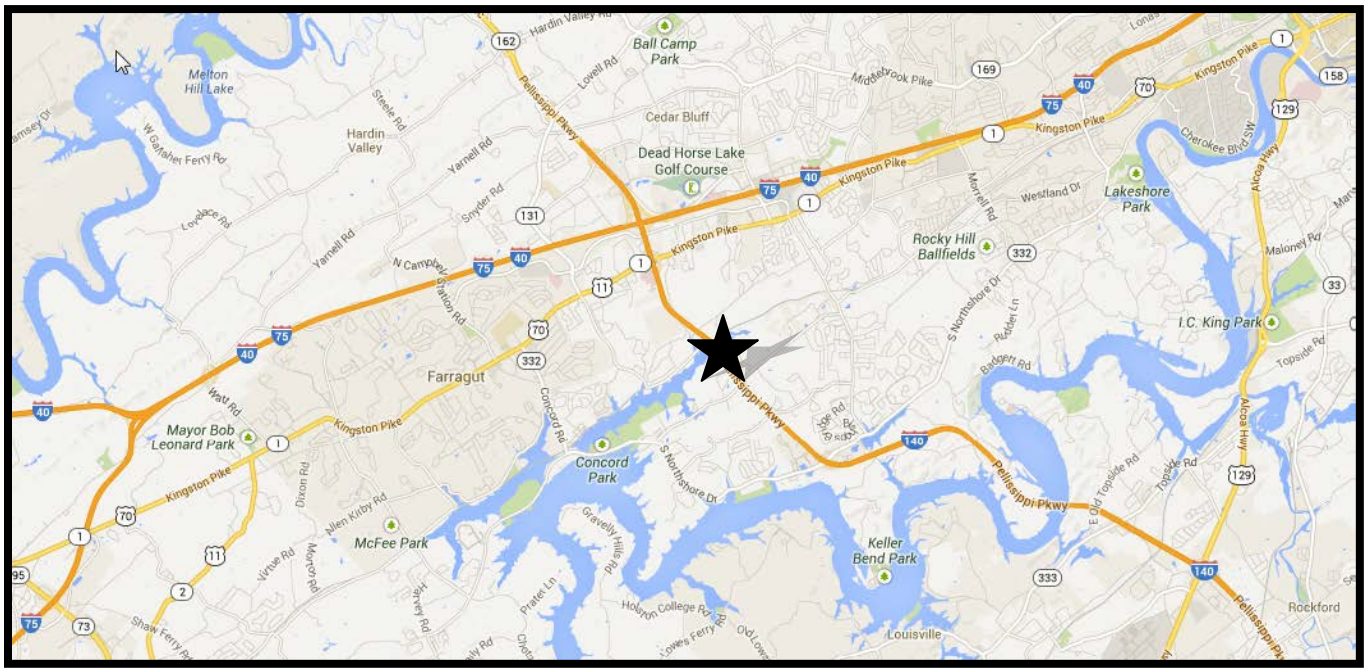

TRAFFIC IMPACT STUDY

WESTLAND COVE

KNOX COUNTY, TENNESSEE

-Prepared For-

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September 2013

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INTRODUCTION

The purpose of this traffic study is to analyze the traffic impacts of a new proposed apartment complex and boat livery/marina named Westland Cove in Knox County, Tennessee. This development is being proposed along Emory Church Road in west Knox County. This traffic impact study for the new development follows the procedures and standards as outlined for a Level 2 study developed by the Knoxville/Knox County Metropolitan Planning Commission.

In this traffic impact study the following analyses/methodologies were employed:

- A review of the operating characteristics of the existing roadway system that will provide access to the proposed site.
- The trips that are expected to be generated by the proposed development were determined and applied to the existing road system.
- The impacted road locations were then re-evaluated to determine the potential traffic impacts of the proposed development.
- The projected traffic volumes are also coupled with identifiable recommendations of road or intersection improvements that would mitigate the expected increase in traffic volume.

PROJECT DESCRIPTION

The proposed location of this new development is shown on a map in Figure 1. The development is to be located on the east and west sides of Emory Church Road starting approximately 1,800 feet to the north of the intersection of Westland Drive and Emory Church Road. Major adjacent access will be provided by Emory Church Road, Westland Drive, and Fox Road. In the vicinity of this study area, there are a couple of other residential subdivisions, individual residences, churches, and vacant land. The existing development site primarily consists of woods and undeveloped land along Fort Loudoun Lake.

The proposed apartment complex and the boat livery/marina are expected to be comprised of several new internal drives and buildings on a property parcel of approximately 80

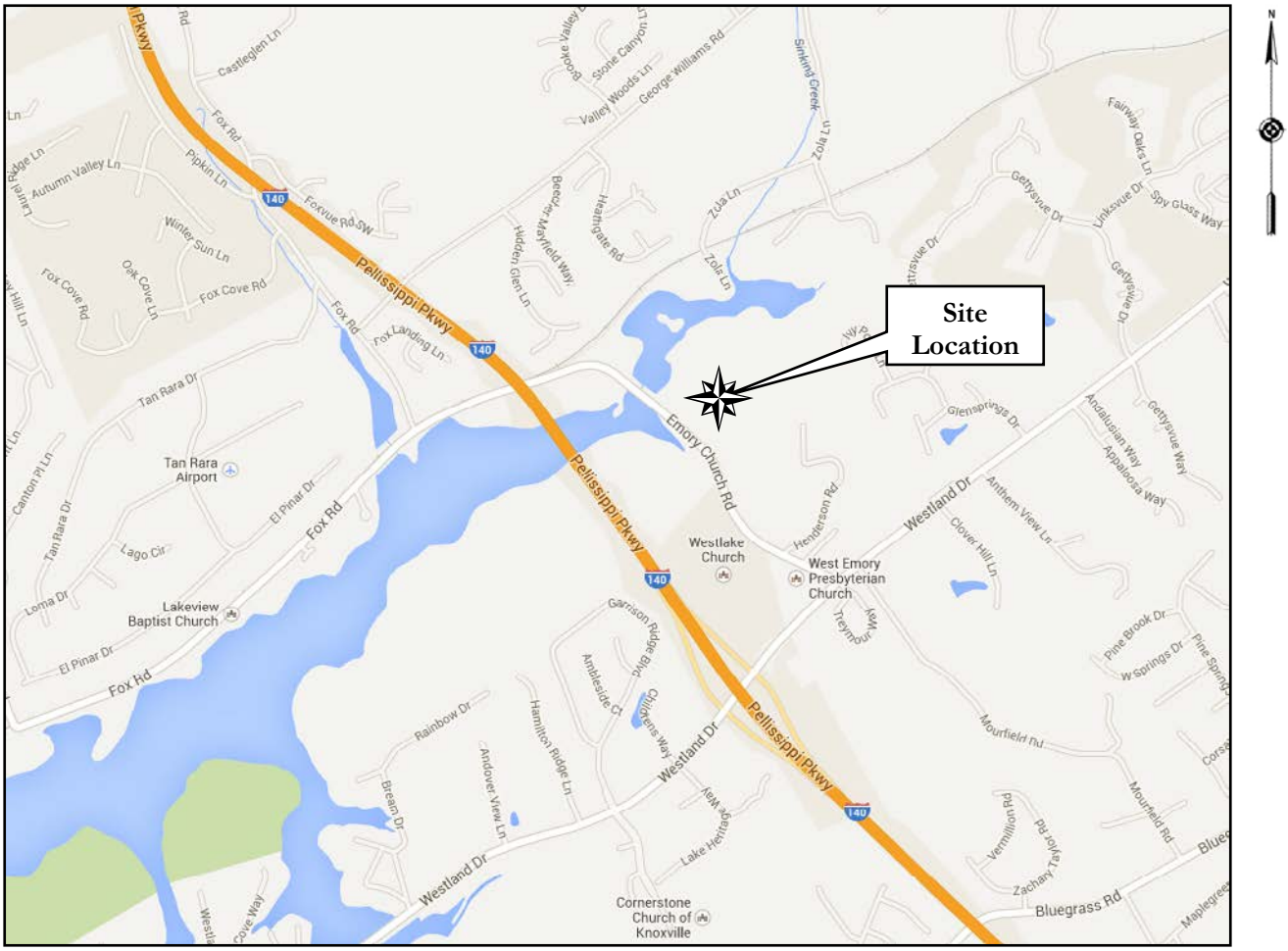

Figure 1
Location Map
Westland Cove

acres that occupies both sides of Emory Church Road and Pellissippi Parkway. A large portion of the existing property will be left as undeveloped. The apartment portion of the development will ultimately include apartments on the east and west side of Emory Church Road. The boat livery/marina will also include development on both sides of Emory Church Road. The project summary is listed below:

Apartments East of Emory Church Road:

- 9 buildings with 28 units each
- 252 total units
- 474 total parking spaces

Apartments West of Emory Church Road:

- 1 building with 28 units
- 2 buildings with 24 units each
- 76 total units
- 158 total parking spaces

TOTAL APARTMENTS = 328 units

Boat Livery/Marina:

- 233 water craft storage stalls
- 75 dock slips
- 80 parking spaces
- 233 slips sized to accommodate launch vehicle

The proposed plan layout given and designed by Nathan Silvus, PE with Silvus Engineering Consulting is shown in Figure 2.

The actual schedule for completion of this new residential and commercial development is dependent on economic factors. This project is also contingent on permitting, design, and other issues. However, for the purposes of this study, it was assumed as anticipated by the developer that the total construction build-out and actual operation of the development will occur by the year 2015.

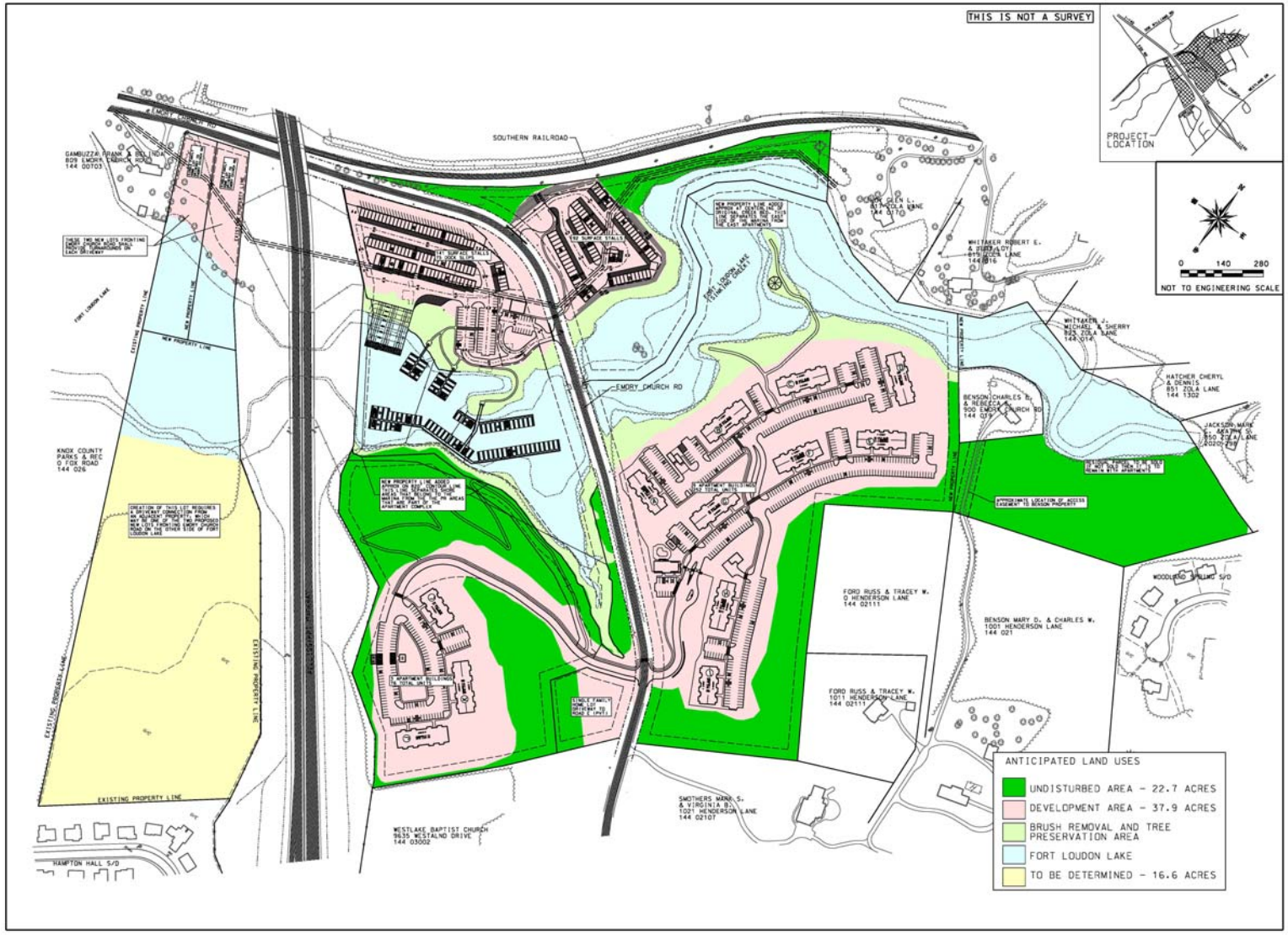

Figure 2

Proposed Plan Layout
Westland Cove

EXISTING CONDITIONS

The intersection and roads to be reviewed for the development were selected to determine the traffic impacts of the proposed new development. These roads include Emory Church Road, Fox Road and Westland Drive. These roadways will provide adjacent access to the proposed new apartment complex and boat livery/marina and are described below:

Westland Drive is classified as a minor arterial road and traverses in a northeast-south west direction in the study area. Westland Drive at the intersection with Emory Church Road consists of a 3-lane section (center turning lane and left turn lane) to the east and west. The speed limit on Westland Drive has been posted at 40 mph in this area. Average Daily Traffic (ADT) on Westland Drive in the vicinity of this intersection (to the northeast) was reported by the Knoxville-Knox County Metropolitan Planning Commission (MPC) at 10,600 vehicles per day in 2012 (Station #M1). Historical MPC data for this traffic count station can be viewed in the Appendix C. A private residential road (Treymour Way) makes up the fourth (southern) leg at the intersection of Westland Drive and Emory Church Road. The northwest and southeast bound approaches (Emory Church Road and Treymour Way) are controlled by stop signs. The eastbound storage length of the left turn lane on Westland Drive is 100 feet (not including taper). The southbound left/thru storage lane is 65 feet (not including taper).

Fox Road is classified as a major collector and is primarily a two-lane road that serves as access to residential and commercial properties. Fox Road intersects Emory Church Road at a three-way intersection. At this intersection, Fox Road is controlled with a yield sign and also includes a railroad crossing at the intersection with Emory Church Road. The speed limit on Fox Road has been posted at 30 mph. Average Daily Traffic (ADT) on Fox Road in the vicinity of this development was reported by the Tennessee Department of Transportation (TDOT) at 2,526 vehicles per day in 2012 (Station #473). Historical TDOT data for this traffic count station can be viewed in Appendix C.

Emory Church Road is classified as a minor collector and is a two-lane road that serves as access to primarily residential properties. This road will be the point of access for the apartment complexes and the boat livery/marina to the existing road system. The speed limit on Emory Church Road has been posted at 30 mph in the area. Average Daily Traffic (ADT) on Emory Church Road in the vicinity of this development was reported by the MPC at 2,830 vehicles per day in 2010 (Station #M268). Historical data for this traffic count station can be viewed in Appendix C.

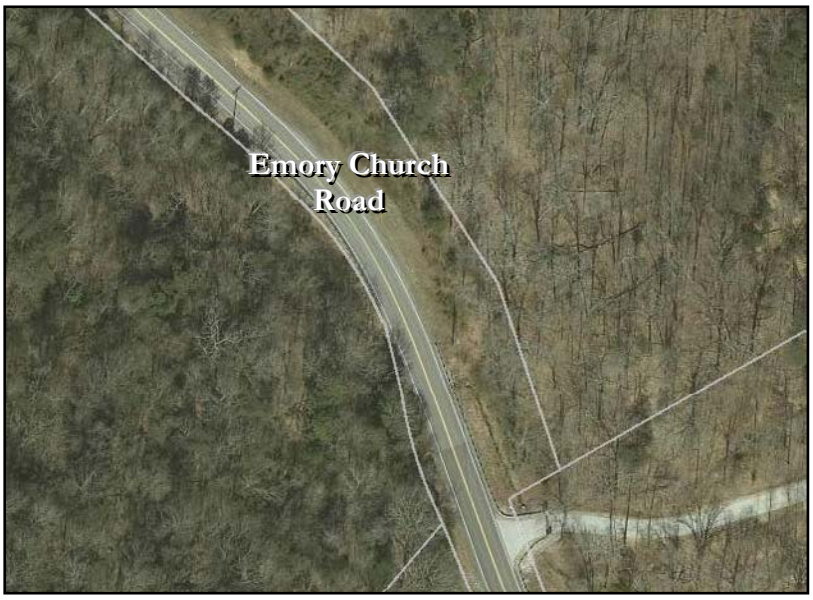

PHOTO REFERENCES

View of Emory Church Road at Westland Drive
(Looking Southbound)

View of Emory Church Road at Westland Drive
(Looking Westbound)

View of Emory Church Road at Westland Drive
(Looking Eastbound)

View of Emory Church Road at Westland Drive
(Looking Northbound)

View of Emory Church Road
at Fox Road
(Looking Southbound)

View of Emory Church Road
at Fox Road
(Looking Westbound)

View of Emory Church Road
at Fox Road
(Looking Eastbound)

View of Emory Church Road
near proposed Apartment Entrances
(Looking Southbound)

View of Emory Church Road
near proposed Boat
Livery/Marina Entrances
(Looking Northbound)

EXISTING TRAFFIC VOLUMES

In order to analyze the traffic impacts associated with the proposed future development, collection of traffic counts were necessary in the area of the proposed new intersections along Emory Church Road and the existing intersections of Fox Road/Emory Church Road and Westland Drive/Emory Church Road. Traffic counts were obtained the week of August 26th, 2013 – two weeks after local schools had been in session and were taken on a Tuesday and Wednesday. The existing intersection at Fox Road/Emory Church Road operates with a single yield sign for the southbound approach. The existing intersection of Westland Drive/Emory Church Road operates with stop control for the north and southbound approaches.

Based on these traffic counts, the AM peak hour of traffic occurred between the hour of 7:15 AM and 8:15 AM at both of the existing intersections. The PM peak hour of traffic occurred between the hour of 5:00 PM and 6:00 PM at both of the existing intersections. The manual traffic counts can be reviewed in Appendix A and the existing peak hour volumes at the road locations are shown in Figure 3.

Capacity analyses were undertaken to determine the existing Level of Service (LOS) for the intersections. The capacity analyses were calculated by following the methods outlined in the Highway Capacity Manual, TRB Special Report 209 and using Synchro Traffic Software (Version 5).

LOS is an indication of how well an intersection or roadway performs, and LOS designations include LOS A through LOS F. The designation of LOS A signifies a roadway or intersection operating at best, while LOS F signifies road operations at the worst. The Highway Capacity Manual lists level of service criteria for unsignalized intersections and is presented in this report as Table 1. For unsignalized intersections, Level of Service is measured in terms of delay. This measure is an attempt to quantify delay that includes lost travel time, driver discomfort, and fuel consumption. Level of Service for unsignalized intersections are calculated for turning

(Source: FDOT)

movements associated with stop or yield control and also for left turns on "un-controlled" major streets. Generally, for most instances, LOS D is considered the upper limit of acceptable delay.

Based on the capacity calculations, the results from the existing peak hour traffic can be seen in Table 2 for the intersections. The intersections are shown with a LOS designation for the AM and PM peak hours in the table. For the existing unsignalized intersection of Fox Road and Emory Church Road, the peak hour levels of service are shown to operate at a very good level during both the AM and PM peak hours. However at the intersection of Westland Drive and Emory Church Road, the northbound and southbound approaches are at failure during the AM and PM peak hours.

For the existing peak hours, the calculations show that the queue length appears to be sufficient for the eastbound approach left turn lane on Westland Drive. The eastbound storage length of the left turn lane on Westland Drive is 100 feet (not including taper). However, as expected with the failure of the southbound approach, it has been calculated that the southbound left/thru lane queue length is not sufficient. . The southbound left/thru storage lane currently is 65 feet (not including taper).

TABLE 1

LEVEL OF SERVICE FOR UNSIGNALIZED INTERSECTIONS

LEVEL OF SERVICE	DESCRIPTION	DELAY RANGE (sec/veh)
A	Little or no delay	<= 10
B	Short Traffic Delays	>10 and <=15
C	Average Traffic Delays	>15 and <=25
D	Long Traffic Delays	>25 and <=35
E	Very Long Traffic Delays	>35 and <=50
F	Extreme Traffic Delays	>50

Source: Highway Capacity Manual, TRB Special Report 209

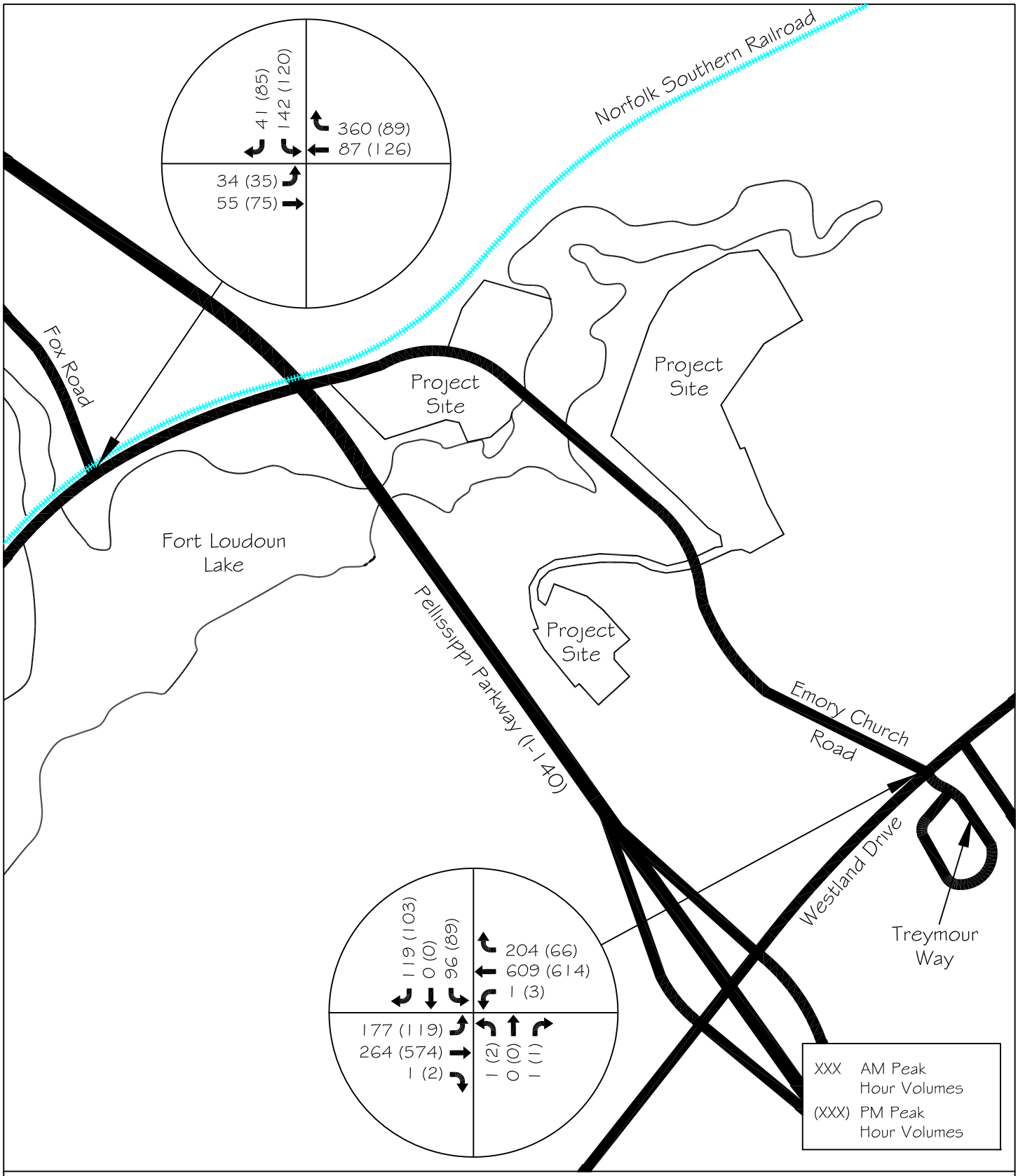

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FIGURE 3

WESTLAND COVE

2013 Peak Hour Traffic Volumes (Existing)

TABLE 2
2013 PEAK HOUR LEVEL OF SERVICE - EXISTING

INTERSECTION	TRAFFIC CONTROL	TURNING MOVEMENT	LEVEL OF SERVICE	
			AM PEAK	PM PEAK
Fox Road and Emory Church Road	Unsignalized 	Eastbound Left	A	A
		Southbound Left	C	B
		Southbound Approach	C	B
Westland Drive and Emory Church Road	Unsignalized 	Eastbound Left	B	A
		Westbound Left	A	A
		Northbound Left	F	F
		Southbound Left	F	F
		Southbound Right	C	C
		Northbound Approach	F	F
		Southbound Approach	F	F

BACKGROUND TRAFFIC VOLUMES

Background traffic volumes are estimates of non-related site generated traffic for a particular horizon or design year. These background traffic volume estimates represent the future base condition for which the proposed study area is subject to without the project being developed. As previously stated, the build-out year for the proposed new apartment complex and boat livery/marina was assumed to occur in 2015. Background traffic volumes for this project were calculated by applying a 4% annual growth rate to the existing traffic volumes counted at the roadways. This growth rate was obtained by analyzing the existing traffic counts in the area provided by TDOT and the MPC. This data is located in Appendix C. A 4% growth was used to take into account any future development in the area and rising travel volumes. The results of this growth rate application to the existing traffic volume at the roadway can be seen in Figure 4 for the year 2015.

The application of background traffic to the existing intersection of Fox Road at Emory Church Road changed the LOS results from the existing traffic analysis for the southbound left

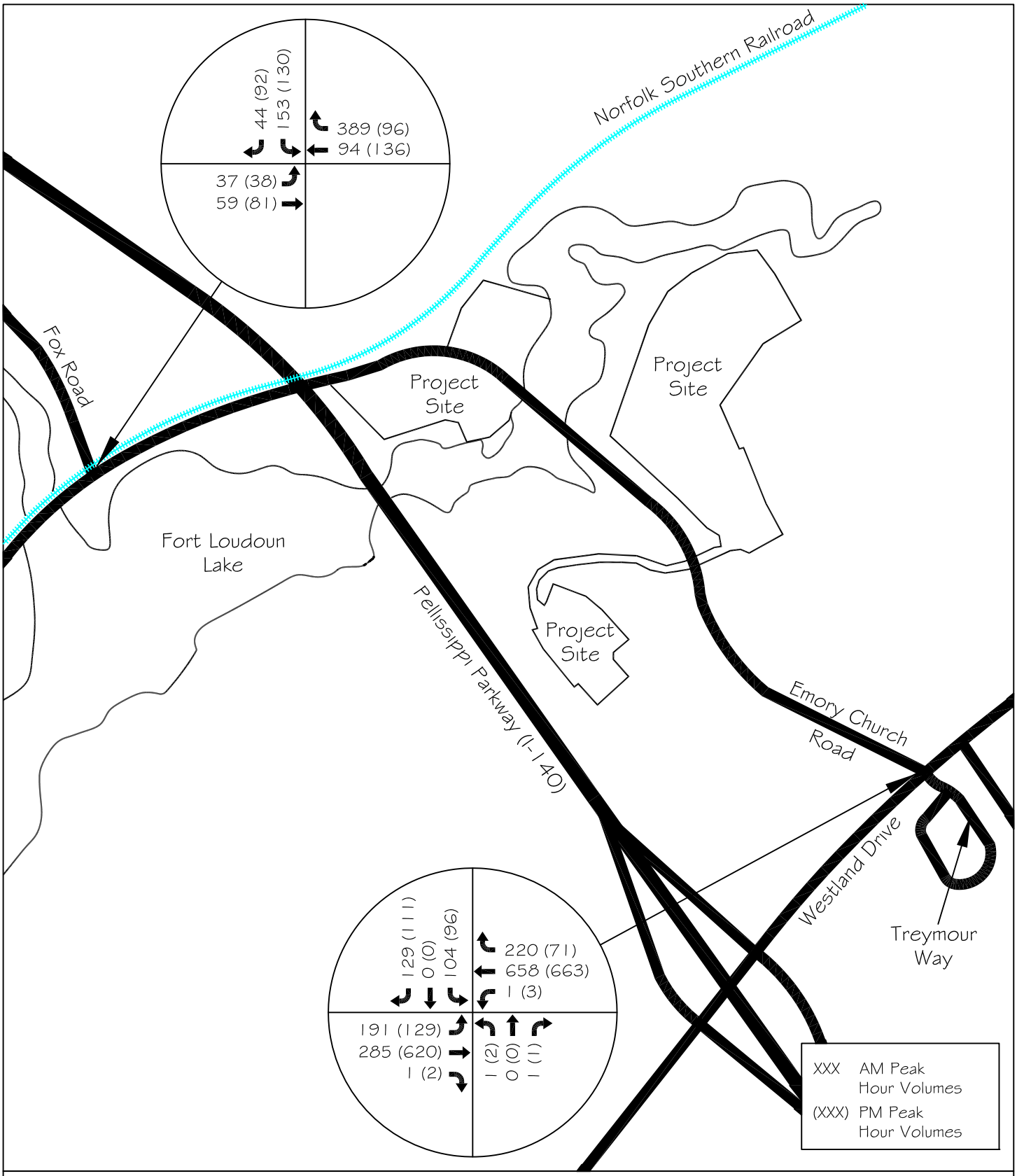

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FIGURE 4

WESTLAND COVE

2015 Peak Hour Traffic Volumes (Background)

turns and overall approach from LOS C to D in the AM peak hour. For Westland Drive and Emory Church Road, the application of the 2015 background volumes contributed to almost the same LOS designations as compared to the existing. The only difference being that the level of service slipped from LOS C to LOS D for the southbound right turns during the AM peak hour and LOS A to B for eastbound left turns in the PM peak hour. Table 3 reports the LOS results and Appendix B contains the LOS worksheets for the background conditions. It is important to point out that these projected LOS designations for the intersections would potentially exist in the future even without the proposed Westland Cove being developed.

TABLE 3
2015 PEAK HOUR LEVEL OF SERVICE - BACKGROUND

INTERSECTION	TRAFFIC CONTROL	TURNING MOVEMENT	LEVEL OF SERVICE	
			AM PEAK	PM PEAK
Fox Road and Emory Church Road	Unsignalized 	Eastbound Left	A	A
		Southbound Left	D	B
		Southbound Approach	D	B
Westland Drive and Emory Church Road	Unsignalized 	Eastbound Left	B	B
		Westbound Left	A	A
		Northbound Left	F	F
		Southbound Left	F	F
		Southbound Right	D	C
		Northbound Approach	F	F
		Southbound Approach	F	F

TRIP GENERATION

The estimated amount of traffic that will be generated by the proposed apartment complex was calculated based upon equations for peak hour trips provided by the Knoxville-Knox County Metropolitan Planning Commission. These equations were developed by the MPC from their own studies to get an accurate picture of apartment traffic generation in the local area and were published in December 1999.

Additionally, the amount of traffic that will be generated by the proposed marina development was estimated based upon a couple of sources. The Institute of Transportation Engineers (ITE) has developed a large range of equations for peak hour trips for various types of developments and is shown in their publication, Trip Generation, 7th Edition. However, for ITE's Land Use Code #420, Marina, only a few studies have been conducted. Since there are few studies and only a small amount of sample size for this land use, local information was reviewed to give a better indication of how much projected traffic could be generated by the boat livery/marina.

For the purposes of this study and to supplement ITE's data, a brief count of a nearby local marina of similar characteristics as the proposed was undertaken to give a better understanding of the amount of traffic that could be generated by the Westland Cove boat livery/marina development. Specifically, Fox Road Marina, which is located approximately 1 mile to the west from the proposed Westland Cove marina, was canvassed for traffic data during the afternoon peak hours on a weekday. This marina was chosen due to its proximity to the new development and similar relative size as the proposed new marina. The count was conducted during the same time frame as the other counts and insured that the counts captured a typical summertime pattern of lake and boat users. The counts from the local marina are shown in Appendix A with the other traffic counts.

Ultimately, the projected amount of traffic generated by the proposed boat livery/marina used for this study was taken from the calculated results from the Trip Generation manual. The local count at Fox Road Marina resulted in very similar results during the PM peak hour as what has been calculated with ITE's Trip Generation small sample size. The Trip Generation manual equations actually estimated slightly higher numbers from the local count that was conducted at the nearby existing Fox Road marina and were used as a more conservative (higher) estimate.

Overall, the amount of traffic generated by the boat livery/marina is negligible in comparison to the amount of traffic potentially generated by the apartment complexes. For this study, the trips projected for the overall development were not reduced for any pass-by or multi-use factors. It is assumed that there will be negligible to no interaction between the marina and the apartment dwellers with respect to generated traffic due to socio-economical reasons. The results are shown below in Table 1. It should be noted that the results shown below for the apartments are shown with additional units as currently planned. This would allow for an additional apartment 28-unit building being planned and developed without having to update this report.

TABLE 4
TRIP GENERATION FOR WESTLAND COVE

LAND USE	SIZE	AVERAGE DAILY TRAFFIC	GENERATED TRAFFIC AM PEAK HOUR			GENERATED TRAFFIC PM PEAK HOUR		
			ENTER	EXIT	TOTAL	ENTER	EXIT	TOTAL
			22%	**78%**		**55%**	**45%**	
Apartment Dwelling Units	356 units	2,988	38	135	173	137	112	249
			33%	**67%**		**60%**	**40%**	
Livery/Marina	75 berths	222	2	4	6	9	6	15
TOTALS		**3,210**	**40**	**139**	**179**	**146**	**118**	**264**

Therefore, based on these calculations, it can be expected that 40 vehicles will enter the overall development during the AM Peak Hour, 139 will exit, for a total of 179 new generated trips during the AM Peak Hour (7:15 AM – 8:15 AM). Similarly, it can be expected that 146 vehicles will enter the overall development during the PM Peak Hour, 118 will exit, for a total of 264 new generated trips during the PM Peak Hour (5:00 PM – 6:00 PM). For further clarification, based on the proposed layout of the apartment complexes and the number of proposed units on each side of Emory Church Road (approximately 75%/25% split East to West), it is assumed that of the 173 total trips generated in the AM for the apartments, 130 trips will be to/from the apartments to the east side and 43 trips will be to/from the apartments to the west side of Emory Church Road. Similarly, during the PM peak hour, of the 249 total trips – 187 trips will be to/from the apartments to the east side and 62 trips will be to the west side.

Also, based on the proposed layout and proposed operations of the marina on each side of Emory Church Road, it is assumed a 50/50 split for the total trips generated. Therefore, of the 6 total trips generated in the AM for the marina, 3 trips will be to/from the marina to the east side and 3 trips will be to and from the marina to the west side of Emory Church Road. Similarly, during the PM peak hour, of the 15 total trips – 8 trips will be to/from the marina to the east side and 7 trips will be to the west side.

Overall, the calculated trips generated for an average day is expected to be approximately 3,210 vehicles for the entire development.

TRIP DISTRIBUTION/ASSIGNMENT

The directional distribution of trips that will be generated by the proposed development were surmised and applied to the new proposed existing intersections as shown in Figure 5 and Figure 6. Figure 5 shows the projected distribution for traffic entering/exiting the new development during the AM and PM peak hours for the apartment complexes. Figure 6 shows the projected distribution during the AM and PM peak hours for the boat livery/marina. The percentages shown only pertain to the new trips generated by the new development. Figure 7, 8, and 9 shows the additional new trips estimated from the trip generation estimates in correlation with their assigned distribution (Figures 5 and 6) for traffic entering/exiting the new development during the AM and PM peak hour for the apartment complexes, boat livery/marina, and combined developments respectively.

These projected trip distributions were based on the existing traffic movements at the examined roadways, reasonable assumptions of popular directions by future motorists' travel patterns, and surrounding concentrations of development and population. Furthermore, another additional traffic count was conducted at the intersection of Westland Crossing Way (Westland Crossing subdivision) and Emory Church Road during the AM and PM peak hours. The results of this count are shown in Appendix A. This count was conducted to gain a better understanding of the existing traffic patterns of a nearby residential development during the peak hours. This data was then correlated to the new residential complex traffic at Westland Cove. Since this was an existing similar land use in the vicinity of this project, the turning movement counts from it were assumed a reasonable estimate of the projected new developments' travel patterns and were used to help determine the future traffic distribution.

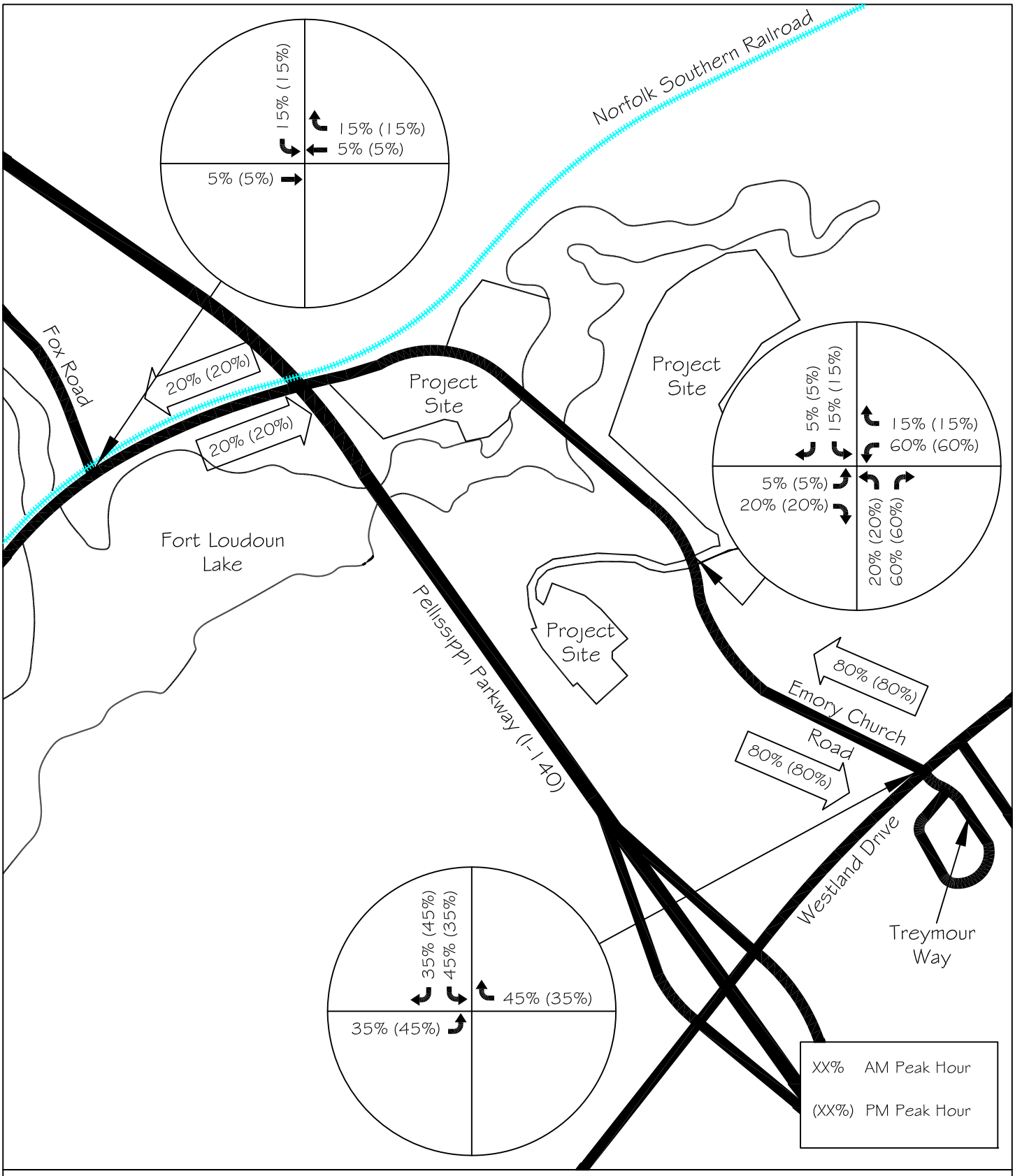

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FIGURE 5

WESTLAND COVE

Directional Distribution
Apartment Complex

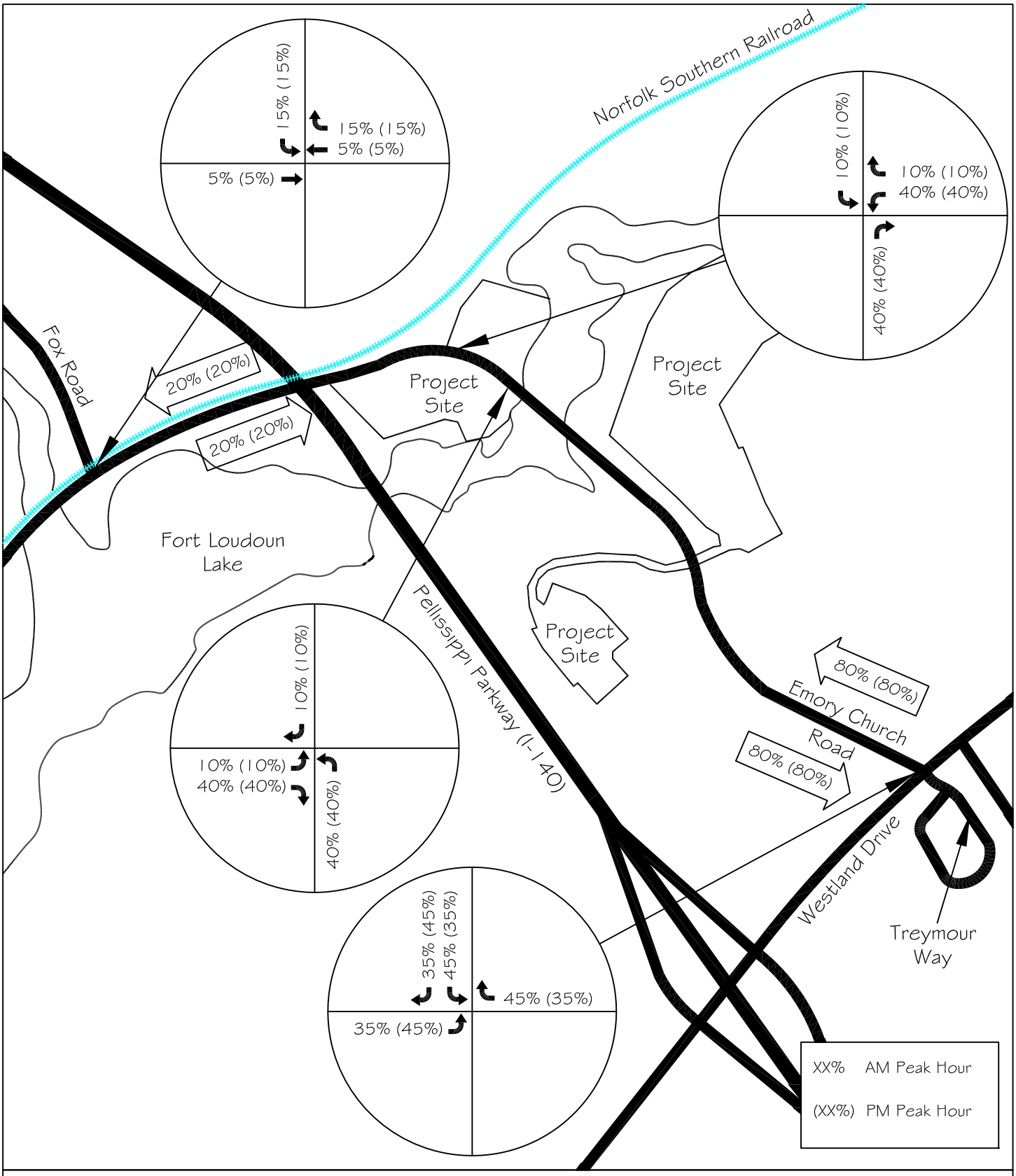

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FIGURE 6

WESTLAND COVE

Directional Distribution
Boat Livery / Marina

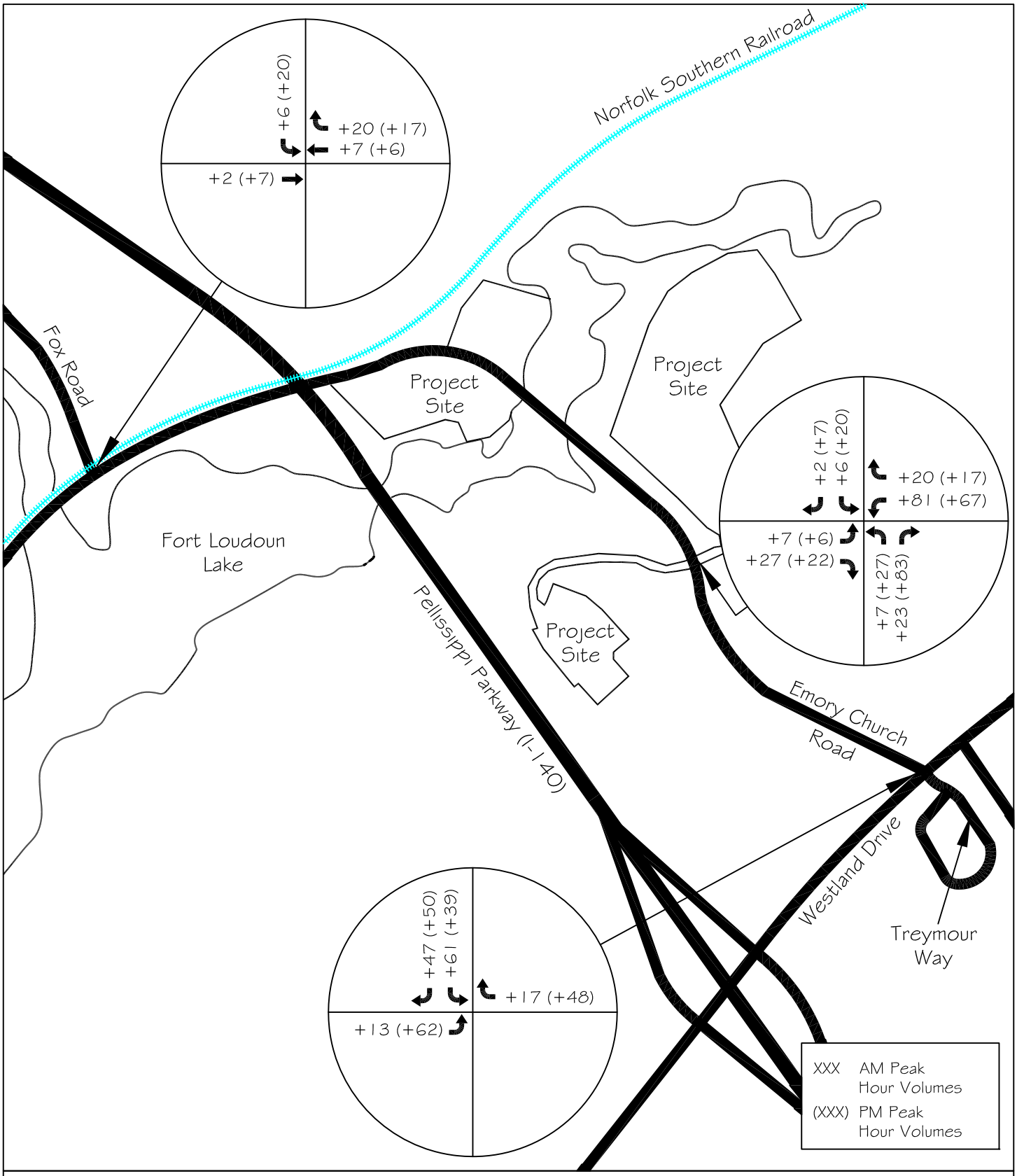

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FIGURE 7

WESTLAND COVE

Traffic Assignment
Apartment Complex

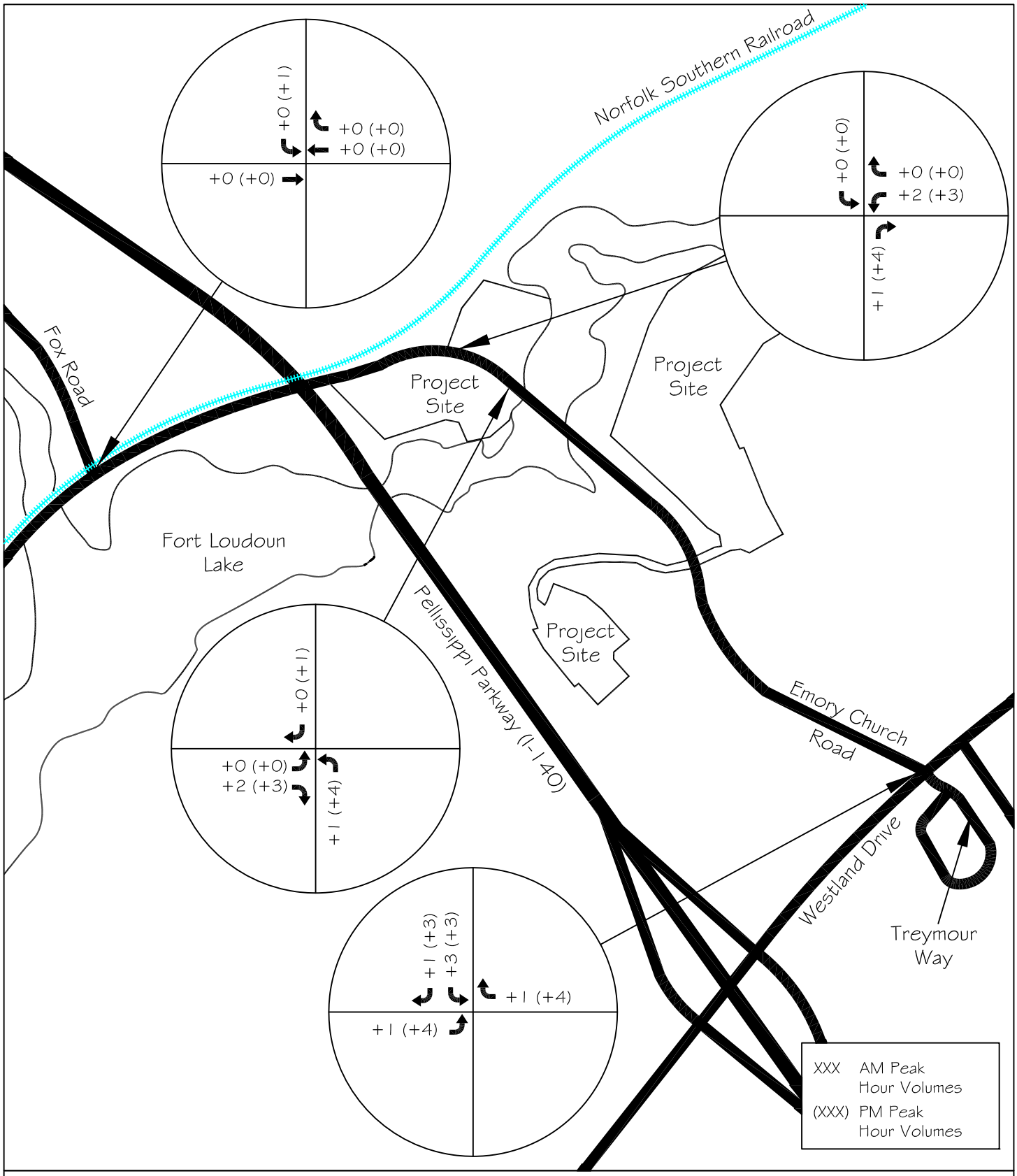

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FIGURE 8

WESTLAND COVE

Traffic Assignment
Boat Livery / Marina

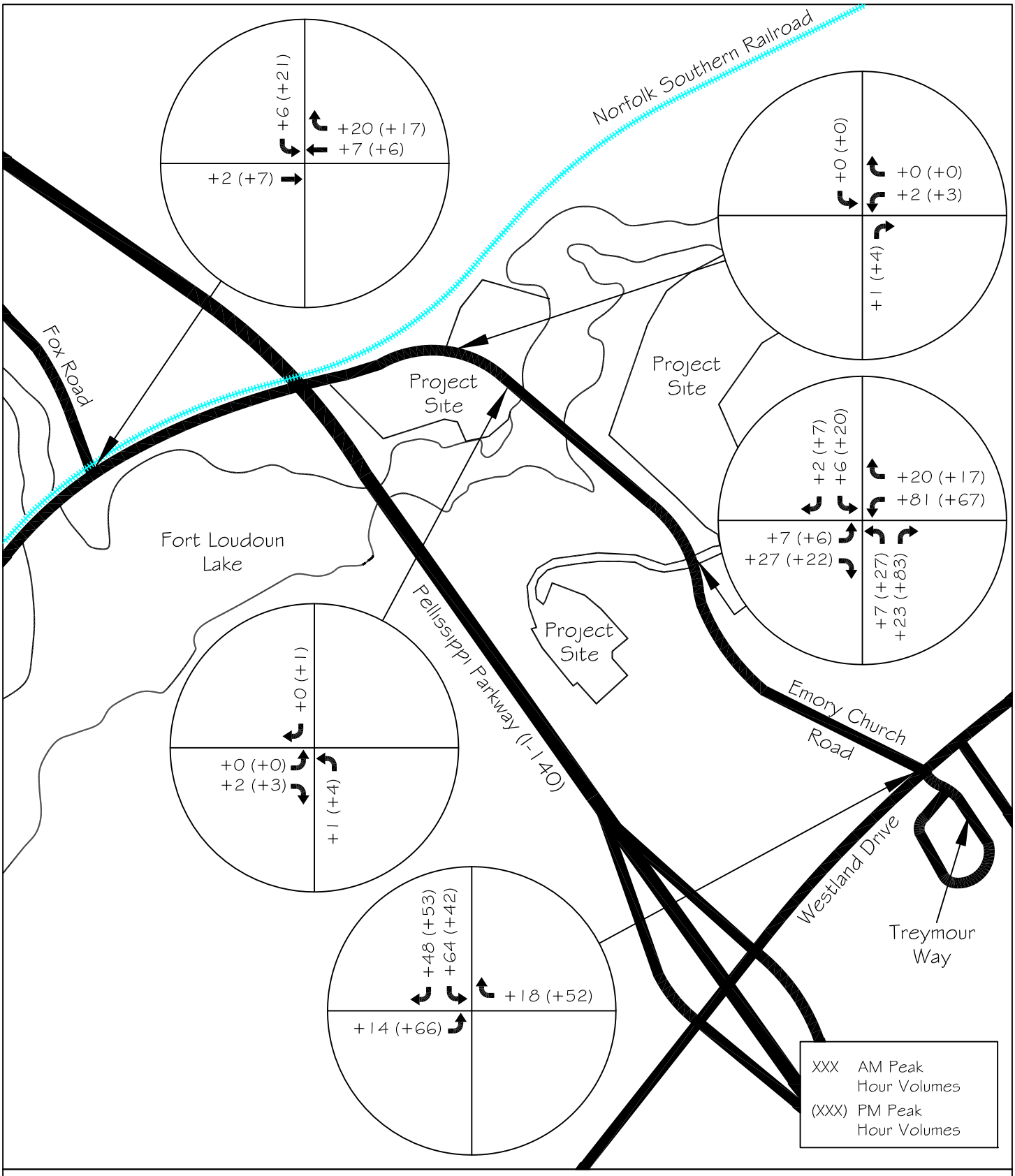

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FIGURE 9

WESTLAND COVE

Traffic Assignment - Combined Apartment Complex & Boat Livery / Marina

PROJECTED TRAFFIC VOLUMES

To calculate the future projected traffic volumes, application of the calculated peak hour traffic (Table 4) generated by the new proposed Westland Cove development were added to the background traffic volumes (Figure 4) according to the predicted directional distributions and assignments (Figure 5-9). This procedure was necessary to obtain the total projected traffic volumes at the time the development is fully operational by the year 2015. AM and PM peak hour capacity analyses were then conducted to determine the traffic impacts of the new development at the new unsignalized driveway intersections along Emory Church Road and at the existing intersections of Fox Road/Emory Church Road and Westland Drive/Emory Church Road. Figure 10 shows these projected AM and PM peak hour volumes at the studied intersections for the year 2015. Appendix B includes the worksheets for these capacity analyses.

The results of the capacity calculations of projected peak hour traffic can be seen in Table 5 for the intersections. The intersections are once again shown with a LOS designation for the AM and PM peak hours in the table. For the three proposed unsignalized intersections for the new development along Emory Church Road, the peak hour levels of service are shown to operate at a very good level during both the AM and PM peak hours. For the projected existing unsignalized intersections, the peak hour levels of service are shown to operate very similarly to the background analysis. The calculations show that once again the northbound and southbound approaches at Westland Drive and Emory Church Road will operate at failure during both the AM and PM peak hours in the projected conditions.

Table 6 shows a summary with respect to LOS for all of the studied intersections for the existing, background, and projected conditions.

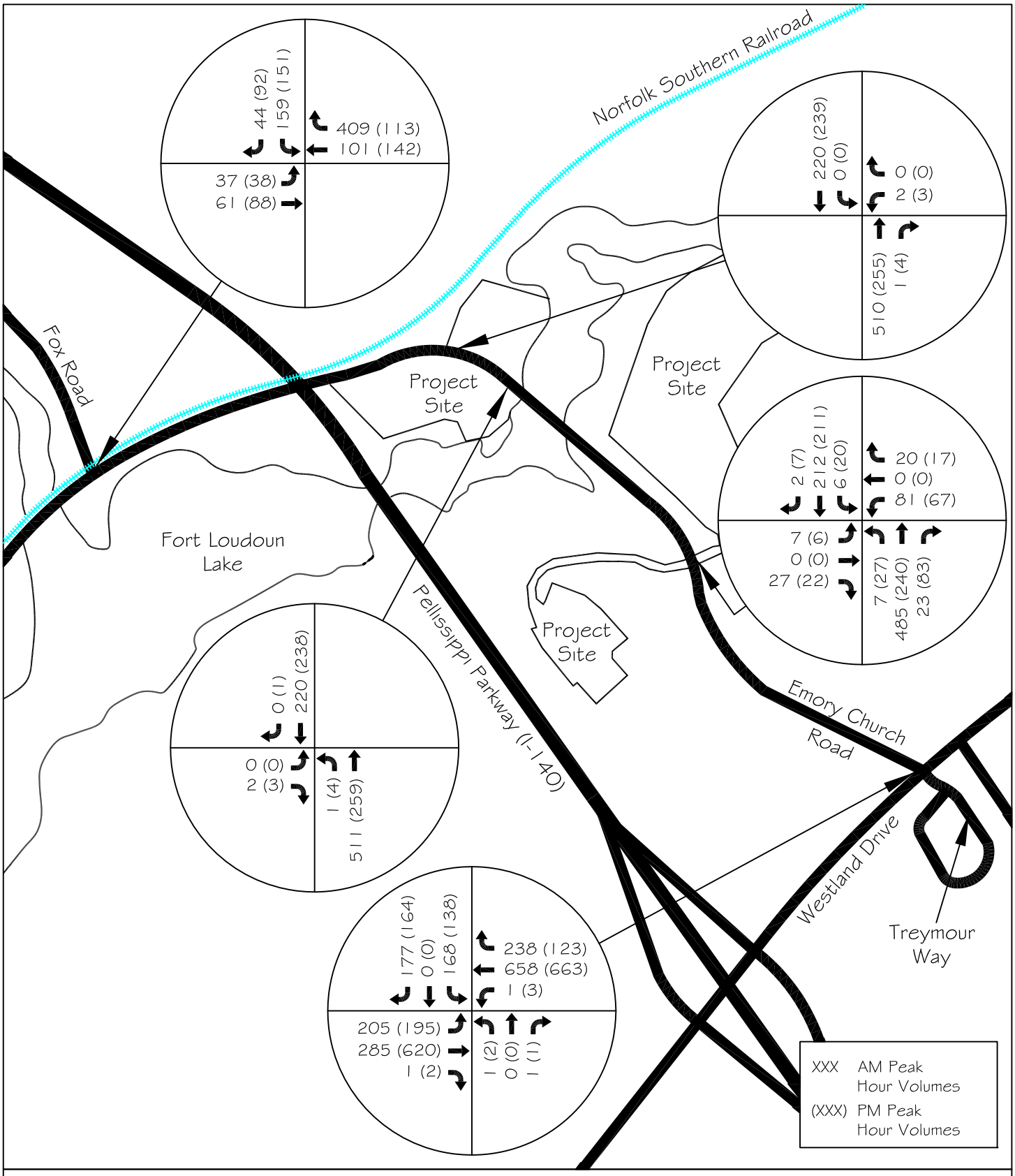

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FIGURE 10
WESTLAND COVE

2015 Peak Hour Traffic Volumes
(Projected)

TABLE 5
2015 PEAK HOUR LEVEL OF SERVICE - PROJECTED

INTERSECTION	TRAFFIC CONTROL	TURNING MOVEMENT	LEVEL OF SERVICE	
			AM PEAK	PM PEAK
Fox Road and Emory Church Road	Unsignalized 	Eastbound Left	A	A
		Southbound Left	D	C
		Southbound Approach	D	C
Westland Drive and Emory Church Road	Unsignalized 	Eastbound Left	C	B
		Westbound Left	A	A
		Northbound Left	F	F
		Southbound Left	F	F
		Southbound Right	F	C
		Northbound Approach	F	F
		Southbound Approach	F	F
Boat Livery/Marina Driveway and Emory Church Road (West Side)	Unsignalized 	Eastbound Left	A	A
		Northbound Left	A	A
		Eastbound Approach	A	A
Boat Livery/Marina Driveway and Emory Church Road (East Side)	Unsignalized 	Westbound Left	C	B
		Westbound Approach	C	B
Apartment Driveways and Emory Church Road	Unsignalized 	Eastbound Left	B	B
		Westbound Left	C	C
		Northbound Left	A	A
		Southbound Left	A	A
		Eastbound Approach	B	B
		Westbound Approach	C	C

TABLE 6
SUMMARY OF PEAK HOUR LEVEL OF SERVICE

INTERSECTION	TRAFFIC CONTROL	TURNING MOVEMENT	EXISTING LEVEL OF SERVICE		BACKGROUND LEVEL OF SERVICE		PROJECTED LEVEL OF SERVICE	
			AM PEAK	PM PEAK	AM PEAK	PM PEAK	AM PEAK	PM PEAK
Fox Road and Emory Church Road	Unsignalized 	Eastbound Left	A	A	A	A	A	A
		Southbound Left	C	B	D	B	D	C
		Southbound Approach	C	B	D	B	D	C
Westland Drive and Emory Church Road	Unsignalized 	Eastbound Left	B	A	B	B	C	B
		Westbound Left	A	A	A	A	A	A
		Northbound Left	F	F	F	F	F	F
		Southbound Left	F	F	F	F	F	F
		Southbound Right	C	C	D	C	F	C
		Northbound Approach	F	F	F	F	F	F
		Southbound Approach	F	F	F	F	F	F
Boat Livery/Marina Driveway and Emory Church Road (West Side)	Unsignalized 	Eastbound Left	-	-	-	-	A	A
		Northbound Left	-	-	-	-	A	A
		Eastbound Approach	-	-	-	-	A	A
Boat Livery/Marina Driveway and Emory Church Road (East Side)	Unsignalized 	Westbound Left	-	-	-	-	C	B
		Westbound Approach	-	-	-	-	C	B
Apartment Driveways and Emory Church Road	Unsignalized 	Eastbound Left	-	-	-	-	B	B
		Westbound Left	-	-	-	-	C	C
		Northbound Left	-	-	-	-	A	A
		Southbound Left	-	-	-	-	A	A
		Eastbound Approach	-	-	-	-	B	B
		Westbound Approach	-	-	-	-	C	C

SPOT SPEED STUDY

As a further investigation of the study area, three spot speed studies were conducted. Two of the spot speed studies were conducted on Emory Church Road to sample and tabulate the existing motoring speeds along the road in the vicinity of the proposed development. Of these two measurements, one spot speed study was conducted near the proposed intersection where the apartment complex driveways intersect Emory Church Road and the other was conducted near the proposed marina intersection on the east side prior to the horizontal curve to the south. The results of the study indicate that the majority of the traffic along Emory Church Road travels at a much greater speed than the posted speed limit. The posted speed limit for Emory Church Road is 30 mph. The results of the spot speed study indicate that the observed 85th percentile speed was nearly 49 mph near the apartment complex intersection and 43 mph near the marina intersection.

Based on observation it appears that motorists perceive Emory Church Road as an isolated "back road" with little impetus to observe the posted speed limit due to the lack of development, driveways, or sense of speed enforcement.

The other spot speed study was conducted along Westland Drive in the vicinity of the intersection with Emory Church Road. The results indicated that the observed 85th percentile speed was approximately 47 mph. The posted speed limit for Westland Drive is 40 mph. All of the field observations are provided in Appendix F.

TRAFFIC SIGNALIZATION WARRANTS

The Manual on Uniform Traffic Control Devices – 2009 Edition (MUTCD) presents 9 different warrants that have been developed by the traffic engineering profession as a means to determine whether or not a traffic signal is warranted. These warrants cover a broad range of minimum elements required to indicate whether a traffic signal is justified for any particular location. These elements exist of traffic volumes, pedestrian volumes, accident history, and other factors. The MUTCD explicitly states that a traffic control signal should not be installed unless one or more of the signal warrants in the manual are met. However, the satisfaction of a warrant does not entirely in itself justify the need for a traffic signal. Sometimes further engineering studies and judgments also need to be applied before justifying the need for a traffic signal to be installed. These extraneous studies are a very important step in insuring that an

installation of a traffic signal will not actually bring about degradations in safety and efficiencies.

Although the MUTCD provides 9 different warrants, only three of these are potentially applicable in this case for the intersection of Westland Drive and Emory Church Road. These three warrants are as follows:

Warrant 1, Eight-Hour Vehicular Volume

Warrant 1 is comprised of 2 conditions – A and B. The Minimum Vehicular Volume, Condition A, is intended for application where the volume of intersecting traffic is the principal reason for consideration of signal installation. The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

Warrant 2, Four-Hour Vehicular Volume

The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

Warrant 3, Peak Hour

The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

The intersection of Westland Drive and Emory Church Road was evaluated for possible justification for a traffic signal based on the MUTCD Warrants listed above. Emory Church Road was used as the minor side street for the warrant analysis and Westland Drive was the major street. Based on the existing traffic volumes at the intersection in the analysis, it appears that this intersection currently warrants signalization. The intersection meets Warrant #2, Four-Hour Vehicular Volume based on the current posted speed limit. The posted speed limit on Westland Drive is 40 mph; however, it was measured that the 85th percentile speed exceeds 40 mph (47 mph) which also allows this intersection to meet Warrant #1, Condition B. Analyzing the intersection during the background conditions also results in the same signalization warrants.

The results of the traffic signal warrant assessments are located in Appendix G and Table 7 lists the results.

TABLE 7
TRAFFIC SIGNAL WARRANT SUMMARY

Intersection	Volume Warrant - Required Number of Hours Satisfied				
	#1A (8 hour)	#1B (8 hour)	Comb. (8 hour)	#2 (4 hour)	#3 (Peak Hour)
EXISTING - 40 mph speed (100% FACTOR) Westland Drive at Emory Church Road	**NO**	**NO**	**NO**	**YES**	**NO**
EXISTING - 47 mph speed (70% FACTOR) Westland Drive at Emory Church Road	**NO**	**YES**	**NO**	**YES**	**NO**
BACKGROUND - 40 mph speed (100% FACTOR) Westland Drive at Emory Church Road	**NO**	**NO**	**NO**	**YES**	**NO**
BACKGROUND - 47 mph speed (70% FACTOR) Westland Drive at Emory Church Road	**NO**	**YES**	**NO**	**YES**	**NO**

EVALUATION OF TURN LANE WARRANTS

The proposed unsignalized intersections located along Emory Church Road for the boat livery/marina and the apartment complexes were evaluated for the need for separate left turn and right turn lanes. Utilizing the Knox County policy for turn lane requirements, it was determined that none of the three proposed intersections warrant separate left or right turn lanes on Emory Church Road. The Access Control and Driveway Design Policy with turn lane warrants relate volume thresholds based on prevailing speeds for two-lane roadways. The speed classification that was chosen for this evaluation was based on the spot speed study that was performed and showed that the 85th percentile speed was approximately 49 mph. Therefore, the evaluation used the Knox County classification for speeds of 46 to 55 mph and the calculated projected volumes. The Knox County evaluation worksheets are contained in Appendix D.

CONCLUSIONS AND RECOMMENDATIONS

The analyses presented in this study of the proposed new Westland Cove indicate that the traffic generated by this development in tandem with existing and future traffic will operate adversely at the intersection of Westland Drive and Emory Church Road. This intersection has been calculated to operate at failure for the southbound and northbound approaches currently, in the future (background conditions), and when the new development has begun operations if no roadway improvements are made.

The following is a presentation of recommendations of what has been concluded as a means to mitigate the impacts of the overall development with the surrounding road system while achieving an acceptable level of traffic flow, safety, and cost.

1) **Fox Road at Emory Church Road**: From the capacity calculations, it has been shown that southbound left turns could operate at LOS D during the AM peak hours once the development becomes operational. It should be noted that this could potentially occur in 2015 even without the new development being constructed as shown in the earlier background discussion. **It does not appear that new separate southbound left and right turn lanes should be constructed.** Since this southbound approach is operating under yield control to avoid vehicles stopping unnecessarily on the railroad tracks, the concern is that allowing two turn lanes on this approach would interfere with sight distance and could cause operational problems near this railroad line. Overall, the small benefit it would provide in vehicle delay reduction as compared to the larger issues involved with adding a turn lane at this intersection with the railroad system do not seem warranted.

2) **Emory Church Road**: The current plans show a crosswalk across Emory Church Road at the apartment complex intersection and at the marina. It is not known at this point whether this will be allowed by the reviewing agencies. Special care should be applied if allowed. If crosswalks are allowed, **it is recommended that a series of warning signs be constructed along the roadway.** The posted speed limit on Emory Church Road is 30 mph but has been shown to operate at much higher speeds. If crosswalks are allowed specific signage should be installed and sidewalks must be present on both sides of the road. Adequate stopping sight distance must be available in both directions. Based on a posted 30 mph speed, the recommended stopping sight distance is approximately 200

feet for level conditions. However, based on the observed operating speeds along Emory Church Road, a stopping sight distance of 425 feet would be required.

2a) The ladder crosswalk design, consisting of two transverse lines parallel to one another together with longitudinal lines parallel to traffic flow, should be used so that the visibility of the crosswalk is maximized.

2b) The crosswalk width of the crosswalk should be 10 feet, solid white in color and the lines should have a width of 12 inches. The longitudinal lines should be spaced 3 feet apart.

2c) Pedestrian in crosswalk signs (W11A-2) with downward arrow plaque (W16-7p) should be installed at each end of the crosswalk location. The signs should be placed in advance of the crosswalk adjacent to the travel lane and facing the driver. Advanced pedestrian warning signs (W11-2) should be installed at a minimum distance of 150 feet but not exceeding 500 feet in advance of the crosswalk in either direction. Advanced warning signs should be accompanied by supplemental plaques with the legend "AHEAD" (W16-9p). See Figure 11 at the end of this report for illustration of recommended signage.

3) **New Driveway Entrances along Emory Church Road**: The current site plan does not show separate lanes for left and right turns out of any of the development entrance points. From the capacity studies it does not appear that they are warranted. Neither does it appear that separate left or right turn lanes into the driveway entrances are warranted based on the examination shown earlier of the turning and opposing volumes.

3a) **All of the new roadway connections with Emory Church Road should be constructed with a Stop Sign (R1-1).**

3b) **Sight distance at the new intersections must not be impacted by new signage or landscaping.** Sight distance at the marina should not be interfered with due to parked vehicles or watercraft at the marina parking ground. Currently there is significant wood and brush growth along this road corridor that would need to be removed to achieve the proper distances.

- Based on a posted 30 mph speed, the recommended stopping sight distance is approximately 200 feet for level conditions and the corner sight distance requirement is 300 feet. However, taking into account the spot speed study results, there is concern that greater lengths should be provided due to the observed high speeds. Based on the higher observed operating speeds along

Emory Church Road, a stopping sight distance of 425 feet would be required. The road layout designer should insure that these sight distance lengths are met, maximized, and they should be labeled on the plans.

- Any design elements that would not impact sight distance, but could be designed such that would lend to a reduction of speeds due to a perceived narrowing of the road template along Emory Church Road should be encouraged. All potential "narrowing" design elements should take into account pedestrians and possible bicycle traffic.
- It is recommended that there be further monitoring of this road area once the development is operational if excessive speeds and conflicts are observed. The developer should work with the Knox County Engineering Department to investigate traffic calming/speed reduction strategies or greater speed enforcement.

3c) **All road grade and intersection elements internally and externally should be designed to AASHTO and Knox County Engineering specifications and guidelines to insure proper operation.**

4) **Westland Drive/AL Lotts Elementary School**: Prior to the commencement of the study, some concerns were discussed by the reviewing agencies in regards to the operation of the Westland Drive/ Emory Church Road intersection during the afternoon school dismissal at AL Lotts Elementary school. It has been suggested that during school dismissal at 2:45 PM, traffic queues have formed all the way from the school to the intersection in question (a distance of approximately 2,300 feet). All of the eastbound approaches along Westland Drive at other intersections in between the school and Emory Church Road are marked with "Do Not Block Intersection" (R10-7) signs which suggests past queuing problems. However, during the several days of current traffic counts for this study, no queuing problems were observed at the intersection of Westland Drive and Emory Church Road. For the most part, the queue line observed for the school dismissal never went much further than Cloverhill Lane which is approximately 1,200 feet from the Westland Drive and Emory Church Road intersection. This queue did not seem to affect operations at the studied intersection in any aspect during the traffic counts.

The school dismissal on Westland Drive in front of AL Lotts Elementary is assisted by Knox County Deputies. The queue on the eastbound side of the school along Westland

Drive was observed starting before the official school dismissal and was completely dissipated off of the street by 3:10. For the eastbound queue along Westland Drive, all of the waiting vehicles were observed parked to the far edge of the pavement along the curb which allowed thru vehicles to proceed cautiously through the school zone.

5) **Westland Drive at Emory Church Road**: From the capacity calculations, it has been shown that the southbound and northbound approaches at this intersection are at failure during the AM peak hour currently and projected to be at failure when the proposed development is operational. The existing and background volumes meet Warrant #2 volume thresholds for a traffic signal based on the posted speed of 40 mph, and they also meet Warrants #1, Condition B and Warrant #2 based on the observed speeds. The posted speed limit on Westland Drive is 40 mph but the spot speed study indicated speeds of approximately 47 mph. **It is recommended that this intersection be signalized.** A preliminary optimized signalization timing plan has been applied to this intersection and is based on a 90 second cycle length for the AM and PM peak hours. These preliminary signalization results for the intersection of Westland Drive and Emory Church Road are shown in Table 8 and the calculations are found in Appendix B.

TABLE 8
2015 PEAK HOUR LEVEL OF SERVICE - PROJECTED WITH SIGNALIZATION

INTERSECTION	TRAFFIC CONTROL	TURNING MOVEMENT	LEVEL OF SERVICE	
			AM PEAK	PM PEAK
Westland Drive and	Signalized 	Eastbound Left	E	E
		Eastbound Thru	A	A
Emory Church Road		Westbound Left	A	A
		Westbound Thru	B	B
		Northbound Left/Thru/Right	C	B
		Southbound Left/Thru	D	C
		Southbound Right	D	C
		Eastbound Approach	C	B
		Westbound Approach	B	B
		Northbound Approach	C	B
		Southbound Approach	D	C

Furthermore, based on nomographs from ITE's publication, Transportation and Land Development, **it is recommended that the southbound approach left/thru lane on Emory Church Road be extended to accommodate the increased future traffic**. The current southbound left/thru shared turn lane storage length is approximately 65 feet in length (excluding taper). With signalization, the needed storage length has been estimated from a "Nomograph for Single-Lane Left Turn Storage at Signalized Intersections" and Synchro software calculations. Based on a presumed 90 second cycle length, the storage length needs to be a minimum of 230 feet.

Additionally, **it is also recommended that the eastbound approach left turn lane on Westland Drive be extended as well.** The current eastbound storage length is approximately 100 feet (not including taper). Using the above method estimations, it has been calculated that the eastbound left turn lane storage length should be approximately 280 feet in length based on a signalized intersection with a presumed 90 second cycle length.

The storage lengths are shown in Table 9 and the calculations are shown in Appendix B (Synchro) and in Appendix H (Nomograph).

TABLE 9
TURN LANE STORAGE SUMMARY
2015 Combined Projected Conditions

Intersection Name/Turn Lane	Turn Volume (vph) *	Existing Storage Length (ft)	Synchro 50% Queue (ft)	Synchro 95% Queue (ft)	Nomograph (See Appendix) Storage Length (ft)
Westland Drive at Emory Church Road SIGNALIZED (100 sec cycle length)					
Eastbound Left Turn	**205**	**100**	**88**	**279**	**250**
Southbound Left/Thru	**168**	**65**	**116**	**228**	**220**

* Queues and turn volumes are taken from worst case scenario for each individual turn movement

In closing, it is believed that the intersection of Westland Drive and Emory Church Drive should be signalized based on traffic signal warrant analysis and based on the LOS for the existing, background, and projected conditions. With the addition of the new development, it is not recommended that this intersection remain unsignalized due to the LOS F conditions and the significant queuing problems that would result.

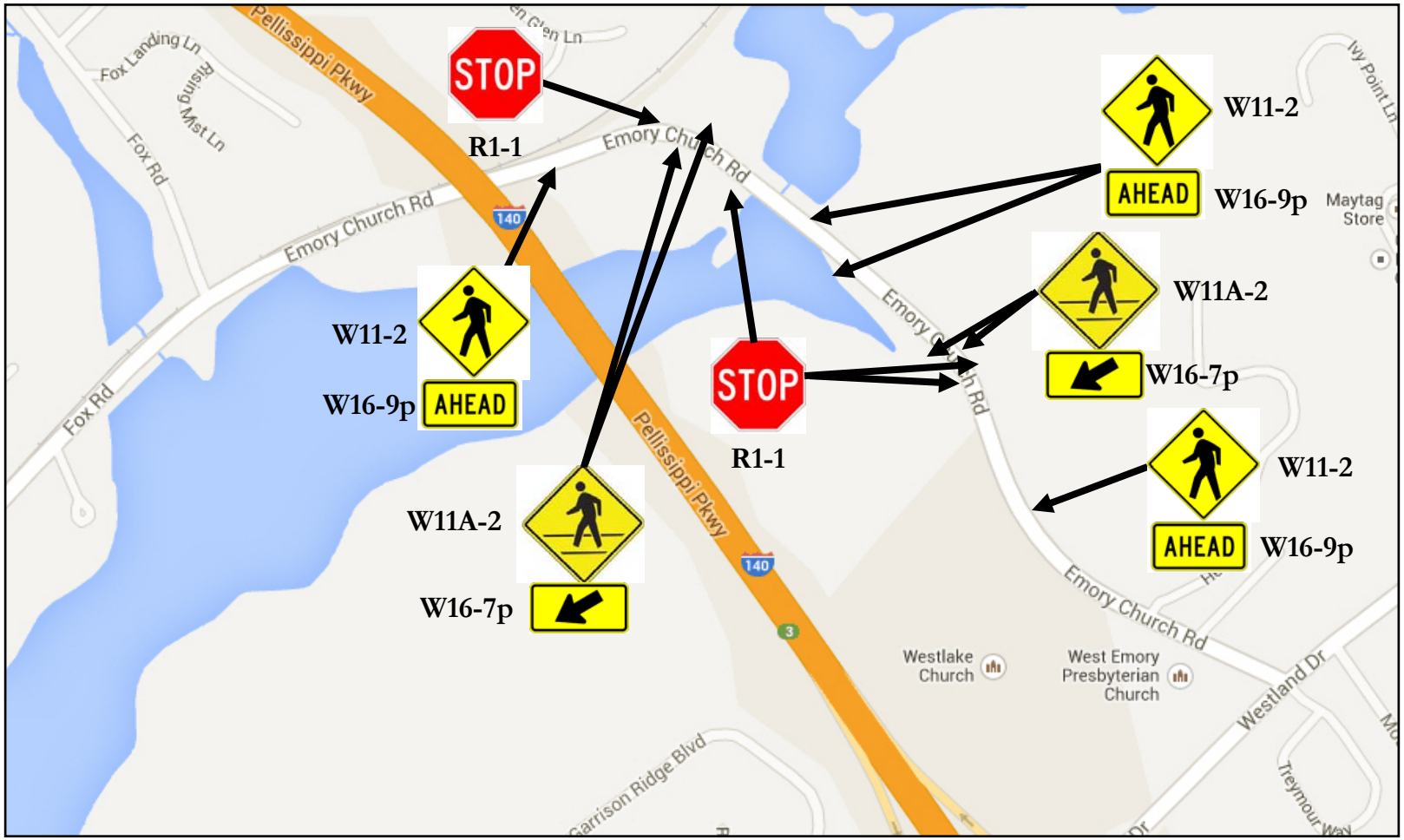


Figure 11
Recommended Signage Map

APPENDIX A
MANUAL TRAFFIC COUNT DATA

TRAFFIC COUNT DATA

Major Street: Emory Church Road 8/14/2013
Minor Street: Fox Road Sunny

Primary Movement: Vehicles

TIME	SOUTHBOUND		WESTBOUND		EASTBOUND		VEHICLE	PEAK
BEGIN	LT	RT	THRU	RT	LT	THRU	TOTAL	HOUR
7:00 AM	35	0	4	13	5	11	68	
7:15 AM	54	7	7	43	14	15	140	7:15 AM - 8:15 AM
7:30 AM	29	8	13	72	15	15	152	
7:45 AM	23	10	14	134	4	13	198	
8:00 AM	24	12	23	66	9	9	143	
8:15 AM	33	13	15	29	8	19	117	
8:30 AM	9	7	11	11	5	10	53	
8:45 AM	14	3	15	15	3	11	61	
TOTAL	221	60	102	383	63	103	932	
4:00 PM	29	21	14	12	10	19	105	
4:15 PM	20	10	19	20	7	16	92	
4:30 PM	21	9	19	16	11	17	93	
4:45 PM	23	19	30	29	9	12	122	
5:00 PM	30	21	38	19	15	10	133	5:00 PM - 6:00 PM
5:15 PM	28	20	32	22	13	24	139	
5:30 PM	24	20	27	22	12	27	132	
5:45 PM	28	23	25	22	9	24	131	
TOTAL	203	143	204	162	86	149	947	

TRAFFIC COUNT DATA

Major Street: Emory Church Road 8/28/2013
Minor Street: Fox Road Sunny

Primary Movement: Vehicles

TIME BEGIN	SOUTHBOUND		WESTBOUND		EASTBOUND		VEH. TOTAL
	LT	RT	THRU	RT	LT	THRU	
7:00 AM	28	1	5	10	3	10	57
7:15 AM	66	4	9	35	8	13	135
7:30 AM	28	11	19	74	12	15	159
7:45 AM	13	11	26	147	10	6	213
8:00 AM	35	15	33	104	4	21	212
8:15 AM	23	9	11	39	6	17	105
8:30 AM	14	10	10	23	10	15	82
8:45 AM	14	10	15	19	3	12	73
TOTAL	221	71	128	451	56	109	1036
4:00 PM	24	15	14	18	16	19	106
4:15 PM	18	16	20	20	10	12	96
4:30 PM	15	12	23	19	10	20	99
4:45 PM	19	17	29	25	7	15	112
5:00 PM	31	19	25	26	8	25	134
5:15 PM	42	25	34	22	8	19	150
5:30 PM	26	24	37	20	7	19	133
5:45 PM	21	17	30	21	12	12	113
TOTAL	196	145	212	171	78	141	943

AM PEAK HOUR	SOUTHBOUND		APP. TOTAL	WESTBOUND		APP. TOTAL	EASTBOUND		APP. TOTAL
	LT	RT		LT	RT		LT	RT	
7:15 AM	66	4	70	9	35	44	8	13	21
7:30 AM	28	11	39	19	74	93	12	15	27
7:45 AM	13	11	24	26	147	173	10	6	16
8:00 AM	35	15	50	33	104	137	4	21	25
TOTAL	142	41	183	87	360	447	34	55	89
PHF	0.54	0.68	0.65	0.66	0.61	0.65	0.71	0.65	0.82

PM PEAK HOUR	SOUTHBOUND		APP. TOTAL	WESTBOUND		APP. TOTAL	EASTBOUND		APP. TOTAL
	LT	RT		LT	RT		LT	RT	
5:00 PM	31	19	50	25	26	51	8	25	33
5:15 PM	42	25	67	34	22	56	8	19	27
5:30 PM	26	24	50	37	20	57	7	19	26
5:45 PM	21	17	38	30	21	51	12	12	24
TOTAL	120	85	205	126	89	215	35	75	110
PHF	0.71	0.85	0.76	0.85	0.86	0.94	0.73	0.75	0.83

TRAFFIC COUNT DATA

Major Street: Westland Drive
Minor Street: Emory Church Road

8/13/2013
Sunny

Primary Movement: Vehicles

TIME	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND			VEHICLE	PEAK
BEGIN	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	TOTAL	HOUR
7:00 AM	25	1	14	0	123	8	0	0	0	10	53	0	234	
7:15 AM	51	0	21	0	150	32	1	0	1	25	44	1	326	7:15 AM - 8:15 AM
7:30 AM	14	0	31	0	173	48	0	0	2	30	46	0	344	
7:45 AM	4	0	28	0	160	57	0	0	0	59	78	0	386	
8:00 AM	8	0	36	0	133	42	1	0	2	47	83	0	352	
8:15 AM	9	0	32	0	125	18	1	0	0	23	61	3	272	
8:30 AM	18	0	24	0	128	19	0	0	0	18	77	1	285	
8:45 AM	9	0	26	0	106	14	0	1	0	15	59	0	230	
TOTAL	138	1	212	0	1098	238	3	1	5	227	501	5	2429	
11:00 AM	13	0	12	0	59	20	2	0	0	8	65	0	179	
11:15 AM	7	1	14	2	65	8	1	1	1	16	46	0	162	
11:30 AM	6	0	15	0	67	5	3	1	0	17	66	0	180	
11:45 AM	11	1	14	1	79	10	0	0	0	7	86	1	210	
12:00 PM	6	1	8	0	72	8	2	0	1	21	85	1	205	
12:15 PM	16	1	11	0	77	10	1	0	2	16	58	1	193	
12:30 PM	10	0	16	0	85	5	1	0	0	10	77	1	205	
12:45 PM	11	0	15	2	67	8	1	0	0	19	78	0	201	
1:00 PM	11	0	15	1	85	11	3	0	1	6	62	1	196	1:00 PM - 2:00 PM
1:15 PM	16	0	9	0	87	8	2	0	0	11	71	2	206	
1:30 PM	11	0	16	0	77	9	2	0	1	18	60	1	195	
1:45 PM	15	1	17	1	90	17	2	0	0	13	74	2	232	
TOTAL	133	5	162	7	910	119	20	2	6	162	828	10	2364	
3:00 PM	14	0	16	0	87	30	0	0	2	27	90	2	268	
3:15 PM	14	0	13	2	94	31	1	0	1	15	77	0	248	
3:30 PM	18	0	15	2	105	20	0	1	0	21	85	1	268	
3:45 PM	19	1	31	0	128	23	0	1	0	14	95	2	314	
4:00 PM	21	1	23	0	107	9	2	1	1	16	125	2	308	
4:15 PM	24	1	26	0	98	12	0	0	1	16	112	0	290	
4:30 PM	15	0	16	1	118	8	2	0	0	23	126	3	312	
4:45 PM	13	1	18	1	124	12	0	0	0	31	114	0	314	5:00 PM - 6:00 PM
5:00 PM	27	0	24	1	136	19	0	0	0	27	131	1	366	
5:15 PM	28	0	29	1	161	19	0	0	1	34	143	0	416	
5:30 PM	29	0	29	0	141	18	0	0	0	40	148	0	405	
5:45 PM	18	0	20	1	151	21	0	0	2	35	145	3	396	
TOTAL	240	4	260	9	1450	222	5	3	8	299	1391	14	3905	

TRAFFIC COUNT DATA

Major Street: Westland Drive
Minor Street: Emory Church Road

8/28/2013
Sunny

Primary Movement: Vehicles

TIME	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND			VEH.
BEGIN	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	TOTAL
7:00 AM	10	1	21	1	120	14	4	0	1	8	57	0	237
7:15 AM	61	0	22	0	162	26	0	0	1	17	57	0	346
7:30 AM	19	0	34	1	183	55	0	0	0	42	47	0	381
7:45 AM	3	0	23	0	145	77	0	0	0	85	90	0	423
8:00 AM	13	0	40	0	119	46	1	0	0	33	70	1	323
8:15 AM	7	0	34	0	130	12	2	0	0	17	67	0	269
8:30 AM	10	0	12	0	138	24	0	0	0	18	67	1	270
8:45 AM	8	0	31	0	136	22	1	0	1	16	69	0	284
TOTAL	131	1	217	2	1133	276	8	0	3	236	524	2	2533
11:00 AM	9	0	12	1	68	9	3	0	1	8	70	1	182
11:15 AM	9	0	15	1	53	7	1	0	0	4	69	1	160
11:30 AM	6	0	11	0	75	12	0	2	0	12	64	1	183
11:45 AM	5	0	8	2	77	9	1	0	1	14	67	0	184
12:00 PM	17	0	9	0	68	10	0	1	1	9	63	1	179
12:15 PM	8	1	19	1	61	10	0	0	1	17	77	2	197
12:30 PM	9	0	22	1	79	7	0	1	2	16	88	1	226
12:45 PM	5	1	17	3	81	8	0	0	2	17	67	1	202
1:00 PM	13	0	14	1	66	16	1	0	3	16	77	1	208
1:15 PM	10	0	13	2	73	11	0	0	0	11	67	0	187
1:30 PM	19	2	20	2	76	10	2	0	0	11	64	0	206
1:45 PM	12	1	16	0	77	16	1	1	0	12	68	2	206
TOTAL	122	5	176	14	854	125	9	5	11	147	841	11	2320
3:00 PM	10	0	6	0	96	23	0	0	0	25	94	2	256
3:15 PM	15	1	9	0	86	25	0	0	0	16	89	0	241
3:30 PM	14	0	20	1	94	27	0	0	0	16	103	1	276
3:45 PM	17	0	27	0	120	22	1	0	1	23	109	0	320
4:00 PM	26	0	39	1	130	23	0	0	2	19	98	1	339
4:15 PM	11	0	15	0	126	19	1	0	0	24	127	1	324
4:30 PM	16	0	24	1	107	11	0	0	0	24	129	0	312
4:45 PM	26	0	25	1	134	24	0	0	2	30	131	1	374
5:00 PM	18	0	24	1	142	13	0	0	0	27	145	0	370
5:15 PM	27	0	30	0	162	19	1	0	0	32	143	0	414
5:30 PM	24	0	25	1	166	22	1	0	1	32	125	2	399
5:45 PM	20	0	24	1	144	12	0	0	0	28	161	0	390
TOTAL	224	1	268	7	1507	240	4	0	6	296	1454	8	4015

AM PEAK HOUR	SOUTHBOUND			APP. TOTAL	WESTBOUND			APP. TOTAL	NORTHBOUND			APP. TOTAL	EASTBOUND			APP. TOTAL
	LT	THRU	RT		LT	THRU	RT		LT	THRU	RT		LT	THRU	RT	
7:15 AM	61	0	22	83	0	162	26	188	0	0	1	1	17	57	0	74
7:30 AM	19	0	34	53	1	183	55	239	0	0	0	0	42	47	0	89
7:45 AM	3	0	23	26	0	145	77	222	0	0	0	0	85	90	0	175
8:00 AM	13	0	40	53	0	119	46	165	1	0	0	1	33	70	1	104
TOTAL	96	0	119	215	1	609	204	814	1	0	1	2	177	264	1	442
PHF	0.39	-	0.74	0.65	0.25	-	0.66	0.85	0.25	-	0.25	0.50	0.52	-	0.25	0.63

PM PEAK HOUR	SOUTHBOUND			APP. TOTAL	WESTBOUND			APP. TOTAL	NORTHBOUND			APP. TOTAL	EASTBOUND			APP. TOTAL
	LT	THRU	RT		LT	THRU	RT		LT	THRU	RT		LT	THRU	RT	
5:00 PM	18	0	24	42	1	142	13	156	0	0	0	0	27	145	0	172
5:15 PM	27	0	30	57	0	162	19	181	1	0	0	1	32	143	0	175
5:30 PM	24	0	25	49	1	166	22	189	1	0	1	2	32	125	2	159
5:45 PM	20	0	24	44	1	144	12	157	0	0	0	0	28	161	0	189
TOTAL	89	0	103	192	3	614	66	683	2	0	1	3	119	574	2	695
PHF	0.82	-	0.86	0.84	0.75	-	0.75	0.90	0.50	-	0.25	0.38	0.93	-	0.25	0.92

TRAFFIC COUNT DATA

Major Street: Fox Road 8/13/2013
Minor Street: Fox Road Marina Driveway Partly Cloudy

Primary Movement: Vehicles

TIME	WESTBOUND		NORTHBOUND		EASTBOUND		VEHICLE	PEAK
BEGIN	LT	THRU	LT	RT	THRU	RT	TOTAL	HOUR
4:00 PM	2	27	1	1	25	0	56	
4:15 PM	2	25	0	0	20	0	47	
4:30 PM	2	23	0	1	11	1	38	
4:45 PM	0	29	1	3	24	1	58	
5:00 PM	0	49	1	1	34	1	86	5:00 PM - 6:00 PM
5:15 PM	1	55	0	1	33	0	90	
5:30 PM	2	52	0	3	30	2	89	
5:45 PM	0	43	0	0	33	1	77	
TOTAL	9	303	3	10	210	6	541	

TRAFFIC COUNT DATA

Major Street: Emory Church Road 8/13/2013
Minor Street: Westland Crossing Private Drive Overcast

Primary Movement: Vehicles

TIME BEGIN	SOUTHBOUND LT TURN IN	NORTHBOUND RT TURN IN	WESTBOUND LT TURN OUT	WESTBOUND RT TURN OUT	VEHICLE TOTAL	PEAK HOUR
7:00 AM	0	0	2	0	2	
7:15 AM	1	0	1	0	2	
7:30 AM	0	0	1	1	2	
7:45 AM	0	0	0	0	0	
8:00 AM	0	0	0	2	2	8:00 AM - 9:00 AM
8:15 AM	0	2	0	0	2	
8:30 AM	1	3	0	1	5	
8:45 AM	0	1	2	0	3	
TOTAL	2	6	6	4	18	
4:00 PM	0	3	0	1	4	4:00 PM - 5:00 PM
4:15 PM	0	2	1	1	4	
4:30 PM	0	1	1	0	2	
4:45 PM	0	0	2	0	2	
5:00 PM	1	0	0	0	1	
5:15 PM	1	0	1	0	2	
5:30 PM	0	0	1	0	1	
5:45 PM	0	0	0	0	0	
TOTAL	2	6	6	2	16	

APPENDIX B
CAPACITY ANALYSES

HCM WORKSHEETS
(SYNCHRO 5)

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Yield	
Grade		5%	5%		-3%	
Volume (veh/h)	34	55	87	360	142	41
Peak Hour Factor	0.82	0.82	0.65	0.65	0.65	0.65
Hourly flow rate (veh/h)	41	67	134	554	218	63
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume	688				561	411
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	95				53	90
cM capacity (veh/h)	906				467	641

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	109	688	282
Volume Left	41	0	218
Volume Right	0	554	63
cSH	906	1700	497
Volume to Capacity	0.05	0.40	0.57
Queue Length (ft)	4	0	87
Control Delay (s)	3.8	0.0	21.3
Lane LOS	A		C
Approach Delay (s)	3.8	0.0	21.3
Approach LOS			C

Intersection Summary			
Average Delay	5.9		
Intersection Capacity Utilization	63.8%	ICU Level of Service	B

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Yield	
Grade		5%	5%		-3%	
Volume (veh/h)	35	75	126	89	120	85
Peak Hour Factor	0.83	0.83	0.94	0.94	0.76	0.76
Hourly flow rate (veh/h)	42	90	134	95	158	112
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume	229				356	181
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				75	87
cM capacity (veh/h)	1339				622	861

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	133	229	270
Volume Left	42	0	158
Volume Right	0	95	112
cSH	1339	1700	703
Volume to Capacity	0.03	0.13	0.38
Queue Length (ft)	2	0	45
Control Delay (s)	2.7	0.0	13.3
Lane LOS	A		B
Approach Delay (s)	2.7	0.0	13.3
Approach LOS			B

Intersection Summary			
Average Delay	6.2		
Intersection Capacity Utilization	38.3%	ICU Level of Service	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		2%			-2%			2%			-5%	
Volume (veh/h)	177	264	1	1	609	204	1	0	1	96	0	119
Peak Hour Factor	0.63	0.63	0.63	0.85	0.85	0.85	0.50	0.50	0.50	0.65	0.65	0.65
Hourly flow rate (veh/h)	281	419	2	1	716	240	2	0	2	148	0	183
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	956			421			1884	1941	420	1822	1821	836
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	61			100			89	100	100	0	100	50
cM capacity (veh/h)	719			1139			19	40	633	42	47	367

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total	281	421	1	956	4	148	183
Volume Left	281	0	1	0	2	148	0
Volume Right	0	2	0	240	2	0	183
cSH	719	1700	1139	1700	36	42	367
Volume to Capacity	0.39	0.25	0.00	0.56	0.11	3.55	0.50
Queue Length (ft)	47	0	0	0	9	Err	67
Control Delay (s)	13.2	0.0	8.2	0.0	115.6	Err	24.2
Lane LOS	B		A		F	F	C
Approach Delay (s)	5.3		0.0		115.6	4478.0	
Approach LOS					F	F	

Intersection Summary			
Average Delay	744.9		
Intersection Capacity Utilization	92.7%	ICU Level of Service	E

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		2%			-2%			2%			-5%	
Volume (veh/h)	119	574	2	3	614	66	2	0	1	89	0	103
Peak Hour Factor	0.92	0.92	0.92	0.90	0.90	0.90	0.38	0.38	0.38	0.84	0.84	0.84
Hourly flow rate (veh/h)	129	624	2	3	682	73	5	0	3	106	0	123
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	756			626			1695	1646	625	1611	1610	719
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	85			100			89	100	99	0	100	71
cM capacity (veh/h)	855			956			46	84	485	74	89	429

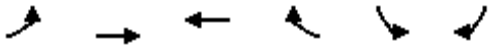
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total	129	626	3	756	8	106	123
Volume Left	129	0	3	0	5	106	0
Volume Right	0	2	0	73	3	0	123
cSH	855	1700	956	1700	66	74	429
Volume to Capacity	0.15	0.37	0.00	0.44	0.12	1.43	0.29
Queue Length (ft)	13	0	0	0	10	215	29
Control Delay (s)	10.0	0.0	8.8	0.0	66.9	352.9	16.7
Lane LOS	A		A		F	F	C
Approach Delay (s)	1.7		0.0		66.9	172.5	
Approach LOS					F	F	

Intersection Summary			
Average Delay	23.6		
Intersection Capacity Utilization	70.1%	ICU Level of Service	C

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Yield	
Grade		5%	5%		-3%	
Volume (veh/h)	37	59	94	389	153	44
Peak Hour Factor	0.82	0.82	0.65	0.65	0.65	0.65
Hourly flow rate (veh/h)	45	72	145	598	235	68
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume	743				606	444
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	95				46	89
cM capacity (veh/h)	864				437	614

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	117	743	303
Volume Left	45	0	235
Volume Right	0	598	68
cSH	864	1700	467
Volume to Capacity	0.05	0.44	0.65
Queue Length (ft)	4	0	114
Control Delay (s)	3.9	0.0	25.9
Lane LOS	A		D
Approach Delay (s)	3.9	0.0	25.9
Approach LOS			D

Intersection Summary			
Average Delay	7.1		
Intersection Capacity Utilization	68.3%	ICU Level of Service	B



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Yield	
Grade		5%	5%		-3%	
Volume (veh/h)	38	81	136	96	130	92
Peak Hour Factor	0.83	0.83	0.94	0.94	0.76	0.76
Hourly flow rate (veh/h)	46	98	145	102	171	121
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume	247				385	196
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				71	86
cM capacity (veh/h)	1319				597	846

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	143	247	292
Volume Left	46	0	171
Volume Right	0	102	121
cSH	1319	1700	680
Volume to Capacity	0.03	0.15	0.43
Queue Length (ft)	3	0	54
Control Delay (s)	2.7	0.0	14.2
Lane LOS	A		B
Approach Delay (s)	2.7	0.0	14.2
Approach LOS			B

Intersection Summary			
Average Delay	6.7		
Intersection Capacity Utilization	45.2%	ICU Level of Service	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		2%			-2%			2%			-5%	
Volume (veh/h)	191	285	1	1	658	220	1	0	1	104	0	129
Peak Hour Factor	0.63	0.63	0.63	0.85	0.85	0.85	0.50	0.50	0.50	0.65	0.65	0.65
Hourly flow rate (veh/h)	303	452	2	1	774	259	2	0	2	160	0	198
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	1033			454			2034	2095	453	1967	1966	904
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	55			100			82	100	100	0	100	41
cM capacity (veh/h)	673			1107			11	29	606	31	35	336

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total	303	454	1	1033	4	160	198
Volume Left	303	0	1	0	2	160	0
Volume Right	0	2	0	259	2	0	198
cSH	673	1700	1107	1700	22	31	336
Volume to Capacity	0.45	0.27	0.00	0.61	0.18	5.24	0.59
Queue Length (ft)	59	0	0	0	14	Err	90
Control Delay (s)	14.7	0.0	8.3	0.0	203.4	Err	30.1
Lane LOS	B		A		F	F	D
Approach Delay (s)	5.9		0.0		203.4	4479.7	
Approach LOS					F	F	

Intersection Summary			
Average Delay	748.0		
Intersection Capacity Utilization	98.8%	ICU Level of Service	E

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		2%			-2%			2%			-5%	
Volume (veh/h)	129	620	2	3	663	71	2	0	1	96	0	111
Peak Hour Factor	0.92	0.92	0.92	0.90	0.90	0.90	0.38	0.38	0.38	0.84	0.84	0.84
Hourly flow rate (veh/h)	140	674	2	3	737	79	5	0	3	114	0	132
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	816			676			1831	1778	675	1740	1739	776
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	83			100			84	100	99	0	100	67
cM capacity (veh/h)	812			915			34	68	454	59	72	398

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total	140	676	3	816	8	114	132
Volume Left	140	0	3	0	5	114	0
Volume Right	0	2	0	79	3	0	132
cSH	812	1700	915	1700	49	59	398
Volume to Capacity	0.17	0.40	0.00	0.48	0.16	1.94	0.33
Queue Length (ft)	16	0	0	0	13	272	36
Control Delay (s)	10.4	0.0	8.9	0.0	92.0	590.5	18.5
Lane LOS	B		A		F	F	C
Approach Delay (s)	1.8		0.0		92.0	283.8	
Approach LOS					F	F	

Intersection Summary			
Average Delay	38.2		
Intersection Capacity Utilization	74.3%	ICU Level of Service	C

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Yield	
Grade		5%	5%		-3%	
Volume (veh/h)	37	61	101	409	159	44
Peak Hour Factor	0.82	0.82	0.65	0.65	0.65	0.65
Hourly flow rate (veh/h)	45	74	155	629	245	68
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume	785				635	470
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	95				42	89
cM capacity (veh/h)	834				419	594

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	120	785	312
Volume Left	45	0	245
Volume Right	0	629	68
cSH	834	1700	448
Volume to Capacity	0.05	0.46	0.70
Queue Length (ft)	4	0	132
Control Delay (s)	3.9	0.0	29.6
Lane LOS	A		D
Approach Delay (s)	3.9	0.0	29.6
Approach LOS			D

Intersection Summary			
Average Delay	8.0		
Intersection Capacity Utilization	71.3%	ICU Level of Service	C

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Yield	
Grade		5%	5%		-3%	
Volume (veh/h)	38	88	142	113	159	44
Peak Hour Factor	0.83	0.83	0.94	0.94	0.76	0.76
Hourly flow rate (veh/h)	46	106	151	120	209	58
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
vC, conflicting volume	271				409	211
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	96				64	93
cM capacity (veh/h)	1292				578	829

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	152	271	267
Volume Left	46	0	209
Volume Right	0	120	58
cSH	1292	1700	619
Volume to Capacity	0.04	0.16	0.43
Queue Length (ft)	3	0	54
Control Delay (s)	2.6	0.0	15.2
Lane LOS	A		C
Approach Delay (s)	2.6	0.0	15.2
Approach LOS			C

Intersection Summary			
Average Delay	6.4		
Intersection Capacity Utilization	45.3%	ICU Level of Service	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		2%			-2%			2%			-5%	
Volume (veh/h)	205	285	1	1	658	238	1	0	1	168	0	177
Peak Hour Factor	0.63	0.63	0.63	0.85	0.85	0.85	0.50	0.50	0.50	0.65	0.65	0.65
Hourly flow rate (veh/h)	325	452	2	1	774	280	2	0	2	258	0	272
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	1054			454			2153	2160	453	2022	2021	914
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	51			100			47	100	100	0	100	18
cM capacity (veh/h)	660			1107			4	24	606	26	30	331

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total	325	454	1	1054	4	258	272
Volume Left	325	0	1	0	2	258	0
Volume Right	0	2	0	280	2	0	272
cSH	660	1700	1107	1700	8	26	331
Volume to Capacity	0.49	0.27	0.00	0.62	0.53	9.78	0.82
Queue Length (ft)	68	0	0	0	26	Err	177
Control Delay (s)	15.6	0.0	8.3	0.0	735.2	Err	50.8
Lane LOS	C		A		F	F	F
Approach Delay (s)	6.5		0.0		735.2	4895.1	
Approach LOS					F	F	

Intersection Summary			
Average Delay	1099.9		
Intersection Capacity Utilization	106.8%	ICU Level of Service	F

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		2%			-2%			2%			-5%	
Volume (veh/h)	195	620	2	3	663	123	2	0	1	138	0	164
Peak Hour Factor	0.92	0.92	0.92	0.90	0.90	0.90	0.38	0.38	0.38	0.84	0.84	0.84
Hourly flow rate (veh/h)	212	674	2	3	737	137	5	0	3	164	0	195
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
vC, conflicting volume	873			676			2037	1979	675	1912	1912	805
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	73			100			67	100	99	0	100	49
cM capacity (veh/h)	772			915			16	45	454	40	49	383

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total	212	676	3	873	8	164	195
Volume Left	212	0	3	0	5	164	0
Volume Right	0	2	0	137	3	0	195
cSH	772	1700	915	1700	24	40	383
Volume to Capacity	0.27	0.40	0.00	0.51	0.33	4.06	0.51
Queue Length (ft)	28	0	0	0	25	Err	70
Control Delay (s)	11.4	0.0	8.9	0.0	218.9	Err	23.8
Lane LOS	B		A		F	F	C
Approach Delay (s)	2.7		0.0		218.9	4582.0	
Approach LOS					F	F	

Intersection Summary			
Average Delay	774.6		
Intersection Capacity Utilization	84.6%	ICU Level of Service	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		2%			2%			5%			-5%	
Volume (veh/h)	7	0	27	81	0	20	7	485	23	6	212	2
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (veh/h)	8	0	30	90	0	22	8	539	26	7	236	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
vC, conflicting volume	839	830	237	847	818	552	238			564		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	96	66	100	96	99			99		
cM capacity (veh/h)	270	302	802	268	306	533	1329			1007		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	38	112	572	244
Volume Left	8	90	8	7
Volume Right	30	22	26	2
cSH	571	298	1329	1007
Volume to Capacity	0.07	0.38	0.01	0.01
Queue Length (ft)	5	42	0	0
Control Delay (s)	11.8	24.2	0.2	0.3
Lane LOS	B	C	A	A
Approach Delay (s)	11.8	24.2	0.2	0.3
Approach LOS	B	C		

Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	54.0%	ICU Level of Service	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		2%			2%			5%			-5%	
Volume (veh/h)	6	0	22	67	0	17	27	240	83	20	211	7
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (veh/h)	7	0	24	74	0	19	30	267	92	22	234	8
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
vC, conflicting volume	674	702	238	680	659	313	242			359		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	100	97	78	100	97	98			98		
cM capacity (veh/h)	347	348	800	343	368	727	1324			1200		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	31	93	389	264
Volume Left	7	74	30	22
Volume Right	24	19	92	8
cSH	625	384	1324	1200
Volume to Capacity	0.05	0.24	0.02	0.02
Queue Length (ft)	4	24	2	1
Control Delay (s)	11.1	17.4	0.8	0.8
Lane LOS	B	C	A	A
Approach Delay (s)	11.1	17.4	0.8	0.8
Approach LOS	B	C		

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	57.3%	ICU Level of Service	A

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	2%		2%			-2%
Volume (veh/h)	2	0	510	1	0	220
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (veh/h)	2	0	567	1	0	244
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
vC, conflicting volume	812	567			568	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	100			100	
cM capacity (veh/h)	348	523			1004	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	2	568	244
Volume Left	2	0	0
Volume Right	0	1	0
cSH	348	1700	1004
Volume to Capacity	0.01	0.33	0.00
Queue Length (ft)	0	0	0
Control Delay (s)	15.4	0.0	0.0
Lane LOS	C		
Approach Delay (s)	15.4	0.0	0.0
Approach LOS	C		

Intersection Summary

Average Delay	0.0		
Intersection Capacity Utilization	39.9%	ICU Level of Service	A

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	2%		2%			-2%
Volume (veh/h)	3	0	255	4	0	239
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (veh/h)	3	0	283	4	0	266
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
vC, conflicting volume	551	286			288	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	100			100	
cM capacity (veh/h)	495	753			1274	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	3	288	266
Volume Left	3	0	0
Volume Right	0	4	0
cSH	495	1700	1274
Volume to Capacity	0.01	0.17	0.00
Queue Length (ft)	1	0	0
Control Delay (s)	12.3	0.0	0.0
Lane LOS	B		
Approach Delay (s)	12.3	0.0	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	25.2%	ICU Level of Service	A

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	2%			2%	-2%	
Volume (veh/h)	0	2	1	511	220	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (veh/h)	0	2	1	568	244	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
vC, conflicting volume	814	244	244			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	347	794	1322			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	2	569	244
Volume Left	0	1	0
Volume Right	2	0	0
cSH	794	1322	1700
Volume to Capacity	0.00	0.00	0.14
Queue Length (ft)	0	0	0
Control Delay (s)	9.5	0.0	0.0
Lane LOS	A	A	
Approach Delay (s)	9.5	0.0	0.0
Approach LOS	A		

Intersection Summary

Average Delay	0.0		
Intersection Capacity Utilization	40.4%	ICU Level of Service	A

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	2%			2%	-2%	
Volume (veh/h)	0	3	4	259	238	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (veh/h)	0	3	4	288	264	1
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
vC, conflicting volume	562	265	266			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	486	774	1298			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	3	292	266
Volume Left	0	4	0
Volume Right	3	0	1
cSH	774	1298	1700
Volume to Capacity	0.00	0.00	0.16
Queue Length (ft)	0	0	0
Control Delay (s)	9.7	0.1	0.0
Lane LOS	A	A	
Approach Delay (s)	9.7	0.1	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	26.4%	ICU Level of Service	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Grade (%)		2%			-2%			2%			-5%	
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Frt	1.00	1.00		1.00	0.96			0.93			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.98			0.95	1.00
Satd. Flow (prot)	1694	1782		1728	1746			1622			1753	1569
Flt Permitted	0.18	1.00		0.56	1.00			0.91			0.76	1.00
Satd. Flow (perm)	327	1782		1020	1746			1510			1396	1569
Volume (vph)	205	285	1	1	658	238	1	0	1	168	0	177
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	228	317	1	1	731	264	1	0	1	187	0	197
Lane Group Flow (vph)	228	318	0	1	995	0	0	2	0	0	187	197
Turn Type	Perm			Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		6
Actuated Green, G (s)	58.6	58.6		58.6	58.6			13.9			13.9	13.9
Effective Green, g (s)	58.6	58.6		58.6	58.6			13.9			13.9	13.9
Actuated g/C Ratio	0.73	0.73		0.73	0.73			0.17			0.17	0.17
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	238	1297		743	1271			261			241	271
v/s Ratio Prot		0.18			0.57							
v/s Ratio Perm	c0.70			0.00				0.00			c0.13	0.13
v/c Ratio	0.96	0.25		0.00	0.78			0.01			0.78	0.73
Uniform Delay, d1	9.8	3.6		3.0	6.9			27.6			31.8	31.5
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	46.1	0.1		0.0	3.2			0.0			14.4	9.3
Delay (s)	56.0	3.7		3.0	10.1			27.6			46.2	40.8
Level of Service	E	A		A	B			C			D	D
Approach Delay (s)		25.5			10.1			27.6			43.5	
Approach LOS		C			B			C			D	

Intersection Summary

HCM Average Control Delay	21.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	80.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	94.2%	ICU Level of Service	E

c Critical Lane Group

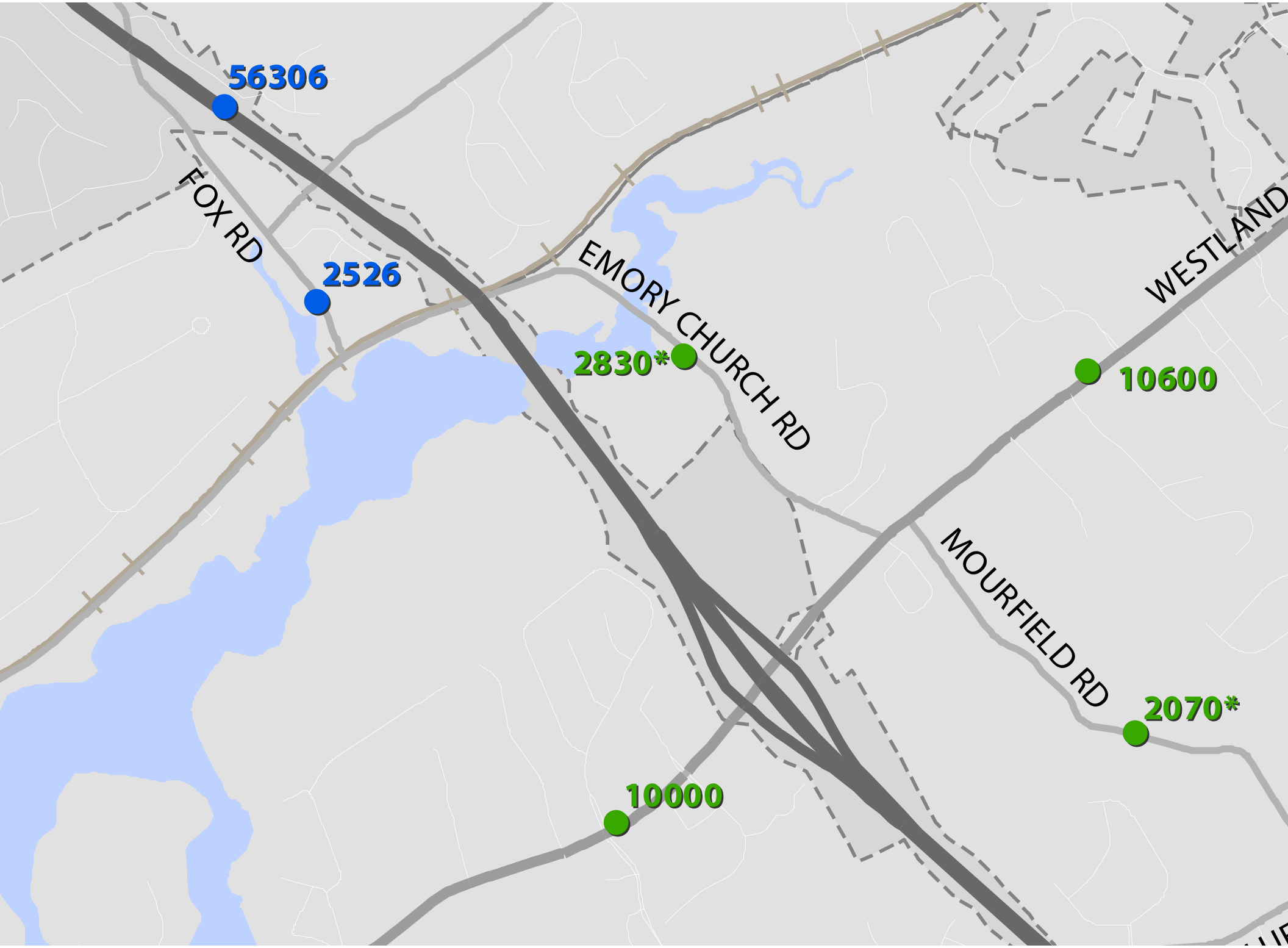
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Grade (%)		2%			-2%			2%			-5%	
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Frt	1.00	1.00		1.00	0.98			0.95			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.97			0.95	1.00
Satd. Flow (prot)	1694	1782		1728	1776			1648			1753	1569
Flt Permitted	0.20	1.00		0.31	1.00			0.88			0.76	1.00
Satd. Flow (perm)	351	1782		558	1776			1490			1395	1569
Volume (vph)	195	620	2	3	663	123	2	0	1	138	0	164
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	217	689	2	3	737	137	2	0	1	153	0	182
Lane Group Flow (vph)	217	691	0	3	874	0	0	3	0	0	153	182
Turn Type	Perm			Perm			Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		6
Actuated Green, G (s)	35.3	35.3		35.3	35.3			11.9			11.9	11.9
Effective Green, g (s)	35.3	35.3		35.3	35.3			11.9			11.9	11.9
Actuated g/C Ratio	0.64	0.64		0.64	0.64			0.22			0.22	0.22
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	224	1140		357	1136			321			301	338
v/s Ratio Prot		0.39			0.49							
v/s Ratio Perm	c0.62			0.01				0.00			0.11	0.12
v/c Ratio	0.97	0.61		0.01	0.77			0.01			0.51	0.54
Uniform Delay, d1	9.4	5.9		3.6	7.1			17.0			19.1	19.2
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	50.7	0.9		0.0	3.2			0.0			1.4	1.7
Delay (s)	60.1	6.8		3.6	10.3			17.0			20.4	20.9
Level of Service	E	A		A	B			B			C	C
Approach Delay (s)		19.5			10.2			17.0			20.7	
Approach LOS		B			B			B			C	

Intersection Summary

HCM Average Control Delay	15.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	55.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	84.2%	ICU Level of Service	D

c Critical Lane Group

APPENDIX C
HISTORICAL TRAFFIC COUNT DATA


56306
FOX RD
2526
EMORY CHURCH RD
2830*
WESTLAND
10600
MOURFIELD RD
2070*
10000

C274	E 5th Ave	E of Georgia St	3770			
C271	E 5th Ave	E of Jessamine St	2569			
C293	E 5th Ave	E of Chesnut Ave	833			
C294	E 5th Ave	W of Chesnut Ave	1332			
C346	East Towne E	S of Mall Rd N	4171			
T038	Eastend Rd	S of Andrew Johnson Hy	757	838	829	808
M12	Ebenezer Rd	250' S of Gleason Dr	8530	8440	8160	7940
M66	Ebenezer Rd	400' N of Gleason Dr	8160	7950	8030	
T286	Ebenezer Rd	S of Nubbin Ridge Rd	15111	14530	15533	14717
T466	Ebenezer Rd	S of Kingston Pk			6563	5988
C367	Edgewood Ave	W of Whittle Springs Rd	3200			
C134	Edington Rd	N of Maryville Pk		3610		
T034	Ellistown Rd	N of Millertown Pk	1700	1660	1601	1636
C226	Elm St	N of University Ave	3394			
M268	Emory Church Rd	N of Westland Dr		3070		2830
T477	Emory Rd	E of Norris Fy			12500	10328
T009	Emory Rd	E of Tazewell Pk	5104	4729	5249	5430
T011	Emory Rd	E of Jim Wolfe Rd	2545	2444	2500	2371
T013	Emory Rd	E of Dyer Rd	1084	1146	1199	1014
T015	Emory Rd	Near Grainger Co Line	899	879	878	904
T019	Emory Rd	E of Willow Fork Ln	11236	11112	10728	11406
T024	Emory Rd	W of Lena Ln	12541	13645	14836	16487
T044	Emory Rd	W of I-75	19329	18481	19271	18534
T046	Emory Rd	E of Conner Rd	14366	14139	13914	13821
T047	Emory Rd	W of Ridge Field Dr	8792	9426	9512	9006
T048	Emory Rd	W of Stratfordshire Dr	12529	12992	12725	12333
T323	Emory Rd	W of Pedigo Rd	19820	20415	23558	23335
C390	Essary Rd	E of Jacksboro Pk	3323			
C391	Essary Rd	E of Broadway	7370		4720	
M78	Everett Rd	N of Union Rd	3310	3040	3380	2920
M351	Everett Rd	W of Yarnell Rd	1040		1190	
M352	Everett Rd	S of Buttermilk Rd	3240		2450	
T136	Everett Rd	S of I-40	802	699	676	718
T244	Everett Rd	At Loudon Co Line	8833	8324	8637	8855
T475	Everett Rd	E of Watt Rd			1804	1664

M361	W Emory Rd	E of Oak Ridge Hwy		770		700
C024	Walbrook Dr	W of Walker Springs Rd		13719		
C032	Walbrook Dr	W of Gallaher View Rd		6580		
C372	Walker Blvd	S of Mineral Springs Ave	2114			
C373	Walker Blvd	N of Mineral Springs Ave	4197			
C023	Walker Springs Rd	N of Walbrook Dr		13083		
C027	Walker Springs Rd	N of Kingston Pk		10108		
C530	Walker Springs Rd	W of Mars Hill Rd	3702			
C531	Walker Springs Rd	W of Broome Rd	8481			
T428	Walker Springs Rd	N of Kingston Pk	10521	10729	10445	10568
C532	Walker Springs Rd S	W of N. Gallaher View Rd	12740			
M266	Wallace Rd	S of Nubbin Ridge Rd		1930		2050
C452	Walnoaks Rd	S of Pleasant Ridge Rd	4358			
C192	Walnut St	S of Church Ave	2463			
C352	Washington Av	W of Millertown Pk	9060		8220	
C263	Washington Ave	E of N 6Th Ave	3377			
C282	Washington Ave	W of Cherry St	2203			
C349	Washington Ave	S of Mall Rd N	18377		14700	
M35	Washington Pk	200' W of Mill Rd	12310	11960	12140	12830
T012	Washington Pk	N of Emory Rd	2196	1536	606	624
T014	Washington Pk	N of Zacharytown Rd	569	506	537	553
T018	Washington Pk	N of Shipe Rd	3981	3633	3600	3615
T033	Washington Pk	E of Murphy Rd	9110	8635	8277	8887
T308	Washington Pk	S of Valley View Dr	9093	9498	8333	9458
T312	Washington Pk	E of Teeple St	7371	7305	7400	6169
T382	Washington Pk	E of Broadway	6058	6267	6455	4910
T383	Washington Pk	N of I-640	18221	18232	17806	17199
M246	Wayland Rd	S of Strawberry Plains Pk		1035		
M347	Weaver Rd	S of Meredith Rd	1870		2010	
C067	Weisgarber Rd	N of Kingston Pk		4959		5230
C501	Weisgarber Rd	N of Papermill Dr	33926			
T325	Weisgarber Rd	S of Casey Dr	17709	18660	17723	19004
C059	Wellington Dr	S of Kingston Pk		1939		
C061	Wesley Rd	N of Kingston Pk		4667		
C513	West Hills Rd	S of Middlebrook Pk	1140			
C048	West Town Way	E of Monvue Rd		20299		
M360	Westcott Blvd	N of Hardin Valley Rd		7490		6910
T147	Western Av	W of Piedmont St	20554	20414	18817	18478
T152	Western Av	E of Carrick St	21943	20234	19104	16704
T153	Western Av	E of Heins St	20324	20563	18198	19273
T377	Western Av	E of 44th St	47050	48418	45507	43798
C455	Western Ave	W of Woods-Smith Rd	15872		15300	
C464	Western Ave	E of Palmetto Rd	19091			
C468	Western Ave	E of Ball Camp Pk E			23630	
C475	Western Ave	W of Sanderson Rd	30290			
C087	Western Plaza	N of Kingston Pk		5119		
C071	Westland Dr	W of Northshore Dr		9066		8990
M1	Westland Dr	100' E of Cloverhill Rd	8730	9670	10190	10580
M2	Westland Dr	1000' E of Villa Crest Dr	9440	8750	9220	8050
M85	Westland Dr	W of I-140	8410	8810	8570	8640
T367	Westland Dr	W of Dartford Rd	7972	8401	8110	8547
T437	Westland Dr	E of Northshore Dr	7475	5865	6706	6634
C069	Westwood Dr	N of Kingston Pk		4881		

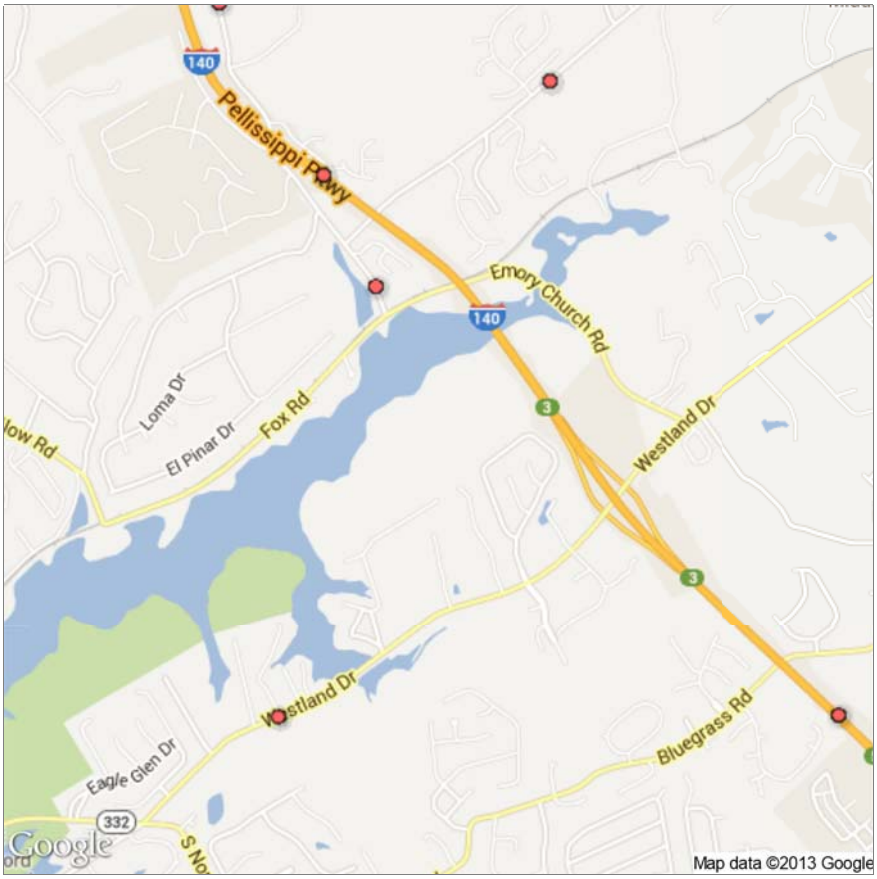
TN.GOV TENNESSEE GOVERNMENT

Tennessee Department of Transportation
John Schroer, Commissioner

Traffic History reflects the Annual Average Daily Traffic (AADT) count along specific locations on Tennessee's road network

View stations on map: Select a county...

Non-Map Record Search: Anderson Station Number: Search



Station Information

Station	000473
Route	05627
Location	FOX RD. - N. OF EMORY CHURCH RD.
County	Knox
2012	2526
2011	2206
2010	2255
2009	NA
2008	NA
2007	NA
2006	NA
2005	NA
2004	NA
2003	NA
2002	NA
2001	NA
2000	NA
1999	NA
1998	NA
1997	NA
1996	NA
1995	NA
1994	NA

Download File:
Open With:

KML	ESRI Geodatabase | ESRI Shapefile	Database Table
Google Earth	ArcGIS Explorer	MS Access or Excel

Department of Transportation
James K. Polk Building, Suite 700
Nashville, TN 37243-0349
615.741.2848

Historical Traffic Counts

Organization: MPC

Station ID #: M1

Location: 100' East of Cloverhill Road

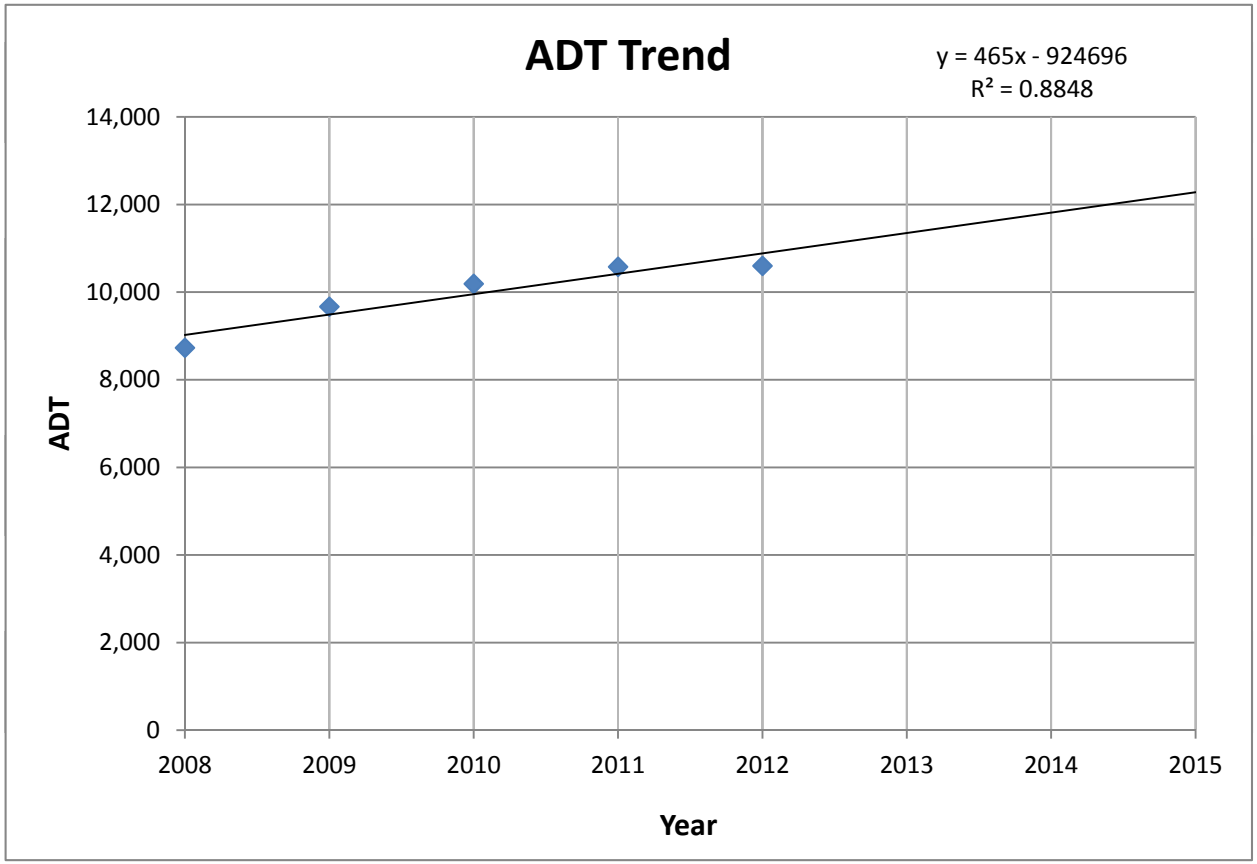
YEAR	ADT
2008	8,730
2009	9,670
2010	10,190
2011	10,580
2012	10,600
2013	*11,349*
2014	*11,814*
2015	***12,279***

Trendline

Recent Trend Line Growth

2013	11,349
2014	11,814

Annual % Growth = 4.1%



Historical Traffic Counts

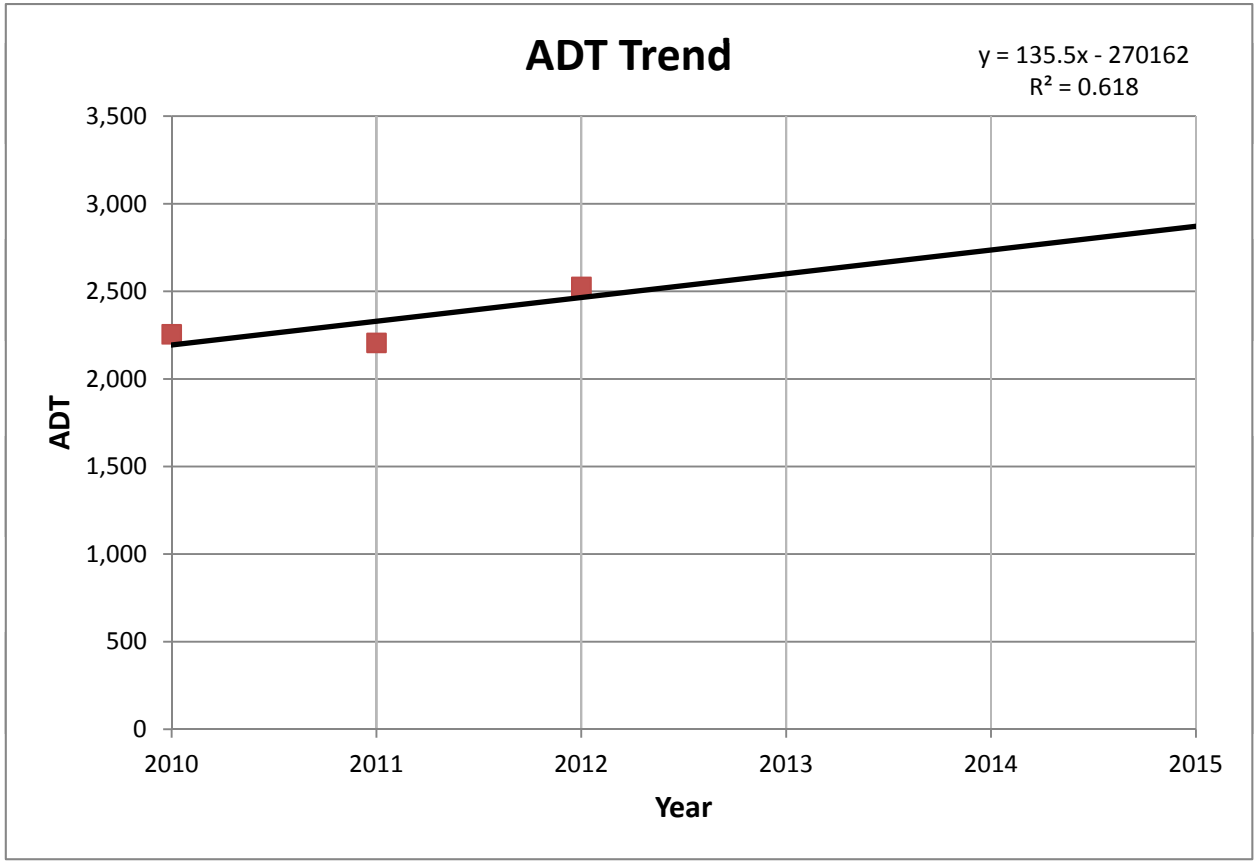
Organization: TDOT

Station ID #: 473

Location: Fox Road - North of Emory Church Road

YEAR	ADT
2010	2,255
2011	2,206
2012	2,526
2013	*2,600*
2014	*2,735*
2015	***2,871***

Trendline



Recent Trend Line Growth

2013	2,600
2014	2,735

Annual % Growth = 5.2%

APPENDIX D
WARRANTS FOR LEFT AND RIGHT TURN STORAGE LANES

TABLE 6A

LEFT-TURN LANE VOLUME THRESHOLDS FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 46 TO 55 MPH

(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 - 149 150 - 199	200 175	140 120	100 85	75 65	60 55	50 45
200 - 249 250 - 299	150 130	100 85	75 65	60 55	50 45	40 35
300 - 349 350 - 399	110 95	75 65	60 55	50 45	40 35	30 25
400 - 449 450 - 499	80 70	60 55	50 45	40 35	30 25	25 20
500 - 549 550 - 599	60 50	50 45	40 35	30 25	25 20	20 20
600 - 649 650 - 699	45 40	40 35	30 30	25 20	20 20	20 20
700 - 749 750 or More	35 35	35 35	25 25	20 20	20 15	15 15

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	=/ > 600
100 - 149 150 - 199	50 45	45 40	40 35	35 30	30 30	25 25
200 - 249 250 - 299	40 35	35 35	30 30	25 25	25 25	20 20
300 - 349 350 - 399	30 25	30 25	25 25	25 20	20 20	20 20
400 - 449 450 - 499	25 20	25 20	20 20	20 20	20 20	15 15
500 - 549 550 - 599	20 20	20 20	20 20	20 15	15 15	15 15
600 - 649 650 - 699	20 20	20 15	15 15	15 15	15 15	15 15
700 - 749 750 or More	15 15	15 15	15 15	15 15	15 15	15 15

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

TABLE 6B

RIGHT-TURN LANE VOLUME THRESHOLDS FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 46 TO 55 MPH

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						
100 - 149 150 - 199						Yes
200 - 249 250 - 299				Yes	Yes Yes	Yes Yes
300 - 349 350 - 399			Yes Yes	Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499		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

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	Yes Yes	Yes Yes
100 - 149 150 - 199	Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
200 - 249 250 - 299	Yes 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.

APPENDIX E
ITE MARINA & MPC LOCAL APARTMENT TRIP GENERATION RATES

Land Use: 420
Marina

Description

The marinas included in this analysis are both public and private facilities. In addition to docks and berths for boats, some of the sites surveyed also have social and club activities, limited retail and restaurants.

Additional Data

The sites were surveyed from the late 1960s to the late 1980s in California and Washington. The number of boat berths ranged from 108 to 1,750; the number of acres ranged from 11 to 105; and the number of parking spaces ranged from 65 to 493.

Source Numbers

6, 12, 19, 101, 123, 265

Marina
(420)

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

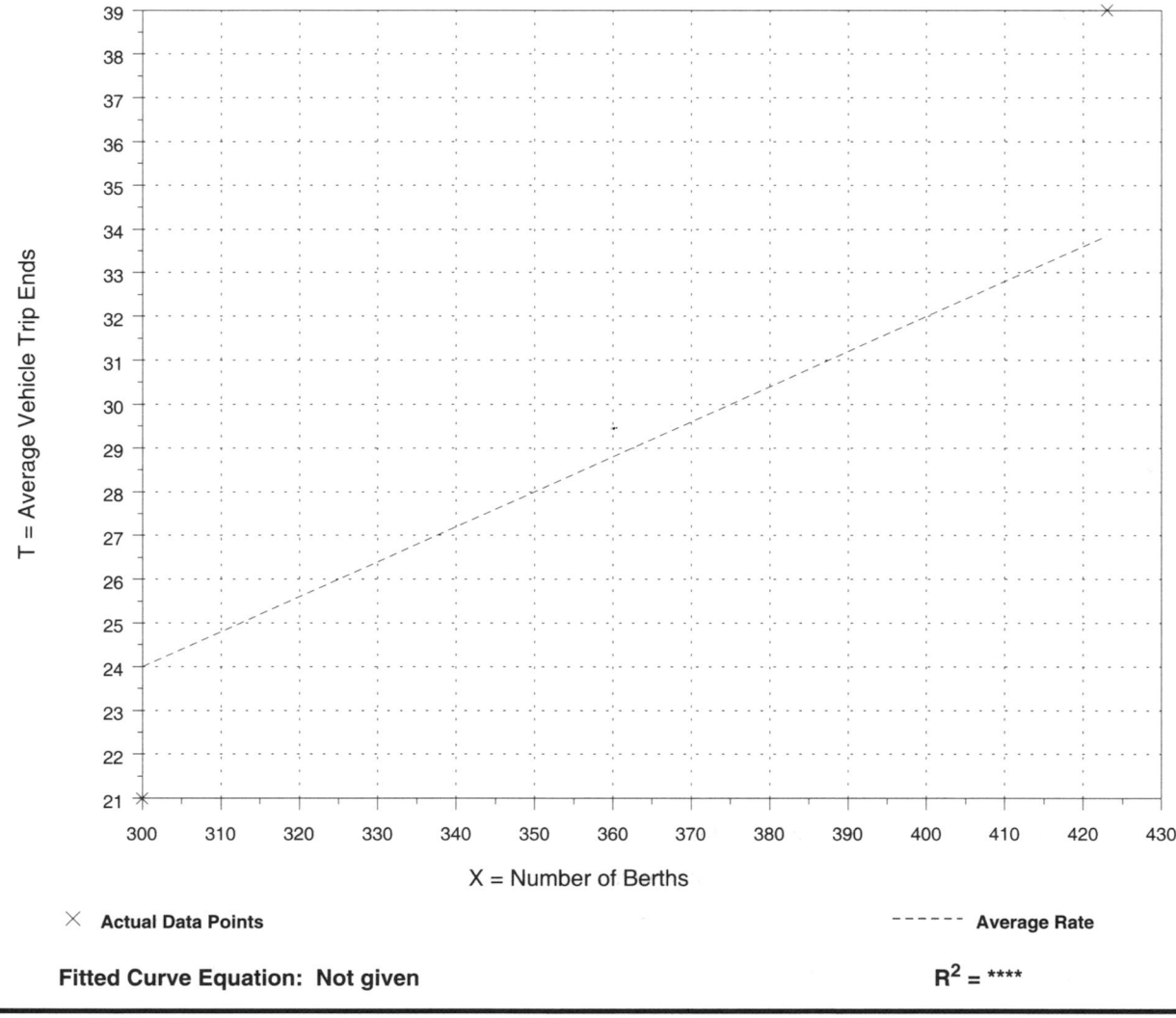
Number of Studies: 2
Average Number of Berths: 362
Directional Distribution: 33% entering, 67% exiting

Trip Generation per Berth

Average Rate	Range of Rates	Standard Deviation
0.08	0.07 - 0.09	*

Data Plot and Equation

Caution - Use Carefully - Small Sample Size



Fitted Curve Equation: Not given

R^2 = ****

Marina
(420)

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

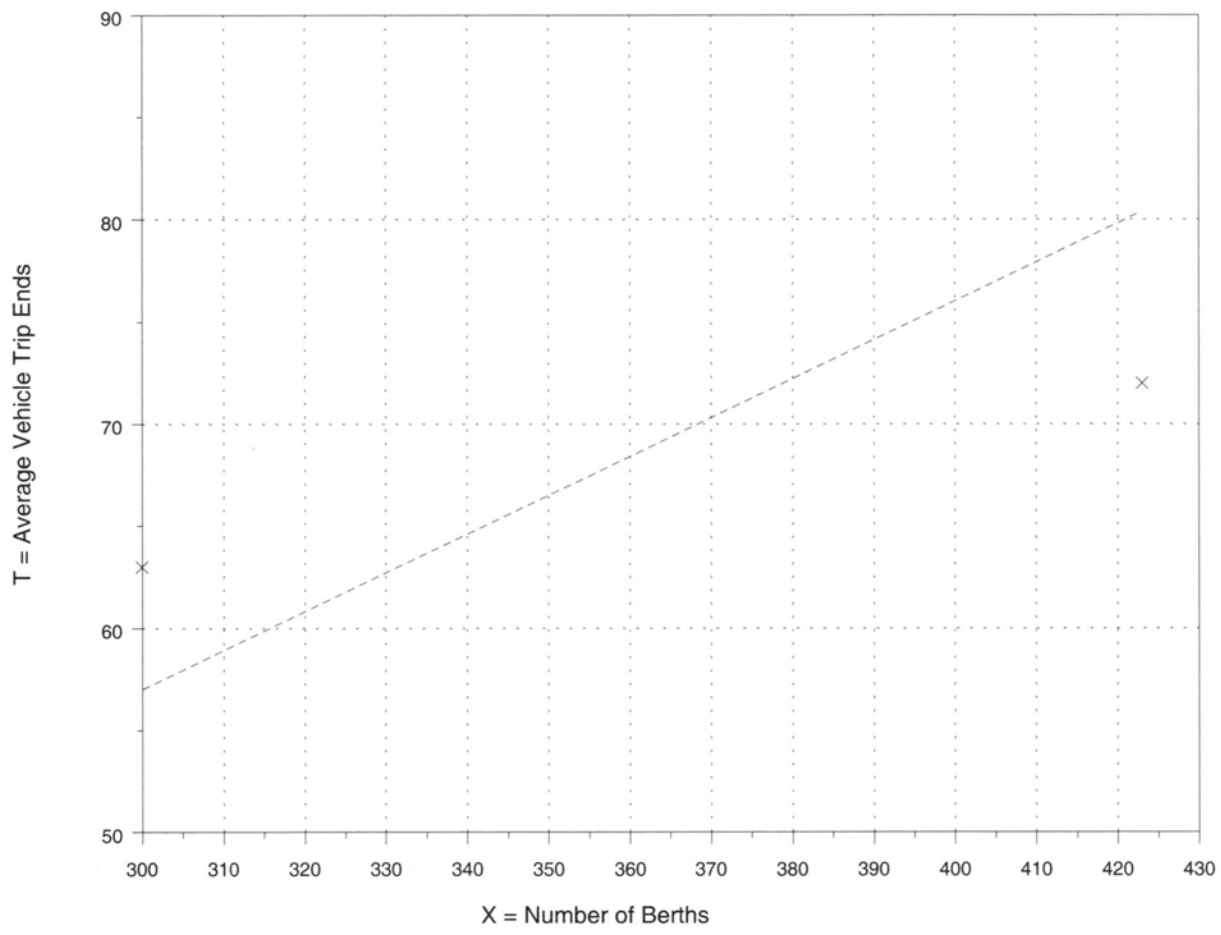
Number of Studies: 2
Average Number of Berths: 362
Directional Distribution: 60% entering, 40% exiting

Trip Generation per Berth

Average Rate	Range of Rates	Standard Deviation
0.19	0.17 - 0.21	*

Data Plot and Equation

Caution - Use Carefully - Small Sample Size



Fitted Curve Equation: Not given

R^2 = ****

Local Apartment
Trip Generation Study

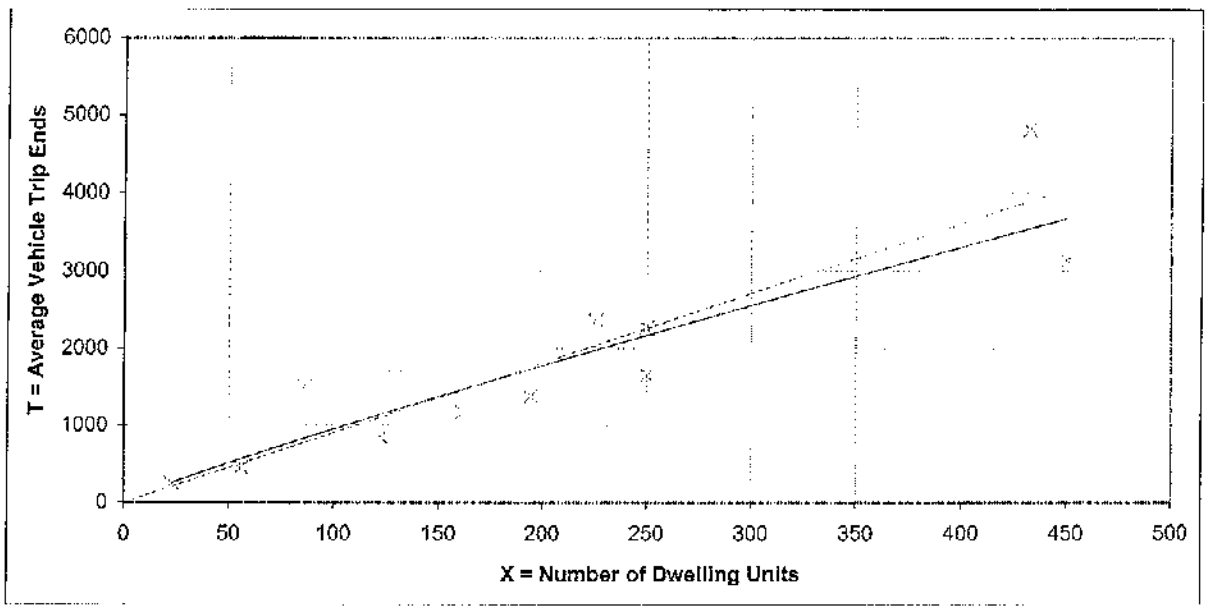
Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday**

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



X Actual Data Points ——— Fitted Curve Average Rate

Fitted Curve Equation: $T = 15.193(X)^{0.899}$ $R^2 = 0.88$

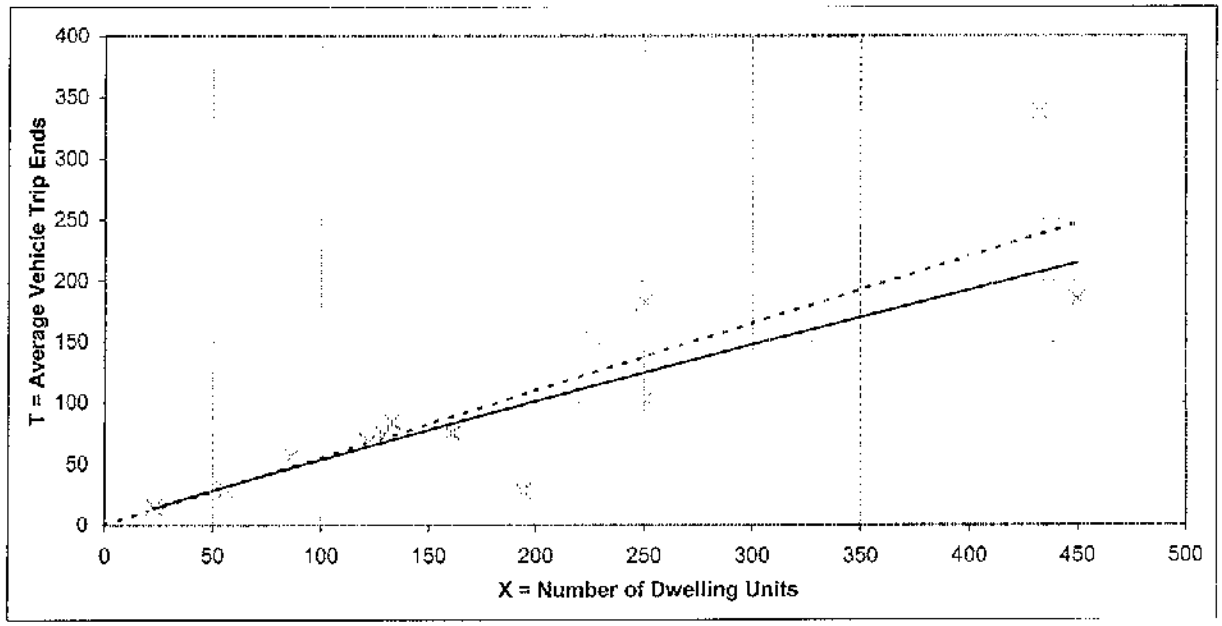
Local Apartment
Trip Generation Study

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



X Actual Data Points ——— Fitted Curve · Average Rate

Fitted Curve Equation: $T = 0.758(X)^{0.924}$ $R^2 = 0.75$

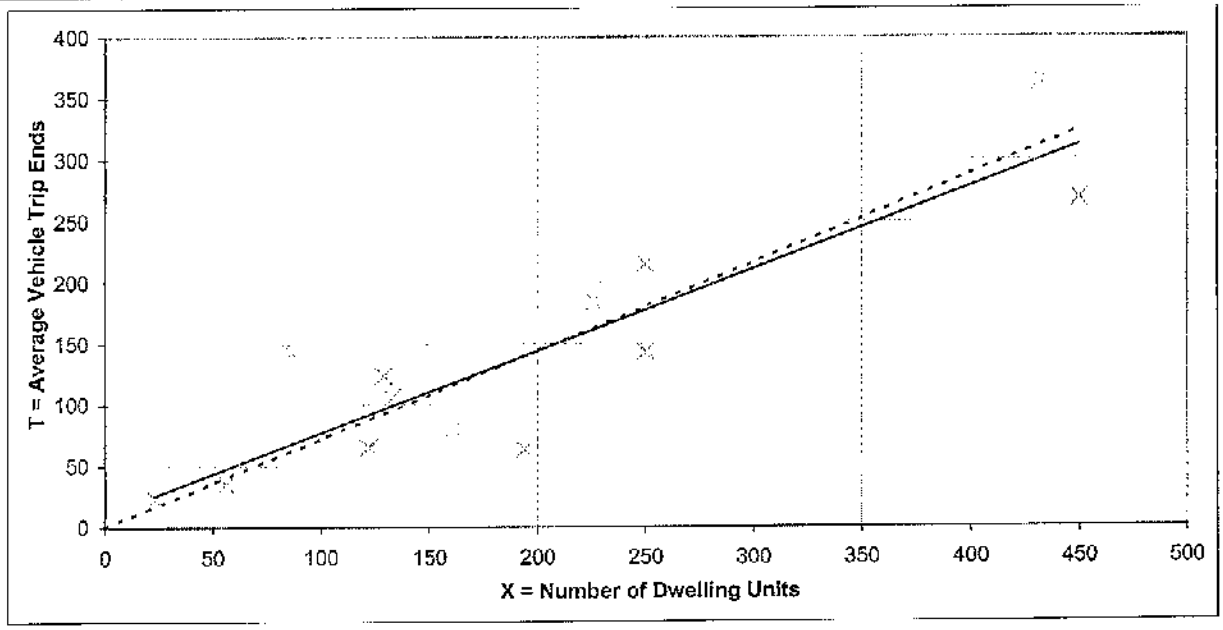
Local Apartment
Trip Generation Study

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



X Actual Data Points ——— Fitted Curve ····· Average Rate

Fitted Curve Equation: T = 0.669(X) + 10.069

R^2 = 0.79

APPENDIX F
SPOT SPEED STUDY

SPOT SPEED STUDY

Location:	Emory Church Road	(near proposed	Date:	8/14/2013
Posted Speed Limit:	30	apartment entrance)	Weather:	Sunny
Distance Counted (ft):	200		Time:	9:10 AM

Vehicle	Seconds	Speed (mph)
1	3.1	44
2	3.4	40
3	3.2	43
4	3.2	43
5	3.0	45
6	2.8	49
7	3.4	40
8	2.8	49
9	3.3	41
10	3.1	44
11	3.7	37
12	2.4	57
13	2.8	49
14	3.7	37
15	3.4	40
16	2.8	49
17	3.3	41
18	3.1	44
19	4.0	34
20	3.3	41
21	3.2	43
22	3.0	45
23	3.2	43
24	3.2	43

Sample Size Requirements (from ITE Manual of Transportation Engineering Studies)

$N = (S * K/E)^2$

where:

N	= minimum number of measured speeds
S	= estimated sample standard deviation (mph)
K	= constant corresponding to the desired confidence level
E	= permitted error in the average speed estimate (mph)

S =	5	mph (Table 3-2, page 38)
K =	2.58	(Confidence level of 99% - Table 3-3, page 38)
E =	2	mph assumed error range

Therefore, N = 42

SPOT SPEED STUDY

Location:	Emory Church Road	(near proposed	Date:	8/14/2013
Posted Speed Limit:	30	apartment entrance)	Weather:	Sunny
Distance Counted (ft):	200		Time:	9:10 AM

25	3.1	44
26	2.8	49
27	3.1	44
28	3.8	36
29	3.8	36
30	2.9	47
31	2.6	52
32	4.1	33
33	3.3	41
34	3.1	44
35	2.9	47
36	3.0	45
37	2.5	54
38	2.9	47
39	3.8	36
40	2.9	47
41	3.1	44
42	3.5	39
43	3.4	40
44	2.8	49
45	2.6	52
46	3.9	35
47	3.4	40
48	3.5	39
49	3.1	44
50	3.2	43

85th percentile speed = 48.6 mph

SPOT SPEED STUDY

Location:	Emory Church Road	(near marina	Date:	8/28/2013
Posted Speed Limit:	30	entrance at curve)	Weather:	Sunny
Distance Counted (ft):	200		Time:	10:00 AM

Vehicle	Seconds	Speed (mph)
1	3.2	43
2	4.1	33
3	3.5	39
4	3.5	39
5	3.8	36
6	3.4	40
7	3.3	41
8	3.9	35
9	2.7	50
10	3.5	39
11	3.1	44
12	3.1	44
13	3.7	37
14	3.6	38
15	4.5	30
16	3.3	41
17	3.2	43
18	3.3	41
19	3.1	44
20	3.3	41
21	4.0	34
22	3.1	44
23	3.2	43
24	3.2	43

Sample Size Requirements (from ITE Manual of Transportation Engineering Studies)

$N = (S * K/E)^2$

where:
- N = minimum number of measured speeds
- S = estimated sample standard deviation (mph)
- K = constant corresponding to the desired confidence level
- E = permitted error in the average speed estimate (mph)

$S =$ 5 mph (Table 3-2, page 38)

$K =$ 2.58 (Confidence level of 99% - Table 3-3, page 38)

$E =$ 2 mph assumed error range

Therefore, $N =$ 42

SPOT SPEED STUDY

Location:	Emory Church Road	(near marina	Date:	8/28/2013
Posted Speed Limit:	30	entrance at curve)	Weather:	Sunny
Distance Counted (ft):	200		Time:	10:00 AM

25	3.4	40
26	3.4	40
27	4.3	32
28	3.8	36
29	3.5	39
30	3.9	35
31	3.4	40
32	3.8	36
33	3.2	43
34	3.6	38
35	3.7	37
36	3.7	37
37	3.7	37
38	3.1	44
39	3.6	38
40	3.5	39
41	3.7	37
42	3.4	40
43	2.9	47
44	3.1	44
45	4.4	31
46	3.6	38
47	3.3	41
48	3.5	39
49	3.3	41
50	3.3	41

85th percentile speed = 43.4 mph

SPOT SPEED STUDY

Location: Westland Drive
Posted Speed Limit: 40
Distance Counted (ft): 310

Date: 8/28/2013
Weather: Sunny
Time: 9:00 AM

Vehicle	Seconds	Speed (mph)
1	4.9	43
2	4.3	49
3	5.3	40
4	5.2	41
5	4.8	44
6	4.5	47
7	5.0	42
8	5.3	40
9	5.1	41
10	4.4	48
11	5.6	38
12	5.9	36
13	5.2	41
14	5.3	40
15	4.5	47
16	5.2	41
17	4.5	47
18	5.3	40
19	4.7	45
20	4.4	48
21	5.9	36
22	4.8	44
23	5.0	42
24	4.1	51

Sample Size Requirements (from ITE Manual of Transportation Engineering Studies)

$N = (S * K/E)^2$

where:
- N = minimum number of measured speeds
- S = estimated sample standard deviation (mph)
- K = constant corresponding to the desired confidence level
- E = permitted error in the average speed estimate (mph)

$S =$ 5 mph (Table 3-2, page 38)
$K =$ 2.58 (Confidence level of 99% - Table 3-3, page 38)
$E =$ 2 mph assumed error range

Therefore, $N =$ 42

SPOT SPEED STUDY

Location:	Westland Drive	Date:	8/28/2013
Posted Speed Limit:	40	Weather:	Sunny
Distance Counted (ft):	310	Time:	9:00 AM

25	5.4	39
26	5.1	41
27	5.1	41
28	5.4	39
29	5.2	41
30	5.7	37
31	5.5	38
32	4.4	48
33	5.7	37
34	5.7	37
35	4.8	44
36	5.3	40
37	4.8	44
38	5.5	38
39	4.9	43
40	5.3	40
41	4.5	47
42	4.9	43
43	4.2	50
44	4.6	46
45	5.9	36
46	4.8	44
47	4.4	48
48	5.4	39
49	4.4	48
50	4.8	44

85th percentile speed = 47.6 mph

APPENDIX G
TRAFFIC SIGNAL WARRANT WORKSHEETS

EXISTING CONDITIONS

Traffic Signal Warrant Analysis Workbook

8/31/2013

STUDY AND ANALYSIS INFORMATION

Municipality:	Knox County	**Analysis Date:**	8/31/2013
County:		**Conducted By:**	RWJ
PennDOT Engineering District:		**Agency/Company Name:**	AJAX

Analysis Information

Data Collection Date:	8/28/2013
Day of the Week:	Tuesday

Is the intersection in a built-up area of an isolated community of <10,000 population? No

Major Street Information

Major Street Name and Route Number:	Westland Drive
Major Street Approach #1 Direction:	E-Bound
Major Street Approach #2 Direction:	W-Bound

Number of Lanes for Moving Traffic on Each Major Street Approach:	1	**LANE(S)**
Speed Limit or 85th Percentile Speed on the Major Street:	47	**MPH**

Minor Street Information

Minor Street Name and Route Number:	Emory Church Road and Treymour Way
Minor Street Approach #1 Direction:	S-Bound
Minor Street Approach #2 Direction:	N-Bound

Number of Lanes for Moving Traffic on Each Minor Street Approach:	1	**LANE(S)**

TRAFFIC SIGNAL WARRANT ANALYSIS FINDINGS

	Applicable?	Warrant Met?
Warrant 1, Eight-Hour Vehicular Volume	**Yes**	**Yes**
Warrant 2, Four-Hour Vehicular Volume	**Yes**	**Yes**
Warrant 3, Peak Hour	**Yes**	**No**
Warrant 4, Pedestrian Volume	**No**	**N/A**
Warrant 5, School Crossing	**No**	**N/A**
Warrant 6, Coordinated Signal System	**No**	**N/A**
Warrant 7, Crash Experience	**No**	**N/A**
Warrant 8, Roadway Network	**No**	**N/A**
Warrant 9, Intersection Near a Grade Crossing	**No**	**N/A**
Warrant PA-1, ADT Volume Warrant	**No**	**N/A**
Warrant PA-2, Midblock and Trail Crossings	**No**	**N/A**

EXISTING CONDITIONS

Traffic Signal Warrant Analysis Workbook

ENTER VOLUME DATA PER 15 MINUTE INTERVAL, PER APPROACH

Time Interval		Major Street Approach #1 (E-Bound)	Major Street Approach #2 (W-Bound)	Major Street Combined	Minor Street Approach #1 (S-Bound)	Minor Street Approach #2 (N-Bound)
Begin At	End Of	Volume	Volume	Total Volume	Volume	Volume
12:00 AM	12:14 AM			0		
12:15 AM	12:29 AM			0		
12:30 AM	12:44 AM			0		
12:45 AM	12:59 AM			0		
1:00 AM	1:14 AM			0		
1:15 AM	1:29 AM			0		
1:30 AM	1:44 AM			0		
1:45 AM	1:59 AM			0		
2:00 AM	2:14 AM			0		
2:15 AM	2:29 AM			0		
2:30 AM	2:44 AM			0		
2:45 AM	2:59 AM			0		
3:00 AM	3:14 AM			0		
3:15 AM	3:29 AM			0		
3:30 AM	3:44 AM			0		
3:45 AM	3:59 AM			0		
4:00 AM	4:14 AM			0		
4:15 AM	4:29 AM			0		
4:30 AM	4:44 AM			0		
4:45 AM	4:59 AM			0		
5:00 AM	5:14 AM			0		
5:15 AM	5:29 AM			0		
5:30 AM	5:44 AM			0		
5:45 AM	5:59 AM			0		
6:00 AM	6:14 AM			0		
6:15 AM	6:29 AM			0		
6:30 AM	6:44 AM			0		
6:45 AM	6:59 AM			0		
7:00 AM	7:14 AM	65	135	200	32	5
7:15 AM	7:29 AM	74	188	262	83	1
7:30 AM	7:44 AM	89	239	328	53	0
7:45 AM	7:59 AM	175	222	397	26	0
8:00 AM	8:14 AM	104	165	269	53	1
8:15 AM	8:29 AM	84	142	226	41	2
8:30 AM	8:44 AM	86	162	248	22	0
8:45 AM	8:59 AM	85	158	243	39	2
9:00 AM	9:14 AM			0		
9:15 AM	9:29 AM			0		
9:30 AM	9:44 AM			0		
9:45 AM	9:59 AM			0		
10:00 AM	10:14 AM			0		
10:15 AM	10:29 AM			0		
10:30 AM	10:44 AM			0		
10:45 AM	10:59 AM			0		
11:00 AM	11:14 AM	79	78	157	21	4
11:15 AM	11:29 AM	74	61	135	24	1
11:30 AM	11:44 AM	77	87	164	17	2
11:45 AM	11:59 AM	81	88	169	13	2

EXISTING CONDITIONS

Traffic Signal Warrant Analysis Workbook

ENTER VOLUME DATA PER 15 MINUTE INTERVAL, PER APPROACH

Time Interval		Major Street Approach #1 (E-Bound)	Major Street Approach #2 (W-Bound)	Major Street Combined	Minor Street Approach #1 (S-Bound)	Minor Street Approach #2 (N-Bound)
Begin At	End Of	Volume	Volume	Total Volume	Volume	Volume
12:00 PM	12:14 PM	73	78	151	26	2
12:15 PM	12:29 PM	96	72	168	28	1
12:30 PM	12:44 PM	105	87	192	31	3
12:45 PM	12:59 PM	85	92	177	23	2
1:00 PM	1:14 PM	94	83	177	27	4
1:15 PM	1:29 PM	78	86	164	23	0
1:30 PM	1:44 PM	75	88	163	41	2
1:45 PM	1:59 PM	82	93	175	29	2
2:00 PM	2:14 PM			0		
2:15 PM	2:29 PM			0		
2:30 PM	2:44 PM			0		
2:45 PM	2:59 PM			0		
3:00 PM	3:14 PM	121	119	240	16	0
3:15 PM	3:29 PM	105	111	216	25	0
3:30 PM	3:44 PM	120	122	242	34	0
3:45 PM	3:59 PM	132	142	274	44	2
4:00 PM	4:14 PM	118	154	272	65	2
4:15 PM	4:29 PM	152	145	297	26	1
4:30 PM	4:44 PM	153	119	272	40	0
4:45 PM	4:59 PM	162	159	321	51	2
5:00 PM	5:14 PM	172	156	328	42	0
5:15 PM	5:29 PM	175	181	356	57	1
5:30 PM	5:44 PM	159	189	348	49	2
5:45 PM	5:59 PM	189	157	346	44	0
6:00 PM	6:14 PM			0		
6:15 PM	6:29 PM			0		
6:30 PM	6:44 PM			0		
6:45 PM	6:59 PM			0		
7:00 PM	7:14 PM			0		
7:15 PM	7:29 PM			0		
7:30 PM	7:44 PM			0		
7:45 PM	7:59 PM			0		
8:00 PM	8:14 PM			0		
8:15 PM	8:29 PM			0		
8:30 PM	8:44 PM			0		
8:45 PM	8:59 PM			0		
9:00 PM	9:14 PM			0		
9:15 PM	9:29 PM			0		
9:30 PM	9:44 PM			0		
9:45 PM	9:59 PM			0		
10:00 PM	10:14 PM			0		
10:15 PM	10:29 PM			0		
10:30 PM	10:44 PM			0		
10:45 PM	10:59 PM			0		
11:00 PM	11:14 PM			0		
11:15 PM	11:29 PM			0		
11:30 PM	11:44 PM			0		

EXISTING CONDITIONS

Traffic Signal Warrant Analysis Workbook

ENTER VOLUME DATA PER 15 MINUTE INTERVAL, PER APPROACH						
Time Interval		Major Street Approach #1 (E-Bound)	Major Street Approach #2 (W-Bound)	Major Street Combined	Minor Street Approach #1 (S-Bound)	Minor Street Approach #2 (N-Bound)
Begin At	End Of	Volume	Volume	Total Volume	Volume	Volume
11:45 PM	11:59 PM			0		
Approach Totals:		3519	4158	7677	1145	46

EXISTING CONDITIONS

MUTCD WARRANT 1, EIGHT-HOUR VEHICULAR VOLUME

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

Built-up Isolated Community With Less Than 10,000 Population or Above 40 MPH on Major Street?	Yes

Combination of Conditions A and B Necessary?*: No

**Only applicable for Warrant 1 if after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems. See Section 4C.02 of the 2009 MUTCD for application.*

Condition A - Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor street approach (one direction only)			
Major Street	Minor Street	100%	80%	70%	56%	100%	80%	70%	56%
1	1	500	400	350	280	150	120	105	84
2 or More	1	600	480	420	336	150	120	105	84
2 or More	2 or More	600	480	420	336	200	160	140	112
1	2 or More	500	400	350	280	200	160	140	112

Condition B - Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor street approach (one direction only)			
Major Street	Minor Street	100%	80%	70%	56%	100%	80%	70%	56%
1	1	750	600	525	420	75	60	53	42
2 or More	1	900	720	630	504	75	60	53	42
2 or More	2 or More	900	720	630	504	100	80	70	56
1	2 or More	750	600	525	420	100	80	70	56

Condition A Evaluation

Number of Unique Hours Met: 7 **Condition A Satisfied?** No

Condition B Evaluation

Number of Unique Hours Met: 8 **Condition B Satisfied?** Yes

Combination of Condition A and Condition B Evaluation

Number of Unique Hours Met for Condition A: N/A

Number of Unique Hours Met for Condition B: N/A

Combination of Condition A and Condition B Satisfied? N/A

EXISTING CONDITIONS

MUTCD WARRANT 2, FOUR-HOUR VEHICULAR VOLUME

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

Total Number of Unique Hours Met On Figure 4C-2
7

Built-up Isolated Community With Less Than 10,000 Population or Above 40 MPH on Major Street?	Yes

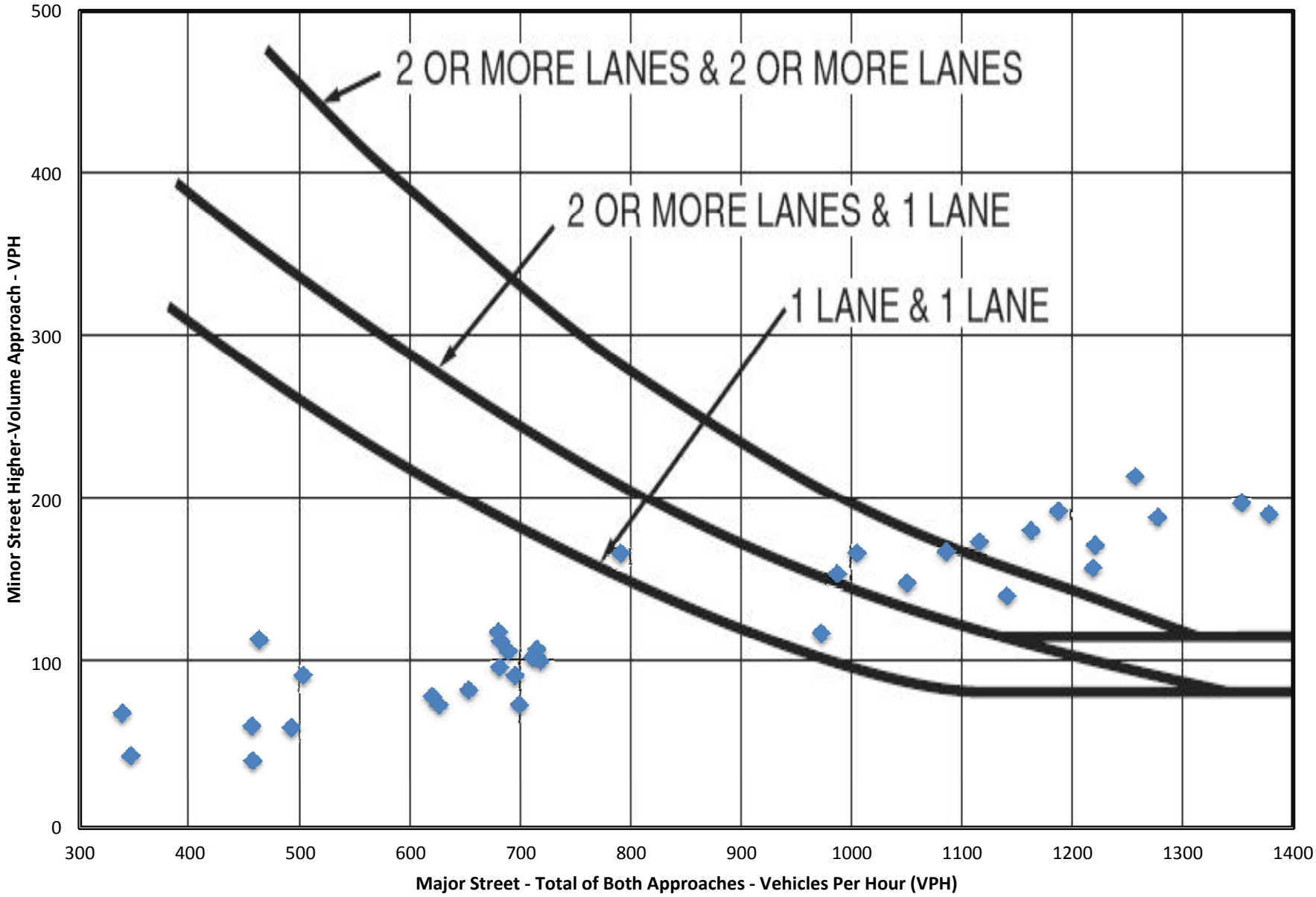
Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 AM	0	0	
12:15 AM	0	0	
12:30 AM	0	0	
12:45 AM	0	0	
1:00 AM	0	0	
1:15 AM	0	0	
1:30 AM	0	0	
1:45 AM	0	0	
2:00 AM	0	0	
2:15 AM	0	0	
2:30 AM	0	0	
2:45 AM	0	0	
3:00 AM	0	0	
3:15 AM	0	0	
3:30 AM	0	0	
3:45 AM	0	0	
4:00 AM	0	0	
4:15 AM	0	0	
4:30 AM	0	0	
4:45 AM	0	0	
5:00 AM	0	0	
5:15 AM	0	0	
5:30 AM	0	0	
5:45 AM	0	0	
6:00 AM	0	0	
6:15 AM	200	32	
6:30 AM	462	115	
6:45 AM	790	168	Met
7:00 AM	1187	194	Met
7:15 AM	1256	215	Met
7:30 AM	1220	173	Met
7:45 AM	1140	142	Met
8:00 AM	986	155	Met
8:15 AM	717	102	Met
8:30 AM	491	61	
8:45 AM	243	39	
9:00 AM	0	0	
9:15 AM	0	0	
9:30 AM	0	0	
9:45 AM	0	0	
10:00 AM	0	0	
10:15 AM	157	21	
10:30 AM	292	45	
10:45 AM	456	62	
11:00 AM	625	75	
11:15 AM	619	80	
11:30 AM	652	84	Met
11:45 AM	680	98	Met

EXISTING CONDITIONS

Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 PM	688	108	Met
12:15 PM	714	109	Met
12:30 PM	710	104	Met
12:45 PM	681	114	Met
1:00 PM	679	120	Met
1:15 PM	502	93	
1:30 PM	338	70	
1:45 PM	175	29	
2:00 PM	0	0	
2:15 PM	240	16	
2:30 PM	456	41	
2:45 PM	698	75	Met
3:00 PM	972	119	Met
3:15 PM	1004	168	Met
3:30 PM	1085	169	Met
3:45 PM	1115	175	Met
4:00 PM	1162	182	Met
4:15 PM	1218	159	Met
4:30 PM	1277	190	Met
4:45 PM	1353	199	Met
5:00 PM	1378	192	Met
5:15 PM	1050	150	Met
5:30 PM	694	93	Met
5:45 PM	346	44	
6:00 PM	0	0	
6:15 PM	0	0	
6:30 PM	0	0	
6:45 PM	0	0	
7:00 PM	0	0	
7:15 PM	0	0	
7:30 PM	0	0	
7:45 PM	0	0	
8:00 PM	0	0	
8:15 PM	0	0	
8:30 PM	0	0	
8:45 PM	0	0	
9:00 PM	0	0	
9:15 PM	0	0	
9:30 PM	0	0	
9:45 PM	0	0	
10:00 PM	0	0	
10:15 PM	0	0	
10:30 PM	0	0	
10:45 PM	0	0	
11:00 PM	0	0	

EXISTING CONDITIONS

MUTCD Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume



EXISTING CONDITIONS

MUTCD WARRANT 2, FOUR-HOUR VEHICULAR VOLUME

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

Total Number of Unique Hours Met On Figure 4C-2
7

Built-up Isolated Community With Less Than 10,000 Population or Above 40 MPH on Major Street?	Yes

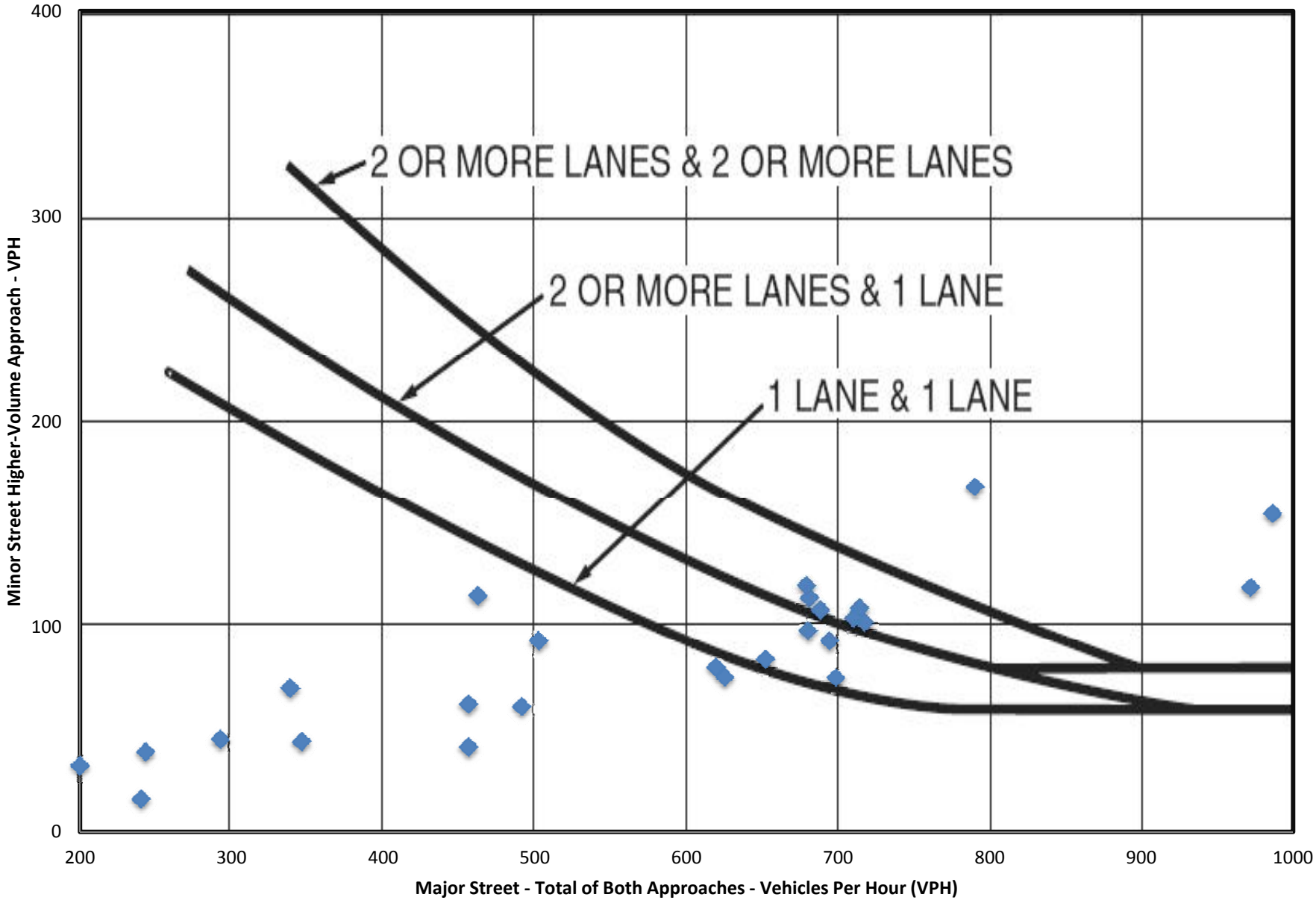
Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 AM	0	0	
12:15 AM	0	0	
12:30 AM	0	0	
12:45 AM	0	0	
1:00 AM	0	0	
1:15 AM	0	0	
1:30 AM	0	0	
1:45 AM	0	0	
2:00 AM	0	0	
2:15 AM	0	0	
2:30 AM	0	0	
2:45 AM	0	0	
3:00 AM	0	0	
3:15 AM	0	0	
3:30 AM	0	0	
3:45 AM	0	0	
4:00 AM	0	0	
4:15 AM	0	0	
4:30 AM	0	0	
4:45 AM	0	0	
5:00 AM	0	0	
5:15 AM	0	0	
5:30 AM	0	0	
5:45 AM	0	0	
6:00 AM	0	0	
6:15 AM	200	32	
6:30 AM	462	115	
6:45 AM	790	168	Met
7:00 AM	1187	194	Met
7:15 AM	1256	215	Met
7:30 AM	1220	173	Met
7:45 AM	1140	142	Met
8:00 AM	986	155	Met
8:15 AM	717	102	Met
8:30 AM	491	61	
8:45 AM	243	39	
9:00 AM	0	0	
9:15 AM	0	0	
9:30 AM	0	0	
9:45 AM	0	0	
10:00 AM	0	0	
10:15 AM	157	21	
10:30 AM	292	45	
10:45 AM	456	62	
11:00 AM	625	75	
11:15 AM	619	80	
11:30 AM	652	84	Met
11:45 AM	680	98	Met

EXISTING CONDITIONS

Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 PM	688	108	Met
12:15 PM	714	109	Met
12:30 PM	710	104	Met
12:45 PM	681	114	Met
1:00 PM	679	120	Met
1:15 PM	502	93	
1:30 PM	338	70	
1:45 PM	175	29	
2:00 PM	0	0	
2:15 PM	240	16	
2:30 PM	456	41	
2:45 PM	698	75	Met
3:00 PM	972	119	Met
3:15 PM	1004	168	Met
3:30 PM	1085	169	Met
3:45 PM	1115	175	Met
4:00 PM	1162	182	Met
4:15 PM	1218	159	Met
4:30 PM	1277	190	Met
4:45 PM	1353	199	Met
5:00 PM	1378	192	Met
5:15 PM	1050	150	Met
5:30 PM	694	93	Met
5:45 PM	346	44	
6:00 PM	0	0	
6:15 PM	0	0	
6:30 PM	0	0	
6:45 PM	0	0	
7:00 PM	0	0	
7:15 PM	0	0	
7:30 PM	0	0	
7:45 PM	0	0	
8:00 PM	0	0	
8:15 PM	0	0	
8:30 PM	0	0	
8:45 PM	0	0	
9:00 PM	0	0	
9:15 PM	0	0	
9:30 PM	0	0	
9:45 PM	0	0	
10:00 PM	0	0	
10:15 PM	0	0	
10:30 PM	0	0	
10:45 PM	0	0	
11:00 PM	0	0	

EXISTING CONDITIONS

MUTCD Figure 4C-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)



EXISTING CONDITIONS

MUTCD WARRANT 3, PEAK HOUR

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

Built-up Isolated Community With Less Than 10,000 Population or Above 40 MPH on Major Street?	Yes
Is this signal warrant being applied for an unusual case, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time?	N/A

Indicate whether all three of the following conditions for the same 1 hour (any four consecutive 15-minute periods) of an average day are present*	
Does the total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equal or exceed 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach?	N/A
Does the volume on the same minor-street approach (one direction only) equal or exceed 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes?	N/A
Does the total entering volume serviced during the hour equal or exceed 650 vehicles per hour for intersection with three approaches or 800 vehicles per hour for intersections with four or more approaches?	N/A
**If applicable, attach all supporting calculations and documentation.*	

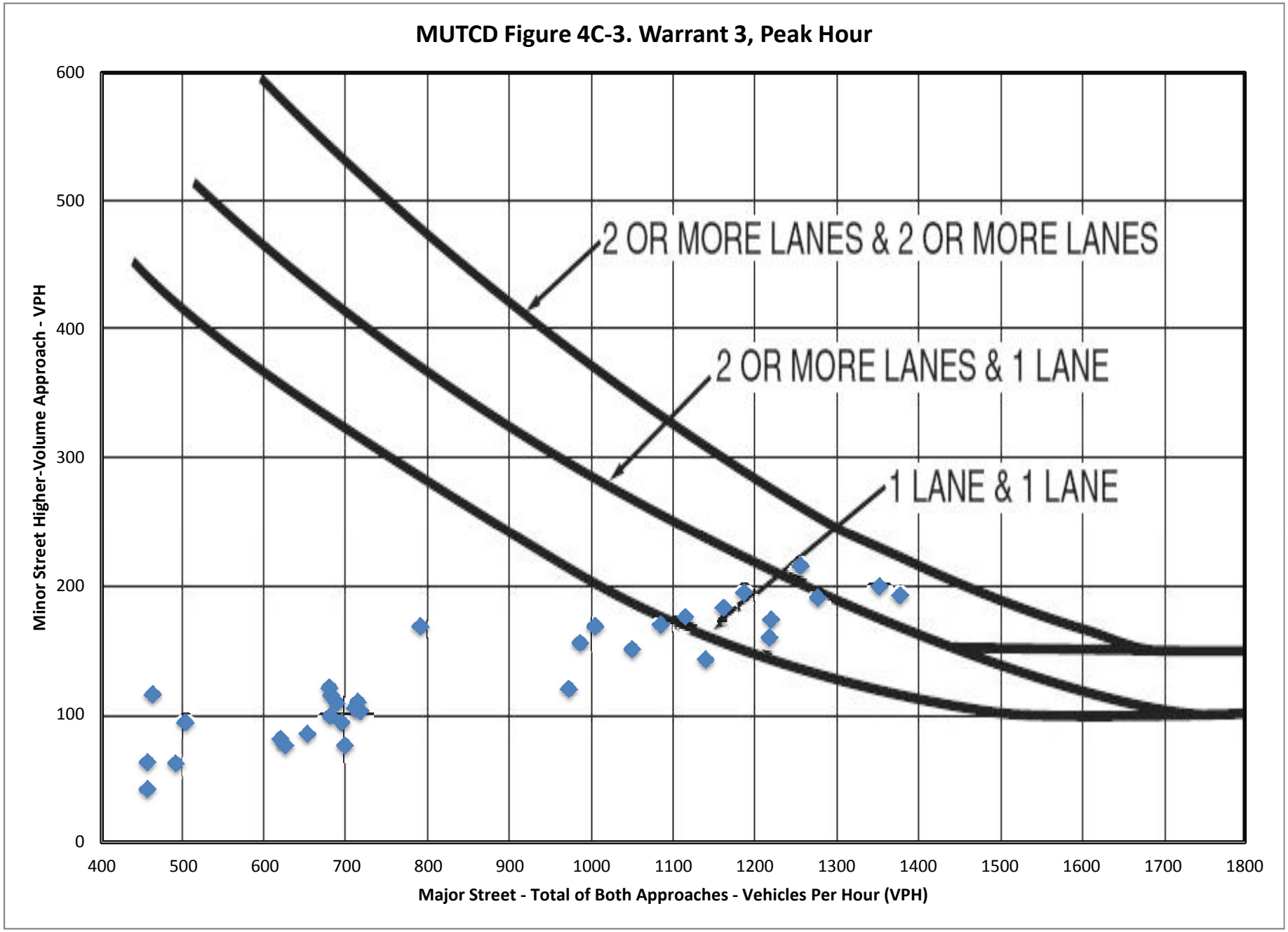
Total Number of Unique Hours Met On Figure 4C-4
5

Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 AM	0	0	
12:15 AM	0	0	
12:30 AM	0	0	
12:45 AM	0	0	
1:00 AM	0	0	
1:15 AM	0	0	
1:30 AM	0	0	
1:45 AM	0	0	
2:00 AM	0	0	
2:15 AM	0	0	
2:30 AM	0	0	
2:45 AM	0	0	
3:00 AM	0	0	
3:15 AM	0	0	
3:30 AM	0	0	
3:45 AM	0	0	
4:00 AM	0	0	
4:15 AM	0	0	
4:30 AM	0	0	
4:45 AM	0	0	
5:00 AM	0	0	
5:15 AM	0	0	
5:30 AM	0	0	
5:45 AM	0	0	
6:00 AM	0	0	
6:15 AM	200	32	
6:30 AM	462	115	
6:45 AM	790	168	Met
7:00 AM	1187	194	Met
7:15 AM	1256	215	Met
7:30 AM	1220	173	Met
7:45 AM	1140	142	Met
8:00 AM	986	155	Met
8:15 AM	717	102	

EXISTING CONDITIONS

Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
8:30 AM	491	61	
8:45 AM	243	39	
9:00 AM	0	0	
9:15 AM	0	0	
9:30 AM	0	0	
9:45 AM	0	0	
10:00 AM	0	0	
10:15 AM	157	21	
10:30 AM	292	45	
10:45 AM	456	62	
11:00 AM	625	75	
11:15 AM	619	80	
11:30 AM	652	84	
11:45 AM	680	98	
12:00 PM	688	108	
12:15 PM	714	109	
12:30 PM	710	104	
12:45 PM	681	114	
1:00 PM	679	120	
1:15 PM	502	93	
1:30 PM	338	70	
1:45 PM	175	29	
2:00 PM	0	0	
2:15 PM	240	16	
2:30 PM	456	41	
2:45 PM	698	75	
3:00 PM	972	119	Met
3:15 PM	1004	168	Met
3:30 PM	1085	169	Met
3:45 PM	1115	175	Met
4:00 PM	1162	182	Met
4:15 PM	1218	159	Met
4:30 PM	1277	190	Met
4:45 PM	1353	199	Met
5:00 PM	1378	192	Met
5:15 PM	1050	150	Met
5:30 PM	694	93	
5:45 PM	346	44	
6:00 PM	0	0	
6:15 PM	0	0	
6:30 PM	0	0	
6:45 PM	0	0	
7:00 PM	0	0	
7:15 PM	0	0	
7:30 PM	0	0	
7:45 PM	0	0	
8:00 PM	0	0	
8:15 PM	0	0	
8:30 PM	0	0	
8:45 PM	0	0	
9:00 PM	0	0	
9:15 PM	0	0	
9:30 PM	0	0	
9:45 PM	0	0	
10:00 PM	0	0	
10:15 PM	0	0	
10:30 PM	0	0	
10:45 PM	0	0	
11:00 PM	0	0	

EXISTING CONDITIONS



EXISTING CONDITIONS

MUTCD WARRANT 3, PEAK HOUR

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

Built-up Isolated Community With Less Than 10,000 Population or Above 40 MPH on Major Street?	Yes
Is this signal warrant being applied for an unusual case, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time?	N/A

Indicate whether all three of the following conditions for the same 1 hour (any four consecutive 15-minute periods) of an average day are present*	
Does the total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equal or exceed 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach?	N/A
Does the volume on the same minor-street approach (one direction only) equal or exceed 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes?	N/A
Does the total entering volume serviced during the hour equal or exceed 650 vehicles per hour for intersection with three approaches or 800 vehicles per hour for intersections with four or more approaches?	N/A
**If applicable, attach all supporting calculations and documentation.*	

Total Number of Unique Hours Met On Figure 4C-4
5

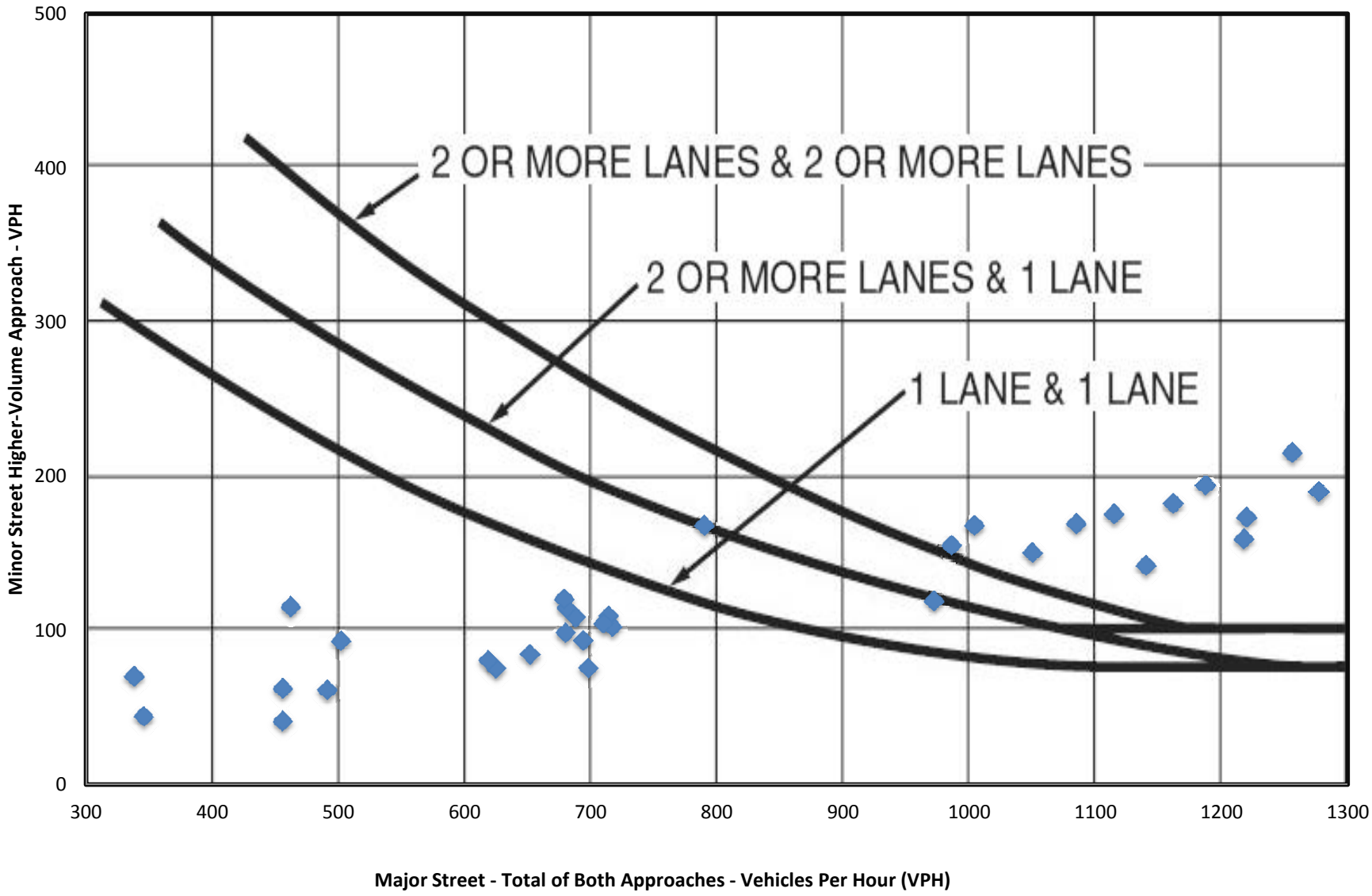
Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 AM	0	0	
12:15 AM	0	0	
12:30 AM	0	0	
12:45 AM	0	0	
1:00 AM	0	0	
1:15 AM	0	0	
1:30 AM	0	0	
1:45 AM	0	0	
2:00 AM	0	0	
2:15 AM	0	0	
2:30 AM	0	0	
2:45 AM	0	0	
3:00 AM	0	0	
3:15 AM	0	0	
3:30 AM	0	0	
3:45 AM	0	0	
4:00 AM	0	0	
4:15 AM	0	0	
4:30 AM	0	0	
4:45 AM	0	0	
5:00 AM	0	0	
5:15 AM	0	0	
5:30 AM	0	0	
5:45 AM	0	0	
6:00 AM	0	0	
6:15 AM	200	32	
6:30 AM	462	115	
6:45 AM	790	168	Met
7:00 AM	1187	194	Met
7:15 AM	1256	215	Met
7:30 AM	1220	173	Met
7:45 AM	1140	142	Met
8:00 AM	986	155	Met
8:15 AM	717	102	

EXISTING CONDITIONS

Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
8:30 AM	491	61	
8:45 AM	243	39	
9:00 AM	0	0	
9:15 AM	0	0	
9:30 AM	0	0	
9:45 AM	0	0	
10:00 AM	0	0	
10:15 AM	157	21	
10:30 AM	292	45	
10:45 AM	456	62	
11:00 AM	625	75	
11:15 AM	619	80	
11:30 AM	652	84	
11:45 AM	680	98	
12:00 PM	688	108	
12:15 PM	714	109	
12:30 PM	710	104	
12:45 PM	681	114	
1:00 PM	679	120	
1:15 PM	502	93	
1:30 PM	338	70	
1:45 PM	175	29	
2:00 PM	0	0	
2:15 PM	240	16	
2:30 PM	456	41	
2:45 PM	698	75	
3:00 PM	972	119	Met
3:15 PM	1004	168	Met
3:30 PM	1085	169	Met
3:45 PM	1115	175	Met
4:00 PM	1162	182	Met
4:15 PM	1218	159	Met
4:30 PM	1277	190	Met
4:45 PM	1353	199	Met
5:00 PM	1378	192	Met
5:15 PM	1050	150	Met
5:30 PM	694	93	
5:45 PM	346	44	
6:00 PM	0	0	
6:15 PM	0	0	
6:30 PM	0	0	
6:45 PM	0	0	
7:00 PM	0	0	
7:15 PM	0	0	
7:30 PM	0	0	
7:45 PM	0	0	
8:00 PM	0	0	
8:15 PM	0	0	
8:30 PM	0	0	
8:45 PM	0	0	
9:00 PM	0	0	
9:15 PM	0	0	
9:30 PM	0	0	
9:45 PM	0	0	
10:00 PM	0	0	
10:15 PM	0	0	
10:30 PM	0	0	
10:45 PM	0	0	
11:00 PM	0	0	

EXISTING CONDITIONS

MUTCD Figure 4C-4. Warrant 3, Peak Hour (70% Factor)



BACKGROUND CONDITIONS

Traffic Signal Warrant Analysis Workbook

8/31/2013

STUDY AND ANALYSIS INFORMATION

Municipality:	Knox County	**Analysis Date:**	8/31/2013
County:		**Conducted By:**	RWJ
PennDOT Engineering District:		**Agency/Company Name:**	AJAX

Analysis Information

Data Collection Date:	8/28/2013
Day of the Week:	Tuesday

Is the intersection in a built-up area of an isolated community of <10,000 population? No

Major Street Information

Major Street Name and Route Number:	Westland Drive
Major Street Approach #1 Direction:	E-Bound
Major Street Approach #2 Direction:	W-Bound

Number of Lanes for Moving Traffic on Each Major Street Approach:	1	**LANE(S)**
Speed Limit or 85th Percentile Speed on the Major Street:	47	**MPH**

Minor Street Information

Minor Street Name and Route Number:	Emory Church Road and Treymour Way
Minor Street Approach #1 Direction:	S-Bound
Minor Street Approach #2 Direction:	N-Bound

Number of Lanes for Moving Traffic on Each Minor Street Approach:	1	**LANE(S)**

TRAFFIC SIGNAL WARRANT ANALYSIS FINDINGS

	Applicable?	Warrant Met?
Warrant 1, Eight-Hour Vehicular Volume	**Yes**	**Yes**
Warrant 2, Four-Hour Vehicular Volume	**Yes**	**Yes**
Warrant 3, Peak Hour	**Yes**	**No**
Warrant 4, Pedestrian Volume	**No**	**N/A**
Warrant 5, School Crossing	**No**	**N/A**
Warrant 6, Coordinated Signal System	**No**	**N/A**
Warrant 7, Crash Experience	**No**	**N/A**
Warrant 8, Roadway Network	**No**	**N/A**
Warrant 9, Intersection Near a Grade Crossing	**No**	**N/A**
Warrant PA-1, ADT Volume Warrant	**No**	**N/A**
Warrant PA-2, Midblock and Trail Crossings	**No**	**N/A**

BACKGROUND CONDITIONS

Traffic Signal Warrant Analysis Workbook

8/31/2013

ENTER VOLUME DATA PER 15 MINUTE INTERVAL, PER APPROACH						
Time Interval		Major Street Approach #1 (E-Bound)	Major Street Approach #2 (W-Bound)	Major Street Combined	Minor Street Approach #1 (S-Bound)	Minor Street Approach #2 (N-Bound)
Begin At	End Of	Volume	Volume	Total Volume	Volume	Volume
12:00 AM	12:14 AM			0		
12:15 AM	12:29 AM			0		
12:30 AM	12:44 AM			0		
12:45 AM	12:59 AM			0		
1:00 AM	1:14 AM			0		
1:15 AM	1:29 AM			0		
1:30 AM	1:44 AM			0		
1:45 AM	1:59 AM			0		
2:00 AM	2:14 AM			0		
2:15 AM	2:29 AM			0		
2:30 AM	2:44 AM			0		
2:45 AM	2:59 AM			0		
3:00 AM	3:14 AM			0		
3:15 AM	3:29 AM			0		
3:30 AM	3:44 AM			0		
3:45 AM	3:59 AM			0		
4:00 AM	4:14 AM			0		
4:15 AM	4:29 AM			0		
4:30 AM	4:44 AM			0		
4:45 AM	4:59 AM			0		
5:00 AM	5:14 AM			0		
5:15 AM	5:29 AM			0		
5:30 AM	5:44 AM			0		
5:45 AM	5:59 AM			0		
6:00 AM	6:14 AM			0		
6:15 AM	6:29 AM			0		
6:30 AM	6:44 AM			0		
6:45 AM	6:59 AM			0		
7:00 AM	7:14 AM	71	146	217	35	6
7:15 AM	7:29 AM	80	204	284	90	2
7:30 AM	7:44 AM	97	259	356	58	0
7:45 AM	7:59 AM	189	240	429	29	0
8:00 AM	8:14 AM	113	179	292	58	2
8:15 AM	8:29 AM	91	154	245	45	3
8:30 AM	8:44 AM	93	175	268	24	0
8:45 AM	8:59 AM	92	171	263	43	3
9:00 AM	9:14 AM			0		
9:15 AM	9:29 AM			0		
9:30 AM	9:44 AM			0		
9:45 AM	9:59 AM			0		
10:00 AM	10:14 AM			0		
10:15 AM	10:29 AM			0		
10:30 AM	10:44 AM			0		
10:45 AM	10:59 AM			0		
11:00 AM	11:14 AM	86	85	171	23	5
11:15 AM	11:29 AM	80	66	146	26	2
11:30 AM	11:44 AM	84	94	178	19	3
11:45 AM	11:59 AM	88	96	184	15	3

BACKGROUND CONDITIONS

Traffic Signal Warrant Analysis Workbook

8/31/2013

ENTER VOLUME DATA PER 15 MINUTE INTERVAL, PER APPROACH

Time Interval		Major Street Approach #1 (E-Bound)	Major Street Approach #2 (W-Bound)	Major Street Combined	Minor Street Approach #1 (S-Bound)	Minor Street Approach #2 (N-Bound)
Begin At	End Of	Volume	Volume	Total Volume	Volume	Volume
12:00 PM	12:14 PM	79	85	164	29	3
12:15 PM	12:29 PM	104	78	182	31	2
12:30 PM	12:44 PM	114	94	208	34	4
12:45 PM	12:59 PM	92	100	192	25	3
1:00 PM	1:14 PM	102	90	192	30	5
1:15 PM	1:29 PM	85	93	178	25	0
1:30 PM	1:44 PM	81	96	177	45	3
1:45 PM	1:59 PM	89	101	190	32	3
2:00 PM	2:14 PM			0		
2:15 PM	2:29 PM			0		
2:30 PM	2:44 PM			0		
2:45 PM	2:59 PM			0		
3:00 PM	3:14 PM	131	129	260	18	0
3:15 PM	3:29 PM	114	120	234	27	0
3:30 PM	3:44 PM	130	132	262	37	0
3:45 PM	3:59 PM	143	154	297	48	3
4:00 PM	4:14 PM	128	167	295	71	3
4:15 PM	4:29 PM	165	157	322	29	2
4:30 PM	4:44 PM	166	129	295	44	0
4:45 PM	4:59 PM	175	172	347	56	3
5:00 PM	5:14 PM	186	169	355	46	0
5:15 PM	5:29 PM	189	196	385	62	2
5:30 PM	5:44 PM	172	205	377	53	3
5:45 PM	5:59 PM	205	170	375	48	0
6:00 PM	6:14 PM			0		
6:15 PM	6:29 PM			0		
6:30 PM	6:44 PM			0		
6:45 PM	6:59 PM			0		
7:00 PM	7:14 PM			0		
7:15 PM	7:29 PM			0		
7:30 PM	7:44 PM			0		
7:45 PM	7:59 PM			0		
8:00 PM	8:14 PM			0		
8:15 PM	8:29 PM			0		
8:30 PM	8:44 PM			0		
8:45 PM	8:59 PM			0		
9:00 PM	9:14 PM			0		
9:15 PM	9:29 PM			0		
9:30 PM	9:44 PM			0		
9:45 PM	9:59 PM			0		
10:00 PM	10:14 PM			0		
10:15 PM	10:29 PM			0		
10:30 PM	10:44 PM			0		
10:45 PM	10:59 PM			0		
11:00 PM	11:14 PM			0		
11:15 PM	11:29 PM			0		
11:30 PM	11:44 PM			0		
11:45 PM	11:59 PM			0		
	Approach Totals:	3814	4506	8320	1255	68

BACKGROUND CONDITIONS

MUTCD WARRANT 1, EIGHT-HOUR VEHICULAR VOLUME

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

Built-up Isolated Community With Less Than 10,000 Population or Above 40 MPH on Major Street?	Yes

Combination of Conditions A and B Necessary?*: No

**Only applicable for Warrant 1 if after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems. See Section 4C.02 of the 2009 MUTCD for application.*

Condition A - Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor street approach (one direction only)			
Major Street	Minor Street	100%	80%	70%	56%	100%	80%	70%	56%
1	1	500	400	350	280	150	120	105	84
2 or More	1	600	480	420	336	150	120	105	84
2 or More	2 or More	600	480	420	336	200	160	140	112
1	2 or More	500	400	350	280	200	160	140	112

Condition B - Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor street approach (one direction only)			
Major Street	Minor Street	100%	80%	70%	56%	100%	80%	70%	56%
1	1	750	600	525	420	75	60	53	42
2 or More	1	900	720	630	504	75	60	53	42
2 or More	2 or More	900	720	630	504	100	80	70	56
1	2 or More	750	600	525	420	100	80	70	56

Condition A Evaluation

Number of Unique Hours Met: 7 **Condition A Satisfied?** No

Condition B Evaluation

Number of Unique Hours Met: 8 **Condition B Satisfied?** Yes

Combination of Condition A and Condition B Evaluation

Number of Unique Hours Met for Condition A: N/A

Number of Unique Hours Met for Condition B: N/A

Combination of Condition A and Condition B Satisfied? N/A

BACKGROUND CONDITIONS

MUTCD WARRANT 2, FOUR-HOUR VEHICULAR VOLUME

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

Total Number of Unique Hours Met On Figure 4C-2
8

Built-up Isolated Community With Less Than 10,000 Population or Above 40 MPH on Major Street?	Yes

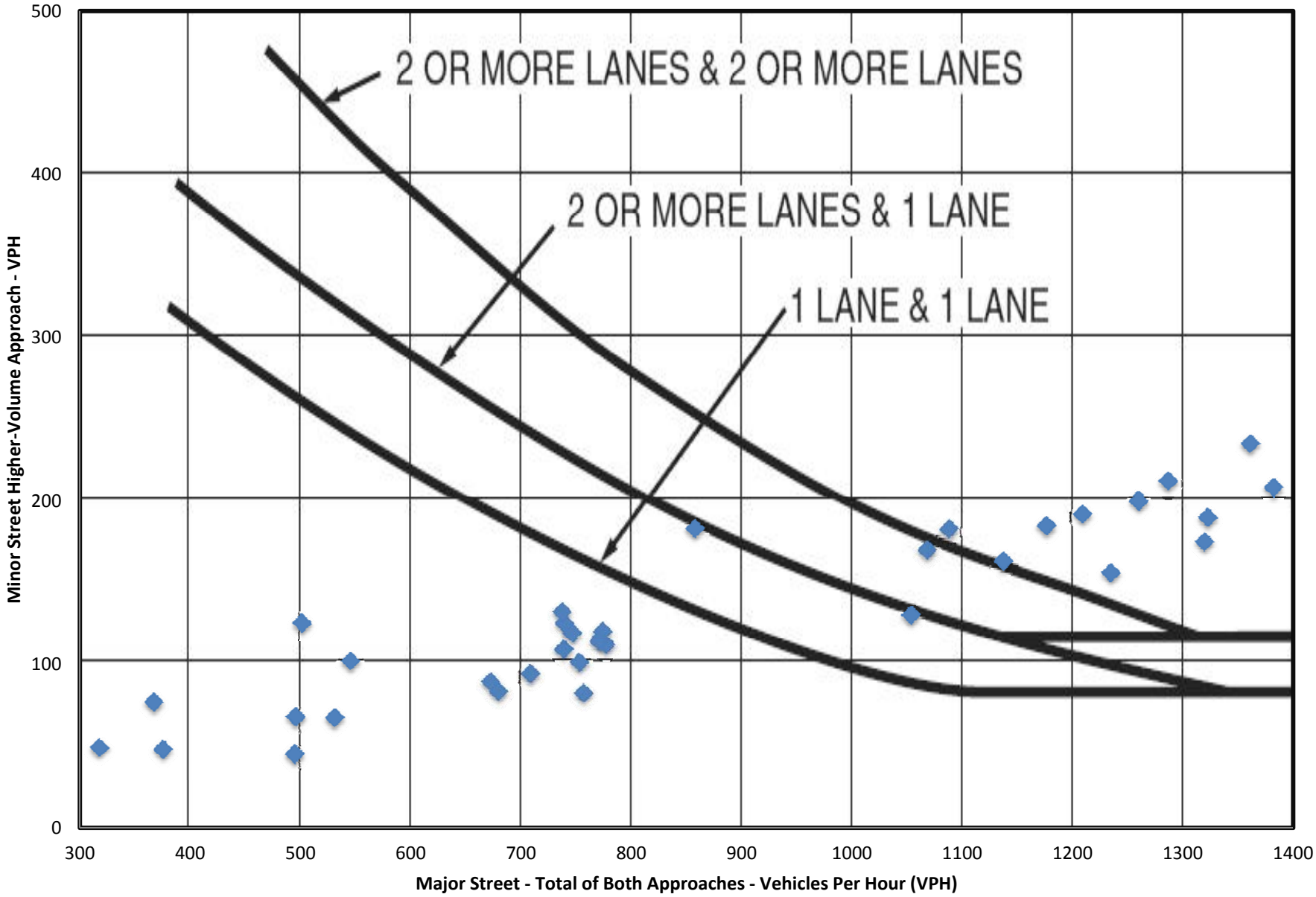
Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 AM	0	0	
12:15 AM	0	0	
12:30 AM	0	0	
12:45 AM	0	0	
1:00 AM	0	0	
1:15 AM	0	0	
1:30 AM	0	0	
1:45 AM	0	0	
2:00 AM	0	0	
2:15 AM	0	0	
2:30 AM	0	0	
2:45 AM	0	0	
3:00 AM	0	0	
3:15 AM	0	0	
3:30 AM	0	0	
3:45 AM	0	0	
4:00 AM	0	0	
4:15 AM	0	0	
4:30 AM	0	0	
4:45 AM	0	0	
5:00 AM	0	0	
5:15 AM	0	0	
5:30 AM	0	0	
5:45 AM	0	0	
6:00 AM	0	0	
6:15 AM	217	35	
6:30 AM	501	125	Met
6:45 AM	857	183	Met
7:00 AM	1286	212	Met
7:15 AM	1361	235	Met
7:30 AM	1322	190	Met
7:45 AM	1234	156	Met
8:00 AM	1068	170	Met
8:15 AM	776	112	Met
8:30 AM	531	67	
8:45 AM	263	43	
9:00 AM	0	0	
9:15 AM	0	0	
9:30 AM	0	0	
9:45 AM	0	0	
10:00 AM	0	0	
10:15 AM	171	23	
10:30 AM	317	49	
10:45 AM	495	68	
11:00 AM	679	83	Met
11:15 AM	672	89	Met
11:30 AM	708	94	Met
11:45 AM	738	109	Met

BACKGROUND CONDITIONS

Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 PM	746	119	Met
12:15 PM	774	120	Met
12:30 PM	770	114	Met
12:45 PM	739	125	Met
1:00 PM	737	132	Met
1:15 PM	545	102	
1:30 PM	367	77	
1:45 PM	190	32	
2:00 PM	0	0	
2:15 PM	260	18	
2:30 PM	494	45	
2:45 PM	756	82	Met
3:00 PM	1053	130	Met
3:15 PM	1088	183	Met
3:30 PM	1176	185	Met
3:45 PM	1209	192	Met
4:00 PM	1259	200	Met
4:15 PM	1319	175	Met
4:30 PM	1382	208	Met
4:45 PM	1464	217	Met
5:00 PM	1492	209	Met
5:15 PM	1137	163	Met
5:30 PM	752	101	Met
5:45 PM	375	48	
6:00 PM	0	0	
6:15 PM	0	0	
6:30 PM	0	0	
6:45 PM	0	0	
7:00 PM	0	0	
7:15 PM	0	0	
7:30 PM	0	0	
7:45 PM	0	0	
8:00 PM	0	0	
8:15 PM	0	0	
8:30 PM	0	0	
8:45 PM	0	0	
9:00 PM	0	0	
9:15 PM	0	0	
9:30 PM	0	0	
9:45 PM	0	0	
10:00 PM	0	0	
10:15 PM	0	0	
10:30 PM	0	0	
10:45 PM	0	0	
11:00 PM	0	0	

BACKGROUND CONDITIONS

MUTCD Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume



BACKGROUND CONDITIONS

MUTCD WARRANT 2, FOUR-HOUR VEHICULAR VOLUME

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

Total Number of Unique Hours Met On Figure 4C-2
8

Built-up Isolated Community With Less Than 10,000 Population or Above 40 MPH on Major Street?	Yes

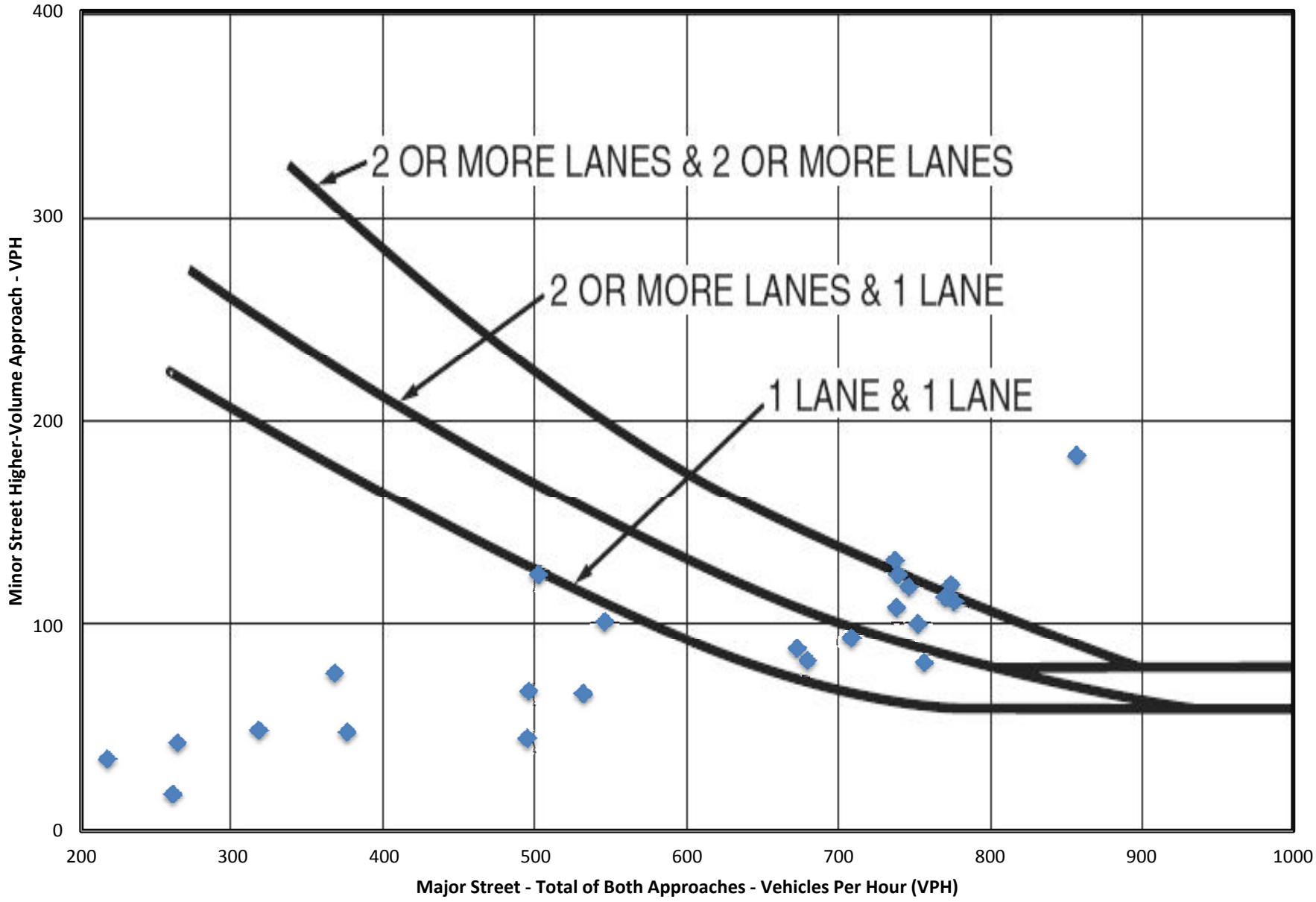
Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 AM	0	0	
12:15 AM	0	0	
12:30 AM	0	0	
12:45 AM	0	0	
1:00 AM	0	0	
1:15 AM	0	0	
1:30 AM	0	0	
1:45 AM	0	0	
2:00 AM	0	0	
2:15 AM	0	0	
2:30 AM	0	0	
2:45 AM	0	0	
3:00 AM	0	0	
3:15 AM	0	0	
3:30 AM	0	0	
3:45 AM	0	0	
4:00 AM	0	0	
4:15 AM	0	0	
4:30 AM	0	0	
4:45 AM	0	0	
5:00 AM	0	0	
5:15 AM	0	0	
5:30 AM	0	0	
5:45 AM	0	0	
6:00 AM	0	0	
6:15 AM	217	35	
6:30 AM	501	125	Met
6:45 AM	857	183	Met
7:00 AM	1286	212	Met
7:15 AM	1361	235	Met
7:30 AM	1322	190	Met
7:45 AM	1234	156	Met
8:00 AM	1068	170	Met
8:15 AM	776	112	Met
8:30 AM	531	67	
8:45 AM	263	43	
9:00 AM	0	0	
9:15 AM	0	0	
9:30 AM	0	0	
9:45 AM	0	0	
10:00 AM	0	0	
10:15 AM	171	23	
10:30 AM	317	49	
10:45 AM	495	68	
11:00 AM	679	83	Met
11:15 AM	672	89	Met
11:30 AM	708	94	Met
11:45 AM	738	109	Met

BACKGROUND CONDITIONS

Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 PM	746	119	Met
12:15 PM	774	120	Met
12:30 PM	770	114	Met
12:45 PM	739	125	Met
1:00 PM	737	132	Met
1:15 PM	545	102	
1:30 PM	367	77	
1:45 PM	190	32	
2:00 PM	0	0	
2:15 PM	260	18	
2:30 PM	494	45	
2:45 PM	756	82	Met
3:00 PM	1053	130	Met
3:15 PM	1088	183	Met
3:30 PM	1176	185	Met
3:45 PM	1209	192	Met
4:00 PM	1259	200	Met
4:15 PM	1319	175	Met
4:30 PM	1382	208	Met
4:45 PM	1464	217	Met
5:00 PM	1492	209	Met
5:15 PM	1137	163	Met
5:30 PM	752	101	Met
5:45 PM	375	48	
6:00 PM	0	0	
6:15 PM	0	0	
6:30 PM	0	0	
6:45 PM	0	0	
7:00 PM	0	0	
7:15 PM	0	0	
7:30 PM	0	0	
7:45 PM	0	0	
8:00 PM	0	0	
8:15 PM	0	0	
8:30 PM	0	0	
8:45 PM	0	0	
9:00 PM	0	0	
9:15 PM	0	0	
9:30 PM	0	0	
9:45 PM	0	0	
10:00 PM	0	0	
10:15 PM	0	0	
10:30 PM	0	0	
10:45 PM	0	0	
11:00 PM	0	0	

BACKGROUND CONDITIONS

MUTCD Figure 4C-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)



BACKGROUND CONDITIONS

MUTCD WARRANT 3, PEAK HOUR

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

Built-up Isolated Community With Less Than 10,000 Population or Above 40 MPH on Major Street?	Yes
Is this signal warrant being applied for an unusual case, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time?	N/A

Indicate whether all three of the following conditions for the same 1 hour (any four consecutive 15-minute periods) of an average day are present*	
Does the total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equal or exceed 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach?	N/A
Does the volume on the same minor-street approach (one direction only) equal or exceed 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes?	N/A
Does the total entering volume serviced during the hour equal or exceed 650 vehicles per hour for intersection with three approaches or 800 vehicles per hour for intersections with four or more approaches?	N/A
**If applicable, attach all supporting calculations and documentation.*	

Total Number of Unique Hours Met On Figure 4C-4
5

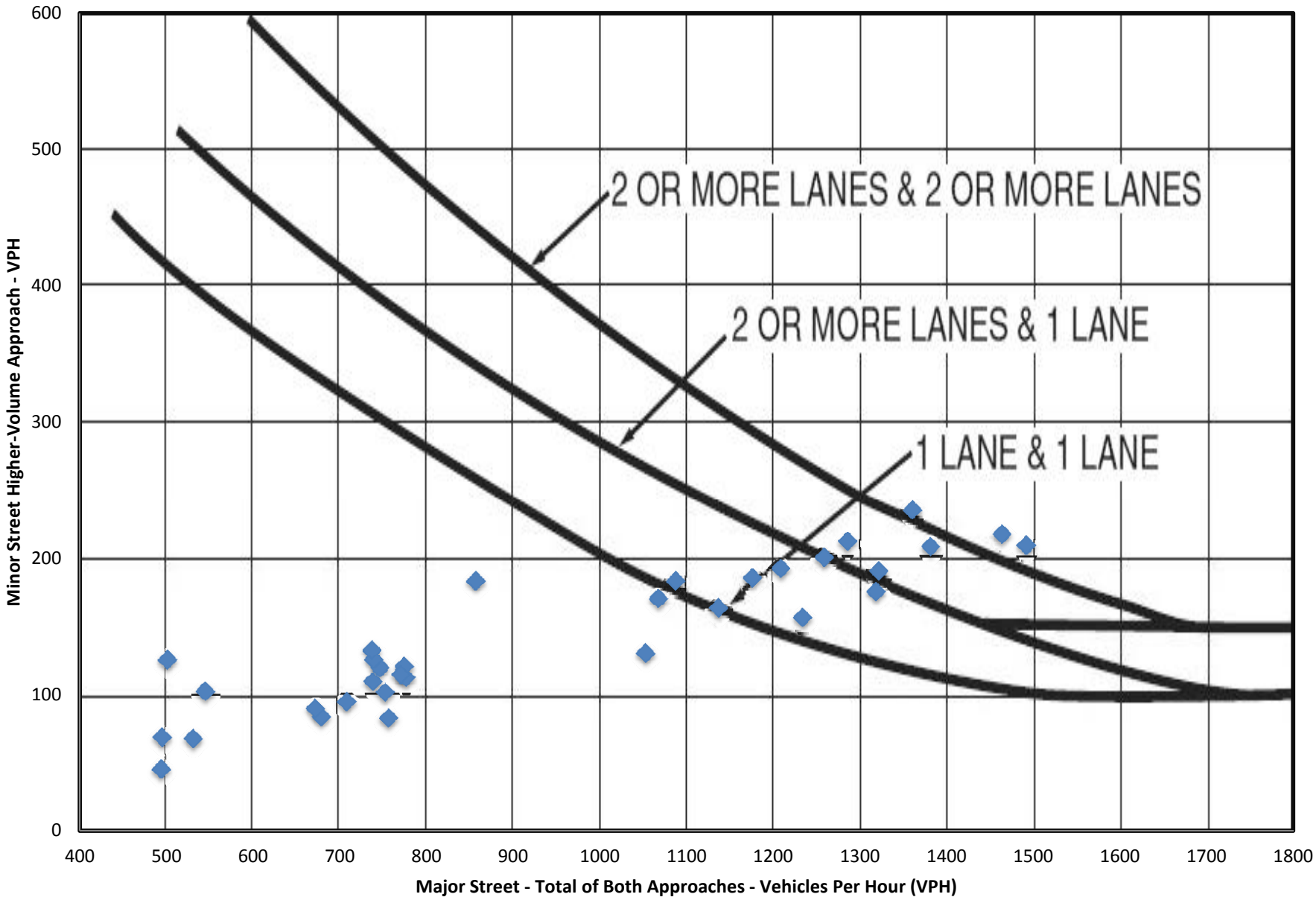
Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 AM	0	0	
12:15 AM	0	0	
12:30 AM	0	0	
12:45 AM	0	0	
1:00 AM	0	0	
1:15 AM	0	0	
1:30 AM	0	0	
1:45 AM	0	0	
2:00 AM	0	0	
2:15 AM	0	0	
2:30 AM	0	0	
2:45 AM	0	0	
3:00 AM	0	0	
3:15 AM	0	0	
3:30 AM	0	0	
3:45 AM	0	0	
4:00 AM	0	0	
4:15 AM	0	0	
4:30 AM	0	0	
4:45 AM	0	0	
5:00 AM	0	0	
5:15 AM	0	0	
5:30 AM	0	0	
5:45 AM	0	0	
6:00 AM	0	0	
6:15 AM	217	35	
6:30 AM	501	125	
6:45 AM	857	183	Met
7:00 AM	1286	212	Met
7:15 AM	1361	235	Met
7:30 AM	1322	190	Met
7:45 AM	1234	156	Met
8:00 AM	1068	170	Met
8:15 AM	776	112	

BACKGROUND CONDITIONS

Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
8:30 AM	531	67	
8:45 AM	263	43	
9:00 AM	0	0	
9:15 AM	0	0	
9:30 AM	0	0	
9:45 AM	0	0	
10:00 AM	0	0	
10:15 AM	171	23	
10:30 AM	317	49	
10:45 AM	495	68	
11:00 AM	679	83	
11:15 AM	672	89	
11:30 AM	708	94	
11:45 AM	738	109	
12:00 PM	746	119	
12:15 PM	774	120	
12:30 PM	770	114	
12:45 PM	739	125	
1:00 PM	737	132	
1:15 PM	545	102	
1:30 PM	367	77	
1:45 PM	190	32	
2:00 PM	0	0	
2:15 PM	260	18	
2:30 PM	494	45	
2:45 PM	756	82	
3:00 PM	1053	130	Met
3:15 PM	1088	183	Met
3:30 PM	1176	185	Met
3:45 PM	1209	192	Met
4:00 PM	1259	200	Met
4:15 PM	1319	175	Met
4:30 PM	1382	208	Met
4:45 PM	1464	217	Met
5:00 PM	1492	209	Met
5:15 PM	1137	163	Met
5:30 PM	752	101	
5:45 PM	375	48	
6:00 PM	0	0	
6:15 PM	0	0	
6:30 PM	0	0	
6:45 PM	0	0	
7:00 PM	0	0	
7:15 PM	0	0	
7:30 PM	0	0	
7:45 PM	0	0	
8:00 PM	0	0	
8:15 PM	0	0	
8:30 PM	0	0	
8:45 PM	0	0	
9:00 PM	0	0	
9:15 PM	0	0	
9:30 PM	0	0	
9:45 PM	0	0	
10:00 PM	0	0	
10:15 PM	0	0	
10:30 PM	0	0	
10:45 PM	0	0	
11:00 PM	0	0	

BACKGROUND CONDITIONS

MUTCD Figure 4C-3. Warrant 3, Peak Hour



BACKGROUND CONDITIONS

MUTCD WARRANT 3, PEAK HOUR

Number of Lanes for Moving Traffic on Each Approach	
Major Street:	1 Lane
Minor Street:	1 Lane

Built-up Isolated Community With Less Than 10,000 Population or Above 40 MPH on Major Street?	Yes
Is this signal warrant being applied for an unusual case, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time?	N/A

Indicate whether all three of the following conditions for the same 1 hour (any four consecutive 15-minute periods) of an average day are present*	
Does the total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equal or exceed 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach?	N/A
Does the volume on the same minor-street approach (one direction only) equal or exceed 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes?	N/A
Does the total entering volume serviced during the hour equal or exceed 650 vehicles per hour for intersection with three approaches or 800 vehicles per hour for intersections with four or more approaches?	N/A
**If applicable, attach all supporting calculations and documentation.*	

Total Number of Unique Hours Met On Figure 4C-4
5

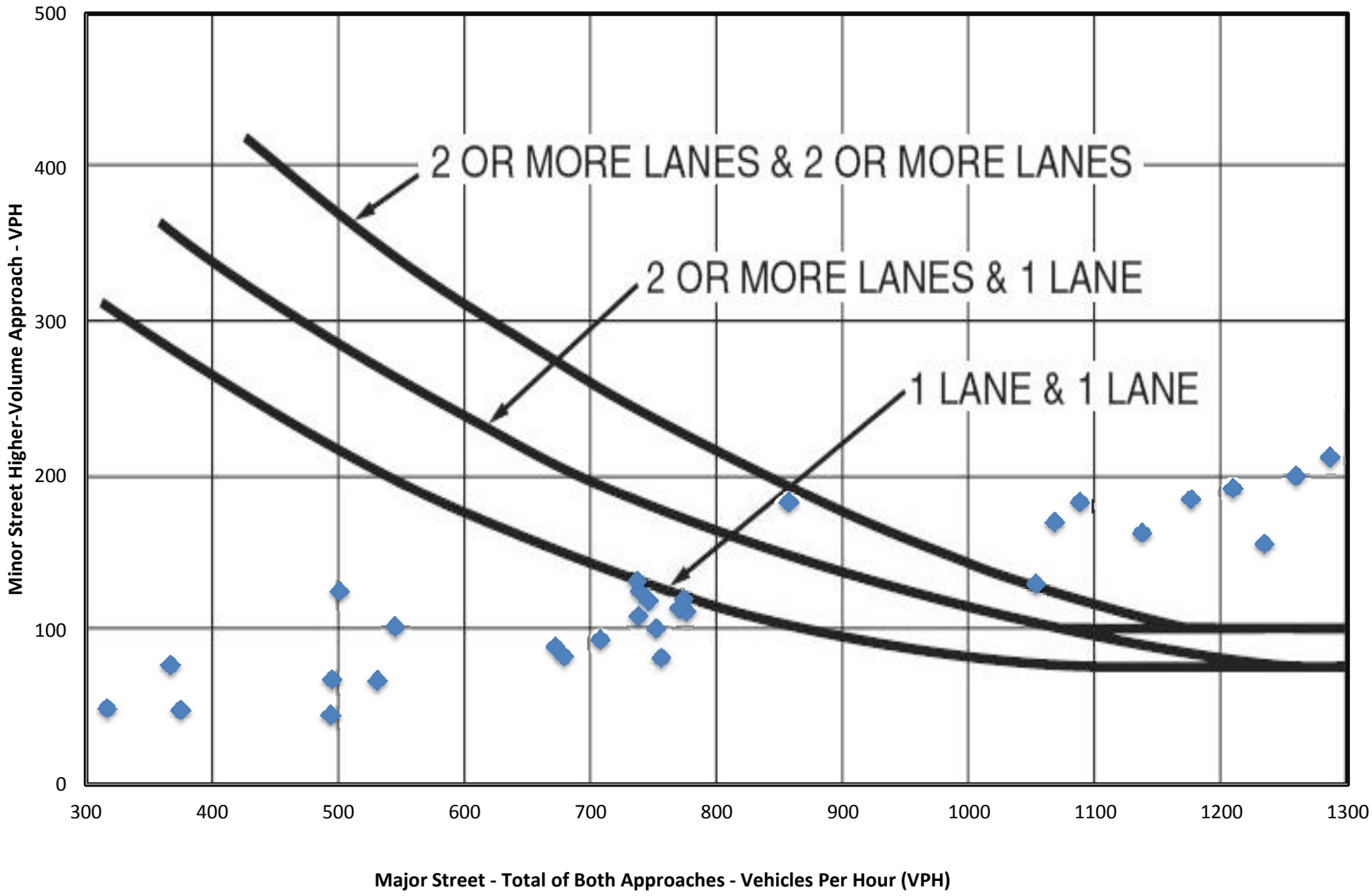
Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
12:00 AM	0	0	
12:15 AM	0	0	
12:30 AM	0	0	
12:45 AM	0	0	
1:00 AM	0	0	
1:15 AM	0	0	
1:30 AM	0	0	
1:45 AM	0	0	
2:00 AM	0	0	
2:15 AM	0	0	
2:30 AM	0	0	
2:45 AM	0	0	
3:00 AM	0	0	
3:15 AM	0	0	
3:30 AM	0	0	
3:45 AM	0	0	
4:00 AM	0	0	
4:15 AM	0	0	
4:30 AM	0	0	
4:45 AM	0	0	
5:00 AM	0	0	
5:15 AM	0	0	
5:30 AM	0	0	
5:45 AM	0	0	
6:00 AM	0	0	
6:15 AM	217	35	
6:30 AM	501	125	
6:45 AM	857	183	Met
7:00 AM	1286	212	Met
7:15 AM	1361	235	Met
7:30 AM	1322	190	Met
7:45 AM	1234	156	Met
8:00 AM	1068	170	Met
8:15 AM	776	112	

BACKGROUND CONDITIONS

Hourly Vehicular Volume			
Hour Interval Beginning At	Major Street Combined Vehicles Per Hour (VPH)	Highest Minor Street Approach Vehicles Per Hour (VPH)	Hour Met?
8:30 AM	531	67	
8:45 AM	263	43	
9:00 AM	0	0	
9:15 AM	0	0	
9:30 AM	0	0	
9:45 AM	0	0	
10:00 AM	0	0	
10:15 AM	171	23	
10:30 AM	317	49	
10:45 AM	495	68	
11:00 AM	679	83	
11:15 AM	672	89	
11:30 AM	708	94	
11:45 AM	738	109	
12:00 PM	746	119	
12:15 PM	774	120	
12:30 PM	770	114	
12:45 PM	739	125	
1:00 PM	737	132	
1:15 PM	545	102	
1:30 PM	367	77	
1:45 PM	190	32	
2:00 PM	0	0	
2:15 PM	260	18	
2:30 PM	494	45	
2:45 PM	756	82	
3:00 PM	1053	130	Met
3:15 PM	1088	183	Met
3:30 PM	1176	185	Met
3:45 PM	1209	192	Met
4:00 PM	1259	200	Met
4:15 PM	1319	175	Met
4:30 PM	1382	208	Met
4:45 PM	1464	217	Met
5:00 PM	1492	209	Met
5:15 PM	1137	163	Met
5:30 PM	752	101	
5:45 PM	375	48	
6:00 PM	0	0	
6:15 PM	0	0	
6:30 PM	0	0	
6:45 PM	0	0	
7:00 PM	0	0	
7:15 PM	0	0	
7:30 PM	0	0	
7:45 PM	0	0	
8:00 PM	0	0	
8:15 PM	0	0	
8:30 PM	0	0	
8:45 PM	0	0	
9:00 PM	0	0	
9:15 PM	0	0	
9:30 PM	0	0	
9:45 PM	0	0	
10:00 PM	0	0	
10:15 PM	0	0	
10:30 PM	0	0	
10:45 PM	0	0	
11:00 PM	0	0	

BACKGROUND CONDITIONS

MUTCD Figure 4C-4. Warrant 3, Peak Hour (70% Factor)



APPENDIX H
LEFT TURN LANE STORAGE NOMOGRAPH

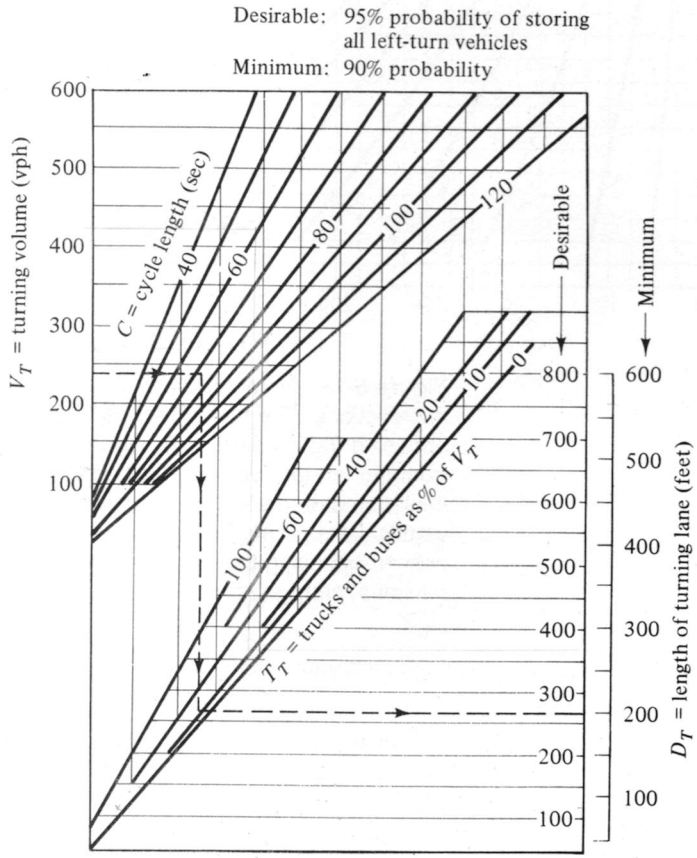


Figure 5-14 Nomograph for a single-lane left-turn storage at signalized intersections. As illustrated, with a left-turn volume of 240 vehicles per hour (vph), a 70-second cycle, and 10% trucks, a storage length of about 260 feet is required for desirable conditions and about 200 feet for a minimum. These storage lengths would accommodate 10 or 11 vehicles for the desirable conditions and about 8 for the minimum. The figure can be used to estimate the storage length (excluding taper) of a double left-turn bay by dividing by 1.8. Thus, for the desirable conditions, a double left-turn bay of about 145 feet (excluding taper) would be required. SOURCE: Northwestern University Traffic Institute [26].