Memorandum

To: Mr. Michael Thompson

From: Michael J. Labadie, PE and Jill M. Bauer, PE, PTOE

Date: January 20, 2022

RE: Response to MDOT Review of the Bebb Oak Meadows Traffic Study

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The following are our responses to the review comments received from Michigan Department of Transportation (MDOT) January 17, 2022.

- Table 2 - Although it was mentioned by MDOT in previous meeting held in September, the trip generation still includes internal capture reductions Further review of TIS has not been conducted, please provide revised TIS and Synchro models with updated information for further review.

Included as an attachment to the TIS (appendix F) and attached to this memo is an analysis of the study intersections using trip generation without internal capture. This scenario also reviewed the site with only one driveway. A comparison of the results is included for each intersection. The Synchro models have been provided and have been included in this submittal.

- Synchro models does not incorporate "No Turn on Red" for right turn lanes for both Rochester Road and Auburn Road. Please make appropriate changes and provide revised models to review.

The future conditions scenario model for the above discussed scenario were edited to reflect "No Turn on Red" for Rochester Road and Auburn Road. Below is a table comparing the results. These Synchro files have been included with this submittal.

Intersection	Control Type	Approach	LOS Results - with RTOR			LOS Results - No RTOR			Difference					
			AM Peak	PM Peak	Sat. Peak	AM Peak	PM Peak	Sat. Peak	AM Peak		PM Peak		Sat. Peak	
Rochester Road (M-150) & Auburn Road	Signalized	Eastbound	E 76.9	E 72.7	E 62.1	E 77.1	E 72.7	E 63.7	-	0.2	-	0.0	-	1.6
		Westbound	E 73.2	E 77.3	E 66.1	E 72.6	E 77.4	E 67.4	-	-0.6	-	0.1	-	1.3
		Northbound	C 29.9	C 22.6	E 62.1	C 29.9	C 22.5	E 62.1	-	0.0	-	-0.1	-	0.0
		Southbound	C 34.9	E 75.5	D 50.7	D 35.1	E 75.5	D 50.7	C to D	0.2	-	0.0	-	0.0
		Overall	**D 43.4**	**E 57.0**	**E 58.5**	**D 43.5**	**E 57.0**	**E 59.0**	**-**	**0.1**	**-**	**0.0**	**-**	**0.5**

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September 29, 2021

Mr. Michael Thompson
Stucky Vitale Architects
27172 Woodward Avenue
Royal Oak, MI 48067

RE: Addendum to the Traffic Impact Study for Proposed Bebb Oak Development in Rochester Hills, MI

Dear Mr. Thompson:

ROWE Professional Services Company completed a Traffic Impact Study (TIS) related to a proposed mixed-use development located at 2800 South Rochester Road (M-150) in the City of Rochester Hills, MI. Comments received from the Michigan Department of Transportation (MDOT), the City of Rochester Hills, and their consultants have requested additional analyses to be included with the previously completed TIS. The following items/comments have been addressed:

- Trip Generation should be revised, and the revised trip generation should not include internal capture trips
    - As described in the TIS, internal capture can be included in mixed-use developments similar to this proposed site. However, this analysis removed the internal capture at the request of the reviewing agencies.
- The revised future scenario should model a single, full access driveway
    - The analyses in this addendum included a single, full access driveway. The TIS included two driveways – one with full movements, one with right in/right out operations
- Include Non-motorized considerations
    - Non-motorized trip generation and impacts are discussed in this addendum

Trip Generation

Using the information and methodologies specified in the latest version of Trip Generation (Trip Generation Manual, 10th Edition, 2017), ROWE forecast the weekday AM and PM peak hour trips associated with the proposed development. At the request of the reviewing agencies and their consultants, the trip generation for the proposed "Restaurant with Drive Through" was calculated using a mix of two land uses. The proposed site will operate like a Fast Casual restaurant with Drive Through. The latest version of Trip Generation does not have a land use for a Fast Casual Restaurant with Drive Through. The land use for Fast Casual (LUC 930) has limited data in the AM peak hour. To best model the trips associated with this portion of the development, the trip generation for the AM peak hour was calculated using LUC 934 Fast-Food with Drive Through Window, while the trip generation for the PM peak hour and Weekend midday peak was calculated using LUC 930 Fast Casual Restaurant. Pass-by rates for LUC 934 were used in the AM and PM peak hour, and the PM peak hour rate was used during the Weekend Midday peak.

In multi-use developments, not all the trips generated are from sources outside the boundaries of the development but are rather trips that are “internally captured” within the site. The methodology presented in the Trip Generation Handbook (Trip Generation Handbook, 3rd Edition, 2017) was followed to determine an appropriate internal capture rate for the proposed development. Accepted practice allows for the inclusion of internal capture reductions for mixed-use developments. However, these calculations were omitted in this addendum at the request of the reviewing agencies.

Not all the traffic generated by the proposed development will be new traffic added onto the adjacent roadway network. As with most new commercial development, a significant amount of the site-generated traffic is considered “pass-by” traffic. Pass-by trips are trips already present on the adjacent roadway network, which are interrupted to visit the site. Pass-by trips are accounted for by reducing the number of forecast new trips to be added to the roadway network; however, actual driveway volumes are not reduced. Pass-by trips are normally expressed as a percentage of trips generated by the new development. These pass-by rates are published in the Trip Generation Handbook.

The Trip Generation Handbook suggests a 34 percent PM pass-by rate for the Shopping Center and a 49 percent AM and 50 percent PM pass-by rate for the Fast-Food Restaurant with Drive-Through Window.

With the application of the pass-by trip factors, the site-generated trips can be classified as “pass-by” and “new” trips. The proposed development is expected to generate 185 total trips during the AM peak hour, 224 total trips during the PM peak hour, and 304 total trips during the Weekend midday peak hour. However, only 116 of the AM peak hour trips, 149 of the PM peak hour trips, and 199 of the Weekend midday peak hour trips will be new traffic not currently using the adjacent street network, whose primary purpose is to visit the new development.

The results of the trip generation forecasts are provided below in Table 1.

Table 1: Trip Generation for Proposed Development

Land Use	Land Use Code	Units	AM Peak Hour			PM Peak Hour			Sat. Midday Peak			Week Day
			In	Out	Total	In	Out	Total	In	Out	Total	
Multifamily Housing (Mid-Rise)	221	94 DU	9	25	34	25	16	41	22	24	46	511
Retail - Shopping Center	820	10,245 SF	6	4	10	48	53	101	53	49	102	1,277
Fast-Food with Drive Through Window	934	3,503 SF	72	69	141	43	39	82	82	74	156	1,650
Total	**-**	**-**	**87**	**98**	**185**	**116**	**108**	**224**	**157**	**147**	**304**	**3,438**
Pass-By Rates, LUC 820: 34% PM			-	-	-	16	18	34	14	13	27	-
Pass-By Rates, LUC 934: 49% AM; 50% PM			35	34	69	22	19	41	41	37	78	-
Total New Trips			**52**	**64**	**116**	**78**	**71**	**149**	**102**	**97**	**199**	**3,438**

Future Conditions

The results of the LOS analysis for future conditions reveals that several movements and approaches of the studied intersections would continue to operate at LOS D or better during the AM and PM peak hours, with the following exceptions:

- Rochester Road (M-150) & Auburn Road
  - LOS E
    - AM Peak Hour Movements: EBT, WBT, WBR
    - AM Peak Hour Approaches: EB, WB
    - PM Peak Hour Movements: EBT, EBR, WBT, WBR, SBT
    - PM Peak Hour Approaches: EB, WB, SB
    - PM Peak Hour Overall Intersection
    - Saturday Peak Hour Movements: EBL, EBR, WBR, NBL, SBL
    - Saturday Peak Hour Approaches: EB, WB, NB
    - Saturday Peak Hour Overall Intersection
  - LOS F
    - AM Peak Hour Movements: EBL, EBR, WBL, NBL, SBL
    - PM Peak Hour Movements: EBL, WBL, NBL, SBL
    - Saturday Peak Hour Movements: WBL, NBT, SBT
- Rochester Road (M-150) & Wabash Road/Barclay Circle
  - LOS E
    - AM Peak Hour Movements: EBL, WBL, WBL/T, WBR, NBL, SBL
    - AM Peak Hour Approaches: EB, WB
    - PM Peak Hour Movements: EBL, EBT/R, WBL, WBT/R, WBR, SBL
    - PM Peak Hour Approaches: EB, WB
    - Saturday Peak Hour Movements: NBL
  - LOS F
    - AM Peak Hour Movements: EBT/R
    - PM Peak Hour Movements: NBL
- Rochester Road (M-150) & South Site Driveway
  - LOS F
    - AM Peak Hour Movements: EBL
    - AM Peak Hour Approaches: EB
    - PM Peak Hour Movements: EBL
    - PM Peak Hour Approaches: EB
    - Saturday Peak Hour Movements: EBL
    - Saturday Peak Hour Approaches: EB

95th percentile queue lengths were reviewed at the site driveways. Queue lengths for left turning vehicles entering at the south site driveway do not exceed 65 feet (3 vehicles) in the AM peak hour, 73 feet (3 vehicles) in the PM peak hour, and 69 feet (3 vehicles) in the Saturday Midday peak hour. Queue lengths for vehicles exiting the south site driveway towards the north will not exceed 171 feet (7 vehicles) in the AM peak hour, 104 feet (4 vehicles) in the PM peak hour, and 289 feet (12 vehicles) in the Saturday Midday peak hour. Queue lengths for vehicles exiting the site driveway towards the south will not exceed 91 feet (4 vehicles) in the AM peak hour, 81 feet (3 vehicles) in the PM peak hour, and 333 feet (13 vehicles) in the Saturday Midday peak hour.

The following observations were made, and improvements were recommended, if applicable, at the following intersections due to future traffic conditions:

- Rochester Road (M-150) & Auburn Road
  - Southbound Rochester Road (M-150) operates at poor LOS due to the lack of progression caused by the split signal phasing at Rochester Road (M-150) & Wabash Road/Barclay Circle. It is understood that improvements are planned for this intersection which will result in the removal of this split phasing, cycle length optimization, and coordination with the Rochester Road (M-150) corridor and will improve intersection operations.
- Rochester Road (M-150) & Wabash Road/Barclay Circle
  - This signal currently operates with split signal phasing for Wabash Road and Barclay Circle. It is understood that improvements are planned for this intersection which will result in the removal of this split phasing, cycle length optimization, and coordination with the Rochester Road (M-150) corridor and will improve intersection operations.

The operational results for future conditions are presented in Table 2.

Table 2: LOS Analysis for Future Conditions

Intersection	Control Type	Approach	LOS Results							Change from Previous Study					
			AM Peak		PM Peak		Sat. Peak			AM Peak		PM Peak		Sat. Peak	
Rochester Road (M-150) & Auburn Road	Signalized	Eastbound	E	76.9	E	72.7	E	62.1	-	-	-	+0.5	-	+1.0
		Westbound	E	73.2	E	77.3	E	66.1	-	+0.1	-	+0.6	-	+1.3
		Northbound	C	29.9	C	22.6	E	62.1	-	+0.1	-	+0.5	D to E	+7.5
		Southbound	C	34.9	E	75.5	D	50.7	-	+0.2	-	+2.8	C to D	+17.0
		Overall	**D**	**43.4**	**E**	**57.0**	**E**	**58.5**	**-**	**+0.1**	**-**	**+1.3**	**D to E**	**+9.0**
Rochester Road (M-150) & Wabash Road/Barclay Circle	Signalized	Eastbound	E	79.5	E	64.6	D	47.2	-	-	-	-	-	-
		Westbound	E	63.3	E	63.9	D	46.1	-	-	-	+0.5	-	+0.4
		Northbound	B	15.7	B	16.4	C	29.9	-	+0.1	-	+0.7	-	+0.2
		Southbound	C	23.4	C	29.1	C	26.6	-	-	-	+0.3	-	+0.7
		Overall	**C**	**26.5**	**C**	**30.2**	**C**		**-**	**-**	**-**	**+0.4**	**-**	**+0.5**
Rochester Road (M-150) & South Site Driveway	Stop	Eastbound	F	76.1	E	68.7	F		-	+6.0	-	+19.1	-	+59.7
	Free	Northbound	A	0.7	A	0.7	A	1.1	-	-	-	+0.3	-	+0.6
		Southbound	A	0.0	A	0.0	A	0.0	-	-	-	-	-	-
	TWSC	**Overall**	**A**	**3.8**	**A**	**2.9**	**A**	**7.8**	**-**	**+2.1**	**-**	**+2.0**	**-**	**+5.9**

XX.X Average seconds of delay per vehicle

Turn Lane, Passing Lane, and Taper Warrants

An evaluation was performed in accordance with MDOT requirements to determine if right turn deceleration lanes are required at the site driveways. The results of the analysis indicated that a right turn taper is warranted at the south site driveway. All turn lane warrant charts are attached to this memorandum.

The results of the analysis are presented in Table 3.

Table 3: Turn Lane Warrants

Intersection	Movement	Result
Rochester Road (M-150) & South Site Driveway	NB LT	Existing Two-Way Left Turn Lane
	SB RT	Turn Lane Warranted

Non-motorized Impacts

Reviewing pedestrian data from latest version of the Trip Generation Manual, shows that this proposed development will generate an additional two pedestrians in the AM peak hour and three additional pedestrians in the PM peak hour. The reviewing agencies expressed concern for non-motorized traffic at the intersection of Rochester Road (M-150) and Wabash Road/Barclay Circle, due to the lack of a pedestrian crossing on the south side of the intersection (running parallel to EB traffic). There are existing pedestrian signals on all other approaches of this signal. The addition of a pedestrian signal on the south side of the intersection would have a significant negative impact on the operations of the signal, given the significant number of WB to SB left turning vehicles.

Conclusions and Recommendations

The proposed project consists of 94 units of multifamily residential, 10,245 square feet of retail, and 3,503 square feet of fast-food restaurant with a drive-through with a build-out year of approximately 2022. The proposed development will have access to Rochester Road (M-150) via one existing driveway. The existing north driveway was removed at the request of MDOT, the City of Rochester Hills, and their consultants. The eastbound approach of the south site driveway will be widened to allow for a dedicated left turn lane and a dedicated right turn lane, which would replace the existing shared left/right turn lane. A Southbound right turn lane would be warranted with the removal of the north driveway.

The previously completed TIA was completed with the inclusion of internal capture reductions, in accordance with accepted practice for estimating the trip generation of a mixed-use development. MDOT, the City of Rochester Hills, and their consultants have requested that internal capture reductions should not be included in this analysis.

With the revised trip generation calculations requested by MDOT, the City of Rochester Hills, and their consultants, the proposed site is forecast to generate 116 new trips during the AM peak hour (52 inbound and 64 outbound from the site), 149 new trips during the PM peak hour (78 inbound and 71 outbound from the site), and 197 new trips during Saturday peak hour (102 inbound and 97 outbound from the site).

An operational analysis was performed for existing, background, and total future (build) conditions for the intersections of:

- Rochester Road (M-150) & Wabash Road/Barclay Circle
- Rochester Road (M-150) & Auburn Road
- Rochester Road (M-150) & South Site Driveway

The operational analysis indicated that several movements and approaches of the study intersections would operate at acceptable levels during the AM, PM, and Saturday peak hours. While several movements and approaches operate at typically unacceptable levels in all of the studied peak hours, these are existing conditions and require analysis of the entire Rochester Road (M-150) corridor to optimize the signal cycle length, splits, and coordination, which it outside the scope of this study. The addition of traffic from the proposed development does not significantly impact the operations of the studied intersections.

The signal at the intersection of Rochester Road (M-150) & Wabash Road/Barclay Circle currently operates with split signal phasing for Wabash Road and Barclay Circle. Removal of this split phasing, cycle length optimization, and coordination with the Rochester Road (M-150) corridor will improve operations at this intersection, will improve progression and gaps in traffic along southbound Rochester Road (M-150) for vehicles exiting the site driveways and will improve operations for the southbound approach at the intersection of Rochester Road (M-150) & Auburn Road.

We hope that this report meets your needs. If you have any questions, please feel free to contact us at your convenience.

Sincerely,
ROWE Professional Services Company

Michael J. Labadie, PE
Senior Project Manager

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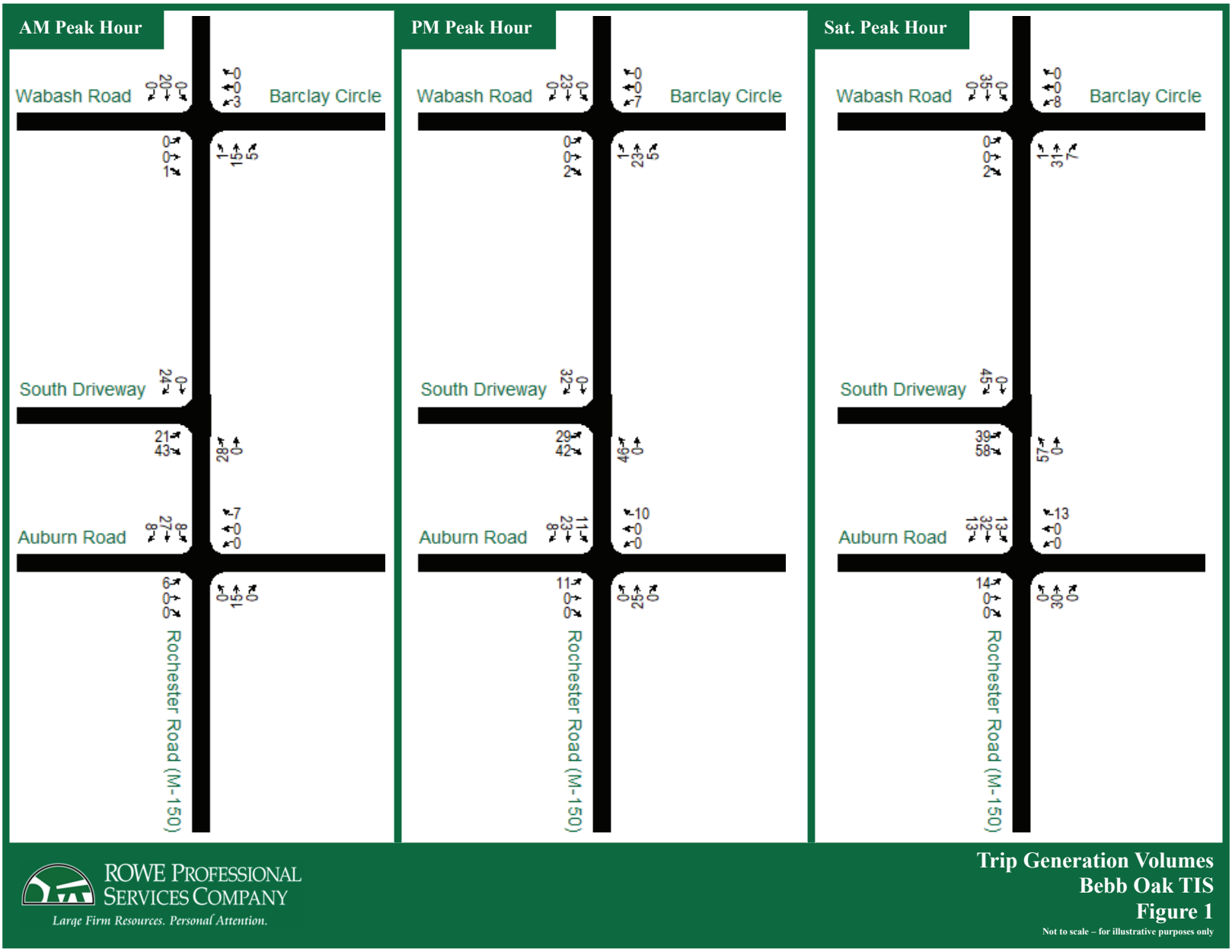

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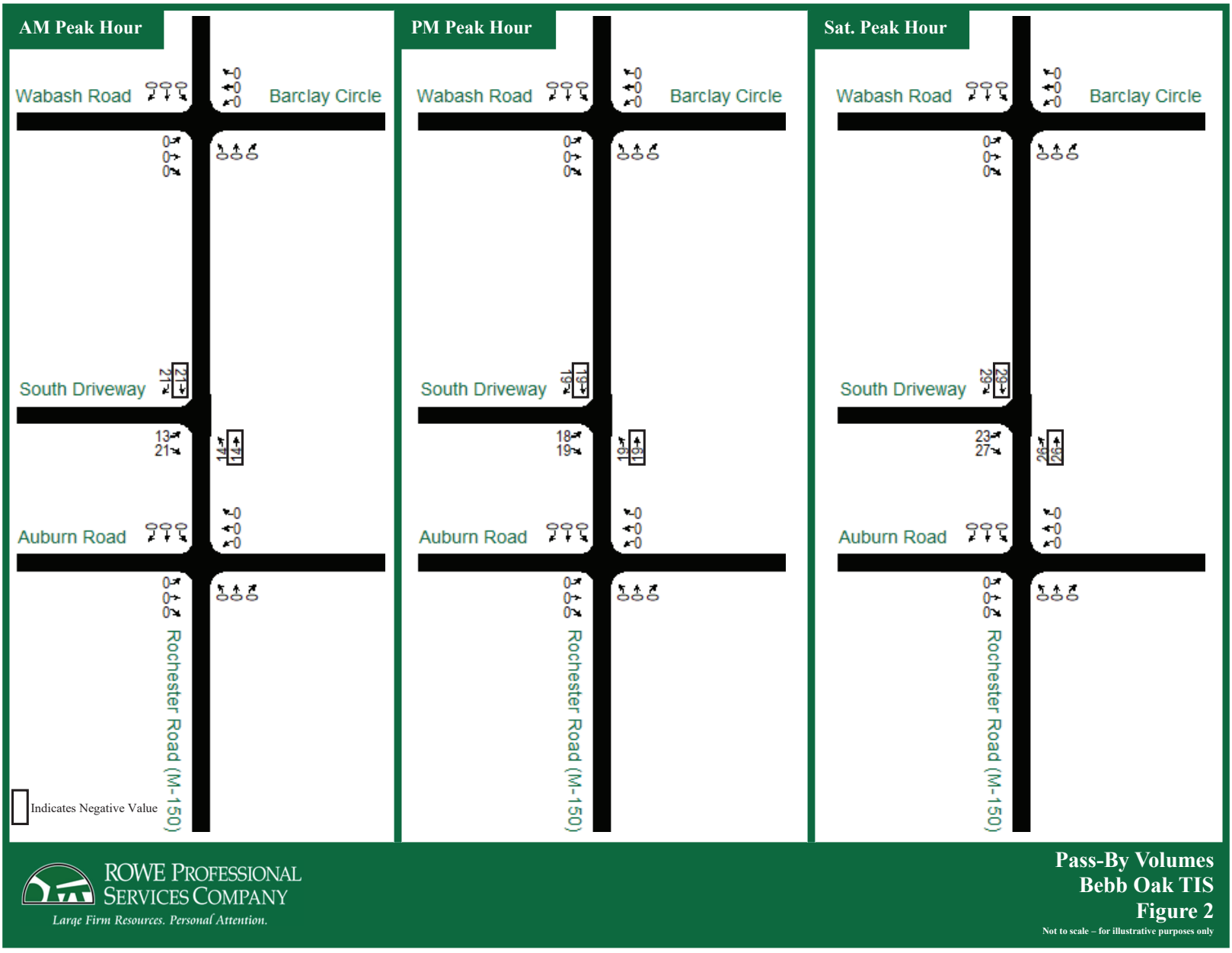
Trip Generation Volumes
Bebb Oak TIS
Figure 1
Not to scale – for illustrative purposes only



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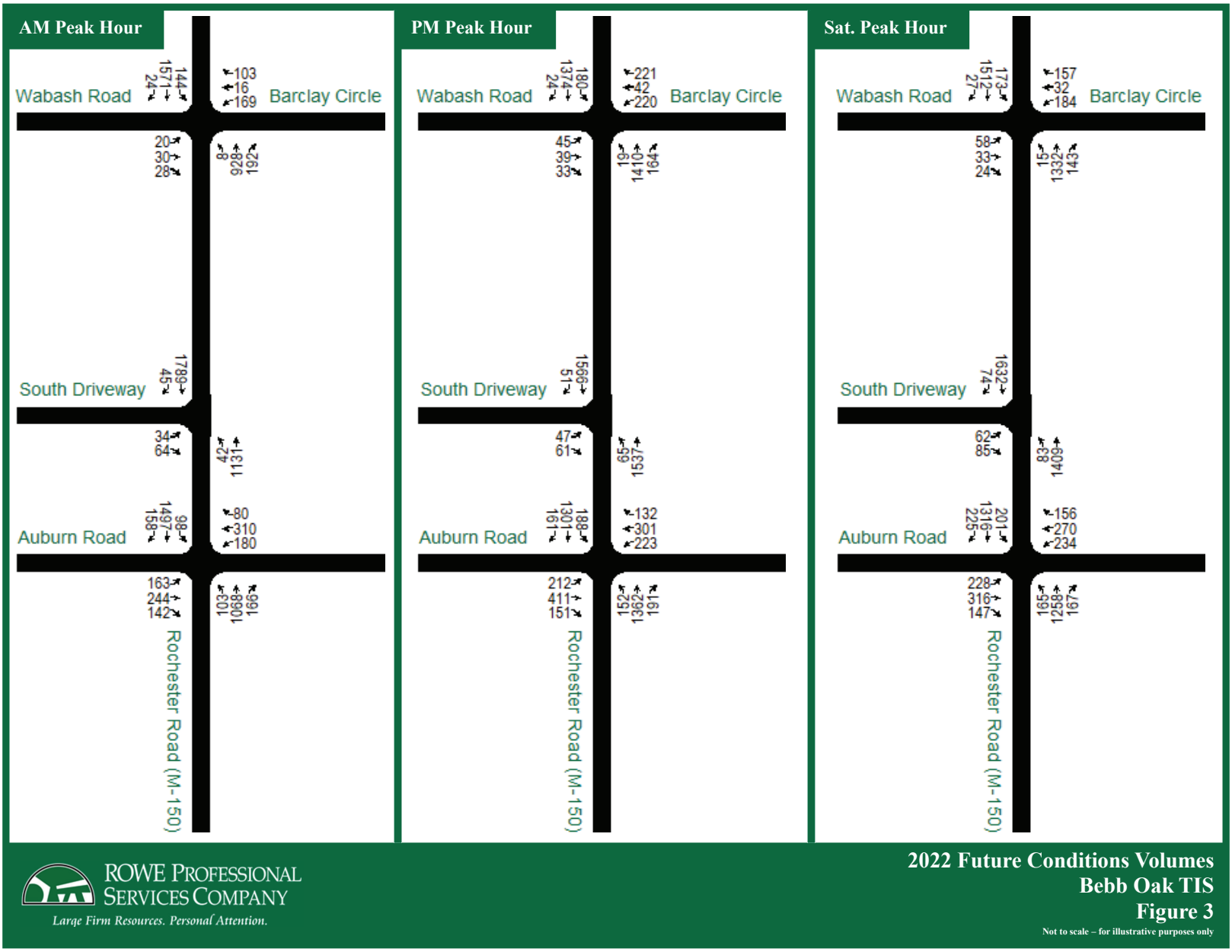
Pass-By Volumes
Bebb Oak TIS
Figure 2
Not to scale – for illustrative purposes only



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2022 Future Conditions Volumes
Bebb Oak TIS
Figure 3
Not to scale – for illustrative purposes only

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	163	244	142	180	310	80	103	1068	166	98	1497	158
Future Volume (veh/h)	163	244	142	180	310	80	103	1068	166	98	1497	158
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	1953	1953	1953	1953	1953	1953	1953	1953	1953	1969	1969	1969
Adj Flow Rate, veh/h	183	274	157	191	330	73	129	1335	199	103	1576	160
Peak Hour Factor	0.89	0.89	0.89	0.94	0.94	0.94	0.80	0.80	0.80	0.95	0.95	0.95
Percent Heavy Veh, %	3	3	3	3	3	3	3	3	3	2	2	2
Cap, veh/h	209	407	182	217	423	188	112	1949	869	113	1965	876
Arrive On Green	0.11	0.11	0.11	0.12	0.11	0.11	0.08	0.70	0.70	0.06	0.53	0.53
Sat Flow, veh/h	1860	3711	1655	1860	3711	1655	1860	3711	1655	1875	3741	1668
Grp Volume(v), veh/h	183	274	157	191	330	73	129	1335	199	103	1576	160
Grp Sat Flow(s),veh/h/ln	1860	1856	1655	1860	1856	1655	1860	1856	1655	1875	1870	1668
Q Serve(g_s), s	13.6	9.9	13.1	14.2	12.1	5.7	8.4	29.1	6.0	7.6	48.4	7.0
Cycle Q Clear(g_c), s	13.6	9.9	13.1	14.2	12.1	5.7	8.4	29.1	6.0	7.6	48.4	7.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	209	407	182	217	423	188	112	1949	869	113	1965	876
V/C Ratio(X)	0.88	0.67	0.86	0.88	0.78	0.39	1.16	0.68	0.23	0.92	0.80	0.18
Avail Cap(c_a), veh/h	258	435	194	258	435	194	112	1949	869	113	1965	876
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.33	1.33	1.33	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	61.2	59.9	61.3	60.9	60.3	57.5	64.4	14.4	10.9	65.4	27.3	17.4
Incr Delay (d2), s/veh	23.4	3.7	29.8	25.0	8.7	1.3	133.1	2.0	0.6	59.0	3.6	0.5
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	7.6	4.8	6.9	8.1	6.1	2.4	7.9	9.1	2.2	5.4	21.0	2.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	84.6	63.6	91.1	85.9	69.0	58.8	197.5	16.4	11.5	124.4	30.8	17.9
LnGrp LOS	F	E	F	F	E	E	F	B	B	F	C	B
Approach Vol, veh/h		614			594			1663			1839	
Approach Delay, s/veh		76.9			73.2			29.9			34.9	
Approach LOS		E			E			C			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.0	80.1	22.3	22.5	15.0	80.1	22.9	22.0
Change Period (Y+Rc), s	* 6.6	* 6.6	* 6.6	* 6.6	* 6.6	* 6.6	* 6.6	* 6.6
Max Green Setting (Gmax), s	* 8.4	* 69	* 19	* 16	* 8.4	* 69	* 19	* 16
Max Q Clear Time (g_c+I1), s	9.6	31.1	15.6	14.1	10.4	50.4	16.2	15.1
Green Ext Time (p_c), s	0.0	12.6	0.2	0.5	0.0	11.1	0.1	0.3

Intersection Summary	
HCM 6th Ctrl Delay	43.4
HCM 6th LOS	D

Notes

User approved pedestrian interval to be less than phase max green.

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	20	30	28	169	16	103	8	928	192	144	1571	24
Future Volume (vph)	20	30	28	169	16	103	8	928	192	144	1571	24
Ideal Flow (vphpl)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Total Lost time (s)	6.8	6.8		6.3	6.3	6.3	6.7	6.7	6.7	6.7	6.7	
Lane Util. Factor	1.00	1.00		0.95	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.93		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00		0.95	0.96	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1863	1818		1787	1807	1683	1845	3689	1650	1845	3681	
Flt Permitted	0.95	1.00		0.95	0.96	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1863	1818		1787	1807	1683	1845	3689	1650	1845	3681	
Peak-hour factor, PHF	0.60	0.60	0.60	0.80	0.80	0.80	0.85	0.85	0.85	0.92	0.92	0.92
Adj. Flow (vph)	33	50	47	211	20	129	9	1092	226	157	1708	26
RTOR Reduction (vph)	0	25	0	0	0	116	0	0	70	0	0	0
Lane Group Flow (vph)	33	72	0	116	115	13	9	1092	156	157	1734	0
Heavy Vehicles (%)	2%	2%	2%	1%	1%	1%	3%	3%	3%	3%	3%	3%
Turn Type	Split	NA		Split	NA	Perm	Prot	NA	Perm	Prot	NA	
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases						4			2			
Actuated Green, G (s)	8.0	8.0		14.4	14.4	14.4	1.5	74.3	74.3	16.8	89.6	
Effective Green, g (s)	8.0	8.0		14.4	14.4	14.4	1.5	74.3	74.3	16.8	89.6	
Actuated g/C Ratio	0.06	0.06		0.10	0.10	0.10	0.01	0.53	0.53	0.12	0.64	
Clearance Time (s)	6.8	6.8		6.3	6.3	6.3	6.7	6.7	6.7	6.7	6.7	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	106	103		183	185	173	19	1957	875	221	2355	
v/s Ratio Prot	0.02	c0.04		c0.06	0.06		0.00	0.30		c0.09	c0.47	
v/s Ratio Perm						0.01			0.09			
v/c Ratio	0.31	0.70		0.63	0.62	0.08	0.47	0.56	0.18	0.71	0.74	
Uniform Delay, d1	63.4	64.8		60.3	60.2	56.8	68.9	21.9	17.0	59.3	17.2	
Progression Factor	1.00	1.00		1.00	1.00	1.00	0.94	0.70	0.61	1.00	1.00	
Incremental Delay, d2	1.7	19.6		7.0	6.3	0.2	14.8	1.0	0.4	10.3	2.1	
Delay (s)	65.0	84.4		67.3	66.5	57.0	79.6	16.2	10.7	69.5	19.2	
Level of Service	E	F		E	E	E	E	B	B	E	B	
Approach Delay (s)		79.5			63.3			15.7			23.4	
Approach LOS		E			E			B			C	

Intersection Summary			
HCM 2000 Control Delay	26.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	26.5
Intersection Capacity Utilization	74.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	3.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	34	64	42	1131	1789	45
Future Vol, veh/h	34	64	42	1131	1789	45
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	0	50	-	-	100
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	84	84	93	93
Heavy Vehicles, %	0	0	4	4	2	2
Mvmt Flow	57	107	50	1346	1924	48

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2697	962	1972	0	-	0
Stage 1	1924	-	-	-	-	-
Stage 2	773	-	-	-	-	-
Critical Hdwy	6.8	6.9	4.18	-	-	-
Critical Hdwy Stg 1	5.8	-	-	-	-	-
Critical Hdwy Stg 2	5.8	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.24	-	-	-
Pot Cap-1 Maneuver	~ 18	260	283	-	-	-
Stage 1	102	-	-	-	-	-
Stage 2	421	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 15	260	283	-	-	-
Mov Cap-2 Maneuver	68	-	-	-	-	-
Stage 1	84	-	-	-	-	-
Stage 2	421	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	76.1	0.7	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	283	-	68	260	-	-
HCM Lane V/C Ratio	0.177	-	0.833	0.41	-	-
HCM Control Delay (s)	20.4	-	166.2	28.2	-	-
HCM Lane LOS	C	-	F	D	-	-
HCM 95th %tile Q(veh)	0.6	-	4	1.9	-	-

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

Intersection: 1: M-150 & Auburn /Auburn

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	189	326	257	159	297	238	210	76	219	341	362	200
Average Queue (ft)	124	138	92	70	158	138	105	28	129	195	194	69
95th Queue (ft)	194	237	191	130	257	209	183	62	220	322	321	197
Link Distance (ft)		792	792			597	597			378	378	
Upstream Blk Time (%)										1	1	
Queuing Penalty (veh)										6	5	
Storage Bay Dist (ft)	110			135	430			155	160			175
Storage Blk Time (%)	24	20	1	2			2		11	11	9	0
Queuing Penalty (veh)	29	33	2	2			2		63	13	17	0

Intersection: 1: M-150 & Auburn /Auburn

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	214	552	547	385
Average Queue (ft)	128	324	326	84
95th Queue (ft)	226	505	502	296
Link Distance (ft)		490	490	
Upstream Blk Time (%)		2	2	
Queuing Penalty (veh)		16	17	
Storage Bay Dist (ft)	170			260
Storage Blk Time (%)	4	30	19	
Queuing Penalty (veh)	33	29	30	

Intersection: 2: M-150 & Wabash /Barclay

Movement	EB	EB	WB	WB	WB	NB	NB	NB	NB	SB	SB	SB
Directions Served	L	TR	L	LT	R	L	T	T	R	L	T	TR
Maximum Queue (ft)	73	181	172	154	84	33	311	318	212	195	474	452
Average Queue (ft)	23	55	94	57	25	4	159	167	53	132	255	213
95th Queue (ft)	61	125	157	129	59	18	266	274	148	222	459	392
Link Distance (ft)		586	359	359			524	524			445	445
Upstream Blk Time (%)											2	1
Queuing Penalty (veh)											0	0
Storage Bay Dist (ft)	200				180	175			175	170		
Storage Blk Time (%)		0		0			8	8		7	9	
Queuing Penalty (veh)		0		0			1	17		53	13	

Intersection: 4: M-150 & South Driveway

Movement	EB	EB	NB	NB	NB	SB
Directions Served	L	R	L	T	T	R
Maximum Queue (ft)	198	140	70	117	56	17
Average Queue (ft)	59	35	29	11	5	1
95th Queue (ft)	171	91	65	67	44	7
Link Distance (ft)	251	251		437	437	
Upstream Blk Time (%)	1					
Queuing Penalty (veh)	0					
Storage Bay Dist (ft)			50			100
Storage Blk Time (%)			10	0		
Queuing Penalty (veh)			63	0		

Zone Summary

Zone wide Queuing Penalty: 443

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	212	411	151	223	301	132	152	1362	191	188	1301	161
Future Volume (veh/h)	212	411	151	223	301	132	152	1362	191	188	1301	161
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	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984
Adj Flow Rate, veh/h	233	452	164	275	372	156	162	1449	197	202	1399	170
Peak Hour Factor	0.91	0.91	0.91	0.81	0.81	0.81	0.94	0.94	0.94	0.93	0.93	0.93
Percent Heavy Veh, %	1	1	1	1	1	1	1	1	1	1	1	1
Cap, veh/h	258	534	238	275	569	254	167	1642	733	167	1642	733
Arrive On Green	0.14	0.14	0.14	0.15	0.15	0.15	0.18	0.87	0.87	0.03	0.14	0.14
Sat Flow, veh/h	1890	3770	1682	1890	3770	1682	1890	3770	1682	1890	3770	1682
Grp Volume(v), veh/h	233	452	164	275	372	156	162	1449	197	202	1399	170
Grp Sat Flow(s),veh/h/ln	1890	1885	1682	1890	1885	1682	1890	1885	1682	1890	1885	1682
Q Serve(g_s), s	17.0	16.4	13.0	20.4	13.0	12.2	11.9	29.9	2.8	12.4	50.7	12.5
Cycle Q Clear(g_c), s	17.0	16.4	13.0	20.4	13.0	12.2	11.9	29.9	2.8	12.4	50.7	12.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	258	534	238	275	569	254	167	1642	733	167	1642	733
V/C Ratio(X)	0.90	0.85	0.69	1.00	0.65	0.61	0.97	0.88	0.27	1.21	0.85	0.23
Avail Cap(c_a), veh/h	275	630	281	275	630	281	167	1642	733	167	1642	733
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	0.33	0.33	0.33
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	59.5	58.6	57.2	59.8	56.0	55.6	57.4	7.0	5.3	68.0	55.5	39.2
Incr Delay (d2), s/veh	29.6	9.2	5.6	53.8	2.1	3.4	59.8	7.2	0.9	136.0	5.8	0.7
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	10.0	8.3	5.7	13.7	6.2	5.3	7.8	4.9	1.0	12.5	26.9	5.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	89.1	67.8	62.8	113.6	58.1	59.0	117.2	14.2	6.2	203.9	61.3	39.9
LnGrp LOS	F	E	E	F	E	E	F	B	A	F	E	D
Approach Vol, veh/h		849			803			1808			1771	
Approach Delay, s/veh		72.7			77.3			22.6			75.5	
Approach LOS		E			E			C			E	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	19.0	67.6	25.7	27.7	19.0	67.6	27.0	26.4
Change Period (Y+Rc), s	* 6.6	* 6.6	* 6.6	* 6.6	* 6.6	* 6.6	* 6.6	* 6.6
Max Green Setting (Gmax), s	* 12	* 57	* 20	* 23	* 12	* 57	* 20	* 23
Max Q Clear Time (g_c+I1), s	14.4	31.9	19.0	15.0	13.9	52.7	22.4	18.4
Green Ext Time (p_c), s	0.0	12.1	0.1	1.7	0.0	3.4	0.0	1.4

Intersection Summary	
HCM 6th Ctrl Delay	57.0
HCM 6th LOS	E

Notes

User approved pedestrian interval to be less than phase max green.

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	45	39	33	220	42	221	19	1410	164	180	1374	24
Future Volume (vph)	45	39	33	220	42	221	19	1410	164	180	1374	24
Ideal Flow (vphpl)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Total Lost time (s)	6.8	6.8		6.3	6.3	6.3	6.7	6.7	6.7	6.7	6.7	
Lane Util. Factor	1.00	1.00		0.95	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.93		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00		0.95	0.97	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1881	1843		1805	1837	1700	1881	3762	1683	1881	3753	
Flt Permitted	0.95	1.00		0.95	0.97	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1881	1843		1805	1837	1700	1881	3762	1683	1881	3753	
Peak-hour factor, PHF	0.68	0.68	0.68	0.85	0.85	0.85	0.95	0.95	0.95	0.93	0.93	0.93
Adj. Flow (vph)	66	57	49	259	49	260	20	1484	173	194	1477	26
RTOR Reduction (vph)	0	23	0	0	0	229	0	0	68	0	1	0
Lane Group Flow (vph)	66	83	0	153	155	31	20	1484	105	194	1502	0
Heavy Vehicles (%)	1%	1%	1%	0%	0%	0%	1%	1%	1%	1%	1%	1%
Turn Type	Split	NA		Split	NA	Perm	Prot	NA	Perm	Prot	NA	
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases						4			2			
Actuated Green, G (s)	11.6	11.6		16.5	16.5	16.5	4.7	67.6	67.6	17.8	80.7	
Effective Green, g (s)	11.6	11.6		16.5	16.5	16.5	4.7	67.6	67.6	17.8	80.7	
Actuated g/C Ratio	0.08	0.08		0.12	0.12	0.12	0.03	0.48	0.48	0.13	0.58	
Clearance Time (s)	6.8	6.8		6.3	6.3	6.3	6.7	6.7	6.7	6.7	6.7	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	155	152		212	216	200	63	1816	812	239	2163	
v/s Ratio Prot	0.04	c0.05		c0.08	0.08		0.01	c0.39		c0.10	c0.40	
v/s Ratio Perm						0.02			0.06			
v/c Ratio	0.43	0.55		0.72	0.72	0.15	0.32	0.82	0.13	0.81	0.69	
Uniform Delay, d1	61.0	61.7		59.5	59.5	55.5	66.1	30.9	20.0	59.5	20.9	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.27	0.48	0.14	1.00	1.00	
Incremental Delay, d2	1.9	4.0		11.5	10.8	0.4	1.6	2.4	0.2	18.5	1.9	
Delay (s)	62.9	65.6		71.0	70.3	55.8	85.3	17.1	2.9	78.0	22.8	
Level of Service	E	E		E	E	E	F	B	A	E	C	
Approach Delay (s)		64.6			63.9			16.4			29.1	
Approach LOS		E			E			B			C	

Intersection Summary			
HCM 2000 Control Delay	30.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	26.5
Intersection Capacity Utilization	76.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	2.9

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	47	61	65	1537	1566	51
Future Vol, veh/h	47	61	65	1537	1566	51
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	0	50	-	-	100
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	81	81	95	95	94	94
Heavy Vehicles, %	8	8	1	1	1	1
Mvmt Flow	58	75	68	1618	1666	54

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2611	833	1720	0	-	0
Stage 1	1666	-	-	-	-	-
Stage 2	945	-	-	-	-	-
Critical Hdwy	6.96	7.06	4.12	-	-	-
Critical Hdwy Stg 1	5.96	-	-	-	-	-
Critical Hdwy Stg 2	5.96	-	-	-	-	-
Follow-up Hdwy	3.58	3.38	2.21	-	-	-
Pot Cap-1 Maneuver	~ 18	300	368	-	-	-
Stage 1	131	-	-	-	-	-
Stage 2	324	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 15	300	368	-	-	-
Mov Cap-2 Maneuver	78	-	-	-	-	-
Stage 1	107	-	-	-	-	-
Stage 2	324	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	68.7	0.7	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	368	-	78	300	-	-
HCM Lane V/C Ratio	0.186	-	0.744	0.251	-	-
HCM Control Delay (s)	17	-	130.5	21	-	-
HCM Lane LOS	C	-	F	C	-	-
HCM 95th %tile Q(veh)	0.7	-	3.6	1	-	-

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

Intersection: 1: M-150 & Auburn /Auburn

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	290	324	245	183	379	224	192	124	310	398	413	200
Average Queue (ft)	171	179	141	75	210	128	95	51	215	353	356	142
95th Queue (ft)	274	274	220	160	345	199	176	101	362	450	454	272
Link Distance (ft)		792	792			597	597			378	378	
Upstream Blk Time (%)										20	20	
Queuing Penalty (veh)										170	171	
Storage Bay Dist (ft)	250			135	430			155	250			175
Storage Blk Time (%)	4	1	11	0	0		2	0	4	37	46	0
Queuing Penalty (veh)	7	1	16	1	0		3	0	30	56	87	1

Intersection: 1: M-150 & Auburn /Auburn

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	395	581	585	385
Average Queue (ft)	320	478	474	170
95th Queue (ft)	475	634	626	451
Link Distance (ft)		490	490	
Upstream Blk Time (%)		16	15	
Queuing Penalty (veh)		131	127	
Storage Bay Dist (ft)	350			260
Storage Blk Time (%)	18	26	38	
Queuing Penalty (veh)	116	49	62	

Intersection: 2: M-150 & Wabash /Barclay

Movement	EB	EB	WB	WB	WB	NB	NB	NB	NB	SB	SB	SB
Directions Served	L	TR	L	LT	R	L	T	T	R	L	T	TR
Maximum Queue (ft)	112	149	235	203	184	187	353	357	204	195	464	456
Average Queue (ft)	45	54	127	94	89	22	225	231	53	155	311	256
95th Queue (ft)	92	108	206	178	161	99	325	330	159	234	498	449
Link Distance (ft)		586	359	359			524	524			445	445
Upstream Blk Time (%)											5	1
Queuing Penalty (veh)											0	0
Storage Bay Dist (ft)	200				180	175			175	170		
Storage Blk Time (%)		0		0	1		26	27		14	12	
Queuing Penalty (veh)		0		1	1		5	45		100	22	

Intersection: 4: M-150 & South Driveway

Movement	EB	EB	NB	NB	NB	SB
Directions Served	L	R	L	T	T	R
Maximum Queue (ft)	124	101	74	182	155	26
Average Queue (ft)	45	35	40	21	12	1
95th Queue (ft)	104	81	73	111	86	13
Link Distance (ft)	251	251		437	437	
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)			50			100
Storage Blk Time (%)			16			
Queuing Penalty (veh)			125			

Zone Summary

Zone wide Queuing Penalty: 1327

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	228	316	147	234	270	156	165	1258	167	201	1316	225
Future Volume (veh/h)	228	316	147	234	270	156	165	1258	167	201	1316	225
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	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984
Adj Flow Rate, veh/h	248	343	150	257	297	166	181	1382	183	212	1385	234
Peak Hour Factor	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.91	0.91	0.95	0.95	0.95
Percent Heavy Veh, %	1	1	1	1	1	1	1	1	1	1	1	1
Cap, veh/h	272	430	192	272	430	192	215	1335	595	234	1374	613
Arrive On Green	0.14	0.11	0.11	0.14	0.11	0.11	0.11	0.35	0.35	0.16	0.48	0.48
Sat Flow, veh/h	1890	3770	1682	1890	3770	1682	1890	3770	1682	1890	3770	1682
Grp Volume(v), veh/h	248	343	150	257	297	166	181	1382	183	212	1385	234
Grp Sat Flow(s),veh/h/ln	1890	1885	1682	1890	1885	1682	1890	1885	1682	1890	1885	1682
Q Serve(g_s), s	12.9	8.9	8.7	13.5	7.6	9.7	9.4	35.4	7.9	11.0	36.4	8.8
Cycle Q Clear(g_c), s	12.9	8.9	8.7	13.5	7.6	9.7	9.4	35.4	7.9	11.0	36.4	8.8
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	272	430	192	272	430	192	215	1335	595	234	1374	613
V/C Ratio(X)	0.91	0.80	0.78	0.94	0.69	0.87	0.84	1.04	0.31	0.90	1.01	0.38
Avail Cap(c_a), veh/h	272	430	192	272	430	192	234	1335	595	234	1374	613
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.33	1.33	1.33
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	42.2	43.2	43.1	42.4	42.6	43.5	43.4	32.3	23.4	41.2	25.8	18.6
Incr Delay (d2), s/veh	32.3	10.2	18.7	39.7	4.7	31.5	22.1	34.3	1.3	34.4	26.3	1.8
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	8.1	4.5	4.4	9.0	3.7	5.5	5.5	21.0	3.1	6.9	17.4	3.3
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	74.5	53.3	61.8	82.1	47.3	75.0	65.5	66.6	24.7	75.6	52.0	20.4
LnGrp LOS	E	D	E	F	D	E	E	F	C	E	F	C
Approach Vol, veh/h		741			720			1746			1831	
Approach Delay, s/veh		62.1			66.1			62.1			50.7	
Approach LOS		E			E			E			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	19.0	42.0	21.0	18.0	18.0	43.0	21.0	18.0
Change Period (Y+Rc), s	* 6.6	* 6.6	* 6.6	* 6.6	* 6.6	* 6.6	* 6.6	* 6.6
Max Green Setting (Gmax), s	* 12	* 35	* 14	* 11	* 12	* 35	* 14	* 11
Max Q Clear Time (g_c+I1), s	13.0	37.4	14.9	11.7	11.4	38.4	15.5	10.9
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

Intersection Summary	
HCM 6th Ctrl Delay	58.5
HCM 6th LOS	E

Notes

User approved pedestrian interval to be less than phase max green.

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	58	33	24	184	32	157	15	1332	143	173	1512	27
Future Volume (vph)	58	33	24	184	32	157	15	1332	143	173	1512	27
Ideal Flow (vphpl)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Total Lost time (s)	6.8	6.8		6.3	6.3	6.3	6.7	6.7	6.7	6.7	6.7	
Lane Util. Factor	1.00	1.00		0.95	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.94		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00		0.95	0.97	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1881	1854		1805	1835	1700	1881	3762	1683	1881	3753	
Flt Permitted	0.95	1.00		0.95	0.97	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1881	1854		1805	1835	1700	1881	3762	1683	1881	3753	
Peak-hour factor, PHF	0.84	0.84	0.84	0.78	0.78	0.78	0.93	0.93	0.93	0.95	0.95	0.95
Adj. Flow (vph)	69	39	29	236	41	201	16	1432	154	182	1592	28
RTOR Reduction (vph)	0	27	0	0	0	178	0	0	91	0	1	0
Lane Group Flow (vph)	69	41	0	137	140	23	16	1432	63	182	1619	0
Heavy Vehicles (%)	1%	1%	1%	0%	0%	0%	1%	1%	1%	1%	1%	1%
Turn Type	Split	NA		Split	NA	Perm	Prot	NA	Perm	Prot	NA	
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases						4			2			
Actuated Green, G (s)	7.0	7.0		11.4	11.4	11.4	3.0	40.6	40.6	14.5	52.1	
Effective Green, g (s)	7.0	7.0		11.4	11.4	11.4	3.0	40.6	40.6	14.5	52.1	
Actuated g/C Ratio	0.07	0.07		0.11	0.11	0.11	0.03	0.41	0.41	0.14	0.52	
Clearance Time (s)	6.8	6.8		6.3	6.3	6.3	6.7	6.7	6.7	6.7	6.7	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	131	129		205	209	193	56	1527	683	272	1955	
v/s Ratio Prot	c0.04	0.02		0.08	c0.08		0.01	c0.38		c0.10	c0.43	
v/s Ratio Perm						0.01			0.04			
v/c Ratio	0.53	0.32		0.67	0.67	0.12	0.29	0.94	0.09	0.67	0.83	
Uniform Delay, d1	44.9	44.2		42.5	42.5	39.8	47.5	28.5	18.3	40.5	20.2	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.19	0.76	2.52	1.00	1.00	
Incremental Delay, d2	3.8	1.4		8.0	7.9	0.3	1.2	6.1	0.1	6.1	4.2	
Delay (s)	48.7	45.7		50.5	50.4	40.1	57.7	27.9	46.3	46.6	24.4	
Level of Service	D	D		D	D	D	E	C	D	D	C	
Approach Delay (s)		47.2			46.1			29.9			26.6	
Approach LOS		D			D			C			C	

Intersection Summary			
HCM 2000 Control Delay	31.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	26.5
Intersection Capacity Utilization	73.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	7.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	62	85	82	1410	1632	74
Future Vol, veh/h	62	85	82	1410	1632	74
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	0	50	-	-	100
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	70	70	94	94	94	94
Heavy Vehicles, %	0	0	1	1	1	1
Mvmt Flow	89	121	87	1500	1736	79

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2660	868	1815	0	-	0
Stage 1	1736	-	-	-	-	-
Stage 2	924	-	-	-	-	-
Critical Hdwy	6.8	6.9	4.12	-	-	-
Critical Hdwy Stg 1	5.8	-	-	-	-	-
Critical Hdwy Stg 2	5.8	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.21	-	-	-
Pot Cap-1 Maneuver	~ 19	300	338	-	-	-
Stage 1	130	-	-	-	-	-
Stage 2	352	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 14	300	338	-	-	-
Mov Cap-2 Maneuver	~ 74	-	-	-	-	-
Stage 1	97	-	-	-	-	-
Stage 2	352	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	126.5	1.1	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	338	-	74	300	-	-
HCM Lane V/C Ratio	0.258	-	1.197	0.405	-	-
HCM Control Delay (s)	19.3	-	265.8	24.9	-	-
HCM Lane LOS	C	-	F	C	-	-
HCM 95th %tile Q(veh)	1	-	6.7	1.9	-	-

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

Intersection: 1: M-150 & Auburn /Auburn

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	190	420	379	140	260	186	154	122	220	321	325	200
Average Queue (ft)	143	191	137	56	147	103	66	52	174	292	295	146
95th Queue (ft)	211	415	338	124	229	165	132	98	270	331	332	276
Link Distance (ft)		792	792			597	597			287	287	
Upstream Blk Time (%)										30	32	
Queuing Penalty (veh)										242	252	
Storage Bay Dist (ft)	110			135	430			155	160			175
Storage Blk Time (%)	38	15	5	0			0	0	8	48	49	0
Queuing Penalty (veh)	60	33	7	0			0	0	50	79	81	1

Intersection: 1: M-150 & Auburn /Auburn

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	215	570	575	385
Average Queue (ft)	175	416	421	199
95th Queue (ft)	262	678	674	487
Link Distance (ft)		490	490	
Upstream Blk Time (%)		21	23	
Queuing Penalty (veh)		183	196	
Storage Bay Dist (ft)	170			260
Storage Blk Time (%)	9	41	35	
Queuing Penalty (veh)	58	81	78	

Intersection: 2: M-150 & Wabash /Barclay

Movement	EB	EB	WB	WB	WB	NB	NB	NB	NB	SB	SB	SB
Directions Served	L	TR	L	LT	R	L	T	T	R	L	T	TR
Maximum Queue (ft)	99	108	177	126	128	142	323	308	152	195	438	423
Average Queue (ft)	43	41	90	51	53	10	149	164	32	125	246	215
95th Queue (ft)	85	83	157	112	106	55	264	272	100	214	407	357
Link Distance (ft)		586	359	359			524	524			445	445
Upstream Blk Time (%)											1	0
Queuing Penalty (veh)											0	0
Storage Bay Dist (ft)	200				180	175			175	170		
Storage Blk Time (%)							5	6		2	13	
Queuing Penalty (veh)							1	9		15	22	

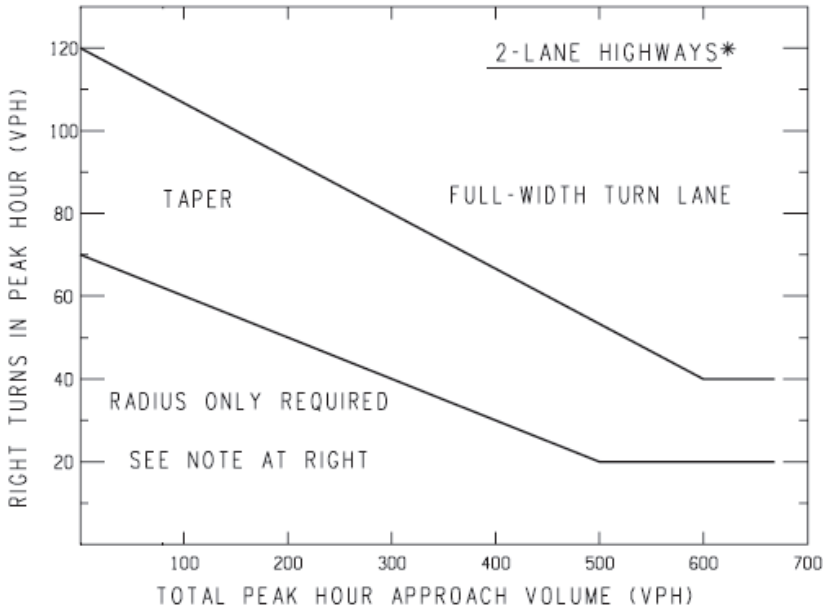
Intersection: 4: M-150 & South Driveway

Movement	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	R	L	T	T	T	T	R
Maximum Queue (ft)	266	260	69	93	90	103	86	48
Average Queue (ft)	245	133	36	11	7	11	11	3
95th Queue (ft)	289	333	69	78	68	79	81	38
Link Distance (ft)	251	251		437	437	613	613	
Upstream Blk Time (%)	85	44						
Queuing Penalty (veh)	0	0						
Storage Bay Dist (ft)			50					100
Storage Blk Time (%)			15				1	
Queuing Penalty (veh)			106				1	

Zone Summary

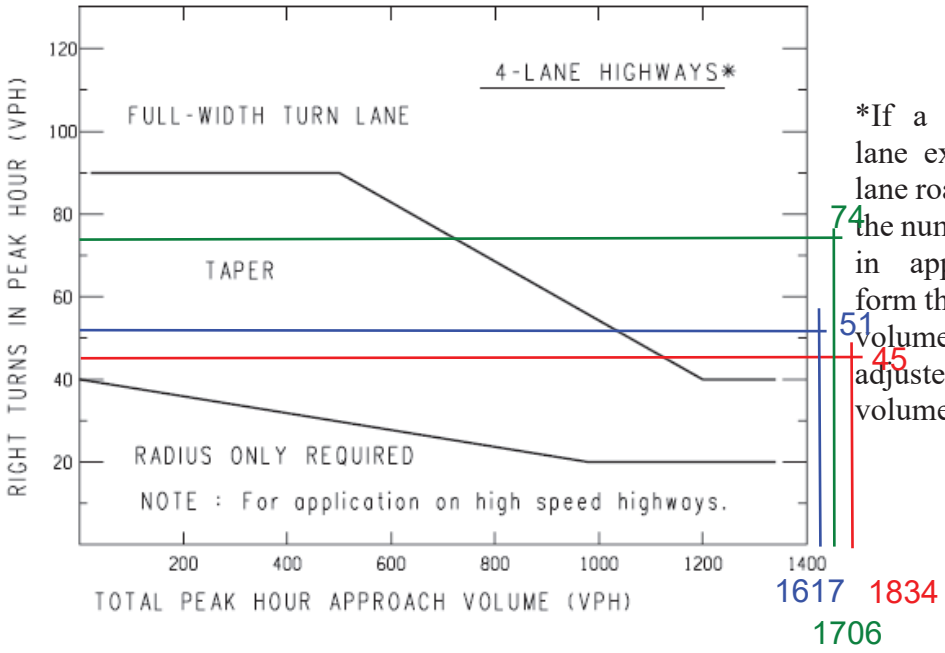
Zone wide Queuing Penalty: 1557

South Driveway:
AM Peak Hour
PM Peak Hour
Saturday Peak Hour



NOTE: For posted speeds at or under 45 mph, peak hour right turns greater than 40 vph, and total peak hour approach less than 300 vph, adjust right turn volumes.

Adjust peak hour
Right turns = Peak hour Right turns – 20



*If a center left-turn lane exists (ie 3 or 5 lane roadway), subtract the number of left turns in approach volume form the total approach volume to get an adjusted total approach volume.

Sample Problem: The Design Speed is 55 mph. The Peak Hour Approach Volume is 300 vph. The Number of Right Turns in the Peak Hous is 100 vph. Determine if a right turn lane is recommended.

Solution: Figure indicates that the intersection of 300 vph and 100 vph is located above the upper trend line; thus, a right-turn lane may be recommended.