85	27	5	0	0	32	8	77	0	1	85	202
9:30 AM	64	17	0	0	81	27	0	0	2	27	6	97	0	0	103	211
9:45 AM	67	24	0	0	91	27	3	0	2	30	4	88	0	0	92	213
Hourly Total	259	86	0	0	345	109	8	0	4	117	27	354	0	1	381	843
10:00 AM	73	25	0	0	98	33	5	0	0	38	6	81	0	0	87	223
10:15 AM	75	15	0	0	90	31	7	0	4	38	5	79	0	0	84	212
10:30 AM	67	37	0	0	104	29	4	0	0	33	5	95	0	0	100	237
10:45 AM	65	24	0	0	89	29	0	0	2	29	8	74	0	0	82	200
Hourly Total	280	101	0	0	381	122	16	0	6	138	24	329	0	0	353	872
11:00 AM	91	45	0	0	136	47	3	0	0	50	8	98	0	0	106	292
11:15 AM	94	30	0	1	124	41	11	0	0	52	4	91	0	0	95	271
11:30 AM	100	40	0	0	140	50	4	0	0	54	7	96	0	0	103	297
11:45 AM	106	33	0	0	139	54	3	0	1	57	7	101	0	0	108	304
Hourly Total	391	148	0	1	539	192	21	0	1	213	26	386	0	0	412	1164
12:00 PM	97	35	0	0	132	56	2	0	0	58	6	106	0	0	112	302
12:15 PM	116	45	0	0	161	49	4	0	0	53	4	89	0	1	93	307
12:30 PM	110	42	0	0	152	42	7	0	0	49	5	100	0	0	105	306
12:45 PM	118	45	0	0	163	41	1	0	0	42	10	102	0	0	112	317
Hourly Total	441	167	0	0	608	188	14	0	0	202	25	397	0	1	422	1232
1:00 PM	120	36	0	0	156	44	4	0	0	48	5	86	0	0	91	295
1:15 PM	112	39	0	0	151	57	5	0	2	62	10	68	0	0	78	291
1:30 PM	99	45	0	0	144	35	5	0	0	40	4	91	0	0	95	279

1:45 PM	117	38	0	0	155	39	9	0	0	48	4	97	0	0	101	304
Hourly Total	448	158	0	0	606	175	23	0	2	198	23	342	0	0	365	1169
2:00 PM	128	39	0	0	167	51	4	0	0	55	9	106	0	0	115	337
2:15 PM	93	54	0	0	147	35	3	0	1	38	7	86	0	0	93	278
2:30 PM	114	69	0	0	183	39	3	0	0	42	13	112	0	0	125	350
2:45 PM	133	71	0	0	204	41	2	0	0	43	9	102	0	0	111	358
Hourly Total	468	233	0	0	701	166	12	0	1	178	38	406	0	0	444	1323
3:00 PM	143	63	0	0	206	90	4	0	1	94	13	122	0	0	135	435
3:15 PM	168	39	0	0	207	63	7	0	0	70	7	119	0	1	126	403
3:30 PM	143	72	0	0	215	69	5	0	0	74	14	132	0	2	146	435
3:45 PM	194	81	0	0	275	63	3	0	2	66	4	137	0	2	141	482
Hourly Total	648	255	0	0	903	285	19	0	3	304	38	510	0	5	548	1755
4:00 PM	200	43	0	0	243	74	3	0	2	77	8	136	0	0	144	464
4:15 PM	175	56	0	0	231	65	6	0	0	71	15	121	0	0	136	438
4:30 PM	188	51	0	1	239	74	8	0	2	82	12	120	0	0	132	453
4:45 PM	204	62	0	0	266	57	2	0	0	59	7	148	0	0	155	480
Hourly Total	767	212	0	1	979	270	19	0	4	289	42	525	0	0	567	1835
5:00 PM	206	48	0	0	254	54	2	0	0	56	7	145	0	0	152	462
5:15 PM	208	47	0	0	255	53	3	0	0	56	10	151	0	0	161	472
5:30 PM	177	41	0	0	218	59	4	0	1	63	12	148	0	0	160	441
5:45 PM	191	34	0	0	225	49	3	0	0	52	10	141	0	0	151	428
Hourly Total	782	170	0	0	952	215	12	0	1	227	39	585	0	0	624	1803
Grand Total	5246	1966	0	2	7212	2204	165	0	32	2369	391	5648	0	7	6039	15620
Approach %	72.7	27.3	0.0	-	-	93.0	7.0	0.0	-	-	6.5	93.5	0.0	-	-	-
Total %	33.6	12.6	0.0	-	46.2	14.1	1.1	0.0	-	15.2	2.5	36.2	0.0	-	38.7	-
Lights	5134	1889	0	-	7023	2138	160	0	-	2298	378	5522	0	-	5900	15221
% Lights	97.9	96.1	-	-	97.4	97.0	97.0	-	-	97.0	96.7	97.8	-	-	97.7	97.4
Buses	36	36	0	-	72	32	2	0	-	34	6	44	0	-	50	156
% Buses	0.7	1.8	-	-	1.0	1.5	1.2	-	-	1.4	1.5	0.8	-	-	0.8	1.0
Trucks	76	41	0	-	117	34	3	0	-	37	7	82	0	-	89	243
% Trucks	1.4	2.1	-	-	1.6	1.5	1.8	-	-	1.6	1.8	1.5	-	-	1.5	1.6
Bicycles on Crosswalk	-	-	-	0	-	-	-	-	5	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	0.0	-	-	-	-	15.6	-	-	-	-	0.0	-	-
Pedestrians	-	-	-	2	-	-	-	-	27	-	-	-	-	7	-	-
% Pedestrians	-	-	-	100.0	-	-	-	-	84.4	-	-	-	-	100.0	-	-



MSA Professional Services, Inc.  
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Count Name: Radford Rd  
Site Code:  
Start Date: 05/15/2019  
Page No: 3



Turning Movement Data Plot

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Count Name: Radford Rd  
Site Code:  
Start Date: 05/15/2019  
Page No: 4

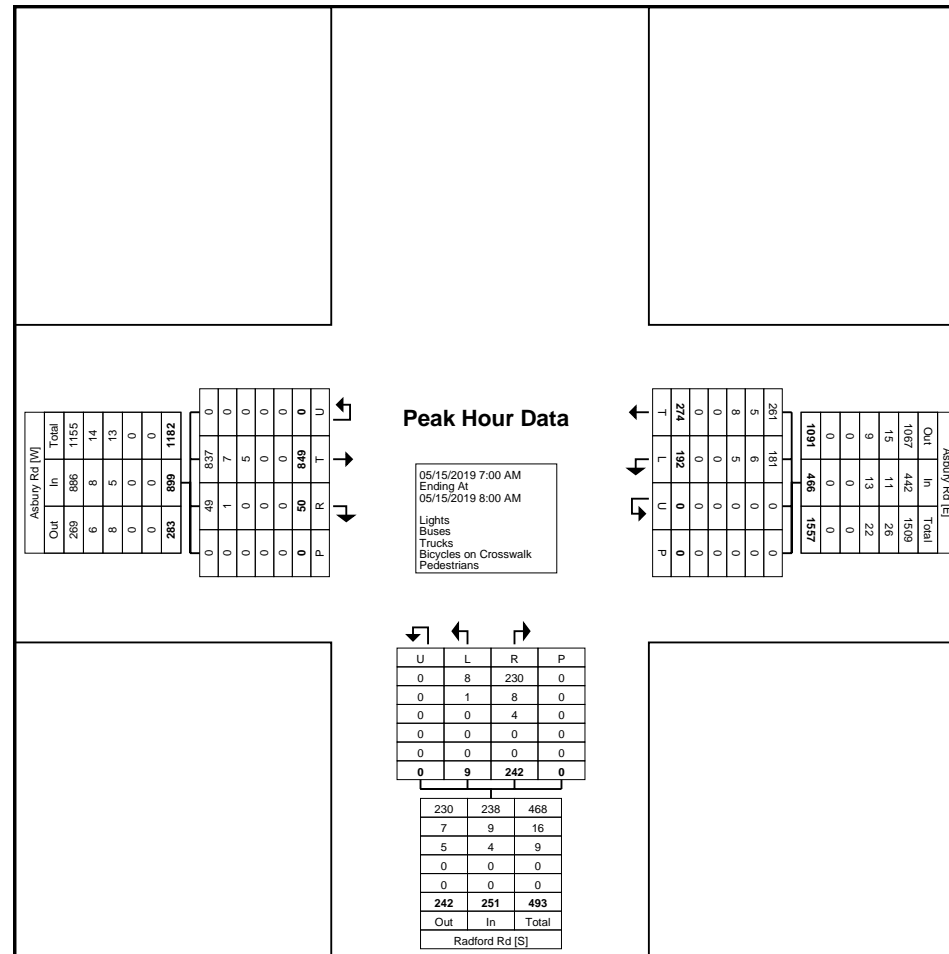
### Turning Movement Peak Hour Data (7:00 AM)

[illegible]



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Turning Movement Peak Hour Data Plot (7:00 AM)



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Page No: 6

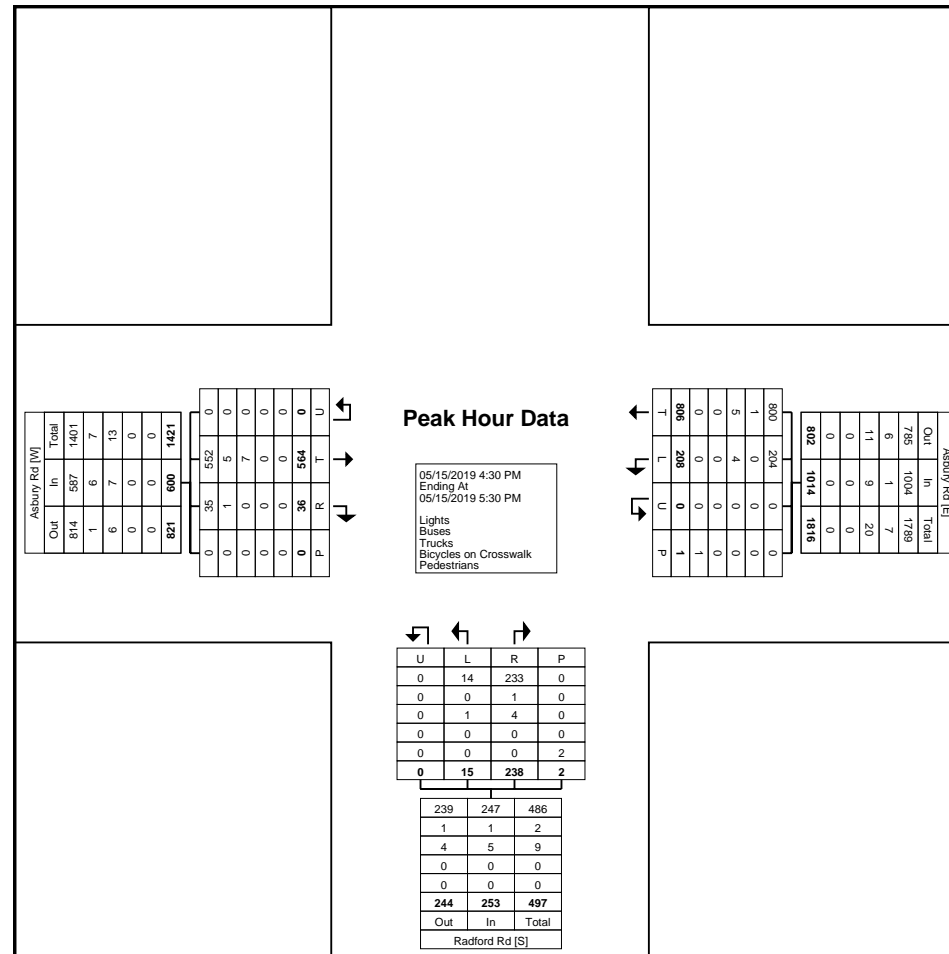
### Turning Movement Peak Hour Data (4:30 PM)

Start Time	Asbury Rd Westbound					Radford Rd Northbound					Asbury Rd Eastbound					Int. Total
	Thru	Left	U-Turn	Peds	App. Total	Right	Left	U-Turn	Peds	App. Total	Right	Thru	U-Turn	Peds	App. Total	
4:30 PM	188	51	0	1	239	74	8	0	2	82	12	120	0	0	132	453
4:45 PM	204	62	0	0	266	57	2	0	0	59	7	148	0	0	155	480
5:00 PM	206	48	0	0	254	54	2	0	0	56	7	145	0	0	152	462
5:15 PM	208	47	0	0	255	53	3	0	0	56	10	151	0	0	161	472
Total	806	208	0	1	1014	238	15	0	2	253	36	564	0	0	600	1867
Approach %	79.5	20.5	0.0	-	-	94.1	5.9	0.0	-	-	6.0	94.0	0.0	-	-	-
Total %	43.2	11.1	0.0	-	54.3	12.7	0.8	0.0	-	13.6	1.9	30.2	0.0	-	32.1	-
PHF	0.969	0.839	0.000	-	0.953	0.804	0.469	0.000	-	0.771	0.750	0.934	0.000	-	0.932	0.972
Lights	800	204	0	-	1004	233	14	0	-	247	35	552	0	-	587	1838
% Lights	99.3	98.1	-	-	99.0	97.9	93.3	-	-	97.6	97.2	97.9	-	-	97.8	98.4
Buses	1	0	0	-	1	1	0	0	-	1	1	5	0	-	6	8
% Buses	0.1	0.0	-	-	0.1	0.4	0.0	-	-	0.4	2.8	0.9	-	-	1.0	0.4
Trucks	5	4	0	-	9	4	1	0	-	5	0	7	0	-	7	21
% Trucks	0.6	1.9	-	-	0.9	1.7	6.7	-	-	2.0	0.0	1.2	-	-	1.2	1.1
Bicycles on Crosswalk	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	0.0	-	-	-	-	0.0	-	-	-	-	-	-	-
Pedestrians	-	-	-	1	-	-	-	-	2	-	-	-	-	0	-	-
% Pedestrians	-	-	-	100.0	-	-	-	-	100.0	-	-	-	-	-	-	-



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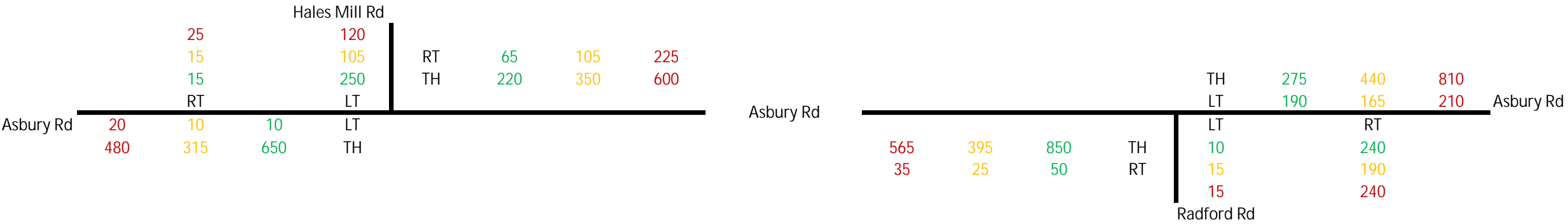
Count Name: Radford Rd  
Site Code:  
Start Date: 05/15/2019  
Page No: 7



Turning Movement Peak Hour Data Plot (4:30 PM)

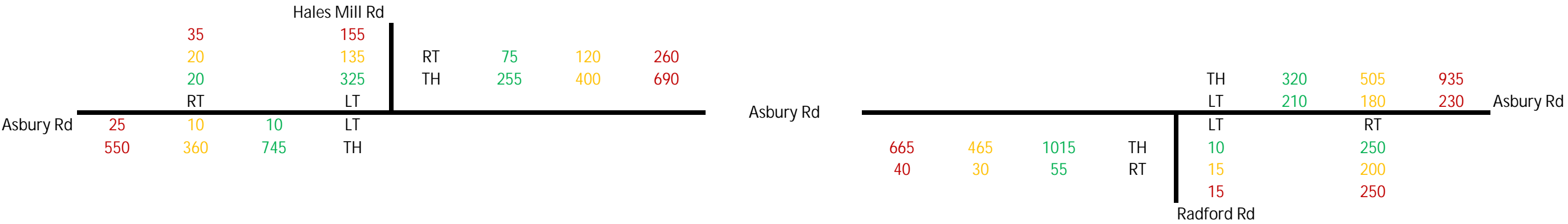
2019 Traffic Counts, Balanced Rounded

AM Peak Hour: 7:00 - 8:00 AM  
Midday Peak Hour: Noon - 1 PM  
PM Peak Hour: 4:00 - 5:00 PM

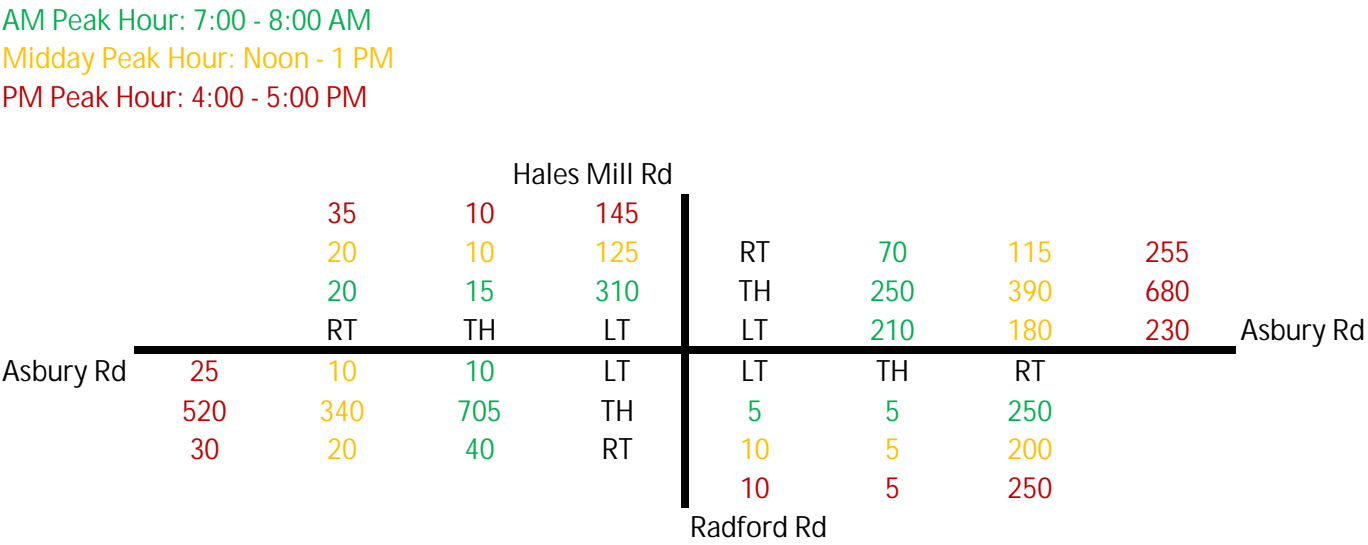


2029 Volumes

AM Peak Hour: 7:00 - 8:00 AM  
Midday Peak Hour: Noon - 1 PM  
PM Peak Hour: 4:00 - 5:00 PM

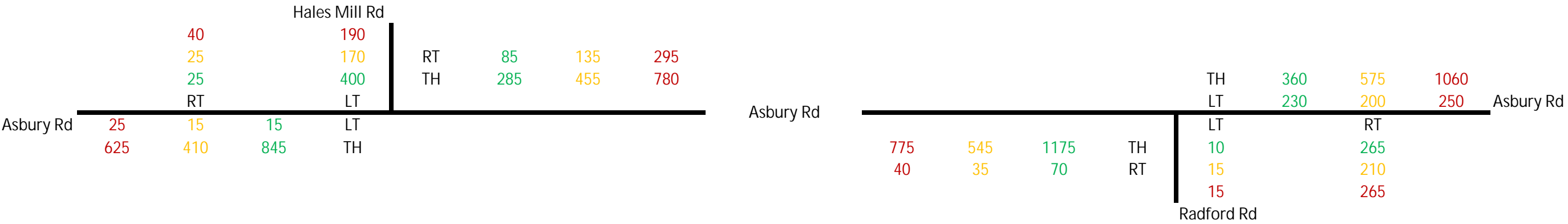


2029 Volumes, Combined Intersection

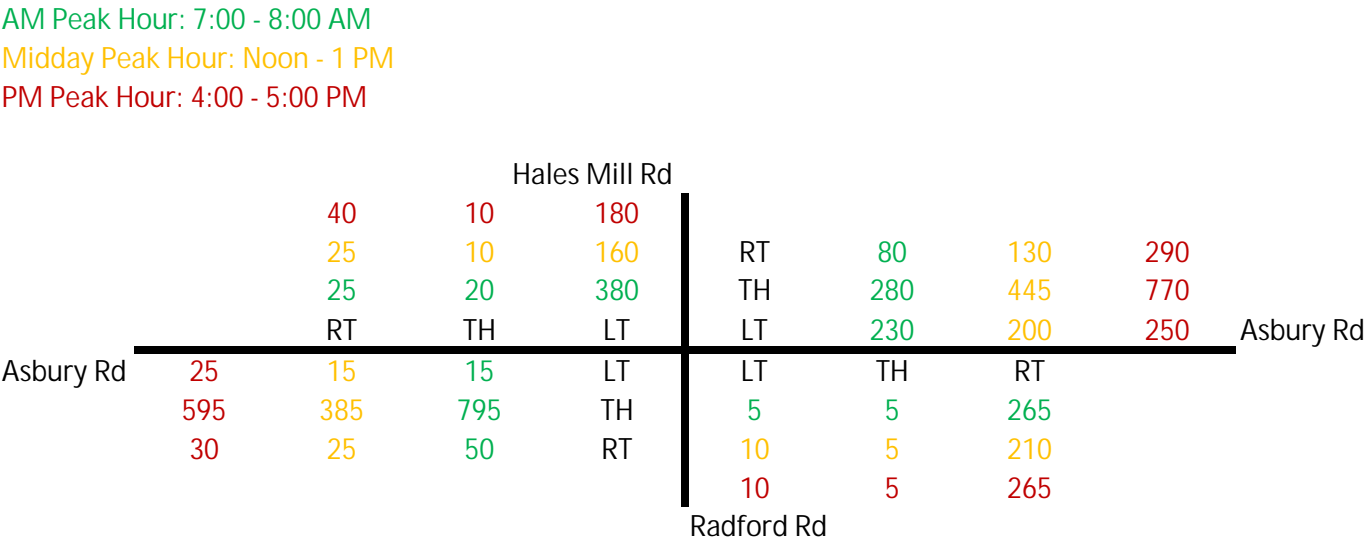


2039 Volumes

AM Peak Hour: 7:00 - 8:00 AM  
Midday Peak Hour: Noon - 1 PM  
PM Peak Hour: 4:00 - 5:00 PM








2039 Volumes, Combined Intersection



Appendix B  
Existing Transportation System Operational Analysis

Intersection

Int Delay, s/veh 29.4

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	10	650	220	65	250	15
Future Vol, veh/h	10	650	220	65	250	15
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	50	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	2	2	4	4	2	2
Mvmt Flow	11	739	250	74	284	17

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	324	0	0 1048 287
Stage 1	-	-	- 287 -
Stage 2	-	-	- 761 -
Critical Hdwy	4.12	-	- 6.42 6.22
Critical Hdwy Stg 1	-	-	- 5.42 -
Critical Hdwy Stg 2	-	-	- 5.42 -
Follow-up Hdwy	2.218	-	- 3.518 3.318
Pot Cap-1 Maneuver	1236	-	- ~ 252 752
Stage 1	-	-	- 762 -
Stage 2	-	-	- 461 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	1236	-	- ~ 250 752
Mov Cap-2 Maneuver	-	-	- ~ 250 -
Stage 1	-	-	- 755 -
Stage 2	-	-	- 461 -

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	133.8
HCM LOS			F






Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1236	-	-	-	250	752
HCM Lane V/C Ratio	0.009	-	-	-	1.136	0.023
HCM Control Delay (s)	7.9	-	-	-	141.2	9.9
HCM Lane LOS	A	-	-	-	F	A
HCM 95th %tile Q(veh)	0	-	-	-	12.7	0.1

Notes

~: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

Intersection

Int Delay, s/veh 14.1

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	850	50	190	275	10	240
Future Vol, veh/h	850	50	190	275	10	240
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	75	-	0	150
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	87	87	87	87	87	87
Heavy Vehicles, %	2	2	5	5	5	5
Mvmt Flow	977	57	218	316	11	276






Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	1034
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.15
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.245
Pot Cap-1 Maneuver	-	-	661
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	661
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	5.4	80.9
HCM LOS			F

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	62	289	-	-	661	-
HCM Lane V/C Ratio	0.185	0.955	-	-	0.33	-
HCM Control Delay (s)	75.8	81.1	-	-	13.1	-
HCM Lane LOS	F	F	-	-	B	-
HCM 95th %tile Q(veh)	0.6	9.4	-	-	1.4	-

Intersection

Int Delay, s/veh 5.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	20	480	600	225	120	25
Future Vol, veh/h	20	480	600	225	120	25
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	50	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	21	495	619	232	124	26






Major/Minor	Major1	Major2	Minor2		
Conflicting Flow All	851	0	0	1272	735
Stage 1	-	-	-	735	-
Stage 2	-	-	-	537	-
Critical Hdwy	4.12	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	3.518	3.318
Pot Cap-1 Maneuver	788	-	-	185	420
Stage 1	-	-	-	474	-
Stage 2	-	-	-	586	-
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	788	-	-	180	420
Mov Cap-2 Maneuver	-	-	-	180	-
Stage 1	-	-	-	461	-
Stage 2	-	-	-	586	-

Approach	EB	WB	SB
HCM Control Delay, s	0.4	0	52.3
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	788	-	-	-	180	420
HCM Lane V/C Ratio	0.026	-	-	-	0.687	0.061
HCM Control Delay (s)	9.7	-	-	-	60.2	14.1
HCM Lane LOS	A	-	-	-	F	B
HCM 95th %tile Q(veh)	0.1	-	-	-	4.1	0.2

Intersection






Int Delay, s/veh 4.2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	565	35	210	810	15	240
Future Vol, veh/h	565	35	210	810	15	240
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	75	-	0	150
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	582	36	216	835	15	247

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	618
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.12
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.218
Pot Cap-1 Maneuver	-	-	962
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	962
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	2	22.7
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	62	501	-	-	962	-
HCM Lane V/C Ratio	0.249	0.494	-	-	0.225	-
HCM Control Delay (s)	81.4	19	-	-	9.8	-
HCM Lane LOS	F	C	-	-	A	-
HCM 95th %tile Q(veh)	0.9	2.7	-	-	0.9	-






Intersection						
Int Delay, s/veh	98.2					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	10	745	255	75	325	20
Future Vol, veh/h	10	745	255	75	325	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	50	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	2	2	4	4	2	2
Mvmt Flow	11	847	290	85	369	23

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	375	0	0 1202 333
Stage 1	-	-	- 333 -
Stage 2	-	-	- 869 -
Critical Hdwy	4.12	-	- 6.42 6.22
Critical Hdwy Stg 1	-	-	- 5.42 -
Critical Hdwy Stg 2	-	-	- 5.42 -
Follow-up Hdwy	2.218	-	- 3.518 3.318
Pot Cap-1 Maneuver	1183	-	- ~ 204 709
Stage 1	-	-	- 726 -
Stage 2	-	-	- 410 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	1183	-	- ~ 202 709
Mov Cap-2 Maneuver	-	-	- ~ 202 -
Stage 1	-	-	- 719 -
Stage 2	-	-	- 410 -

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	\$ 407
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1183	-	-	-	202	709
HCM Lane V/C Ratio	0.01	-	-	-	1.828	0.032
HCM Control Delay (s)	8.1	-	-	-	\$ 431.4	10.2
HCM Lane LOS	A	-	-	-	F	B
HCM 95th %tile Q(veh)	0	-	-	-	26.2	0.1

Notes			
~: Volume exceeds capacity	\$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon






Intersection						
Int Delay, s/veh	29.9					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	1015	55	210	320	10	250
Future Vol, veh/h	1015	55	210	320	10	250
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	75	-	0	150
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	87	87	87	87	87	87
Heavy Vehicles, %	2	2	5	5	5	5
Mvmt Flow	1167	63	241	368	11	287

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	1230
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.15
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.245
Pot Cap-1 Maneuver	-	-	556
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	556
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	6.5	200.9
HCM LOS			F

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	34	223	-	-	556	-
HCM Lane V/C Ratio	0.338	1.289	-	-	0.434	-
HCM Control Delay (s)	157.6	202.6	-	-	16.3	-
HCM Lane LOS	F	F	-	-	C	-
HCM 95th %tile Q(veh)	1.1	15.2	-	-	2.2	-

Notes			
~: Volume exceeds capacity	\$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon






Intersection						
Int Delay, s/veh	18.1					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	25	550	690	260	155	35
Future Vol, veh/h	25	550	690	260	155	35
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	50	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	26	567	711	268	160	36

Major/Minor	Major1	Major2	Minor2		
Conflicting Flow All	979	0	-	0	1464
Stage 1	-	-	-	-	845
Stage 2	-	-	-	-	619
Critical Hdwy	4.12	-	-	-	6.42
Critical Hdwy Stg 1	-	-	-	-	5.42
Critical Hdwy Stg 2	-	-	-	-	5.42
Follow-up Hdwy	2.218	-	-	-	3.518
Pot Cap-1 Maneuver	705	-	-	-	~ 141
Stage 1	-	-	-	-	421
Stage 2	-	-	-	-	537
Platoon blocked, %		-	-	-	
Mov Cap-1 Maneuver	705	-	-	-	~ 136
Mov Cap-2 Maneuver	-	-	-	-	~ 136
Stage 1	-	-	-	-	405
Stage 2	-	-	-	-	537

Approach	EB	WB	SB
HCM Control Delay, s	0.4	0	162.4
HCM LOS			F






Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	705	-	-	-	136	363
HCM Lane V/C Ratio	0.037	-	-	-	1.175	0.099
HCM Control Delay (s)	10.3	-	-	-	195.5	16
HCM Lane LOS	B	-	-	-	F	C
HCM 95th %tile Q(veh)	0.1	-	-	-	9.4	0.3

Notes			
~: Volume exceeds capacity	\$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection								
Int Delay, s/veh	5.1							
Movement	EBT	EBR	WBL	WBT	NBL	NBR		
Lane Configurations								
Traffic Vol, veh/h	665	40	230	935	15	250		
Future Vol, veh/h	665	40	230	935	15	250		
Conflicting Peds, #/hr	0	0	0	0	0	0		
Sign Control	Free	Free	Free	Free	Stop	Stop		
RT Channelized	-	None	-	None	-	None		
Storage Length	-	-	75	-	0	150		
Veh in Median Storage, #	0	-	-	0	0	-		
Grade, %	0	-	-	0	0	-		
Peak Hour Factor	97	97	97	97	97	97		
Heavy Vehicles, %	2	2	2	2	2	2		
Mvmt Flow	686	41	237	964	15	258		
Major/Minor	Major1		Major2		Minor1			
Conflicting Flow All	0	0	727	0	2145	707		
Stage 1	-	-	-	-	707	-		
Stage 2	-	-	-	-	1438	-		
Critical Hdwy	-	-	4.12	-	6.42	6.22		
Critical Hdwy Stg 1	-	-	-	-	5.42	-		
Critical Hdwy Stg 2	-	-	-	-	5.42	-		
Follow-up Hdwy	-	-	2.218	-	3.518	3.318		
Pot Cap-1 Maneuver	-	-	876	-	53	435		
Stage 1	-	-	-	-	489	-		
Stage 2	-	-	-	-	219	-		
Platoon blocked, %	-	-		-				
Mov Cap-1 Maneuver	-	-	876	-	39	435		
Mov Cap-2 Maneuver	-	-	-	-	39	-		
Stage 1	-	-	-	-	356	-		
Stage 2	-	-	-	-	219	-		
Approach	EB		WB		NB			
HCM Control Delay, s	0		2.1		31.6			
HCM LOS	D							
Minor Lane/Major Mvmt	NBLn1		NBLn2		EBT	EBR	WBL	WBT
Capacity (veh/h)	39		435		-	-	876	-
HCM Lane V/C Ratio	0.397		0.592		-	-	0.271	-
HCM Control Delay (s)	148.4		24.6		-	-	10.6	-
HCM Lane LOS	F		C		-	-	B	-
HCM 95th %tile Q(veh)	1.4		3.7		-	-	1.1	-

Intersection

Int Delay, s/veh 215.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	15	845	285	85	400	25
Future Vol, veh/h	15	845	285	85	400	25
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	50	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	2	2	4	4	2	2
Mvmt Flow	17	960	324	97	455	28

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	421	0	0 1367 373
Stage 1	-	-	- 373 -
Stage 2	-	-	- 994 -
Critical Hdwy	4.12	-	- 6.42 6.22
Critical Hdwy Stg 1	-	-	- 5.42 -
Critical Hdwy Stg 2	-	-	- 5.42 -
Follow-up Hdwy	2.218	-	- 3.518 3.318
Pot Cap-1 Maneuver	1138	-	- ~ 162 673
Stage 1	-	-	- 696 -
Stage 2	-	-	- ~ 358 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	1138	-	- ~ 160 673
Mov Cap-2 Maneuver	-	-	- ~ 160 -
Stage 1	-	-	- 686 -
Stage 2	-	-	- ~ 358 -

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	\$ 837.6
HCM LOS			F






Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1138	-	-	-	160	673
HCM Lane V/C Ratio	0.015	-	-	-	2.841	0.042
HCM Control Delay (s)	8.2	-	-	-	\$ 889.3	10.6
HCM Lane LOS	A	-	-	-	F	B
HCM 95th %tile Q(veh)	0	-	-	-	41	0.1

Notes

~: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

Intersection

Int Delay, s/veh 57.2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	1175	70	230	360	10	265
Future Vol, veh/h	1175	70	230	360	10	265
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	75	-	0	150
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	87	87	87	87	87	87
Heavy Vehicles, %	2	2	5	5	5	5
Mvmt Flow	1351	80	264	414	11	305






Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	1431
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.15
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.245
Pot Cap-1 Maneuver	-	-	466
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	466
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	8.7	\$ 419.9
HCM LOS			F

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	17	171	-	-	466	-
HCM Lane V/C Ratio	0.676	1.781	-	-	0.567	-
HCM Control Delay (s)	\$ 408	\$ 420.4	-	-	22.4	-
HCM Lane LOS	F	F	-	-	C	-
HCM 95th %tile Q(veh)	1.8	21.9	-	-	3.5	-

Notes

~: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

Intersection						
Int Delay, s/veh	49.2					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	25	625	780	295	190	40
Future Vol, veh/h	25	625	780	295	190	40
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	50	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	26	644	804	304	196	41

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	1108	0	0 1652 956
Stage 1	-	-	- 956 -
Stage 2	-	-	- 696 -
Critical Hdwy	4.12	-	- 6.42 6.22
Critical Hdwy Stg 1	-	-	- 5.42 -
Critical Hdwy Stg 2	-	-	- 5.42 -
Follow-up Hdwy	2.218	-	- 3.518 3.318
Pot Cap-1 Maneuver	630	-	- ~ 108 313
Stage 1	-	-	- 373 -
Stage 2	-	-	- 495 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	630	-	- ~ 104 313
Mov Cap-2 Maneuver	-	-	- ~ 104 -
Stage 1	-	-	- 358 -
Stage 2	-	-	- 495 -






Approach	EB	WB	SB
HCM Control Delay, s	0.4	0	\$ 416.9
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	630	-	-	-	104	313
HCM Lane V/C Ratio	0.041	-	-	-	1.883	0.132
HCM Control Delay (s)	11	-	-	-	\$ 500.8	18.2
HCM Lane LOS	B	-	-	-	F	C
HCM 95th %tile Q(veh)	0.1	-	-	-	16.1	0.4

Notes			
-: Volume exceeds capacity	\$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection

Int Delay, s/veh 7.1

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	775	40	250	1060	15	265
Future Vol, veh/h	775	40	250	1060	15	265
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	75	-	0	150
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	799	41	258	1093	15	273

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	840
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.12
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.218
Pot Cap-1 Maneuver	-	-	795
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	795
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	2.2	50.5
HCM LOS			F

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	24	375	-	-	795	-
HCM Lane V/C Ratio	0.644	0.729	-	-	0.324	-
HCM Control Delay (s)	298.3	36.5	-	-	11.7	-
HCM Lane LOS	F	E	-	-	B	-
HCM 95th %tile Q(veh)	1.9	5.6	-	-	1.4	-

## Appendix C

### Initial Alternatives Operational Analysis

- I. Alternative 1, Traffic Signal with Existing Lanes/Geometry
- II. Alternative 2, Traffic Signal, with Two Eastbound Lanes
- III. Alternative 3, Mini Roundabout
- IV. Alternative 4, Single-lane Roundabout
- V. Alternative 5, Multilane Roundabout

## Appendix C

### Initial Alternatives Operational Analysis

#### I. Alternative 1, Traffic Signal with Existing Lanes/Geometry

Lanes, Volumes, Timings  
5: Radford Rd & Asbury Rd

08/30/2019

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↗		↖	↗	↖	↗
Traffic Volume (vph)	850	50	190	275	10	240
Future Volume (vph)	850	50	190	275	10	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		0	75		0	150
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.993					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	1850	0	1719	1810	1719	1538
Flt Permitted			0.072		0.950	
Satd. Flow (perm)	1850	0	130	1810	1719	1538
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	5					111
Link Speed (mph)	35			35	35	
Link Distance (ft)	654			1327	414	
Travel Time (s)	12.7			25.9	8.1	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Heavy Vehicles (%)	2%	2%	5%	5%	5%	5%
Adj. Flow (vph)	977	57	218	316	11	276
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1034	0	218	316	11	276
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)		9	15		15	9
Number of Detectors	2		1	2	1	1
Detector Template	Thru		Left	Thru	Left	Right
Leading Detector (ft)	100		20	100	20	20
Trailing Detector (ft)	0		0	0	0	0
Detector 1 Position(ft)	0		0	0	0	0
Detector 1 Size(ft)	6		20	6	20	20
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	0.0
Detector 2 Position(ft)	94			94		
Detector 2 Size(ft)	6			6		
Detector 2 Type	Cl+Ex			Cl+Ex		
Detector 2 Channel						
Detector 2 Extend (s)	0.0			0.0		
Turn Type	NA		pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	8	1

# Lanes, Volumes, Timings

## 5: Radford Rd & Asbury Rd

08/30/2019

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Permitted Phases			6		8	
Detector Phase	2		1	6	8	1
Switch Phase						
Minimum Initial (s)	10.0		5.0	15.0	10.0	5.0
Minimum Split (s)	25.0		9.5	21.0	16.0	9.5
Total Split (s)	57.0		15.0	72.0	18.0	15.0
Total Split (%)	63.3%		16.7%	80.0%	20.0%	16.7%
Maximum Green (s)	51.0		10.5	66.0	12.0	10.5
Yellow Time (s)	4.0		3.5	4.0	4.0	3.5
All-Red Time (s)	2.0		1.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		4.5	6.0	6.0	4.5
Lead/Lag	Lag		Lead		Lead	
Lead-Lag Optimize?	Yes		Yes		Yes	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Recall Mode	Max		None	None	Max	None
Walk Time (s)	7.0					
Flash Dont Walk (s)	12.0					
Pedestrian Calls (#/hr)	0					
Act Effct Green (s)	51.0		66.9	65.4	12.0	27.9
Actuated g/C Ratio	0.57		0.75	0.73	0.13	0.31
v/c Ratio	0.98		0.80	0.24	0.05	0.50
Control Delay	43.2		41.7	4.4	34.7	18.0
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	43.2		41.7	4.4	34.7	18.0
LOS	D		D	A	C	B
Approach Delay	43.2			19.6	18.7	
Approach LOS	D			B	B	

### Intersection Summary

Area Type: Other  
 Cycle Length: 90  
 Actuated Cycle Length: 89.4  
 Natural Cycle: 90  
 Control Type: Actuated-Uncoordinated  
 Maximum v/c Ratio: 0.98  
 Intersection Signal Delay: 32.6  
 Intersection LOS: C  
 Intersection Capacity Utilization 80.4%  
 ICU Level of Service D  
 Analysis Period (min) 15

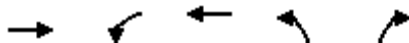
Splits and Phases: 5: Radford Rd & Asbury Rd



## Queues

## 5: Radford Rd &amp; Asbury Rd

08/30/2019



Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	1034	218	316	11	276
v/c Ratio	0.98	0.80	0.24	0.05	0.50
Control Delay	43.2	41.7	4.4	34.7	18.0
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	43.2	41.7	4.4	34.7	18.0
Queue Length 50th (ft)	534	69	48	6	72
Queue Length 95th (ft)	#798	#168	72	20	139
Internal Link Dist (ft)	574		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	1058	283	1337	230	565
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	0.98	0.77	0.24	0.05	0.49

## Intersection Summary

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

# HCM 6th Signalized Intersection Summary 5: Radford Rd & Asbury Rd

08/30/2019

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↰		↱	↲	↳	↴
Traffic Volume (veh/h)	850	50	190	275	10	240
Future Volume (veh/h)	850	50	190	275	10	240
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1826	1826	1826	1826
Adj Flow Rate, veh/h	977	57	218	316	11	276
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Percent Heavy Veh, %	2	2	5	5	5	5
Cap, veh/h	1038	61	257	1316	243	333
Arrive On Green	0.59	0.59	0.08	0.72	0.14	0.14
Sat Flow, veh/h	1750	102	1739	1826	1739	1547
Grp Volume(v), veh/h	0	1034	218	316	11	276
Grp Sat Flow(s),veh/h/ln	0	1852	1739	1826	1739	1547
Q Serve(g_s), s	0.0	44.2	4.3	5.0	0.5	12.0
Cycle Q Clear(g_c), s	0.0	44.2	4.3	5.0	0.5	12.0
Prop In Lane		0.06	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	0	1098	257	1316	243	333
V/C Ratio(X)	0.00	0.94	0.85	0.24	0.05	0.83
Avail Cap(c_a), veh/h	0	1098	338	1402	243	333
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	16.1	21.6	4.1	32.0	32.2
Incr Delay (d2), s/veh	0.0	16.3	14.4	0.1	0.4	20.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	20.4	3.6	1.4	0.2	7.2
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	0.0	32.4	36.0	4.1	32.4	53.0
LnGrp LOS	A	C	D	A	C	D
Approach Vol, veh/h	1034			534	287	
Approach Delay, s/veh	32.4			17.1	52.2	
Approach LOS	C			B	D	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	11.0	57.0			68.0	18.0
Change Period (Y+Rc), s	4.5	6.0			6.0	6.0
Max Green Setting (Gmax), s	10.5	51.0			66.0	12.0
Max Q Clear Time (g_c+I1), s	6.3	46.2			7.0	14.0
Green Ext Time (p_c), s	0.2	3.0			2.0	0.0
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			31.1			
HCM 6th LOS			C			
<b>Notes</b>						
User approved pedestrian interval to be less than phase max green.						

Lanes, Volumes, Timings  
5: Radford Rd & Asbury Rd

08/30/2019

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↗		↖	↗	↖	↗
Traffic Volume (vph)	565	35	210	810	15	240
Future Volume (vph)	565	35	210	810	15	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		0	75		0	150
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.992					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	1848	0	1770	1863	1770	1583
Flt Permitted			0.214		0.950	
Satd. Flow (perm)	1848	0	399	1863	1770	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	7					187
Link Speed (mph)	35			35	35	
Link Distance (ft)	652			1327	414	
Travel Time (s)	12.7			25.9	8.1	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	582	36	216	835	15	247
Shared Lane Traffic (%)						
Lane Group Flow (vph)	618	0	216	835	15	247
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)		9	15		15	9
Number of Detectors	2		1	2	1	1
Detector Template	Thru		Left	Thru	Left	Right
Leading Detector (ft)	100		20	100	20	20
Trailing Detector (ft)	0		0	0	0	0
Detector 1 Position(ft)	0		0	0	0	0
Detector 1 Size(ft)	6		20	6	20	20
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	0.0
Detector 2 Position(ft)	94			94		
Detector 2 Size(ft)	6			6		
Detector 2 Type	Cl+Ex			Cl+Ex		
Detector 2 Channel						
Detector 2 Extend (s)	0.0			0.0		
Turn Type	NA		pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	8	1
Permitted Phases			6			8

Lanes, Volumes, Timings  
5: Radford Rd & Asbury Rd

08/30/2019

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Detector Phase	2		1	6	8	1
Switch Phase						
Minimum Initial (s)	10.0		6.0	15.0	10.0	6.0
Minimum Split (s)	25.0		10.5	21.0	16.0	10.5
Total Split (s)	32.0		12.0	44.0	16.0	12.0
Total Split (%)	53.3%		20.0%	73.3%	26.7%	20.0%
Maximum Green (s)	26.0		7.5	38.0	10.0	7.5
Yellow Time (s)	4.0		3.5	4.0	4.0	3.5
All-Red Time (s)	2.0		1.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		4.5	6.0	6.0	4.5
Lead/Lag	Lag		Lead		Lead	
Lead-Lag Optimize?	Yes		Yes		Yes	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Recall Mode	Min		None	None	None	None
Walk Time (s)	7.0					
Flash Dont Walk (s)	12.0					
Pedestrian Calls (#/hr)	0					
Act Effect Green (s)	18.2		31.8	35.9	10.7	9.2
Actuated g/C Ratio	0.47		0.82	0.93	0.28	0.24
v/c Ratio	0.71		0.37	0.48	0.03	0.47
Control Delay	15.0		3.5	3.7	16.3	7.7
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	15.0		3.5	3.7	16.3	7.7
LOS	B		A	A	B	A
Approach Delay	15.0			3.7	8.2	
Approach LOS	B			A	A	

Intersection Summary

Area Type: Other  
 Cycle Length: 60  
 Actuated Cycle Length: 38.7  
 Natural Cycle: 60  
 Control Type: Semi Act-Uncoord  
 Maximum v/c Ratio: 0.71  
 Intersection Signal Delay: 7.9  
 Intersection Capacity Utilization 65.6%  
 Analysis Period (min) 15

Intersection LOS: A

ICU Level of Service C

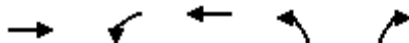
Splits and Phases: 5: Radford Rd & Asbury Rd



## Queues

## 5: Radford Rd &amp; Asbury Rd

08/30/2019



Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	618	216	835	15	247
v/c Ratio	0.71	0.37	0.48	0.03	0.47
Control Delay	15.0	3.5	3.7	16.3	7.7
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	15.0	3.5	3.7	16.3	7.7
Queue Length 50th (ft)	74	0	0	2	10
Queue Length 95th (ft)	#342	46	288	18	53
Internal Link Dist (ft)	572		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	1331	612	1715	489	551
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	0.46	0.35	0.49	0.03	0.45












## Intersection Summary






# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

# HCM 6th Signalized Intersection Summary 5: Radford Rd & Asbury Rd

08/30/2019

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	565	35	210	810	15	240
Future Volume (veh/h)	565	35	210	810	15	240
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	582	36	216	835	15	247
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	681	42	400	1095	332	468
Arrive On Green	0.39	0.39	0.11	0.59	0.19	0.19
Sat Flow, veh/h	1743	108	1781	1870	1781	1585
Grp Volume(v), veh/h	0	618	216	835	15	247
Grp Sat Flow(s),veh/h/ln	0	1851	1781	1870	1781	1585
Q Serve(g_s), s	0.0	16.1	3.4	17.6	0.4	6.8
Cycle Q Clear(g_c), s	0.0	16.1	3.4	17.6	0.4	6.8
Prop In Lane		0.06	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	0	723	400	1095	332	468
V/C Ratio(X)	0.00	0.85	0.54	0.76	0.05	0.53
Avail Cap(c_a), veh/h	0	916	460	1352	339	475
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	14.6	10.5	8.2	17.6	15.5
Incr Delay (d2), s/veh	0.0	6.5	1.1	2.1	0.1	1.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	6.7	1.0	5.1	0.1	2.2
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	0.0	21.2	11.6	10.2	17.6	16.5
LnGrp LOS	A	C	B	B	B	B
Approach Vol, veh/h	618			1051	262	
Approach Delay, s/veh	21.2			10.5	16.6	
Approach LOS	C			B	B	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	10.2	26.5			36.8	15.8
Change Period (Y+Rc), s	4.5	6.0			6.0	6.0
Max Green Setting (Gmax), s	7.5	26.0			38.0	10.0
Max Q Clear Time (g_c+I1), s	5.4	18.1			19.6	8.8
Green Ext Time (p_c), s	0.1	2.5			5.9	0.1
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			14.8			
HCM 6th LOS			B			

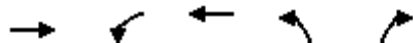
Intersection						
Int Delay, s/veh	98.2					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	10	745	255	75	325	20
Future Vol, veh/h	10	745	255	75	325	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	50	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	2	2	4	4	2	2
Mvmt Flow	11	847	290	85	369	23
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	375	0	-	0	1202	333
Stage 1	-	-	-	-	333	-
Stage 2	-	-	-	-	869	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1183	-	-	-	~ 204	709
Stage 1	-	-	-	-	726	-
Stage 2	-	-	-	-	410	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1183	-	-	-	~ 202	709
Mov Cap-2 Maneuver	-	-	-	-	~ 202	-
Stage 1	-	-	-	-	719	-
Stage 2	-	-	-	-	410	-
Approach	EB	WB		SB		
HCM Control Delay, s	0.1	0		\$ 407		
HCM LOS	F					
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1183	-	-	-	202	709
HCM Lane V/C Ratio	0.01	-	-	-	1.828	0.032
HCM Control Delay (s)	8.1	-	-	-	\$ 431.4	10.2
HCM Lane LOS	A	-	-	-	F	B
HCM 95th %tile Q(veh)	0	-	-	-	26.2	0.1
Notes						
~: Volume exceeds capacity		\$: Delay exceeds 300s		+: Computation Not Defined		*: All major volume in platoon

## Queues

## 2029 Improvements (Signal) - AM Peak Hour

## 5: Radford Rd &amp; Asbury Rd

10/03/2019



Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	1230	241	368	11	287
v/c Ratio	0.89	0.83	0.21	0.07	0.88
Control Delay	21.9	53.1	1.0	48.0	54.5
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	21.9	53.1	1.0	48.0	54.5
Queue Length 50th (ft)	482	103	0	7	125
Queue Length 95th (ft)	#1187	#267	71	27	210
Internal Link Dist (ft)	549		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	1379	304	1736	162	338
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	0.89	0.79	0.21	0.07	0.85

## Intersection Summary

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

Timing Report, Sorted By Phase  
5: Radford Rd & Asbury Rd

2029 Improvements (Signal) - AM Peak Hour

10/03/2019



Phase Number	1	2	6	8
Movement	WBL	EBT	WBTL	NBL
Lead/Lag	Lead	Lag		
Lead-Lag Optimize	Yes	Yes		
Recall Mode	None	Max	None	None
Maximum Split (s)	19	85	104	16
Maximum Split (%)	15.8%	70.8%	86.7%	13.3%
Minimum Split (s)	10.5	25	21	16
Yellow Time (s)	3.5	4	4	4
All-Red Time (s)	1	2	2	2
Minimum Initial (s)	6	15	15	10
Vehicle Extension (s)	3	3	3	3
Minimum Gap (s)	3	3	3	3
Time Before Reduce (s)	0	0	0	0
Time To Reduce (s)	0	0	0	0
Walk Time (s)				
Flash Dont Walk (s)				
Dual Entry	No	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes	Yes
Start Time (s)	0	19	0	104
End Time (s)	19	104	104	0
Yield/Force Off (s)	14.5	98	98	114
Yield/Force Off 170(s)	14.5	98	98	114
Local Start Time (s)	101	0	101	85
Local Yield (s)	115.5	79	79	95
Local Yield 170(s)	115.5	79	79	95

Intersection Summary

Cycle Length	120
Control Type	Actuated-Uncoordinated
Natural Cycle	120

Splits and Phases: 5: Radford Rd & Asbury Rd



# HCM 6th Signalized Intersection Summary

## 5: Radford Rd & Asbury Rd






2029 Improvements (Signal) - AM Peak Hour

10/03/2019

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↗		↖	↗	↖	↗
Traffic Volume (veh/h)	1015	55	210	320	10	250
Future Volume (veh/h)	1015	55	210	320	10	250
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1826	1826	1826	1826
Adj Flow Rate, veh/h	1167	63	241	368	11	287
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Percent Heavy Veh, %	2	2	5	5	5	5
Cap, veh/h	1161	63	266	1490	145	313
Arrive On Green	0.66	0.66	0.12	0.82	0.08	0.08
Sat Flow, veh/h	1758	95	1739	1826	1739	1547
Grp Volume(v), veh/h	0	1230	241	368	11	287
Grp Sat Flow(s),veh/h/ln	0	1853	1739	1826	1739	1547
Q Serve(g_s), s	0.0	79.0	12.2	5.6	0.7	10.0
Cycle Q Clear(g_c), s	0.0	79.0	12.2	5.6	0.7	10.0
Prop In Lane		0.05	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	0	1223	266	1490	145	313
V/C Ratio(X)	0.00	1.01	0.91	0.25	0.08	0.92
Avail Cap(c_a), veh/h	0	1223	271	1495	145	313
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	20.3	44.2	2.5	50.6	46.8
Incr Delay (d2), s/veh	0.0	27.1	30.9	0.1	0.2	30.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	38.7	9.0	1.4	0.3	10.9
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	0.0	47.4	75.1	2.6	50.8	77.4
LnGrp LOS	A	F	E	A	D	E
Approach Vol, veh/h	1230			609	298	
Approach Delay, s/veh	47.4			31.3	76.4	
Approach LOS	D			C	E	
Timer - Assigned Phs	1	2		6	8	
Phs Duration (G+Y+Rc), s	18.7	85.0		103.7	16.0	
Change Period (Y+Rc), s	4.5	6.0		6.0	6.0	
Max Green Setting (Gmax), s	14.5	79.0		98.0	10.0	
Max Q Clear Time (g_c+l1), s	14.2	81.0		7.6	12.0	
Green Ext Time (p_c), s	0.0	0.0		2.4	0.0	
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			46.9			
HCM 6th LOS			D			
<b>Notes</b>						
User approved pedestrian interval to be less than phase max green.						

Intersection

Int Delay, s/veh 18.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	25	550	690	260	155	35
Future Vol, veh/h	25	550	690	260	155	35
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	50	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	26	567	711	268	160	36

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	979	0	0 1464 845
Stage 1	-	-	- 845 -
Stage 2	-	-	- 619 -
Critical Hdwy	4.12	-	- 6.42 6.22
Critical Hdwy Stg 1	-	-	- 5.42 -
Critical Hdwy Stg 2	-	-	- 5.42 -
Follow-up Hdwy	2.218	-	- 3.518 3.318
Pot Cap-1 Maneuver	705	-	- ~ 141 363
Stage 1	-	-	- 421 -
Stage 2	-	-	- 537 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	705	-	- ~ 136 363
Mov Cap-2 Maneuver	-	-	- ~ 136 -
Stage 1	-	-	- 405 -
Stage 2	-	-	- 537 -

Approach	EB	WB	SB
HCM Control Delay, s	0.4	0	162.4
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	705	-	-	-	136	363
HCM Lane V/C Ratio	0.037	-	-	-	1.175	0.099
HCM Control Delay (s)	10.3	-	-	-	195.5	16
HCM Lane LOS	B	-	-	-	F	C
HCM 95th %tile Q(veh)	0.1	-	-	-	9.4	0.3

Notes

~: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

## Queues

## 2029 Improvements (Signal) - PM Peak Hour

## 5: Radford Rd &amp; Asbury Rd

10/03/2019



Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	727	237	964	15	258
v/c Ratio	0.75	0.46	0.55	0.04	0.54
Control Delay	16.6	6.2	4.5	19.2	11.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	16.6	6.2	4.5	19.2	11.4
Queue Length 50th (ft)	108	0	0	3	21
Queue Length 95th (ft)	#445	74	385	20	74
Internal Link Dist (ft)	571		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	1337	558	1712	426	517
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	0.54	0.42	0.56	0.04	0.50

## Intersection Summary

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

Timing Report, Sorted By Phase  
5: Radford Rd & Asbury Rd

2029 Improvements (Signal) - PM Peak Hour

10/03/2019



Phase Number	1	2	6	8
Movement	WBL	EBT	WBTL	NBL
Lead/Lag	Lead	Lag		
Lead-Lag Optimize	Yes	Yes		
Recall Mode	None	Min	None	None
Maximum Split (s)	13	36	49	16
Maximum Split (%)	20.0%	55.4%	75.4%	24.6%
Minimum Split (s)	10.5	25	21	16
Yellow Time (s)	3.5	4	4	4
All-Red Time (s)	1	2	2	2
Minimum Initial (s)	6	15	15	10
Vehicle Extension (s)	3	3	3	3
Minimum Gap (s)	3	3	3	3
Time Before Reduce (s)	0	0	0	0
Time To Reduce (s)	0	0	0	0
Walk Time (s)		7		
Flash Dont Walk (s)		12		
Dual Entry	No	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes	Yes
Start Time (s)	0	13	0	49
End Time (s)	13	49	49	0
Yield/Force Off (s)	8.5	43	43	59
Yield/Force Off 170(s)	8.5	43	43	59
Local Start Time (s)	52	0	52	36
Local Yield (s)	60.5	30	30	46
Local Yield 170(s)	60.5	30	30	46

Intersection Summary

Cycle Length	65
Control Type	Semi Act-Uncoord
Natural Cycle	65

Splits and Phases: 5: Radford Rd & Asbury Rd














# HCM 6th Signalized Intersection Summary

## 5: Radford Rd & Asbury Rd

2029 Improvements (Signal) - PM Peak Hour

10/03/2019

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	665	40	230	935	15	250
Future Volume (veh/h)	665	40	230	935	15	250
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	686	41	237	964	15	258
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	773	46	364	1162	307	433
Arrive On Green	0.44	0.44	0.10	0.62	0.17	0.17
Sat Flow, veh/h	1747	104	1781	1870	1781	1585
Grp Volume(v), veh/h	0	727	237	964	15	258
Grp Sat Flow(s),veh/h/ln	0	1852	1781	1870	1781	1585
Q Serve(g_s), s	0.0	20.9	3.8	23.4	0.4	8.2
Cycle Q Clear(g_c), s	0.0	20.9	3.8	23.4	0.4	8.2
Prop In Lane		0.06	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	0	820	364	1162	307	433
V/C Ratio(X)	0.00	0.89	0.65	0.83	0.05	0.60
Avail Cap(c_a), veh/h	0	956	445	1385	307	433
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	14.9	12.0	8.6	20.1	18.3
Incr Delay (d2), s/veh	0.0	9.1	2.4	3.8	0.1	2.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	9.1	1.3	7.2	0.2	2.9
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	0.0	24.0	14.4	12.4	20.1	20.5
LnGrp LOS	A	C	B	B	C	C
Approach Vol, veh/h	727			1201	273	
Approach Delay, s/veh	24.0			12.8	20.5	
Approach LOS	C			B	C	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	10.4	31.7			42.1	16.0
Change Period (Y+Rc), s	4.5	6.0			6.0	6.0
Max Green Setting (Gmax), s	8.5	30.0			43.0	10.0
Max Q Clear Time (g_c+l1), s	5.8	22.9			25.4	10.2
Green Ext Time (p_c), s	0.2	2.8			7.1	0.0
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			17.4			
HCM 6th LOS			B			

## Appendix C

### Initial Alternatives Operational Analysis

#### II. Alternative 2, Traffic Signal, with Two Eastbound Lanes

Lanes, Volumes, Timings  
5: Radford Rd & Asbury Rd

08/30/2019

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↘	↑	↘	↗
Traffic Volume (vph)	850	50	190	275	10	240
Future Volume (vph)	850	50	190	275	10	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		0	75		0	150
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	1.00
Frt	0.992					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3511	0	1719	1810	1719	1538
Flt Permitted			0.145		0.950	
Satd. Flow (perm)	3511	0	262	1810	1719	1538
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	12					41
Link Speed (mph)	35			35	35	
Link Distance (ft)	654			1327	414	
Travel Time (s)	12.7			25.9	8.1	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Heavy Vehicles (%)	2%	2%	5%	5%	5%	5%
Adj. Flow (vph)	977	57	218	316	11	276
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1034	0	218	316	11	276
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)		9	15		15	9
Number of Detectors	2		1	2	1	1
Detector Template	Thru		Left	Thru	Left	Right
Leading Detector (ft)	100		20	100	20	20
Trailing Detector (ft)	0		0	0	0	0
Detector 1 Position(ft)	0		0	0	0	0
Detector 1 Size(ft)	6		20	6	20	20
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	0.0
Detector 2 Position(ft)	94			94		
Detector 2 Size(ft)	6			6		
Detector 2 Type	Cl+Ex			Cl+Ex		
Detector 2 Channel						
Detector 2 Extend (s)	0.0			0.0		
Turn Type	NA		pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	8	1

# Lanes, Volumes, Timings

## 5: Radford Rd & Asbury Rd

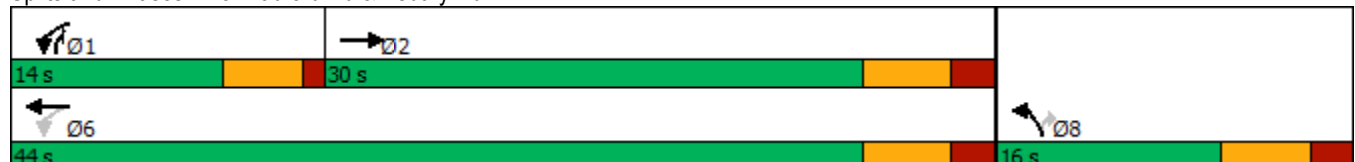
08/30/2019

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Permitted Phases			6		8	
Detector Phase	2		1	6	8	1
Switch Phase						
Minimum Initial (s)	15.0		6.0	15.0	10.0	6.0
Minimum Split (s)	25.0		10.5	21.0	16.0	10.5
Total Split (s)	30.0		14.0	44.0	16.0	14.0
Total Split (%)	50.0%		23.3%	73.3%	26.7%	23.3%
Maximum Green (s)	24.0		9.5	38.0	10.0	9.5
Yellow Time (s)	4.0		3.5	4.0	4.0	3.5
All-Red Time (s)	2.0		1.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		4.5	6.0	6.0	4.5
Lead/Lag	Lag		Lead		Lead	
Lead-Lag Optimize?	Yes		Yes		Yes	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Recall Mode	Max		None	None	Max	None
Walk Time (s)	7.0					
Flash Dont Walk (s)	12.0					
Pedestrian Calls (#/hr)	0					
Act Effect Green (s)	24.0		38.2	36.7	10.0	24.2
Actuated g/C Ratio	0.41		0.65	0.63	0.17	0.41
v/c Ratio	0.72		0.58	0.28	0.04	0.42
Control Delay	18.0		13.0	5.7	21.4	12.6
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	18.0		13.0	5.7	21.4	12.6
LOS	B		B	A	C	B
Approach Delay	18.0			8.7	12.9	
Approach LOS	B			A	B	

### Intersection Summary

Area Type: Other  
 Cycle Length: 60  
 Actuated Cycle Length: 58.7  
 Natural Cycle: 60  
 Control Type: Actuated-Uncoordinated  
 Maximum v/c Ratio: 0.72  
 Intersection Signal Delay: 14.5  
 Intersection LOS: B  
 Intersection Capacity Utilization 57.7%  
 ICU Level of Service B  
 Analysis Period (min) 15






Splits and Phases: 5: Radford Rd & Asbury Rd



## Queues

## 5: Radford Rd &amp; Asbury Rd












08/30/2019

					
Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	1034	218	316	11	276
v/c Ratio	0.72	0.58	0.28	0.04	0.42
Control Delay	18.0	13.0	5.7	21.4	12.6
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	18.0	13.0	5.7	21.4	12.6
Queue Length 50th (ft)	152	25	43	3	55
Queue Length 95th (ft)	212	69	71	14	103
Internal Link Dist (ft)	574		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	1442	406	1171	292	691
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	0.72	0.54	0.27	0.04	0.40
Intersection Summary					

# HCM 6th Signalized Intersection Summary

## 5: Radford Rd & Asbury Rd

08/30/2019

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	850	50	190	275	10	240
Future Volume (veh/h)	850	50	190	275	10	240
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1826	1826	1826	1826
Adj Flow Rate, veh/h	977	57	218	316	11	276
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Percent Heavy Veh, %	2	2	5	5	5	5
Cap, veh/h	1455	85	412	1112	309	434
Arrive On Green	0.43	0.43	0.10	0.61	0.18	0.18
Sat Flow, veh/h	3506	199	1739	1826	1739	1547
Grp Volume(v), veh/h	509	525	218	316	11	276
Grp Sat Flow(s),veh/h/ln	1777	1835	1739	1826	1739	1547
Q Serve(g_s), s	13.0	13.0	3.5	4.6	0.3	8.8
Cycle Q Clear(g_c), s	13.0	13.0	3.5	4.6	0.3	8.8
Prop In Lane		0.11	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	757	782	412	1112	309	434
V/C Ratio(X)	0.67	0.67	0.53	0.28	0.04	0.64
Avail Cap(c_a), veh/h	757	782	526	1232	309	434
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.0	13.0	9.5	5.2	19.2	17.7
Incr Delay (d2), s/veh	4.7	4.6	1.1	0.1	0.2	6.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.2	5.3	1.0	1.2	0.1	3.6
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	17.7	17.6	10.5	5.3	19.4	24.7
LnGrp LOS	B	B	B	A	B	C
Approach Vol, veh/h	1034			534	287	
Approach Delay, s/veh	17.6			7.5	24.5	
Approach LOS	B			A	C	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	10.3	30.0			40.3	16.0
Change Period (Y+Rc), s	4.5	6.0			6.0	6.0
Max Green Setting (Gmax), s	9.5	24.0			38.0	10.0
Max Q Clear Time (g_c+I1), s	5.5	15.0			6.6	10.8
Green Ext Time (p_c), s	0.2	4.3			1.9	0.0
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			15.8			
HCM 6th LOS			B			
<b>Notes</b>						
User approved pedestrian interval to be less than phase max green.						

Lanes, Volumes, Timings  
5: Radford Rd & Asbury Rd

08/30/2019

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↘	↑	↘	↗
Traffic Volume (vph)	565	35	210	810	15	240
Future Volume (vph)	565	35	210	810	15	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		0	75		0	150
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	1.00
Frt	0.991					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3507	0	1770	1863	1770	1583
Flt Permitted			0.328		0.950	
Satd. Flow (perm)	3507	0	611	1863	1770	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	13					126
Link Speed (mph)	35			35	35	
Link Distance (ft)	652			1327	414	
Travel Time (s)	12.7			25.9	8.1	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	582	36	216	835	15	247
Shared Lane Traffic (%)						
Lane Group Flow (vph)	618	0	216	835	15	247
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)		9	15		15	9
Number of Detectors	2		1	2	1	1
Detector Template	Thru		Left	Thru	Left	Right
Leading Detector (ft)	100		20	100	20	20
Trailing Detector (ft)	0		0	0	0	0
Detector 1 Position(ft)	0		0	0	0	0
Detector 1 Size(ft)	6		20	6	20	20
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	0.0
Detector 2 Position(ft)	94			94		
Detector 2 Size(ft)	6			6		
Detector 2 Type	Cl+Ex			Cl+Ex		
Detector 2 Channel						
Detector 2 Extend (s)	0.0			0.0		
Turn Type	NA		pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	8	1
Permitted Phases			6			8

# Lanes, Volumes, Timings

## 5: Radford Rd & Asbury Rd

08/30/2019

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Detector Phase	2		1	6	8	1
Switch Phase						
Minimum Initial (s)	15.0		6.0	15.0	10.0	6.0
Minimum Split (s)	25.0		10.5	21.0	16.0	10.5
Total Split (s)	25.6		13.4	39.0	16.0	13.4
Total Split (%)	46.5%		24.4%	70.9%	29.1%	24.4%
Maximum Green (s)	19.6		8.9	33.0	10.0	8.9
Yellow Time (s)	4.0		3.5	4.0	4.0	3.5
All-Red Time (s)	2.0		1.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		4.5	6.0	6.0	4.5
Lead/Lag	Lag		Lead			Lead
Lead-Lag Optimize?	Yes		Yes			Yes
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Recall Mode	Min		None	None	None	None
Walk Time (s)	7.0					
Flash Dont Walk (s)	12.0					
Pedestrian Calls (#/hr)	0					
Act Effect Green (s)	16.3		30.4	34.3	10.5	10.0
Actuated g/C Ratio	0.44		0.82	0.92	0.28	0.27
v/c Ratio	0.40		0.29	0.49	0.03	0.48
Control Delay	9.2		2.9	4.2	14.2	8.8
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	9.2		2.9	4.2	14.2	8.8
LOS	A		A	A	B	A
Approach Delay	9.2			4.0	9.1	
Approach LOS	A			A	A	

### Intersection Summary

Area Type: Other

Cycle Length: 55

Actuated Cycle Length: 37.3

Natural Cycle: 55

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.49

Intersection Signal Delay: 6.3

Intersection LOS: A

Intersection Capacity Utilization 61.0%

ICU Level of Service B

Analysis Period (min) 15

Splits and Phases: 5: Radford Rd & Asbury Rd



## Queues

## 5: Radford Rd &amp; Asbury Rd













08/30/2019








Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	618	216	835	15	247
v/c Ratio	0.40	0.29	0.49	0.03	0.48
Control Delay	9.2	2.9	4.2	14.2	8.8
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	9.2	2.9	4.2	14.2	8.8
Queue Length 50th (ft)	33	0	0	2	18
Queue Length 95th (ft)	119	47	298	17	58
Internal Link Dist (ft)	572		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	1932	787	1693	495	574
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	0.32	0.27	0.49	0.03	0.43
Intersection Summary					

# HCM 6th Signalized Intersection Summary 5: Radford Rd & Asbury Rd

08/30/2019

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	 					
Traffic Volume (veh/h)	565	35	210	810	15	240
Future Volume (veh/h)	565	35	210	810	15	240
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	582	36	216	835	15	247
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1089	67	513	1005	368	518
Arrive On Green	0.32	0.32	0.12	0.54	0.21	0.21
Sat Flow, veh/h	3493	210	1781	1870	1781	1585
Grp Volume(v), veh/h	304	314	216	835	15	247
Grp Sat Flow(s),veh/h/ln	1777	1833	1781	1870	1781	1585
Q Serve(g_s), s	6.6	6.6	3.3	17.5	0.3	5.8
Cycle Q Clear(g_c), s	6.6	6.6	3.3	17.5	0.3	5.8
Prop In Lane		0.11	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	569	587	513	1005	368	518
V/C Ratio(X)	0.53	0.53	0.42	0.83	0.04	0.48
Avail Cap(c_a), veh/h	744	767	637	1319	381	530
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.0	13.0	8.2	9.1	14.9	12.6
Incr Delay (d2), s/veh	0.8	0.8	0.5	3.6	0.0	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.2	2.3	1.0	5.4	0.1	1.7
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	13.8	13.8	8.7	12.6	14.9	13.2
LnGrp LOS	B	B	A	B	B	B
Approach Vol, veh/h	618			1051	262	
Approach Delay, s/veh	13.8			11.8	13.3	
Approach LOS	B			B	B	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	10.1	21.0			31.1	15.7
Change Period (Y+Rc), s	4.5	6.0			6.0	6.0
Max Green Setting (Gmax), s	8.9	19.6			33.0	10.0
Max Q Clear Time (g_c+I1), s	5.3	8.6			19.5	7.8
Green Ext Time (p_c), s	0.2	2.7			5.0	0.2
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			12.7			
HCM 6th LOS			B			

Intersection						
Int Delay, s/veh	98.2					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	10	745	255	75	325	20
Future Vol, veh/h	10	745	255	75	325	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	50	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	2	2	4	4	2	2
Mvmt Flow	11	847	290	85	369	23

Major/Minor	Major1	Major2	Minor2		
Conflicting Flow All	375	0	0	1202	333
Stage 1	-	-	-	333	-
Stage 2	-	-	-	869	-
Critical Hdwy	4.12	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	3.518	3.318
Pot Cap-1 Maneuver	1183	-	-	~ 204	709
Stage 1	-	-	-	726	-
Stage 2	-	-	-	410	-
Platoon blocked, %	-	-	-		
Mov Cap-1 Maneuver	1183	-	-	~ 202	709
Mov Cap-2 Maneuver	-	-	-	~ 202	-
Stage 1	-	-	-	719	-
Stage 2	-	-	-	410	-

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	\$ 407
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1183	-	-	-	202	709
HCM Lane V/C Ratio	0.01	-	-	-	1.828	0.032
HCM Control Delay (s)	8.1	-	-	-	\$ 431.4	10.2
HCM Lane LOS	A	-	-	-	F	B
HCM 95th %tile Q(veh)	0	-	-	-	26.2	0.1

Notes			
-: Volume exceeds capacity	\$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

## Queues

2029 Existing - AM Peak Hour

## 5: Radford Rd &amp; Asbury Rd

09/28/2019



Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	1230	241	368	11	287
v/c Ratio	0.66	0.49	0.22	0.03	0.73
Control Delay	12.3	8.9	2.1	17.8	26.5
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	12.3	8.9	2.1	17.8	26.5
Queue Length 50th (ft)	93	0	0	2	64
Queue Length 95th (ft)	#280	86	84	14	115
Internal Link Dist (ft)	549		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	1852	503	1636	371	404
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	0.66	0.48	0.22	0.03	0.71

## Intersection Summary

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

Timing Report, Sorted By Phase  
5: Radford Rd & Asbury Rd

2029 Existing - AM Peak Hour

09/28/2019



Phase Number	1	2	6	8
Movement	WBL	EBT	WBTL	NBL
Lead/Lag	Lead	Lag		
Lead-Lag Optimize	Yes	Yes		
Recall Mode	None	Max	None	None
Maximum Split (s)	13.7	30.3	44	16
Maximum Split (%)	22.8%	50.5%	73.3%	26.7%
Minimum Split (s)	10.5	25	21	16
Yellow Time (s)	3.5	4	4	4
All-Red Time (s)	1	2	2	2
Minimum Initial (s)	6	15	15	10
Vehicle Extension (s)	3	3	3	3
Minimum Gap (s)	3	3	3	3
Time Before Reduce (s)	0	0	0	0
Time To Reduce (s)	0	0	0	0
Walk Time (s)		7		
Flash Dont Walk (s)		12		
Dual Entry	No	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes	Yes
Start Time (s)	0	13.7	0	44
End Time (s)	13.7	44	44	0
Yield/Force Off (s)	9.2	38	38	54
Yield/Force Off 170(s)	9.2	26	38	54
Local Start Time (s)	46.3	0	46.3	30.3
Local Yield (s)	55.5	24.3	24.3	40.3
Local Yield 170(s)	55.5	12.3	24.3	40.3

Intersection Summary

Cycle Length	60
Control Type	Semi Act-Uncoord
Natural Cycle	60

Splits and Phases: 5: Radford Rd & Asbury Rd









# HCM 6th Signalized Intersection Summary

## 5: Radford Rd & Asbury Rd






2029 Existing - AM Peak Hour

09/28/2019

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↵	↑	↵	↵
Traffic Volume (veh/h)	1015	55	210	320	10	250
Future Volume (veh/h)	1015	55	210	320	10	250
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1826	1826	1826	1826
Adj Flow Rate, veh/h	1167	63	241	368	11	287
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Percent Heavy Veh, %	2	2	5	5	5	5
Cap, veh/h	1466	79	369	1119	306	436
Arrive On Green	0.43	0.43	0.11	0.61	0.18	0.18
Sat Flow, veh/h	3522	185	1739	1826	1739	1547
Grp Volume(v), veh/h	604	626	241	368	11	287
Grp Sat Flow(s),veh/h/ln	1777	1837	1739	1826	1739	1547
Q Serve(g_s), s	16.8	16.8	3.9	5.6	0.3	9.3
Cycle Q Clear(g_c), s	16.8	16.8	3.9	5.6	0.3	9.3
Prop In Lane		0.10	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	760	786	369	1119	306	436
V/C Ratio(X)	0.80	0.80	0.65	0.33	0.04	0.66
Avail Cap(c_a), veh/h	760	786	467	1221	306	436
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	14.1	14.1	11.3	5.3	19.4	18.0
Incr Delay (d2), s/veh	8.4	8.2	2.2	0.2	0.0	3.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	7.2	7.4	1.2	1.4	0.1	3.3
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	22.5	22.3	13.5	5.5	19.5	21.6
LnGrp LOS	C	C	B	A	B	C
Approach Vol, veh/h	1230			609	298	
Approach Delay, s/veh	22.4			8.7	21.5	
Approach LOS	C			A	C	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	10.5	30.3			40.8	16.0
Change Period (Y+Rc), s	4.5	6.0			6.0	6.0
Max Green Setting (Gmax), s	9.2	24.3			38.0	10.0
Max Q Clear Time (g_c+l1), s	5.9	18.8			7.6	11.3
Green Ext Time (p_c), s	0.2	3.4			2.3	0.0
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			18.4			
HCM 6th LOS			B			
<b>Notes</b>						
User approved pedestrian interval to be less than phase max green.						

Intersection

Int Delay, s/veh 18.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	25	550	690	260	155	35
Future Vol, veh/h	25	550	690	260	155	35
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	50	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	26	567	711	268	160	36

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	979	0	0 1464 845
Stage 1	-	-	- 845 -
Stage 2	-	-	- 619 -
Critical Hdwy	4.12	-	- 6.42 6.22
Critical Hdwy Stg 1	-	-	- 5.42 -
Critical Hdwy Stg 2	-	-	- 5.42 -
Follow-up Hdwy	2.218	-	- 3.518 3.318
Pot Cap-1 Maneuver	705	-	- ~ 141 363
Stage 1	-	-	- 421 -
Stage 2	-	-	- 537 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	705	-	- ~ 136 363
Mov Cap-2 Maneuver	-	-	- ~ 136 -
Stage 1	-	-	- 405 -
Stage 2	-	-	- 537 -

Approach	EB	WB	SB
HCM Control Delay, s	0.4	0	162.4
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	705	-	-	-	136	363
HCM Lane V/C Ratio	0.037	-	-	-	1.175	0.099
HCM Control Delay (s)	10.3	-	-	-	195.5	16
HCM Lane LOS	B	-	-	-	F	C
HCM 95th %tile Q(veh)	0.1	-	-	-	9.4	0.3

Notes

~: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

## Queues

## 2029 Improvements - PM Peak Hour

## 5: Radford Rd &amp; Asbury Rd

09/28/2019



Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	727	237	964	15	258
v/c Ratio	0.44	0.34	0.55	0.03	0.49
Control Delay	8.7	2.7	3.8	19.0	8.3
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	8.7	2.7	3.8	19.0	8.3
Queue Length 50th (ft)	38	0	0	2	11
Queue Length 95th (ft)	142	47	364	22	73
Internal Link Dist (ft)	571		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	3165	804	1754	479	645
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	0.23	0.29	0.55	0.03	0.40
Intersection Summary					

Timing Report, Sorted By Phase  
5: Radford Rd & Asbury Rd

2029 Improvements - PM Peak Hour

09/28/2019

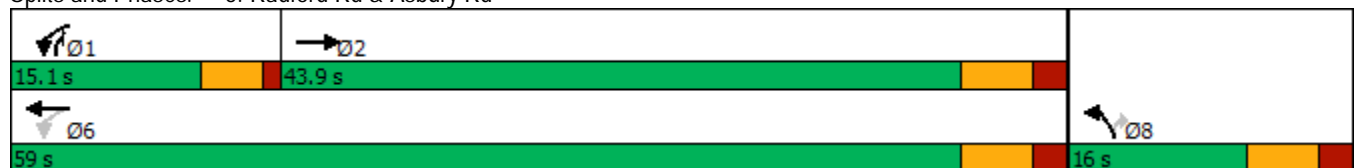


Phase Number	1	2	6	8
Movement	WBL	EBT	WBTL	NBL
Lead/Lag	Lead	Lag		
Lead-Lag Optimize	Yes	Yes		
Recall Mode	None	Min	None	None
Maximum Split (s)	15.1	43.9	59	16
Maximum Split (%)	20.1%	58.5%	78.7%	21.3%
Minimum Split (s)	10.5	25	21	16
Yellow Time (s)	3.5	4	4	4
All-Red Time (s)	1	2	2	2
Minimum Initial (s)	6	15	15	10
Vehicle Extension (s)	3	3	3	3
Minimum Gap (s)	3	3	3	3
Time Before Reduce (s)	0	0	0	0
Time To Reduce (s)	0	0	0	0
Walk Time (s)		7		
Flash Dont Walk (s)		12		
Dual Entry	No	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes	Yes
Start Time (s)	0	15.1	0	59
End Time (s)	15.1	59	59	0
Yield/Force Off (s)	10.6	53	53	69
Yield/Force Off 170(s)	10.6	53	53	69
Local Start Time (s)	59.9	0	59.9	43.9
Local Yield (s)	70.5	37.9	37.9	53.9
Local Yield 170(s)	70.5	37.9	37.9	53.9

Intersection Summary

Cycle Length	75
Control Type	Semi Act-Uncoord
Natural Cycle	60

Splits and Phases: 5: Radford Rd & Asbury Rd



# HCM 6th Signalized Intersection Summary 5: Radford Rd & Asbury Rd

2029 Improvements - PM Peak Hour












09/28/2019

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↘	↑	↘	↗
Traffic Volume (veh/h)	665	40	230	935	15	250
Future Volume (veh/h)	665	40	230	935	15	250
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	686	41	237	964	15	258
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1439	86	518	1138	315	447
Arrive On Green	0.42	0.42	0.11	0.61	0.18	0.18
Sat Flow, veh/h	3501	203	1781	1870	1781	1585
Grp Volume(v), veh/h	358	369	237	964	15	258
Grp Sat Flow(s),veh/h/ln	1777	1834	1781	1870	1781	1585
Q Serve(g_s), s	8.1	8.1	3.7	23.2	0.4	7.8
Cycle Q Clear(g_c), s	8.1	8.1	3.7	23.2	0.4	7.8
Prop In Lane		0.11	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	750	774	518	1138	315	447
V/C Ratio(X)	0.48	0.48	0.46	0.85	0.05	0.58
Avail Cap(c_a), veh/h	1207	1246	669	1777	319	451
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	11.7	11.7	7.5	8.8	19.1	17.2
Incr Delay (d2), s/veh	0.5	0.5	0.6	2.4	0.1	1.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.7	2.8	1.1	6.6	0.2	0.2
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	12.1	12.1	8.1	11.2	19.1	19.0
LnGrp LOS	B	B	A	B	B	B
Approach Vol, veh/h	727			1201	273	
Approach Delay, s/veh	12.1			10.6	19.0	
Approach LOS	B			B	B	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	10.4	29.6			39.9	15.9
Change Period (Y+Rc), s	4.5	6.0			6.0	6.0
Max Green Setting (Gmax), s	10.6	37.9			53.0	10.0
Max Q Clear Time (g_c+l1), s	5.7	10.1			25.2	9.8
Green Ext Time (p_c), s	0.3	4.7			8.7	0.0
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			12.2			
HCM 6th LOS			B			

Lanes, Volumes, Timings  
5: Radford Rd & Asbury Rd

2039 Improvements - AM Peak Hour

08/30/2019

						
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1175	70	230	360	10	265
Future Volume (vph)	1175	70	230	360	10	265
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		100	75		0	150
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	1.00
Frt	0.992					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3511	0	1719	1810	1719	1538
Flt Permitted			0.108		0.950	
Satd. Flow (perm)	3511	0	195	1810	1719	1538
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	11					20
Link Speed (mph)	35			35	35	
Link Distance (ft)	591			1327	414	
Travel Time (s)	11.5			25.9	8.1	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Heavy Vehicles (%)	2%	2%	5%	5%	5%	5%
Adj. Flow (vph)	1351	80	264	414	11	305
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1431	0	264	414	11	305
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)		9	15		15	9
Number of Detectors	2		1	2	1	1
Detector Template	Thru		Left	Thru	Left	Right
Leading Detector (ft)	100		20	100	20	20
Trailing Detector (ft)	0		0	0	0	0
Detector 1 Position(ft)	0		0	0	0	0
Detector 1 Size(ft)	6		20	6	20	20
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	0.0
Detector 2 Position(ft)	94			94		
Detector 2 Size(ft)	6			6		
Detector 2 Type	Cl+Ex			Cl+Ex		
Detector 2 Channel						
Detector 2 Extend (s)	0.0			0.0		
Turn Type	NA		pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	8	1

Lanes, Volumes, Timings  
5: Radford Rd & Asbury Rd

2039 Improvements - AM Peak Hour

08/30/2019

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Permitted Phases			6		8	
Detector Phase	2		1	6	8	1
Switch Phase						
Minimum Initial (s)	15.0		6.0	15.0	10.0	6.0
Minimum Split (s)	25.0		10.5	21.0	16.0	10.5
Total Split (s)	38.0		16.0	54.0	16.0	16.0
Total Split (%)	54.3%		22.9%	77.1%	22.9%	22.9%
Maximum Green (s)	32.0		11.5	48.0	10.0	11.5
Yellow Time (s)	4.0		3.5	4.0	4.0	3.5
All-Red Time (s)	2.0		1.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		4.5	6.0	6.0	4.5
Lead/Lag	Lag		Lead		Lead	
Lead-Lag Optimize?	Yes		Yes		Yes	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Recall Mode	Max		None	None	None	None
Walk Time (s)	7.0					
Flash Dont Walk (s)	12.0					
Pedestrian Calls (#/hr)	0					
Act Effect Green (s)	32.4		49.7	53.2	10.1	13.8
Actuated g/C Ratio	0.57		0.88	0.94	0.18	0.24
v/c Ratio	0.71		0.56	0.24	0.04	0.79
Control Delay	13.2		14.1	1.9	22.7	34.0
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	13.2		14.1	1.9	22.7	34.0
LOS	B		B	A	C	C
Approach Delay	13.2			6.6	33.6	
Approach LOS	B			A	C	

Intersection Summary

Area Type: Other

Cycle Length: 70

Actuated Cycle Length: 56.8

Natural Cycle: 70

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.79

Intersection Signal Delay: 14.0

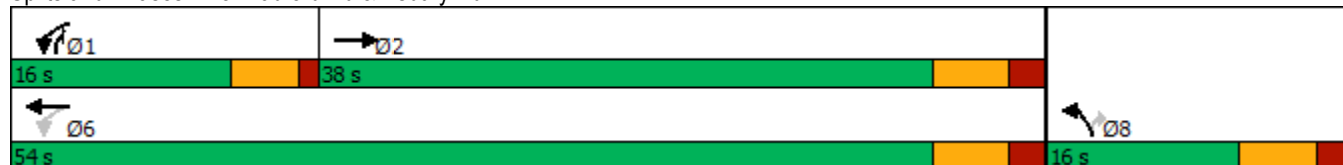
Intersection LOS: B

Intersection Capacity Utilization 69.5%

ICU Level of Service C






Analysis Period (min) 15

Splits and Phases: 5: Radford Rd & Asbury Rd



Queues  
5: Radford Rd & Asbury Rd

2039 Improvements - AM Peak Hour  
08/30/2019

					
Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	1431	264	414	11	305
v/c Ratio	0.71	0.56	0.24	0.04	0.79
Control Delay	13.2	14.1	1.9	22.7	34.0
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	13.2	14.1	1.9	22.7	34.0
Queue Length 50th (ft)	140	18	0	3	89
Queue Length 95th (ft)	#365	#127	92	17	151
Internal Link Dist (ft)	511		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	2006	482	1668	306	400
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	0.71	0.55	0.25	0.04	0.76

Intersection Summary

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

# HCM 6th Signalized Intersection Summary

## 5: Radford Rd & Asbury Rd

2039 Improvements - AM Peak Hour

08/30/2019

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↘	↑	↘	↗
Traffic Volume (veh/h)	1175	70	230	360	10	265
Future Volume (veh/h)	1175	70	230	360	10	265
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1826	1826	1826	1826
Adj Flow Rate, veh/h	1351	80	264	414	11	305
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Percent Heavy Veh, %	2	2	5	5	5	5
Cap, veh/h	1674	99	345	1210	267	396
Arrive On Green	0.49	0.49	0.10	0.66	0.15	0.15
Sat Flow, veh/h	3503	201	1739	1826	1739	1547
Grp Volume(v), veh/h	703	728	264	414	11	305
Grp Sat Flow(s),veh/h/ln	1777	1834	1739	1826	1739	1547
Q Serve(g_s), s	21.7	21.9	4.4	6.5	0.4	10.0
Cycle Q Clear(g_c), s	21.7	21.9	4.4	6.5	0.4	10.0
Prop In Lane		0.11	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	872	900	345	1210	267	396
V/C Ratio(X)	0.81	0.81	0.76	0.34	0.04	0.77
Avail Cap(c_a), veh/h	872	900	474	1345	267	396
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	14.0	14.0	13.2	4.8	23.5	22.5
Incr Delay (d2), s/veh	7.8	7.8	4.9	0.2	0.1	9.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	9.0	9.3	2.1	1.7	0.1	4.9
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	21.8	21.8	18.1	5.0	23.6	31.4
LnGrp LOS	C	C	B	A	C	C
Approach Vol, veh/h	1431			678	316	
Approach Delay, s/veh	21.8			10.1	31.2	
Approach LOS	C			B	C	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	11.2	38.0			49.2	16.0
Change Period (Y+Rc), s	4.5	6.0			6.0	6.0
Max Green Setting (Gmax), s	11.5	32.0			48.0	10.0
Max Q Clear Time (g_c+I1), s	6.4	23.9			8.5	12.0
Green Ext Time (p_c), s	0.4	5.4			2.7	0.0
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			19.7			
HCM 6th LOS			B			
<b>Notes</b>						
User approved pedestrian interval to be less than phase max green.						

Lanes, Volumes, Timings  
5: Radford Rd & Asbury Rd

2029 Improvements - PM Peak Hour

08/30/2019

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↘	↑	↘	↗
Traffic Volume (vph)	775	40	250	1060	15	265
Future Volume (vph)	775	40	250	1060	15	265
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		0	75		0	150
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	1.00
Frt	0.993					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3514	0	1770	1863	1770	1583
Flt Permitted			0.228		0.950	
Satd. Flow (perm)	3514	0	425	1863	1770	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	8					93
Link Speed (mph)	35			35	35	
Link Distance (ft)	652			1327	414	
Travel Time (s)	12.7			25.9	8.1	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	799	41	258	1093	15	273
Shared Lane Traffic (%)						
Lane Group Flow (vph)	840	0	258	1093	15	273
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)		9	15		15	9
Number of Detectors	2		1	2	1	1
Detector Template	Thru		Left	Thru	Left	Right
Leading Detector (ft)	100		20	100	20	20
Trailing Detector (ft)	0		0	0	0	0
Detector 1 Position(ft)	0		0	0	0	0
Detector 1 Size(ft)	6		20	6	20	20
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	0.0
Detector 2 Position(ft)	94			94		
Detector 2 Size(ft)	6			6		
Detector 2 Type	Cl+Ex			Cl+Ex		
Detector 2 Channel						
Detector 2 Extend (s)	0.0			0.0		
Turn Type	NA		pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	8	1
Permitted Phases			6			8

Lanes, Volumes, Timings  
5: Radford Rd & Asbury Rd

2029 Improvements - PM Peak Hour

08/30/2019

	→	↘	↙	←	↖	↗
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Detector Phase	2		1	6	8	1
Switch Phase						
Minimum Initial (s)	15.0		6.0	15.0	10.0	6.0
Minimum Split (s)	25.0		23.5	21.0	16.0	23.5
Total Split (s)	40.5		23.5	64.0	16.0	23.5
Total Split (%)	50.6%		29.4%	80.0%	20.0%	29.4%
Maximum Green (s)	34.5		19.0	58.0	10.0	19.0
Yellow Time (s)	4.0		3.5	4.0	4.0	3.5
All-Red Time (s)	2.0		1.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		4.5	6.0	6.0	4.5
Lead/Lag	Lag		Lead			Lead
Lead-Lag Optimize?	Yes		Yes			Yes
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Recall Mode	Min		Min	None	None	Min
Walk Time (s)	7.0		7.0			7.0
Flash Dont Walk (s)	12.0		12.0			12.0
Pedestrian Calls (#/hr)	0		0			0
Act Effect Green (s)	20.1		38.5	42.8	11.2	13.5
Actuated g/C Ratio	0.44		0.85	0.94	0.25	0.30
v/c Ratio	0.54		0.36	0.62	0.03	0.51
Control Delay	11.1		2.7	4.7	21.9	12.8
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	11.1		2.7	4.7	21.9	12.8
LOS	B		A	A	C	B
Approach Delay	11.1			4.4	13.3	
Approach LOS	B			A	B	

Intersection Summary

Area Type: Other

Cycle Length: 80

Actuated Cycle Length: 45.3

Natural Cycle: 65

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.62

Intersection Signal Delay: 7.7

Intersection LOS: A

Intersection Capacity Utilization 74.1%

ICU Level of Service D






Analysis Period (min) 15

Splits and Phases: 5: Radford Rd & Asbury Rd



Queues  
5: Radford Rd & Asbury Rd

2029 Improvements - PM Peak Hour  
08/30/2019

					
Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	840	258	1093	15	273
v/c Ratio	0.54	0.36	0.62	0.03	0.51
Control Delay	11.1	2.7	4.7	21.9	12.8
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	11.1	2.7	4.7	21.9	12.8
Queue Length 50th (ft)	64	0	0	2	28
Queue Length 95th (ft)	177	51	493	24	130
Internal Link Dist (ft)	572		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	2978	990	1760	435	849
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	0.28	0.26	0.62	0.03	0.32
Intersection Summary					

# HCM 6th Signalized Intersection Summary

## 5: Radford Rd & Asbury Rd

2029 Improvements - PM Peak Hour

08/30/2019

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↘	↑	↘	↗
Traffic Volume (veh/h)	775	40	250	1060	15	265
Future Volume (veh/h)	775	40	250	1060	15	265
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	799	41	258	1093	15	273
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1690	87	515	1241	273	406
Arrive On Green	0.49	0.49	0.10	0.66	0.15	0.15
Sat Flow, veh/h	3533	176	1781	1870	1781	1585
Grp Volume(v), veh/h	413	427	258	1093	15	273
Grp Sat Flow(s),veh/h/ln	1777	1839	1781	1870	1781	1585
Q Serve(g_s), s	10.1	10.1	4.1	30.9	0.5	10.0
Cycle Q Clear(g_c), s	10.1	10.1	4.1	30.9	0.5	10.0
Prop In Lane		0.10	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	873	904	515	1241	273	406
V/C Ratio(X)	0.47	0.47	0.50	0.88	0.06	0.67
Avail Cap(c_a), veh/h	938	970	849	1660	273	406
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	11.0	11.0	7.2	8.9	23.6	21.8
Incr Delay (d2), s/veh	0.4	0.4	0.8	4.6	0.1	4.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.4	3.5	1.2	9.5	0.2	3.9
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	11.4	11.4	8.0	13.5	23.7	26.2
LnGrp LOS	B	B	A	B	C	C
Approach Vol, veh/h	840			1351	288	
Approach Delay, s/veh	11.4			12.4	26.0	
Approach LOS	B			B	C	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	11.2	38.1			49.4	16.0
Change Period (Y+Rc), s	4.5	6.0			6.0	6.0
Max Green Setting (Gmax), s	19.0	34.5			58.0	10.0
Max Q Clear Time (g_c+I1), s	6.1	12.1			32.9	12.0
Green Ext Time (p_c), s	0.6	5.3			10.4	0.0
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			13.7			
HCM 6th LOS			B			
<b>Notes</b>						
User approved pedestrian interval to be less than phase max green.						

Appendix C  
Initial Alternatives Operational Analysis  
III. Alternative 3, Mini Roundabout

# Mini Roundabout ARCADY Analysis

2019 AM Peak

## Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

**Demand (Veh/hr)** **Calculations** **Options**

From \ To	1st exit	2nd exit	U-Turn	Total
EB Asbury Rd	50	850	0	900
NB Radford Rd	240	10	0	250
WB Asbury Rd	275	190	0	465
<b>Total</b>	<b>565</b>	<b>1050</b>	<b>0</b>	<b>-</b>

## Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

**Truck %** **PCE per Veh** **Options**

From \ To	1st exit	2nd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2
NB Radford Rd	5	5	5	5
WB Asbury Rd	5	5	5	5
<b>Average</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>-</b>

## Roundabout Geometry

Customise Filters Rotate Full-size

Widths:



## Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd
V - Approach road half-width (ft)	12.00	12.00	12.00
E - Entry width (ft)	14.00	14.00	14.00
l' - Effective flare length (ft)	25.0	20.0	15.0
R - Entry radius (ft)	65.0	65.0	65.0
D - Inscribed circle diameter (ft)	94.0	94.0	94.0
PHI - Conflict (entry) angle (deg)	28.3	30.2	39.4
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	90.00	90.00	90.00
Average Demand (Veh/hr)	900	250	465
Max Delay (s)	81.10	12.30	7.09
Max LOS	F	B	A
Max 95th percentile Queue (Veh)	77.5	3.9	1.8
Max V/C Ratio	1.00	0.49	0.50

## 2019 PM Peak

### Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

#### Demand (Veh/hr)

#### Calculations

#### Options

From \ To	1st exit	2nd exit	U-Turn	Total
EB Asbury Rd	35	565	0	600
NB Radford Rd	240	15	0	255
WB Asbury Rd	810	210	0	1020
Total	1085	790	0	-

### Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

#### Truck %

#### PCE per Veh

#### Options

From \ To	1st exit	2nd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2
NB Radford Rd	2	2	2	2
WB Asbury Rd	2	2	2	2
Average	2	2	2	-

### Roundabout Geometry

Customise ▾ Filters ▾

Rotate

Full-size

Widths:



### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd
V - Approach road half-width (ft)	12.00	12.00	12.00
E - Entry width (ft)	14.00	14.00	14.00
I' - Effective flare length (ft)	25.0	20.0	15.0
R - Entry radius (ft)	65.0	65.0	65.0
D - Inscribed circle diameter (ft)	94.0	94.0	94.0
PHI - Conflict (entry) angle (deg)	28.3	30.2	39.4
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	90.00	90.00	90.00
Average Demand (Veh/hr)	600	255	1020
Max Delay (s)	10.94	7.71	150.22
Max LOS	B	A	F
Max 95th percentile Queue (Veh)	5.0	2.8	108.2
Max V/C Ratio	0.67	0.38	1.07

## Residual Capacity

	AM							PM						
	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity
Singe Lane - 2019														
EB Asbury Rd	43.5	30.60	0.90	D	19.97	C	1 %	1.8	8.41	0.61	A	26.75	D	-2 %
NB Radford Rd	3.3	9.52	0.42	A			[EB Asbury Rd]	2.2	6.29	0.33	A			[WB Asbury Rd]
WB Asbury Rd	2.2	5.59	0.44	A			63.9	42.67	0.95	E				
Singe Lane - 2029														
EB Asbury Rd	116.3	161.57	1.09	F	95.25	F	-14 %	8.4	11.58	0.71	B	89.30	F	-14 %
NB Radford Rd	3.6	11.43	0.48	B			[EB Asbury Rd]	2.7	7.24	0.37	A			[WB Asbury Rd]
WB Asbury Rd	1.5	6.29	0.50	A			121.8	155.09	1.08	F				
Singe Lane - 2039														
EB Asbury Rd	200.0	564.32	1.28	F	332.59	F	-26 %	22.8	18.38	0.82	C	247.12	F	-24 %
NB Radford Rd	2.8	11.76	0.50	B			[EB Asbury Rd]	3.3	8.78	0.43	A			[WB Asbury Rd]
WB Asbury Rd	1.4	7.11	0.56	A			200.0	440.65	1.22	F				
Multi Lane - 2019														
EB Asbury Rd	1.5	4.62	0.56	A	4.73	A	38 %	2.7	3.29	0.38	A	4.34	A	63 %
NB Radford Rd	3.2	8.98	0.41	A			[NB Radford Rd]	2.0	6.05	0.32	A			[WB Asbury Rd]
WB Asbury Rd	1.1	2.66	0.27	A			1.9	4.54	0.59	A				
Multi Lane - 2029														
EB Asbury Rd	3.6	6.26	0.67	A	6.14	A	21 %	2.1	3.74	0.45	A	5.19	A	43 %
NB Radford Rd	4.2	12.48	0.50	B			[NB Radford Rd]	2.6	6.91	0.36	A			[WB Asbury Rd]
WB Asbury Rd	1.9	2.81	0.31	A			3.8	5.69	0.67	A				
Multi Lane - 2039														
EB Asbury Rd	14.3	9.81	0.79	A	9.30	A	7 %	1.5	4.36	0.52	A	6.58	A	27 %
NB Radford Rd	7.6	20.65	0.64	C			[NB Radford Rd]	3.2	8.29	0.42	A			[WB Asbury Rd]
WB Asbury Rd	2.5	2.96	0.35	A			7.4	7.60	0.75	A				

# LANE SUMMARY



Site: [2019 AM Peak\_Mini RAB]

Asbury Rd at Radford Rd

E.F. 1.1, PHF 0.87

Site Category: -

Roundabout

Lane Use and Performance													
	Demand Total veh/h	Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: NB Radford Rd													
Lane 1 <sup>d</sup>	287	5.0	298	0.966	100	61.3	LOS F	15.4	400.7	Full	1600	0.0	0.0
Approach	287	5.0		0.966		61.3	LOS F	15.4	400.7				
East: WB Asbury Rd													
Lane 1 <sup>d</sup>	534	5.0	1437	0.372	100	0.1	LOS A	3.3	86.5	Full	1600	0.0	0.0
Approach	534	5.0		0.372		0.1	LOS A	3.3	86.5				
West: EB Asbury Rd													
Lane 1 <sup>d</sup>	1034	2.0	1061	0.975	100	20.5	LOS C	33.5	850.9	Full	1600	0.0	0.0
Approach	1034	2.0		0.975		20.5	LOS C	33.5	850.9				
Intersection	1856	3.3		0.975		20.9	LOS C	33.5	850.9				

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Sign Control.

Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.

LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option is selected.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

<sup>d</sup> Dominant lane on roundabout approach

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Organisation: MSA PROFESSIONAL SERVICES | Processed: Tuesday, August 20, 2019 12:07:32 PM

Project: G:\00\00465\00465212\Traffic\SIDRA\Mini\Asbury at Radford SIDRA mini analysis.sip8

# LANE SUMMARY



Site: [2019 PM Peak\_Mini\_RAB]

Asbury Rd at Radford Rd

E.F. 1.1, PHF 0.97

Site Category: -

Roundabout

Lane Use and Performance													
	Demand Total veh/h	Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: NB Radford Rd													
Lane 1 <sup>d</sup>	263	2.0	637	0.413	100	5.5	LOS A	2.9	72.5	Full	1600	0.0	0.0
Approach	263	2.0		0.413		5.5	LOS A	2.9	72.5				
East: WB Asbury Rd													
Lane 1 <sup>d</sup>	1052	2.0	1502	0.700	100	0.2	LOS A	10.9	278.0	Full	1600	0.0	0.0
Approach	1052	2.0		0.700		0.2	LOS A	10.9	278.0				
West: EB Asbury Rd													
Lane 1 <sup>d</sup>	619	2.0	1026	0.603	100	2.4	LOS A	5.1	130.4	Full	1600	0.0	0.0
Approach	619	2.0		0.603		2.4	LOS A	5.1	130.4				
Intersection	1933	2.0		0.700		1.6	LOS A	10.9	278.0				

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Sign Control.

Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.

LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option is selected.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

<sup>d</sup> Dominant lane on roundabout approach

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Appendix C  
Initial Alternatives Operational Analysis  
IV. Alternative 4, Single-lane Roundabout

# Single Lane Modern Roundabout ARCADY Analysis

2019 AM Peak

## Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

**Demand (Veh/hr)** **Calculations** **Options**

From \ To	1st exit	2nd exit	U-Turn	Total
EB Asbury Rd	50	850	0	900
NB Radford Rd	240	10	0	250
WB Asbury Rd	275	190	0	465
Total	565	1050	0	-

## Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

**Truck %** **PCE per Veh** **Options**

From \ To	1st exit	2nd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2
NB Radford Rd	5	5	5	5
WB Asbury Rd	5	5	5	5
Average	4	4	4	-

## Roundabout Geometry

Customise Filters Rotate Full-size Widths: 



### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd
V - Approach road half-width (ft)	12.00	12.00	12.00
E - Entry width (ft)	14.00	14.00	14.00
I' - Effective flare length (ft)	81.0	27.0	76.0
R - Entry radius (ft)	71.0	71.0	71.0
D - Inscribed circle diameter (ft)	118.0	118.0	118.0
PHI - Conflict (entry) angle (deg)	23.3	20.3	29.8
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	90.00	90.00	90.00
Average Demand (Veh/hr)	900	250	465
Max Delay (s)	52.76	11.24	6.18
Max LOS	F	B	A
Max 95th percentile Queue (Veh)	64.7	3.7	2.0
Max V/C Ratio	0.96	0.46	0.47

## 2019 PM Peak

### Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

**Demand (Veh/hr)** **Calculations** **Options**


From \ To	1st exit	2nd exit	U-Turn	Total
EB Asbury Rd	35	565	0	600
NB Radford Rd	240	15	0	255
WB Asbury Rd	810	210	0	1020
<b>Total</b>	<b>1085</b>	<b>790</b>	<b>0</b>	<b>-</b>

### Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

**Truck %** **PCE per Veh** **Options**

From \ To	1st exit	2nd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2
NB Radford Rd	2	2	2	2
WB Asbury Rd	2	2	2	2
<b>Average</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>-</b>

### Roundabout Geometry

Customise ▾ Filters ▾ Rotate Full-size Widths: 



### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd
V - Approach road half-width (ft)	12.00	12.00	12.00
E - Entry width (ft)	14.00	14.00	14.00
l' - Effective flare length (ft)	81.0	27.0	76.0
R - Entry radius (ft)	71.0	71.0	71.0
D - Inscribed circle diameter (ft)	118.0	118.0	118.0
PHI - Conflict (entry) angle (deg)	23.3	20.3	29.8
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	90.00	90.00	90.00
Average Demand (Veh/hr)	600	255	1020
Max Delay (s)	9.83	7.09	75.64
Max LOS	A	A	F
Max 95th percentile Queue (Veh)	3.1	2.6	83.0
Max V/C Ratio	0.64	0.36	1.00

## 2029 AM Peak

### Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

#### Demand (Veh/hr)

#### Calculations

#### Options

From \ To	1st exit	2nd exit	U-Turn	Total
EB Asbury Rd	55	1015	0	1070
NB Radford Rd	250	10	0	260
WB Asbury Rd	320	210	0	530
Total	625	1235	0	-

### Vehicle Mix - Whole Period - Asbury Rd at Radford Rd


#### Truck %

#### PCE per Veh

#### Options

From \ To	1st exit	2nd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2
NB Radford Rd	5	5	5	5
WB Asbury Rd	5	5	5	5
Average	4	4	4	-

### Roundabout Geometry

Customise ▾ Filters ▾ Rotate Full-size Widths: 



### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd
V - Approach road half-width (ft)	12.00	12.00	12.00
E - Entry width (ft)	14.00	14.00	14.00
l' - Effective flare length (ft)	81.0	27.0	76.0
R - Entry radius (ft)	71.0	71.0	71.0
D - Inscribed circle diameter (ft)	118.0	118.0	118.0
PHI - Conflict (entry) angle (deg)	23.3	20.3	29.8
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	95.00	95.00	95.00
Average Demand (Veh/hr)	1070	260	530
Max Delay (s)	161.57	11.43	6.29
Max LOS	F	B	A
Max 95th percentile Queue (Veh)	116.3	3.6	1.5
Max V/C Ratio	1.09	0.48	0.50

## 2029 PM Peak

### Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

#### Demand (Veh/hr) Calculations Options


From \ To	1st exit	2nd exit	U-Turn	Total
EB Asbury Rd	40	665	0	705
NB Radford Rd	250	15	0	265
WB Asbury Rd	935	230	0	1165
Total	1225	910	0	-

### Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

#### Truck % PCE per Veh Options

From \ To	1st exit	2nd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2
NB Radford Rd	2	2	2	2
WB Asbury Rd	2	2	2	2
Average	2	2	2	-

### Roundabout Geometry

Customise Filters Rotate Full-size Widths: 



#### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd
V - Approach road half-width (ft)	12.00	12.00	12.00
E - Entry width (ft)	14.00	14.00	14.00
l' - Effective flare length (ft)	81.0	27.0	76.0
R - Entry radius (ft)	71.0	71.0	71.0
D - Inscribed circle diameter (ft)	118.0	118.0	118.0
PHI - Conflict (entry) angle (deg)	23.3	20.3	29.8
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	95.00	95.00	95.00
Average Demand (Veh/hr)	705	265	1165
Max Delay (s)	11.58	7.24	155.09
Max LOS	B	A	F
Max 95th percentile Queue (Veh)	8.4	2.7	121.8
Max V/C Ratio	0.71	0.37	1.08

## Residual Capacity

	AM							PM						
	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity
Singe Lane - 2019														
EB Asbury Rd	43.5	30.60	0.90	D	19.97	C	1 %	1.8	8.41	0.61	A	26.75	D	-2 %
NB Radford Rd	3.3	9.52	0.42	A			[EB Asbury Rd]	2.2	6.29	0.33	A			[WB Asbury Rd]
WB Asbury Rd	2.2	5.59	0.44	A			63.9	42.67	0.95	E				
Singe Lane - 2029														
EB Asbury Rd	116.3	161.57	1.09	F	95.25	F	-14 %	8.4	11.58	0.71	B	89.30	F	-14 %
NB Radford Rd	3.6	11.43	0.48	B			[EB Asbury Rd]	2.7	7.24	0.37	A			[WB Asbury Rd]
WB Asbury Rd	1.5	6.29	0.50	A			121.8	155.09	1.08	F				
Singe Lane - 2039														
EB Asbury Rd	200.0	564.32	1.28	F	332.59	F	-26 %	22.8	18.38	0.82	C	247.12	F	-24 %
NB Radford Rd	2.8	11.76	0.50	B			[EB Asbury Rd]	3.3	8.78	0.43	A			[WB Asbury Rd]
WB Asbury Rd	1.4	7.11	0.56	A			200.0	440.65	1.22	F				
Multi Lane - 2019														
EB Asbury Rd	1.5	4.62	0.56	A	4.73	A	38 %	2.7	3.29	0.38	A	4.34	A	63 %
NB Radford Rd	3.2	8.98	0.41	A			[NB Radford Rd]	2.0	6.05	0.32	A			[WB Asbury Rd]
WB Asbury Rd	1.1	2.66	0.27	A			1.9	4.54	0.59	A				
Multi Lane - 2029														
EB Asbury Rd	3.6	6.26	0.67	A	6.14	A	21 %	2.1	3.74	0.45	A	5.19	A	43 %
NB Radford Rd	4.2	12.48	0.50	B			[NB Radford Rd]	2.6	6.91	0.36	A			[WB Asbury Rd]
WB Asbury Rd	1.9	2.81	0.31	A			3.8	5.69	0.67	A				
Multi Lane - 2039														
EB Asbury Rd	14.3	9.81	0.79	A	9.30	A	7 %	1.5	4.36	0.52	A	6.58	A	27 %
NB Radford Rd	7.6	20.65	0.64	C			[NB Radford Rd]	3.2	8.29	0.42	A			[WB Asbury Rd]
WB Asbury Rd	2.5	2.96	0.35	A			7.4	7.60	0.75	A				

## LANE SUMMARY

 Site: [2019 AM Peak\_Single Lane RAB]

Asbury Rd at Radford Rd

E.F. 1.1, PHF 0.87

Site Category: -

Roundabout

Lane Use and Performance													
	Demand Total veh/h	Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Veh	Queue Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: NB Radford Rd													
Lane 1 <sup>d</sup>	287	5.0	340	0.846	100	37.5	LOS E	11.0	286.9	Full	1600	0.0	0.0
Approach	287	5.0		0.846		37.5	LOS E	11.0	286.9				
East: WB Asbury Rd													
Lane 1 <sup>d</sup>	534	5.0	1502	0.356	100	0.1	LOS A	3.1	81.8	Full	1600	0.0	0.0
Approach	534	5.0		0.356		0.1	LOS A	3.1	81.8				
West: EB Asbury Rd													
Lane 1 <sup>d</sup>	1034	2.0	1129	0.916	100	11.2	LOS B	23.0	583.0	Full	1600	0.0	0.0
Approach	1034	2.0		0.916		11.2	LOS B	23.0	583.0				
Intersection	1856	3.3		0.916		12.1	LOS B	23.0	583.0				

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Sign Control.

Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.

LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option is selected.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

<sup>d</sup> Dominant lane on roundabout approach

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# LANE SUMMARY



**Site: [2019 PM Peak\_Single Lane RAB]**

Asbury Rd at Radford Rd

E.F. 1.1, PHF 0.97

Site Category: -

Roundabout

Lane Use and Performance													
	Demand Total veh/h	Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: NB Radford Rd													
Lane 1 <sup>d</sup>	263	2.0	720	0.365	100	4.4	LOS A	2.5	62.5	Full	1600	0.0	0.0
Approach	263	2.0		0.365		4.4	LOS A	2.5	62.5				
East: WB Asbury Rd													
Lane 1 <sup>d</sup>	1052	2.0	1566	0.671	100	0.2	LOS A	9.7	245.5	Full	1600	0.0	0.0
Approach	1052	2.0		0.671		0.2	LOS A	9.7	245.5				
West: EB Asbury Rd													
Lane 1 <sup>d</sup>	619	2.0	1098	0.563	100	2.0	LOS A	4.5	115.3	Full	1600	0.0	0.0
Approach	619	2.0		0.563		2.0	LOS A	4.5	115.3				
Intersection	1933	2.0		0.671		1.3	LOS A	9.7	245.5				

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Sign Control.

Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.

LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option is selected.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

<sup>d</sup> Dominant lane on roundabout approach

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# LANE SUMMARY

 **Site: [2029 AM Peak\_Single Lane RAB]**

Asbury Rd at Radford Rd  
E.F. 1.05, PHF 0.87  
Site Category: -  
Roundabout

Lane Use and Performance													
	Demand Total veh/h	Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: NB Radford Rd													
Lane 1 <sup>d</sup>	299	5.0	289	1.033	100	88.5	LOS F	20.6	536.2	Full	1600	0.0	0.0
Approach	299	5.0		1.033		88.5	LOS F	20.6	536.2				
East: WB Asbury Rd													
Lane 1 <sup>d</sup>	609	5.0	1550	0.393	100	0.1	LOS A	3.7	95.5	Full	1600	0.0	0.0
Approach	609	5.0		0.393		0.1	LOS A	3.7	95.5				
West: EB Asbury Rd													
Lane 1 <sup>d</sup>	1230	2.0	1166	1.055	100	41.1	LOS F	54.8	1391.2	Full	1600	0.0	1.0
Approach	1230	2.0		1.055		41.1	LOS E	54.8	1391.2				
Intersection	2138	3.3		1.055		36.0	LOS E	54.8	1391.2				

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Sign Control.

Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.

LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option is selected.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

<sup>d</sup> Dominant lane on roundabout approach

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# LANE SUMMARY

 Site: [2029 PM Peak\_Single Lane RAB]

Asbury Rd at Radford Rd  
E.F. 1.05, PHF 0.97  
Site Category: -  
Roundabout

Lane Use and Performance													
	Demand Total veh/h	Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: NB Radford Rd													
Lane 1 <sup>d</sup>	273	2.0	675	0.405	100	5.3	LOS A	3.0	75.3	Full	1600	0.0	0.0
Approach	273	2.0		0.405		5.3	LOS A	3.0	75.3				
East: WB Asbury Rd													
Lane 1 <sup>d</sup>	1201	2.0	1610	0.746	100	0.2	LOS A	13.8	349.8	Full	1600	0.0	0.0
Approach	1201	2.0		0.746		0.2	LOS A	13.8	349.8				
West: EB Asbury Rd													
Lane 1 <sup>d</sup>	727	2.0	1136	0.640	100	2.6	LOS A	6.1	154.0	Full	1600	0.0	0.0
Approach	727	2.0		0.640		2.6	LOS A	6.1	154.0				
Intersection	2201	2.0		0.746		1.6	LOS A	13.8	349.8				

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Sign Control.

Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.

LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option is selected.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

<sup>d</sup> Dominant lane on roundabout approach

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# HCS7 Roundabouts Report

## General Information

Analyst	NRC
Agency or Co.	Asbury IA
Date Performed	8/20/2019
Analysis Year	2019
Time Analyzed	AM Peak
Project Description	Asbury Rd at Radford Rd

## Site Information

Intersection	Asbury Rd at Radford Rd
E/W Street Name	Asbury Rd
N/S Street Name	Radford Rd
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.87
Jurisdiction	

## Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0
Lane Assignment	TR				LT				LR							
Volume (V), veh/h	0		850	50	0	190	275		0	10		240				
Percent Heavy Vehicles, %	2		2	2	5	5	5		5	5		5				
Flow Rate ( $V_{PCE}$ ), pc/h	0		997	59	0	229	332		0	12		290				
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1							
Pedestrians Crossing, p/h	0				0				0							

## Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763				
Follow-Up Headway (s)		2.6087			2.6087			2.6087				

## Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow ( $v_e$ ), pc/h		1056.00			561.00			302.00				
Entry Volume veh/h		1035.29			534.29			287.62				
Circulating Flow ( $v_c$ ), pc/h	229			12			997			573		
Exiting Flow ( $v_{ex}$ ), pc/h	1287			344			0			288		
Capacity ( $C_{PCE}$ ), pc/h		1092.54			1363.21			499.15				
Capacity (c), veh/h		1071.12			1298.29			475.38				
v/c Ratio (x)		0.97			0.41			0.61				

## Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		39.6			6.8			21.5				
Lane LOS		E			A			C				
95% Queue, veh		17.6			2.1			3.9				
Approach Delay, s/veh	39.6			6.8			21.5					
Approach LOS	E			A			C					
Intersection Delay, s/veh   LOS	27.4						D					

# HCS7 Roundabouts Report

## General Information

Analyst	NRC
Agency or Co.	Asbury IA
Date Performed	8/20/2019
Analysis Year	2019
Time Analyzed	PM Peak
Project Description	Asbury Rd at Radford Rd

## Site Information

Intersection	Asbury Rd at Radford Rd
E/W Street Name	Asbury Rd
N/S Street Name	Radford Rd
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.97
Jurisdiction	

## Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0
Lane Assignment	TR				LT				LR							
Volume (V), veh/h	0		565	35	0	210	810		0	15		240				
Percent Heavy Vehicles, %	2		2	2	2	2	2		2	2		2				
Flow Rate ( $V_{PCE}$ ), pc/h	0		594	37	0	221	852		0	16		252				
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1							
Pedestrians Crossing, p/h	0				0				0							

## Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763				
Follow-Up Headway (s)		2.6087			2.6087			2.6087				

## Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow ( $v_e$ ), pc/h		631.00			1073.00			268.00				
Entry Volume veh/h		618.63			1051.96			262.75				
Circulating Flow ( $v_c$ ), pc/h	221			16			594			1089		
Exiting Flow ( $v_{ex}$ ), pc/h	846			868			0			258		
Capacity ( $C_{PCE}$ ), pc/h		1101.49			1357.66			752.92				
Capacity (c), veh/h		1079.89			1331.04			738.16				
v/c Ratio (x)		0.57			0.79			0.36				

## Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		10.6			15.9			9.3				
Lane LOS		B			C			A				
95% Queue, veh		3.8			9.0			1.6				
Approach Delay, s/veh	10.6			15.9			9.3					
Approach LOS	B			C			A					
Intersection Delay, s/veh   LOS	13.3						B					

# HCS7 Roundabouts Report

## General Information

Analyst	NRC
Agency or Co.	Asbury IA
Date Performed	8/20/2019
Analysis Year	2029
Time Analyzed	AM Peak
Project Description	Asbury Rd at Radford Rd

## Site Information

Intersection	Asbury Rd at Radford Rd
E/W Street Name	Asbury Rd
N/S Street Name	Radford Rd
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.87
Jurisdiction	

## Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0
Lane Assignment	TR				LT				LR							
Volume (V), veh/h	0		1015	55	0	210	320		0	10		250				
Percent Heavy Vehicles, %	2		2	2	5	5	5		5	5		5				
Flow Rate ( $V_{PCE}$ ), pc/h	0		1190	64	0	253	386		0	12		302				
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1							
Pedestrians Crossing, p/h	0				0				0							

## Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763				
Follow-Up Headway (s)		2.6087			2.6087			2.6087				

## Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow ( $v_e$ ), pc/h		1254.00			639.00			314.00				
Entry Volume veh/h		1229.41			608.57			299.05				
Circulating Flow ( $v_c$ ), pc/h	253			12			1190			651		
Exiting Flow ( $v_{ex}$ ), pc/h	1492			398			0			317		
Capacity ( $C_{PCE}$ ), pc/h		1066.12			1363.21			409.96				
Capacity (c), veh/h		1045.22			1298.29			390.44				
v/c Ratio (x)		1.18			0.47			0.77				

## Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		106.4			7.5			37.5				
Lane LOS		F			A			E				
95% Queue, veh		35.9			2.6			6.3				
Approach Delay, s/veh	106.4			7.5			37.5					
Approach LOS	F			A			E					
Intersection Delay, s/veh   LOS	68.6						F					

# HCS7 Roundabouts Report

## General Information

Analyst	NRC
Agency or Co.	Asbury IA
Date Performed	8/20/2019
Analysis Year	2029
Time Analyzed	PM Peak
Project Description	Asbury Rd at Radford Rd

## Site Information

Intersection	Asbury Rd at Radford Rd
E/W Street Name	Asbury Rd
N/S Street Name	Radford Rd
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.97
Jurisdiction	

## Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0
Lane Assignment	TR				LT				LR							
Volume (V), veh/h	0		665	40	0	230	935		0	15		250				
Percent Heavy Vehicles, %	2		2	2	2	2	2		2	2		2				
Flow Rate ( $V_{PCE}$ ), pc/h	0		699	42	0	242	983		0	16		263				
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1							
Pedestrians Crossing, p/h	0				0				0							

## Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763				
Follow-Up Headway (s)		2.6087			2.6087			2.6087				

## Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow ( $v_e$ ), pc/h		741.00			1225.00			279.00				
Entry Volume veh/h		726.47			1200.98			273.53				
Circulating Flow ( $v_c$ ), pc/h	242			16			699			1241		
Exiting Flow ( $v_{ex}$ ), pc/h	962			999			0			284		
Capacity ( $C_{PCE}$ ), pc/h		1078.15			1357.66			676.46				
Capacity (c), veh/h		1057.01			1331.04			663.19				
v/c Ratio (x)		0.69			0.90			0.41				

## Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		14.0			25.0			11.2				
Lane LOS		B			C			B				
95% Queue, veh		5.8			14.6			2.0				
Approach Delay, s/veh	14.0			25.0			11.2					
Approach LOS	B			C			B					
Intersection Delay, s/veh   LOS	19.6						C					

# HCS7 Roundabouts Report

## General Information

Analyst	NRC
Agency or Co.	Asbury IA
Date Performed	8/20/2019
Analysis Year	2039
Time Analyzed	AM Peak
Project Description	Asbury Rd at Radford Rd

## Site Information

Intersection	Asbury Rd at Radford Rd
E/W Street Name	Asbury Rd
N/S Street Name	Radford Rd
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.87
Jurisdiction	

## Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0
Lane Assignment	TR				LT				LR							
Volume (V), veh/h	0		1175	70	0	230	360		0	10		265				
Percent Heavy Vehicles, %	2		2	2	5	5	5		5	5		5				
Flow Rate ( $V_{PCE}$ ), pc/h	0		1378	82	0	278	434		0	12		320				
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1							
Pedestrians Crossing, p/h	0				0				0							

## Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763				
Follow-Up Headway (s)		2.6087			2.6087			2.6087				

## Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow ( $v_e$ ), pc/h		1460.00			712.00			332.00				
Entry Volume veh/h		1431.37			678.10			316.19				
Circulating Flow ( $v_c$ ), pc/h	278			12			1378			724		
Exiting Flow ( $v_{ex}$ ), pc/h	1698			446			0			360		
Capacity ( $C_{PCE}$ ), pc/h		1039.28			1363.21			338.42				
Capacity (c), veh/h		1018.90			1298.29			322.31				
v/c Ratio (x)		1.40			0.52			0.98				

## Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		202.2			8.4			82.2				
Lane LOS		F			A			F				
95% Queue, veh		60.4			3.2			10.5				
Approach Delay, s/veh	202.2			8.4			82.2					
Approach LOS	F			A			F					
Intersection Delay, s/veh   LOS	132.4						F					

# HCS7 Roundabouts Report

## General Information

Analyst	NRC
Agency or Co.	Asbury IA
Date Performed	8/20/2019
Analysis Year	2039
Time Analyzed	PM Peak
Project Description	Asbury Rd at Radford Rd

## Site Information

Intersection	Asbury Rd at Radford Rd
E/W Street Name	Asbury Rd
N/S Street Name	Radford Rd
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.97
Jurisdiction	

## Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0
Lane Assignment	TR				LT				LR							
Volume (V), veh/h	0		775	40	0	250	1060		0	15		265				
Percent Heavy Vehicles, %	2		2	2	2	2	2		2	2		2				
Flow Rate ( $V_{PCE}$ ), pc/h	0		815	42	0	263	1115		0	16		279				
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1							
Pedestrians Crossing, p/h	0				0				0							

## Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763				
Follow-Up Headway (s)		2.6087			2.6087			2.6087				

## Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow ( $v_e$ ), pc/h		857.00			1378.00			295.00				
Entry Volume veh/h		840.20			1350.98			289.22				
Circulating Flow ( $v_c$ ), pc/h	263			16			815			1394		
Exiting Flow ( $v_{ex}$ ), pc/h	1094			1131			0			305		
Capacity ( $C_{PCE}$ ), pc/h		1055.30			1357.66			600.97				
Capacity (c), veh/h		1034.61			1331.04			589.19				
v/c Ratio (x)		0.81			1.01			0.49				

## Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		20.6			46.4			14.3				
Lane LOS		C			F			B				
95% Queue, veh		9.4			23.8			2.7				
Approach Delay, s/veh	20.6			46.4			14.3					
Approach LOS	C			E			B					
Intersection Delay, s/veh   LOS	33.9						D					

Appendix C  
Initial Alternatives Operational Analysis  
V. Alternative 5, Multilane Roundabout

# Multi-Lane Modern Roundabout ARCADY Analysis

2019 AM Peak


## Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

Demand (Veh/hr)	Calculations	Options		
From \ To	1st exit	2nd exit	U-Turn	Total
EB Asbury Rd	50	850	0	900
NB Radford Rd	240	10	0	250
WB Asbury Rd	275	190	0	465
Total	565	1050	0	-

## Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

Truck %	PCE per Veh	Options		
From \ To	1st exit	2nd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2
NB Radford Rd	5	5	5	5
WB Asbury Rd	5	5	5	5
Average	4	4	4	-

## Roundabout Geometry

Customise Filters Rotate Full-size Widths: 



### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd
V - Approach road half-width (ft)	12.00	12.00	12.00
E - Entry width (ft)	26.00	14.00	26.00
I' - Effective flare length (ft)	100.0	100.0	100.0
R - Entry radius (ft)	65.0	65.0	65.0
D - Inscribed circle diameter (ft)	122.0	134.0	122.0
PHI - Conflict (entry) angle (deg)	20.0	20.0	20.0
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	90.00	90.00	90.00
Average Demand (Veh/hr)	900	250	465
Max Delay (s)	5.31	10.65	2.87
Max LOS	A	B	A
Max 95th percentile Queue (Veh)	1.9	3.5	1.5
Max V/C Ratio	0.59	0.45	0.29

## 2019 PM Peak

### Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

**Demand (Veh/hr)** **Calculations** **Options**

From \ To	1st exit	2nd exit	U-Turn	Total
EB Asbury Rd	35	565	0	600
NB Radford Rd	240	15	0	255
WB Asbury Rd	810	210	0	1020
<b>Total</b>	<b>1085</b>	<b>790</b>	<b>0</b>	<b>-</b>

### Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

**Truck %** **PCE per Veh** **Options**

From \ To	1st exit	2nd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2
NB Radford Rd	2	2	2	2
WB Asbury Rd	2	2	2	2
<b>Average</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>-</b>

### Roundabout Geometry

Customise ▾ Filters ▾ Rotate Full-size Widths: 



### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd
V - Approach road half-width (ft)	12.00	12.00	12.00
E - Entry width (ft)	26.00	14.00	26.00
l' - Effective flare length (ft)	100.0	100.0	100.0
R - Entry radius (ft)	65.0	65.0	65.0
D - Inscribed circle diameter (ft)	122.0	134.0	122.0
PHI - Conflict (entry) angle (deg)	20.0	20.0	20.0
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	90.00	90.00	90.00
Average Demand (Veh/hr)	600	255	1020
Max Delay (s)	3.62	6.79	5.21
Max LOS	A	A	A
Max 95th percentile Queue (Veh)	2.7	2.4	2.6
Max V/C Ratio	0.40	0.35	0.62

## 2029 AM Peak

### Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

**Demand (Veh/hr)** **Calculations** **Options**


From \ To	1st exit	2nd exit	U-Turn	Total
EB Asbury Rd	55	1015	0	1070
NB Radford Rd	250	10	0	260
WB Asbury Rd	320	210	0	530
<b>Total</b>	<b>625</b>	<b>1235</b>	<b>0</b>	<b>-</b>

### Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

**Truck %** **PCE per Veh** **Options**

From \ To	1st exit	2nd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2
NB Radford Rd	5	5	5	5
WB Asbury Rd	5	5	5	5
<b>Average</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>-</b>

### Roundabout Geometry

Customise ▾ Filters ▾ Rotate Full-size Widths: 



### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd
V - Approach road half-width (ft)	12.00	12.00	12.00
E - Entry width (ft)	26.00	14.00	26.00
l' - Effective flare length (ft)	100.0	100.0	100.0
R - Entry radius (ft)	65.0	65.0	65.0
D - Inscribed circle diameter (ft)	122.0	134.0	122.0
PHI - Conflict (entry) angle (deg)	20.0	20.0	20.0
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	95.00	95.00	95.00
Average Demand (Veh/hr)	1070	260	530
Max Delay (s)	6.26	12.48	2.81
Max LOS	A	B	A
Max 95th percentile Queue (Veh)	3.6	4.2	1.9
Max V/C Ratio	0.67	0.50	0.31

## 2029 PM Peak

### Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

#### Demand (Veh/hr) Calculations Options

From \ To	1st exit	2nd exit	U-Turn	Total
EB Asbury Rd	40	665	0	705
NB Radford Rd	250	15	0	265
WB Asbury Rd	935	230	0	1165
Total	1225	910	0	-

### Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

#### Truck % PCE per Veh Options

From \ To	1st exit	2nd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2
NB Radford Rd	2	2	2	2
WB Asbury Rd	2	2	2	2
Average	2	2	2	-

### Roundabout Geometry

Customise Filters Rotate Full-size Widths:



#### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd
V - Approach road half-width (ft)	12.00	12.00	12.00
E - Entry width (ft)	26.00	14.00	26.00
l - Effective flare length (ft)	100.0	100.0	100.0
R - Entry radius (ft)	65.0	65.0	65.0
D - Inscribed circle diameter (ft)	122.0	134.0	122.0
PHI - Conflict (entry) angle (deg)	20.0	20.0	20.0
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	95.00	95.00	95.00
Average Demand (Veh/hr)	705	265	1165
Max Delay (s)	3.74	6.91	5.69
Max LOS	A	A	A
Max 95th percentile Queue (Veh)	2.1	2.6	3.8
Max V/C Ratio	0.45	0.36	0.67

## 2039 AM Peak

### Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

**Demand (Veh/hr)** **Calculations** **Options**

From \ To	1st exit	2nd exit	U-Turn	Total
EB Asbury Rd	70	1175	0	1245
NB Radford Rd	265	10	0	275
WB Asbury Rd	360	230	0	590
<b>Total</b>	<b>695</b>	<b>1415</b>	<b>0</b>	<b>-</b>

### Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

**Truck %** **PCE per Veh** **Options**

From \ To	1st exit	2nd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2
NB Radford Rd	5	5	5	5
WB Asbury Rd	5	5	5	5
<b>Average</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>-</b>

### Roundabout Geometry

Customise Filters Rotate Full-size Widths:



### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd
V - Approach road half-width (ft)	12.00	12.00	12.00
E - Entry width (ft)	26.00	14.00	26.00
I - Effective flare length (ft)	100.0	100.0	100.0
R - Entry radius (ft)	65.0	65.0	65.0
D - Inscribed circle diameter (ft)	122.0	134.0	122.0
PHI - Conflict (entry) angle (deg)	20.0	20.0	20.0
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	95.00	95.00	95.00
Average Demand (Veh/hr)	1245	275	590
Max Delay (s)	9.81	20.65	2.96
Max LOS	A	C	A
Max 95th percentile Queue (Veh)	14.3	7.6	2.5
Max V/C Ratio	0.79	0.64	0.35

## 2039 PM Peak

### Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

**Demand (Veh/hr)** **Calculations** **Options**

From \ To	1st exit	2nd exit	U-Turn	Total
EB Asbury Rd	40	775	0	815
NB Radford Rd	265	15	0	280
WB Asbury Rd	1060	250	0	1310
<b>Total</b>	<b>1365</b>	<b>1040</b>	<b>0</b>	<b>-</b>

### Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

**Truck %** **PCE per Veh** **Options**

From \ To	1st exit	2nd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2
NB Radford Rd	2	2	2	2
WB Asbury Rd	2	2	2	2
<b>Average</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>-</b>

### Roundabout Geometry

Customise Filters Rotate Full-size Widths: 



### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd
V - Approach road half-width (ft)	12.00	12.00	12.00
E - Entry width (ft)	26.00	14.00	26.00
f - Effective flare length (ft)	100.0	100.0	100.0
R - Entry radius (ft)	65.0	65.0	65.0
D - Inscribed circle diameter (ft)	122.0	134.0	122.0
PHI - Conflict (entry) angle (deg)	20.0	20.0	20.0
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	95.00	95.00	95.00
Average Demand (Veh/hr)	815	280	1310
Max Delay (s)	4.36	8.29	7.60
Max LOS	A	A	A
Max 95th percentile Queue (Veh)	1.5	3.2	7.4
Max V/C Ratio	0.52	0.42	0.75

## Residual Capacity

	AM							PM						
	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity
Singe Lane - 2019														
EB Asbury Rd	43.5	30.60	0.90	D	19.97	C	1 %	1.8	8.41	0.61	A	26.75	D	-2 %
NB Radford Rd	3.3	9.52	0.42	A			[EB Asbury Rd]	2.2	6.29	0.33	A			[WB Asbury Rd]
WB Asbury Rd	2.2	5.59	0.44	A			63.9	42.67	0.95	E				
Singe Lane - 2029														
EB Asbury Rd	116.3	161.57	1.09	F	95.25	F	-14 %	8.4	11.58	0.71	B	89.30	F	-14 %
NB Radford Rd	3.6	11.43	0.48	B			[EB Asbury Rd]	2.7	7.24	0.37	A			[WB Asbury Rd]
WB Asbury Rd	1.5	6.29	0.50	A			121.8	155.09	1.08	F				
Singe Lane - 2039														
EB Asbury Rd	200.0	564.32	1.28	F	332.59	F	-26 %	22.8	18.38	0.82	C	247.12	F	-24 %
NB Radford Rd	2.8	11.76	0.50	B			[EB Asbury Rd]	3.3	8.78	0.43	A			[WB Asbury Rd]
WB Asbury Rd	1.4	7.11	0.56	A			200.0	440.65	1.22	F				
Multi Lane - 2019														
EB Asbury Rd	1.5	4.62	0.56	A	4.73	A	38 %	2.7	3.29	0.38	A	4.34	A	63 %
NB Radford Rd	3.2	8.98	0.41	A			[NB Radford Rd]	2.0	6.05	0.32	A			[WB Asbury Rd]
WB Asbury Rd	1.1	2.66	0.27	A			1.9	4.54	0.59	A				
Multi Lane - 2029														
EB Asbury Rd	3.6	6.26	0.67	A	6.14	A	21 %	2.1	3.74	0.45	A	5.19	A	43 %
NB Radford Rd	4.2	12.48	0.50	B			[NB Radford Rd]	2.6	6.91	0.36	A			[WB Asbury Rd]
WB Asbury Rd	1.9	2.81	0.31	A			3.8	5.69	0.67	A				
Multi Lane - 2039														
EB Asbury Rd	14.3	9.81	0.79	A	9.30	A	7 %	1.5	4.36	0.52	A	6.58	A	27 %
NB Radford Rd	7.6	20.65	0.64	C			[NB Radford Rd]	3.2	8.29	0.42	A			[WB Asbury Rd]
WB Asbury Rd	2.5	2.96	0.35	A			7.4	7.60	0.75	A				

# LANE SUMMARY

 Site: [2019 AM Peak\_Multi Lane RAB]

Asbury Rd at Radford Rd  
E.F. 1.1, PHF 0.87  
Site Category: -  
Roundabout

Lane Use and Performance													
	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Queue Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: NB Radford Rd													
Lane 1 <sup>d</sup>	287	5.0	508	0.566	100	9.1	LOS A	3.7	95.9	Full	1600	0.0	0.0
Approach	287	5.0		0.566		9.1	LOS A	3.7	95.9				
East: WB Asbury Rd													
Lane 1 <sup>d</sup>	405	5.0	1635	0.248	100	0.1	LOS A	1.9	48.4	Full	1600	0.0	0.0
Lane 2	130	5.0	1178	0.110	44 <sup>6</sup>	0.1	LOS A	0.7	17.5	Short	200	0.0	NA
Approach	534	5.0		0.248		0.1	LOS A	1.9	48.4				
West: EB Asbury Rd													
Lane 1 <sup>d</sup>	798	2.0	1305	0.612	100	1.8	LOS A	5.2	133.1	Full	1600	0.0	0.0
Lane 2	237	2.0	857	0.276	45 <sup>6</sup>	2.1	LOS A	1.6	39.6	Short	200	0.0	NA
Approach	1034	2.0		0.612		1.8	LOS A	5.2	133.1				
Intersection	1856	3.3		0.612		2.5	LOS A	5.2	133.1				

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Sign Control.

Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.

LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option is selected.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

<sup>6</sup> Lane under-utilisation due to downstream effects

<sup>d</sup> Dominant lane on roundabout approach

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# LANE SUMMARY



Site: [2019 PM Peak\_Multi Lane RAB]

Asbury Rd at Radford Rd

E.F. 1.1, PHF 0.97

Site Category: -

Roundabout

Lane Use and Performance													
	Demand Total veh/h	Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Veh	Queue Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: NB Radford Rd													
Lane 1 <sup>d</sup>	263	2.0	725	0.363	100	3.4	LOS A	1.8	45.6	Full	1600	0.0	0.0
Approach	263	2.0		0.363		3.4	LOS A	1.8	45.6				
East: WB Asbury Rd													
Lane 1 <sup>d</sup>	793	2.0	1697	0.467	100	0.1	LOS A	4.4	111.4	Full	1600	0.0	0.0
Lane 2	259	2.0	1248	0.207	44 <sup>6</sup>	0.1	LOS A	1.4	34.5	Short	200	0.0	NA
Approach	1052	2.0		0.467		0.1	LOS A	4.4	111.4				
West: EB Asbury Rd													
Lane 1 <sup>d</sup>	471	2.0	1286	0.366	100	1.2	LOS A	2.4	60.5	Full	1600	0.0	0.0
Lane 2	148	2.0	892	0.165	45 <sup>6</sup>	1.7	LOS A	0.9	22.1	Short	200	0.0	NA
Approach	619	2.0		0.366		1.3	LOS A	2.4	60.5				
Intersection	1933	2.0		0.467		0.9	LOS A	4.4	111.4				

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Sign Control.

Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.

LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option is selected.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

<sup>6</sup> Lane under-utilisation due to downstream effects

<sup>d</sup> Dominant lane on roundabout approach

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# LANE SUMMARY

 **Site:** [2029 AM Peak\_Multi Lane RAB]

Asbury Rd at Radford Rd  
E.F. 1.05, PHF 0.87  
Site Category: -  
Roundabout

Lane Use and Performance													
	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Queue Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: NB Radford Rd													
Lane 1 <sup>d</sup>	299	5.0	459	0.651	100	12.5	LOS B	4.8	124.1	Full	1600	0.0	0.0
Approach	299	5.0		0.651		12.5	LOS B	4.8	124.1				
East: WB Asbury Rd													
Lane 1 <sup>d</sup>	460	5.0	1681	0.273	100	0.0	LOS A	2.2	56.6	Full	1600	0.0	0.0
Lane 2	150	5.0	1231	0.121	44 <sup>6</sup>	0.1	LOS A	0.8	20.0	Short	200	0.0	NA
Approach	609	5.0		0.273		0.1	LOS A	2.2	56.6				
West: EB Asbury Rd													
Lane 1 <sup>d</sup>	944	2.0	1348	0.700	100	2.6	LOS A	7.5	190.4	Full	1600	0.0	0.0
Lane 2	286	2.0	905	0.316	45 <sup>6</sup>	2.1	LOS A	1.9	47.0	Short	200	0.0	NA
Approach	1230	2.0		0.700		2.5	LOS A	7.5	190.4				
Intersection	2138	3.3		0.700		3.2	LOS A	7.5	190.4				

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Sign Control.

Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.

LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option is selected.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

<sup>6</sup> Lane under-utilisation due to downstream effects

<sup>d</sup> Dominant lane on roundabout approach

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# LANE SUMMARY

 Site: [2029 PM Peak\_Multi Lane RAB]

Asbury Rd at Radford Rd  
E.F. 1.05, PHF 0.97  
Site Category: -  
Roundabout

Lane Use and Performance													
	Demand Total veh/h	Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Veh	Queue Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: NB Radford Rd													
Lane 1 <sup>d</sup>	273	2.0	722	0.378	100	3.7	LOS A	2.0	50.0	Full	1600	0.0	0.0
Approach	273	2.0		0.378		3.7	LOS A	2.0	50.0				
East: WB Asbury Rd													
Lane 1 <sup>d</sup>	903	2.0	1741	0.519	100	0.1	LOS A	5.4	136.0	Full	1600	0.0	0.0
Lane 2	298	2.0	1291	0.230	44 <sup>6</sup>	0.1	LOS A	1.6	39.7	Short	200	0.0	NA
Approach	1201	2.0		0.519		0.1	LOS A	5.4	136.0				
West: EB Asbury Rd													
Lane 1 <sup>d</sup>	553	2.0	1336	0.414	100	1.3	LOS A	2.9	72.5	Full	1600	0.0	0.0
Lane 2	173	2.0	928	0.187	45 <sup>6</sup>	1.8	LOS A	1.0	25.4	Short	200	0.0	NA
Approach	727	2.0		0.414		1.4	LOS A	2.9	72.5				
Intersection	2201	2.0		0.519		1.0	LOS A	5.4	136.0				

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Sign Control.

Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.

LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option is selected.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

<sup>6</sup> Lane under-utilisation due to downstream effects

<sup>d</sup> Dominant lane on roundabout approach

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# LANE SUMMARY

 **Site: [2039 AM Peak\_Multi Lane RAB]**

Asbury Rd at Radford Rd  
E.F. 1.05, PHF 0.87  
Site Category: -  
Roundabout

Lane Use and Performance													
	Demand Flows			Deg.	Lane	Average	Level of	95% Back of Queue		Lane	Lane	Cap.	Prob.
	Total	HV	Cap.	Satn	Util.	Delay	Service	Veh	Dist	Config	Length	Adj.	Block.
	veh/h	%	veh/h	v/c	%	sec			ft		ft	%	%
South: NB Radford Rd													
Lane 1 <sup>d</sup>	316	5.0	356	0.888	100	32.8	LOS D	9.5	248.0	Full	1600	0.0	0.0
Approach	316	5.0		0.888		32.8	LOS D	9.5	248.0				
East: WB Asbury Rd													
Lane 1 <sup>d</sup>	512	5.0	1685	0.304	100	0.1	LOS A	2.6	67.0	Full	1600	0.0	0.0
Lane 2	167	5.0	1234	0.135	44 <sup>6</sup>	0.1	LOS A	0.9	23.0	Short	200	0.0	NA
Approach	678	5.0		0.304		0.1	LOS A	2.6	67.0				
West: EB Asbury Rd													
Lane 1 <sup>d</sup>	1100	2.0	1328	0.829	100	5.6	LOS A	13.9	353.7	Full	1600	0.0	0.0
Lane 2	331	2.0	884	0.374	45 <sup>6</sup>	2.5	LOS A	2.3	58.3	Short	200	0.0	NA
Approach	1431	2.0		0.829		4.9	LOS A	13.9	353.7				
Intersection	2425	3.2		0.888		7.2	LOS A	13.9	353.7				

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Sign Control.

Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.

LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option is selected.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

<sup>6</sup> Lane under-utilisation due to downstream effects

<sup>d</sup> Dominant lane on roundabout approach

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# LANE SUMMARY

 Site: [2039 PM Peak\_Multi Lane RAB]

Asbury Rd at Radford Rd  
E.F. 1.05, PHF 0.97  
Site Category: -  
Roundabout

Lane Use and Performance													
	Demand Total veh/h	Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Veh	Queue Dist ft	Lane Config	Lane Length ft	Cap. Adj. %	Prob. Block. %
South: NB Radford Rd													
Lane 1 <sup>d</sup>	289	2.0	665	0.434	100	4.9	LOS A	2.5	63.1	Full	1600	0.0	0.0
Approach	289	2.0		0.434		4.9	LOS A	2.5	63.1				
East: WB Asbury Rd													
Lane 1 <sup>d</sup>	1015	2.0	1745	0.582	100	0.1	LOS A	6.8	173.3	Full	1600	0.0	0.0
Lane 2	335	2.0	1297	0.258	44 <sup>6</sup>	0.1	LOS A	1.8	46.8	Short	200	0.0	NA
Approach	1351	2.0		0.582		0.1	LOS A	6.8	173.3				
West: EB Asbury Rd													
Lane 1 <sup>d</sup>	641	2.0	1318	0.486	100	1.6	LOS A	3.6	91.9	Full	1600	0.0	0.0
Lane 2	200	2.0	910	0.219	45 <sup>6</sup>	2.0	LOS A	1.2	30.7	Short	200	0.0	NA
Approach	840	2.0		0.486		1.7	LOS A	3.6	91.9				
Intersection	2479	2.0		0.582		1.2	LOS A	6.8	173.3				

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Sign Control.

Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.

LOS F will result if v/c > 1 irrespective of lane delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option is selected.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

<sup>6</sup> Lane under-utilisation due to downstream effects

<sup>d</sup> Dominant lane on roundabout approach

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Appendix D  
Short-Term & Long-Term Alternatives Operational Analysis

- I. Short-Term: Traffic Signal at Hales Mill Road with Minor Geometric Improvements
- II. Short-Term: Traffic Signals at Both Intersections with Existing Lanes/Geometry
- III. Long-Term: Two Eastbound Lanes on Asbury Road with:
  - a. Traffic Signal at Hales Mill Road
  - b. Traffic Signal at Radford Road
  - c. Traffic Signal at Both Intersections
- IV. Long-Term: Realign Hales Mill Road and Radford Road into One Intersection:
  - a. Multilane Roundabout
  - b. Traffic Signal with Two Eastbound Lanes on Asbury Road

## Appendix D

### Short-Term & Long-Term Alternatives Operational Analysis

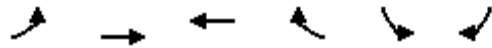
#### I. Short-Term: Traffic Signal at Hales Mill Road with Minor Geometric Improvements

## Queues

## 2029 Improved WB RTL at HM - AM Peak Hour

## 3: Asbury Rd &amp; Hales Mill Rd

09/27/2019



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Group Flow (vph)	13	931	319	94	406	25
v/c Ratio	0.02	0.94	0.33	0.11	0.79	0.05
Control Delay	7.5	33.6	9.4	2.4	30.8	6.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	7.5	33.6	9.4	2.4	30.8	6.8
Queue Length 50th (ft)	2	293	61	0	126	0
Queue Length 95th (ft)	9	#536	107	17	#213	13
Internal Link Dist (ft)		302	565		354	
Turn Bay Length (ft)	50			275		
Base Capacity (vph)	559	994	975	872	604	556
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	0.02	0.94	0.33	0.11	0.67	0.04

## Intersection Summary

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

Timing Report, Sorted By Phase  
3: Asbury Rd & Hales Mill Rd

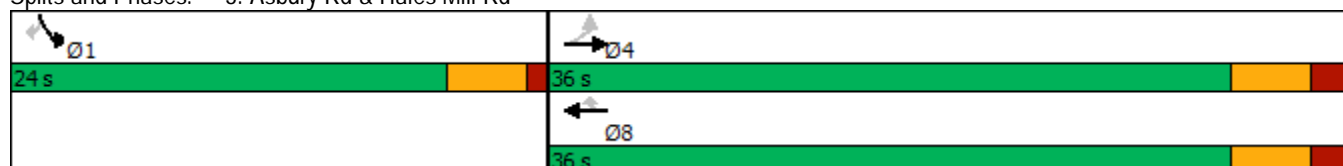
2029 Improved WB RTL at HM - AM Peak Hour

09/27/2019



Phase Number	1	4	8
Movement	SBL	EBTL	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	None	Min	Min
Maximum Split (s)	24	36	36
Maximum Split (%)	40.0%	60.0%	60.0%
Minimum Split (s)	9.5	23.5	23.5
Yellow Time (s)	3.5	3.5	3.5
All-Red Time (s)	1	2	2
Minimum Initial (s)	5	15	15
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)			
Flash Dont Walk (s)			
Dual Entry	No	Yes	Yes
Inhibit Max	Yes	Yes	Yes
Start Time (s)	0	24	24
End Time (s)	24	0	0
Yield/Force Off (s)	19.5	54.5	54.5
Yield/Force Off 170(s)	19.5	54.5	54.5
Local Start Time (s)	0	24	24
Local Yield (s)	19.5	54.5	54.5
Local Yield 170(s)	19.5	54.5	54.5
<b>Intersection Summary</b>			
Cycle Length	60		
Control Type	Actuated-Uncoordinated		
Natural Cycle	65		

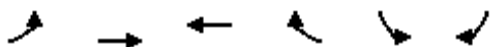
Splits and Phases: 3: Asbury Rd & Hales Mill Rd



# HCM 6th Signalized Intersection Summary 3: Asbury Rd & Hales Mill Rd

2029 Improved WB RTL at HM - AM Peak Hour






09/27/2019



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	10	745	255	75	325	20
Future Volume (veh/h)	10	745	255	75	325	20
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	1870	1870	1841	1841	1870	1870
Adj Flow Rate, veh/h	12	931	319	94	406	25
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	2	2	4	4	2	2
Cap, veh/h	571	1014	998	845	478	425
Arrive On Green	0.54	0.54	0.54	0.54	0.27	0.27
Sat Flow, veh/h	973	1870	1841	1560	1781	1585
Grp Volume(v), veh/h	12	931	319	94	406	25
Grp Sat Flow(s),veh/h/ln	973	1870	1841	1560	1781	1585
Q Serve(g_s), s	0.4	23.9	5.1	1.5	11.4	0.6
Cycle Q Clear(g_c), s	5.4	23.9	5.1	1.5	11.4	0.6
Prop In Lane	1.00			1.00	1.00	1.00
Lane Grp Cap(c), veh/h	571	1014	998	845	478	425
V/C Ratio(X)	0.02	0.92	0.32	0.11	0.85	0.06
Avail Cap(c_a), veh/h	607	1083	1066	904	660	587
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	8.2	11.0	6.7	5.9	18.3	14.3
Incr Delay (d2), s/veh	0.0	11.8	0.2	0.1	7.6	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	10.0	1.4	2.0	5.0	0.2
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	8.2	22.8	6.9	5.9	25.9	14.4
LnGrp LOS	A	C	A	A	C	B
Approach Vol, veh/h		943	413		431	
Approach Delay, s/veh		22.6	6.7		25.2	
Approach LOS		C	A		C	
Timer - Assigned Phs				4	6	8
Phs Duration (G+Y+Rc), s				34.0	18.6	34.0
Change Period (Y+Rc), s				5.5	4.5	5.5
Max Green Setting (Gmax), s				30.5	19.5	30.5
Max Q Clear Time (g_c+l1), s				25.9	13.4	7.1
Green Ext Time (p_c), s				2.6	0.8	2.1
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			19.5			
HCM 6th LOS			B			

Intersection

Int Delay, s/veh 29.9

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	1015	55	210	320	10	250
Future Vol, veh/h	1015	55	210	320	10	250
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	75	-	0	150
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	87	87	87	87	87	87
Heavy Vehicles, %	2	2	5	5	5	5
Mvmt Flow	1167	63	241	368	11	287

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	1230
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.15
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.245
Pot Cap-1 Maneuver	-	-	556
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	556
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	6.5	200.9
HCM LOS			F

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	34	223	-	-	556	-
HCM Lane V/C Ratio	0.338	1.289	-	-	0.434	-
HCM Control Delay (s)	157.6	202.6	-	-	16.3	-
HCM Lane LOS	F	F	-	-	C	-
HCM 95th %tile Q(veh)	1.1	15.2	-	-	2.2	-

Notes

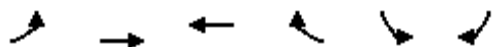
~: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

## Queues

## 2029 Improved WB RTL at HM - PM Peak Hour

## 3: Asbury Rd &amp; Hales Mill Rd

09/27/2019



Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Group Flow (vph)	26	567	711	268	160	36
v/c Ratio	0.08	0.49	0.61	0.25	0.37	0.09
Control Delay	6.3	8.8	10.7	1.6	19.4	7.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	6.3	8.8	10.7	1.6	19.4	7.6
Queue Length 50th (ft)	3	85	120	0	35	0
Queue Length 95th (ft)	13	183	260	25	89	18
Internal Link Dist (ft)		302	579		252	
Turn Bay Length (ft)	50			275		
Base Capacity (vph)	380	1317	1317	1197	695	643
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	0.07	0.43	0.54	0.22	0.23	0.06
Intersection Summary						

Timing Report, Sorted By Phase  
3: Asbury Rd & Hales Mill Rd

2029 Improved WB RTL at HM - PM Peak Hour

09/27/2019

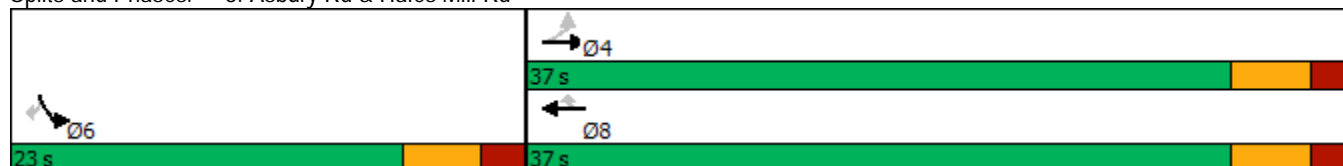


Phase Number	4	6	8
Movement	EBTL	SBL	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	Min	None	Min
Maximum Split (s)	37	23	37
Maximum Split (%)	61.7%	38.3%	61.7%
Minimum Split (s)	22.5	22.5	22.5
Yellow Time (s)	3.5	3.5	3.5
All-Red Time (s)	2	2	2
Minimum Initial (s)	15	10	15
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)			
Flash Dont Walk (s)			
Dual Entry	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes
Start Time (s)	23	0	23
End Time (s)	0	23	0
Yield/Force Off (s)	54.5	17.5	54.5
Yield/Force Off 170(s)	54.5	17.5	54.5
Local Start Time (s)	23	0	23
Local Yield (s)	54.5	17.5	54.5
Local Yield 170(s)	54.5	17.5	54.5

Intersection Summary

Cycle Length	60
Control Type	Actuated-Uncoordinated
Natural Cycle	60

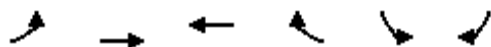
Splits and Phases: 3: Asbury Rd & Hales Mill Rd



# HCM 6th Signalized Intersection Summary 3: Asbury Rd & Hales Mill Rd

2029 Improved WB RTL at HM - PM Peak Hour






09/27/2019



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	25	550	690	260	155	35
Future Volume (veh/h)	25	550	690	260	155	35
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	26	567	711	268	160	36
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	291	931	931	789	399	355
Arrive On Green	0.50	0.50	0.50	0.50	0.22	0.22
Sat Flow, veh/h	575	1870	1870	1585	1781	1585
Grp Volume(v), veh/h	26	567	711	268	160	36
Grp Sat Flow(s),veh/h/ln	575	1870	1870	1585	1781	1585
Q Serve(g_s), s	1.5	8.6	12.2	4.0	3.0	0.7
Cycle Q Clear(g_c), s	13.7	8.6	12.2	4.0	3.0	0.7
Prop In Lane	1.00			1.00	1.00	1.00
Lane Grp Cap(c), veh/h	291	931	931	789	399	355
V/C Ratio(X)	0.09	0.61	0.76	0.34	0.40	0.10
Avail Cap(c_a), veh/h	464	1492	1492	1264	789	702
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(l)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.6	7.1	8.0	6.0	13.1	12.2
Incr Delay (d2), s/veh	0.1	0.6	1.3	0.3	0.7	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	2.1	3.1	0.8	1.0	0.2
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	13.7	7.8	9.4	6.2	13.7	12.3
LnGrp LOS	B	A	A	A	B	B
Approach Vol, veh/h		593	979		196	
Approach Delay, s/veh		8.1	8.5		13.5	
Approach LOS		A	A		B	
Timer - Assigned Phs				4	6	8
Phs Duration (G+Y+Rc), s				25.2	14.3	25.2
Change Period (Y+Rc), s				5.5	5.5	5.5
Max Green Setting (Gmax), s				31.5	17.5	31.5
Max Q Clear Time (g_c+l1), s				15.7	5.0	14.2
Green Ext Time (p_c), s				3.5	0.4	5.5
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			8.9			
HCM 6th LOS			A			

Intersection

Int Delay, s/veh 5.1

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	665	40	230	935	15	250
Future Vol, veh/h	665	40	230	935	15	250
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	75	-	0	150
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	686	41	237	964	15	258

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	727
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.12
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.218
Pot Cap-1 Maneuver	-	-	876
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	876
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	2.1	31.6
HCM LOS			D

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	39	435	-	-	876	-
HCM Lane V/C Ratio	0.397	0.592	-	-	0.271	-
HCM Control Delay (s)	148.4	24.6	-	-	10.6	-
HCM Lane LOS	F	C	-	-	B	-
HCM 95th %tile Q(veh)	1.4	3.7	-	-	1.1	-

## Appendix D

### Short-Term & Long-Term Alternatives Operational Analysis

#### II. Short-Term: Traffic Signals at Both Intersections with Existing Lanes/Geometry

## Queues

## 2029 Existing - AM Peak Hour Signals at HM &amp; Radford\_PP

## 3: Asbury Rd &amp; Hales Mill Rd

09/20/2019



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	11	847	375	369	23
v/c Ratio	0.02	0.70	0.32	0.81	0.05
Control Delay	9.9	19.0	10.2	55.2	10.9
Queue Delay	0.0	0.2	0.0	0.5	0.0
Total Delay	9.9	19.3	10.2	55.7	10.9
Queue Length 50th (ft)	3	390	121	268	0
Queue Length 95th (ft)	12	644	209	335	18
Internal Link Dist (ft)		302	565	354	
Turn Bay Length (ft)	50				
Base Capacity (vph)	605	1211	1157	700	640
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	56	0	90	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.02	0.73	0.32	0.60	0.04
Intersection Summary					

Timing Report, Sorted By Phase 2029 Existing - AM Peak Hour Signals at HM & Radford\_PP  
3: Asbury Rd & Hales Mill Rd

09/20/2019

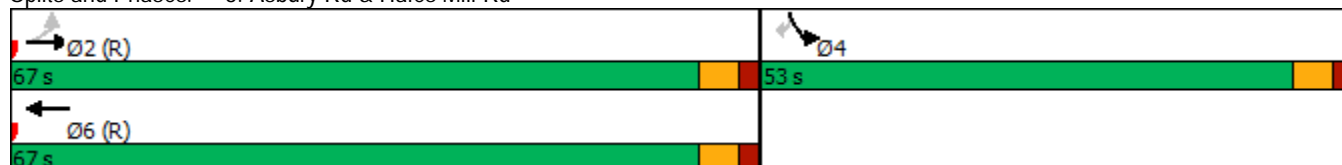


Phase Number	2	4	6
Movement	EBTL	SBL	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	C-Max	None	C-Max
Maximum Split (s)	67	53	67
Maximum Split (%)	55.8%	44.2%	55.8%
Minimum Split (s)	23.5	23.5	23.5
Yellow Time (s)	3.5	3.5	3.5
All-Red Time (s)	2	2	2
Minimum Initial (s)	15	10	15
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)			
Flash Dont Walk (s)			
Dual Entry	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes
Start Time (s)	23	90	23
End Time (s)	90	23	90
Yield/Force Off (s)	84.5	17.5	84.5
Yield/Force Off 170(s)	84.5	17.5	84.5
Local Start Time (s)	0	67	0
Local Yield (s)	61.5	114.5	61.5
Local Yield 170(s)	61.5	114.5	61.5

Intersection Summary

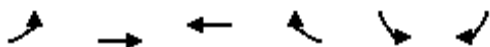
Cycle Length	120
Control Type	Actuated-Coordinated
Natural Cycle	60
Offset: 23 (19%), Referenced to phase 2:EBTL and 6:WBT, Start of Green	

Splits and Phases: 3: Asbury Rd & Hales Mill Rd



# HCM 6th Signalized Intersection S2020 Existing - AM Peak Hour Signals at HM & Radford\_PP 3: Asbury Rd & Hales Mill Rd

09/20/2019



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	10	745	255	75	325	20
Future Volume (veh/h)	10	745	255	75	325	20
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	1870	1870	1841	1841	1870	1870
Adj Flow Rate, veh/h	11	847	290	85	369	23
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	2	2	4	4	2	2
Cap, veh/h	745	1272	930	273	406	361
Arrive On Green	0.68	0.68	1.00	1.00	0.23	0.23
Sat Flow, veh/h	1008	1870	1368	401	1781	1585
Grp Volume(v), veh/h	11	847	0	375	369	23
Grp Sat Flow(s),veh/h/ln	1008	1870	0	1769	1781	1585
Q Serve(g_s), s	0.4	31.7	0.0	0.0	24.2	1.4
Cycle Q Clear(g_c), s	0.4	31.7	0.0	0.0	24.2	1.4
Prop In Lane	1.00			0.23	1.00	1.00
Lane Grp Cap(c), veh/h	745	1272	0	1203	406	361
V/C Ratio(X)	0.01	0.67	0.00	0.31	0.91	0.06
Avail Cap(c_a), veh/h	745	1272	0	1203	705	627
HCM Platoon Ratio	1.00	1.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	0.99	1.00	1.00
Uniform Delay (d), s/veh	6.2	11.2	0.0	0.0	45.1	36.3
Incr Delay (d2), s/veh	0.0	2.8	0.0	0.7	9.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	12.7	0.0	0.2	11.6	0.5
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	6.2	14.0	0.0	0.7	54.2	36.4
LnGrp LOS	A	B	A	A	D	D
Approach Vol, veh/h		858	375		392	
Approach Delay, s/veh		13.9	0.7		53.2	
Approach LOS		B	A		D	
Timer - Assigned Phs		2		4		6
Phs Duration (G+Y+Rc), s		87.1		32.9		87.1
Change Period (Y+Rc), s		5.5		5.5		5.5
Max Green Setting (Gmax), s		61.5		47.5		61.5
Max Q Clear Time (g_c+l1), s		33.7		26.2		2.0
Green Ext Time (p_c), s		7.0		1.2		2.5
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			20.3			
HCM 6th LOS			C			

## Queues

## 2029 Existing - AM Peak Hour Signals at HM &amp; Radford\_PP

## 5: Radford Rd &amp; Asbury Rd

09/20/2019



Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	1230	241	368	11	287
v/c Ratio	0.82	0.82	0.21	0.05	1.15
Control Delay	11.2	39.5	1.3	47.1	134.3
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	11.3	39.5	1.3	47.1	134.3
Queue Length 50th (ft)	117	35	0	8	~226
Queue Length 95th (ft)	#1153	#197	88	25	218
Internal Link Dist (ft)	565		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	1502	295	1731	265	249
Starvation Cap Reductn	7	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.82	0.82	0.21	0.04	1.15

## Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.  
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.  
Queue shown is maximum after two cycles.

Timing Report, Sorted By Phase 2029 Existing - AM Peak Hour Signals at HM & Radford\_PP  
5: Radford Rd & Asbury Rd

09/20/2019



Phase Number	1	2	6	8
Movement	WBL	EBT	WBTL	NBL
Lead/Lag	Lag	Lead		
Lead-Lag Optimize	Yes	Yes		
Recall Mode	None	C-Max	C-Max	None
Maximum Split (s)	13	83	96	24
Maximum Split (%)	10.8%	69.2%	80.0%	20.0%
Minimum Split (s)	10.5	23.5	23.5	23.5
Yellow Time (s)	3.5	3.5	3.5	3.5
All-Red Time (s)	1	2	2	2
Minimum Initial (s)	6	15	10	15
Vehicle Extension (s)	3	3	3	3
Minimum Gap (s)	3	3	3	3
Time Before Reduce (s)	0	0	0	0
Time To Reduce (s)	0	0	0	0
Walk Time (s)				
Flash Dont Walk (s)				
Dual Entry	No	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes	Yes
Start Time (s)	83	0	0	96
End Time (s)	96	83	96	0
Yield/Force Off (s)	91.5	77.5	90.5	114.5
Yield/Force Off 170(s)	91.5	77.5	90.5	114.5
Local Start Time (s)	83	0	0	96
Local Yield (s)	91.5	77.5	90.5	114.5
Local Yield 170(s)	91.5	77.5	90.5	114.5

Intersection Summary












Cycle Length 120  
Control Type Actuated-Coordinated  
Natural Cycle 150  
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBTL, Start of Green

Splits and Phases: 5: Radford Rd & Asbury Rd



# HCM 6th Signalized Intersection Synchro 10 Existing - AM Peak Hour Signals at HM & Radford\_PP 5: Radford Rd & Asbury Rd

09/20/2019

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	1015	55	210	320	10	250
Future Volume (veh/h)	1015	55	210	320	10	250
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1826	1826	1826	1826
Adj Flow Rate, veh/h	1167	63	241	368	11	287
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Percent Heavy Veh, %	2	2	5	5	5	5
Cap, veh/h	1136	61	251	1430	217	335
Arrive On Green	1.00	1.00	0.09	0.78	0.12	0.12
Sat Flow, veh/h	1758	95	1739	1826	1739	1547
Grp Volume(v), veh/h	0	1230	241	368	11	287
Grp Sat Flow(s),veh/h/ln	0	1853	1739	1826	1739	1547
Q Serve(g_s), s	0.0	66.9	10.2	6.6	0.7	10.4
Cycle Q Clear(g_c), s	0.0	66.9	10.2	6.6	0.7	10.4
Prop In Lane		0.05	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	0	1197	251	1430	217	335
V/C Ratio(X)	0.00	1.03	0.96	0.26	0.05	0.86
Avail Cap(c_a), veh/h	0	1197	251	1430	268	380
HCM Platoon Ratio	2.00	2.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.00	0.60	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	0.0	51.6	3.5	46.2	45.2
Incr Delay (d2), s/veh	0.0	27.6	45.5	0.4	0.1	15.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	9.2	10.3	2.1	0.3	4.8
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	0.0	27.6	97.1	4.0	46.3	61.0
LnGrp LOS	A	F	F	A	D	E
Approach Vol, veh/h	1230			609	298	
Approach Delay, s/veh	27.6			40.8	60.4	
Approach LOS	C			D	E	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	16.5	83.0			99.5	20.5
Change Period (Y+Rc), s	5.5	* 5.5			5.5	5.5
Max Green Setting (Gmax), s	8.5	* 78			90.5	18.5
Max Q Clear Time (g_c+I1), s	12.2	68.9			8.6	12.4
Green Ext Time (p_c), s	0.0	6.1			2.4	0.5
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			35.9			
HCM 6th LOS			D			
<b>Notes</b>						
* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.						

## Queues

## 2029 Existing - PM Peak Hour Signals at HM &amp; Radford

## 3: Asbury Rd &amp; Hales Mill Rd

09/19/2019



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	26	567	979	160	36
v/c Ratio	0.08	0.39	0.70	0.67	0.15
Control Delay	5.0	5.9	8.9	62.3	14.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	5.0	5.9	8.9	62.3	14.4
Queue Length 50th (ft)	4	121	325	119	0
Queue Length 95th (ft)	15	215	589	183	29
Internal Link Dist (ft)		302	579	252	
Turn Bay Length (ft)	50				
Base Capacity (vph)	313	1439	1392	567	532
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	0.08	0.39	0.70	0.28	0.07
Intersection Summary					

Timing Report, Sorted By Phase  
3: Asbury Rd & Hales Mill Rd

2029 Existing - PM Peak Hour Signals at HM & Radford

09/19/2019



Phase Number	2	4	6
Movement	EBTL	SBL	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	C-Max	None	C-Max
Maximum Split (s)	76	44	76
Maximum Split (%)	63.3%	36.7%	63.3%
Minimum Split (s)	23.5	43.5	23.5
Yellow Time (s)	3.5	3.5	3.5
All-Red Time (s)	2	2	2
Minimum Initial (s)	15	10	15
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)			
Flash Dont Walk (s)			
Dual Entry	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes
Start Time (s)	10	86	10
End Time (s)	86	10	86
Yield/Force Off (s)	80.5	4.5	80.5
Yield/Force Off 170(s)	80.5	4.5	80.5
Local Start Time (s)	0	76	0
Local Yield (s)	70.5	114.5	70.5
Local Yield 170(s)	70.5	114.5	70.5

Intersection Summary

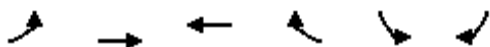
Cycle Length	120
Control Type	Actuated-Coordinated
Natural Cycle	100
Offset: 10 (8%), Referenced to phase 2:EBTL and 6:WBT, Start of Green	

Splits and Phases: 3: Asbury Rd & Hales Mill Rd



# HCM 6th Signalized Intersection Summary 2019 Existing - PM Peak Hour Signals at HM & Radford 3: Asbury Rd & Hales Mill Rd

09/19/2019








Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	25	550	690	260	155	35
Future Volume (veh/h)	25	550	690	260	155	35
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	26	567	711	268	160	36
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	519	1495	1035	390	194	173
Arrive On Green	0.80	0.80	1.00	1.00	0.11	0.11
Sat Flow, veh/h	575	1870	1295	488	1781	1585
Grp Volume(v), veh/h	26	567	0	979	160	36
Grp Sat Flow(s),veh/h/ln	575	1870	0	1783	1781	1585
Q Serve(g_s), s	1.1	10.5	0.0	0.0	10.6	2.5
Cycle Q Clear(g_c), s	1.1	10.5	0.0	0.0	10.6	2.5
Prop In Lane	1.00			0.27	1.00	1.00
Lane Grp Cap(c), veh/h	519	1495	0	1425	194	173
V/C Ratio(X)	0.05	0.38	0.00	0.69	0.82	0.21
Avail Cap(c_a), veh/h	519	1495	0	1425	571	509
HCM Platoon Ratio	1.00	1.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	0.82	1.00	1.00
Uniform Delay (d), s/veh	2.5	3.5	0.0	0.0	52.3	48.7
Incr Delay (d2), s/veh	0.2	0.7	0.0	2.2	8.5	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	3.2	0.0	0.9	5.1	1.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	2.7	4.2	0.0	2.2	60.8	49.3
LnGrp LOS	A	A	A	A	E	D
Approach Vol, veh/h		593	979		196	
Approach Delay, s/veh		4.1	2.2		58.7	
Approach LOS		A	A		E	
Timer - Assigned Phs		2		4		6
Phs Duration (G+Y+Rc), s		101.4		18.6		101.4
Change Period (Y+Rc), s		5.5		5.5		5.5
Max Green Setting (Gmax), s		70.5		38.5		70.5
Max Q Clear Time (g_c+l1), s		12.5		12.6		2.0
Green Ext Time (p_c), s		4.5		0.5		11.1
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			9.1			
HCM 6th LOS			A			

## Queues

## 2029 Existing - PM Peak Hour Signals at HM &amp; Radford

## 5: Radford Rd &amp; Asbury Rd

09/19/2019

					
Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	727	237	964	15	258
v/c Ratio	0.49	0.38	0.56	0.10	0.67
Control Delay	5.2	2.9	3.5	52.7	17.2
Queue Delay	0.1	0.0	0.0	0.0	0.0
Total Delay	5.4	2.9	3.5	52.7	17.2
Queue Length 50th (ft)	68	0	0	11	23
Queue Length 95th (ft)	117	41	294	33	96
Internal Link Dist (ft)	579		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	1477	702	1732	287	483
Starvation Cap Reductn	154	0	0	0	0
Spillback Cap Reductn	0	0	54	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.55	0.34	0.57	0.05	0.53
Intersection Summary					

Timing Report, Sorted By Phase  
5: Radford Rd & Asbury Rd

2029 Existing - PM Peak Hour Signals at HM & Radford

09/19/2019

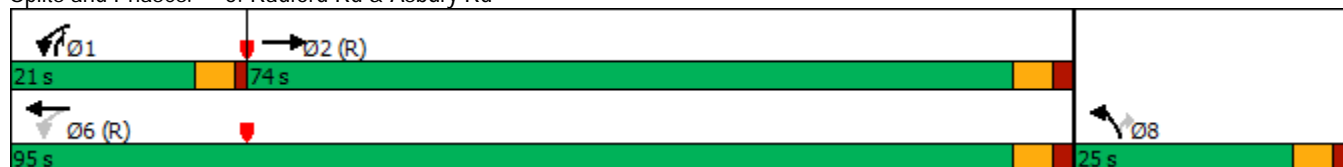


Phase Number	1	2	6	8
Movement	WBL	EBT	WBTL	NBL
Lead/Lag	Lead	Lag		
Lead-Lag Optimize	Yes	Yes		
Recall Mode	None	C-Max	C-Max	None
Maximum Split (s)	21	74	95	25
Maximum Split (%)	17.5%	61.7%	79.2%	20.8%
Minimum Split (s)	10.5	22.5	22.5	22.5
Yellow Time (s)	3.5	3.5	3.5	3.5
All-Red Time (s)	1	2	2	2
Minimum Initial (s)	6	15	15	10
Vehicle Extension (s)	3	3	3	3
Minimum Gap (s)	3	3	3	3
Time Before Reduce (s)	0	0	0	0
Time To Reduce (s)	0	0	0	0
Walk Time (s)				
Flash Dont Walk (s)				
Dual Entry	No	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes	Yes
Start Time (s)	99	0	99	74
End Time (s)	0	74	74	99
Yield/Force Off (s)	115.5	68.5	68.5	93.5
Yield/Force Off 170(s)	115.5	68.5	68.5	93.5
Local Start Time (s)	99	0	99	74
Local Yield (s)	115.5	68.5	68.5	93.5
Local Yield 170(s)	115.5	68.5	68.5	93.5

Intersection Summary

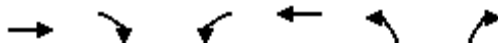
Cycle Length 120  
Control Type Actuated-Coordinated  
Natural Cycle 75  
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBTL, Start of Green

Splits and Phases: 5: Radford Rd & Asbury Rd



# HCM 6th Signalized Intersection Summary 2019 Existing - PM Peak Hour Signals at HM & Radford 5: Radford Rd & Asbury Rd

09/19/2019



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↩		↩	↩	↩	↩
Traffic Volume (veh/h)	665	40	230	935	15	250
Future Volume (veh/h)	665	40	230	935	15	250
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	686	41	237	964	15	258
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1128	67	641	1395	289	357
Arrive On Green	1.00	1.00	0.06	0.75	0.16	0.16
Sat Flow, veh/h	1747	104	1781	1870	1781	1585
Grp Volume(v), veh/h	0	727	237	964	15	258
Grp Sat Flow(s),veh/h/ln	0	1852	1781	1870	1781	1585
Q Serve(g_s), s	0.0	0.0	5.1	32.4	0.9	18.1
Cycle Q Clear(g_c), s	0.0	0.0	5.1	32.4	0.9	18.1
Prop In Lane		0.06	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	0	1196	641	1395	289	357
V/C Ratio(X)	0.00	0.61	0.37	0.69	0.05	0.72
Avail Cap(c_a), veh/h	0	1196	775	1395	289	357
HCM Platoon Ratio	2.00	2.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.00	0.89	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	0.0	5.3	8.0	42.4	43.0
Incr Delay (d2), s/veh	0.0	2.1	0.4	2.8	0.1	7.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	0.7	1.7	11.8	0.4	7.7
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	0.0	2.1	5.6	10.8	42.5	50.1
LnGrp LOS	A	A	A	B	D	D
Approach Vol, veh/h	727			1201	273	
Approach Delay, s/veh	2.1			9.8	49.7	
Approach LOS	A			A	D	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	12.0	83.0			95.0	25.0
Change Period (Y+Rc), s	4.5	5.5			5.5	5.5
Max Green Setting (Gmax), s	16.5	68.5			89.5	19.5
Max Q Clear Time (g_c+l1), s	7.1	2.0			34.4	20.1
Green Ext Time (p_c), s	0.5	6.1			10.0	0.0

## Intersection Summary

HCM 6th Ctrl Delay	12.2
HCM 6th LOS	B

## Appendix D

### Short-Term & Long-Term Alternatives Operational Analysis

#### III. Long-Term: Two Eastbound Lanes on Asbury Road with:

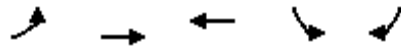
- a. Traffic Signal at Hales Mill Road

## Queues

2029 Improved 2 Ln EB, Sig HM - AM Peak Hour

## 3: Asbury Rd &amp; Hales Mill Rd

09/26/2019



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	13	931	413	406	25
v/c Ratio	0.03	0.92	0.42	0.79	0.05
Control Delay	7.5	31.0	9.6	32.7	7.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	7.5	31.0	9.6	32.7	7.4
Queue Length 50th (ft)	2	309	80	141	0
Queue Length 95th (ft)	9	#554	137	#238	14
Internal Link Dist (ft)		302	565	354	
Turn Bay Length (ft)	50				
Base Capacity (vph)	513	1076	1037	607	559
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	0.03	0.87	0.40	0.67	0.04

## Intersection Summary

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

Timing Report, Sorted By Phase  
3: Asbury Rd & Hales Mill Rd

2029 Improved 2 Ln EB, Sig HM - AM Peak Hour

09/26/2019

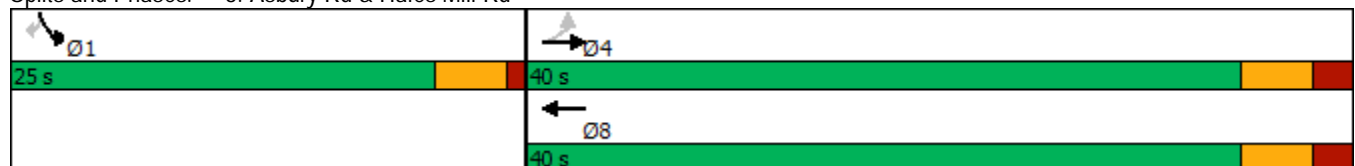


Phase Number	1	4	8
Movement	SBL	EBTL	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	None	Min	Min
Maximum Split (s)	25	40	40
Maximum Split (%)	38.5%	61.5%	61.5%
Minimum Split (s)	9.5	23.5	23.5
Yellow Time (s)	3.5	3.5	3.5
All-Red Time (s)	1	2	2
Minimum Initial (s)	5	15	15
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)			
Flash Dont Walk (s)			
Dual Entry	No	Yes	Yes
Inhibit Max	Yes	Yes	Yes
Start Time (s)	0	25	25
End Time (s)	25	0	0
Yield/Force Off (s)	20.5	59.5	59.5
Yield/Force Off 170(s)	20.5	59.5	59.5
Local Start Time (s)	0	25	25
Local Yield (s)	20.5	59.5	59.5
Local Yield 170(s)	20.5	59.5	59.5

Intersection Summary

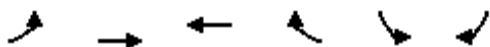
Cycle Length	65
Control Type	Actuated-Uncoordinated
Natural Cycle	65

Splits and Phases: 3: Asbury Rd & Hales Mill Rd



# HCM 6th Signalized Intersection Summary 2029 Improved 2 Ln EB, Sig HM - AM Peak Hour 3: Asbury Rd & Hales Mill Rd

09/26/2019



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	10	745	255	75	325	20
Future Volume (veh/h)	10	745	255	75	325	20
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	1870	1870	1841	1841	1870	1870
Adj Flow Rate, veh/h	12	931	319	94	406	25
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	2	2	4	4	2	2
Cap, veh/h	535	1034	755	223	475	423
Arrive On Green	0.55	0.55	0.55	0.55	0.27	0.27
Sat Flow, veh/h	973	1870	1366	402	1781	1585
Grp Volume(v), veh/h	12	931	0	413	406	25
Grp Sat Flow(s),veh/h/ln	973	1870	0	1768	1781	1585
Q Serve(g_s), s	0.4	24.6	0.0	7.5	12.0	0.7
Cycle Q Clear(g_c), s	8.0	24.6	0.0	7.5	12.0	0.7
Prop In Lane	1.00			0.23	1.00	1.00
Lane Grp Cap(c), veh/h	535	1034	0	978	475	423
V/C Ratio(X)	0.02	0.90	0.00	0.42	0.85	0.06
Avail Cap(c_a), veh/h	603	1164	0	1101	659	586
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(l)	1.00	1.00	0.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	9.5	11.0	0.0	7.2	19.3	15.1
Incr Delay (d2), s/veh	0.0	9.0	0.0	0.3	7.9	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	9.6	0.0	2.1	5.4	0.2
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	9.6	20.0	0.0	7.5	27.2	15.2
LnGrp LOS	A	B	A	A	C	B
Approach Vol, veh/h		943	413		431	
Approach Delay, s/veh		19.9	7.5		26.5	
Approach LOS		B	A		C	
Timer - Assigned Phs				4	6	8
Phs Duration (G+Y+Rc), s				36.1	19.3	36.1
Change Period (Y+Rc), s				5.5	4.5	5.5
Max Green Setting (Gmax), s				34.5	20.5	34.5
Max Q Clear Time (g_c+l1), s				26.6	14.0	9.5
Green Ext Time (p_c), s				4.1	0.8	2.6
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			18.6			
HCM 6th LOS			B			

Intersection

Int Delay, s/veh 6.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↑	↑	↑	↑
Traffic Vol, veh/h	1015	55	210	320	10	250
Future Vol, veh/h	1015	55	210	320	10	250
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	75	-	0	150
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	87	87	87	87	87	87
Heavy Vehicles, %	2	2	5	5	5	5
Mvmt Flow	1167	63	241	368	11	287

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	1230
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.175
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.2475
Pot Cap-1 Maneuver	-	-	551
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	551
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	6.5	34.9
HCM LOS			D

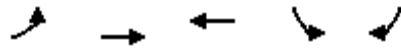
Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	30	429	-	-	551	-
HCM Lane V/C Ratio	0.383	0.67	-	-	0.438	-
HCM Control Delay (s)	186.1	28.8	-	-	16.5	-
HCM Lane LOS	F	D	-	-	C	-
HCM 95th %tile Q(veh)	1.2	4.8	-	-	2.2	-

## Queues

2029 Improved 2 Ln EB, Sig HM - PM Peak Hour

## 3: Asbury Rd &amp; Hales Mill Rd

09/26/2019



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	26	567	979	160	36
v/c Ratio	0.12	0.43	0.77	0.44	0.10
Control Delay	7.0	7.2	14.7	26.7	8.9
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	7.0	7.2	14.7	26.7	8.9
Queue Length 50th (ft)	3	90	222	56	0
Queue Length 95th (ft)	15	186	#580	106	20
Internal Link Dist (ft)		302	579	252	
Turn Bay Length (ft)	50				
Base Capacity (vph)	217	1343	1306	590	552
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	0.12	0.42	0.75	0.27	0.07

## Intersection Summary

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

Timing Report, Sorted By Phase  
3: Asbury Rd & Hales Mill Rd

2029 Improved 2 Ln EB, Sig HM - PM Peak Hour

09/26/2019



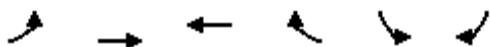
Phase Number	4	6	8
Movement	EBTL	SBL	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	Min	None	Min
Maximum Split (s)	46	24	46
Maximum Split (%)	65.7%	34.3%	65.7%
Minimum Split (s)	22.5	22.5	22.5
Yellow Time (s)	3.5	3.5	3.5
All-Red Time (s)	2	2	2
Minimum Initial (s)	15	10	15
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)			
Flash Dont Walk (s)			
Dual Entry	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes
Start Time (s)	24	0	24
End Time (s)	0	24	0
Yield/Force Off (s)	64.5	18.5	64.5
Yield/Force Off 170(s)	64.5	18.5	64.5
Local Start Time (s)	24	0	24
Local Yield (s)	64.5	18.5	64.5
Local Yield 170(s)	64.5	18.5	64.5
<b>Intersection Summary</b>			
Cycle Length	70		
Control Type	Actuated-Uncoordinated		
Natural Cycle	70		

Splits and Phases: 3: Asbury Rd & Hales Mill Rd



# HCM 6th Signalized Intersection Summary 2029 Improved 2 Ln EB, Sig HM - PM Peak Hour 3: Asbury Rd & Hales Mill Rd

09/26/2019



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	25	550	690	260	155	35
Future Volume (veh/h)	25	550	690	260	155	35
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	26	567	711	268	160	36
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	224	1159	802	302	313	279
Arrive On Green	0.62	0.62	0.62	0.62	0.18	0.18
Sat Flow, veh/h	575	1870	1295	488	1781	1585
Grp Volume(v), veh/h	26	567	0	979	160	36
Grp Sat Flow(s),veh/h/ln	575	1870	0	1783	1781	1585
Q Serve(g_s), s	2.2	8.9	0.0	24.9	4.4	1.0
Cycle Q Clear(g_c), s	27.1	8.9	0.0	24.9	4.4	1.0
Prop In Lane	1.00			0.27	1.00	1.00
Lane Grp Cap(c), veh/h	224	1159	0	1105	313	279
V/C Ratio(X)	0.12	0.49	0.00	0.89	0.51	0.13
Avail Cap(c_a), veh/h	300	1407	0	1341	612	545
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(l)	1.00	1.00	0.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	20.1	5.6	0.0	8.6	20.1	18.7
Incr Delay (d2), s/veh	0.2	0.3	0.0	6.5	1.3	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	2.2	0.0	7.6	1.7	0.4
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	20.3	5.9	0.0	15.1	21.4	18.9
LnGrp LOS	C	A	A	B	C	B
Approach Vol, veh/h		593	979		196	
Approach Delay, s/veh		6.5	15.1		20.9	
Approach LOS		A	B		C	
Timer - Assigned Phs				4	6	8
Phs Duration (G+Y+Rc), s				38.9	15.0	38.9
Change Period (Y+Rc), s				5.5	5.5	5.5
Max Green Setting (Gmax), s				40.5	18.5	40.5
Max Q Clear Time (g_c+l1), s				29.1	6.4	26.9
Green Ext Time (p_c), s				3.0	0.4	6.4
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			12.9			
HCM 6th LOS			B			

Intersection

Int Delay, s/veh 4.1

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↘	↑	↘	↘
Traffic Vol, veh/h	665	40	230	935	15	250
Future Vol, veh/h	665	40	230	935	15	250
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	75	-	0	150
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	686	41	237	964	15	258

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	727
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.13
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.219
Pot Cap-1 Maneuver	-	-	874
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	874
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	2.1	23.9
HCM LOS			C






Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	34	634	-	-	874	-
HCM Lane V/C Ratio	0.455	0.407	-	-	0.271	-
HCM Control Delay (s)	179.8	14.5	-	-	10.6	-
HCM Lane LOS	F	B	-	-	B	-
HCM 95th %tile Q(veh)	1.5	2	-	-	1.1	-

## Appendix D

### Short-Term & Long-Term Alternatives Operational Analysis

#### III. Long-Term: Two Eastbound Lanes on Asbury Road with:

##### b. Traffic Signal at Radford Road

Intersection						
Int Delay, s/veh	98.2					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	10	745	255	75	325	20
Future Vol, veh/h	10	745	255	75	325	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	50	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	2	2	4	4	2	2
Mvmt Flow	11	847	290	85	369	23

Major/Minor	Major1	Major2	Minor2		
Conflicting Flow All	375	0	0	1202	333
Stage 1	-	-	-	333	-
Stage 2	-	-	-	869	-
Critical Hdwy	4.12	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	3.518	3.318
Pot Cap-1 Maneuver	1183	-	-	~ 204	709
Stage 1	-	-	-	726	-
Stage 2	-	-	-	410	-
Platoon blocked, %	-	-	-		
Mov Cap-1 Maneuver	1183	-	-	~ 202	709
Mov Cap-2 Maneuver	-	-	-	~ 202	-
Stage 1	-	-	-	719	-
Stage 2	-	-	-	410	-

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	\$ 407
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1183	-	-	-	202	709
HCM Lane V/C Ratio	0.01	-	-	-	1.828	0.032
HCM Control Delay (s)	8.1	-	-	-	\$ 431.4	10.2
HCM Lane LOS	A	-	-	-	F	B
HCM 95th %tile Q(veh)	0	-	-	-	26.2	0.1

Notes			
-: Volume exceeds capacity	\$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

## Queues

2029 Existing - AM Peak Hour

## 5: Radford Rd &amp; Asbury Rd

09/28/2019



Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	1230	241	368	11	287
v/c Ratio	0.66	0.49	0.22	0.03	0.73
Control Delay	12.3	8.9	2.1	17.8	26.5
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	12.3	8.9	2.1	17.8	26.5
Queue Length 50th (ft)	93	0	0	2	64
Queue Length 95th (ft)	#280	86	84	14	115
Internal Link Dist (ft)	549		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	1852	503	1636	371	404
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	0.66	0.48	0.22	0.03	0.71

## Intersection Summary

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

Timing Report, Sorted By Phase  
5: Radford Rd & Asbury Rd

2029 Existing - AM Peak Hour

09/28/2019



Phase Number	1	2	6	8
Movement	WBL	EBT	WBTL	NBL
Lead/Lag	Lead	Lag		
Lead-Lag Optimize	Yes	Yes		
Recall Mode	None	Max	None	None
Maximum Split (s)	13.7	30.3	44	16
Maximum Split (%)	22.8%	50.5%	73.3%	26.7%
Minimum Split (s)	10.5	25	21	16
Yellow Time (s)	3.5	4	4	4
All-Red Time (s)	1	2	2	2
Minimum Initial (s)	6	15	15	10
Vehicle Extension (s)	3	3	3	3
Minimum Gap (s)	3	3	3	3
Time Before Reduce (s)	0	0	0	0
Time To Reduce (s)	0	0	0	0
Walk Time (s)		7		
Flash Dont Walk (s)		12		
Dual Entry	No	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes	Yes
Start Time (s)	0	13.7	0	44
End Time (s)	13.7	44	44	0
Yield/Force Off (s)	9.2	38	38	54
Yield/Force Off 170(s)	9.2	26	38	54
Local Start Time (s)	46.3	0	46.3	30.3
Local Yield (s)	55.5	24.3	24.3	40.3
Local Yield 170(s)	55.5	12.3	24.3	40.3

Intersection Summary

Cycle Length	60
Control Type	Semi Act-Uncoord
Natural Cycle	60












Splits and Phases: 5: Radford Rd & Asbury Rd



# HCM 6th Signalized Intersection Summary 5: Radford Rd & Asbury Rd






2029 Existing - AM Peak Hour

09/28/2019

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	1015	55	210	320	10	250
Future Volume (veh/h)	1015	55	210	320	10	250
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1826	1826	1826	1826
Adj Flow Rate, veh/h	1167	63	241	368	11	287
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Percent Heavy Veh, %	2	2	5	5	5	5
Cap, veh/h	1466	79	369	1119	306	436
Arrive On Green	0.43	0.43	0.11	0.61	0.18	0.18
Sat Flow, veh/h	3522	185	1739	1826	1739	1547
Grp Volume(v), veh/h	604	626	241	368	11	287
Grp Sat Flow(s),veh/h/ln	1777	1837	1739	1826	1739	1547
Q Serve(g_s), s	16.8	16.8	3.9	5.6	0.3	9.3
Cycle Q Clear(g_c), s	16.8	16.8	3.9	5.6	0.3	9.3
Prop In Lane		0.10	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	760	786	369	1119	306	436
V/C Ratio(X)	0.80	0.80	0.65	0.33	0.04	0.66
Avail Cap(c_a), veh/h	760	786	467	1221	306	436
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	14.1	14.1	11.3	5.3	19.4	18.0
Incr Delay (d2), s/veh	8.4	8.2	2.2	0.2	0.0	3.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	7.2	7.4	1.2	1.4	0.1	3.3
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	22.5	22.3	13.5	5.5	19.5	21.6
LnGrp LOS	C	C	B	A	B	C
Approach Vol, veh/h	1230			609	298	
Approach Delay, s/veh	22.4			8.7	21.5	
Approach LOS	C			A	C	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	10.5	30.3			40.8	16.0
Change Period (Y+Rc), s	4.5	6.0			6.0	6.0
Max Green Setting (Gmax), s	9.2	24.3			38.0	10.0
Max Q Clear Time (g_c+l1), s	5.9	18.8			7.6	11.3
Green Ext Time (p_c), s	0.2	3.4			2.3	0.0
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			18.4			
HCM 6th LOS			B			
<b>Notes</b>						
User approved pedestrian interval to be less than phase max green.						

Intersection

Int Delay, s/veh 18.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	25	550	690	260	155	35
Future Vol, veh/h	25	550	690	260	155	35
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	50	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	26	567	711	268	160	36

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	979	0	0 1464 845
Stage 1	-	-	- 845 -
Stage 2	-	-	- 619 -
Critical Hdwy	4.12	-	- 6.42 6.22
Critical Hdwy Stg 1	-	-	- 5.42 -
Critical Hdwy Stg 2	-	-	- 5.42 -
Follow-up Hdwy	2.218	-	- 3.518 3.318
Pot Cap-1 Maneuver	705	-	- ~ 141 363
Stage 1	-	-	- 421 -
Stage 2	-	-	- 537 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	705	-	- ~ 136 363
Mov Cap-2 Maneuver	-	-	- ~ 136 -
Stage 1	-	-	- 405 -
Stage 2	-	-	- 537 -

Approach	EB	WB	SB
HCM Control Delay, s	0.4	0	162.4
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	705	-	-	-	136	363
HCM Lane V/C Ratio	0.037	-	-	-	1.175	0.099
HCM Control Delay (s)	10.3	-	-	-	195.5	16
HCM Lane LOS	B	-	-	-	F	C
HCM 95th %tile Q(veh)	0.1	-	-	-	9.4	0.3

Notes






~: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

## Queues

## 2029 Improvements - PM Peak Hour

## 5: Radford Rd &amp; Asbury Rd

09/28/2019

					
Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	727	237	964	15	258
v/c Ratio	0.44	0.34	0.55	0.03	0.49
Control Delay	8.7	2.7	3.8	19.0	8.3
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	8.7	2.7	3.8	19.0	8.3
Queue Length 50th (ft)	38	0	0	2	11
Queue Length 95th (ft)	142	47	364	22	73
Internal Link Dist (ft)	571		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	3165	804	1754	479	645
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	0.23	0.29	0.55	0.03	0.40
Intersection Summary					

Timing Report, Sorted By Phase  
5: Radford Rd & Asbury Rd

2029 Improvements - PM Peak Hour

09/28/2019



Phase Number	1	2	6	8
Movement	WBL	EBT	WBTL	NBL
Lead/Lag	Lead	Lag		
Lead-Lag Optimize	Yes	Yes		
Recall Mode	None	Min	None	None
Maximum Split (s)	15.1	43.9	59	16
Maximum Split (%)	20.1%	58.5%	78.7%	21.3%
Minimum Split (s)	10.5	25	21	16
Yellow Time (s)	3.5	4	4	4
All-Red Time (s)	1	2	2	2
Minimum Initial (s)	6	15	15	10
Vehicle Extension (s)	3	3	3	3
Minimum Gap (s)	3	3	3	3
Time Before Reduce (s)	0	0	0	0
Time To Reduce (s)	0	0	0	0
Walk Time (s)		7		
Flash Dont Walk (s)		12		
Dual Entry	No	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes	Yes
Start Time (s)	0	15.1	0	59
End Time (s)	15.1	59	59	0
Yield/Force Off (s)	10.6	53	53	69
Yield/Force Off 170(s)	10.6	53	53	69
Local Start Time (s)	59.9	0	59.9	43.9
Local Yield (s)	70.5	37.9	37.9	53.9
Local Yield 170(s)	70.5	37.9	37.9	53.9

Intersection Summary

Cycle Length	75
Control Type	Semi Act-Uncoord
Natural Cycle	60












Splits and Phases: 5: Radford Rd & Asbury Rd



# HCM 6th Signalized Intersection Summary 5: Radford Rd & Asbury Rd

2029 Improvements - PM Peak Hour

09/28/2019

						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	665	40	230	935	15	250
Future Volume (veh/h)	665	40	230	935	15	250
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	686	41	237	964	15	258
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1439	86	518	1138	315	447
Arrive On Green	0.42	0.42	0.11	0.61	0.18	0.18
Sat Flow, veh/h	3501	203	1781	1870	1781	1585
Grp Volume(v), veh/h	358	369	237	964	15	258
Grp Sat Flow(s),veh/h/ln	1777	1834	1781	1870	1781	1585
Q Serve(g_s), s	8.1	8.1	3.7	23.2	0.4	7.8
Cycle Q Clear(g_c), s	8.1	8.1	3.7	23.2	0.4	7.8
Prop In Lane		0.11	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	750	774	518	1138	315	447
V/C Ratio(X)	0.48	0.48	0.46	0.85	0.05	0.58
Avail Cap(c_a), veh/h	1207	1246	669	1777	319	451
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	11.7	11.7	7.5	8.8	19.1	17.2
Incr Delay (d2), s/veh	0.5	0.5	0.6	2.4	0.1	1.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.7	2.8	1.1	6.6	0.2	0.2
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	12.1	12.1	8.1	11.2	19.1	19.0
LnGrp LOS	B	B	A	B	B	B
Approach Vol, veh/h	727			1201	273	
Approach Delay, s/veh	12.1			10.6	19.0	
Approach LOS	B			B	B	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	10.4	29.6			39.9	15.9
Change Period (Y+Rc), s	4.5	6.0			6.0	6.0
Max Green Setting (Gmax), s	10.6	37.9			53.0	10.0
Max Q Clear Time (g_c+l1), s	5.7	10.1			25.2	9.8
Green Ext Time (p_c), s	0.3	4.7			8.7	0.0
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			12.2			
HCM 6th LOS			B			

## Appendix D

### Short-Term & Long-Term Alternatives Operational Analysis

#### III. Long-Term: Two Eastbound Lanes on Asbury Road with:

##### c. Traffic Signal at Both Intersections

## Queues

## 2029 Improved 2 Ln EB - AM Peak Hour Signals at HM &amp; Radford\_PP

## 3: Asbury Rd &amp; Hales Mill Rd

09/26/2019



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	11	847	375	369	23
v/c Ratio	0.02	0.83	0.38	0.77	0.05
Control Delay	7.5	22.3	8.3	31.9	7.3
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	7.5	22.3	8.3	31.9	7.3
Queue Length 50th (ft)	2	243	74	118	0
Queue Length 95th (ft)	8	#466	95	192	13
Internal Link Dist (ft)		302	565	354	
Turn Bay Length (ft)	50				
Base Capacity (vph)	520	1018	983	545	504
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	0.02	0.83	0.38	0.68	0.05

## Intersection Summary

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

# Timing Report, Sorted By 2019 Approved 2 Ln EB - AM Peak Hour Signals at HM & Radford\_PP 3: Asbury Rd & Hales Mill Rd

09/26/2019

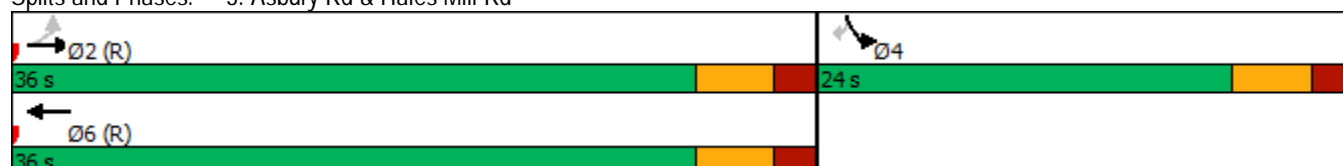


Phase Number	2	4	6
Movement	EBTL	SBL	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	C-Max	None	C-Max
Maximum Split (s)	36	24	36
Maximum Split (%)	60.0%	40.0%	60.0%
Minimum Split (s)	23.5	23.5	23.5
Yellow Time (s)	3.5	3.5	3.5
All-Red Time (s)	2	2	2
Minimum Initial (s)	15	10	15
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)			
Flash Dont Walk (s)			
Dual Entry	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes
Start Time (s)	24	0	24
End Time (s)	0	24	0
Yield/Force Off (s)	54.5	18.5	54.5
Yield/Force Off 170(s)	54.5	18.5	54.5
Local Start Time (s)	0	36	0
Local Yield (s)	30.5	54.5	30.5
Local Yield 170(s)	30.5	54.5	30.5












## Intersection Summary

Cycle Length	60
Control Type	Actuated-Coordinated
Natural Cycle	60
Offset: 24 (40%), Referenced to phase 2:EBTL and 6:WBT, Start of Green	

Splits and Phases: 3: Asbury Rd & Hales Mill Rd



# HCM 6th Signalized Intersection Summary - Tuesday, 09/26/2019 3: Asbury Rd & Hales Mill Rd

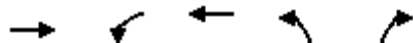
						
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	10	745	255	75	325	20
Future Volume (veh/h)	10	745	255	75	325	20
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	1870	1870	1841	1841	1870	1870
Adj Flow Rate, veh/h	11	847	290	85	369	23
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	2	2	4	4	2	2
Cap, veh/h	700	1077	788	231	429	381
Arrive On Green	0.58	0.58	1.00	1.00	0.24	0.24
Sat Flow, veh/h	1008	1870	1368	401	1781	1585
Grp Volume(v), veh/h	11	847	0	375	369	23
Grp Sat Flow(s),veh/h/ln	1008	1870	0	1769	1781	1585
Q Serve(g_s), s	0.3	21.1	0.0	0.0	11.9	0.7
Cycle Q Clear(g_c), s	0.3	21.1	0.0	0.0	11.9	0.7
Prop In Lane	1.00			0.23	1.00	1.00
Lane Grp Cap(c), veh/h	700	1077	0	1019	429	381
V/C Ratio(X)	0.02	0.79	0.00	0.37	0.86	0.06
Avail Cap(c_a), veh/h	700	1077	0	1019	549	489
HCM Platoon Ratio	1.00	1.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	0.99	1.00	1.00
Uniform Delay (d), s/veh	5.5	9.9	0.0	0.0	21.8	17.6
Incr Delay (d2), s/veh	0.0	5.8	0.0	1.0	10.8	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	7.9	0.0	0.3	5.7	0.2
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	5.5	15.6	0.0	1.0	32.6	17.6
LnGrp LOS	A	B	A	A	C	B
Approach Vol, veh/h		858	375		392	
Approach Delay, s/veh		15.5	1.0		31.7	
Approach LOS		B	A		C	
Timer - Assigned Phs		2		4		6
Phs Duration (G+Y+Rc), s		40.1		19.9		40.1
Change Period (Y+Rc), s		5.5		5.5		5.5
Max Green Setting (Gmax), s		30.5		18.5		30.5
Max Q Clear Time (g_c+l1), s		23.1		13.9		2.0
Green Ext Time (p_c), s		3.5		0.6		2.4
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			16.1			
HCM 6th LOS			B			

## Queues

## 2029 Improved 2 Ln EB - AM Peak Hour Signals at HM &amp; Radford\_PP

## 5: Radford Rd &amp; Asbury Rd

09/26/2019



Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	1230	241	368	11	287
v/c Ratio	0.50	0.44	0.21	0.05	0.78
Control Delay	8.8	5.2	1.3	47.1	50.7
Queue Delay	0.3	0.0	0.0	0.0	0.0
Total Delay	9.1	5.2	1.3	47.1	50.7
Queue Length 50th (ft)	134	0	0	8	185
Queue Length 95th (ft)	341	71	88	25	224
Internal Link Dist (ft)	565		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	2447	589	1731	307	417
Starvation Cap Reductn	531	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.64	0.41	0.21	0.04	0.69
Intersection Summary					

# Timing Report, Sorted By 2019 Approved 2 Ln EB - AM Peak Hour Signals at HM & Radford\_PP 5: Radford Rd & Asbury Rd

09/26/2019



Phase Number	1	2	6	8
Movement	WBL	EBT	WBTL	NBL
Lead/Lag	Lead	Lag		
Lead-Lag Optimize	Yes	Yes		
Recall Mode	None	C-Max	C-Max	None
Maximum Split (s)	30	63	93	27
Maximum Split (%)	25.0%	52.5%	77.5%	22.5%
Minimum Split (s)	10.5	23.5	23.5	23.5
Yellow Time (s)	3.5	3.5	3.5	3.5
All-Red Time (s)	1	2	2	2
Minimum Initial (s)	6	15	10	15
Vehicle Extension (s)	3	3	3	3
Minimum Gap (s)	3	3	3	3
Time Before Reduce (s)	0	0	0	0
Time To Reduce (s)	0	0	0	0
Walk Time (s)				
Flash Dont Walk (s)				
Dual Entry	No	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes	Yes
Start Time (s)	34	64	34	7
End Time (s)	64	7	7	34
Yield/Force Off (s)	59.5	1.5	1.5	28.5
Yield/Force Off 170(s)	59.5	1.5	1.5	28.5
Local Start Time (s)	90	0	90	63
Local Yield (s)	115.5	57.5	57.5	84.5
Local Yield 170(s)	115.5	57.5	57.5	84.5

## Intersection Summary

Cycle Length	120
Control Type	Actuated-Coordinated
Natural Cycle	70
Offset: 64 (53%), Referenced to phase 2:EBT and 6:WBTL, Start of Green	

Splits and Phases: 5: Radford Rd & Asbury Rd



HCM 6th Signalized Intersection Summary - Ln EB - AM Peak Hour Signals at HM & Radford\_PP  
5: Radford Rd & Asbury Rd

09/26/2019

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↘	↑	↘	↗
Traffic Volume (veh/h)	1015	55	210	320	10	250
Future Volume (veh/h)	1015	55	210	320	10	250
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1826	1826	1826	1826
Adj Flow Rate, veh/h	1167	63	241	368	11	287
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Percent Heavy Veh, %	2	2	5	5	5	5
Cap, veh/h	2136	115	455	1331	312	384
Arrive On Green	1.00	1.00	0.07	0.73	0.18	0.18
Sat Flow, veh/h	3522	185	1739	1826	1739	1547
Grp Volume(v), veh/h	604	626	241	368	11	287
Grp Sat Flow(s),veh/h/ln	1777	1837	1739	1826	1739	1547
Q Serve(g_s), s	0.0	0.0	5.6	8.2	0.6	20.6
Cycle Q Clear(g_c), s	0.0	0.0	5.6	8.2	0.6	20.6
Prop In Lane		0.10	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	1107	1144	455	1331	312	384
V/C Ratio(X)	0.55	0.55	0.53	0.28	0.04	0.75
Avail Cap(c_a), veh/h	1107	1144	705	1331	312	384
HCM Platoon Ratio	2.00	2.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.48	0.48	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	0.0	6.0	5.5	40.7	41.7
Incr Delay (d2), s/veh	0.9	0.9	1.0	0.5	0.0	7.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	0.3	2.0	2.9	0.3	8.6
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	0.9	0.9	6.9	6.0	40.7	49.6
LnGrp LOS	A	A	A	A	D	D
Approach Vol, veh/h	1230			609	298	
Approach Delay, s/veh	0.9			6.4	49.2	
Approach LOS	A			A	D	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	12.7	80.3			93.0	27.0
Change Period (Y+Rc), s	4.5	5.5			5.5	5.5
Max Green Setting (Gmax), s	25.5	57.5			87.5	21.5
Max Q Clear Time (g_c+l1), s	7.6	2.0			10.2	22.6
Green Ext Time (p_c), s	0.6	11.0			2.4	0.0
Intersection Summary						
HCM 6th Ctrl Delay			9.2			
HCM 6th LOS			A			

## Queues

## 2029 Improved 2 Ln EB - PM Peak Hour Signals at HM &amp; Radford\_PP

## 3: Asbury Rd &amp; Hales Mill Rd

09/26/2019



Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Group Flow (vph)	26	567	979	160	36
v/c Ratio	0.08	0.39	0.70	0.67	0.15
Control Delay	5.0	5.9	8.7	62.3	14.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	5.0	5.9	8.7	62.3	14.4
Queue Length 50th (ft)	4	121	325	119	0
Queue Length 95th (ft)	15	215	588	183	29
Internal Link Dist (ft)		302	579	252	
Turn Bay Length (ft)	50				
Base Capacity (vph)	313	1439	1392	564	529
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	0.08	0.39	0.70	0.28	0.07
Intersection Summary					

# Timing Report, Sorted By Phase 3: Asbury Rd & Hales Mill Rd

09/26/2019



Phase Number	2	4	6
Movement	EBTL	SBL	WBT
Lead/Lag			
Lead-Lag Optimize			
Recall Mode	C-Max	None	C-Max
Maximum Split (s)	76.2	43.8	76.2
Maximum Split (%)	63.5%	36.5%	63.5%
Minimum Split (s)	23.5	43.5	23.5
Yellow Time (s)	3.5	3.5	3.5
All-Red Time (s)	2	2	2
Minimum Initial (s)	15	10	15
Vehicle Extension (s)	3	3	3
Minimum Gap (s)	3	3	3
Time Before Reduce (s)	0	0	0
Time To Reduce (s)	0	0	0
Walk Time (s)			
Flash Dont Walk (s)			
Dual Entry	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes
Start Time (s)	0	76.2	0
End Time (s)	76.2	0	76.2
Yield/Force Off (s)	70.7	114.5	70.7
Yield/Force Off 170(s)	70.7	114.5	70.7
Local Start Time (s)	0	76.2	0
Local Yield (s)	70.7	114.5	70.7
Local Yield 170(s)	70.7	114.5	70.7












## Intersection Summary

Cycle Length	120
Control Type	Actuated-Coordinated
Natural Cycle	100
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBT, Start of Green	

Splits and Phases: 3: Asbury Rd & Hales Mill Rd



HCM 6th Signalized Intersection Summary - Tuesday, 09/26/2019  
 3: Asbury Rd & Hales Mill Rd

						
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	25	550	690	260	155	35
Future Volume (veh/h)	25	550	690	260	155	35
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	26	567	711	268	160	36
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	519	1495	1035	390	194	173
Arrive On Green	0.80	0.80	1.00	1.00	0.11	0.11
Sat Flow, veh/h	575	1870	1295	488	1781	1585
Grp Volume(v), veh/h	26	567	0	979	160	36
Grp Sat Flow(s),veh/h/ln	575	1870	0	1783	1781	1585
Q Serve(g_s), s	1.1	10.5	0.0	0.0	10.6	2.5
Cycle Q Clear(g_c), s	1.1	10.5	0.0	0.0	10.6	2.5
Prop In Lane	1.00			0.27	1.00	1.00
Lane Grp Cap(c), veh/h	519	1495	0	1425	194	173
V/C Ratio(X)	0.05	0.38	0.00	0.69	0.82	0.21
Avail Cap(c_a), veh/h	519	1495	0	1425	569	506
HCM Platoon Ratio	1.00	1.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	0.82	1.00	1.00
Uniform Delay (d), s/veh	2.5	3.5	0.0	0.0	52.3	48.7
Incr Delay (d2), s/veh	0.2	0.7	0.0	2.2	8.5	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	3.2	0.0	0.9	5.1	1.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	2.7	4.2	0.0	2.2	60.8	49.3
LnGrp LOS	A	A	A	A	E	D
Approach Vol, veh/h		593	979		196	
Approach Delay, s/veh		4.1	2.2		58.7	
Approach LOS		A	A		E	
Timer - Assigned Phs		2		4		6
Phs Duration (G+Y+Rc), s		101.4		18.6		101.4
Change Period (Y+Rc), s		5.5		5.5		5.5
Max Green Setting (Gmax), s		70.7		38.3		70.7
Max Q Clear Time (g_c+l1), s		12.5		12.6		2.0
Green Ext Time (p_c), s		4.5		0.5		11.1
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			9.1			
HCM 6th LOS			A			

## Queues

## 2029 Improved 2 Ln EB - PM Peak Hour Signals at HM &amp; Radford\_PP

## 5: Radford Rd &amp; Asbury Rd

09/26/2019



Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	727	237	964	15	258
v/c Ratio	0.26	0.35	0.56	0.10	0.66
Control Delay	3.4	2.6	3.5	52.7	16.3
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	3.4	2.6	3.5	52.7	16.3
Queue Length 50th (ft)	19	0	0	11	20
Queue Length 95th (ft)	115	41	294	33	92
Internal Link Dist (ft)	579		1247	334	
Turn Bay Length (ft)		75			150
Base Capacity (vph)	2809	730	1732	302	465
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	54	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.26	0.32	0.57	0.05	0.55
Intersection Summary					

# Timing Report, Sorted By Phase 5: Radford Rd & Asbury Rd

09/26/2019



Phase Number	1	2	6	8
Movement	WBL	EBT	WBTL	NBL
Lead/Lag	Lead	Lag		
Lead-Lag Optimize	Yes	Yes		
Recall Mode	None	C-Max	C-Max	None
Maximum Split (s)	19	75	94	26
Maximum Split (%)	15.8%	62.5%	78.3%	21.7%
Minimum Split (s)	10.5	22.5	22.5	22.5
Yellow Time (s)	3.5	3.5	3.5	3.5
All-Red Time (s)	1	2	2	2
Minimum Initial (s)	6	15	15	10
Vehicle Extension (s)	3	3	3	3
Minimum Gap (s)	3	3	3	3
Time Before Reduce (s)	0	0	0	0
Time To Reduce (s)	0	0	0	0
Walk Time (s)				
Flash Dont Walk (s)				
Dual Entry	No	Yes	Yes	Yes
Inhibit Max	Yes	Yes	Yes	Yes
Start Time (s)	101	0	101	75
End Time (s)	0	75	75	101
Yield/Force Off (s)	115.5	69.5	69.5	95.5
Yield/Force Off 170(s)	115.5	69.5	69.5	95.5
Local Start Time (s)	101	0	101	75
Local Yield (s)	115.5	69.5	69.5	95.5
Local Yield 170(s)	115.5	69.5	69.5	95.5

## Intersection Summary

Cycle Length 120  
 Control Type Actuated-Coordinated  
 Natural Cycle 70  
 Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBTL, Start of Green

Splits and Phases: 5: Radford Rd & Asbury Rd



HCM 6th Signalized Intersection Summary - Ln EB - PM Peak Hour Signals at HM & Radford\_PP  
5: Radford Rd & Asbury Rd

09/26/2019

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↘	↑	↘	↗
Traffic Volume (veh/h)	665	40	230	935	15	250
Future Volume (veh/h)	665	40	230	935	15	250
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	686	41	237	964	15	258
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	2185	130	638	1387	297	364
Arrive On Green	1.00	1.00	0.06	0.74	0.17	0.17
Sat Flow, veh/h	3501	203	1781	1870	1781	1585
Grp Volume(v), veh/h	358	369	237	964	15	258
Grp Sat Flow(s),veh/h/ln	1777	1834	1781	1870	1781	1585
Q Serve(g_s), s	0.0	0.0	5.1	33.0	0.8	18.0
Cycle Q Clear(g_c), s	0.0	0.0	5.1	33.0	0.8	18.0
Prop In Lane		0.11	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	1139	1176	638	1387	297	364
V/C Ratio(X)	0.31	0.31	0.37	0.70	0.05	0.71
Avail Cap(c_a), veh/h	1139	1176	742	1387	304	370
HCM Platoon Ratio	2.00	2.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.89	0.89	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	0.0	5.4	8.3	42.0	42.5
Incr Delay (d2), s/veh	0.6	0.6	0.4	2.9	0.1	6.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.2	1.7	12.1	0.4	7.6
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	0.6	0.6	5.8	11.2	42.1	48.6
LnGrp LOS	A	A	A	B	D	D
Approach Vol, veh/h	727			1201	273	
Approach Delay, s/veh	0.6			10.1	48.2	
Approach LOS	A			B	D	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	12.0	82.4			94.5	25.5
Change Period (Y+Rc), s	4.5	5.5			5.5	5.5
Max Green Setting (Gmax), s	14.5	69.5			88.5	20.5
Max Q Clear Time (g_c+l1), s	7.1	2.0			35.0	20.0
Green Ext Time (p_c), s	0.4	5.0			10.0	0.1
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			11.7			
HCM 6th LOS			B			

## Appendix D

### Short-Term & Long-Term Alternatives Operational Analysis

#### IV. Long-Term: Realign Hales Mill Road and Radford Road into One Intersection:

##### a. Multilane Roundabout

# Multi-Lane Modern Roundabout ARCADY Analysis

2029 AM Peak

Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

Demand (Veh/hr)	Calculations	Options			
From \ To	1st exit	2nd exit	3rd exit	U-Turn	Total
EB Asbury Rd	40	705	10	0	755
NB Radford Rd	250	5	5	0	260
WB Asbury Rd	70	250	210	0	530
SB Hales Mill Rd	20	15	310	0	345
Total	380	975	535	0	-

Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

Truck %	PCE per Veh	Options			
From \ To	1st exit	2nd exit	3rd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2	2
NB Radford Rd	5	5	5	5	5
WB Asbury Rd	5	5	5	5	5
SB Hales Mill Rd	2	2	2	2	2
Average	4	4	4	4	-

Roundabout Geometry

Customise Filters Rotate Full-size Widths:

## Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd	SB Hales Mill Rd
V - Approach road half-width (ft)	12.00	12.00	12.00	12.00
E - Entry width (ft)	26.00	14.00	26.00	14.00
l' - Effective flare length (ft)	100.0	100.0	100.0	100.0
R - Entry radius (ft)	65.0	65.0	65.0	65.0
D - Inscribed circle diameter (ft)	122.0	134.0	122.0	134.0
PHI - Conflict (entry) angle (deg)	20.0	20.0	20.0	20.0
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	95.00	95.00	95.00	95.00
Average Demand (Veh/hr)	755	260	530	345
Max Delay (s)	5.46	12.75	2.83	6.53
Max LOS	A	B	A	A
Max 95th percentile Queue (Veh)	1.5	4.2	1.9	2.9
Max V/C Ratio	0.56	0.50	0.31	0.41

## 2029 PM Peak

### Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

**Demand (Veh/hr)** **Calculations** **Options**

From \ To	1st exit	2nd exit	3rd exit	U-Turn	Total
EB Asbury Rd	30	520	25	0	575
NB Radford Rd	250	5	10	0	265
WB Asbury Rd	255	680	230	0	1165
SB Hales Mill Rd	35	10	145	0	190
<b>Total</b>	<b>570</b>	<b>1215</b>	<b>410</b>	<b>0</b>	<b>-</b>

### Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

**Truck %** **PCE per Veh** **Options**

From \ To	1st exit	2nd exit	3rd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2	2
NB Radford Rd	2	2	2	2	2
WB Asbury Rd	2	2	2	2	2
SB Hales Mill Rd	2	2	2	2	2
<b>Average</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>-</b>

### Roundabout Geometry

Customise ▾ Filters ▾ Rotate Full-size Widths:



### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd	SB Hales Mill Rd
V - Approach road half-width (ft)	12.00	12.00	12.00	12.00
E - Entry width (ft)	26.00	14.00	26.00	14.00
l' - Effective flare length (ft)	100.0	100.0	100.0	100.0
R - Entry radius (ft)	65.0	65.0	65.0	65.0
D - Inscribed circle diameter (ft)	122.0	134.0	122.0	134.0
PHI - Conflict (entry) angle (deg)	20.0	20.0	20.0	20.0
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	95.00	95.00	95.00	95.00
Average Demand (Veh/hr)	575	265	1165	190
Max Delay (s)	3.67	7.13	5.87	8.14
Max LOS	A	A	A	A
Max 95th percentile Queue (Veh)	2.8	2.7	3.9	1.9
Max V/C Ratio	0.39	0.37	0.68	0.32

## 2039 AM Peak

### Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

**Demand (Veh/hr)** **Calculations** **Options**


From \ To	1st exit	2nd exit	3rd exit	U-Turn	Total
EB Asbury Rd	50	795	15	0	860
NB Radford Rd	265	5	5	0	275
WB Asbury Rd	80	280	230	0	590
SB Hales Mill Rd	25	20	380	0	425
<b>Total</b>	<b>420</b>	<b>1100</b>	<b>630</b>	<b>0</b>	<b>-</b>

### Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

**Truck %** **PCE per Veh** **Options**





























From \ To	1st exit	2nd exit	3rd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2	2
NB Radford Rd	5	5	5	5	5
WB Asbury Rd	5	5	5	5	5
SB Hales Mill Rd	2	2	2	2	2
<b>Average</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>-</b>

### Roundabout Geometry

Customise Filters Rotate Full-size Widths: 



### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd	SB Hales Mill Rd
V - Approach road half-width (ft)	12.00 	12.00 	12.00 	12.00 
E - Entry width (ft)	26.00 	14.00 	26.00 	14.00 
l - Effective flare length (ft)	100.0 	100.0 	100.0 	100.0 
R - Entry radius (ft)	65.0 	65.0 	65.0 	65.0 
D - Inscribed circle diameter (ft)	122.0 	134.0 	122.0 	134.0 
PHI - Conflict (entry) angle (deg)	20.0 	20.0 	20.0 	20.0 
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	95.00 	95.00 	95.00 	95.00 
Average Demand (Veh/hr)	860	275	590	425
Max Delay (s)	7.70	21.82	2.99	8.35
Max LOS	A	C	A	A
Max 95th percentile Queue (Veh)	2.8	8.1	2.5	2.6
Max V/C Ratio	0.67	0.65	0.35	0.52

## 2039 PM Peak

### Origin-Destination Data - Whole Period - Asbury Rd at Radford Rd

**Demand (Veh/hr)** **Calculations** **Options**


From \ To	1st exit	2nd exit	3rd exit	U-Turn	Total
EB Asbury Rd	30	595	25	0	650
NB Radford Rd	265	5	10	0	280
WB Asbury Rd	290	770	250	0	1310
SB Hales Mill Rd	40	10	180	0	230
<b>Total</b>	<b>625</b>	<b>1380</b>	<b>465</b>	<b>0</b>	<b>-</b>

### Vehicle Mix - Whole Period - Asbury Rd at Radford Rd

**Truck %** **PCE per Veh** **Options**





























From \ To	1st exit	2nd exit	3rd exit	U-Turn	Average
EB Asbury Rd	2	2	2	2	2
NB Radford Rd	2	2	2	2	2
WB Asbury Rd	2	2	2	2	2
SB Hales Mill Rd	2	2	2	2	2
<b>Average</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>-</b>

### Roundabout Geometry

Customise ▾ Filters ▾ **Rotate** **Full-size** Widths: 



### Roundabout Geometry

Leg	EB Asbury Rd	NB Radford Rd	WB Asbury Rd	SB Hales Mill Rd
V - Approach road half-width (ft)	12.00 	12.00 	12.00 	12.00 
E - Entry width (ft)	26.00 	14.00 	26.00 	14.00 
l - Effective flare length (ft)	100.0 	100.0 	100.0 	100.0 
R - Entry radius (ft)	65.0 	65.0 	65.0 	65.0 
D - Inscribed circle diameter (ft)	122.0 	134.0 	122.0 	134.0 
PHI - Conflict (entry) angle (deg)	20.0 	20.0 	20.0 	20.0 
Exit only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg has bypass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Percentage intercept adjustment (%)	95.00 	95.00 	95.00 	95.00 
Average Demand (Veh/hr)	650	280	1310	230
Max Delay (s)	4.21	8.60	7.93	10.95
Max LOS	A	A	A	B
Max 95th percentile Queue (Veh)	2.2	3.2	8.6	3.6
Max V/C Ratio	0.46	0.42	0.76	0.44

## Residual Capacity

AM							
	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity
Multi Lane - 2039							
EB Asbury Rd	2.8	7.70	0.67	A	8.35	A	6 % [NB Radford Rd]
NB Radford Rd	8.1	21.82	0.65	C			
WB Asbury Rd	2.5	2.99	0.35	A			
SB Hales Mill Rd	2.6	8.35	0.52	A			

PM							
	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity
Multi Lane - 2039							
EB Asbury Rd	2.2	4.21	0.46	A	7.31	A	25 % [WB Asbury Rd]
NB Radford Rd	3.2	8.60	0.42	A			
WB Asbury Rd	8.6	7.93	0.76	A			
SB Hales Mill Rd	3.6	10.95	0.44	B			

## Appendix D

### Short-Term & Long-Term Alternatives Operational Analysis

#### IV. Long-Term: Realign Hales Mill Road and Radford Road into One Intersection:

##### b. Traffic Signal with Two Eastbound Lanes on Asbury Road

## Queues

## 2029 Improved 2 Ln EB AM Peak Hour - Hales Mills-Radford Combined

## 5: Radford Rd/Hales Mills Rd &amp; Asbury Rd

10/04/2019



Lane Group	EBL	EBT	WBL	WBT	WBR	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	11	856	241	287	80	17	287	356	40
v/c Ratio	0.03	0.67	0.69	0.28	0.06	0.05	0.83	0.89	0.10
Control Delay	12.4	17.7	20.2	7.4	0.7	21.7	36.3	47.6	11.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	12.4	17.7	20.2	7.4	0.7	21.7	36.3	47.6	11.3
Queue Length 50th (ft)	2	106	27	36	0	4	-59	107	4
Queue Length 95th (ft)	12	201	#135	102	9	21	115	#219	23
Internal Link Dist (ft)		565		1247		334			329
Turn Bay Length (ft)	200		125		125		150		
Base Capacity (vph)	483	1565	351	1181	1450	633	345	401	960
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.02	0.55	0.69	0.24	0.06	0.03	0.83	0.89	0.04

## Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.  
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.  
Queue shown is maximum after two cycles.

Timing Report, Sorted by Phase  
 5: Radford Rd/Hales Mills Rd & Asbury Rd  
 10/04/2019

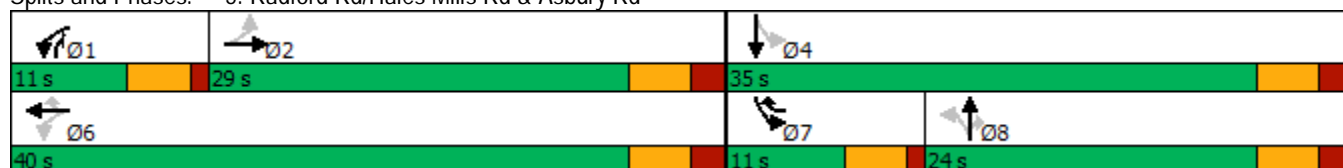


Phase Number	1	2	4	6	7	8
Movement	WBL	EBTL	SBTL	WBTL	SBL	NBTL
Lead/Lag	Lead	Lag			Lead	Lag
Lead-Lag Optimize	Yes	Yes			Yes	Yes
Recall Mode	None	Min	None	Min	None	None
Maximum Split (s)	11	29	35	40	11	24
Maximum Split (%)	14.7%	38.7%	46.7%	53.3%	14.7%	32.0%
Minimum Split (s)	10.5	23.5	23.5	23.5	10.5	23.5
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1	2	2	2	1	2
Minimum Initial (s)	6	15	10	15	6	10
Vehicle Extension (s)	3	3	3	3	3	3
Minimum Gap (s)	3	3	3	3	3	3
Time Before Reduce (s)	0	0	0	0	0	0
Time To Reduce (s)	0	0	0	0	0	0
Walk Time (s)						
Flash Dont Walk (s)						
Dual Entry	No	Yes	Yes	Yes	No	Yes
Inhibit Max	Yes	Yes	Yes	Yes	Yes	Yes
Start Time (s)	0	11	40	0	40	51
End Time (s)	11	40	0	40	51	0
Yield/Force Off (s)	6.5	34.5	69.5	34.5	46.5	69.5
Yield/Force Off 170(s)	6.5	34.5	69.5	34.5	46.5	69.5
Local Start Time (s)	64	0	29	64	29	40
Local Yield (s)	70.5	23.5	58.5	23.5	35.5	58.5
Local Yield 170(s)	70.5	23.5	58.5	23.5	35.5	58.5

Intersection Summary

Cycle Length	75
Control Type	Actuated-Uncoordinated
Natural Cycle	75

Splits and Phases: 5: Radford Rd/Hales Mills Rd & Asbury Rd



HCM 6th Signalized Intersection Analysis - EB AM Peak Hour - Hales Mills-Radford Combined  
 5: Radford Rd/Hales Mills Rd & Asbury Rd

10/04/2019

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	←	↑↑		←	↑	↑		↑	↑	←	↑	
Traffic Volume (veh/h)	10	705	40	210	250	70	10	5	250	310	15	20
Future Volume (veh/h)	10	705	40	210	250	70	10	5	250	310	15	20
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1826	1826	1826	1826	1826	1826	1870	1870	1870
Adj Flow Rate, veh/h	11	810	46	241	287	80	11	6	287	356	17	23
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Percent Heavy Veh, %	2	2	2	5	5	5	5	5	5	2	2	2
Cap, veh/h	411	1011	57	332	848	873	264	125	461	495	264	358
Arrive On Green	0.30	0.30	0.30	0.10	0.46	0.46	0.20	0.20	0.20	0.10	0.37	0.37
Sat Flow, veh/h	1015	3418	194	1739	1826	1547	874	630	1547	1781	720	975
Grp Volume(v), veh/h	11	421	435	241	287	80	17	0	287	356	0	40
Grp Sat Flow(s),veh/h/ln	1015	1777	1835	1739	1826	1547	1504	0	1547	1781	0	1695
Q Serve(g_s), s	0.5	14.3	14.3	6.0	6.5	1.6	0.0	0.0	10.4	6.5	0.0	1.0
Cycle Q Clear(g_c), s	0.5	14.3	14.3	6.0	6.5	1.6	0.5	0.0	10.4	6.5	0.0	1.0
Prop In Lane	1.00		0.11	1.00		1.00	0.65		1.00	1.00		0.57
Lane Grp Cap(c), veh/h	411	526	543	332	848	873	390	0	461	495	0	622
V/C Ratio(X)	0.03	0.80	0.80	0.73	0.34	0.09	0.04	0.00	0.62	0.72	0.00	0.06
Avail Cap(c_a), veh/h	476	640	661	332	965	972	515	0	593	495	0	766
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	16.4	21.2	21.2	15.5	11.1	6.5	21.2	0.0	19.7	20.0	0.0	13.4
Incr Delay (d2), s/veh	0.0	6.0	5.8	7.7	0.2	0.0	0.0	0.0	1.4	5.0	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	6.2	6.4	2.7	2.3	0.4	0.2	0.0	3.6	2.0	0.0	0.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	16.4	27.2	27.0	23.2	11.3	6.6	21.2	0.0	21.1	25.0	0.0	13.4
LnGrp LOS	B	C	C	C	B	A	C	A	C	C	A	B
Approach Vol, veh/h		867			608			304			396	
Approach Delay, s/veh		27.0			15.4			21.1			23.9	
Approach LOS		C			B			C			C	
Timer - Assigned Phs	1	2		4		6	7	8				
Phs Duration (G+Y+Rc), s	11.0	24.8		29.5		35.8	11.0	18.5				
Change Period (Y+Rc), s	4.5	5.5		5.5		5.5	4.5	5.5				
Max Green Setting (Gmax), s	6.5	23.5		29.5		34.5	6.5	18.5				
Max Q Clear Time (g_c+l1), s	8.0	16.3		3.0		8.5	8.5	12.4				
Green Ext Time (p_c), s	0.0	3.0		0.1		1.9	0.0	0.6				
<b>Intersection Summary</b>												
HCM 6th Ctrl Delay				22.4								
HCM 6th LOS				C								

## Queues

## 2029 Improved 2 Ln EB PM Peak Hour - Hales Mills-Radford Combined

## 5: Radford Rd/Hales Mill Rd &amp; Asbury Rd

10/04/2019



Lane Group	EBL	EBT	WBL	WBT	WBR	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	26	567	237	701	263	15	258	149	46
v/c Ratio	0.12	0.50	0.50	0.69	0.18	0.04	0.56	0.35	0.11
Control Delay	15.0	15.9	10.7	14.3	0.7	19.3	9.8	17.7	8.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.0	15.9	10.7	14.3	0.7	19.3	9.8	17.7	8.1
Queue Length 50th (ft)	5	63	27	117	0	3	11	34	2
Queue Length 95th (ft)	24	133	86	#350	17	19	55	77	21
Internal Link Dist (ft)		579		1247		334			319
Turn Bay Length (ft)	200		125		125		150		
Base Capacity (vph)	274	1380	470	1141	1498	655	459	426	957
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.09	0.41	0.50	0.61	0.18	0.02	0.56	0.35	0.05

## Intersection Summary

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Timing Report, Sorted by Phase  
 5: Radford Rd/Hales Mill Rd & Asbury Rd  
 10/04/2019

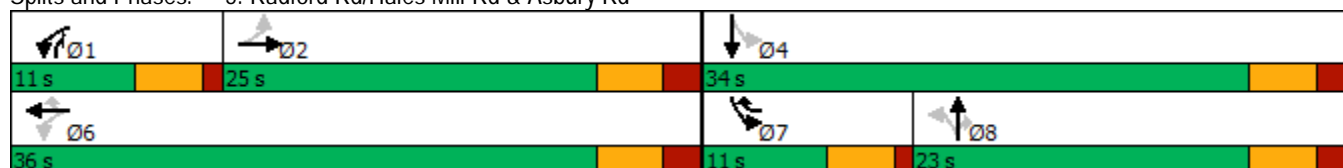


Phase Number	1	2	4	6	7	8
Movement	WBL	EBTL	SBTL	WBTL	SBL	NBTL
Lead/Lag	Lead	Lag			Lead	Lag
Lead-Lag Optimize	Yes	Yes			Yes	Yes
Recall Mode	None	Min	None	Min	None	None
Maximum Split (s)	11	25	34	36	11	23
Maximum Split (%)	15.7%	35.7%	48.6%	51.4%	15.7%	32.9%
Minimum Split (s)	10.5	22.5	22.5	22.5	10.5	22.5
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1	2	2	2	1	2
Minimum Initial (s)	6	15	10	15	6	10
Vehicle Extension (s)	3	3	3	3	3	3
Minimum Gap (s)	3	3	3	3	3	3
Time Before Reduce (s)	0	0	0	0	0	0
Time To Reduce (s)	0	0	0	0	0	0
Walk Time (s)						
Flash Dont Walk (s)						
Dual Entry	No	Yes	Yes	Yes	No	Yes
Inhibit Max	Yes	Yes	Yes	Yes	Yes	Yes
Start Time (s)	0	11	36	0	36	47
End Time (s)	11	36	0	36	47	0
Yield/Force Off (s)	6.5	30.5	64.5	30.5	42.5	64.5
Yield/Force Off 170(s)	6.5	30.5	64.5	30.5	42.5	64.5
Local Start Time (s)	59	0	25	59	25	36
Local Yield (s)	65.5	19.5	53.5	19.5	31.5	53.5
Local Yield 170(s)	65.5	19.5	53.5	19.5	31.5	53.5

Intersection Summary























Cycle Length	70
Control Type	Actuated-Uncoordinated
Natural Cycle	70

Splits and Phases: 5: Radford Rd/Hales Mill Rd & Asbury Rd



HCM 6th Signalized Intersection Summary - EB PM Peak Hour - Hales Mills-Radford Combined  
 5: Radford Rd/Hales Mill Rd & Asbury Rd

10/04/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	25	520	30	230	680	255	10	5	250	145	10	35
Future Volume (veh/h)	25	520	30	230	680	255	10	5	250	145	10	35
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	26	536	31	237	701	263	10	5	258	149	10	36
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
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	199	894	52	432	849	870	268	114	466	489	126	454
Arrive On Green	0.26	0.26	0.26	0.11	0.45	0.45	0.18	0.18	0.18	0.09	0.35	0.35
Sat Flow, veh/h	583	3415	197	1781	1870	1585	901	631	1585	1781	356	1283
Grp Volume(v), veh/h	26	278	289	237	701	263	15	0	258	149	0	46
Grp Sat Flow(s),veh/h/ln	583	1777	1835	1781	1870	1585	1532	0	1585	1781	0	1639
Q Serve(g_s), s	2.3	7.9	7.9	5.2	18.8	5.1	0.0	0.0	7.9	3.6	0.0	1.1
Cycle Q Clear(g_c), s	10.1	7.9	7.9	5.2	18.8	5.1	0.4	0.0	7.9	3.6	0.0	1.1
Prop In Lane	1.00		0.11	1.00		1.00	0.67		1.00	1.00		0.78
Lane Grp Cap(c), veh/h	199	465	480	432	849	870	382	0	466	489	0	581
V/C Ratio(X)	0.13	0.60	0.60	0.55	0.83	0.30	0.04	0.00	0.55	0.30	0.00	0.08
Avail Cap(c_a), veh/h	245	605	624	432	996	994	568	0	664	522	0	815
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	22.9	18.5	18.5	12.7	13.7	7.0	19.4	0.0	17.0	14.9	0.0	12.3
Incr Delay (d2), s/veh	0.3	1.2	1.2	1.5	5.1	0.2	0.0	0.0	1.0	0.3	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	3.0	3.1	1.9	7.4	1.3	0.2	0.0	0.1	1.3	0.0	0.3
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	23.2	19.8	19.7	14.1	18.7	7.2	19.4	0.0	18.1	15.3	0.0	12.3
LnGrp LOS	C	B	B	B	B	A	B	A	B	B	A	B
Approach Vol, veh/h		593			1201			273			195	
Approach Delay, s/veh		19.9			15.3			18.1			14.6	
Approach LOS		B			B			B			B	
Timer - Assigned Phs	1	2		4		6	7	8				
Phs Duration (G+Y+Rc), s	11.0	20.5		25.8		31.5	9.9	15.9				
Change Period (Y+Rc), s	4.5	5.5		5.5		5.5	4.5	5.5				
Max Green Setting (Gmax), s	6.5	19.5		28.5		30.5	6.5	17.5				
Max Q Clear Time (g_c+l1), s	7.2	12.1		3.1		20.8	5.6	9.9				
Green Ext Time (p_c), s	0.0	2.1		0.2		4.0	0.0	0.6				
<b>Intersection Summary</b>												
HCM 6th Ctrl Delay				16.8								
HCM 6th LOS				B								

## Queues

## 2039 Improved 2 Ln EB AM Peak Hour - Hales Mills-Radford Combined

## 5: Radford Rd/Hales Mills Rd &amp; Asbury Rd

10/04/2019



Lane Group	EBL	EBT	WBL	WBT	WBR	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	17	971	264	316	98	12	305	437	52
v/c Ratio	0.04	0.72	0.72	0.29	0.07	0.04	0.88	1.13	0.13
Control Delay	13.3	19.7	24.2	7.5	0.6	27.1	46.4	112.9	12.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.3	19.7	24.2	7.5	0.6	27.1	46.4	112.9	12.9
Queue Length 50th (ft)	3	138	33	41	0	4	-82	-196	7
Queue Length 95th (ft)	17	270	#193	127	8	21	168	#362	31
Internal Link Dist (ft)		565		1247		334			329
Turn Bay Length (ft)	275		200		150		150		
Base Capacity (vph)	557	1848	365	1345	1467	559	346	387	994
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.03	0.53	0.72	0.23	0.07	0.02	0.88	1.13	0.05

## Intersection Summary

- ~ Volume exceeds capacity, queue is theoretically infinite.  
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.  
Queue shown is maximum after two cycles.

Timing Report, Sorted by Phase  
 5: Radford Rd/Hales Mills Rd & Asbury Rd  
 10/04/2019



Phase Number	1	2	4	6	7	8
Movement	WBL	EBTL	SBTL	WBTL	SBL	NBTL
Lead/Lag	Lead	Lag			Lead	Lag
Lead-Lag Optimize	Yes	Yes			Yes	Yes
Recall Mode	None	Min	None	Min	None	None
Maximum Split (s)	13	37	40	50	16	24
Maximum Split (%)	14.4%	41.1%	44.4%	55.6%	17.8%	26.7%
Minimum Split (s)	10.5	23.5	23.5	23.5	10.5	23.5
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1	2	2	2	1	2
Minimum Initial (s)	6	15	10	15	6	10
Vehicle Extension (s)	3	3	3	3	3	3
Minimum Gap (s)	3	3	3	3	3	3
Time Before Reduce (s)	0	0	0	0	0	0
Time To Reduce (s)	0	0	0	0	0	0
Walk Time (s)						
Flash Dont Walk (s)						
Dual Entry	No	Yes	Yes	Yes	No	Yes
Inhibit Max	Yes	Yes	Yes	Yes	Yes	Yes
Start Time (s)	0	13	50	0	50	66
End Time (s)	13	50	0	50	66	0
Yield/Force Off (s)	8.5	44.5	84.5	44.5	61.5	84.5
Yield/Force Off 170(s)	8.5	44.5	84.5	44.5	61.5	84.5
Local Start Time (s)	77	0	37	77	37	53
Local Yield (s)	85.5	31.5	71.5	31.5	48.5	71.5
Local Yield 170(s)	85.5	31.5	71.5	31.5	48.5	71.5

Intersection Summary























Cycle Length	90
Control Type	Actuated-Uncoordinated
Natural Cycle	90

Splits and Phases: 5: Radford Rd/Hales Mills Rd & Asbury Rd



# HCM 6th Signalized Intersection Analysis - EB AM Peak Hour - Hales Mills-Radford Combined 5: Radford Rd/Hales Mills Rd & Asbury Rd

10/04/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	15	795	50	230	275	85	5	5	265	380	20	25
Future Volume (veh/h)	15	795	50	230	275	85	5	5	265	380	20	25
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1826	1826	1826	1826	1826	1826	1870	1870	1870
Adj Flow Rate, veh/h	17	914	57	264	316	98	6	6	305	437	23	29
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Percent Heavy Veh, %	2	2	2	5	5	5	5	5	5	2	2	2
Cap, veh/h	399	1091	68	304	871	952	199	178	465	539	294	370
Arrive On Green	0.32	0.32	0.32	0.10	0.48	0.48	0.20	0.20	0.20	0.14	0.39	0.39
Sat Flow, veh/h	972	3397	212	1739	1826	1547	674	894	1547	1781	752	948
Grp Volume(v), veh/h	17	478	493	264	316	98	12	0	305	437	0	52
Grp Sat Flow(s),veh/h/ln	972	1777	1832	1739	1826	1547	1568	0	1547	1781	0	1700
Q Serve(g_s), s	1.0	20.8	20.8	8.2	9.1	2.2	0.0	0.0	14.3	11.5	0.0	1.6
Cycle Q Clear(g_c), s	1.0	20.8	20.8	8.2	9.1	2.2	0.4	0.0	14.3	11.5	0.0	1.6
Prop In Lane	1.00		0.12	1.00		1.00	0.50		1.00	1.00		0.56
Lane Grp Cap(c), veh/h	399	571	589	304	871	952	376	0	465	539	0	664
V/C Ratio(X)	0.04	0.84	0.84	0.87	0.36	0.10	0.03	0.00	0.66	0.81	0.00	0.08
Avail Cap(c_a), veh/h	454	672	693	304	975	1040	412	0	501	539	0	704
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	19.5	26.3	26.3	19.5	13.8	6.6	26.9	0.0	25.4	24.2	0.0	16.0
Incr Delay (d2), s/veh	0.0	8.0	7.8	22.4	0.3	0.0	0.0	0.0	2.8	9.1	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	9.5	9.8	4.9	3.5	0.6	0.2	0.0	5.3	3.2	0.0	0.6
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	19.6	34.3	34.1	41.9	14.0	6.6	27.0	0.0	28.2	33.3	0.0	16.0
LnGrp LOS	B	C	C	D	B	A	C	A	C	C	A	B
Approach Vol, veh/h		988			678			317			489	
Approach Delay, s/veh		33.9			23.8			28.1			31.5	
Approach LOS		C			C			C			C	
Timer - Assigned Phs	1	2		4		6	7	8				
Phs Duration (G+Y+Rc), s	13.0	32.3		38.1		45.3	16.0	22.1				
Change Period (Y+Rc), s	4.5	5.5		5.5		5.5	4.5	5.5				
Max Green Setting (Gmax), s	8.5	31.5		34.5		44.5	11.5	18.5				
Max Q Clear Time (g_c+l1), s	10.2	22.8		3.6		11.1	13.5	16.3				
Green Ext Time (p_c), s	0.0	3.9		0.2		2.3	0.0	0.3				
<b>Intersection Summary</b>												
HCM 6th Ctrl Delay				29.9								
HCM 6th LOS				C								

## Queues

## 2039 Improved 2 Ln EB PM Peak Hour - Hales Mills-Radford Combined

## 5: Radford Rd/Hales Mill Rd &amp; Asbury Rd

10/04/2019



Lane Group	EBL	EBT	WBL	WBT	WBR	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	26	644	258	794	299	15	273	186	51
v/c Ratio	0.15	0.51	0.57	0.75	0.20	0.04	0.66	0.46	0.13
Control Delay	15.0	15.3	12.4	15.7	0.7	21.8	16.5	21.8	8.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.0	15.3	12.4	15.7	0.7	21.8	16.5	21.8	8.9
Queue Length 50th (ft)	5	74	29	144	0	4	28	48	2
Queue Length 95th (ft)	24	151	#98	#468	17	21	84	105	24
Internal Link Dist (ft)		579		1247		334			319
Turn Bay Length (ft)	275		200		150		150		
Base Capacity (vph)	232	1651	450	1266	1507	624	413	405	911
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.11	0.39	0.57	0.63	0.20	0.02	0.66	0.46	0.06

## Intersection Summary

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

# Timing Report, Sorted by Phase 5: Radford Rd/Hales Mill Rd & Asbury Rd

10/04/2019

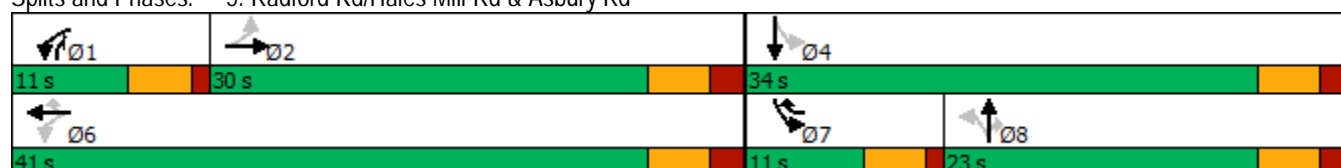


Phase Number	1	2	4	6	7	8
Movement	WBL	EBTL	SBTL	WBTL	SBL	NBTL
Lead/Lag	Lead	Lag			Lead	Lag
Lead-Lag Optimize	Yes	Yes			Yes	Yes
Recall Mode	None	Min	None	Min	None	None
Maximum Split (s)	11	30	34	41	11	23
Maximum Split (%)	14.7%	40.0%	45.3%	54.7%	14.7%	30.7%
Minimum Split (s)	10.5	22.5	22.5	22.5	10.5	22.5
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1	2	2	2	1	2
Minimum Initial (s)	6	15	10	15	6	10
Vehicle Extension (s)	3	3	3	3	3	3
Minimum Gap (s)	3	3	3	3	3	3
Time Before Reduce (s)	0	0	0	0	0	0
Time To Reduce (s)	0	0	0	0	0	0
Walk Time (s)						
Flash Dont Walk (s)						
Dual Entry	No	Yes	Yes	Yes	No	Yes
Inhibit Max	Yes	Yes	Yes	Yes	Yes	Yes
Start Time (s)	0	11	41	0	41	52
End Time (s)	11	41	0	41	52	0
Yield/Force Off (s)	6.5	35.5	69.5	35.5	47.5	69.5
Yield/Force Off 170(s)	6.5	35.5	69.5	35.5	47.5	69.5
Local Start Time (s)	64	0	30	64	30	41
Local Yield (s)	70.5	24.5	58.5	24.5	36.5	58.5
Local Yield 170(s)	70.5	24.5	58.5	24.5	36.5	58.5

## Intersection Summary























Cycle Length	75
Control Type	Actuated-Uncoordinated
Natural Cycle	75

Splits and Phases: 5: Radford Rd/Hales Mill Rd & Asbury Rd



HCM 6th Signalized Intersection Summary - EB PM Peak Hour - Hales Mills-Radford Combined  
 5: Radford Rd/Hales Mill Rd & Asbury Rd

10/04/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	25	595	30	250	770	290	10	5	265	180	10	40
Future Volume (veh/h)	25	595	30	250	770	290	10	5	265	180	10	40
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	26	613	31	258	794	299	10	5	273	186	10	41
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
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	162	1101	56	417	906	922	260	113	449	479	112	461
Arrive On Green	0.32	0.32	0.32	0.10	0.48	0.48	0.19	0.19	0.19	0.10	0.35	0.35
Sat Flow, veh/h	516	3442	174	1781	1870	1585	914	608	1585	1781	320	1314
Grp Volume(v), veh/h	26	316	328	258	794	299	15	0	273	186	0	51
Grp Sat Flow(s),veh/h/ln	516	1777	1839	1781	1870	1585	1522	0	1585	1781	0	1634
Q Serve(g_s), s	3.2	9.8	9.9	6.3	25.4	6.5	0.0	0.0	10.0	5.3	0.0	1.4
Cycle Q Clear(g_c), s	17.6	9.8	9.9	6.3	25.4	6.5	0.4	0.0	10.0	5.3	0.0	1.4
Prop In Lane	1.00		0.09	1.00		1.00	0.67		1.00	1.00		0.80
Lane Grp Cap(c), veh/h	162	568	588	417	906	922	373	0	449	479	0	573
V/C Ratio(X)	0.16	0.56	0.56	0.62	0.88	0.32	0.04	0.00	0.61	0.39	0.00	0.09
Avail Cap(c_a), veh/h	186	652	675	417	994	997	486	0	570	479	0	697
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	28.2	18.8	18.8	13.5	15.4	7.2	22.3	0.0	20.7	17.6	0.0	14.5
Incr Delay (d2), s/veh	0.5	0.9	0.8	2.8	8.4	0.2	0.0	0.0	1.3	0.5	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	3.8	3.9	2.5	11.0	1.8	0.2	0.0	3.5	2.1	0.0	0.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	28.7	19.6	19.6	16.3	23.8	7.4	22.3	0.0	22.0	18.1	0.0	14.6
LnGrp LOS	C	B	B	B	C	A	C	A	C	B	A	B
Approach Vol, veh/h		670			1351			288			237	
Approach Delay, s/veh		20.0			18.7			22.1			17.4	
Approach LOS		B			B			C			B	
Timer - Assigned Phs	1	2		4		6	7	8				
Phs Duration (G+Y+Rc), s	11.0	26.9		28.9		37.9	11.0	17.9				
Change Period (Y+Rc), s	4.5	5.5		5.5		5.5	4.5	5.5				
Max Green Setting (Gmax), s	6.5	24.5		28.5		35.5	6.5	17.5				
Max Q Clear Time (g_c+l1), s	8.3	19.6		3.4		27.4	7.3	12.0				
Green Ext Time (p_c), s	0.0	1.8		0.2		4.0	0.0	0.5				
<b>Intersection Summary</b>												
HCM 6th Ctrl Delay				19.3								
HCM 6th LOS				B								

Appendix E  
Traffic Signal Warrant Analysis

# Traffic Signal Warrant Summary Worksheet

100%

The Worksheet(s) attached are provided as an attachment to the Engineering Investigation Study for:

Intersection: Asbury Rd & Hales Mill Rd

County: Dubuque

City: Asbury, Iowa

Major Street: Asbury Rd

Minor Street:

Hales Mill Rd

Critical Approach Speed: 35 mph

Critical Approach Speed: 25 mph

Lanes: 1 lane

Lanes: 2 or more lanes

% Right Turns Included

From North (SB) 0%

From East (WB) 100%

From South (NB) 100%

From West (EB) 100%

In built-up area of isolated community of < 10,000 population? No

Total number of approaches at intersection? 4 or more

If it is a "T" intersection, inflate minor threshold to 150%? No

Manually set volume level? No

Analysis based on EXISTING volume data.

Date	Day of the Week	Time (HH:MM)			
		From	AM / PM	To	AM / PM
5/15/2019	Wednesday	6:00	AM	6:00	PM

Warrant Evaluation Summary	Warrant Met:
Warrant 1: Eight - Hour Vehicular Volume	No
Condition A: Minimum Vehicular Volume	No
Condition B: Interruption of Continuous Traffic	No
Condition C: Combination: 80% of A and B	No
Warrant 2: Four-Hour Volume	No
Warrant 3: Peak Hour Volume	N/A
Warrant 4: Pedestrian Volume	N/A
Criterion A: Four-Hour	
Criterion B: Peak-Hour	
Warrant 5: School Crossing	N/A
Warrant 6: Coordinated Signal System	N/A
Warrant 7: Crash Experience	No
Warrant 8: Roadway Network	N/A
Warrant 9: Intersection Near a Grade Crossing	N/A

Warrant Analysis Conducted By:

Name: EKJ

Agency: MSA Professional Services

Date: 1/3/2019

## Warrant 1: Eight - Hour Vehicular Volume

100%

Warrant Evaluated? Yes

Warrant Satisfied? No

Manually Set To:

Condition A : Min. Veh. Volume		
Volume Level	100%	80%
Major Rd. Req	500	400
Minor Rd. Req	200	160
Number of Hours	1	1

Satisfied? No

Condition B: Interruption of Continuous Traffic		
Volume Level	100%	80%
Major Rd. Req	750	600
Minor Rd. Req	100	80
Number of Hours	7	8

Satisfied? No

Condition C: Combination of A & B at 80%		
---	--	--

Satisfied? No

6:00 AM		Enter Start Time (Military Time) (HH:MM)			
Time Period	From	To	Major Road: Both	Minor Road: High	Total
			App. (VPH)	App. (VPH)	
1	6:00	7:00	489	142	631
2	7:00	8:00	906	250	1156
3	8:00	9:00	751	140	891
4	9:00	10:00	569	83	652
5	10:00	11:00	566	85	651
6	11:00	12:00	743	78	821
7	12:00	13:00	769	107	876
8	13:00	14:00	743	85	828
9	14:00	15:00	818	107	925
10	15:00	16:00	1101	112	1213
11	16:00	17:00	1235	117	1352
12	17:00	18:00	1284	114	1398
13	18:00	19:00	0	0	0
14	19:00	20:00	0	0	0
15	20:00	21:00	0	0	0
16	21:00	22:00	0	0	0

## Warrant 2: Four-Hour Volume

100%

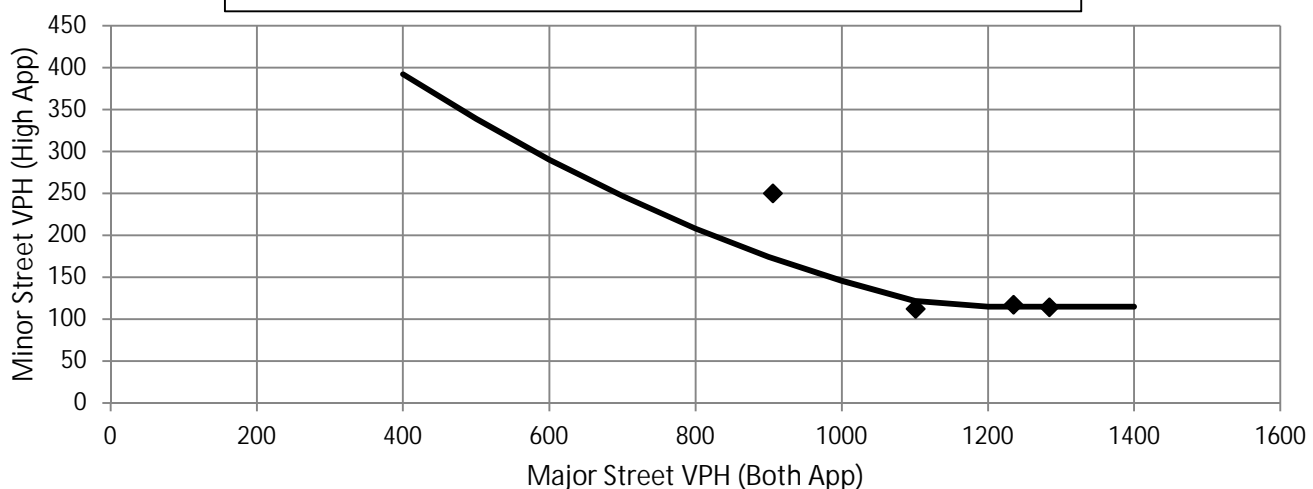
Warrant Evaluated? Yes

Warrant Satisfied? No

Manually Set To:

Hour Start	16:00	7:00	17:00	15:00
Major Road Vol.	1235	906	1284	1101
Minor Road Vol.	117	250	114	112

Figure 4C-1 Warrant 2, Four-Hour Vehicular Volume



## Warrant 3: Peak Hour Volume

100%

Warrant Evaluated? No

Warrant Satisfied? N/A

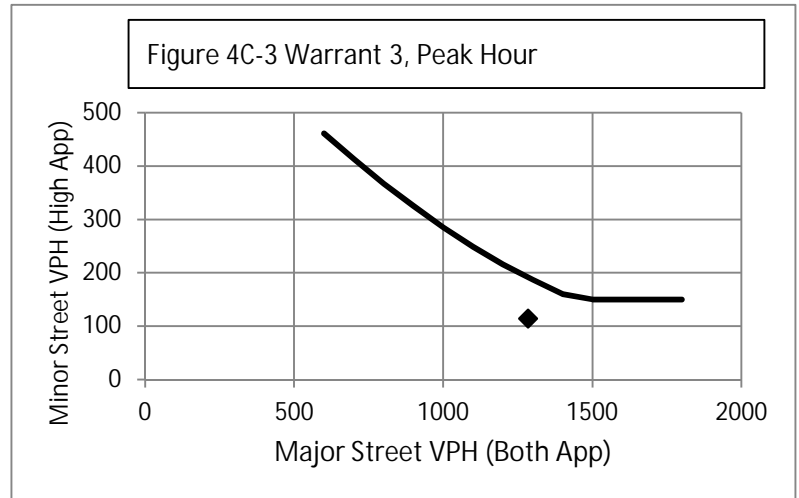
Manually Set To:

Condition justifying use of warrant:

Criteria		Met?
Delay on Minor Approach	5	
Volume on Minor Approach	150	
Total Entering Volume (veh/h)	800	

Manually Set Peak Hour? No

Peak Hour	Major Road Vol. (Both App.)	Minor Road Vol. (High App.)
17:00	1284	114



## Warrant 4: Pedestrian Volume

100%

Warrant Evaluated? No

Warrant Satisfied? N/A

Manually Set To:

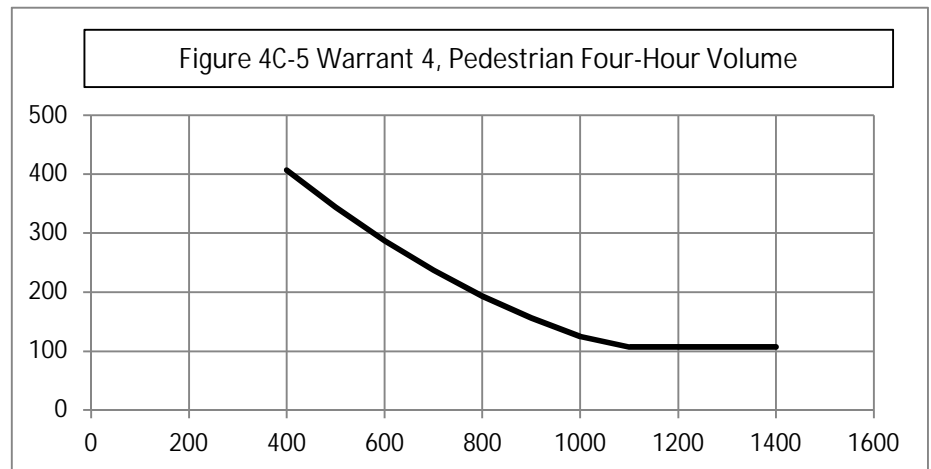
Criterion A: Four Hour

Hour (Start)	Pedestrian Volume	Major Road Vol.
		0
		0
		0
		0

Manually Set Major Rd Vol?

Avg. walk speed less than 3.5 ft/s?

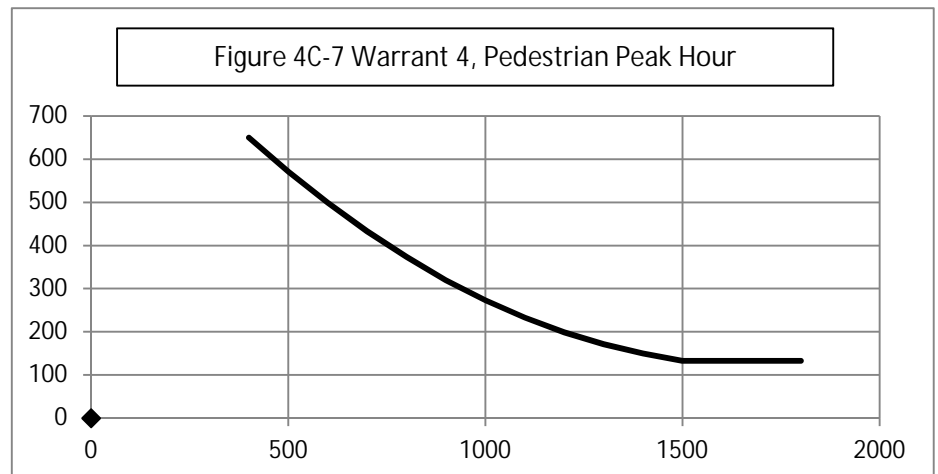
Criterion A Satisfied?



Criterion B: Peak Hour

Peak Hour	Pedestrian Vol.	Major Road Vol.
0:00	0	0

Criterion B Satisfied?



## Warrant 5: School Crossing

100%

Warrant Evaluated? No

Warrant Satisfied? N/A

Manually Set To:

Criteria

Fulfilled?

1	There are a MINIMUM of 20 school children during the highest crossing hour.	
2	There are fewer adequate gaps in the major road traffic stream during the period when the school children are using the crossing than the number of minutes in the same period.	
3	The nearest traffic signal along the major road is located more than 300 ft away. Or, the nearest traffic signal is within 300 ft but the proposed traffic signal will not restrict the progressive movement of traffic.	

## Warrant 6: Coordinated Signal System

100%

Warrant Evaluated? No

Warrant Satisfied? N/A

Manually Set To:

Criteria

Fulfilled?

1	Signal spacing > 1000 ft	
2	On a one-way road or a road that has traffic predominantly in one direction, the adjacent signals are so far apart that they do not provide the necessary degree of vehicle platooning.	
3	On a two-way road, adjacent signals do not provide the necessary degree of platooning and the proposed and the adjacent signals will collectively provide a progressive operation.	

## Warrant 7: Crash Experience

100%

Warrant Evaluated? Yes

Warrant Satisfied? No

Manually Set To:

Criteria

Met?

Fulfilled?

1	Adequate trial of other remedial measures has failed to reduce crash frequency.			No
	Measures Tried:			
2	Five or more reported crashes, of types susceptible to correction by signal, have occurred within a 12 month period.	# of crashes per 12 months	3	No
3	Warrant 1, Condition A (80%)	No		Yes
	Warrant 1, Condition B (80%)	Yes		
	Warrant 4, Criterion A (80%)	No		
	Warrant 4, Criterion B (80%)	Yes		

## Warrant 8: Roadway Network

100%

Warrant Evaluated? No

Warrant Satisfied? N/A

Manually Set To:

Criteria

Met?

Fulfilled?

1	Total entering volume of at least 1,000 veh/h during typical weekday peak hour		1398	Yes	No
	Five-year projected volumes that satisfy one or more of Warrants 1, 2, or 3.			No	
2	Total entering vol. of at least 1,000 veh/h for each of any 5 hrs of non-normal business day (Sat. or Sun.)				
	Hour				
	Volume				

Characteristics of Major Routes - Select yes if all intersecting routes have characteristic

Fulfilled?

1	Part of the road or highway system that serves as the principal roadway network for through traffic flow	
2	Rural or suburban highway outside of, entering, or traversing a city	
3	Appears as a major route on an official plan	

# Warrant 9: Intersection Near a Grade Crossing

100%

Warrant Evaluated? No

Warrant Satisfied? N/A

Manually Set To:

Adjustment Factors			Manually Set Peak Hour?				
Rail Traffic per Day	% High Occupancy Buses on Minor Road	% Tractor-Trailer Trucks on Minor Road	D	Peak Hour	Major Road Vol.	Minor Road Vol.	Adjusted Minor Vol.
				17:00	1284	114	114

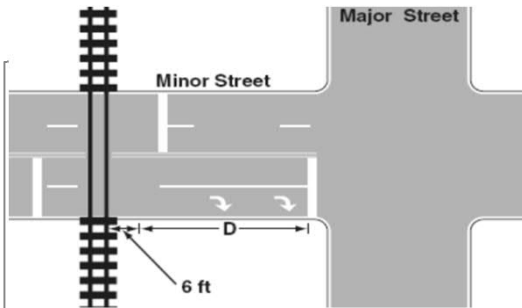
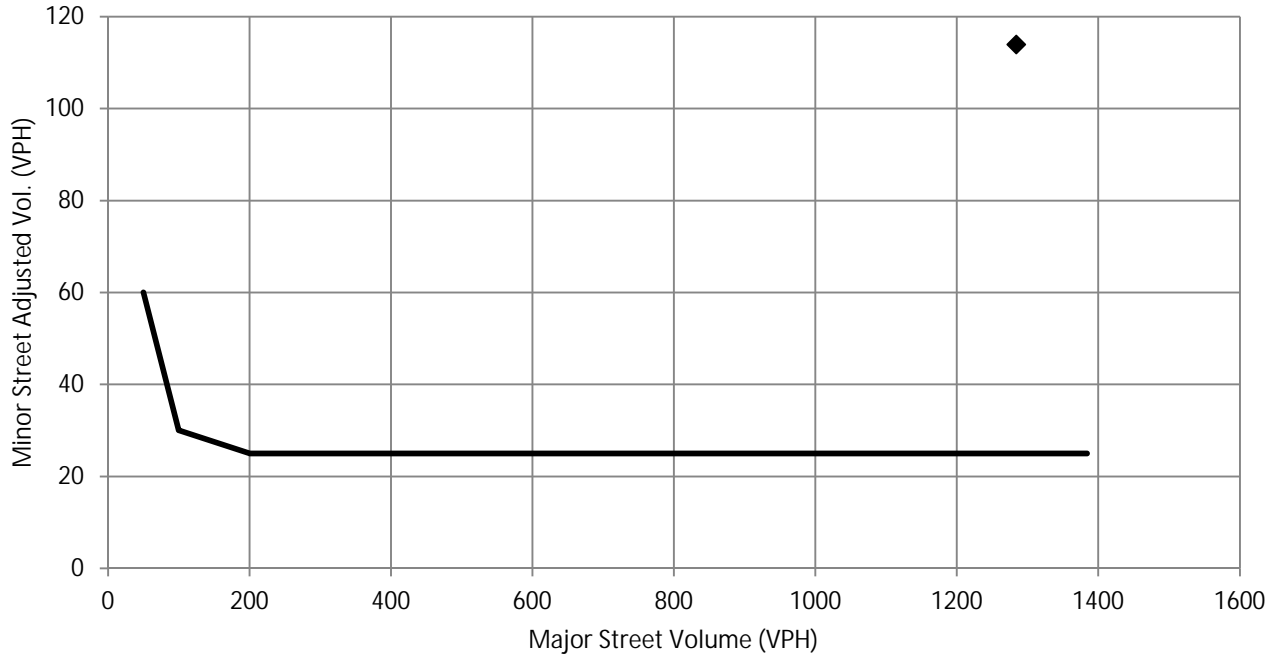


Figure 4C-10 Warrant 9, Intersection Near a grade Crossing  
(Two or More Approach Lanes at the Track Crossing)



Conclusions/Comments:

Updated: 6/23/2015