

**Traffic Analysis for  
Route 29 Between Routes 600 and 215  
Fauquier County, Virginia**

**Prepared for:  
Fauquier County Department of Community Development  
Warrenton, Virginia**

**Prepared by**



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**June 30, 2011**

## **Introduction**

MCV Associates Inc. conducted the traffic analysis for the Route 29 intersections with Broad Run Church Road (Route 600), Cross Creek Blvd and Riley Road (Route 676) as roundabouts. In addition, the intersection of Lee Highway (Route 29) and Vint Hill Road (Route 215) was analyzed as a modified intersection. The analysis results were presented in a report entitled, “Operational Analysis for Proposed Route 29 Roundabouts, Fauquier County, Virginia, dates June 14, 2010. MCV used the 2030 AM/PM peak hour traffic volumes generated from the previous study entitled, “Traffic Impact Analysis of the New Baltimore Service District Plan” for this analysis. The study area included these intersections along the Route 29 corridor. The base year for the analysis was 2007. Traffic was forecasted at these intersections based on a full build-out of the study area and was projected to occur by 2030. Due to the slowdown of growth in the area due to various reasons, it is now assumed that the full build-out may not occur until 2050. The roundabout analysis was conducted using the SIDRA Model with the revised traffic volumes. The Synchro model was also utilized to estimate the AM and PM peak hour levels of service for the 2030 conditions with the revised traffic volumes.

## **Methodology**

The existing 2007 AM and PM peak hour volumes are shown in Exhibit 1. As noted, Cross Creek Boulevard is a proposed new roadway and only through volumes are shown at this intersection. This intersection is assumed to be constructed by 2030. It was assumed that the growth between 2007 and build-out (2050) would occur in a straight line or at the same rate per year during the entire 43 year period. Based on this assumption, the 2030 AM and PM peak hour volumes were developed, as shown in Exhibit 2. This forecast assumed a 0.6 percent per year growth in normal traffic between 2007 and 2030. Level of service LOS D was considered an acceptable level of service.

## **Lee Highway (Route 29) / Broad Run Church Road (Route 600) Roundabout**

The intersection of Lee Highway (Route 29) and Broad Run Church Road (Route 600) is an existing signalized intersection. It was modeled using (Sidra Intersection 5.0) software as a roundabout.

The proposed roundabout at the intersection of Route 29/Broad Run Church Road (Route 600) is a 180 foot diameter roundabout, with two circulating lanes. The Eastbound, and Westbound approaches consist of one shared lanes configuration (left-through) with a free right turn lane. The southbound approach consists of a left-through lane, and a right channelized lane. The northbound approach consists of a left-through lane and a free right turn lane.

Using (Sidra Intersection 5.0) software, a model was developed for this roundabout to evaluate its performance:

### **2030 Conditions:**

The 2030 AM Peak Hour results are shown in Exhibit 3. As shown in the Exhibit, acceptable LOS are projected on all movements except the northbound left turn movement and through movement which are projected to operate at LOS F.

The 2030 PM Peak Hour results are shown in Exhibit 4. As shown in the Exhibit, acceptable LOS are projected on all movements except the westbound through and left turn movements are projected to be operating at LOS F. The northbound through and left turn movements are also projected to operate at LOS F.

### **Route 29 / Cross Creek Boulevard Roundabout**

The intersection of Cross Creek Blvd and Route 29 does not exist currently. The intersection was modeled using (Sidra Intersection 5.0) software as a roundabout for the 2030 conditions.

The proposed roundabout at the intersection of Route 29/Cross Creek Blvd is a 180 foot diameter roundabout, with two circulating lanes. The eastbound and westbound approaches consist of a shared left through lane and a shared right through lane. The northbound and south bound approaches consist of a shared left, through and right lane.

Using (Sidra Intersection 5.0) software, the model was run for this roundabout to evaluate its performance:

### **2030 Conditions:**

The 2030 AM Peak Hour results are shown in Exhibit 5. As shown in the Exhibit, acceptable LOS are projected on all movements except the northbound left turn movement and through movement which are projected to be operating at LOS E. All eastbound movements are projected to operate at LOS E.

The 2030 PM Peak Hour results are shown in Exhibit 6. As shown in the Exhibit, acceptable LOS are projected on all movements except the southbound movements, which are projected to operate at LOS F. The southbound volumes are low.

### **Route 29 / Riley Road (Route 676) Roundabout**

The existing intersection of Riley Road (Route 676) and Route 29 is stop controlled. It was modeled using (Sidra Intersection 5.0) software as a roundabout in 2030.

The proposed roundabout at the intersection of Route 29/Riley Road (Route 676) is a 180 foot diameter roundabout, with two circulating lanes. The eastbound and westbound

approaches consist of a shared left through lane and a through lane. The northbound approach consists of a shared left, through and right lane whose traffic volume is diverted as a free right turn movement. There is no southbound approach at this intersection.

Using (Sidra Intersection 5.0) software, the model was run for this roundabout to evaluate its performance:

**2030 Conditions:**

The 2030 AM Peak Hour results are shown in Exhibit 7. As shown in the Exhibit, acceptable LOS is projected on all movements at this intersection.

The 2030 PM Peak Hour results are shown in Exhibit 8. As shown in the Exhibit, acceptable LOS (LOS C or better) is projected on all movements at this intersection.

**Levels of Service Comparison**

The level of service for the 2030 interim conditions and the build-out conditions (2050) for the roundabout is shown in Exhibit 9. The level of service for the 2030 conditions as signalized intersections is also shown in Exhibit 9. As noted above, the Synchro model was utilized to estimate the AM and PM peak hour levels of service. The Synchro worksheets are included in the Appendix.

*Route 29 and Broad Run Church Road:*

In the 2030 condition the intersection as a roundabout performs at a level of service C or better for all the main line movements (movement along Route 29 along the East-West direction) except for the westbound left turn and the westbound through movements in the PM peak hour. The minor street movements along the north-south direction perform at a LOS D or better except for the northbound left and through movements during the AM and PM peak hours, as shown in Exhibit 9. The overall level of service as a signalized intersection is LOS E and LOS F during the AM and PM peak hours, respectively.

*Route 29 and Cross Creek Boulevard:*

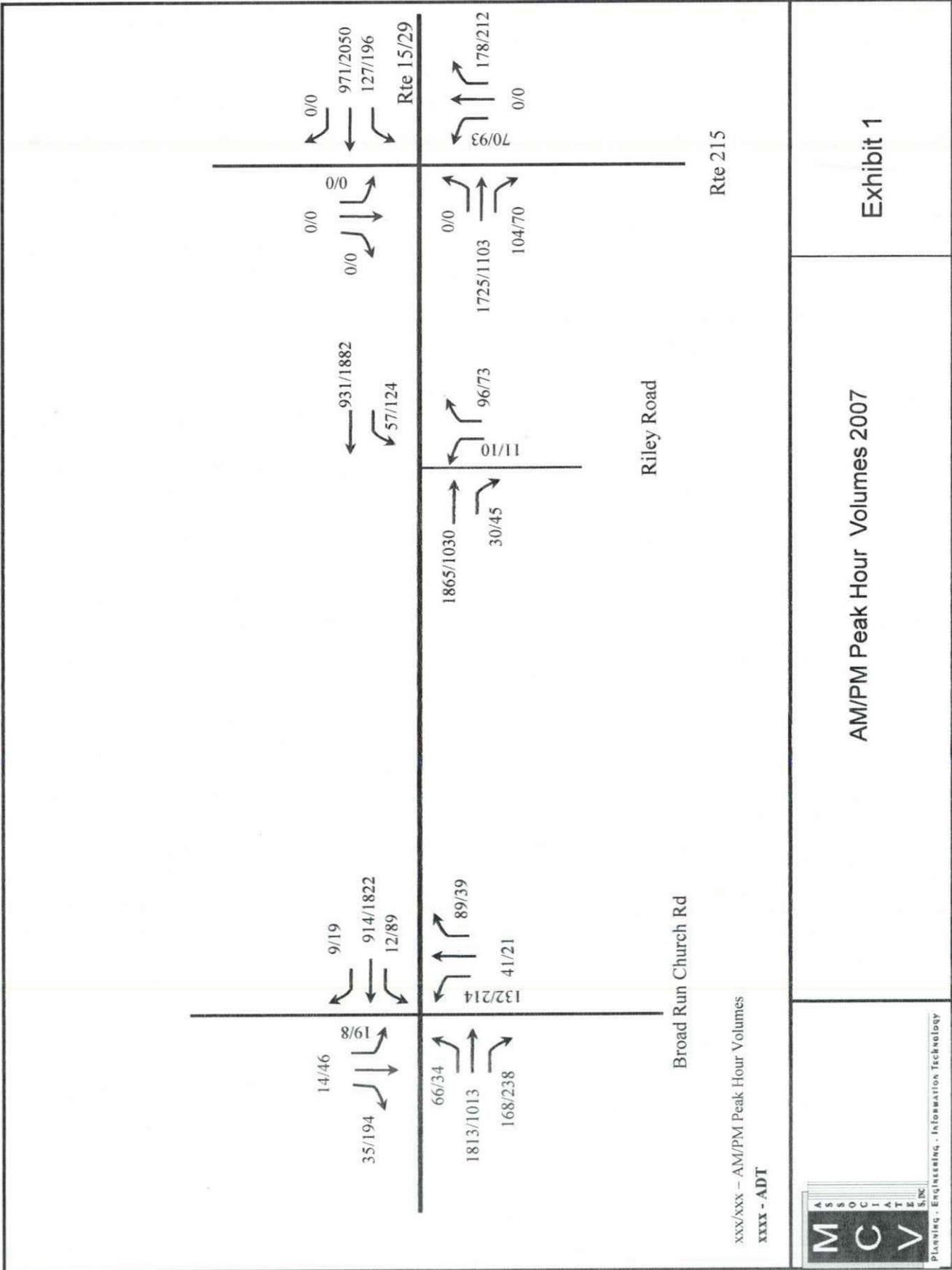
The Level of service comparison for the intersection as a roundabout versus a signalized intersection shows better levels of service for some of the movements as a roundabout compared to a signalized intersection for the 2030 condition. The eastbound through and right turn movements and the northbound left and through movements are projected to operate at LOS E during the AM peak hour, as shown in Exhibit 9.

*Route 29 and Riley Road:*

The Level of service comparison for the intersection as a roundabout versus a signalized intersection shows better levels of service for all the movements as a roundabout compared to a signalized intersection for the 2030 condition as shown in Exhibit 9. All movements, as a roundabout are projected to operate at a LOS D or better during the AM and PM peak hours.

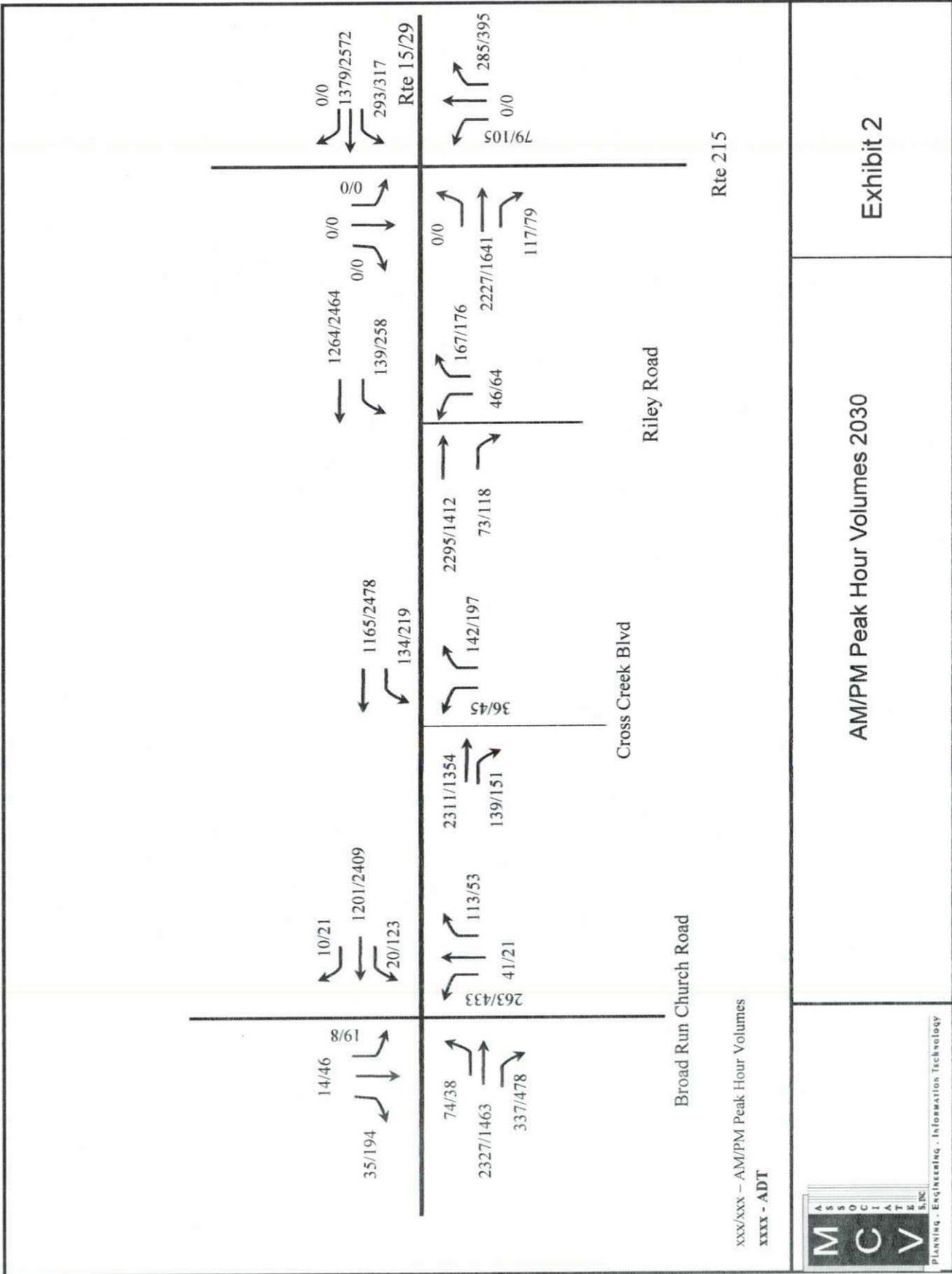
*Route 29 and Route 215:*

The level of service for the signalized intersection of Route 29 and Route 215 (Vint Hill Road) is shown in Exhibit 9. The intersection, as it exists today, is projected to operate at an overall LOS C during the AM and PM peak hours in 2030, although some turning movements are projected to operate at LOS E or LOS F.



AM/PM Peak Hour Volumes 2007

Exhibit 1



AM/PM Peak Hour Volumes 2030

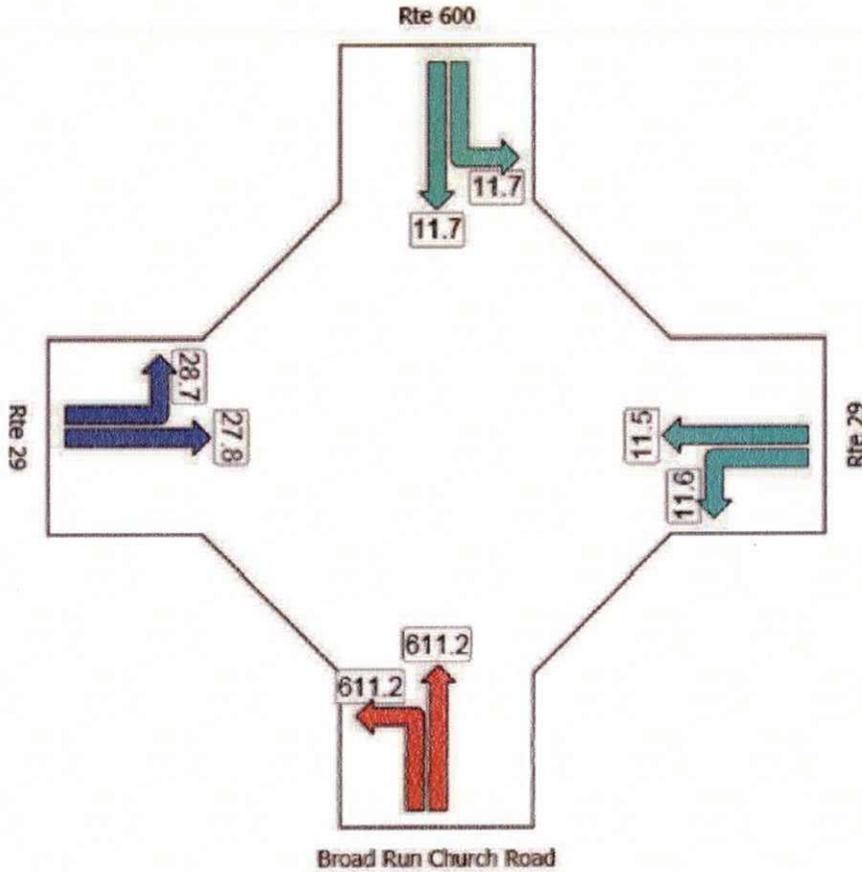
Exhibit 2

# DELAY (AVERAGE)

Site: New Site - 1

Average control delay per vehicle, or average pedestrian delay (seconds)

Rte 29 and Broad Run Church Road\_2030 AM  
Roundabout



	South	East	North	West	Intersection
Delay (Average)	611.2	11.5	11.7	27.9	67.5
LOS	F	B	B	C	E

Colour code based on Level of Service

█ LOS A   
 █ LOS B   
 █ LOS C   
 █ LOS D   
 █ LOS E   
 █ LOS F   
 █ Continuous

Level of Service Method: Delay (HCM 2000)

Roundabout Level of Service Method: Same as Signalised Intersections

HCM Delay Model used.

Processed: Friday, July 22, 2011 9:31:55 AM  
 SIDRA INTERSECTION 5.1.5.2006  
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**ROUTE 29 AND BROAD RUN CHURCH ROAD**  
 2030 AM PEAK HOUR

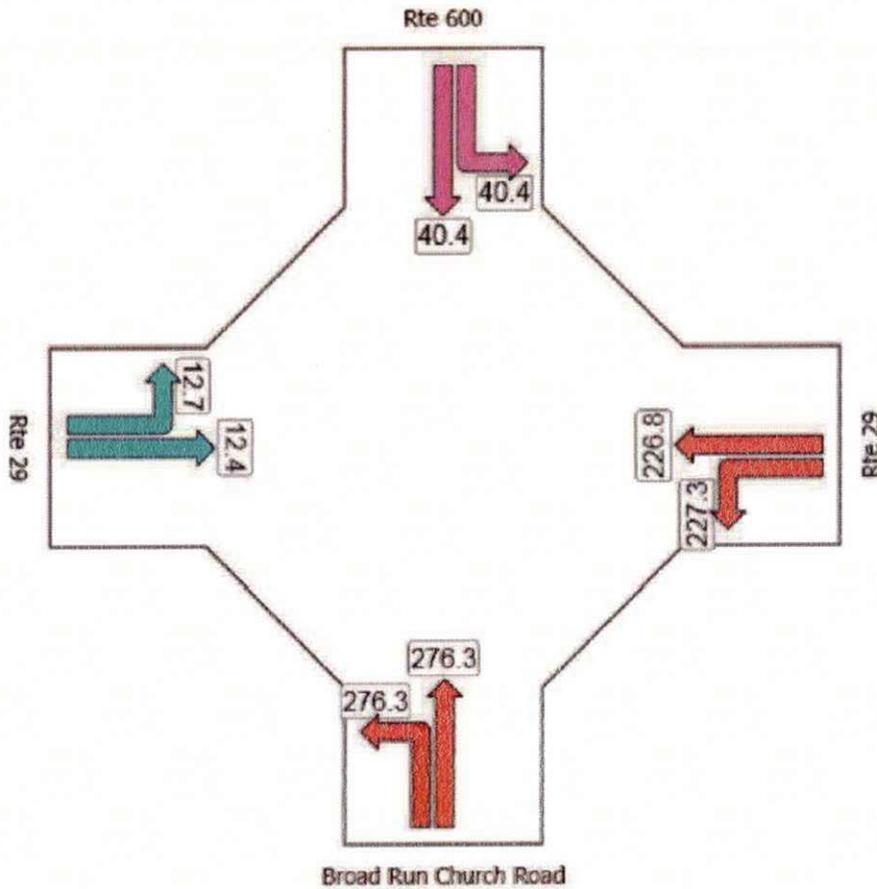
Exhibit 3

# DELAY (AVERAGE)

Site: New Site - 1

Average control delay per vehicle, or average pedestrian delay (seconds)

Rte 29 and Broad Run Church Road\_2030 PM  
Roundabout



	South	East	North	West	Intersection
Delay (Average)	276.3	226.8	40.4	12.4	158.7
LOS	F	F	D	B	F

Colour code based on Level of Service

■ LOS A   
 ■ LOS B   
 ■ LOS C   
 ■ LOS D   
 ■ LOS E   
 ■ LOS F   
 ■ Continuous

Level of Service Method: Delay (HCM 2000)

Roundabout Level of Service Method: Same as Signalised Intersections

HCM Delay Model used.

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**ROUTE 29 AND BROAD RUN CHURCH ROAD**  
**2030 PM PEAK HOUR**

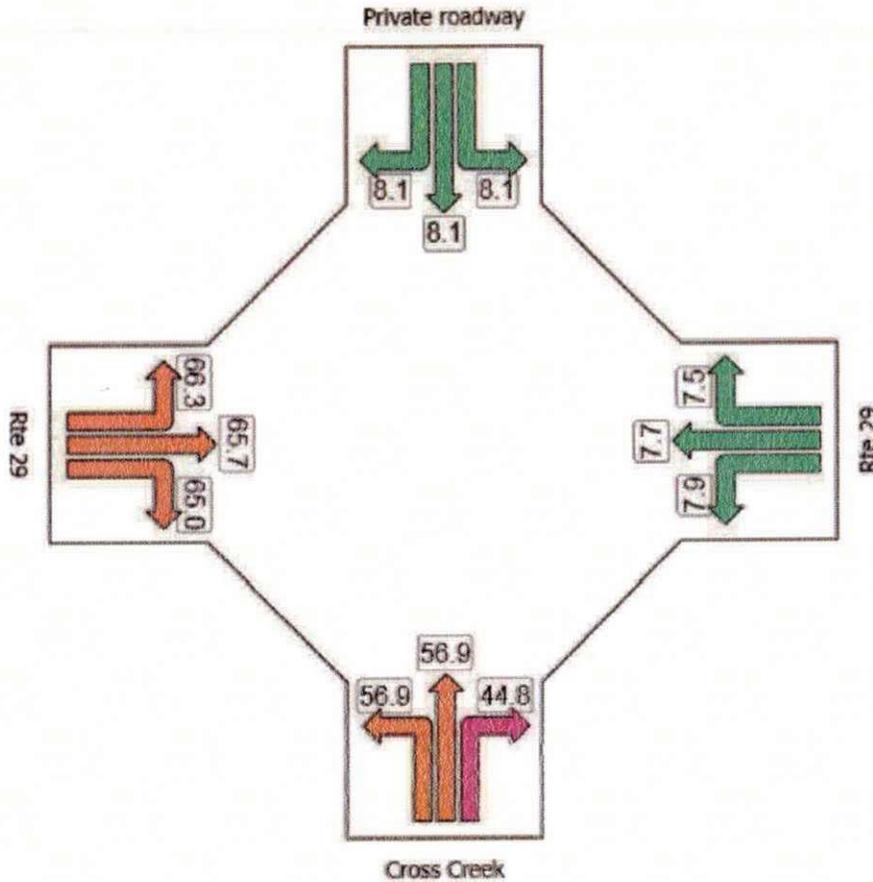
Exhibit 4

# DELAY (AVERAGE)

Site: New Site - 1

Average control delay per vehicle, or average pedestrian delay (seconds)

Rte 29 and Cross Creek\_2030 AM  
Roundabout



	South	East	North	West	Intersection
Delay (Average)	47.3	7.7	8.1	65.6	45.7
LOS	D	A	A	E	D

Colour code based on Level of Service

█ LOS A   
 █ LOS B   
 █ LOS C   
 █ LOS D   
 █ LOS E   
 █ LOS F   
 █ Continuous

Level of Service Method: Delay (HCM 2000)

Roundabout Level of Service Method: Same as Signalised Intersections

HCM Delay Model used.

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ROUTE 29 AND CROSS CREEK Blvd  
2030 AM PEAK HOUR

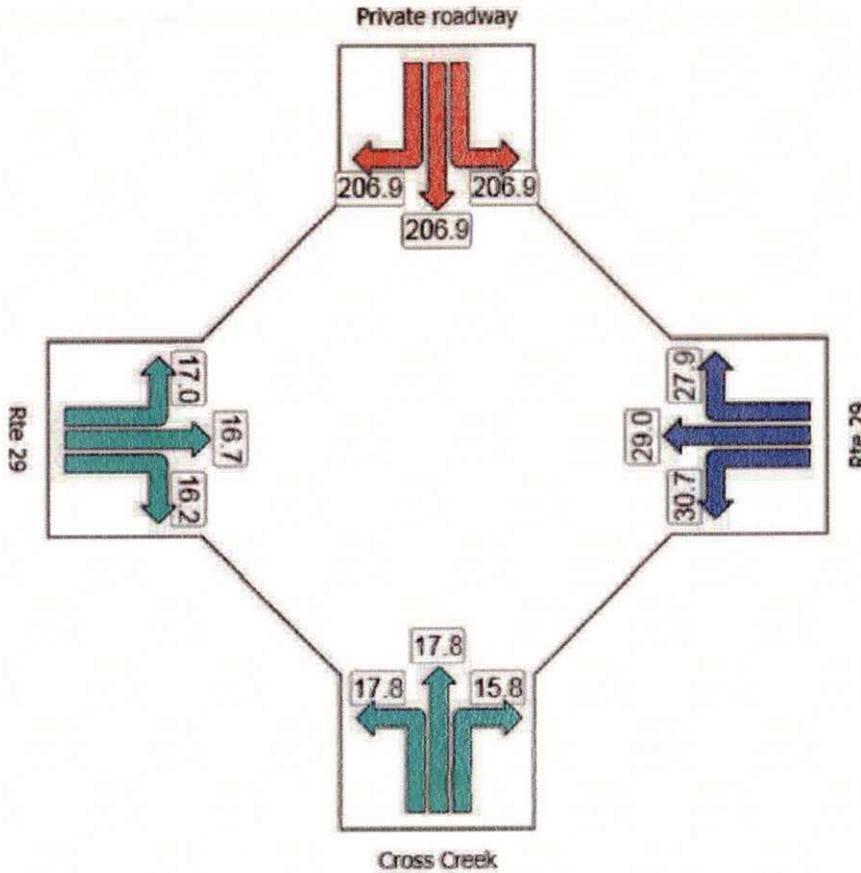
Exhibit 5

# DELAY (AVERAGE)

Site: New Site - 1

Average control delay per vehicle, or average pedestrian delay (seconds)

Rte 29 and Cross Creek\_2030 PM  
Roundabout



	South	East	North	West	Intersection
Delay (Average)	16.2	29.2	206.9	16.6	24.3
LOS	B	C	F	B	C

Colour code based on Level of Service

█ LOS A  
 █ LOS B  
 █ LOS C  
 █ LOS D  
 █ LOS E  
 █ LOS F  
 █ Continuous

Level of Service Method: Delay (HCM 2000)

Roundabout Level of Service Method: Same as Signalised Intersections

HCM Delay Model used.

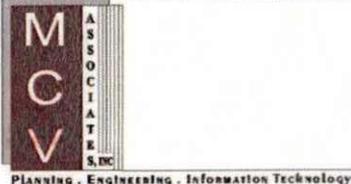
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ROUTE 29 AND CROSS CREEK Blvd  
2030 PM PEAK HOUR

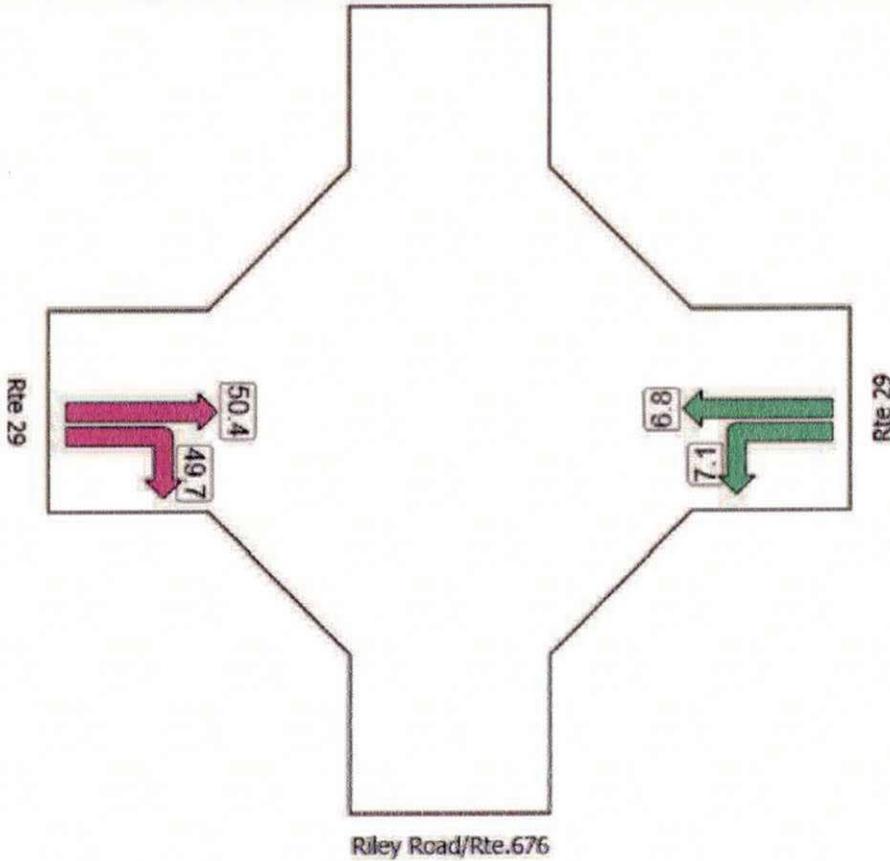
Exhibit 6

# DELAY (AVERAGE)

Site: New Site - 1

Average control delay per vehicle, or average pedestrian delay (seconds)

Rte 29 and Riley Rd\_2030 AM  
Roundabout



	South	East	North	West	Intersection
Delay (Average)	0.0	6.8	0.0	50.3	34.2
LOS	NA	A	NA	D	C

Colour code based on Level of Service

█ LOS A   
 █ LOS B   
 █ LOS C   
 █ LOS D   
 █ LOS E   
 █ LOS F   
 █ Continuous

Level of Service Method: Delay (HCM 2000)

Roundabout Level of Service Method: Same as Signalised Intersections

HCM Delay Model used.

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ROUTE 29 AND RILEY ROAD (RTE 676)  
2030 AM PEAK HOUR

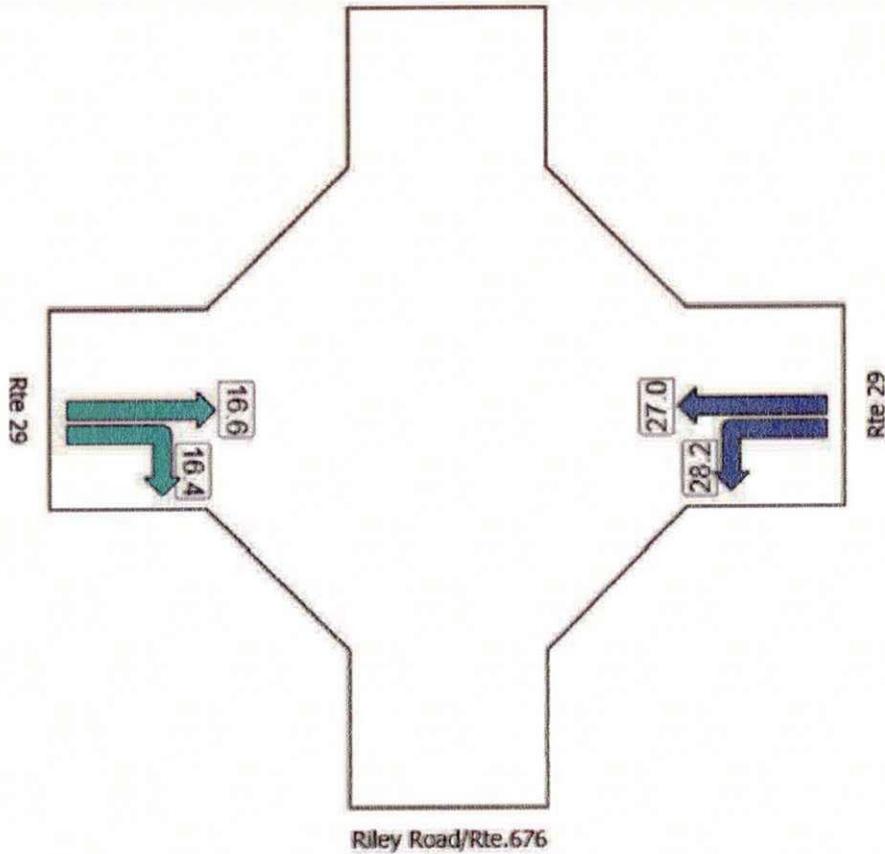
Exhibit 7

# DELAY (AVERAGE)

Site: New Site - 1

Average control delay per vehicle, or average pedestrian delay (seconds)

Rte 29 and Riley Rd\_2030 PM  
Roundabout



	South	East	North	West	Intersection
Delay (Average)	0.0	27.1	0.0	16.6	23.3
LOS	NA	C	NA	B	C

Colour code based on Level of Service

█ LOS A   
 █ LOS B   
 █ LOS C   
 █ LOS D   
 █ LOS E   
 █ LOS F   
 █ Continuous

Level of Service Method: Delay (HCM 2000)

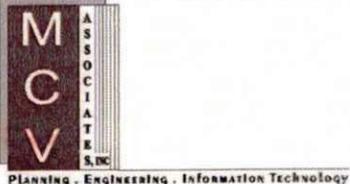
Roundabout Level of Service Method: Same as Signalised Intersections

HCM Delay Model used.

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**ROUTE 29 AND RILEY ROAD (RTE 676)  
2030 PM PEAK HOUR**

Exhibit 8

INTERSECTION/CONDITION	2030 (Signalized)		Builtout 2030 (Roundabout)		Builtout 2050 (Roundabout)	
	AM	PM			AM	PM
Route 29/ Broad Run Church Road (Signalized)	LOS E 74.2 Sec	LOS F 98.5 Sec				
EB L	LOS E 64.3 Sec	LOS F 96.9 Sec	LOS C 28.7 Sec	LOS B 12.7 Sec	LOS F 97.4 Sec	LOS C 26.0 Sec
EB T	LOS F 112.7 Sec	LOS C 34.9 Sec	LOS C 27.8 Sec	LOS B 12.4 Sec	LOS F 89.1 Sec	LOS B 17.6 Sec
EBR	LOS B 13.2 Sec	LOS C 20.3 Sec				
EB Approach	LOS F 99.1 Sec	LOS C 32.5 Sec				
WBL	LOS F 80.2 Sec	LOS E 73.3 Sec	LOS B 11.6 Sec	LOS F 227.3 Sec	LOS B 18.5 Sec	LOS F 252.9 Sec
WBT	LOS C 22.3 Sec	LOS F 149.5 Sec	LOS B 11.5 Sec	LOS F 226.8 Sec	LOS B 10.5 Sec	LOS F 244.6 Sec
WBR	LOS A 8.6 Sec	LOS B 12.8 Sec				
WB Approach	LOS C 23.1 Sec	LOS F 144.7 Sec				
NBL	LOS E 70.6 Sec	LOS F 155.5 Sec	LOS F 611.2 Sec	LOS F 276.3 Sec	LOS F 1311 Sec	LOS F 2261 Sec
NB LT						
NBT			LOS F 611.2 Sec	LOS F 276.3 Sec	LOS F 1303 Sec	LOS F 2253 Sec
NB R						
NBTR	LOS D 49.8 Sec	LOS D 43.8 Sec				
NB Approach	LOS E 62.9 Sec	LOS F 139.1 Sec				
SBLT						
SBL	LOS F 81.4 Sec	LOS F 91.3 Sec	LOS B 11.7 Sec	LOS D 40.4 Sec	LOS B 19.3 Sec	LOS E 55.6 Sec
SBTR	LOS E 58.3 Sec	LOS E 66.3 Sec				
SBT			LOS B 11.7 Sec	LOS D 40.4 Sec	LOS B 11.9 Sec	LOS D 48.2 Sec
SB R	LOS E 57.7 Sec	LOS E 64.8 Sec				
SB Approach	LOS E 64.7 Sec	LOS E 66.5 Sec				
INTERSECTION/CONDITION	Builtout 2030 (Signalized)		Builtout 2030 (Roundabout)		Builtout 2050 (Roundabout)	
	AM	PM	AM	PM	AM	PM
Route 29/Riley Road(Rte 676)	LOS B 12.0 Sec	LOS A 7.4 Sec				
EBT	LOS A 4.2 Sec	LOS A 2.3 Sec	LOS D 50.4 Sec	LOS B 16.6 Sec	LOS F 239.6 Sec	LOS F 145.7 Sec
EBR	LOS A 0.0 Sec	LOS A 0.2 Sec	LOS D 49.7 Sec	LOS B 16.4 Sec	LOS F 240.6 Sec	LOS F 146.7 Sec
EB Approach	LOS A 4.1 Sec	LOS A 2.1 Sec				
WBL	LOS F 95.1 Sec	LOS C 34.7 Sec	LOS A 7.1 Sec	LOS C 28.2 Sec	LOS B 14.1 Sec	LOS F 177.8 Sec
WBT	LOS A 5.2 Sec	LOS A 1.9 Sec	LOS A 6.8 Sec	LOS C 27.0 Sec	LOS A 6.2 Sec	LOS F 169.8 Sec
WB Approach	LOS B 14.4 Sec	LOS A 5.0 Sec				
NBL	LOS E 68.8 Sec	LOS E 72.6 Sec				
NBR	LOS F 90.4 Sec	LOS E 65.7 Sec				
NB Approach	LOS F 85.8 Sec	LOS E 67.6 Sec				
Route 29/Cross Creek Drive	LOS C 23.0 Sec	LOS A 9.8 Sec				
EBT	LOS C 30.3 Sec	LOS A 0.9 Sec	LOS E 65.7 Sec	LOS B 16.7 Sec	LOS F 345.6 Sec	LOS F 126.0 Sec
EBR	LOS A 0.1 Sec	LOS A 0.2 Sec	LOS E 65.0 Sec	LOS B 16.2 Sec	LOS F 346.6 Sec	LOS F 126.9 Sec
EB Approach	LOS C 28.5 Sec	LOS A 0.9 Sec				
WBL	LOS E 55.6 Sec	LOS E 59.6 Sec	LOS A 7.9 Sec	LOS C 30.7 Sec	LOS B 15.2 Sec	LOS F 160.8 Sec
WBT	LOS A 3.3 Sec	LOS A 5.8 Sec	LOS A 7.7 Sec	LOS C 29.0 Sec	LOS A 7.1 Sec	LOS F 151.9 Sec
WB Approach	LOS A 8.7 Sec	LOS B 10.2 Sec				
NBL	LOS E 58.8 Sec	LOS E 69.7 Sec	LOS E 56.9 Sec	LOS B 17.8 Sec	LOS F 510.0 Sec	LOS F 1134.3 Sec
NBR	LOS D 49.5 Sec	LOS E 59.3 Sec	LOS D 44.8 Sec	LOS B 15.8 Sec	LOS F 503.8 Sec	LOS F 1128.1 Sec
NB Approach	LOS D 51.4 Sec	LOS E 61.2 Sec				
Route 29/Vint Hill	LOS C 32.7 Sec	LOS C 31.8 Sec				
EBT	LOS C 26.1 Sec	LOS B 19.7 Sec				
EBR	LOS A 0.7 Sec	LOS A 2.6 Sec				
EB Approach	LOS C 24.8 Sec	LOS B 18.9 Sec				
WBL	LOS F 118.5 Sec	LOS D 47.3 Sec				
WBT	LOS A 3.2 Sec	LOS C 23.7 Sec				
WB Approach	LOS C 23.4 Sec	LOS C 26.3 Sec				
NBLT	LOS F 83.5 Sec	LOS E 76.9 Sec				
NBR	LOS F 137.3 Sec	LOS F 115.7 Sec				
NB Approach	LOS F 125.6 Sec	LOS F 107.6 Sec				



LEVEL OF SERVICE COMPARISON

Exhibit 9

## **APPENDIX**

HCM Signalized Intersection Capacity Analysis  
 15: ROUTE 15/29 Lee Highway & RT 215 Vint Hill Road

2030 AM  
 7/25/2011



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↑	↑	↑↑	↑		↑	↑		↑↓	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0			4.0	4.0			
Lane Util. Factor		0.95	1.00	1.00	0.95			1.00	1.00			
Fr <sub>t</sub>		1.00	0.85	1.00	1.00			1.00	0.85			
Fl <sub>t</sub> Protected		1.00	1.00	0.95	1.00			0.95	1.00			
Satd. Flow (prot)		3438	1583	1770	3438			1770	1583			
Fl <sub>t</sub> Permitted		1.00	1.00	0.04	1.00			0.76	1.00			
Satd. Flow (perm)		3438	1583	70	3438			1410	1583			
Volume (vph)	0	2227	117	293	1379	0	79	0	285	0	0	0
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	2421	127	318	1499	0	86	0	310	0	0	0
RTOR Reduction (vph)	0	0	22	0	0	0	0	0	176	0	0	0
Lane Group Flow (vph)	0	2421	105	318	1499	0	0	86	134	0	0	0
Heavy Vehicles (%)	2%	5%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type			Perm	pm+pt		Perm	Perm		Perm	Perm		
Protected Phases		2		1	6			8			4	
Permitted Phases			2	6		6	8		8	4		
Actuated Green, G (s)		102.0	102.0	129.0	128.0			13.0	13.0			
Effective Green, g (s)		103.0	103.0	129.0	129.0			13.0	13.0			
Actuated g/C Ratio		0.69	0.69	0.86	0.86			0.09	0.09			
Clearance Time (s)		5.0	5.0	4.0	5.0			4.0	4.0			
Vehicle Extension (s)		3.0	3.0	3.0	3.0			3.0	3.0			
Lane Grp Cap (vph)		2361	1087	310	2957			122	137			
v/s Ratio Prot		0.70		c0.15	0.44							
v/s Ratio Perm			0.07	c0.74				0.06	c0.08			
v/c Ratio		1.03	0.10	1.03	0.51			0.70	0.98			
Uniform Delay, d1		23.5	7.9	60.6	2.6			66.6	68.3			
Progression Factor		0.33	0.08	1.00	1.00			1.00	1.00			
Incremental Delay, d2		18.4	0.1	57.9	0.6			16.9	68.9			
Delay (s)		26.1	0.7	118.5	3.2			83.5	137.3			
Level of Service		C	A	F	A			F	F			
Approach Delay (s)		24.8			23.4			125.6			0.0	
Approach LOS		C			C			F			A	

Intersection Summary

HCM Average Control Delay	32.7	HCM Level of Service	C
HCM Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	92.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis  
 13: ROUTE 15/29 Lee Highway & RT 676 Riley Road

2030 AM  
 7/25/2011



Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations	↑↑	↑	↑	↑↑	↑	↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Fr <sub>t</sub>	1.00	0.85	1.00	1.00	1.00	0.85
Fl <sub>t</sub> Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3438	1583	1770	3438	1770	1583
Fl <sub>t</sub> Permitted	1.00	1.00	0.03	1.00	0.95	1.00
Satd. Flow (perm)	3438	1583	62	3438	1770	1583
Volume (vph)	2295	73	139	1264	46	167
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	2495	79	151	1374	50	182
RTOR Reduction (vph)	0	17	0	0	0	99
Lane Group Flow (vph)	2495	62	151	1374	50	83
Heavy Vehicles (%)	5%	2%	2%	5%	2%	2%
Turn Type	Perm pm+pt				Perm	
Protected Phases	2		1	6	3	
Permitted Phases		2	6			3
Actuated Green, G (s)	116.9	116.9	13.4	131.4	10.6	10.6
Effective Green, g (s)	116.9	116.9	13.4	131.4	10.6	10.6
Actuated g/C Ratio	0.78	0.78	0.38	0.88	0.07	0.07
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	2679	1234	174	3012	125	112
v/s Ratio Prot	c0.73		c0.06	0.40	0.03	
v/s Ratio Perm		0.04	0.70			c0.05
v/c Ratio	0.93	0.05	0.37	0.46	0.40	0.74
Uniform Delay, d1	13.3	3.8	51.0	1.9	66.7	68.3
Progression Factor	0.16	0.00	1.27	2.47	1.00	1.00
Incremental Delay, d2	2.0	0.0	30.3	0.4	2.1	22.1
Delay (s)	4.2	0.0	95.1	5.2	68.8	90.4
Level of Service	A	A	F	A	E	F
Approach Delay (s)	4.1			14.1	85.8	
Approach LOS	A			B	F	

Intersection Summary

HCM Average Control Delay	12.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	84.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑	↑	↑↑	↑↑	↑↑	↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	0.97	0.95	0.97	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3438	1583	3433	3438	3433	1583
Flt Permitted	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (perm)	3438	1583	3433	3438	3433	1583
Volume (vph)	2311	139	134	1165	36	142
Peak-hour factor PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	2512	151	146	1266	39	154
RTOR Reduction (vph)	0	25	0	0	0	5
Lane Group Flow (vph)	2512	126	146	1266	39	149
Heavy Vehicles (%)	5%	2%	2%	5%	2%	2%
Turn Type		Perm	Prot			pm+ov
Protected Phases	2		1	6	3	1
Permitted Phases		2				3
Actuated Green, G (s)	103.0	103.0	14.6	122.6	17.4	32.0
Effective Green, g (s)	104.0	104.0	15.6	123.6	18.4	34.0
Actuated g/C Ratio	0.69	0.69	0.10	0.82	0.12	0.23
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	2384	1098	357	2833	421	401
v/s Ratio Prot	c0.73		0.04	c0.37	0.01	c0.04
v/s Ratio Perm		0.08				0.06
v/c Ratio	1.05	0.12	0.41	0.45	0.09	0.37
Uniform Delay, d1	23.0	7.7	62.9	3.7	58.4	49.0
Progression Factor	0.21	0.00	0.87	0.87	1.00	1.00
Incremental Delay, d2	25.4	0.0	0.7	0.1	0.4	0.6
Delay (s)	30.3	0.1	55.6	3.3	58.8	49.5
Level of Service	C	A	E	A	E	D
Approach Delay (s)	28.5			8.7	51.4	
Approach LOS	C			A	D	

**Intersection Summary**

HCM Average Control Delay	23.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	79.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis  
 9: ROUTE 15/29 Lee Highway & RT 600 Broad Run

2030 AM  
 7/25/2011



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↙	↕	↘	↙	↕	↘	↙	↕	↘	↙	↕	↘
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.97	1.00		1.00	0.95	0.95
Fr <sub>t</sub>	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.89		1.00	0.93	0.85
Fl <sub>t</sub> Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	3438	1583	1770	3438	1583	3433	1658		1770	1646	1504
Fl <sub>t</sub> Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1770	3438	1583	1770	3438	1583	3433	1658		1770	1646	1504
Volume (vph)	74	2327	337	20	1201	10	263	41	113	19	14	35
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	80	2529	366	22	1305	11	286	45	123	21	15	38
RTOR Reduction (vph)	0	0	107	0	0	5	0	65	0	0	11	22
Lane Group Flow (vph)	80	2529	259	22	1305	6	286	103	0	21	17	3
Heavy Vehicles (%)	2%	5%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Prot		Perm	Prot		Perm	Prot			Prot		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6						4
Actuated Green, G (s)	13.9	91.8	91.8	2.4	80.3	80.3	15.2	30.2		3.6	16.6	16.6
Effective Green, g (s)	15.9	93.8	93.8	4.4	82.3	82.3	17.2	32.2		3.6	18.6	18.6
Actuated g/C Ratio	0.11	0.63	0.63	0.03	0.55	0.55	0.11	0.21		0.02	0.12	0.12
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0		4.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	188	2150	990	52	1886	869	394	356		42	204	186
v/s Ratio Prot	c0.05	c0.74		0.01	0.38		c0.08	c0.06		0.01	0.01	
v/s Ratio Perm			0.16			0.00						0.00
v/c Ratio	0.43	1.18	0.26	0.42	0.69	0.01	0.73	0.29		0.50	0.08	0.02
Uniform Delay, d1	62.8	28.1	12.6	71.6	24.6	15.3	64.1	49.3		72.3	58.1	57.7
Progression Factor	1.00	1.00	1.00	1.05	0.83	0.56	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	1.6	84.6	0.6	5.0	1.9	0.0	6.5	0.5		9.1	0.2	0.0
Delay (s)	64.3	112.7	13.2	80.2	22.3	8.6	70.6	49.8		81.4	58.3	57.7
Level of Service	E	F	B	F	C	A	E	D		F	E	E
Approach Delay (s)		99.1			23.1			62.9			64.7	
Approach LOS		F			C			E			E	

Intersection Summary

HCM Average Control Delay	74.2	HCM Level of Service	E
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	86.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis  
 15: ROUTE 15/29 Lee Highway & Rt 215 Vint Hill Road

2030 PM  
 7/25/2011



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↗	↘	↑↑	↗		↑	↗		↕	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0			4.0	4.0			
Lane Util. Factor		0.95	1.00	1.00	0.95			1.00	1.00			
Fr <sub>t</sub>		1.00	0.85	1.00	1.00			1.00	0.85			
Fl <sub>t</sub> Protected		1.00	1.00	0.95	1.00			0.95	1.00			
Satd. Flow (prot)		3438	1583	1770	3438			1770	1583			
Fl <sub>t</sub> Permitted		1.00	1.00	0.05	1.00			0.76	1.00			
Satd. Flow (perm)		3438	1583	84	3438			1410	1583			
Volume (vph)	0	1641	79	317	2572	0	105	0	395	0	0	0
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	1784	86	345	2796	0	114	0	429	0	0	0
RTOR Reduction (vph)	0	0	21	0	0	0	0	0	258	0	0	0
Lane Group Flow (vph)	0	1784	65	345	2796	0	0	114	171	0	0	0
Heavy Vehicles (%)	2%	5%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type			Perm	pm+pt		Perm	Perm		Perm	Perm		
Protected Phases		2		1	6			8			4	
Permitted Phases			2	6		6	8		8	4		
Actuated Green, G (s)		83.5	83.5	124.8	123.8			17.2	17.2			
Effective Green, g (s)		84.5	84.5	124.8	124.8			17.2	17.2			
Actuated g/C Ratio		0.56	0.56	0.83	0.83			0.11	0.11			
Clearance Time (s)		5.0	5.0	4.0	5.0			4.0	4.0			
Vehicle Extension (s)		3.0	3.0	3.0	3.0			3.0	3.0			
Lane Grp Cap (vph)		1937	892	478	2860			162	182			
v/s Ratio Prot		0.52		0.17	c0.81							
v/s Ratio Perm			0.04	0.42				0.08	c0.11			
v/c Ratio		0.92	0.07	0.72	0.98			0.70	0.94			
Uniform Delay, d1		29.7	14.9	42.0	11.3			63.9	65.9			
Progression Factor		0.41	0.16	1.00	1.00			1.00	1.00			
Incremental Delay, d2		7.5	0.1	5.3	12.3			13.0	49.8			
Delay (s)		19.7	2.6	47.3	23.7			76.9	115.7			
Level of Service		B	A	D	C			E	F			
Approach Delay (s)		18.9			26.3			107.6			0.0	
Approach LOS		B			C			F			A	

Intersection Summary

HCM Average Control Delay	31.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis  
 13: ROUTE 15/29 Lee Highway & RT 676 Riley Road

2030 PM  
 7/25/2011



Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations	↑↑	↑	↑	↑↑	↑	↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3438	1583	1770	3438	1770	1583
Flt Permitted	1.00	1.00	0.12	1.00	0.95	1.00
Satd. Flow (perm)	3438	1583	227	3438	1770	1583
Volume (vph)	1412	118	256	2464	64	176
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1535	128	278	2678	70	191
RTOR Reduction (vph)	0	33	0	0	0	177
Lane Group Flow (vph)	1535	95	278	2678	70	14
Heavy Vehicles (%)	5%	2%	2%	5%	2%	2%
Turn Type		Perm	pm+pt		Perm	
Protected Phases	2		1	6	3	
Permitted Phases		2	6			3
Actuated Green, G (s)	111.6	111.6	131.3	131.3	10.7	10.7
Effective Green, g (s)	111.6	111.6	131.3	131.3	10.7	10.7
Actuated g/C Ratio	0.74	0.74	0.88	0.88	0.07	0.07
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	2558	1178	360	3009	126	113
v/s Ratio Prot	0.45		0.08	c0.78	c0.04	
v/s Ratio Perm		0.06	0.59			0.01
v/c Ratio	0.60	0.08	0.77	0.89	0.56	0.12
Uniform Delay, d1	8.9	5.2	22.7	5.3	67.4	65.2
Progression Factor	0.16	0.01	1.38	0.08	1.00	1.00
Incremental Delay, d2	0.9	0.1	3.3	1.5	5.2	0.5
Delay (s)	2.3	0.2	34.7	1.9	72.6	65.7
Level of Service	A	A	C	A	E	E
Approach Delay (s)	2.1			5.0	67.6	
Approach LOS	A			A	E	

**Intersection Summary**

HCM Average Control Delay	7.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	78.3%	ICU Level of Service	D
Analysis Period (min)	15		
○ Critical Lane Group			



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑	↑	↑↑	↑↑	↑↑	↑
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	0.97	0.95	0.97	1.00
Fr <sub>t</sub>	1.00	0.85	1.00	1.00	1.00	0.85
Fl <sub>t</sub> Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3438	1583	3433	3438	3433	1583
Fl <sub>t</sub> Permitted	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (perm)	3438	1583	3433	3438	3433	1583
Volume (vph)	1354	151	219	2478	45	197
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1472	164	238	2693	49	214
RTOR Reduction (vph)	0	37	0	0	0	56
Lane Group Flow (vph)	1472	127	238	2693	49	158
Heavy Vehicles (%)	5%	2%	2%	5%	2%	2%
Turn Type		Perm	Prot		pm+ov	
Protected Phases	2		1	6	3	1
Permitted Phases		2				3
Actuated Green, G (s)	112.7	112.7	15.9	133.6	6.4	22.3
Effective Green, g (s)	113.7	113.7	16.9	134.6	7.4	24.3
Actuated g/C Ratio	0.76	0.76	0.11	0.90	0.05	0.16
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	2606	1200	387	3085	169	299
v/s Ratio Prot	0.43		0.07	c0.78	0.01	c0.06
v/s Ratio Perm		0.08				0.04
v/c Ratio	0.56	0.11	0.61	0.87	0.29	0.53
Uniform Delay, d <sub>1</sub>	7.7	4.8	63.4	3.6	68.8	57.6
Progression Factor	0.05	0.02	0.91	1.14	1.00	1.00
Incremental Delay, d <sub>2</sub>	0.5	0.1	1.6	1.7	1.0	1.7
Delay (s)	0.9	0.2	59.6	5.8	69.7	59.3
Level of Service	A	A	E	A	E	E
Approach Delay (s)	0.9			10.2	61.2	
Approach LOS	A			B	E	

Intersection Summary			
HCM Average Control Delay	9.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	78.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.97	1.00		1.00	0.95	0.95
Fr <sub>t</sub>	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.89		1.00	0.90	0.85
Fl <sub>t</sub> Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	3438	1583	1770	3438	1583	3433	1663		1770	1600	1504
Fl <sub>t</sub> Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1770	3438	1583	1770	3438	1583	3433	1663		1770	1600	1504
Volume (vph)	38	1463	478	123	2409	21	433	21	53	8	46	194
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	41	1590	520	134	2618	23	471	23	58	9	50	211
RTOR Reduction (vph)	0	0	239	0	0	6	0	44	0	0	41	41
Lane Group Flow (vph)	41	1590	281	134	2618	17	471	37	0	9	98	81
Heavy Vehicles (%)	2%	5%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Prot		Perm	Prot		Perm	Prot			Prot		Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6						4
Actuated Green, G (s)	3.2	79.0	79.0	12.6	88.4	88.4	16.0	34.8		1.6	18.4	18.4
Effective Green, g (s)	5.2	81.0	81.0	14.6	90.4	90.4	18.0	36.8		1.6	20.4	20.4
Actuated g/C Ratio	0.03	0.54	0.54	0.10	0.60	0.60	0.12	0.25		0.01	0.14	0.14
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0		4.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	61	1857	855	172	2072	954	412	408		19	218	205
v/s Ratio Prot	0.02	0.46		c0.08	c0.76		c0.14	0.02		0.01	c0.06	
v/s Ratio Perm			0.18			0.01						0.05
v/c Ratio	0.67	0.86	0.33	0.78	1.26	0.02	1.14	0.09		0.47	0.45	0.40
Uniform Delay, d1	71.6	29.5	19.3	66.1	29.8	12.0	66.0	43.7		73.8	59.6	59.2
Progression Factor	1.00	1.00	1.00	0.94	0.97	1.07	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	25.4	5.3	1.0	10.9	120.7	0.0	89.5	0.1		17.5	6.6	5.7
Delay (s)	96.9	34.9	20.3	73.3	149.5	12.8	155.5	43.8		91.3	66.3	64.8
Level of Service	F	C	C	E	F	B	F	D		F	E	E
Approach Delay (s)		32.5			144.7			139.1			66.5	
Approach LOS		C			F			F			E	

**Intersection Summary**

HCM Average Control Delay	98.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.11		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	98.9%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group