

HATMAKER SUBDIVISION
Transportation Impact Analysis
W Emory Road
Knoxville, TN

A Transportation Impact Analysis for the Hatmaker Subdivision

Submitted to

Knoxville – Knox County Planning Commission

October 26, 2020
FMA Project No. 592.009

Submitted By:



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Executive Summary

Ball Homes, LLC is proposing a residential development (i.e. Hatmaker Subdivision) with single-family housing located in Knox County. The project is located at the intersection of W Emory Road at Henderson Road. The full build out of the development will consist of 54 single family lots and 58 townhomes for a total of 112 units. Construction is proposed to take place this year and this study assumes full build out for the development will occur in 2023.

There are three proposed driveway connections to W Emory Road. The main driveway connection will be located west of the intersection of W Emory Road at Henderson Road. The townhomes located south of the intersection of W Emory Road at Henderson Road will have two driveway connections to W Emory Road.

In order to maintain or provide an acceptable level-of-service for each of the intersections studied, some recommendations are presented.

W Emory Road at Henderson Road

The full buildout traffic conditions for the eastbound left turn movement (W Emory Road) operates at a LOS A during both the AM and PM peak hours and the southbound approach (Henderson Road) operates at a LOS B during both the AM and PM peak hours.

W Emory Road at Driveway Connections

At the intersection of W Emory Road at the main driveway connection the westbound left turn movement (W Emory Road) operates at a LOS A during both the AM and PM peak hour and the northbound approach (driveway) operates at a LOS A during both the AM and PM peak hours after the completion of the Hatmaker Subdivision.

Neither an eastbound right turn lane nor a westbound left turn lane are warranted at the intersection of W Emory Road at the main driveway connection.

1 Introduction

1.1 Project Description

This report provides a summary of a traffic impact study that was performed for the Hatmaker Subdivision. The project is located at the intersection of W Emory Road at Henderson Road north of Oak Ridge Highway (SR 62) in Knox County, Tennessee. The location of the site is shown in Figure 1.

The full build out of the development will consist of 54 single family lots and 58 townhomes for a total of 112 units. Construction is proposed to take place this year, and this study assumes full build out for the development will occur in 2023.

There are three proposed driveway connections to W Emory Road. The main driveway connection will be located 555 feet west of the intersection of W Emory Road at Henderson Road and approximately 425 feet east of the intersection of Old Cobbs Ferry Road. The townhomes located along W Emory Road will have two driveway connections to W Emory Road. The first driveway connection will be located 315 feet south of the intersection of W Emory Road and the second driveway connection will be located 510 feet south of the first driveway connection. The proposed site layout is shown in Figure 2.

The purpose of this study is to evaluate the impacts to the traffic conditions caused by the proposed development.

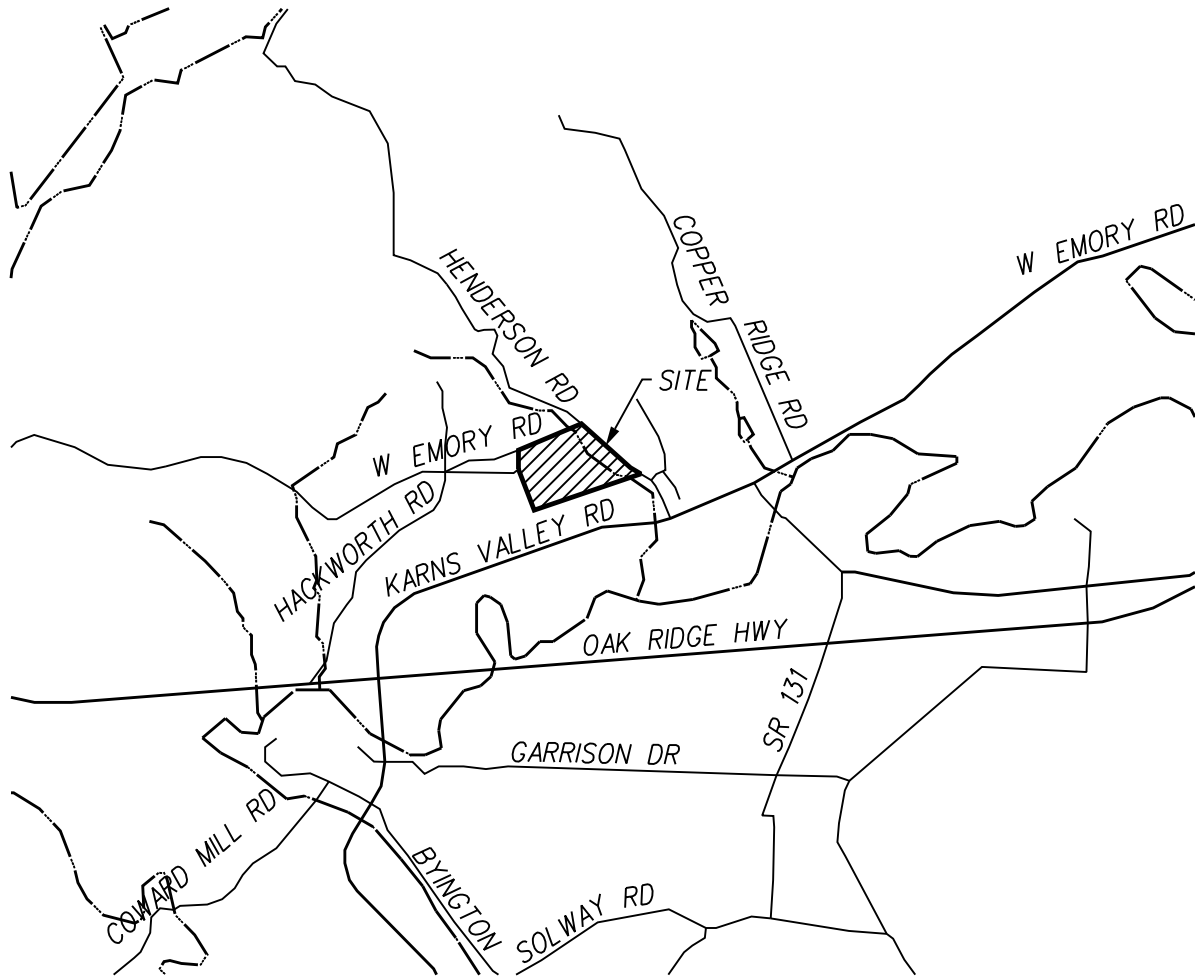


Figure 1: Location Map

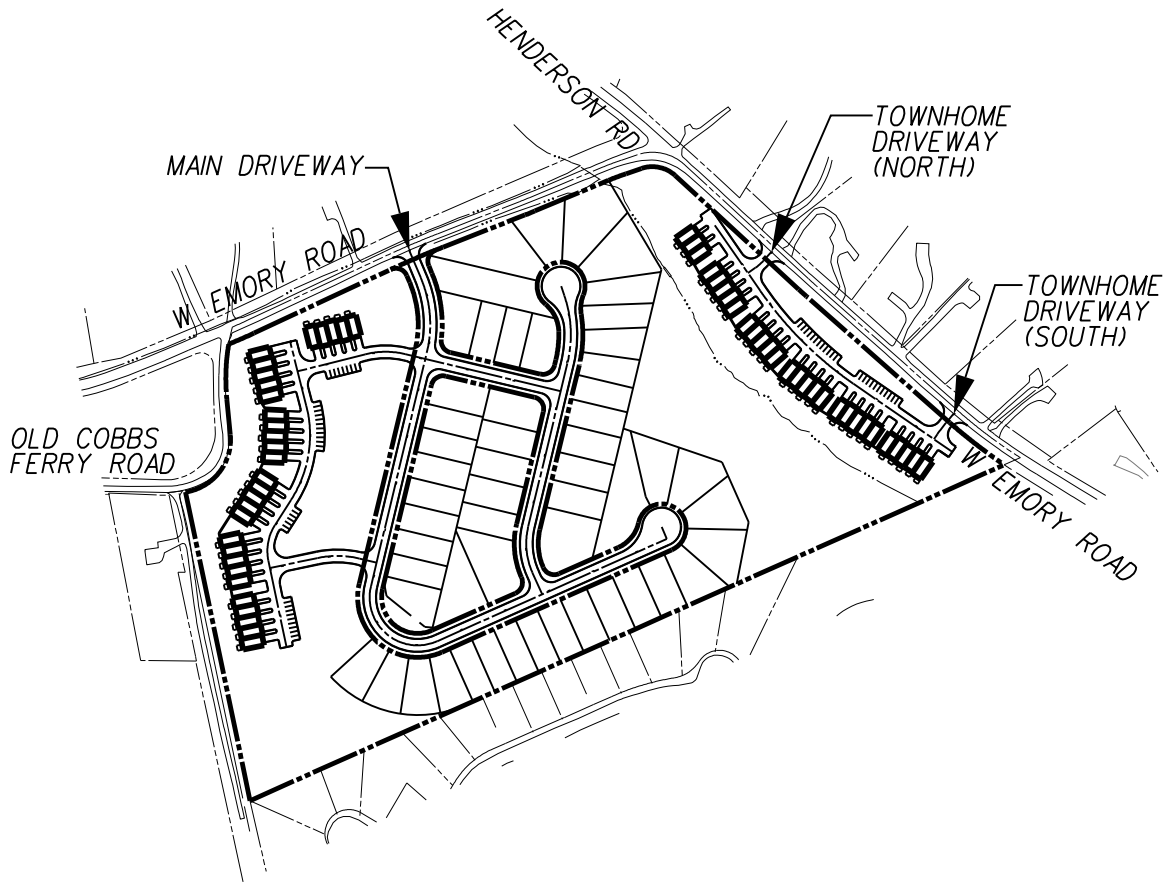


Figure 2: Site Plan

1.2 Existing Site Conditions

W Emory Road is a two-lane road at the intersection with Henderson Road. Knoxville-Knox County Planning classifies W Emory Road between Oak Ridge Highway (SR 62) and Karns Valley Road as a Minor Collector with a 60 foot right-of-way. The posted speed limit on W Emory Road is 30 mph.

Henderson Road is a two-lane road at the intersection with W Emory Road. Knoxville-Knox County Planning classifies Henderson Road between W Emory Road and the Anderson County line as a Minor Collector with a 60 foot right-of-way. The posted speed limit on Henderson Road is 30 mph.

There are no existing sidewalks or designated bike lanes along W Emory Road or Henderson Road in the vicinity of the proposed development.

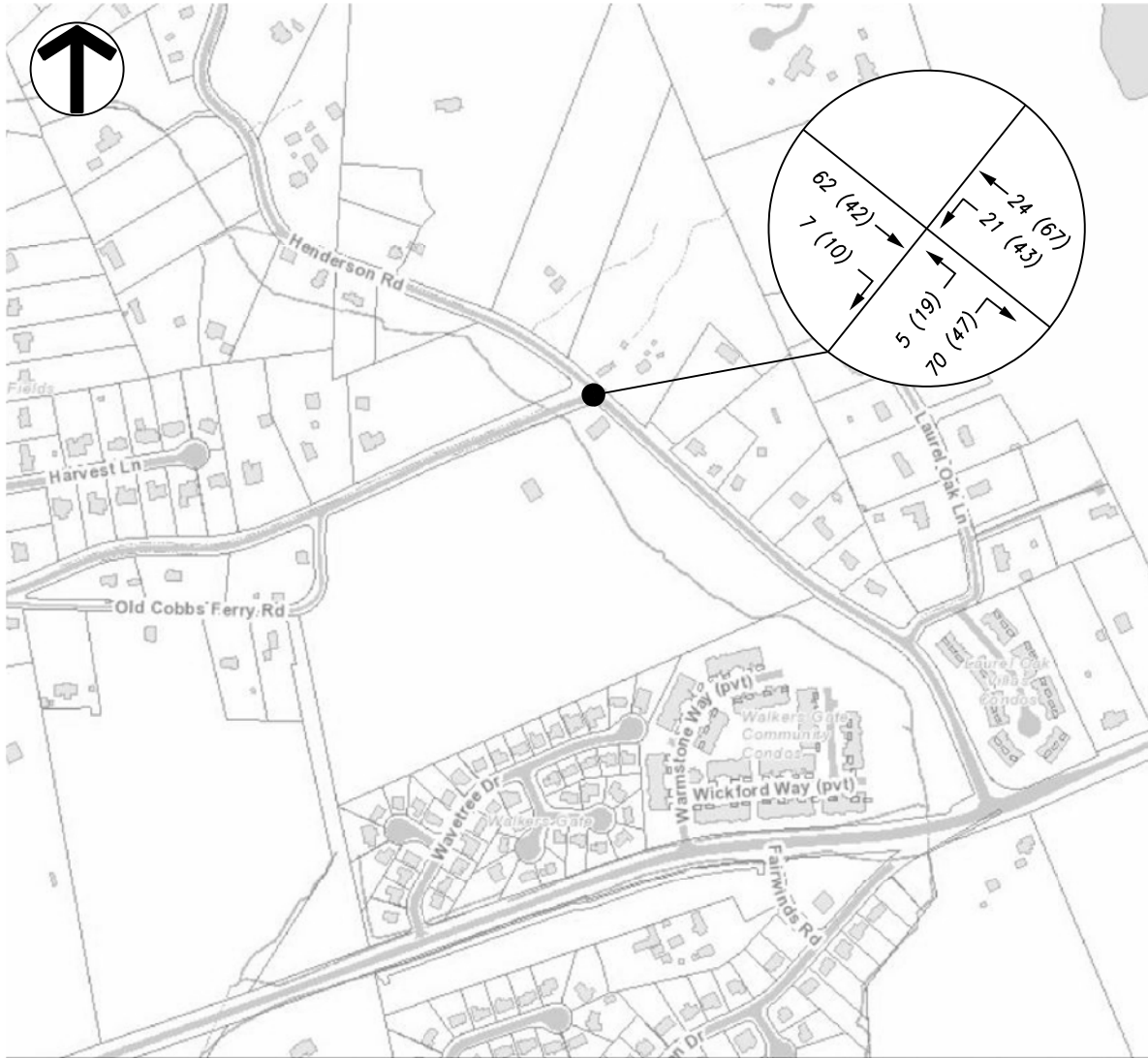
An aerial photo of the existing intersection is included in Attachment 1.

2 Existing Traffic Volumes

FMA conducted a turning movement count at the intersection of W Emory Road at Henderson Road on Thursday September 10, 2020.

The current AM peak hour and PM peak hour were determined using the turning movement count that FMA conducted. At the intersection of W Emory Road at Henderson Road the AM peak hour occurred between 7:15 a.m. and 8:15 a.m., and the PM peak hour occurred between 5:15 p.m. and 6:15 p.m.

The existing volumes including the AM and PM peak hour traffic volumes at the count locations are shown in Figure 3, and the count data collected is included in Attachment 2.



LEGEND:

← 5 (16) TURNING MOVEMENT VOLUME AM (PM)

Figure 3: 2020 Existing Peak Hour Traffic

3 Background Growth

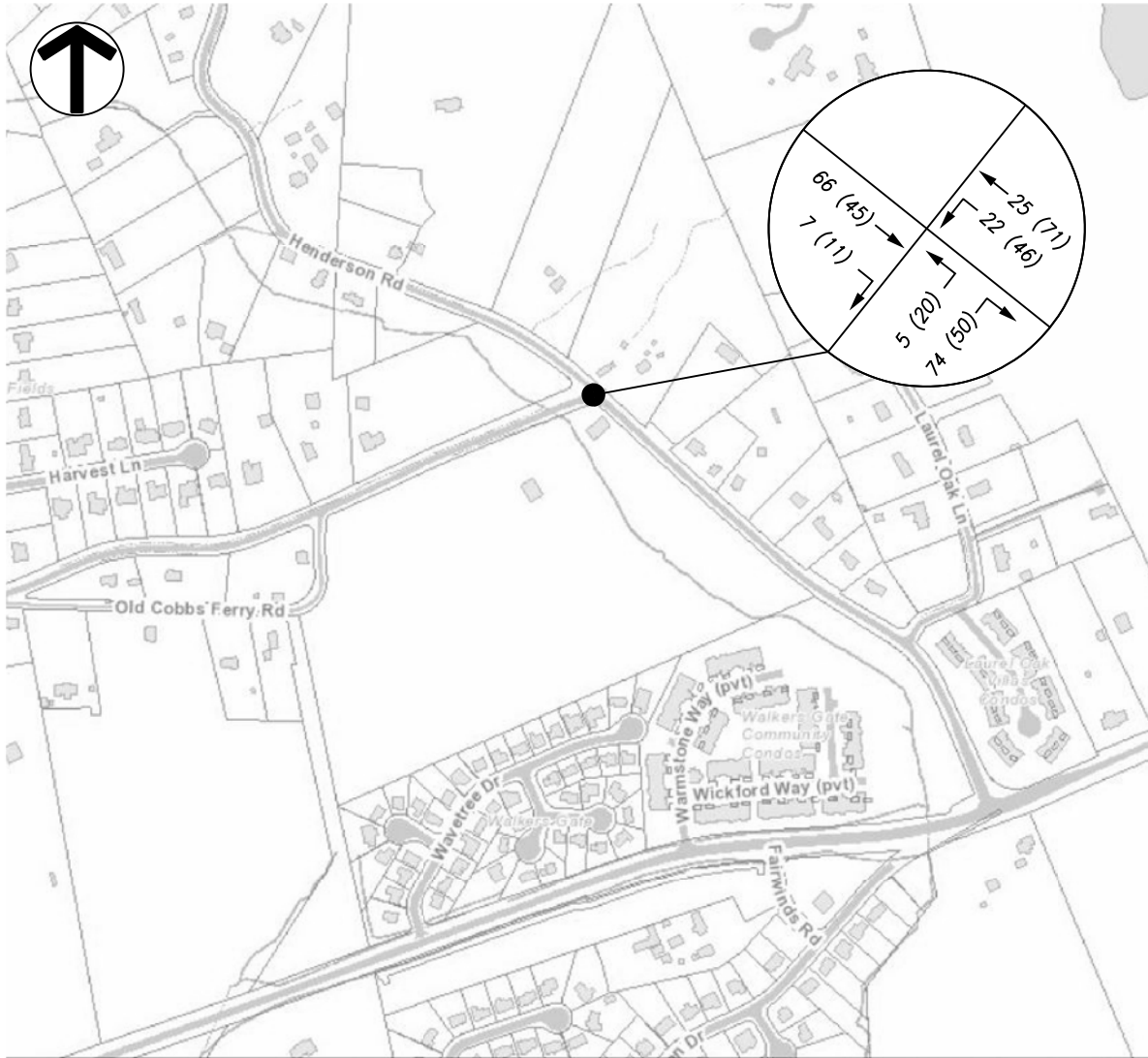
The Tennessee Department of Transportation (TDOT) maintains count stations in the vicinity of the proposed development.

TDOT count station ID: 000178 is located on Henderson Road at the Anderson County line. The annual growth rate for this station over the last ten years is approximately 0.87% and the 2019 ADT was 1,129 vehicles per day.

TDOT count station ID: 000468 is located on Karns Valley Drive west of the intersection of W Emory Road and north of Oak Ridge Highway (SR 62). The annual growth rate for this station over the last eight years is approximately 4.82% and the 2018 ADT was 4,894 vehicles per day.

For the purpose of this study, an annual growth rate of 2.0% was assumed for the traffic at the intersection of W Emory Road at Henderson Road until full occupancy is reached in 2023. Attachment 3 shows the trend line growth charts for the TDOT count stations.

Figure 4 demonstrates the projected background peak hour volumes at the intersection of W Emory Road at Henderson Road after applying the background growth rate to the existing conditions.



LEGEND:

← 5 (16) TURNING MOVEMENT VOLUME AM (PM)

Figure 4: 2023 Background Peak Hour Traffic

4 Trip Generation and Trip Distribution

The Hatmaker Subdivision proposes 54 single family lots and 58 townhomes for a total of 112 units. Single-Family Detached Housing or Land Use 210 was used to calculate site trips for the subdivision using the fitted curve equations from the *Trip Generation, 10th Edition*, published by the Institute of Transportation Engineers.

The Knoxville-Knox County Planning Commission published a memorandum (“Local Trip Generation Rates for Multi-Family Residential Uses”, August 14, 2000) for the purpose of providing locally collected data for all multi-family residential developments. The fitted curve equations from the local study were used to calculate site trips for the 58 townhomes. The land use worksheets are included in Attachment 4.

The total trips generated by the full buildout of the Hatmaker Subdivision was estimated to be 1,175 daily trips. The estimated trips are 75 trips during the AM peak hour and 105 trips during the PM peak hour. A trip generation summary is shown in Table 4-1.

Table 4-1
Hatmaker Subdivision
Trip Generation Summary

Land Use	Density	Daily Trips	AM Peak Hour		PM Peak Hour	
			Enter	Exit	Enter	Exit
Single-Family Detached Housing (Land Use 210)	54 lots	590	11	32	35	21
Apartments (Local Trip Gen Study)	30 units	304	4	13	14	11
Total – Main Driveway	87 units	894	15	45	49	32
Apartments (Local Trip Gen Study) Townhome Driveways	28 units	281	3	12	13	11
Total – Overall	115 units	1,175	18	57	62	43

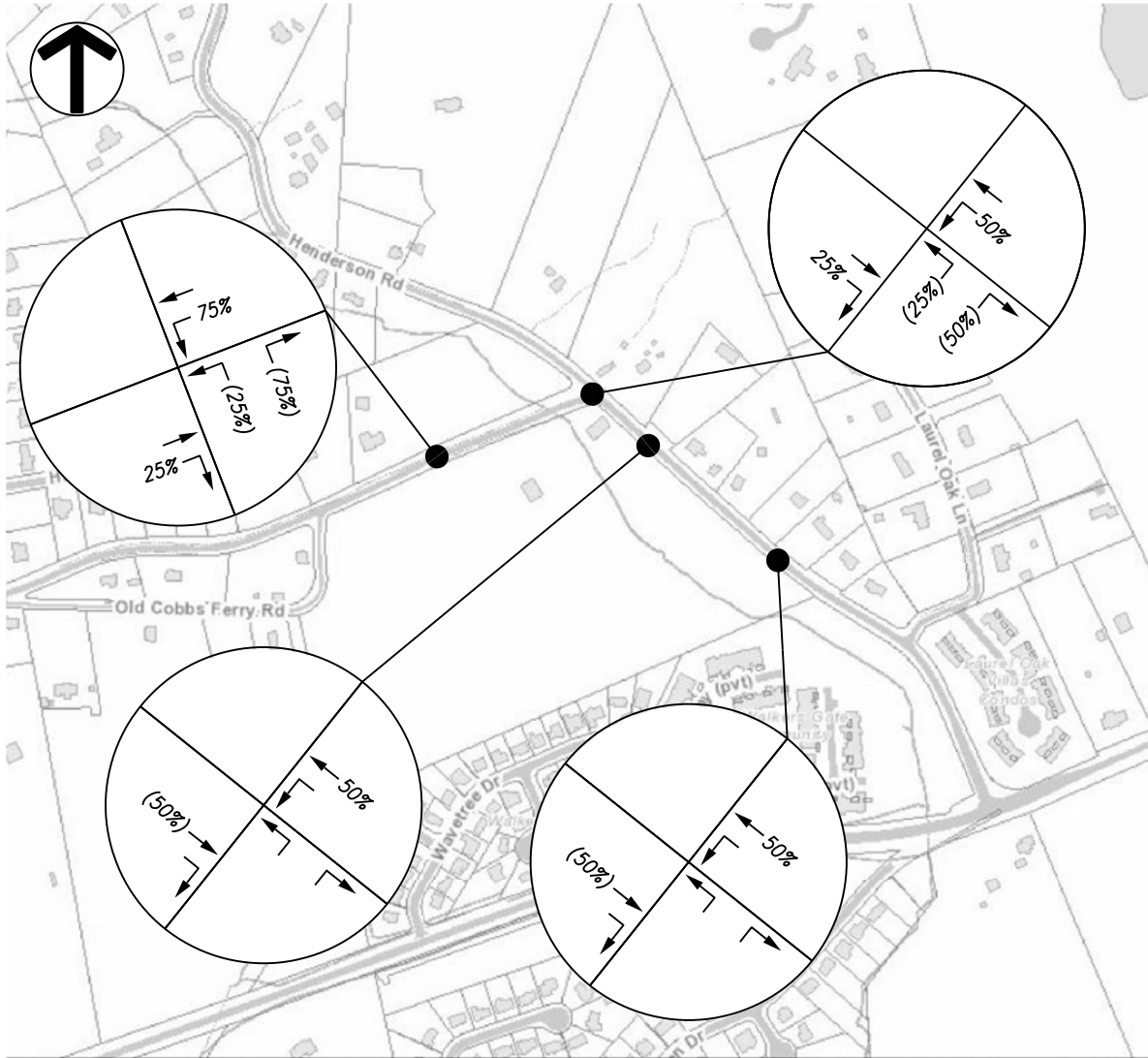
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The existing distribution of traffic at the intersection of W Emory Road at Henderson Road is approximately 50% W Emory Road to/from Karns Valley Drive, 25% Henderson Road and 25% W Emory Road to/from Hackworth Road during both the AM and PM peak hours.

The directional distribution of the traffic generated by the Hatmaker Subdivision was determined using the existing traffic volumes at the intersection of W Emory Road at Henderson Road in combination with the concept plan layout. FMA assumed that 76% of traffic would enter/exit from the main entrance on W Emory Road and 12% of traffic would enter/exit from each of the townhomes driveways on W Emory Road.

Figure 5 shows the peak hour trip distribution for the main driveway and Figure 6 shows the peak hour trip distribution for the townhomes driveways.

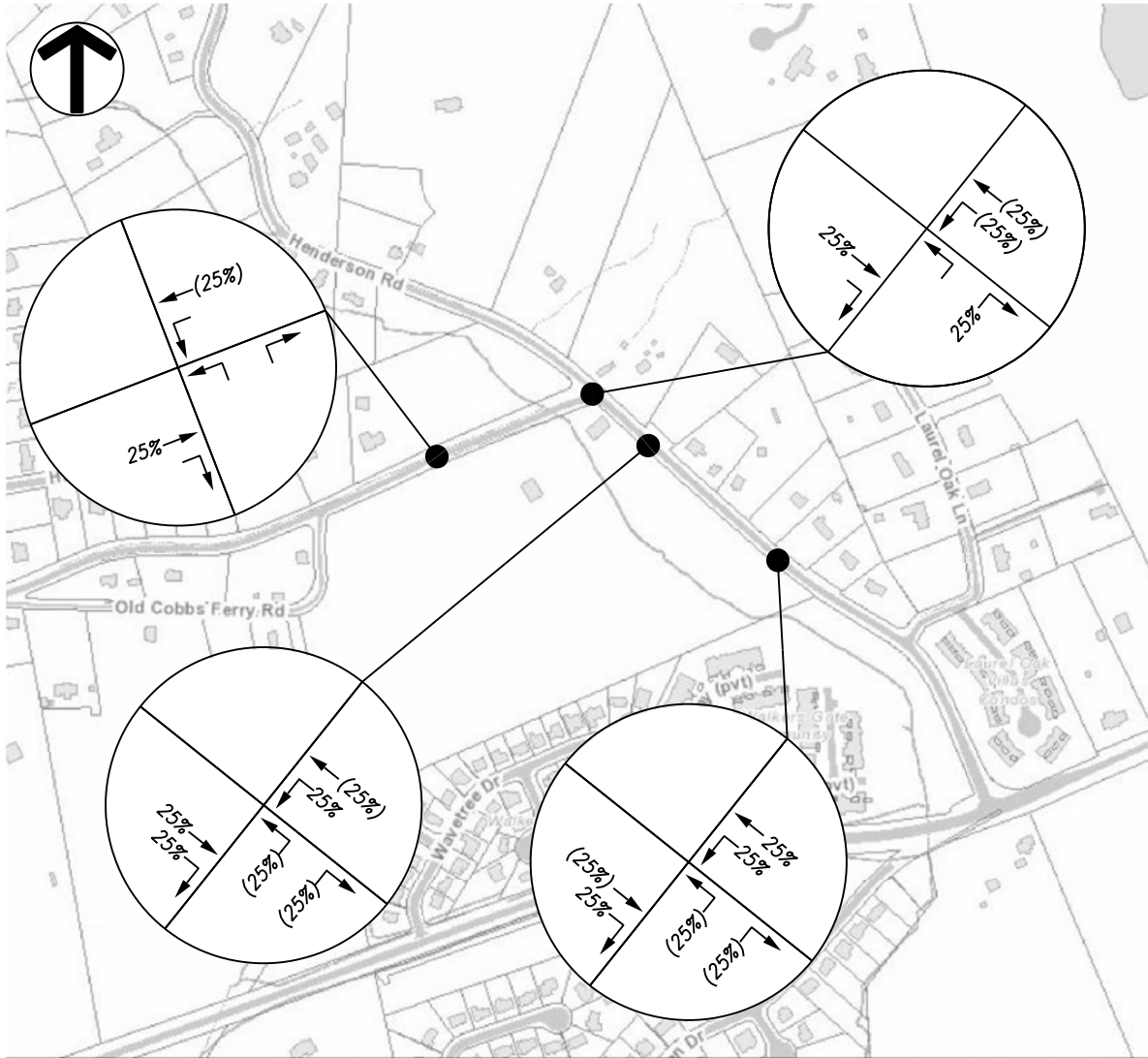
Figure 7 shows the peak hour site trips generated by the Hatmaker Subdivision and Figure 8 shows the projected full buildout peak hour traffic after the completion of the Hatmaker Subdivision.



LEGEND:

← 50% (50%) TRIP DISTRIBUTION ENTERING (EXITING)

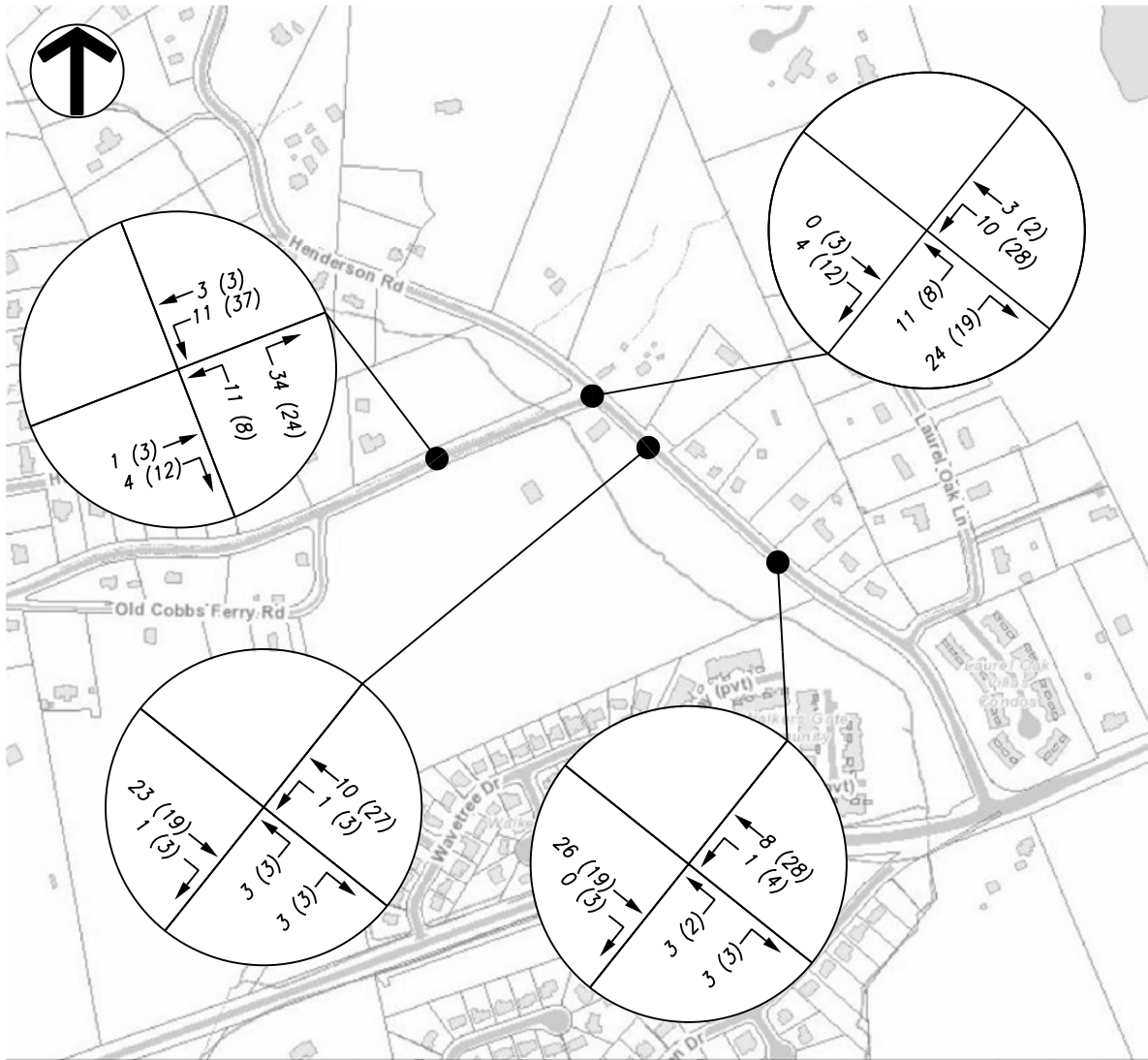
Figure 5: Peak Hour Trip Distribution - Main Driveway



LEGEND:

← 50% (50%) TRIP DISTRIBUTION ENTERING (EXITING)

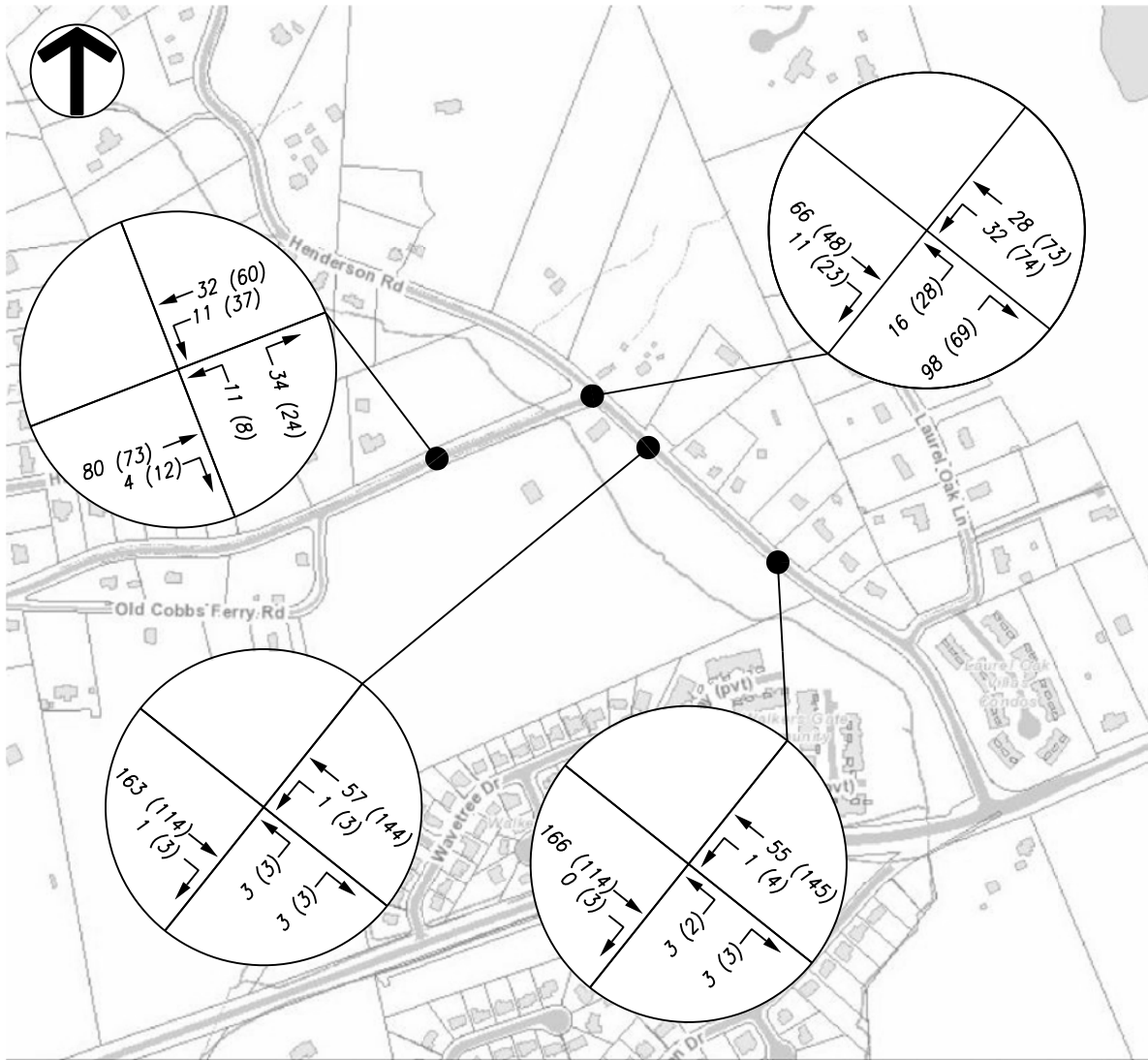
Figure 6: Peak Hour Trip Distribution - Townhome Driveways



LEGEND:

← 5 (16) TURNING MOVEMENT VOLUME AM (PM)

Figure 7: Hatmaker Subdivision Peak Hour Site Trips



LEGEND:

← 5 (16) TURNING MOVEMENT VOLUME AM (PM)

Figure 8: 2023 Full Buildout Peak Hour Traffic

5 Projected Capacity and Level of Service

The existing intersection of W Emory Road at Henderson Road is a three-legged intersection with a stop sign for southbound traffic on Henderson Road.

Unsignalized intersection capacity analyses were performed using the Highway Capacity Software (HCS7) for the AM and PM peak hours to evaluate the existing, background and full buildout conditions at the intersection of W Emory Road at Henderson Road and the full buildout conditions at the intersection of W Emory Road at the three driveway connections.

The results from the analyses are expressed with a term “level of service” (LOS), which is based on the amount of delay experienced at the intersection. The LOS index ranges from LOS A, indicating excellent traffic conditions with minimal delay, to LOS F indicating very congested conditions with excessive delay. LOS D generally is considered the minimum acceptable condition in urban areas. The HCS7 worksheets are included in Attachments 5, 6 and 7.

Table 5-1 shows the results of the capacity analyses.

Table 5-1
Intersection Analysis
Level of Service (LOS) Summary

Delay (sec)/LOS		
W Emory Road @ Henderson Road (Existing 2020)		
AM Peak	EB Left Turn	7.3 / A
	SB Approach	9.7 / A
PM Peak	EB Left Turn	7.5 / A
	SB Approach	9.7 / A
W Emory Road @ Henderson Road (Background 2023)		
AM Peak	EB Left Turn	7.3 / A
	SB Approach	9.8 / A
PM Peak	EB Left Turn	7.5 / A
	SB Approach	9.8 / A

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W Emory Road @ Henderson Road (Full Buildout 2023)

AM Peak	EB Left Turn SB Approach	7.4 / A 10.4 / B
PM Peak	EB Left Turn SB Approach	7.6 / A 10.2 / B

W Emory Road @ Main Driveway (Full Buildout 2023)

AM Peak	WB Left Turn NB Approach	7.4 / A 9.1 / A
PM Peak	WB Left Turn NB Approach	7.5 / A 9.2 / A

W Emory Road @ Townhome Driveway (North) (Full Buildout 2023)

AM Peak	EB Approach NB Left Turn	9.5 / A 7.6 / A
PM Peak	EB Approach NB Left Turn	9.6 / A 7.5 / A

W Emory Road @ Townhome Driveway (South) (Full Buildout 2023)

AM Peak	EB Approach NB Left Turn	9.5 / A 7.6 / A
PM Peak	EB Approach NB Left Turn	9.4 / A 7.5 / A

6 Turn Lane Warrant Analysis

The intersection of W Emory Road at the main driveway connection was evaluated to determine if a right turn lane or a left turn lane are warranted. The Knox County Department of Engineering and Public Works handbook, "Access Control and Driveway Design Policy," was used to analyze the information. Neither an eastbound right turn lane nor a westbound left turn lane on W Emory Road is warranted. The turn lane warrant worksheets and analysis are included in Attachment 8.

7 Conclusions and Recommendations

7.1 W Emory Road @ Henderson Road

The existing, background and full buildout conditions at the unsignalized intersection of W Emory Road at Henderson Road were analyzed using the Highway Capacity Software (HCS7).

The existing and background traffic conditions for the eastbound left turn movement (W Emory Road) operate at a LOS A during both the AM and PM peak hours and the southbound approach (Henderson Road) operates at a LOS A during both the AM and PM peak hours.

The full buildout traffic conditions for the eastbound left turn movement (W Emory Road) operate at a LOS A during both the AM and PM peak hours and the southbound approach (Henderson Road) operates at a LOS B during both the AM and PM peak hours.

7.2 W Emory Road @ Driveway Connections

The full buildout conditions at the unsignalized intersections of W Emory Road at the main driveway connection, townhome driveway (north) and townhome driveway (south) were analyzed using the Highway Capacity Software (HCS7).

At the intersection of W Emory Road at the main driveway connection the westbound left turn movement (W Emory Road) operates at a LOS A during both the AM and PM peak hour and the northbound approach (driveway) operates at a LOS A during both the AM and PM peak hours after the completion of the Hatmaker Subdivision.

Neither an eastbound right turn lane nor a westbound left turn lane are warranted at the intersection of W Emory Road at the main driveway connection.

At the intersection of W Emory Road at the townhome driveway (north) the eastbound approach (driveway) operates at a LOS A during both the AM and PM peak hour and the northbound left turn movement (W Emory Road) operates at a LOS A during both the AM and PM peak hours after the completion of the Hatmaker Subdivision.

At the intersection of W Emory Road at the townhome driveway (south) the eastbound approach (driveway) operates at a LOS A during both the AM and PM peak hour and the northbound left turn movement (W Emory Road) operates at a LOS A during both the AM and PM peak hours after the completion of the Hatmaker Subdivision.

W Emory Road is classified as a Minor Collector per the Major Road Plan. The minimum intersection spacing required on a collector is 300 feet per the “Knoxville-Knox County Subdivision Regulations” amended through February 13, 2020. The proposed main driveway connection is located approximately 425 feet east of the intersection with Old Cobbs Ferry Road. The townhome driveway (north) is located 315 feet south of the intersection of W Emory Road and the townhome driveway (south) is located 510 feet south of the townhome driveway (north). All three driveway connections exceed the typical minimum separation on a collector; therefore, no change is necessary.

The minimum required sight distance for a road with a posted speed limit of 30 mph is 300 feet in each direction in accordance with the “Knoxville-Knox County Subdivision Regulations” amended through February 13, 2020. FMA measured the sight distance at the proposed driveway intersections at W Emory Road in September 2020. For the intersection of W Emory Road at the main driveway connection at 15 feet from the edge of pavement the sight distance is greater than 450 feet eastbound and westbound. For the intersection of W Emory Road at the townhome driveway (north) at 15 feet from the edge of pavement the sight distance is greater than 450 feet eastbound and westbound. For the intersection of W Emory Road at the townhome driveway (south) at 15 feet from the edge of pavement the sight distance is greater than 450 feet eastbound and westbound.

7.3 Subdivision Roads

Road “A”, Road “B”, Road “C”, Road “D”, Road “E” and Road “F” will have a width of 26 feet in accordance with the “Knoxville-Knox County Subdivision Regulations” amended through February 13, 2020.

Any required sight distance easements for the internal subdivision intersections of Road “A”, Road “B”, Road “C”, Road “D”, Road “E” and Road “F” should be coordinated with Knox County Engineering and Public Works and included on the final design drawings prior to construction of the subdivision.

Attachment 1
Aerial Photo



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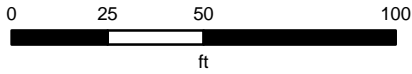
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W Emory Rd at Henderson Rd

Knoxville - Knox County - KUB Geographic Information System



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Attachment 2 Traffic Counts

Project: Hatmaker Subdivision

Intersection: W Emory Rd @ Henderson Rd

Date Conducted: 9/10/2020

Start	W Emory Rd Eastbound			Henderson Road Southbound			W Emory Rd Westbound			Int. Total
	Left	Thru	Total	Left	Right	Total	Thru	Right	Total	
7:00 AM	2	12	14	7	0	7	2	5	7	28
7:15 AM	1	28	29	19	3	22	5	6	11	62
7:30 AM	3	16	19	12	1	13	5	5	10	42
7:45 AM	1	16	17	17	1	18	8	9	17	52
Total	7	72	79	55	5	60	20	25	45	184
8:00 AM	0	10	10	14	2	16	3	4	7	33
8:15 AM	0	7	7	8	1	9	3	8	11	27
8:30 AM	2	5	7	8	0	8	4	8	12	27
8:45 AM	0	7	7	10	0	10	4	2	6	23
Total	2	29	31	40	3	43	14	22	36	110
4:00 PM	1	9	10	7	1	8	6	17	23	41
4:15 PM	3	9	12	4	0	4	5	12	17	33
4:30 PM	4	3	7	13	2	15	7	12	19	41
4:45 PM	3	2	5	10	1	11	17	19	36	52
Total	11	23	34	34	4	38	35	60	95	167
5:00 PM	1	9	10	7	1	8	6	15	21	39
5:15 PM	4	18	22	8	3	11	13	16	29	62
5:30 PM	8	18	26	8	3	11	15	11	26	63
5:45 PM	5	7	12	15	3	18	5	16	21	51
Total	18	52	70	38	10	48	39	58	97	215
6:00 PM	2	4	6	11	1	12	10	24	34	52
6:15 PM	3	2	5	11	3	14	11	17	28	47
6:30 PM	3	12	15	12	6	18	7	13	20	53
6:45 PM	4	12	16	4	2	6	5	10	15	37
Total	12	30	42	38	12	50	33	64	97	189
Grand Total	50	206	256	205	34	239	141	229	370	865
Approach %	19.5	80.5		85.8	14.2		38.1	61.9		
Total %	5.8	23.8	29.6	23.7	3.9	27.6	16.3	26.5	42.8	

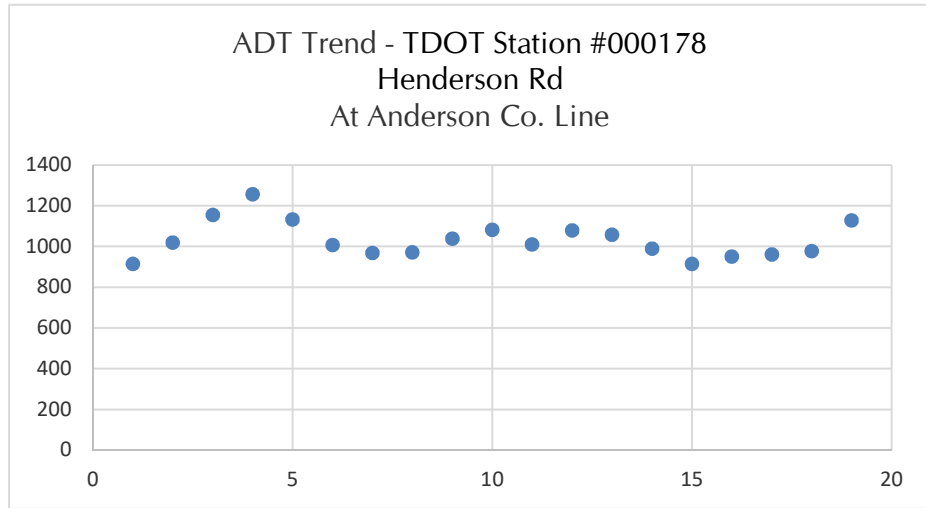
Project: Hatmaker Subdivision
Intersection: W Emory Rd @ Henderson Rd
Date Conducted: 9/10/2020

AM Peak Hour	7:15 AM - 8:15 AM	189
PM Peak Hour	5:15 PM - 6:15 PM	228

Start	W Emory Rd Eastbound			Henderson Rd Southbound			W Emory Rd Westbound			Int. Total
	Left	Thru	Total	Left	Right	Total	Thru	Right	Total	
Peak Hour Analysis from 7:00 AM to 9:00 AM										
AM Peak Hour begins at 7:15 AM										
7:15 AM	1	28	29	19	3	22	5	6	11	62
7:30 AM	3	16	19	12	1	13	5	5	10	42
7:45 AM	1	16	17	17	1	18	8	9	17	52
8:00 AM	0	10	10	14	2	16	3	4	7	33
Total Volume	5	70	75	62	7	69	21	24	45	189
Future (2% over 3 yrs)	5	74		66	7		22	25		201
PHF	0.42	0.63		0.82	0.58		0.66	0.67		0.76
Peak Hour Analysis from 2:30 PM to 7:00 PM										
PM Peak Hour begins at 5:15 PM										
5:15 PM	4	18	22	8	3	11	13	16	29	62
5:30 PM	8	18	26	8	3	11	15	11	26	63
5:45 PM	5	7	12	15	3	18	5	16	21	51
6:00 PM	2	4	6	11	1	12	10	24	34	52
Total Volume	19	47	66	42	10	52	43	67	110	228
Future (2% over 3 yrs)	20	50		45	11		46	71		242
PHF	0.59	0.65		0.70	0.83		0.72	0.70		0.90

Attachment 3 ADT Trends

Year	Adjusted Average Daily Traffic
2001	914
2002	1020
2003	1155
2004	1256
2005	1132
2006	1007
2007	969
2008	972
2009	1039
2010	1082
2011	1010
2012	1079
2013	1058
2014	990
2015	914
2016	951
2017	961
2018	977
2019	1129

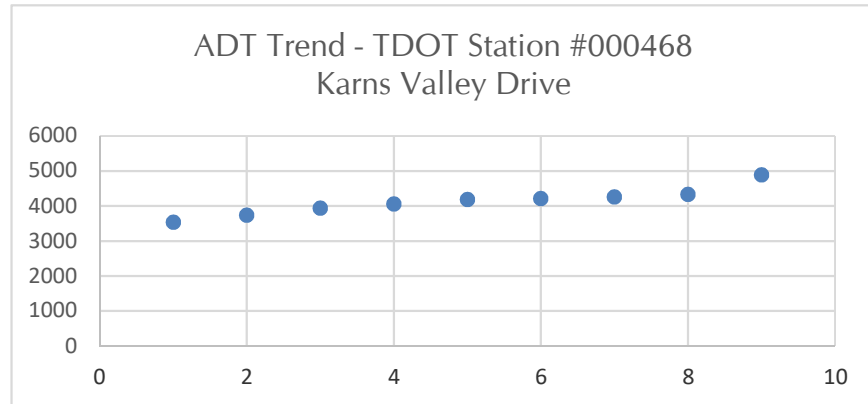


Most Recent Trend Line Growth

Year	ADT
2009	1039
2019	1129

Annual Percent Growth 0.87%

Year	Adjusted Average Daily Traffic
2010	3533
2011	3738
2012	3943
2013	4061
2014	4183
2015	4216
2016	4258
2017	4336
2018	4894



Most Recent Trend Line Growth

Year	ADT
2010	3533
2018	4894

Annual Percent Growth 4.82%

Attachment 4 Trip Generation

Project: Hatmaker Subdivision

Date Conducted: 10/21/2020

Single-Family Detached Housing (LUC 210)

54 Single Family Lots

Average Daily Traffic

$$\ln(T) = 0.92\ln(X) + 2.71$$

$$\ln(T) = 0.92\ln(54) + 2.71$$

$$T = 590$$

Peak Hour of Adjacent Street Traffic

One Hour Between 7 and 9 a.m.

$$T = 0.71(X) + 4.80$$

$$T = 0.71(54) + 4.80$$

$$T = 43$$

Peak Hour of Adjacent Street Traffic

One Hour Between 4 and 6 p.m.

$$\ln(T) = 0.96\ln(X) + 0.20$$

$$\ln(T) = 0.96\ln(54) + 0.20$$

$$T = 56$$

Time Period	Total Trips	Percent		Number	
		Enter	Exit	Enter	Exit
Weekday (24 hours)	590	50%	50%	295	295
AM Peak Hour	43	25%	75%	11	32
PM Peak Hour	56	63%	37%	35	21

Project: Hatmaker Subdivision

Date Conducted: 9/21/2020

Local Apartment Trip Generation Study

58 units

Average Daily Traffic

$$T = 15.193 (X)^{0.899}$$

$$T = 15.193 (58)^{0.899}$$

$$T = 585$$

Peak Hour of Adjacent Street Traffic

One Hour Between 7 and 9 a.m.

$$T = 0.758 (X)^{0.924}$$

$$T = 0.758 (58)^{0.924}$$

$$T = 32$$

Peak Hour of Adjacent Street Traffic

One Hour Between 4 and 6 p.m.

$$T = 0.669 (X) + 10.069$$

$$T = 0.669 (58) + 10.069$$

$$T = 49$$

Time Period	Total Trips	Percent		Number	
		Enter	Exit	Enter	Exit
Weekday (24 hours)	585	50%	50%	293	293
AM Peak Hour	32	22%	78%	7	25
PM Peak Hour	49	55%	45%	27	22

30 Townhomes (52%)

Time Period	Total Trips	Percent		Number	
		Enter	Exit	Enter	Exit
Weekday (24 hours)	304	50%	50%	152	152
AM Peak Hour	17	22%	78%	4	13
PM Peak Hour	25	55%	45%	14	11

28 Townhomes (48%)

Time Period	Total Trips	Percent		Number	
		Enter	Exit	Enter	Exit
Weekday (24 hours)	281	50%	50%	140	140
AM Peak Hour	15	22%	78%	3	12
PM Peak Hour	24	55%	45%	13	11

Single-Family Detached Housing (210)

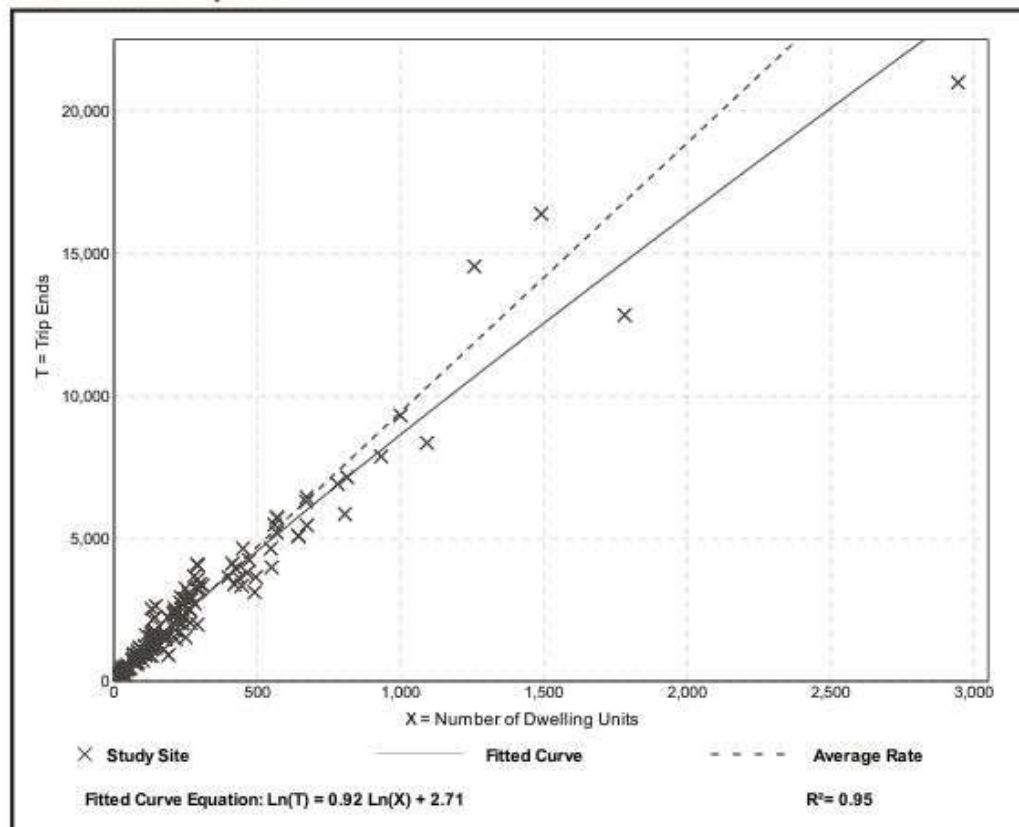
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 159
Avg. Num. of Dwelling Units: 264
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
9.44	4.81 - 19.39	2.10

Data Plot and Equation



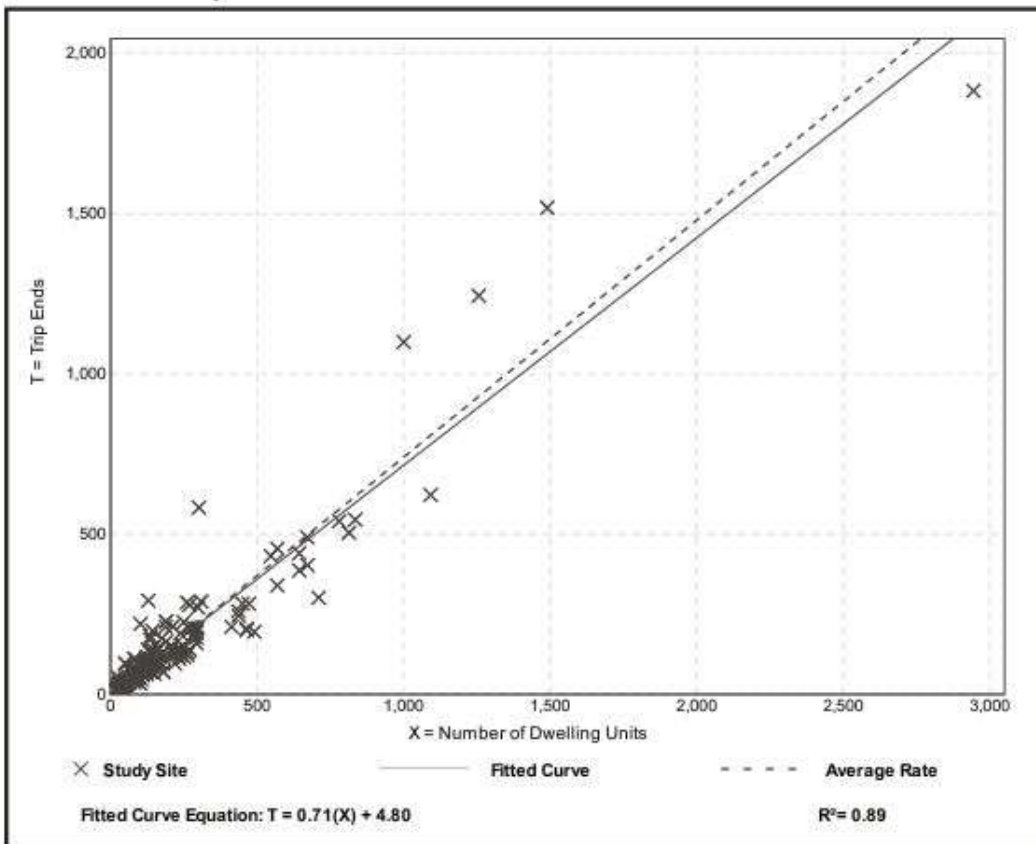
Single-Family Detached Housing (210)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: General Urban/Suburban
 Number of Studies: 173
 Avg. Num. of Dwelling Units: 219
 Directional Distribution: 25% entering, 75% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.74	0.33 - 2.27	0.27

Data Plot and Equation



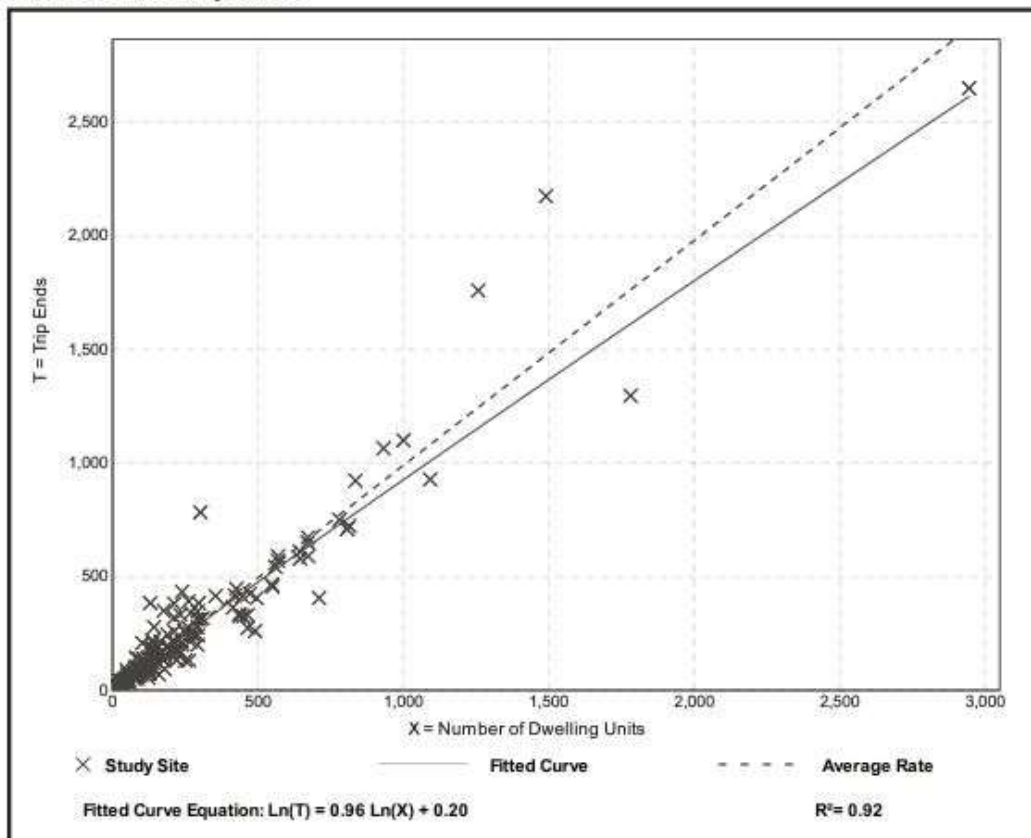
Single-Family Detached Housing (210)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: General Urban/Suburban
 Number of Studies: 190
 Avg. Num. of Dwelling Units: 242
 Directional Distribution: 63% entering, 37% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.99	0.44 - 2.98	0.31

Data Plot and Equation





MEMORANDUM

To: Traffic Impact Study Reviewers and Preparers (see attached list)

From: Mike Conger *ADC*

Date: August 14, 2000

Subject: Local Trip Generation Rates for Multi-Family Residential Uses

Attached please find a summary of the final report with data plots for the Knox County Local Apartment Trip Generation Study. As you will recall, this report was discussed when the traffic impact study group last convened this past February. A consensus was reached at that meeting that the trip generation rates developed in the local study should be used for new apartment complexes and any other "multi-family" residential uses that are being proposed.

The MPC voted at its July 2000 meeting to officially amend the Traffic Impact Study Guidelines with language which reads that "trip generation rates for proposed uses shall be calculated using the latest edition of the ITE Trip Generation Manual, or using local data when it is available". This amendment allows the full implementation of the new rates, and they should be used for future proposed multi-family developments unless it can be demonstrated otherwise.

Thanks for your assistance and cooperation in this matter, if there are any questions or comments, please let me know.

TRAFFIC IMPACT STUDY REVIEWER & PREPARER GROUP

Name	Organization	Phone Number
Daniel Armstrong	Wilbur Smith	584-8584
Rusty Baksa	Land Dev. Solutions	671-2281
Kim Henry Begg	SITE, inc.	693-5010
Mark Best	TDOT	594-9170
Alan Childers	Cannon & Cannon	988-4818
Steve Drummer	Barge Waggoner	637-2810
Mark Geldmeier	City of Knoxville	215-6100
John Gould	Wilbur Smith	584-8584
Barbara Hatcher	SITE, inc.	693-5010
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Bill Kervin	Allen Hoshall	694-1834
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David McGinley	City of Knoxville	215-2148
David Moore	TDOT	594-9170
Linda Mosch	Consultant	777-2025
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Cindy Pionke	Knox County	215-5800
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John Sexton	Allen Hoshall	694-1834
Jim Snowden	Knox County	215-5800
Darcy Sullivan	SITE, inc.	693-5010
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KNOX COUNTY
LOCAL APARTMENT TRIP GENERATION STUDY

PURPOSE

A Traffic Impact Study (TIS) is currently required in Knox County when a proposed development is projected to generate in excess of 750 trips per day. The determinations of when the threshold is met as well as all subsequent analyses in the TIS are performed using the rates and equations given in the Institute of Transportation Engineers (ITE) Trip Generation Manual. Local governmental agencies rely heavily on the accuracy of these trip generation rates in order to correctly predict the impacts of a proposed development on the transportation system. Therefore, in certain instances, it is logical to verify whether the “national” rates and equations given in the ITE Trip Generation Manual are appropriate for use in a specific local area or region.

The decision was made to study the local trip-making characteristics of apartments because of the discrepancy between the trip generation rates for apartments and single family residential land uses as given in the ITE Trip Generation Manual. While these two land uses are similar in nature, the Trip Generation Manual predicts about three less trips per dwelling unit generated by apartments for the average weekday. Additionally the Trip Generation Manual points out that due to the age of their database, which dates back to the 1960’s, “the rates for apartments probably had changed over time”. It is also assumed that some of the ITE data had come from larger metropolitan areas with denser development and greater transit use than Knox County, which would contribute to lower trip generation rates. Therefore, this study will be used to either verify the rates given in the Trip Generation Manual or generate new ones that can be applied to locally proposed apartment developments.

PROCEDURE

The procedures recommended by ITE in conducting local trip generation studies were generally followed for this study, along with some important assumptions that have made. ITE has published a proposed recommended practice entitled “Trip Generation Handbook” which specifically outlines procedures for conducting local trip generation studies and establishing new rates and equations.

The first step in the study was to define the number and location of the sites to be studied, as well as the counting methodology. Initially 14 sites were selected, although one apartment complex – the College Park Apartments – was later omitted due to uncharacteristically high traffic generation numbers. The number of sites used in this study far exceeds the recommended minimum amount suggested by ITE, which is five sites. Traffic counts were taken for week-long periods at 15-minute intervals between July 22, 1996 and August 9, 1996 at the access points to the apartment complexes. A Technical Appendix to this report contains the traffic count data collected at each apartment complex.

RESULTS

The traffic count data was analyzed using spreadsheets in order to determine the weighted average rates and regression equations. In order to be considered valid, the local rates and equations for each time period of analysis that were generated must meet certain statistical criteria. First, the standard deviation of the independent variable (dwelling units) should be no more than 110 percent of the weighted average rate; and secondly, the regression equations require a computed coefficient of determination (R^2) value of at least 0.75 before good data fit is indicated. This statistical criteria is met by the local data results, and in fact it often exceeds the level of data fit given by their counterparts in the ITE Trip Generation Manual. Finally, in order to simplify the use of the local data, plots were generated that appear identical to the actual ones in the ITE Trip Generation Manual.

The resulting rates and equations calculated from the local data indicate that the average weekday trip generation of apartments in this area is well above the national rates reported in the ITE manual. For example, the locally computed average rate for number of trips generated during a weekday is 35% higher than the rate given by ITE (increase from 6.63 trips per dwelling unit to 9.03 trips per dwelling unit). The trip generation rates do not increase as much for the AM and PM peak hours however. The local rate is roughly 8% higher for the AM peak, and 16% higher for the PM peak. The plots from the ITE Trip Generation Manual are included in the Technical Appendix for comparison purposes.

ASSUMPTIONS MADE

Some important assumptions have been made which may affect the results of the local data that was collected:

- It is important to note that the local trip generation rates were computed for the *total* number of dwelling units in the apartment complex, and not necessarily for the number of *occupied* dwelling units. There are several reasons why this was done, chiefly because of the need for comparability with the rates given in ITE Trip Generation Manual, as it does not specify whether the dwelling units are occupied. According to ITE procedures the selected sites must only be of “reasonably full occupancy (i.e. at least 85%)”. The Apartment Association of Greater Knoxville (AAGK) publishes quarterly reports on occupancy levels of apartment complexes, and the report covering the period of the data collection was reviewed to determine occupancy levels. According to the AAGK report from July 1, 1996 – September 30, 1996 all of the apartment complexes surveyed in this study met the minimum 85% occupancy level, with an average occupancy rate for all sites studied of 94%.
- The count data that was collected at each apartment complex was used “raw” meaning that it was not factored for possible daily or seasonal variations. Once again, according to an ITE representative it is not known whether the data used in the Trip Generation Manual was factored or not, so therefore in order to be able to compare

local rates to those in the manual you must assume that count data should not be factored. Additionally, it was felt that apartment complexes would generally not be as susceptible to major seasonal fluctuations as other land uses might be. The local rates were also developed using count data that was collected and averaged over an entire week, which should limit some of the daily variations. Finally, reliable local daily and seasonal variation factors do not truly exist.

CONCLUSION

The local apartment study methodology and results were distributed for comment to a group of local transportation professionals who are directly responsible for either preparing or reviewing traffic impact studies. A meeting was held between this group on February 16, 2000 in order to gather comments and discuss the study in greater detail. The following conclusions are based on the discussion and consensus reached at this meeting:

1. The trip generation rates and equations meet statistical requirements and resulted from a study that followed accepted procedures; therefore they should be adopted for future use. Furthermore, the rates and equations are recommended for use in reviewing the traffic impact of any development termed as “multi-family”, such as townhouse and condominium developments due to their similarity to apartment complexes.
2. The Traffic Access and Impact Study Guidelines and Procedures adopted by MPC should be amended with the language that local data should be used when available, which will allow the implementation of these new multi-family trip generation rates.
3. The following suggestions were made for future consideration:
 - This study should be updated with data collected from local townhouse and condominium developments in order to further justify the use of the new trip generation rates.
 - A statistical comparison should be made between any newly developed rates and the ITE single family trip generation rates to determine if there is a significant difference. If there is no difference then perhaps ITE single-family rates could be used for any residential development proposed in Knox County.

Local Apartment Trip Generation Study

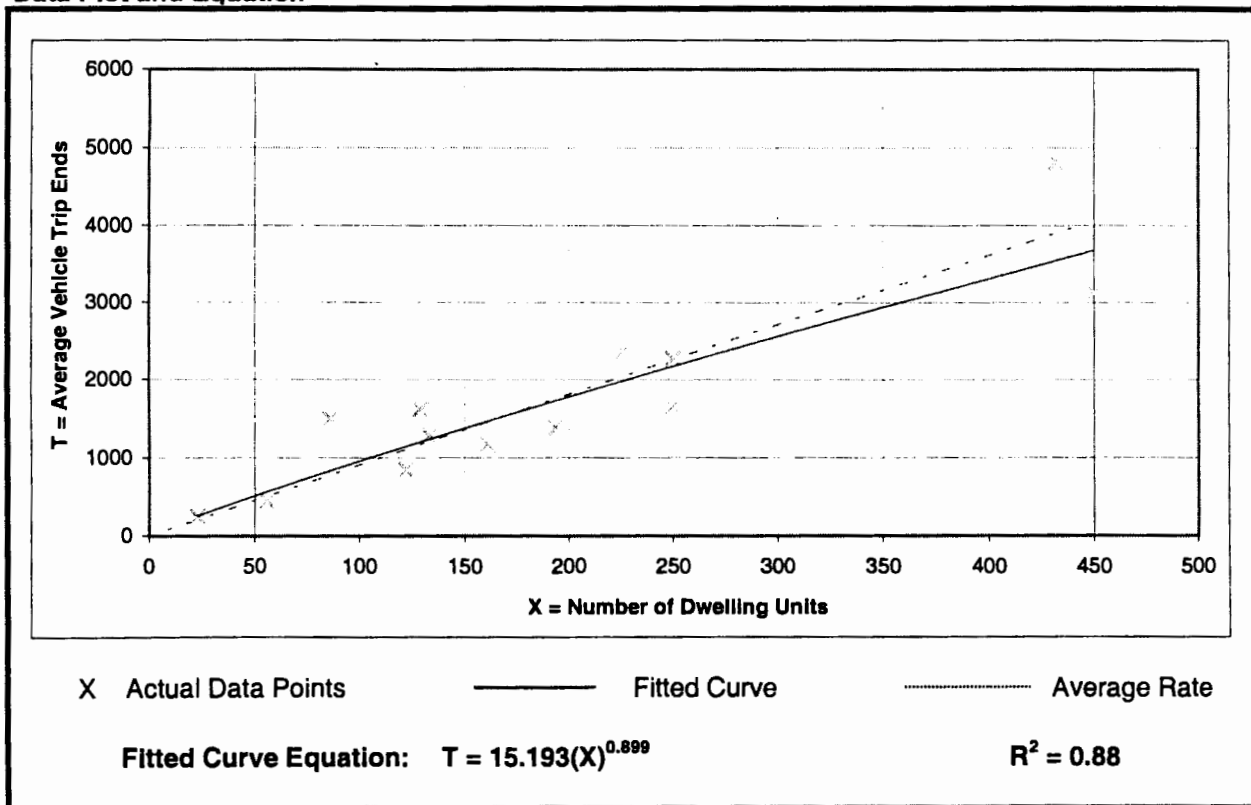
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Number of Studies: 13
Average Number of Dwelling Units: 193
Directional Distribution: 50% entering, 50% exiting

Trip Generation Per Dwelling Unit

Average Rate	Ranges of Rates	Standard Deviation
9.03	6.59 - 17.41	2.47

Data Plot and Equation



Local Apartment Trip Generation Study

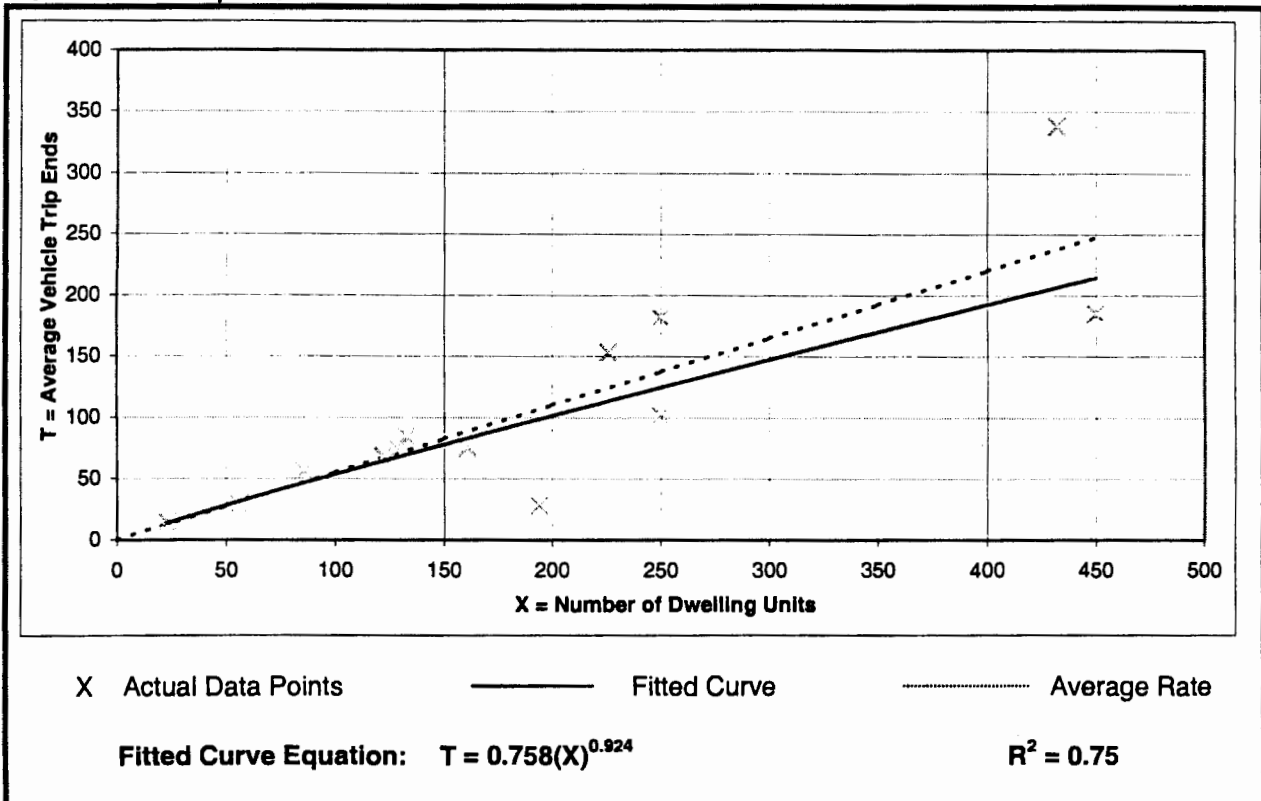
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Number of Studies: 13
 Average Number of Dwelling Units: 193
 Directional Distribution: 22% entering, 78% exiting

Trip Generation Per Dwelling Unit

Average Rate	Ranges of Rates	Standard Deviation
0.55	0.14 - 0.78	0.18

Data Plot and Equation



Local Apartment Trip Generation Study

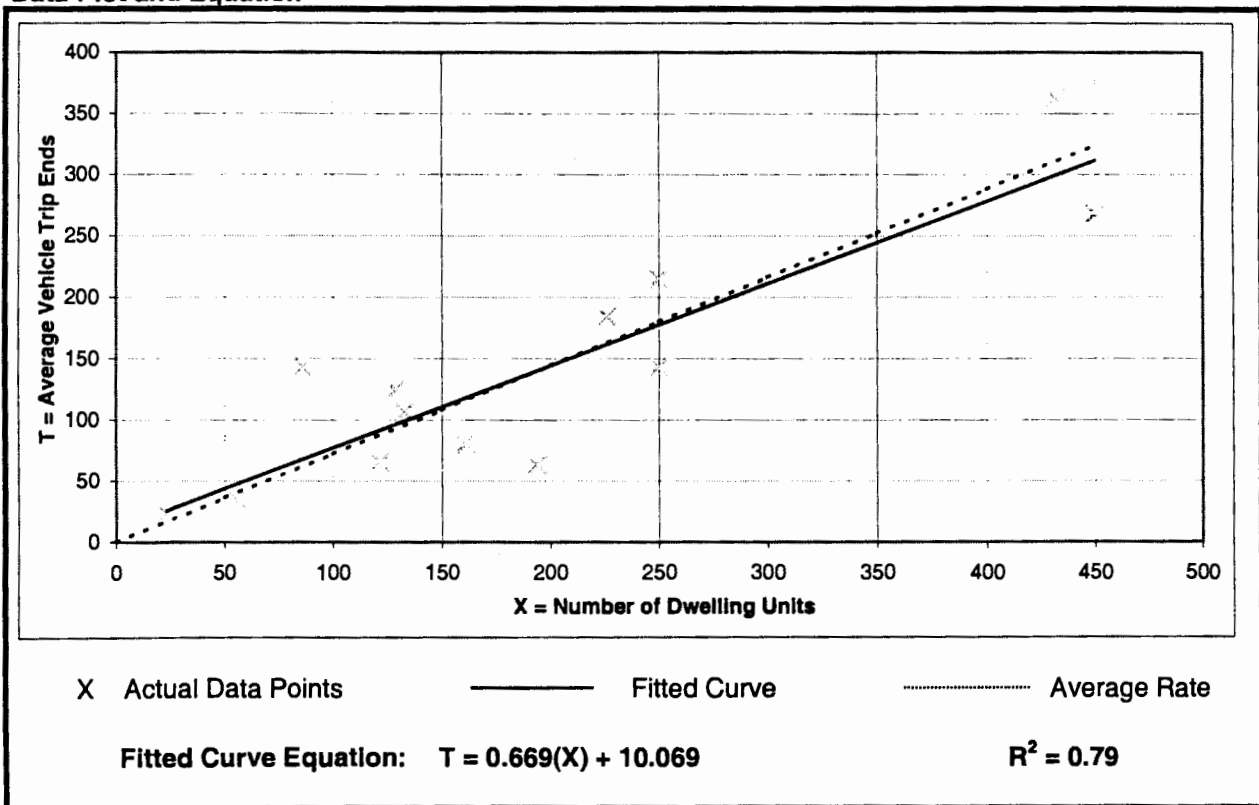
Average Vehicle Trip Ends vs: Dwelling Units
 On a: Weekday,
 Peak Hour of Adjacent Street Traffic,
 One Hour Between 4 and 6 p.m.

Number of Studies: 13
 Average Number of Dwelling Units: 193
 Directional Distribution: 55% entering, 45% exiting

Trip Generation Per Dwelling Unit

Average Rate	Ranges of Rates	Standard Deviation
0.72	0.32 - 1.66	0.25

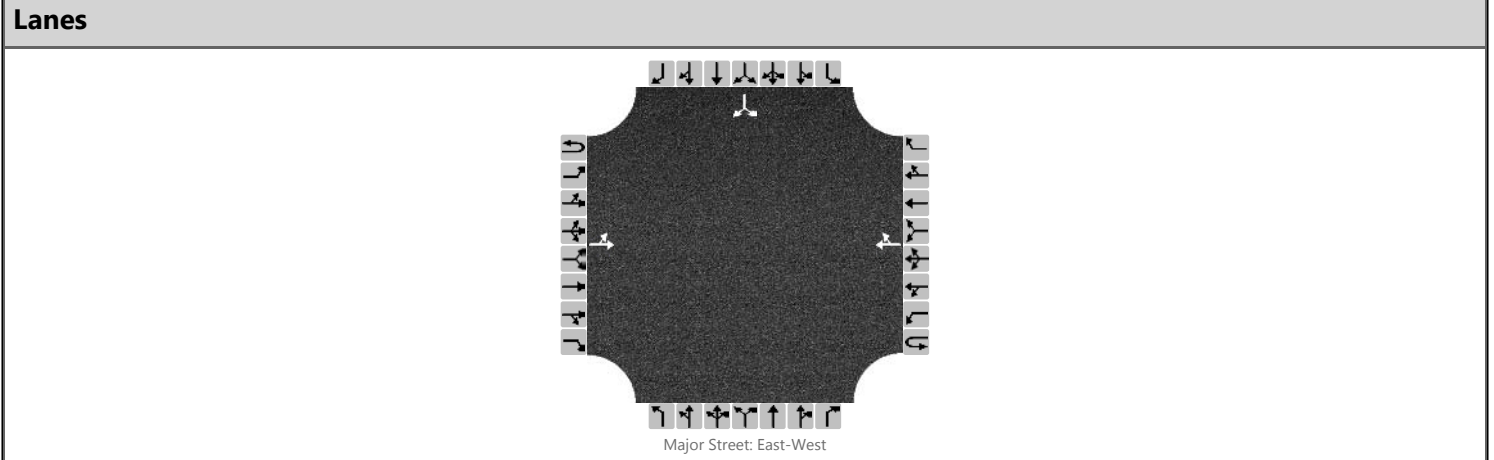
Data Plot and Equation



Attachment 5
Intersection Worksheets – Existing AM/PM Peaks

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Addie Kirkham	Intersection	W Emory Road at Henderson
Agency/Co.	FMA	Jurisdiction	Knox County
Date Performed	9/27/2020	East/West Street	W Emory Road
Analysis Year	2020	North/South Street	Henderson Road
Time Analyzed	Existing AM Peak	Peak Hour Factor	0.76
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	592.009 - Hatmaker Subdivision		



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound				
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12	
Priority																	
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	1	0	
Configuration		LT						TR							LR		
Volume, V (veh/h)		5	70				21	24						62		7	
Percent Heavy Vehicles (%)		2												2		2	
Proportion Time Blocked																	
Percent Grade (%)																0	
Right Turn Channelized		No			No				No				No				
Median Type/Storage		Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

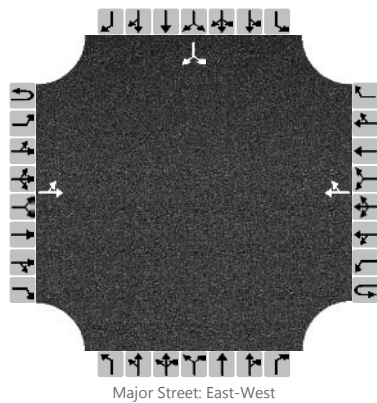
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		7														91	
Capacity, c (veh/h)		1542														853	
v/c Ratio		0.00														0.11	
95% Queue Length, Q ₉₅ (veh)		0.0														0.4	
Control Delay (s/veh)		7.3														9.7	
Level of Service, LOS		A														A	
Approach Delay (s/veh)		0.6												9.7			
Approach LOS														A			

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Addie Kirkham	Intersection	W Emory Road at Henderson
Agency/Co.	FMA	Jurisdiction	Knox County
Date Performed	9/27/2020	East/West Street	W Emory Road
Analysis Year	2020	North/South Street	Henderson Road
Time Analyzed	Existing PM Peak	Peak Hour Factor	0.90
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	592.009 - Hatmaker Subdivision		

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume, V (veh/h)		19	47				43	67						42		10
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

Delay, Queue Length, and Level of Service

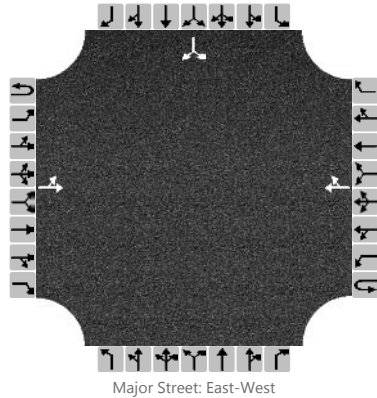
Flow Rate, v (veh/h)		21														58
Capacity, c (veh/h)		1464														827
v/c Ratio		0.01														0.07
95% Queue Length, Q ₉₅ (veh)		0.0														0.2
Control Delay (s/veh)		7.5														9.7
Level of Service, LOS		A														A
Approach Delay (s/veh)	2.2												9.7			
Approach LOS													A			

Attachment 6
Intersection Worksheets – Background AM/PM Peaks

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Addie Kirkham	Intersection	W Emory Road at Henderson
Agency/Co.	FMA	Jurisdiction	Knox County
Date Performed	9/27/2020	East/West Street	W Emory Road
Analysis Year	2023	North/South Street	Henderson Road
Time Analyzed	Background AM Peak	Peak Hour Factor	0.76
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	592.009 - Hatmaker Subdivision		

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume, V (veh/h)		5	74				22	25						66		7
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

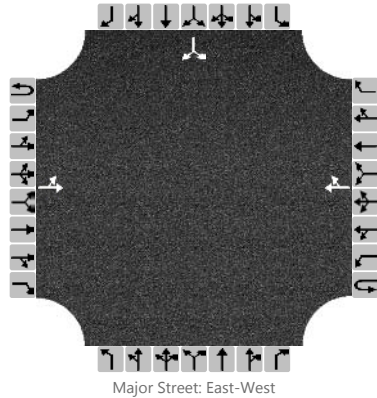
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		7														96
Capacity, c (veh/h)		1540														846
v/c Ratio		0.00														0.11
95% Queue Length, Q ₉₅ (veh)		0.0														0.4
Control Delay (s/veh)		7.3														9.8
Level of Service, LOS		A														A
Approach Delay (s/veh)	0.5												9.8			
Approach LOS													A			

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Addie Kirkham	Intersection	W Emory Road at Henderson
Agency/Co.	FMA	Jurisdiction	Knox County
Date Performed	9/27/2020	East/West Street	W Emory Road
Analysis Year	2023	North/South Street	Henderson Road
Time Analyzed	Background PM Peak	Peak Hour Factor	0.90
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	592.009 - Hatmaker Subdivision		

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume, V (veh/h)		20	50				46	71						45		11
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

Delay, Queue Length, and Level of Service

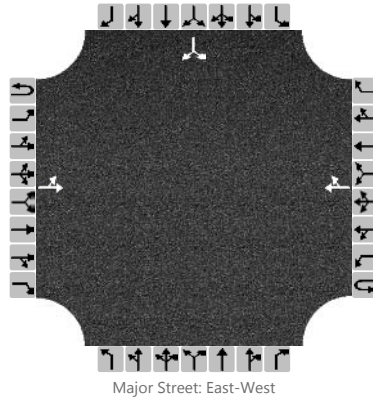
Flow Rate, v (veh/h)		22														62
Capacity, c (veh/h)		1454														816
v/c Ratio		0.02														0.08
95% Queue Length, Q ₉₅ (veh)		0.0														0.2
Control Delay (s/veh)		7.5														9.8
Level of Service, LOS		A														A
Approach Delay (s/veh)	2.2												9.8			
Approach LOS													A			

Attachment 7
Intersection Worksheets – Full Buildout AM/PM Peaks

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Addie Kirkham	Intersection	W Emory Road at Henderson
Agency/Co.	FMA	Jurisdiction	Knox County
Date Performed	10/25/2020	East/West Street	W Emory Road
Analysis Year	2023	North/South Street	Henderson Road
Time Analyzed	Full Buildout AM Peak	Peak Hour Factor	0.76
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	592.009 - Hatmaker Subdivision		

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume, V (veh/h)		16	98				32	28						66		11
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

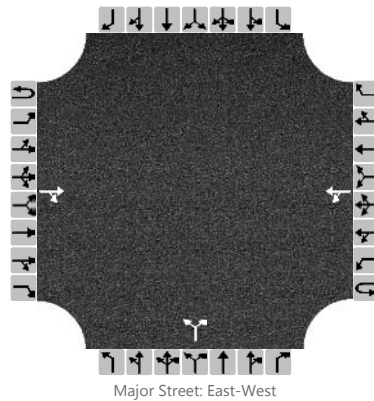
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		21														101
Capacity, c (veh/h)		1518														773
v/c Ratio		0.01														0.13
95% Queue Length, Q ₉₅ (veh)		0.0														0.4
Control Delay (s/veh)		7.4														10.4
Level of Service, LOS		A														B
Approach Delay (s/veh)	1.1												10.4			
Approach LOS													B			

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Addie Kirkham	Intersection	W Emory at Main Driveway
Agency/Co.	FMA	Jurisdiction	Knox County
Date Performed	10/25/2020	East/West Street	W Emory Road
Analysis Year	2023	North/South Street	Driveway
Time Analyzed	Full Buildout AM Peak	Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	592.009 - Hatmaker Subdivision		

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	0	1	0	0	0	1	0		0	1	0		0	0	0
Configuration				TR		LT					LR					
Volume, V (veh/h)			80	4		11	32			11		34				
Percent Heavy Vehicles (%)						2				2		2				
Proportion Time Blocked																
Percent Grade (%)									0							
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1					7.1		6.2			
Critical Headway (sec)						4.12					6.42		6.22			
Base Follow-Up Headway (sec)						2.2					3.5		3.3			
Follow-Up Headway (sec)						2.22					3.52		3.32			

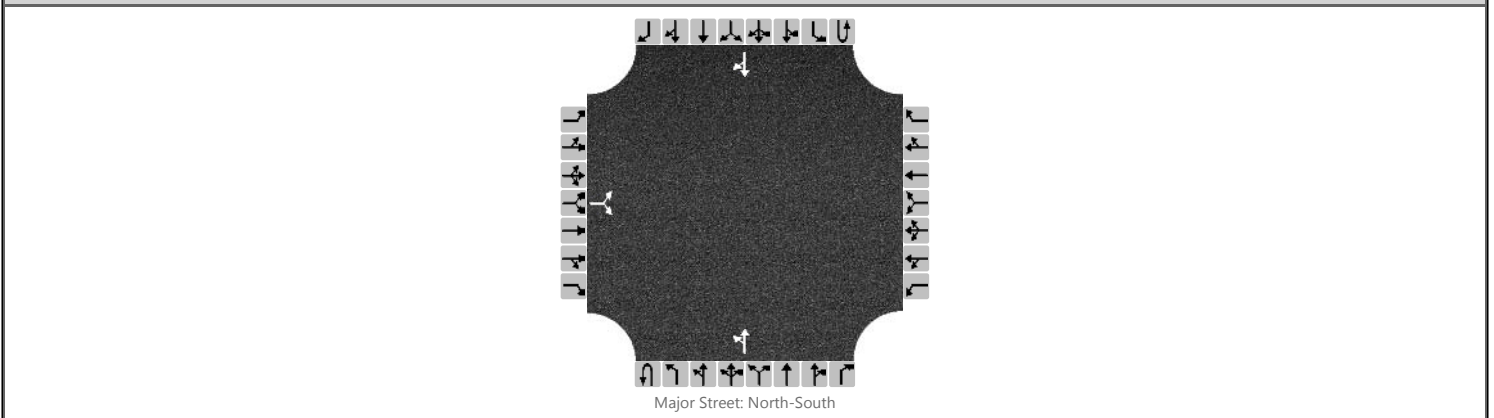
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						12					49					
Capacity, c (veh/h)						1503					933					
v/c Ratio						0.01					0.05					
95% Queue Length, Q ₉₅ (veh)						0.0					0.2					
Control Delay (s/veh)						7.4					9.1					
Level of Service, LOS						A					A					
Approach Delay (s/veh)					1.9				9.1							
Approach LOS									A							

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Addie Kirkham	Intersection	W Emory Road at Driveway
Agency/Co.	FMA	Jurisdiction	Knox County
Date Performed	10/25/2020	East/West Street	Townhome Driveway (North)
Analysis Year	2023	North/South Street	W Emory Road
Time Analyzed	Full Buildout AM Peak	Peak Hour Factor	0.92
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	592.009 - Hatmaker Subdivision		

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement																
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0		0	1	0		0	1	0
Configuration			LR							LT						TR
Volume, V (veh/h)		3		3						1	57				163	1
Percent Heavy Vehicles (%)		2		2						2						
Proportion Time Blocked																
Percent Grade (%)	0															
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.42		6.22						4.12						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.52		3.32						2.22						

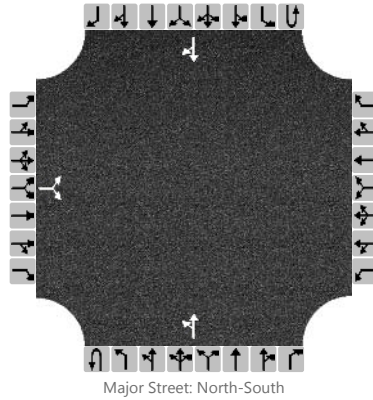
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			6							1						
Capacity, c (veh/h)			801							1397						
v/c Ratio			0.01							0.00						
95% Queue Length, Q ₉₅ (veh)			0.0							0.0						
Control Delay (s/veh)			9.5							7.6						
Level of Service, LOS			A							A						
Approach Delay (s/veh)	9.5								0.1							
Approach LOS	A															

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Addie Kirkham	Intersection	W Emory Road at Driveway
Agency/Co.	FMA	Jurisdiction	Knox County
Date Performed	10/25/2020	East/West Street	Townhome Driveway (South)
Analysis Year	2023	North/South Street	W Emory Road
Time Analyzed	Full Buildout AM Peak	Peak Hour Factor	0.92
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	592.009 - Hatmaker Subdivision		

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement																
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0		0	1	0		0	1	0
Configuration			LR							LT						TR
Volume, V (veh/h)		3		3						1	55				166	0
Percent Heavy Vehicles (%)		2		2						2						
Proportion Time Blocked																
Percent Grade (%)	0															
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.42		6.22						4.12						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.52		3.32						2.22						

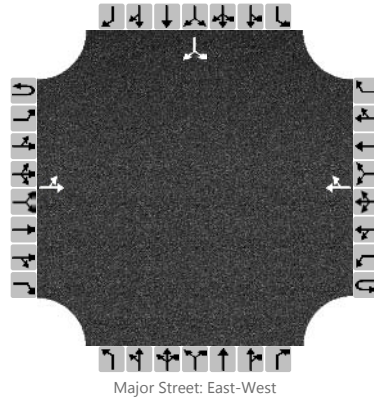
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			6							1						
Capacity, c (veh/h)			800							1394						
v/c Ratio			0.01							0.00						
95% Queue Length, Q ₉₅ (veh)			0.0							0.0						
Control Delay (s/veh)			9.5							7.6						
Level of Service, LOS			A							A						
Approach Delay (s/veh)	9.5								0.1							
Approach LOS	A															

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Addie Kirkham	Intersection	W Emory Road at Henderson
Agency/Co.	FMA	Jurisdiction	Knox County
Date Performed	10/25/2020	East/West Street	W Emory Road
Analysis Year	2023	North/South Street	Henderson Road
Time Analyzed	Full Buildout PM Peak	Peak Hour Factor	0.90
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	592.009 - Hatmaker Subdivision		

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound				
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12	
Priority																	
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	1	0	
Configuration		LT						TR							LR		
Volume, V (veh/h)		28	69				74	73						48		23	
Percent Heavy Vehicles (%)		2												2		2	
Proportion Time Blocked																	
Percent Grade (%)																0	
Right Turn Channelized		No			No				No			No					
Median Type/Storage		Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

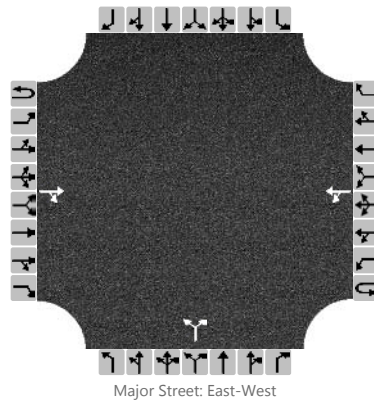
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		31														79	
Capacity, c (veh/h)		1415														770	
v/c Ratio		0.02														0.10	
95% Queue Length, Q ₉₅ (veh)		0.1														0.3	
Control Delay (s/veh)		7.6														10.2	
Level of Service, LOS		A														B	
Approach Delay (s/veh)		2.3												10.2			
Approach LOS														B			

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Addie Kirkham	Intersection	W Emory at Main Driveway
Agency/Co.	FMA	Jurisdiction	Knox County
Date Performed	10/25/2020	East/West Street	W Emory Road
Analysis Year	2023	North/South Street	Driveway
Time Analyzed	Full Buildout PM Peak	Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	592.009 - Hatmaker Subdivision		

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	0	1	0	0	0	1	0		0	1	0		0	0	0
Configuration				TR		LT					LR					
Volume, V (veh/h)			73	12		37	60			8		24				
Percent Heavy Vehicles (%)						2				2		2				
Proportion Time Blocked																
Percent Grade (%)									0							
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1					7.1		6.2			
Critical Headway (sec)						4.12					6.42		6.22			
Base Follow-Up Headway (sec)						2.2					3.5		3.3			
Follow-Up Headway (sec)						2.22					3.52		3.32			

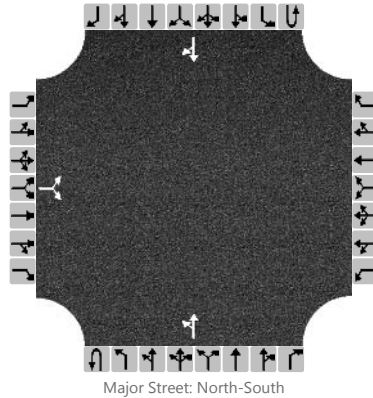
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						40					35					
Capacity, c (veh/h)						1502					899					
v/c Ratio						0.03					0.04					
95% Queue Length, Q ₉₅ (veh)						0.1					0.1					
Control Delay (s/veh)						7.5					9.2					
Level of Service, LOS						A					A					
Approach Delay (s/veh)					3.0				9.2							
Approach LOS									A							

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Addie Kirkham	Intersection	W Emory Road at Driveway
Agency/Co.	FMA	Jurisdiction	Knox County
Date Performed	10/25/2020	East/West Street	Townhome Driveway (North)
Analysis Year	2023	North/South Street	W Emory Road
Time Analyzed	Full Buildout PM Peak	Peak Hour Factor	0.92
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	592.009 - Hatmaker Subdivision		

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound							
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R				
Movement																				
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6				
Number of Lanes		0	1	0		0	0	0	0	0	1	0	0	0	1	0				
Configuration			LR								LT						TR			
Volume, V (veh/h)		3		3						3	144					114	3			
Percent Heavy Vehicles (%)		2		2						2										
Proportion Time Blocked																				
Percent Grade (%)		0																		
Right Turn Channelized		No					No					No					No			
Median Type/Storage		Undivided																		

Critical and Follow-up Headways

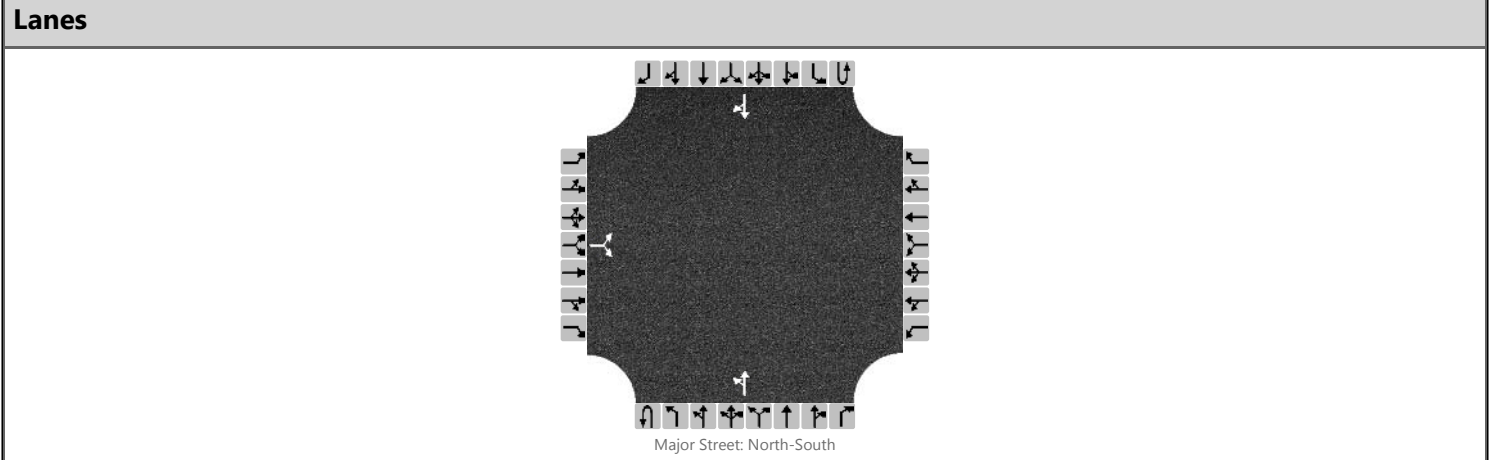
Base Critical Headway (sec)		7.1		6.2						4.1							
Critical Headway (sec)		6.42		6.22						4.12							
Base Follow-Up Headway (sec)		3.5		3.3						2.2							
Follow-Up Headway (sec)		3.52		3.32						2.22							

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			6							3								
Capacity, c (veh/h)			797							1458								
v/c Ratio			0.01							0.00								
95% Queue Length, Q ₉₅ (veh)			0.0							0.0								
Control Delay (s/veh)			9.6							7.5								
Level of Service, LOS			A							A								
Approach Delay (s/veh)		9.6								0.2								
Approach LOS		A																

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Addie Kirkham	Intersection	W Emory Road at Driveway
Agency/Co.	FMA	Jurisdiction	Knox County
Date Performed	10/25/2020	East/West Street	Townhome Driveway (South)
Analysis Year	2023	North/South Street	W Emory Road
Time Analyzed	Full Buildout PM Peak	Peak Hour Factor	0.92
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	592.009 - Hatmaker Subdivision		



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement																
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0		0	1	0		0	1	0
Configuration			LR							LT						TR
Volume, V (veh/h)		2		3						4	145				114	3
Percent Heavy Vehicles (%)		2		2						2						
Proportion Time Blocked																
Percent Grade (%)	0															
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.42		6.22						4.12						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.52		3.32						2.22						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			5							4						
Capacity, c (veh/h)			817							1458						
v/c Ratio			0.01							0.00						
95% Queue Length, Q ₉₅ (veh)			0.0							0.0						
Control Delay (s/veh)			9.4							7.5						
Level of Service, LOS			A							A						
Approach Delay (s/veh)	9.4								0.2							
Approach LOS	A															

Attachment 8

Turn Lane Warrant Analysis

Project: Hatmaker Subdivision

W Emory Road at Main Driveway Connection

W Emory Road at Main Driveway Connection		VOLUMES				
LEFT TURN	Opposing	Thru	LT	LT MAX	Warrant Met	
AM	84	32	11	300	NO	
PM	85	60	37	300	NO	

W Emory Road at Main Driveway Connection

W Emory Road at Main Driveway Connection		VOLUMES				
RIGHT TURN	Thru	RT	RT MAX	Warrant Met		
AM	80	4	599	NO		
PM	73	12	599	NO		

TABLE 4A

LEFT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 35 MPH OR LESS

(If the left-turn volume exceeds the table value a left -turn lane is needed)

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	100 - 149	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399
100 - 149	300		185	145	120	100
150 - 199	245		160	130	110	90
200 - 249		170	140	115	100	80
250 - 299		150	125	105	90	70
300 - 349		135	110	95	80	65
350 - 399		120	100	85	70	60
400 - 449		105	90	75	65	55
450 - 499		90	80	70	60	50
500 - 549		80	70	65	55	50
550 - 599		70	65	60	50	45
600 - 649		65	60	55	45	40
650 - 699		60	55	50	40	35
700 - 749		55	50	45	35	30
750 or More		50	45	40	35	30

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	= / > 600
100 - 149	100	80	70	60	55	50
150 - 199	90	75	65	55	50	45
200 - 249	80	72	460	55	50	45
250 - 299	70	65	55	50	45	40
300 - 349	65	60	50	50	45	40
350 - 399	60	55	50	45	40	40
400 - 449	55	50	45	45	40	35
450 - 499	50	45	45	40	35	35
500 - 549	50	45	40	40	35	35
550 - 599	45	40	40	35	35	35
600 - 649	40	35	35	35	35	30
650 - 699	35	35	35	30	30	30
700 - 749	30	30	30	30	30	30
750 or More	30	30	30	30	30	30

* Or through volume only if a right-turn lane exists.

TABLE 4B
RIGHT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 35 MPH OR LESS

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	<100	100 - 199	200 - 249	250 - 299	300 - 349	350 - 399
Fewer Than 25 25 - 49 50 - 99	<div style="border: 1px solid blue; border-radius: 50%; width: 20px; height: 20px; display: inline-block; vertical-align: middle;"></div> AM Peak = 4 RT PM Peak = 12 RT					
100 - 149 150 - 199						
200 - 249 250 - 299						Yes
300 - 349 350 - 399				Yes	Yes Yes	Yes Yes
400 - 449 450 - 499			Yes Yes	Yes Yes	Yes Yes	Yes Yes
500 - 549 550 - 599		Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 600	+ / > 600
Fewer Than 25 25 - 49 50 - 99					Yes	Yes Yes
100 - 149 150 - 199			Yes	Yes Yes	Yes Yes	Yes Yes
200 - 249 250 - 299	Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
300 - 349 350 - 399	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
500 - 549 550 - 599	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

* Or through volume only if a left-turn lane exists.