A Review of the Reasonableness of an At-Grade Intersection at the U.S. Route 250 – McIntire Road Intersection and Proposed Meadowcreek Parkway

Prepared for
The Free Enterprise Forum

Prepared by
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Review of the Reasonableness of an At-Grade Intersection of U.S. Route 250 and Proposed Meadowcreek Parkway

Meadowcreek Parkway has been in various stages of planning and development since 1967. Connecting Charlottesville's McIntire Road and U.S. Route 250 in Charlottesville with State Route (S.R.) 631 and Rio Road in Albemarle County, this connector is intended to provide traffic relief to heavily congested U.S. Route 29 and unsafe and under-designed Park Street/Rio Road in the County. The connector also has been identified as the McIntire Road extension (see Exhibit A).

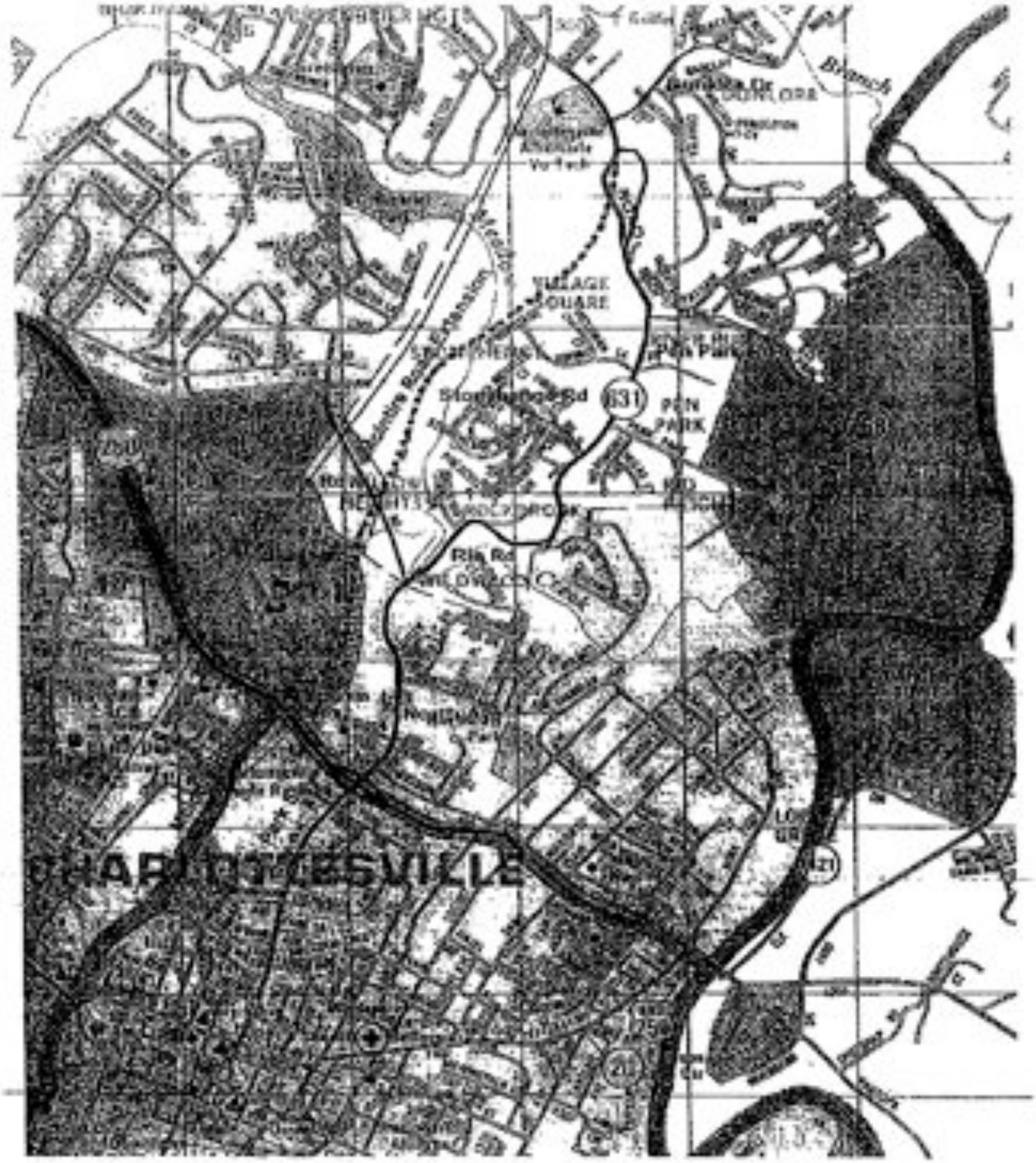
The latest approved plan is for the Meadowcreek Parkway to be constructed as a 2-lane facility connecting with a proposed grade separated interchange project replacing the current U.S. Route 250/McIntire Road signalized intersection. The "future design traffic volume projections" indicate that to satisfactorily accommodate these projected travel demands, a grade separation project is preferred rather than an at-grade intersection. At the same time, cost estimates to construct the Meadowcreek Parkway continue to rise. Finally, it appears that the feeling of a number of involved transportation authorities is that the Meadowcreek Parkway roadway should not be constructed unless the grade separation project at U.S. Route 250 and McIntire Road also is provided. That is, an interim at-grade concept should not be supported.

Accordingly, the Free Enterprise Forum, concerned that construction of the needed roadway itself is not delayed indefinitely, contracted with the engineering firm Draper Aden Associates to perform an overview to ascertain the implications of an intermediate step – an at-grade intersection. The rational behind this would be that an intersection would be more constructible in terms of right-of-way, construction impacts and limited finances. The recently passed federal highway act includes additional funds for a grade separated interchange project at this location, thereby, hopefully, lessening the concerns of the Free Enterprise Forum and others. Regardless, this report summarizes the results of a review assessing the traffic needs and appropriateness of an at-grade intersection versus an interchange project at the McIntire Road/U.S. Route 250/Meadowcreek Parkway intersection.

<u>Planned Roadway Improvements</u>

Although the transportation professionals, for many years, have recommended that Meadowcreek Parkway be a 4-lane, divided facility, the current adopted plan provides for only a 2-lane facility, with right-of-way available for a future four (4) lanes. Although a specific interchange concept plan has not been selected, the selected design firm is encouraged to consider, essentially as a starting point, the options evaluated in the, "Preliminary Study of Interchange Alternatives, Meadowcreek Parkway, McIntire Road and Veterans Memorial Boulevard", prepared by Rieley & Associates in October 2000. Six (6) alternates were evaluated (see attached), with Alternates 3, 4, and 6 recommended for further consideration. In this review, we will not develop the advantages and disadvantages of each of these concepts. Right-of-way requirements, constructability, cost, design standards, and other critical factors all will need to be looked at in greater depth during the design process. An obvious concern, however, involving any interchange project design is the close proximity and likely conflict of any ramps

Exhibit A
LOCATION MAP



or turning lanes on the east side of U.S. Route 250, conflicting with existing Park Street on/off ramps on the west side of that interchange. These two (2) locations are simply too close to each other along U.S. Route 250 to provide normal acceptable separation.

Traffic Projections

A critical factor in our assessment is the traffic projection numbers assumed in the evaluation. For purposes of our effort, we used as a starting point the traffic projections developed by Wilbur Smith Associates (WSA) in their July 26, 1999 document titled "Corridor Traffic Analysis for McIntire Road Extension". An important advantage of these projections is the fact that they take into consideration the type of new roadway facility assumed. Specifically, it is important to utilize traffic numbers based on a 4-lane U.S. Route 250 and a 2-lane Meadowcreek Parkway. As the WSA study indicates, these numbers are different from, say, a 4-lane Meadowcreek Parkway.

Exhibit B represents the assumed road network that provides the basis of the 2-lane Meadowcreek Parkway scenario. Although the type and number of intersection turning lanes at various intersections and the one (1) interchange could vary, the importance of this geometric conditions map is the assumption that U.S. Route 250 is a 4-lane divided facility, Meadowcreek Parkway and Park Street are 2-lane facilities, and the interchange of U.S. Route 250 and Park Street remains as it presently is.

Exhibit C depicts adjusted current AM and PM peak hour turning movement volumes at key locations throughout the analyzed network, including the U.S. Route 250/McIntire Road/Meadowcreek Parkway intersection. This, in effect, represents a "what if" scenario wherein based on existing volumes (at the time of the study, the year 2002), what would the traffic distribution be if Meadowcreek Parkway were in place. Again, it is important to note that the model used accounts for the fact that Meadowcreek Parkway is limited in capacity to two (2) lanes of traffic only. This is not an "unconstrained" network analysis where traffic projections are based on demand, and not constrained by a limited road network.

Utilizing the same model and roadway geometric assumptions, traffic volumes were projected for the AM and PM peak hours to the year 2023 – the project "design year" – and are depicted in Exhibit D. These volumes are approximately 55% higher than the 2002 volumes, at least in the U.S. Route 250 corridor. A critical question is whether or not it is realistic for U.S. Route 250 to, in fact, accommodate such a significant traffic increase based on the maintenance of the current 4-lane divided facility. Through traffic on U.S. Route 250 is constrained by the capacity of the traffic "nodes" on either side of the Meadowcreek Parkway location – the signalized intersection to the west at Hydraulic Road, and the signalized intersection to the east at River Road/High Street. There have been various recommendations for grade separating the Hydraulic Road intersection in the future, and perhaps this is reasonable to assume for the year 2023, thereby allowing some additional traffic flow on U.S. Route 250 through that intersection. However, we are not aware of any plans to upgrade the signalized intersection to the east at High Street/River Road. Therefore, it is a legitimate question whether it is realistic to assume U.S. Route 250 traffic coming to and from the east of the intersection – i.e., the Meadowcreek Parkway intersection – can experience peak hour volumes much higher than current levels.

Exhibit B

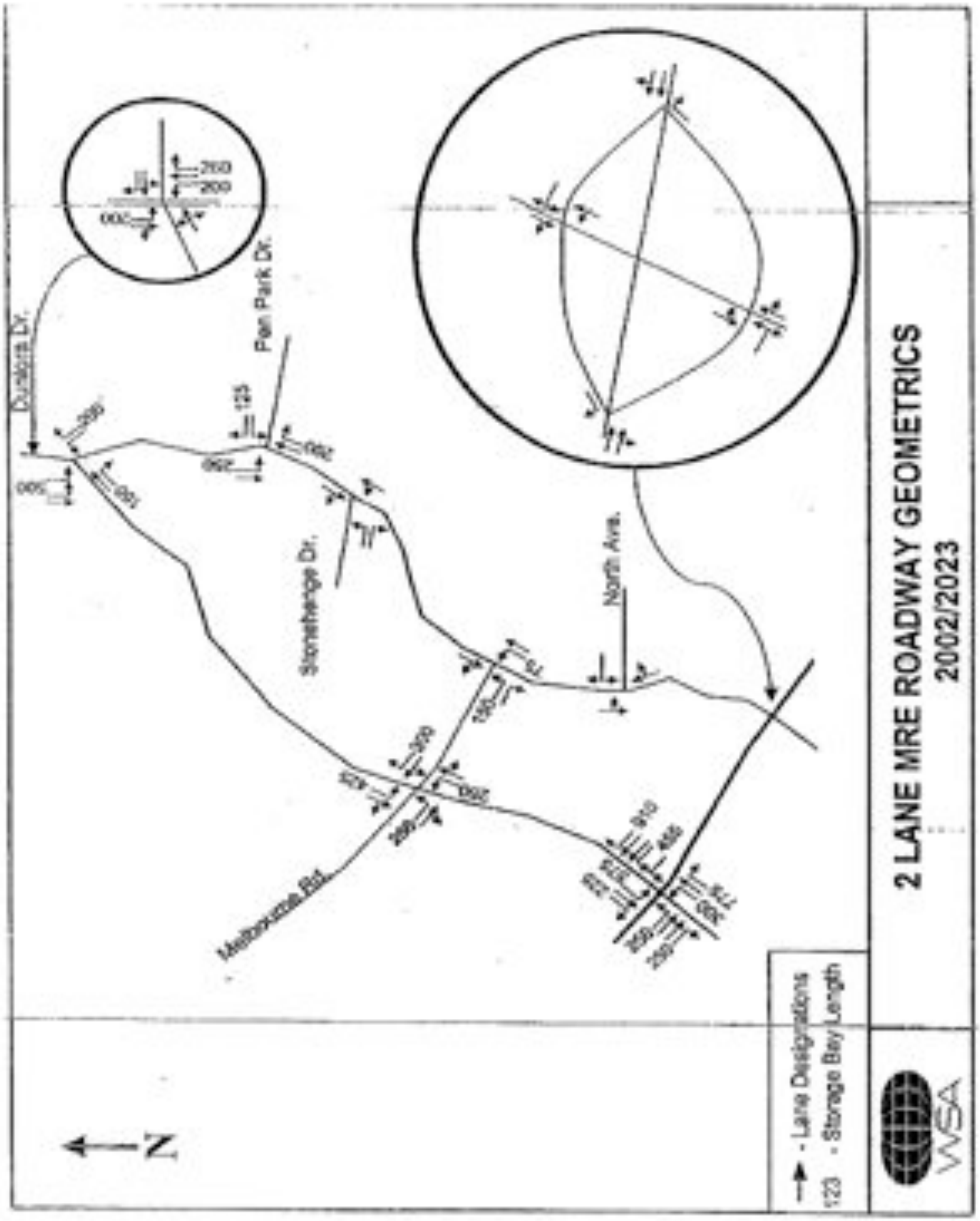

Dundee Dr.
Fan Park Dr.
Stonehenge Dr.
North Ave.
Melbourne Rd.
- Lane Designations
123 - Storage Bay Length
WSA
2 LANE MRE ROADWAY GEOMETRICS
2002/2023

Exhibit C

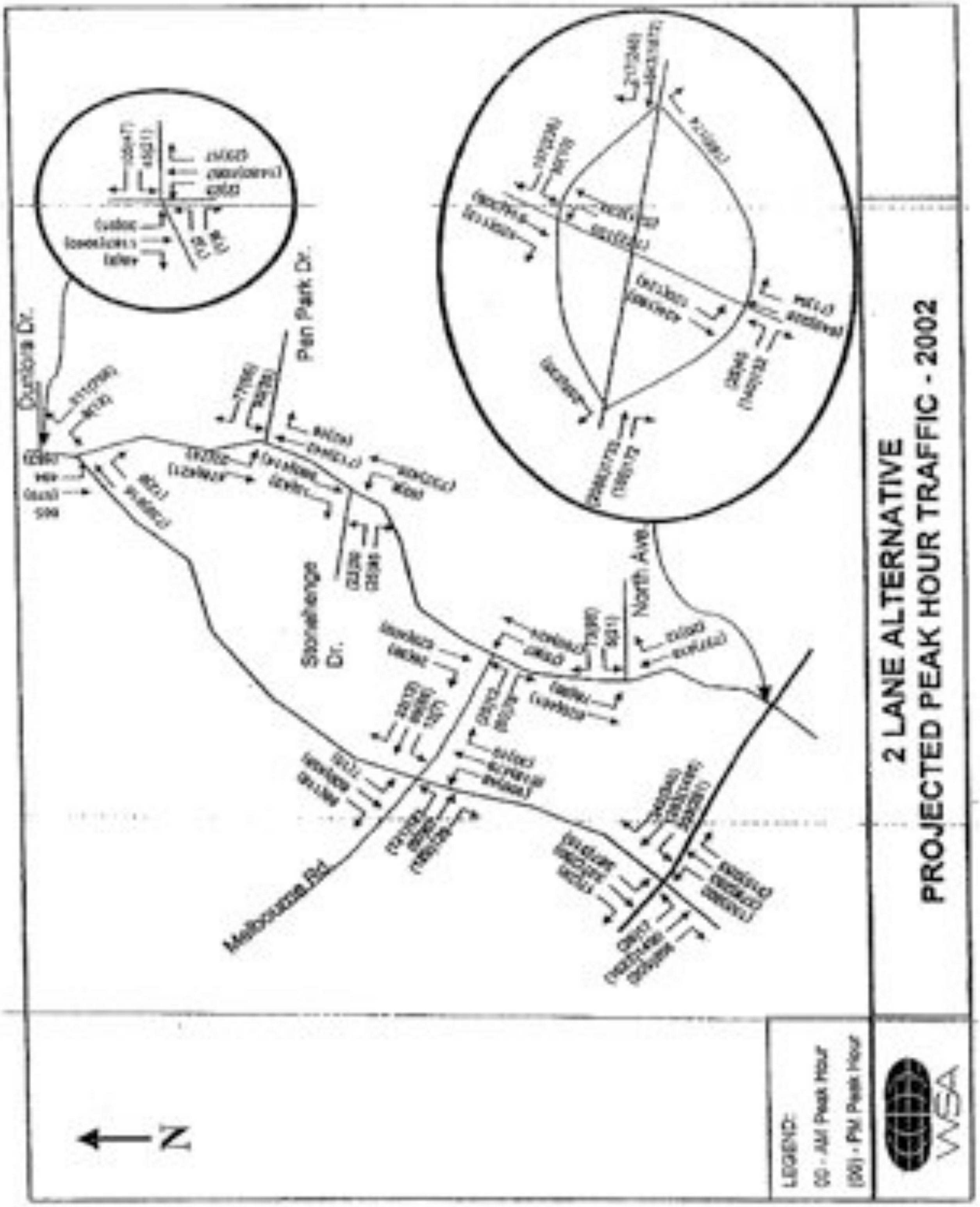
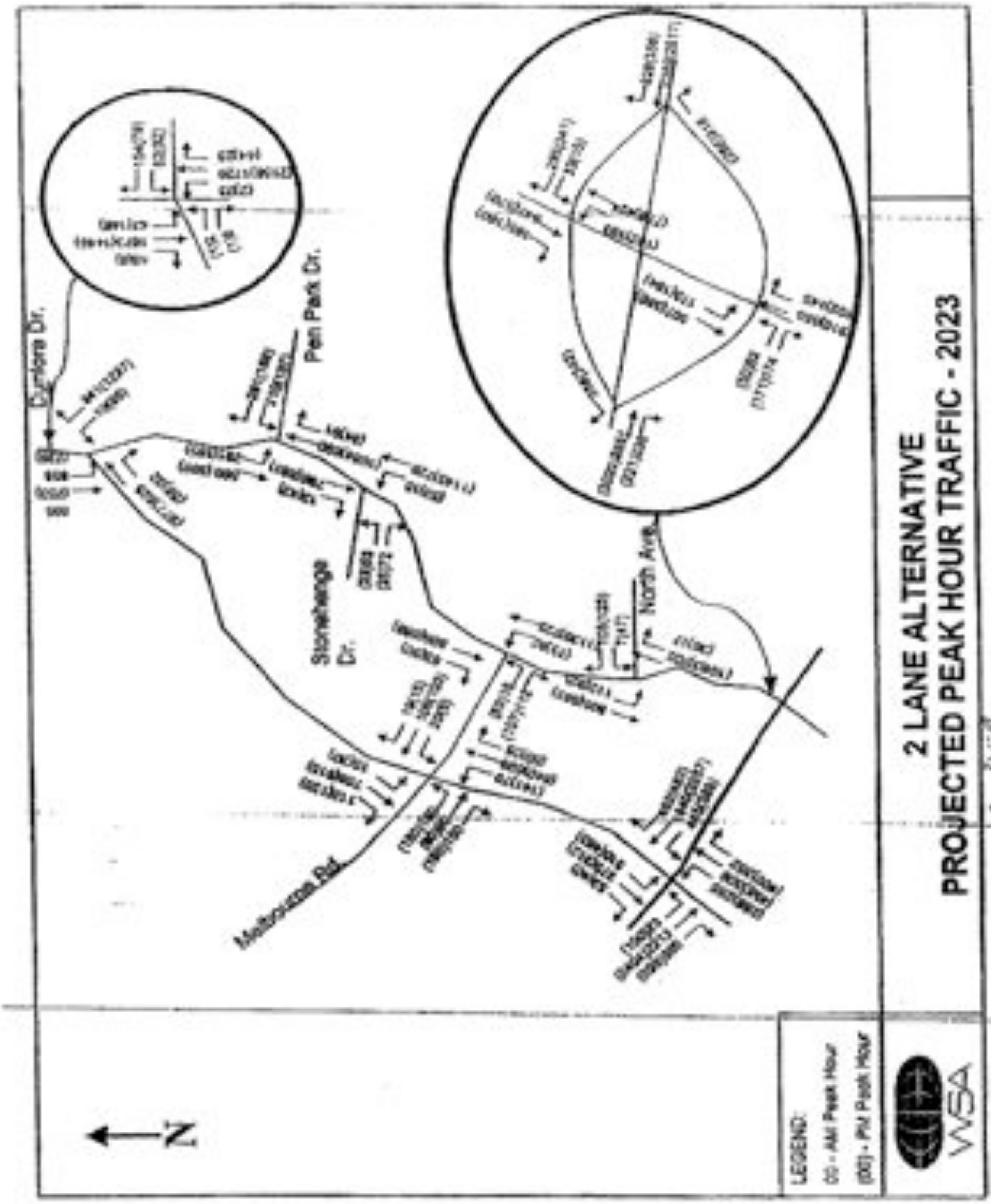

2 LANE ALTERNATIVE
PROJECTED PEAK HOUR TRAFFIC - 2002
Pan Park Dr.
Stonehenge Dr.
North Ave.
LEGEND:
00 - AM Peak Hour
(00) - PM Peak Hour
WSA
N

Exhibit D



2 LANE ALTERNATIVE
PROJECTED PEAK HOUR TRAFFIC - 2023
Pen Park Dr.
Stonehenge Dr.
North Ave.
Melbourne Rd.
N
LEGEND:
00 - AM Peak Hour
(00) - PM Peak Hour
WSA

Utilizing the 2002 and 2023 turning movement counts at the U.S. Route 250/McIntire/Meadowcreek intersection, we extrapolated volumes to estimate an approximate year 2008 traffic volume condition (see Table 1), and a year 2002 plus 8% scenario (see Table 2). The premise behind the 2008 projections is that this would reflect travel demand under the scenario that an interim, at-grade intersection could be built at U.S. Route 250, to enable the Meadowcreek Parkway to be opened by 2008, thereby providing the traffic advantage to the traveling public for the region. These volumes represent an approximate 16% increase over the base 2002 conditions. The year 2002 plus 8% scenario represents a slightly less increase in traffic growth but, it can be argued, is more realistic in terms of the traffic that would be traveling along U.S. Route 250 in the future, given the previous described capacity constraints at Hydraulic and High Street/River Road.

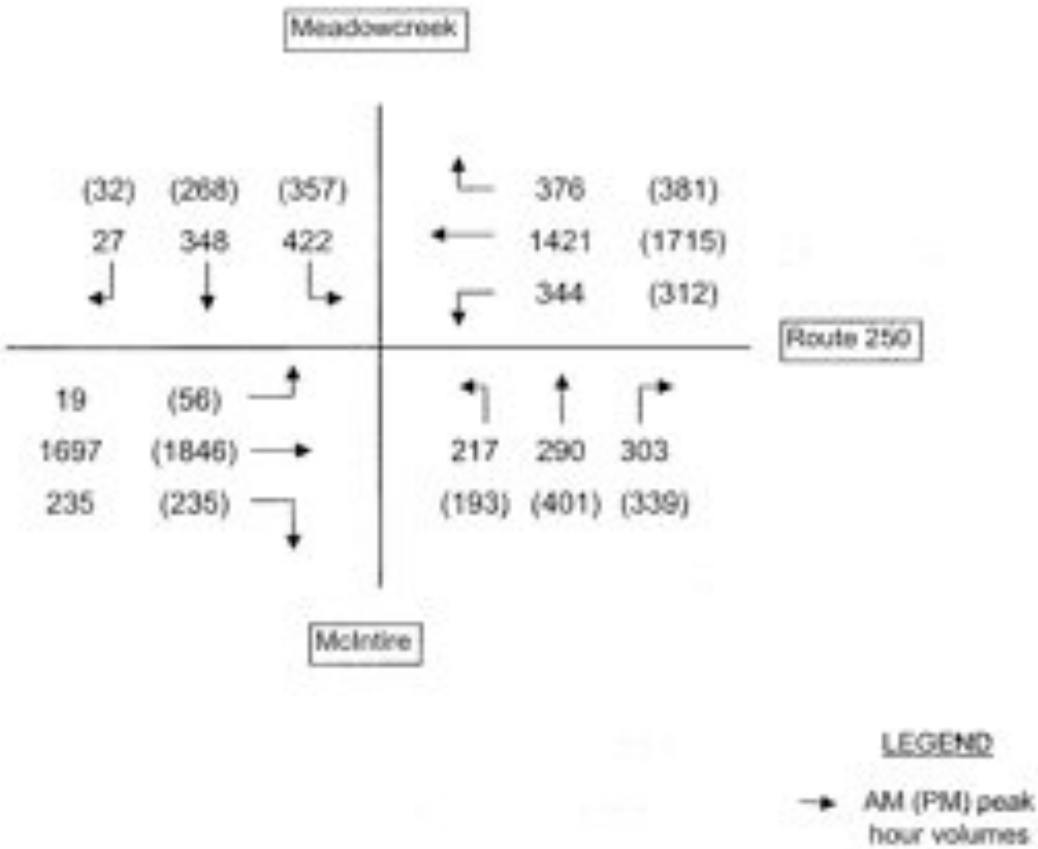
Roadway Capacity Adequacy Analysis

Based on the assumed roadway conditions – U.S. Route 250 is a 4-lane divided facility, and Meadowcreek Parkway is a 2-lane facility – and the peak hour turning movement traffic projections previously described, we evaluated alternative at-grade concepts for accommodating the various traffic conditions. For each combination of traffic conditions and intersection roadway geometrics, a traffic simulation was conducted to estimate the projected "Level of Service" (LOS), a calculation of the quality of traffic flow. Table 3 provides a general description of the various LOS's. Generally speaking, a "C" LOS is a desirable planning goal to achieve, a "D" is acceptable, an "E" and "F" LOS are unacceptable in that they equate to excessive traffic delay and congestion.

Our initial effort was to evaluate a "fully loaded", at-grade signalized intersection (dual left-turn lanes, multiple through lanes, and channelized right-turn lanes of all four (4) approaches). It was evident that the limited at-grade control design as considered could not accommodate the year 2023 projections as has been generally stated in the other engineering efforts to date. Accordingly, the current design effort by the City of Charlottesville is for the design of a separate, federally funded grade separated interchange project, which, in theory, could accommodate the projected long-range traffic volumes. The general hope is that the current design effort will develop a constructible plan which can accommodate future traffic projections, be constructed with available funds, and implemented concurrent with the Meadowcreek Parkway project in accordance with the current schedule that calls for the road being open by 2008. Should completion of the Meadowcreek Parkway and interchange projects be substantially delayed, for any of the above or other reasons, thereby preventing the timely opening of the remainder of Meadowcreek Parkway, then the following analysis of near-term traffic needs and solutions becomes very relevant.

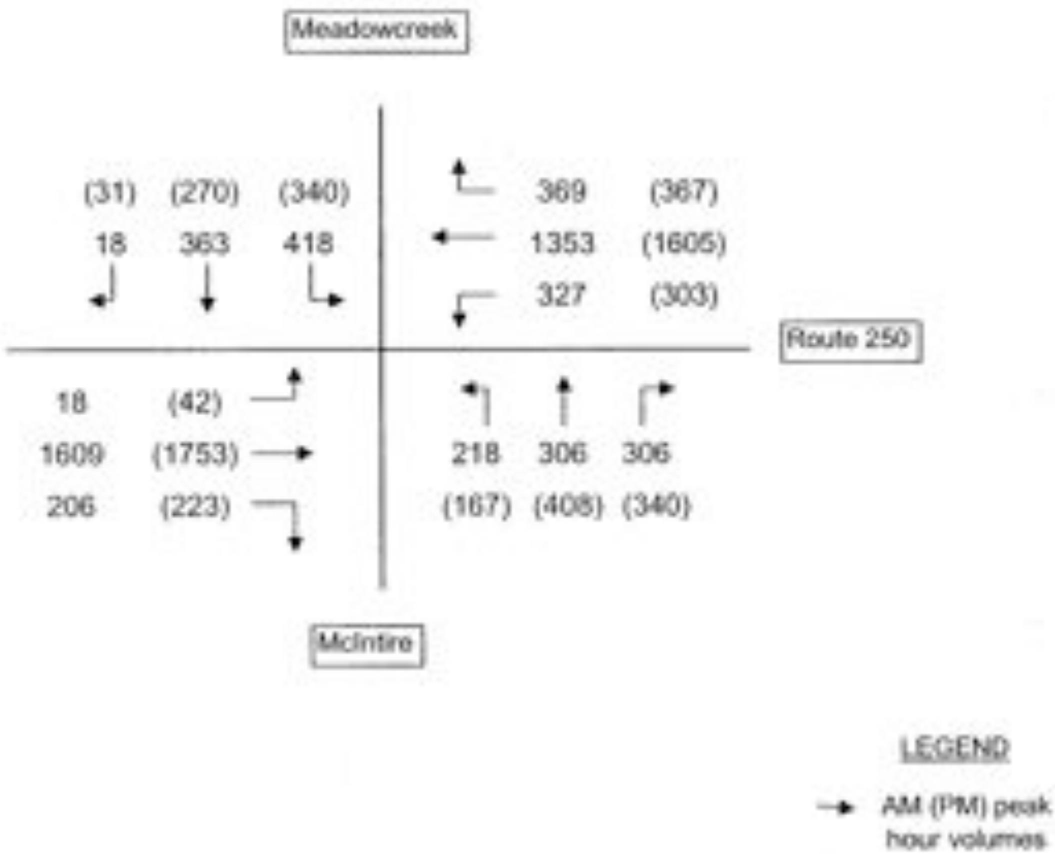
Table 4 summarizes projected traffic LOS for various at-grade intersection concepts based on year 2008 traffic projections. Again, the 2008 projections represent what the demand for the road network would be when a 2-lane Meadowcreek Parkway plus at-grade intersection at U.S. Route 250 and McIntire Road were constructed and fully operational. The two (2) traffic signal scenarios analyzed both assume that there would be separate right-turn lanes and dual left-turn lanes, as needed, on each approach. The scenario of two (2) through lanes per direction on

Table 1
PROJECTED YEAR 2008 PEAK HOUR VOLUMES



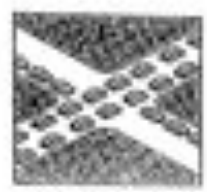
* 2008 volumes interpolated from 2002 and 2023 volumes in WSA McIntire Road Extension Report

Table 2
PROJECTED YEAR 2002 PLUS 8 PERCENT
PEAK HOUR VOLUMES



* 2002 volumes in WSA McIntire Road Extension Report increased by 8%

Table 3
LEVEL OF SERVICE DEFINITIONS

LOS	Roadway Segments Or Controlled Access Highways	Intersections	
A	Free flow, low traffic density.	No vehicle waits longer than one signal indication.	
B	Delay is not unreasonable, stable traffic flow.	On a rare occasion motorists wait through more than one signal indication.	
C	Stable condition, movements somewhat restricted due to higher volumes, but not objectionable for motorists.	Intermittently drivers wait through more than one signal indication, and occasionally backups may develop behind left turning vehicles, traffic flow still stable and acceptable.	
D	Movements more restricted, queues and delays may occur during short peaks, but lower demands occur often enough to permit clearing, thus preventing excessive backups.	Delays at intersections may become extensive with some, especially left-turning vehicles waiting tow or more signal indications, but enough cycles with lower demand occur to permit periodic clearance, thus preventing excessive back-ups.	
E	Actual capacity of the roadway involves delay to all motorists due to congestion.	Very long queues may create lengthy delays, especially for left turning vehicles.	
F	Forced flow with demand volumes greater than capacity resulting in complete congestion. Volumes drop to zero in extreme cases.	Backups from locations downstream restrict or prevent movement of vehicles out of approach creating a storage area during part or all of an hour.	

SOURCE: <u>A Policy on Design of Design of Urban Highways and Arterial Streets</u> – ASSHTO, 1973 based upon material published in Highway Capacity Manual, National Academy of Sciences, 1965.

Table 4
YEAR 2008
LEVELS OF SERVICE (LOS)

TYPE OF INTERSECTION CONTROL	LOS	
	AM	PM
TRAFFIC SIGNAL		
2 thru lanes on Route 250	F	F
3 thru lanes on Route 250	D	D
	AM	PM
ROUNDABOUT		
2 circulating lanes	E	E
3 circulating lanes	B	B
2/3-lane hybrid	D	D

Note: detailed work sheets are included in Appendix

U.S. Route 250 results in unacceptable "F" LOS. If the intersection is upgraded to include three (3) through lanes in each direction on U.S. Route 250, then a marginally acceptable "D" LOS for both peak hour conditions results. However, to provide an acceptable design on relatively high-speed U.S. Route 250, which provides for through traffic expanding from two (2) lanes to three (3) lanes, then transitioning back to two (2) lanes, in effect, would require widening U.S. Route 250 an additional lane per direction, more or less, from the Park Street interchange to the east to the McIntire Park entrance to the west. This obviously is a substantial upgrading for U.S. Route 250 for a portion of the road.

The same intersection scenarios were analyzed with the slightly lower Year 2002 plus 8 percent traffic projections. Results, essentially, are unchanged (see Table 5).

The alternative traffic control concept of a roundabout was evaluated. Roundabouts often will accommodate traffic more efficiently than a standard signalized intersection, especially if there are considerable left-turn movements, as is projected here. The simplest alternative would be a 2-lane roundabout, which would easily accommodate the 2-lane approaches of U.S. Route 250 and the single-lane approaches of McIntire and Meadowcreek (Exhibit E). However, this results in an unacceptable "E" LOS in both AM and PM peak hours for 2008 volumes.

The next scenario considered was a full 3-lane roundabout, which includes three (3) lanes in the circular center, but most importantly, three (3) approach lanes on U.S. Route 250 as well as the discharge (i.e., exiting) lanes on U.S. Route 250 (Exhibit F). Because U.S. Route 250 traffic, at a roundabout, will be slowing down to either a brief STOP condition or a 20 mph intersection movement condition, the need for transition from two (2) lanes to three (3) lanes, than three (3) lanes back to two (2) lanes along U.S. Route 250 is substantially reduced. For example, the 3-lane approach and the discharge lane could be 100-200 feet, versus the 1,000 feet or so required on the signalized 3-through lane option previously discussed. The obvious advantage of the 3-lane roundabout scenario, is the very acceptable "B" LOS in both AM and PM peaks with 2008 volumes, and "B" and "A" LOS, respectively, in 2002 plus 8 percent.

The third option looked at was a multi-lane hybrid roundabout (see Exhibit G), which results in a marginally acceptable "D" LOS in the AM and PM peak hours ("C" and "D" LOS, respectively, in 2002 plus 8 percent). The major advantage of this is that this can easily be integrated into the 2-lane McIntire/Meadowbrook and 4-lane U.S. Route 250 road systems.

Table 5
YEAR 2002 PLUS 8 PERCENT
LEVELS OF SERVICE (LOS)

TYPE OF INTERSECTION CONTROL	LOS	
	AM	PM
TRAFFIC SIGNAL		
2 thru lanes on Route 250	F	F
3 thru lanes on Route 250	D	D
	AM	PM
ROUNDABOUT		
2 circulating lanes	E	E
3 circulating lanes	B	A
2/3-lane hybrid	C	D

Note: detailed work sheets are included in Appendix

Exhibit E
2-LANE ROUNDABOUT

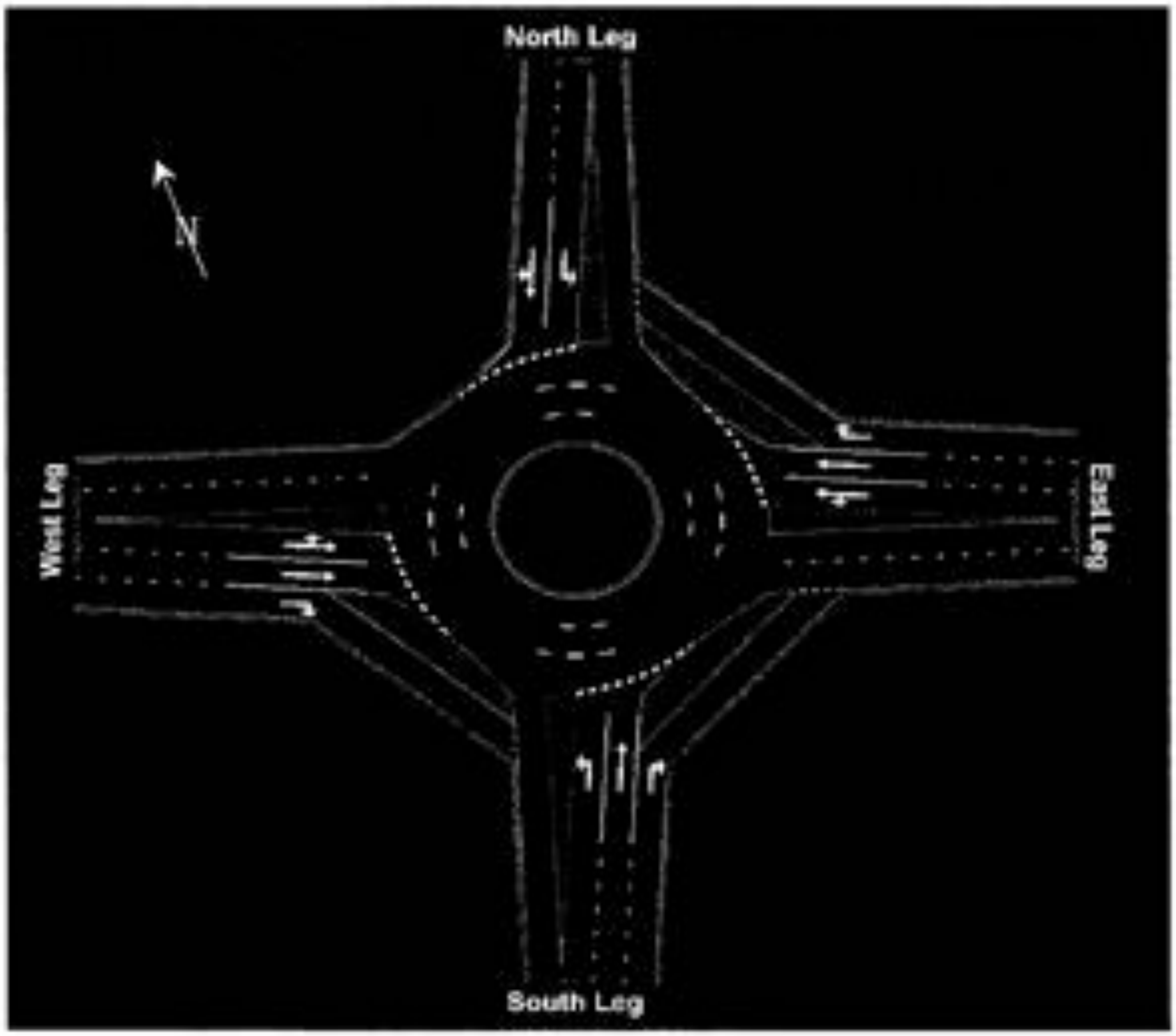


Exhibit F
3-LANE ROUNDABOUT

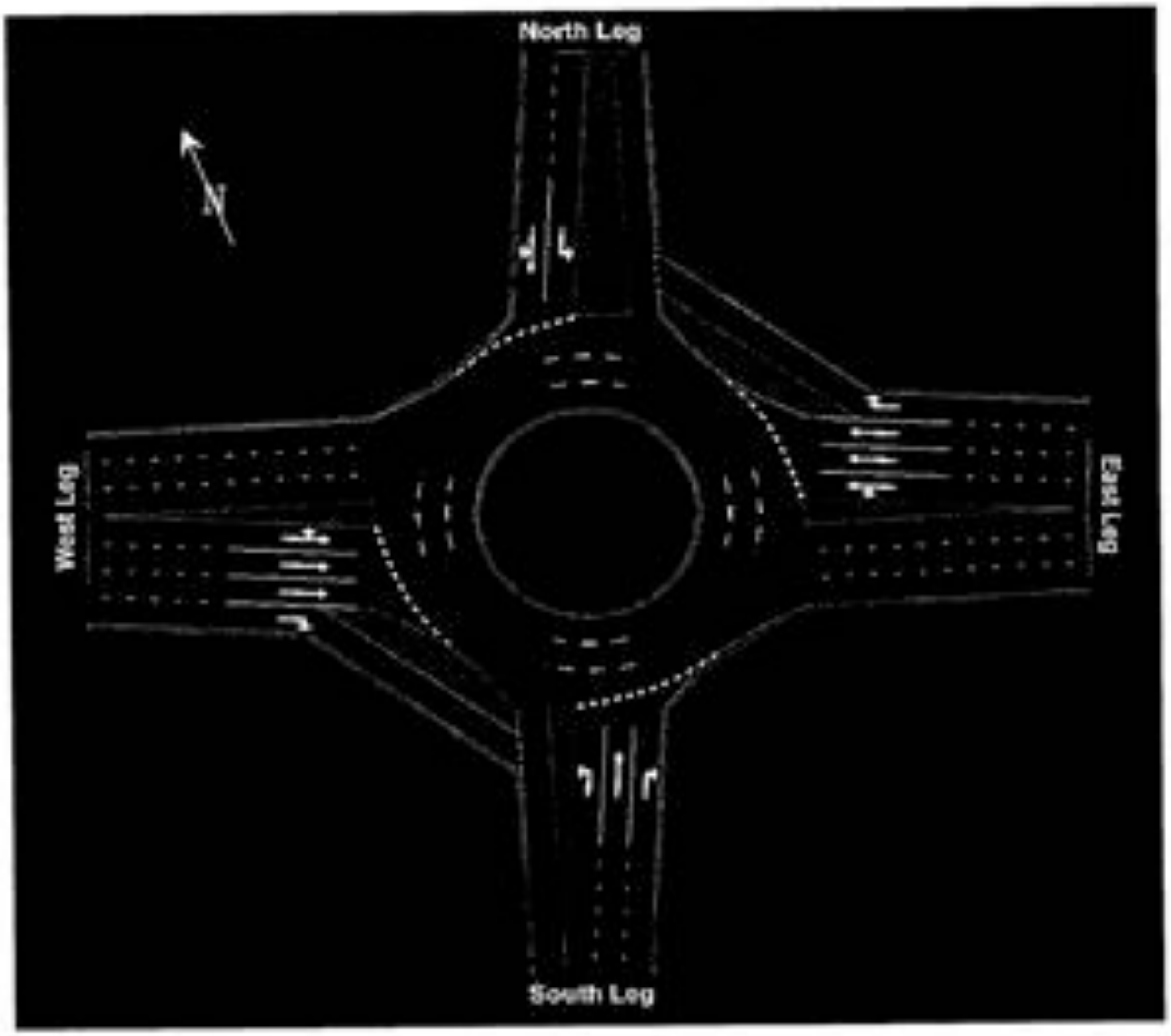
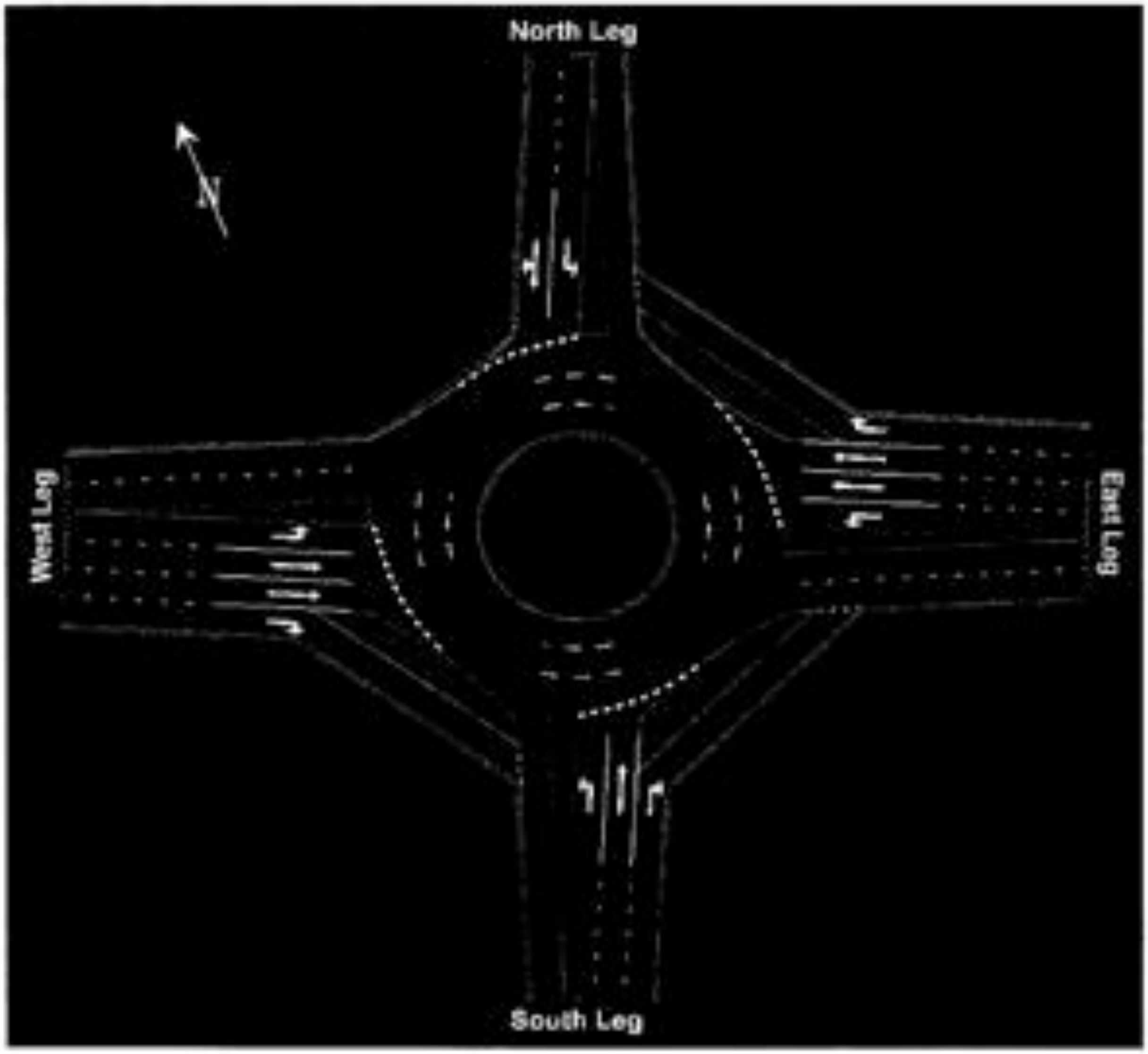


Exhibit G
2/3-LANE HYBRID ROUNDABOUT



Observations and Conclusions

Several reasons have been put forth why it would not be appropriate to construct an at-grade intersection at U.S. Route 250 as part of the initial approved, State funded Meadowcreek Parkway project:

1. An at-grade intersection control cannot accommodate the projected traffic volume;
2. An at-grade intersection would take up too much land; and
3. It would not be cost effective to build a full intersection, then tear it out to construct an interchange.

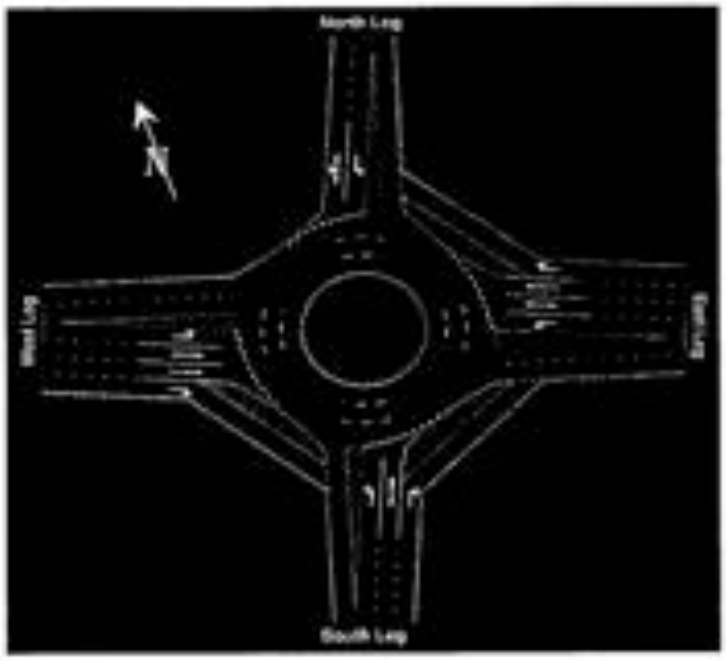
Our response to these is as follows:

1. Assuming no changes in U.S. Route 250, the projected 2023 "Design Year" traffic volumes may not be realistic. The two (2) traffic projection scenarios we evaluated are more realistic in terms of volumes that physically could occur within the current road system;
2. Comparing the at-grade intersection control concepts we considered, and the six (6) alternate interchange concepts that have been suggested, it is our opinion that the at-grade concepts, especially the roundabouts, can be developed within the existing right-of-way and, certainly, will not have as much impact in terms of right-of-way or land disturbance as any of the interchange concepts; and
3. It is very likely that a concept could be developed wherein a later grade separated interchange project with its own design utility can be built upon, rather than replace, an at-grade plan. A possible example of this follows.

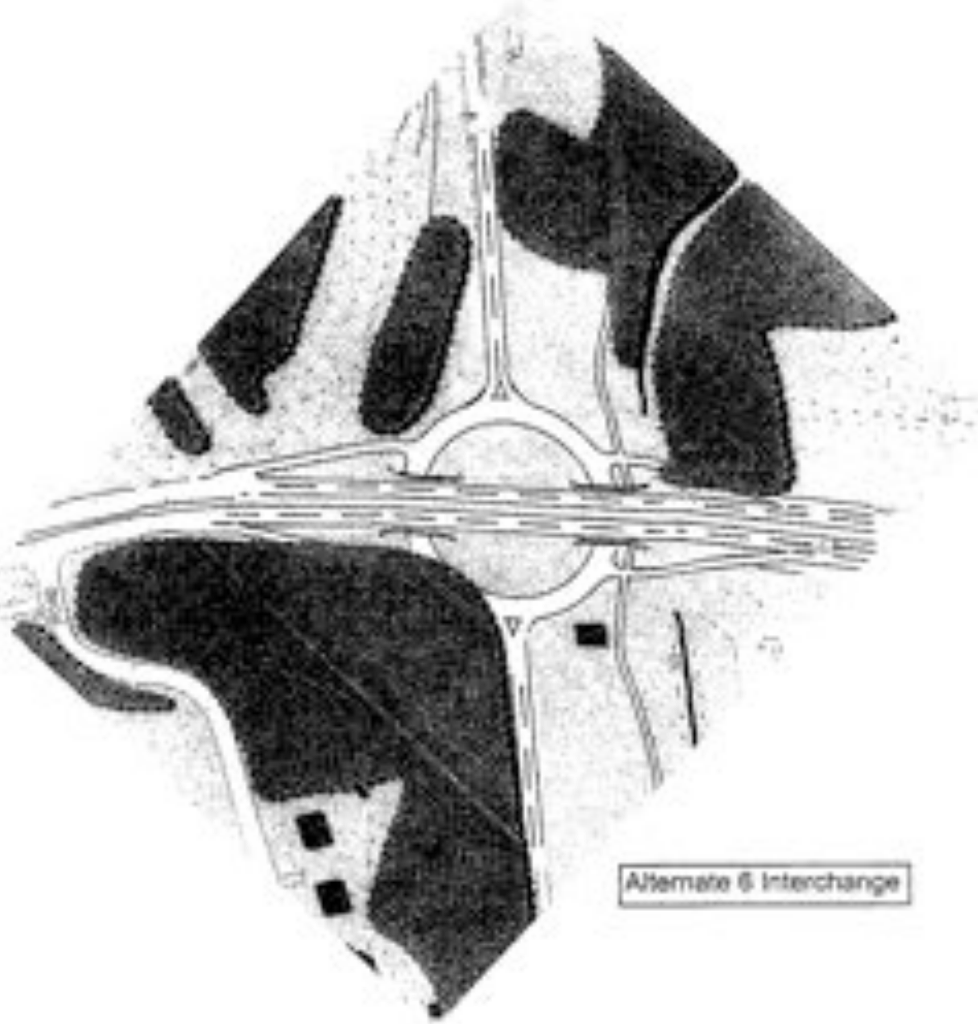
Our brief assessment suggests that the 2/3-lane hybrid roundabout concept is the preferred grade concept: it can accommodate future traffic volumes, likely can be built within existing right-of-way, and is compatible with the 2-lane Meadowcreek/McIntire and 4-lane U.S. Route 250 roadway configuration. Alternate 6 is one of the preferred interchange concepts because it handles projected "design year" volumes well. Exhibit H has these two (2) concepts next to each other. Although these plans are concepts only, and not to scale, it is reasonable to conclude that the at-grade roundabout hybrid could provide the ultimate framework for the lower level roundabout of an interchange plan. The grade separated portion of U.S. Route 250 could be constructed while U.S. Route 250 through volumes are maintained on the intersection roundabout. If coordinated together, there could be limited removal of pavement or regrading to transition to the grade separated roundabout. Further, it is very likely that, regardless of any ultimate interchange design, an at-grade temporary roundabout concept may be required during the interchange construction period to maintain existing McIntire Road and U.S. Route 250 traffic flow.

To summarize, the ultimate plan is for a 4-lane highway (U.S. Route 250) to connect to two 2-lane (McIntire and Meadowcreek) roadways. In the vast majority of cases, this is accomplished at an at-grade intersection. Part of the reason for this is that such roadways (2-lane parkways and city streets) cannot carry the higher volumes necessary to warrant grade separation. If the interchange design effort includes the given that U.S. Route 250/River Road/High Street intersection, and to a lesser extent, the U.S. Route 250/Hydraulic intersection, will not be grade separated, then traffic volumes in excess of our 2008 and 2002 plus 8 percent estimates have to be seriously questioned. If this is a valid statement, then developing an at-grade intersection which will allow Meadowcreek Parkway to operate safely and efficiently in the near term and, perhaps, even the long term, is a valid solution.

Exhibit H
INTERSECTION VERSUS INTERCHANGE COMPARISON



2/3-Lane Hybrid Roundabout



Alternate 6 Interchange

APPENDIX

SIGNALIZED ANALYSIS
YEAR 2008

2 Thru Lanes on Route 250

HCS2000™ DETAILED REPORT

General Information		Site Information	
Analyst	AEB	Intersection	ROUTE 250 @ MCINTIRE RD
Agency or Co.	DAA	Area Type	All other areas
Date Performed	7/18/2005	Jurisdiction	
Time Period	AM	Analysis Year	2008
		Project ID	MCINTIRE RD

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	1	2	1	1	2	1	2	1	0	2	1	0
Lane group	L	T	R	L	T	R	L	T		L	TR	
Volume, V (vph)	19	1697	235	344	1421	376	217	290		422	348	27
% Heavy vehicles, %HV	0	0	0	0	0	0	0	0		0	0	0
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90		0.90	0.90	0.90
Pretimed (P) or actuated (A)	A	A	A	A	A	A	A	A		A	A	A
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Arrival type, AT	3	3	3	3	3	3	3	3		3	3	
Unit extension, UE	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR volumes	0		0	0		0	0			0		0
Lane width	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0	0	0	0		0	0	
Min. time for pedestrians, G_p		3.2			3.2			3.2			3.2	

Phasing	Excl. Left	Thru & RT	03	04	Excl. Left	Thru & RT	07	08
Timing	G = 13.4	G = 42.8	G =	G =	G = 15.7	G = 30.0	G =	G =
	Y = 4	Y = 4	Y =	Y =	Y = 4	Y = 4	Y =	Y =
Duration of Analysis, T = 0.25						Cycle Length, C = 117.9		

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	21	1886	261	382	1579	418	241	322		469	417	
Lane group capacity, c	205	1313	586	205	1313	586	467	483		467	478	
v/c ratio, X	0.10	1.44	0.45	1.86	1.20	0.71	0.52	0.67		1.00	0.87	
Total green ratio, g/C	0.11	0.36	0.36	0.11	0.36	0.36	0.13	0.25		0.13	0.25	
Uniform delay, d_1	46.9	37.5	28.5	52.2	37.5	32.3	47.6	39.5		51.1	42.1	
Progression factor, PF	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Delay calibration, k	0.11	0.50	0.11	0.50	0.50	0.28	0.12	0.24		0.50	0.40	
Incremental delay, d_2	0.2	200.8	0.5	406.6	98.7	4.1	1.0	3.5		42.7	16.1	
Initial queue delay, d_3												
Control delay	47.1	238.3	29.1	458.9	136.2	36.4	48.6	43.0		93.8	58.2	
Lane group LOS	D	F	C	F	F	D	D	D		F	E	
Approach delay		211.3			170.5			45.4			77.1	
Approach LOS		F			F			D			E	
Intersection delay		159.7			X_c = 1.26		Intersection LOS				F	

HCS2000™ DETAILED REPORT

General Information		Site Information	
Analyst	AEB	Intersection	ROUTE 250 @ MCINTIRE RD
Agency or Co.	DAA	Area Type	All other areas
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Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	1	2	1	1	2	1	2	1	0	2	1	0
Lane group	L	T	R	L	T	R	L	T		L	TR	
Volume, V (vph)	56	1846	235	312	1715	381	193	401		357	268	32
% Heavy vehicles, %HV	0	0	0	0	0	0	0	0		0	0	0
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90		0.90	0.90	0.90
Pretimed (P) or actuated (A)	A	A	A	A	A	A	A	A		A	A	A
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Arrival type, AT	3	3	3	3	3	3	3	3		3	3	
Unit extension, UE	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR volumes	0		0	0		0	0			0		0
Lane width	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0	0	0	0		0	0	
Min. time for pedestrians, G_p		3.2			3.2			3.2			3.2	

Phasing	Excl. Left	Thru & RT	03	04	Excl. Left	Thru & RT	07	08
Timing	G = 12.0	G = 50.0	G =	G =	G = 12.0	G = 39.8	G =	G =
	Y = 4	Y = 4	Y =	Y =	Y = 4	Y = 4	Y =	Y =
Duration of Analysis, T = 0.25						Cycle Length, C = 129.8		

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	62	2051	261	347	1906	423	214	446		397	334	
Lane group capacity, c	167	1394	622	167	1394	622	324	582		324	573	
v/c ratio, X	0.37	1.47	0.42	2.08	1.37	0.68	0.66	0.77		1.23	0.58	
Total green ratio, g/C	0.09	0.39	0.39	0.09	0.39	0.39	0.09	0.31		0.09	0.31	
Uniform delay, d_1	55.3	39.9	29.2	58.9	39.9	33.2	56.9	40.8		58.9	38.0	
Progression factor, PF	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Delay calibration, k	0.11	0.50	0.11	0.50	0.50	0.25	0.24	0.32		0.50	0.17	
Incremental delay, d_2	1.4	216.0	0.5	505.0	170.0	3.0	4.9	6.1		125.7	1.5	
Initial queue delay, d_3												
Control delay	56.7	255.9	29.7	563.9	209.8	36.2	61.8	46.9		184.6	39.5	
Lane group LOS	E	F	C	F	F	D	E	D		F	D	
Approach delay		225.8			238.3			51.7			118.3	
Approach LOS		F			F			D			F	
Intersection delay		196.8			X_c = 1.26		Intersection LOS				F	

SIGNALIZED ANALYSIS
YEAR 2008

3 Thru Lanes on Route 250

HCS2000™ DETAILED REPORT

General Information		Site Information	
Analyst	AEB	Intersection	ROUTE 250 @ MCINTIRE RD
Agency or Co.	DAA	Area Type	All other areas
Date Performed	7/18/2005	Jurisdiction	
Time Period	AM	Analysis Year	2008
		Project ID	MCINTIRE RD

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	1	3	1	2	3	1	2	1	0	2	1	0
Lane group	L	T	R	L	T	R	L	T		L	TR	
Volume, V (vph)	19	1697	235	344	1421	376	217	290		422	348	27
% Heavy vehicles, %HV	0	0	0	0	0	0	0	0		0	0	0
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90		0.90	0.90	0.90
Pretimed (P) or actuated (A)	A	A	A	A	A	A	A	A		A	A	A
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Arrival type, AT	3	3	3	3	3	3	3	3		3	3	
Unit extension, UE	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR volumes	0		0	0		0	0			0		0
Lane width	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0	0	0	0		0	0	
Min. time for pedestrians, G_p		3.2			3.2			3.2			3.2	

Phasing	Excl. Left	Thru & RT	03	04	Excl. Left	Thru & RT	07	08
Timing	G = 13.4	G = 42.8	G =	G =	G = 15.7	G = 30.0	G =	G =
	Y = 4	Y = 4	Y =	Y =	Y = 4	Y = 4	Y =	Y =
Duration of Analysis, T = 0.25						Cycle Length, C = 117.9		

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	21	1886	261	382	1579	418	241	322		469	417	
Lane group capacity, c	205	1879	586	398	1879	586	467	483		467	478	
v/c ratio, X	0.10	1.00	0.45	0.96	0.84	0.71	0.52	0.67		1.00	0.87	
Total green ratio, g/C	0.11	0.36	0.36	0.11	0.36	0.36	0.13	0.25		0.13	0.25	
Uniform delay, d_1	46.9	37.5	28.5	52.0	34.4	32.3	47.6	39.5		51.1	42.1	
Progression factor, PF	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Delay calibration, k	0.11	0.50	0.11	0.47	0.38	0.28	0.12	0.24		0.50	0.40	
Incremental delay, d_2	0.2	21.7	0.5	34.7	3.6	4.1	1.0	3.5		42.7	16.1	
Initial queue delay, d_3												
Control delay	47.1	59.2	29.1	86.7	38.0	36.4	48.6	43.0		93.8	58.2	
Lane group LOS	D	E	C	F	D	D	D	D		F	E	
Approach delay		55.5			45.5			45.4			77.1	
Approach LOS		E			D			D			E	
Intersection delay		53.8			X_c = 0.96		Intersection LOS				D	

 Version 4.1

HCS2000™ DETAILED REPORT

General Information		Site Information	
Analyst	AEB	Intersection	ROUTE 250 @ MCINTIRE RD
Agency or Co.	DAA	Area Type	All other areas
Date Performed	7/18/2005	Jurisdiction	
Time Period	PM	Analysis Year	2008
		Project ID	MCINTIRE RD

Volume and Timing Input

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Number of lanes, N_1	1	3	1	2	3	1	2	1	0	2	1	0
Lane group	L	T	R	L	T	R	L	T		L	TR	
Volume, V (vph)	56	1846	235	312	1715	381	193	401		357	268	32
% Heavy vehicles, %HV	0	0	0	0	0	0	0	0		0	0	0
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90		0.90	0.90	0.90
Pretimed (P) or actuated (A)	A	A	A	A	A	A	A	A		A	A	A
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Arrival type, AT	3	3	3	3	3	3	3	3		3	3	
Unit extension, UE	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR volumes	0		0	0		0	0			0		0
Lane width	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0	0	0	0		0	0	
Min. time for pedestrians, G_p		3.2			3.2			3.2			3.2	

Phasing	Excl. Left	Thru & RT	03	04	Excl. Left	Thru & RT	07	08
Timing	G = 13.0	G = 46.0	G =	G =	G = 10.0	G = 28.0	G =	G =
	Y = 4	Y = 4	Y =	Y =	Y = 4	Y = 4	Y =	Y =
Duration of Analysis, T = 0.25						Cycle Length, C = 113.0		

Lane Group Capacity, Control Delay, and LOS Determination

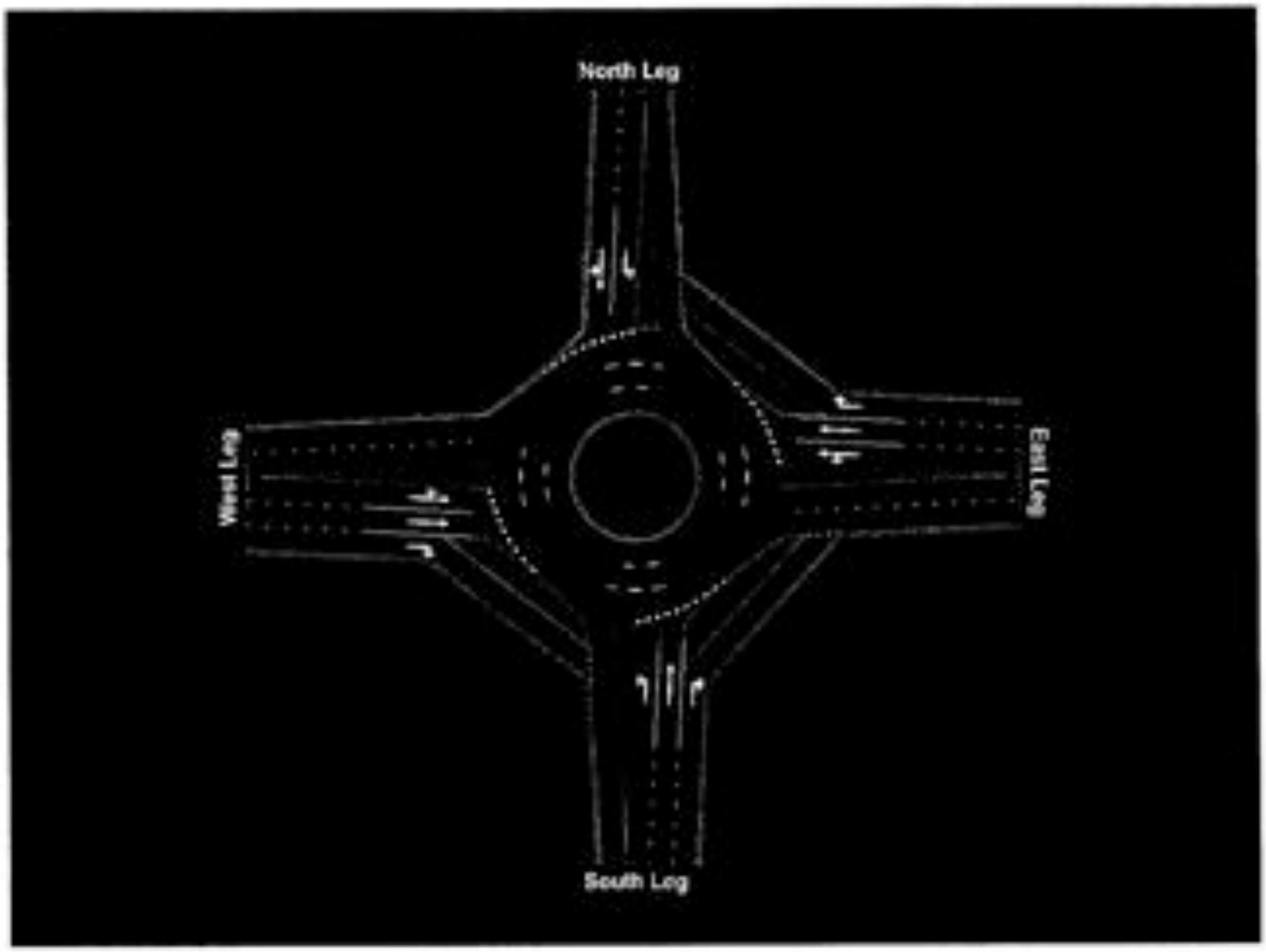
	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Adjusted flow rate, v	62	2051	261	347	1906	423	214	446		397	334	
Lane group capacity, c	207	2107	658	403	2107	658	310	471		310	463	
v/c ratio, X	0.30	0.97	0.40	0.86	0.90	0.64	0.69	0.95		1.28	0.72	
Total green ratio, g/C	0.11	0.41	0.41	0.11	0.41	0.41	0.09	0.25		0.09	0.25	
Uniform delay, d_1	45.8	32.9	23.7	49.1	31.4	26.9	50.0	41.8		51.5	38.9	
Progression factor, PF	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Delay calibration, k	0.11	0.48	0.11	0.39	0.43	0.22	0.26	0.46		0.50	0.28	
Incremental delay, d_2	0.8	13.9	0.4	17.0	6.0	2.2	6.4	28.5		148.8	5.5	
Initial queue delay, d_3												
Control delay	46.6	46.8	24.1	66.1	37.5	29.0	56.4	70.3		200.3	44.4	
Lane group LOS	D	D	C	E	D	C	E	E		F	D	
Approach delay		44.3			39.9			65.8			129.0	
Approach LOS		D			D			E			F	
Intersection delay		54.3			X_c = 0.98		Intersection LOS				D	

HCS2000™ Version 4.1

ROUNDABOUT ANALYSIS
YEAR 2008

2 Circulating Lanes

2 Lane Roundabout



Movement Summary

MCINTIRE RD

2008 AM

Roundabout

Vehicle Movements

Mov No	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (ft)	Prop. Queued	Eff. Stop Rate	Aver Speed (mph)
South Approach										
32	L	228	2.0	0.722	20.3	LOS C	181	0.99	1.18	21.0
32	T	305	2.0	0.722	20.3	LOS C	181	0.99	1.18	21.0
32	R	319	2.0	0.722	20.3	LOS C	181	0.99	1.18	21.0
Approach		**853**	**2.0**	**0.723**	**20.3**	**LOS C**	**182**	**0.99**	**1.18**	**21.0**
East Approach										
22	L	362	1.9	0.955	23.6	LOS C	519	1.00	1.50	20.4
21	T	1496	2.0	0.955	15.7	LOS B	544	1.00	1.46	22.4
23	R	396	2.0	0.315	3.8	LOS A	61	0.51	0.43	26.6
Approach		**2254**	**2.0**	**0.954**	**14.9**	**LOS B**	**544**	**0.91**	**1.29**	**22.6**
North Approach										
42	L	444	2.0	1.384	208.4	LOS F	1458	1.00	3.13	5.7
42	T	366	2.0	1.384	208.4	LOS F	1458	1.00	3.13	5.7
42	R	28	2.0	1.384	208.4	LOS F	1458	1.00	3.13	5.7
Approach		**839**	**2.0**	**1.384**	**208.4**	**LOS F**	**1458**	**1.00**	**3.13**	**5.7**
West Approach										
12	L	20	4.8	1.235	124.9	LOS F	1590	1.00	3.64	8.6
11	T	1786	2.0	1.224	117.3	LOS F	1898	1.00	3.83	8.5
13	R	247	2.0	0.228	4.9	LOS A	43	0.62	0.55	26.2
Approach		**2055**	**2.0**	**1.224**	**103.9**	**LOS F**	**1898**	**0.95**	**3.43**	**9.2**
All Vehicles		**6001**	**2.0**	**1.384**	**73.2**	**LOS E**	**1898**	**0.95**	**2.27**	**11.7**

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Movement Summary

MCINTIRE RD 2 LANE ROUNDABOUT

2008 PM

Roundabout

Vehicle Movements

Mov No	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (ft)	Prop. Queued	Eff. Stop Rate	Aver Speed (mph)
South Leg										
32	L	203	1.9	1.070	59.7	LOS E	621	0.98	1.82	13.4
32	T	422	1.9	1.070	59.7	LOS E	621	0.98	1.82	13.4
33	R	357	2.0	0.881	35.3	LOS D	293	1.00	1.36	19.6
Approach		**982**	**1.9**	**1.070**	**50.9**	**LOS D**	**621**	**0.99**	**1.65**	**15.1**
East Leg										
22	L	328	2.1	1.134	77.4	LOS E	1377	1.00	3.08	12.0
21	T	1805	2.0	1.134	70.1	LOS E	1495	1.00	3.15	12.0
23	R	401	2.0	0.356	3.5	LOS A	66	0.55	0.41	26.7
Approach		**2535**	**2.0**	**1.134**	**60.5**	**LOS E**	**1495**	**0.93**	**2.71**	**13.1**
North Leg										
42	L	376	2.2	1.150	82.9	LOS F	619	1.00	1.99	11.2
42	T	282	2.2	1.150	82.9	LOS F	619	1.00	1.99	11.2
42	R	34	2.2	1.150	82.9	LOS F	619	1.00	1.99	11.2
Approach		**692**	**2.2**	**1.149**	**82.9**	**LOS F**	**619**	**1.00**	**1.99**	**11.2**
West Leg										
12	L	59	1.7	1.255	128.6	LOS F	1829	1.00	4.09	8.6
11	T	1943	2.0	1.246	121.4	LOS F	2054	1.00	4.23	8.4
13	R	247	2.0	0.220	3.7	LOS A	36	0.52	0.43	26.8
Approach		**2249**	**2.0**	**1.246**	**108.7**	**LOS F**	**2054**	**0.95**	**3.81**	**9.1**
All Vehicles		**6458**	**2.0**	**1.255**	**78.2**	**LOS E**	**2054**	**0.95**	**2.85**	**11.4**

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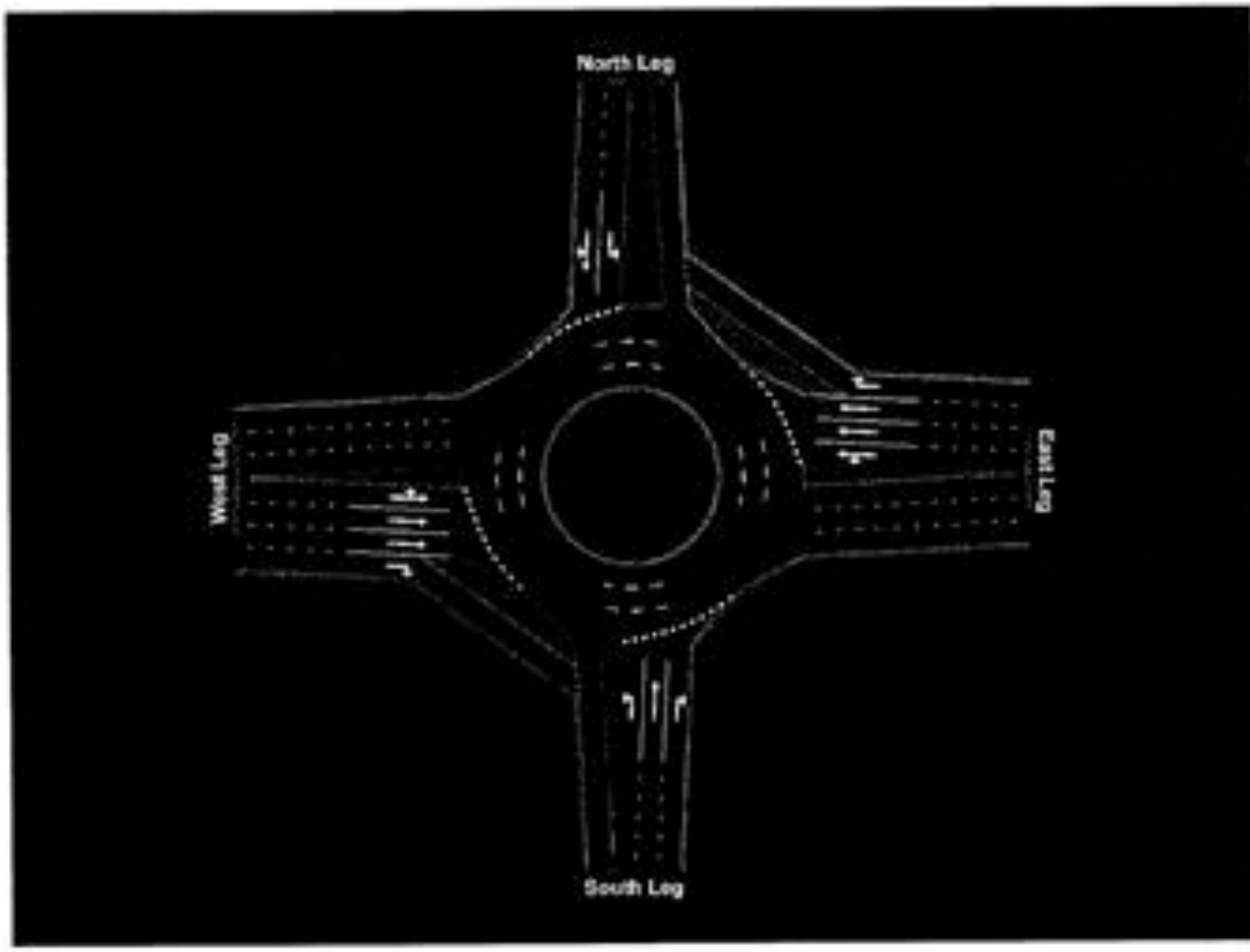
ROUNDABOUT ANALYSIS
YEAR 2008

3 Circulating Lanes

3 Lane Roundabout



Movement Summary

MCINTIRE RD 3 LANE ROUNDABOUT

2008 AM

Roundabout

Vehicle Movements

Mov No	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (ft)	Prop. Queued	Eff. Stop Rate	Aver Speed (mph)
South Leg										
32	L	228	2.1	0.796	28.4	LOS C	204	0.97	1.27	19.0
32	T	305	2.1	0.796	28.4	LOS C	204	0.97	1.27	19.0
33	R	319	1.9	0.812	29.1	LOS C	221	0.99	1.26	21.5
Approach		**853**	**2.0**	**0.812**	**28.6**	**LOS C**	**221**	**0.98**	**1.27**	**19.8**
East Leg										
22	L	362	1.9	0.558	10.0	LOS A	112	0.66	0.79	24.6
21	T	1496	2.0	0.557	3.1	LOS A	118	0.65	0.40	26.7
23	R	396	2.0	0.274	3.1	LOS A	49	0.44	0.36	27.0
Approach		**2254**	**2.0**	**0.557**	**4.2**	**LOS A**	**118**	**0.62**	**0.46**	**26.3**
North Leg										
42	L	444	2.0	0.929	24.0	LOS C	272	0.95	1.35	20.2
42	T	366	2.0	0.929	24.0	LOS C	272	0.95	1.35	20.2
42	R	28	2.0	0.929	24.0	LOS C	272	0.95	1.35	20.2
Approach		**839**	**2.0**	**0.929**	**24.0**	**LOS C**	**272**	**0.95**	**1.35**	**20.2**
West Leg										
12	L	20	4.8	0.778	17.5	LOS B	223	0.93	1.20	22.4
11	T	1786	2.0	0.785	10.3	LOS B	262	0.94	1.18	24.6
13	R	247	2.0	0.203	4.6	LOS A	42	0.66	0.52	26.3
Approach		**2055**	**2.0**	**0.785**	**9.7**	**LOS A**	**262**	**0.91**	**1.10**	**24.8**
All Vehicles		**6001**	**2.0**	**0.929**	**12.3**	**LOS B**	**272**	**0.81**	**0.92**	**23.7**

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Movement Summary

MCINTIRE RD 3 LANE ROUNDABOUT

2008 PM

Roundabout

Vehicle Movements

Mov No	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (ft)	Prop. Queued	Eff. Stop Rate	Aver Speed (mph)
South Leg										
32	L	203	1.9	1.122	73.2	LOS E	718	0.98	2.00	11.9
32	T	422	1.9	1.122	73.2	LOS E	718	0.98	2.00	11.9
33	R	357	2.0	0.922	43.0	LOS D	317	1.00	1.45	17.7
Approach		**982**	**1.9**	**1.123**	**62.2**	**LOS E**	**718**	**0.99**	**1.80**	**13.5**
East Leg										
22	L	328	2.1	0.676	11.4	LOS B	166	0.77	0.94	24.3
21	T	1805	2.0	0.675	4.4	LOS A	177	0.77	0.60	26.3
23	R	401	2.0	0.297	3.5	LOS A	58	0.53	0.40	26.7
Approach		**2535**	**2.0**	**0.675**	**5.2**	**LOS A**	**177**	**0.73**	**0.61**	**26.0**
North Leg										
42	L	376	2.2	0.926	29.2	LOS C	248	0.97	1.36	18.9
42	T	282	2.2	0.926	29.2	LOS C	248	0.97	1.36	18.9
42	R	34	2.2	0.926	29.2	LOS C	248	0.97	1.36	18.9
Approach		**692**	**2.2**	**0.926**	**29.2**	**LOS C**	**248**	**0.97**	**1.36**	**18.9**
West Leg										
12	L	59	1.7	0.766	15.5	LOS B	218	0.90	1.15	23.1
11	T	1943	2.0	0.768	8.3	LOS A	246	0.90	1.10	25.5
13	R	247	2.0	0.185	3.9	LOS A	34	0.55	0.45	26.6
Approach		**2249**	**2.0**	**0.768**	**8.0**	**LOS A**	**246**	**0.86**	**1.03**	**25.5**
All Vehicles		**6458**	**2.0**	**1.122**	**17.4**	**LOS B**	**718**	**0.84**	**1.02**	**21.9**

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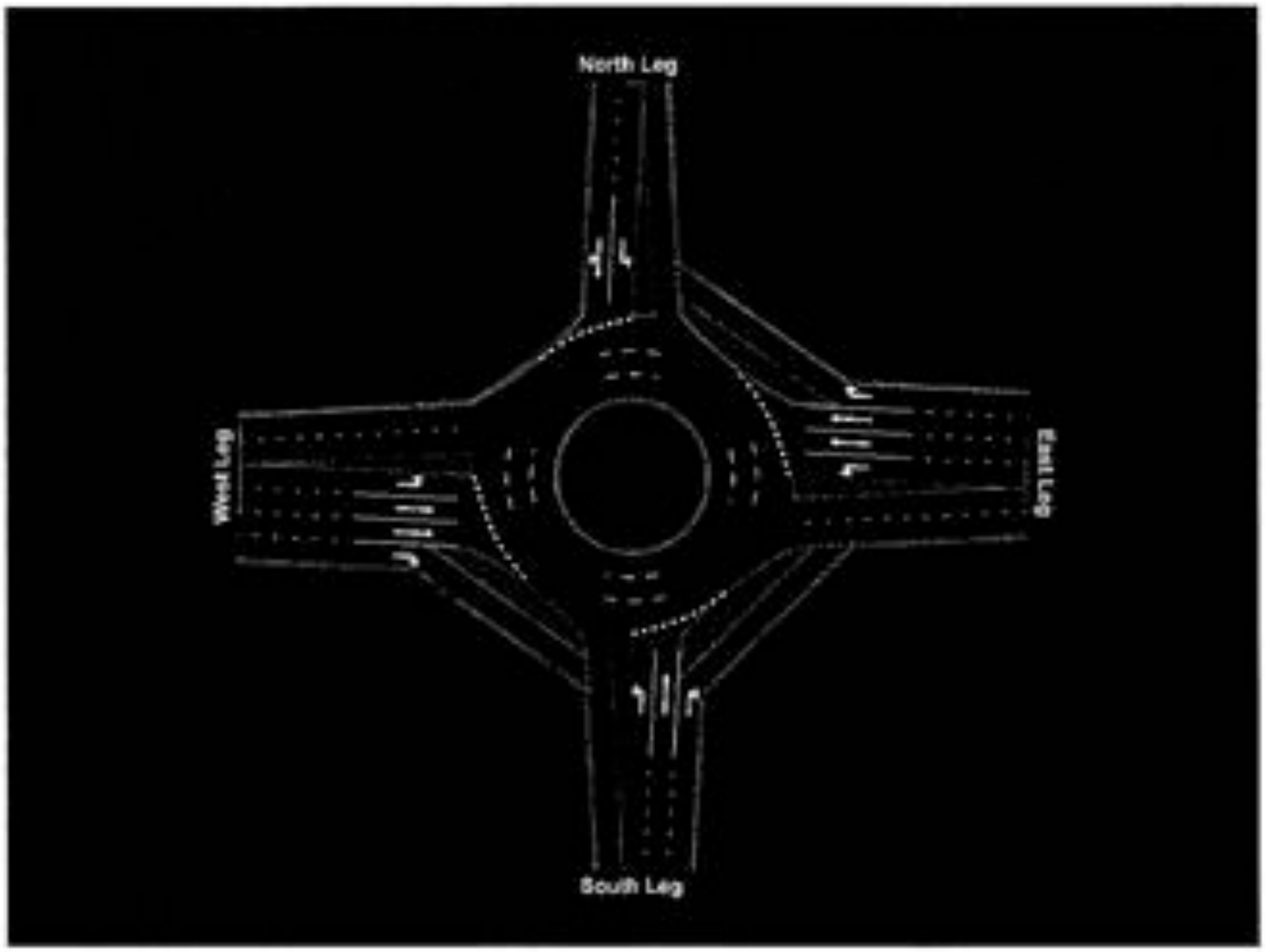
ROUNDABOUT ANALYSIS
YEAR 2008

2-3 Lane Hybrid

3 Lane Hybrid Roundabout



Movement Summary

MCINTIRE RD 2/3 LANE HYBRID ROUNDABOUT

2008 AM

Roundabout

Vehicle Movements

Mov No	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (ft)	Prop. Queued	Eff. Stop Rate	Aver Speed (mph)
South Leg										
32	L	228	2.1	0.937	59.6	LOS E	353	1.00	1.59	13.5
32	T	305	2.1	0.937	59.6	LOS E	353	1.00	1.59	13.5
33	R	319	1.9	0.979	68.9	LOS E	425	1.00	1.61	13.3
Approach		**853**	**2.0**	**0.978**	**63.0**	**LOS E**	**425**	**1.00**	**1.59**	**13.5**
East Leg										
22	L	362	1.9	0.378	9.4	LOS A	59	0.58	0.71	24.7
21	T	1496	2.0	0.653	3.6	LOS A	159	0.71	0.48	26.5
23	R	396	2.0	0.274	3.1	LOS A	50	0.44	0.36	27.0
Approach		**2254**	**2.0**	**0.653**	**4.4**	**LOS A**	**159**	**0.64**	**0.50**	**26.2**
North Leg										
42	L	444	2.0	1.021	39.4	LOS D	435	0.98	1.62	16.7
42	T	366	2.0	1.021	39.4	LOS D	435	0.98	1.62	16.7
42	R	28	2.0	1.021	39.4	LOS D	435	0.98	1.62	16.7
Approach		**839**	**2.0**	**1.021**	**39.4**	**LOS D**	**435**	**0.98**	**1.62**	**16.7**
West Leg										
12	L	20	4.8	0.031	10.8	LOS B	5	0.68	0.76	24.5
11	T	1786	2.0	1.117	69.5	LOS E	1319	1.00	3.03	12.1
13	R	247	2.0	0.202	4.5	LOS A	42	0.66	0.52	26.3
Approach		**2055**	**2.0**	**1.117**	**61.1**	**LOS E**	**1319**	**0.96**	**2.70**	**13.0**
All Vehicles		**6001**	**2.0**	**1.117**	**37.1**	**LOS D**	**1319**	**0.85**	**1.57**	**16.8**

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Movement Summary

MCINTIRE RD 3 LANE HYBRID ROUNDABOUT

2008 PM

Roundabout

Vehicle Movements

Mov No	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (ft)	Prop. Queued	Eff. Stop Rate	Aver Speed (mph)
South Leg										
32	L	203	1.9	1.513	209.2	LOS F	1487	1.00	2.74	5.6
32	T	422	1.9	1.513	209.2	LOS F	1487	1.00	2.74	5.6
33	R	357	2.0	1.275	176.6	LOS F	973	1.00	2.30	6.5
Approach		**982**	**1.9**	**1.514**	**197.3**	**LOS F**	**1487**	**1.00**	**2.58**	**5.9**
East Leg										
22	L	328	2.1	0.360	9.6	LOS A	56	0.57	0.72	24.7
21	T	1805	2.0	0.784	5.1	LOS A	252	0.82	0.72	26.1
23	R	401	2.0	0.278	3.2	LOS A	49	0.44	0.36	27.0
Approach		**2535**	**2.0**	**0.784**	**5.4**	**LOS A**	**252**	**0.73**	**0.67**	**26.0**
North Leg										
42	L	376	2.2	1.075	62.9	LOS E	485	1.00	1.81	13.2
42	T	282	2.2	1.075	62.9	LOS E	485	1.00	1.81	13.2
42	R	34	2.2	1.075	62.9	LOS E	485	1.00	1.81	13.2
Approach		**692**	**2.2**	**1.074**	**62.9**	**LOS E**	**485**	**1.00**	**1.81**	**13.2**
West Leg										
12	L	59	1.7	0.081	10.4	LOS B	12	0.63	0.78	24.6
11	T	1943	2.0	1.065	46.7	LOS D	1078	1.00	2.54	15.0
13	R	247	2.0	0.183	3.9	LOS A	32	0.53	0.44	26.7
Approach		**2249**	**2.0**	**1.065**	**41.1**	**LOS D**	**1078**	**0.94**	**2.26**	**16.0**
All Vehicles		**6458**	**2.0**	**1.513**	**53.2**	**LOS D**	**1487**	**0.87**	**1.63**	**14.1**

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