Butler Street Traffic Impact Study

Marietta, Ohio

Prepared For:

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Executive Summary

This traffic impact study focuses on the effects of the proposed Marietta College Enhancement Plan on the transportation network surrounding the campus of Marietta College in Marietta, Ohio. The Enhancement Plan includes upgrades throughout the campus including building and parking expansions, pedestrian facility updates, sport complex upgrades, construction of a student center, and general improvements. This study closely examines the potential closure of Butler Street between 4th Street and 7th Street to through vehicles. This study will provide the City with data to make an informed decision when determining if a closure will be approved as part of the Enhancement Plan. If approved, access to parking lots will still be available from Butler Street.

The traffic data showed 2,937 vehicles per day on Butler Street between 4th Street and 7th Street. Counts showed 199 vehicles traveling on Butler Street in the AM peak, 195 in the Midday Peak, and 245 in the PM Peak. This averages to 3-4 cars per mins during any given peak. Directional distribution was even (50/50) throughout the day.

Peak hour (worst-case) traffic volumes were redistributed based upon existing travel patterns collected from Bluetooth data. Assuming growth in the college and new trips coming to and from the campus as a result of the Enhancements, new volumes were added to the transportation network in the build model. Transportation network models were created using *Synchro* and *SimTraffic*. The results showed that intersection approach delay changed by less than 4 seconds for most intersection approaches. Several approaches showed in a decrease in delay based upon the volume redistribution.

TEC hosted a survey to receive feedback from residents, College students and employees, City employees, etc. The survey was first hosted on Google Forms then hosted by SurveyMonkey.com. A paper form was also available. As a result, 961 surveys were received with 402 (42%) absolutely in favor of closing Butler Street for Marietta College improvements and 438 (46%) not in favor. As a result, the percentage of people effected by the closing is less than neutral while the percentage of people strongly against the closing is slightly higher than neutral. There were some responses that were indifferent. A comment section was provided in the survey. Various concerns were evaluated and addressed in recommendations, including emergency vehicles, flooding, pedestrian safety, and vehicular safety. These concerns, as well as general transportation upgrades, are summarized in the table below:

No Build Recommendations	Term Length*	Est. Cost	Build Recommendations	Term Length*	Est. Cost
Install Midblock Pedestrian Flashing Beacon	Short	$40,000	Increase Storage Lane Lengths	Short	$32,000
Increase Storage Lane Lengths	Short	$32,000	Retiming Traffic Signals	Mid	$32,000
General Lane Width Improvements	Short	$120,000	General Lane Width Improvements	Short	$120,000
Retiming Traffic Signals	Mid	$32,000	Implement Special Event Signal Timing Plans	Mid	$32,000
EBR Lane at Williamstown Bridge	Mid	$9,000	EBR Lane at Williamstown Bridge	Mid	$9,000
Repair Butler Street	Long	$580,000	Provide Access for Emergency Vehicles	Mid	$32,600
7th Street and Putnam Improvements	Mid	$112,000	Provide Pre-Emption for Emergency Vehicles	Long	$350,000
			7th Street and Putnam Improvements	Mid	$112,000
			Short (1-2 years), Mid (2-5 years), Long (5+ years)		

"Build" recommendations are to be considered if the Enhancement Plan is implemented and includes a closure of Butler Street. Additional "No-Build" recommendations are available in the recommendations section of this study that should be considered to improve safety and capacity throughout the Marietta College study area, even if the enhancements and closure is not implemented.

TEC Engineering recommends a temporary closure of Butler Street before a permanent closure, to fully examine the effects on the surrounding system and to validate simulation models. If closed temporarily, it should remain closed for a month. The first two weeks will allow for drivers to establish new traffic routines. The second half of the temporary closure can be used for analysis. Traffic counts and routing can be collected during that time period to fully analyze the effects of a permanent closure and to finalize "build" recommendations if implementation is to occur.

1. Purpose

The purpose of this study is to determine the effects of the proposed Marietta College Campus Enhancement Plan on the surrounding transportation network. Marietta College is planning major changes to the campus including building and parking expansions, pedestrian facility upgrades, sport complex upgrades, construction of a student center, and general improvements throughout the campus. The Enhancement Plan is to grow enrollment by attracting and retaining students which would contribute to economic development. In addition to these changes, the plan includes the possibility for the closure of Butler Street between 4th Street and 7th Street.

TEC Engineering was retained by the City of Marietta to analyze the effects of the Marietta College Enhancement Plan. The study area was established as the area outlined by 7th Street to the east, 3rd Street to the west, Greene Street to the south and Putnam Street to the north. For this study, Butler Street is considered to be east-west. The intersections and midblocks within this area were reviewed as part of this study. TEC Engineering reviewed no-build conditions, with no implementation of the Enhancement Plan, and build conditions, with implementation and the resulting closure of Butler Street.

Figure 1.1: Study Area

The Marietta College Campus Enhancement Plan is included in *Appendix A.*

2. Existing Conditions

For the purpose of this study, Butler Street is considered to be east-west.

Butler Street is a two lane local road with a speed limit of 25 MPH located in the City of Marietta within Washington County, Ohio. Eastbound and westbound lanes are 16 feet wide. Right-of-way is approximately 80'. Sidewalks are present on both sides of the roadway and vary in width. Signage is limited. The section of Butler Street between 7th Street and 4th Street provides direct access to multiple parking lots for Marietta College.

The average daily traffic (ADT) for Butler Street is 2,937 per day. Counts showed 199 vehicles traveling on Butler Street in the AM peak, 195 in the Midday Peak, and 245 in the PM Peak. Data was also recorded during a Friday night basketball game to represent unusual traffic during a special event. The data was collected on November 9th from 6:15pm-7:15pm and there were 170 vehicles on Butler Street during this peak hour.

SR 7 between Williamstown Bridge and 7th Street has an ADT of 18,535. 7th Street has an ADT of 7,923. Putnam Street has an ADT of 5,832 while 4th Street has an ADT of 4,340.

Marietta College is located on either side of Butler Street. To the south, there is campus areas for first year housing of 450 students, student activity space for 390 students, athletic fields and locker rooms. To the north side of Butler Street is the academic, administrative and recreation buildings. With the campus spanning over Butler Street, students and faculty frequently cross Butler Street between 4th Street and 7th Street to access various parts of campus.

The surrounding area includes a mix of signalized and unsignalized intersections in a downtown grid layout. The following intersections were included in this study:

- 3rd Street & Pike Street (Signalized)
- 4th Street & Pike St (Signalized)
- Williamstown Bridge & Pike Street (Signalized)
- 7th Street, Pike Street & Green St (Signalized)
- Butler Street & 7th Street (Unsignalized)
- Putnam Street & 7th Street (Signalized)
- Putnam Street & 6th Street (Unsignalized)
- Putnam Street & 5th Street (Unsignalized)
- Putnam Street & 4th Street (Signalized)
- Putnam Street & 3rd Street (Signalized)
- Butler Street & 3rd Street (Signalized)
- Butler Street & 4th Street (Unsignalized)

3. Previous Studies

Previous studies have been performed on Butler Street and in the general project area. TEC Engineering has worked with the City of Marietta on various projects over the past decade. TEC performed a safety study at 3rd Street and Putnam in 2009, pedestrian safety study within the project area in 2012, signal retiming in 2017 along SR 7, a safety study at Greene St and Williamstown Bridge in 2010, a Greene Street safety study in 2008, an asset management inventory in 2015, and an intersection review along 3rd Street at Sacra Via in 2015. TEC is currently working on a fiber interconnect project for the City. The fiber interconnect project will improve connectivity between traffic signals while upgrading dated signal equipment. There is potential for a central-based signal system, and Pan-Tilt-Zoom (PTZ) cameras would be installed throughout the City. Curb ramps would be updated to meet ADA compliance.

Butler Street has also been investigated by other consultants. In 2008, W.E. Stilson Consulting Group reviewed the closure of Butler Street as well as TranSystems. Both reports resulted in similar conclusions as this current study.

In 2018, Ohio University completed the "Economic Impact of Marietta College" study. This study examined the economic effects Marietta College has on the surrounding region. As a result, it was determined that Marietta College contributed to over $55 million to the region in fiscal year 2017.

4. Traffic Volumes

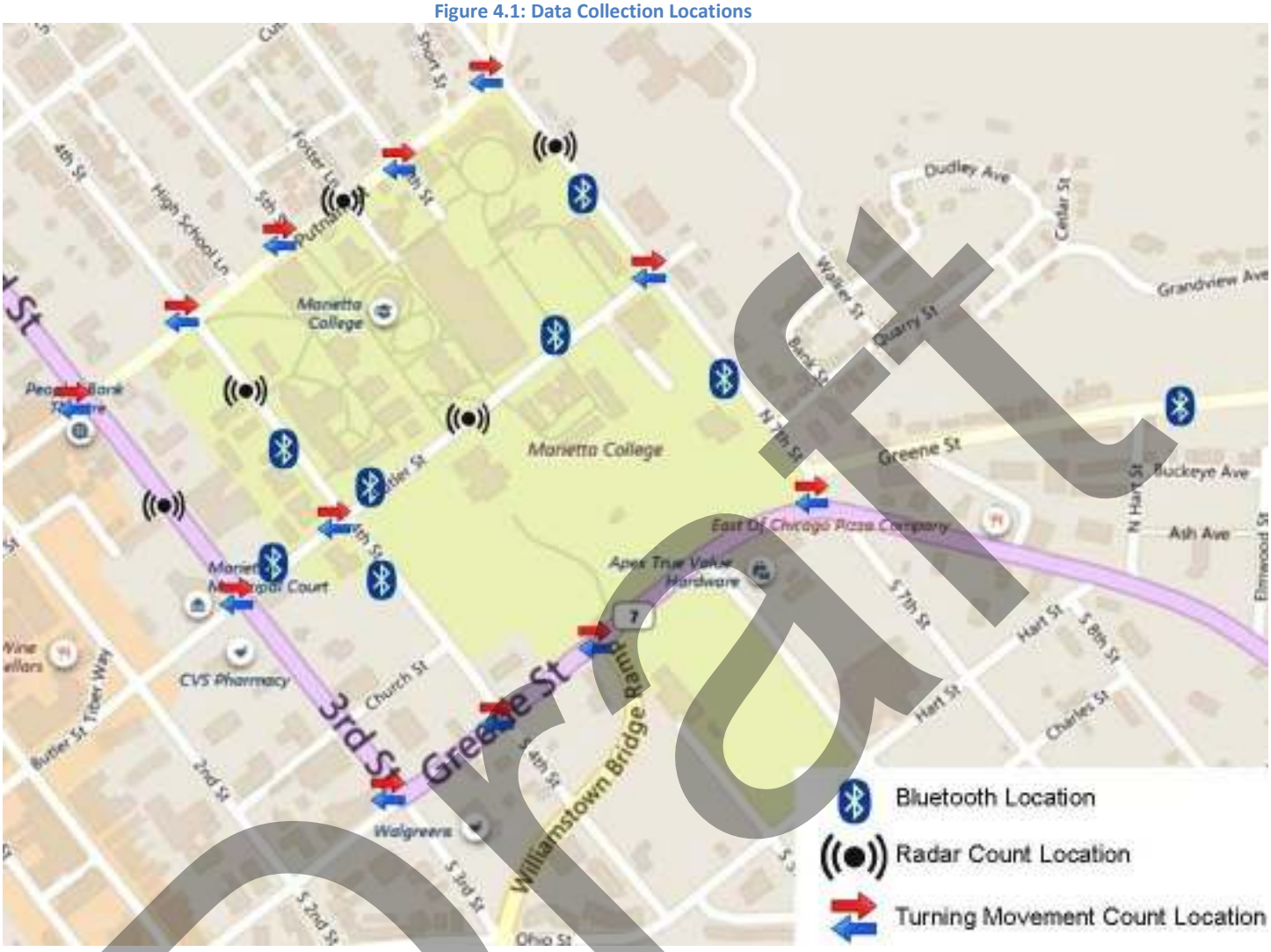
Traffic volumes in the area were collected to determine current traffic patterns, which are used to anticipate future volumes. Radar units were placed within the study area to determine ADT and peak hours along roads surrounding Marietta College. Turning movement counts were collected during the following peak hours: 7:30am-8:30am, 11:30am-12:30pm, and 4:15pm-5:15pm. A special event was analyzed to determine unusual traffic patterns with events at the College; specifically, 6:15pm-7:15pm on November 9th 2018 was recorded to count vehicles coming to a basketball game.

Radar units were placed at the following locations:

- Butler Street between 4th and 7th
- Putnam St between 5th and 6th
- 4th between Butler St and Putnam St
- 3rd between Butler St and Putnam St
- 7th between Butler St and Putnam St

The following figure shows the locations of data collection devices. Data collection was performed between November 7th 2018 and November 14th 2018. Bluetooth data collection will be discussed in a later section of this report.

Figure 4.1: Data Collection Locations



Turning movement counts were utilized to model peak hour traffic. Traffic volume data can be found in *Appendix B.*

In addition to TEC's traffic counts from this report, traffic counts were reviewed from previous projects, including ODOT counts completed in 2009, 2013, 2015 and 2018 on Butler Street, Putnam Street, 4th Street, and 7th Street. These counts are typically conducted between April and October. Counts were also reviewed that were completed by TEC in 2007 (Dec), 2008 (Feb), 2010 (Jan) and 2017 (April & May).

5. Growth Rate

This study will look at opening year 2020 and future year 2040. To account for growth in the area, a growth rate was applied to existing 2018 volumes. This growth rate was based on various counts in the area performed by ODOT and TEC Engineering. At most count stations provided by ODOT and TEC Engineering, the volume trends have shown negative growth rate. Some areas did result in a positive growth rate but overall the growth rate was relatively small. The average growth rate was determined to be 0.4%. A further discussion of the growth rate is provided in *Appendix C*.

6. Trip Generation

The Marietta College Enhancement Plan includes various upgrades and additions to the campus. However, the Plan does not include significant expansion. The admission center will increase in size. A student center is proposed which will include an event space. While a majority of the student center will not generate new trips to the campus, the event space will be available to the public for meetings or presentations. Growth in enrollment was also taken into consideration as a factor for generating new trips to the areas. As a result, the following table estimates the new trips that will access the campus as a direct result of the campus improvements.

Table 6.1: Trip Generation

	AM Peak					PM Peak					Special Event				
	Gen Trip	% Enter	% Exit	Enter	Exit	Gen Trip	% Enter	% Exit	Enter	Exit	Gen Trip	% Enter	% Exit	Enter	Exit
Enrollment Growth	49	100%	0%	49	0	49	0%	100%	0	49	0	0%	0	0	0
1/3 Increase in Admission Building	4	83%	17%	3	1	5	32%	68%	2	3	0	0%	0%	0	0
Event/Meeting Space	32	89%	11%	28	4	42	15%	85%	6	36	375	90%	10%	338	37
Total	**85**	**-**	**-**	**80**	**5**	**96**	**-**	**-**	**8**	**88**	**375**	**-**	**-**	**338**	**37**

The generated new trips can then be distributed based on existing traffic patterns and proposed parking lot locations and access points. The trip distribution percentages and volumes can be found in *Appendix D.* For further discussion on generated trips, refer to the memorandum provided in *Appendix E.*

7. Traffic Distribution

To determine the effects of the closure of Butler Street, existing routes were analyzed to predict routes if Butler Street were closed. Bluetooth devices were deployed to determine routes drivers are taking in the area. The Bluetooth devices were deployed at specific locations to determine a general area of trip origins and destinations while routing through Butler Street. The locations of the devices are shown in *Figure 4.1: Data Collection Locations*.

The Bluetooth units are small devices mounted alongside the roadway. The device sends out a Bluetooth signal searching for other Bluetooth signals to pair with. The device can pair with Bluetooth devices from passing vehicles or passing cellular phones. Once it pairs, it is considered to be a "hit." That vehicle is then tracked to determine its path. Typically, the Bluetooth devices detect 2%-6% of traffic, creating a statistical representation of traffic patterns within the project area.

The data is analyzed so that extraneous data, such as constant detection from a nearby device, is not included in the results. To further verify the validity of data, the number of "hits" per location was compared against ADT provided by our mechanical tube counts. The Bluetooth devices picked up about 5% of the traffic during peak hours.

Bluetooth distribution percentages are provided in the figures in *Appendix F.*

The Bluetooth data percentages were directly used to predict routes of drivers currently using Butler Street as a through street. Since access to parking areas will still be available in the proposed improvement plan, the percentage of through traffic was determined and only through traffic was redistributed. For example, during the AM peak 248 vehicles entered Butler Street from 7th Street or 4th Street and only 178 vehicles exited Butler Street.

Therefore the difference of 70 vehicles was assumed to park on Butler Street or an adjacent lot. With the improvements, these vehicles would still be accessing Butler Street for parking.

The parking vehicles and through vehicles were determined for each peak, and a growth rate was applied to account for the 2020 and 2040 scenarios. Only the through vehicles were rerouted based on percentages of origin-destinations provided by Bluetooth. The following figures further explain how the volumes were distributed.

The first figure shows the destination percentages of through traffic turning left onto Butler from northbound 7th. The second figure shows the breakdown of the approaches that would be affected by the closure and the distribution percentages associated. The northbound left turn would be affected so new routes were determined for 100% of through movement vehicles, resulting in 33% rerouted to 4th Street north of Butler Street, 56% rerouted to Butler Street west of 4th Street and 11% rerouted to 4th Street south of Butler Street.

Figure 7.1: SAMPLE of Existing Routing Based Upon Bluetooth Results for NBL at 7th St/Butler St

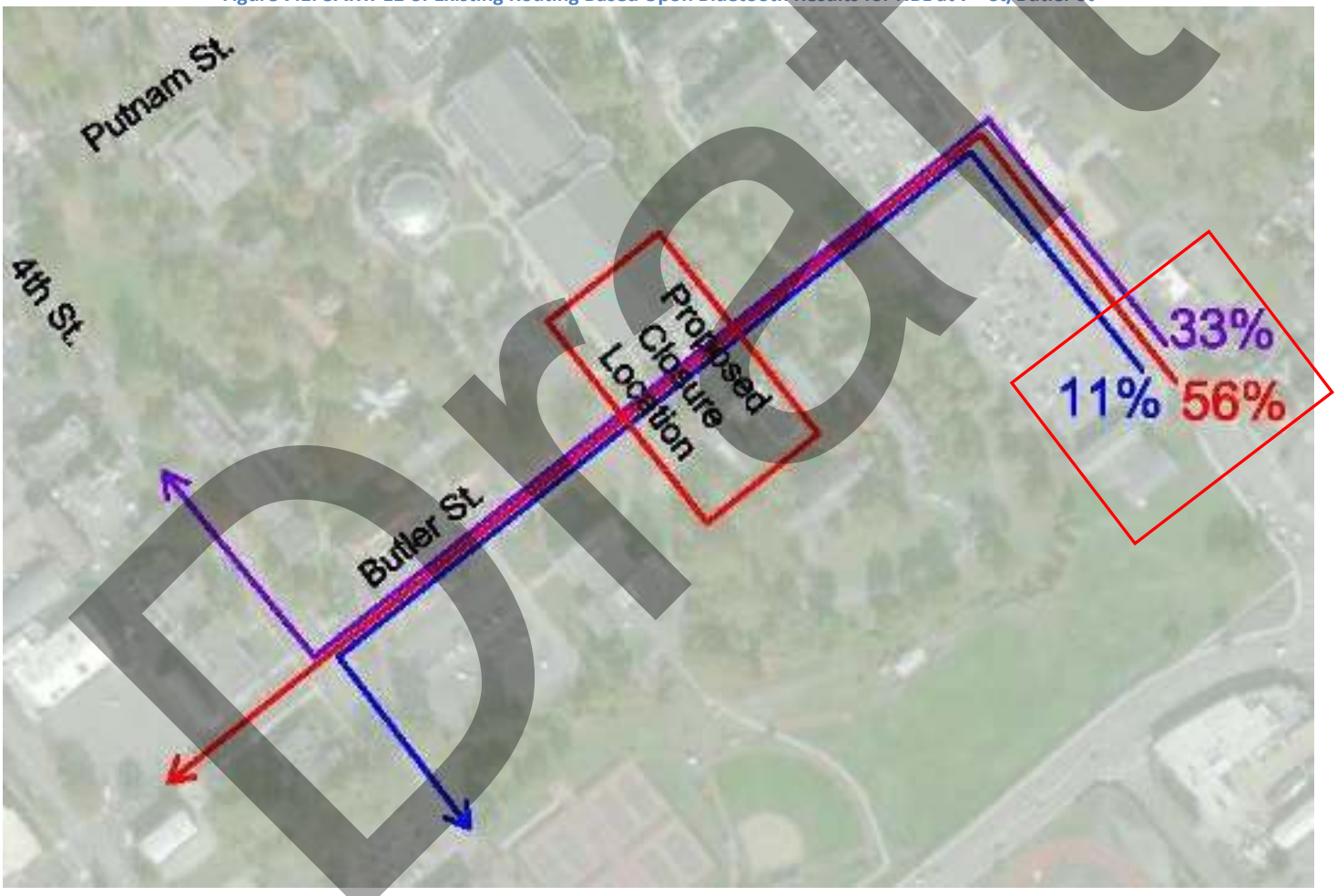
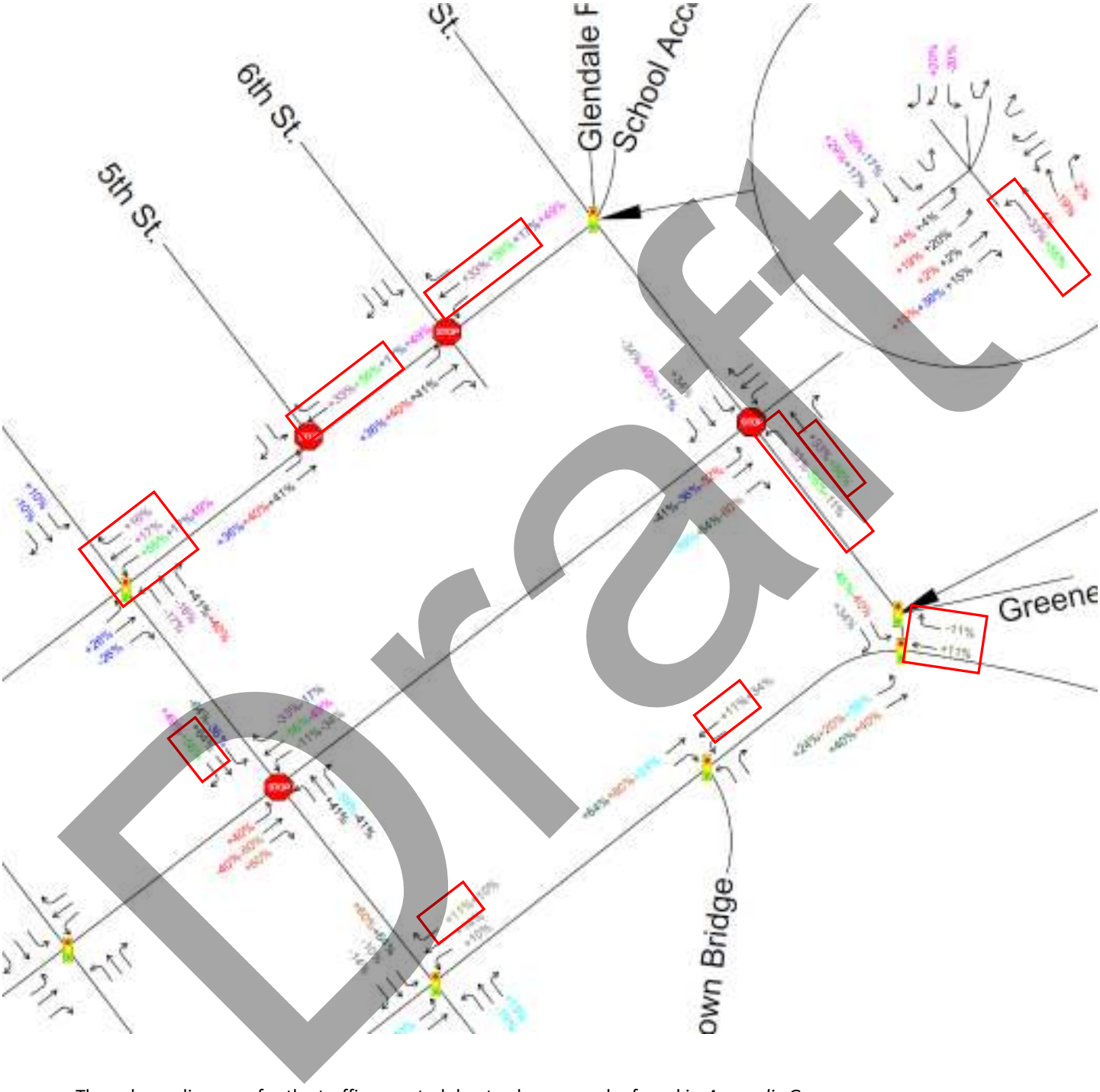


Figure 7.2: SAMPLE of Redistributed Percentages Based Upon Bluetooth Data



The volume diagrams for the traffic rerouted due to closure can be found in *Appendix G.*

8. Capacity Analysis

To determine any improvements necessary to accommodate the traffic generated by the proposed campus enhancements or rerouted traffic, the following scenarios were compared and analyzed:

- Existing
- No-Build 2020– Butler Street Open
- Build 2020 –Butler St Closure
- No-Build 2040 – Butler Street Open
- Build 2040 – Butler St Closure

TEC used the software programs *Synchro* and *SimTraffic* to evaluate each scenario individually. The capacity analysis was performed using existing signal timing for both the build and no-build scenarios for consistency.

The Level of Service (LOS) for the intersection is directly related to the average total delay per vehicle. The total delay is the sum of control delay and queue delay. Control delay is the component of delay caused by the downstream control device and is calculated using the Percentile Delay Method. Queue delay is an analysis of the affects of queues and blocking on short links and short turning bays. LOS is defined in terms of delay and is a measure of driver discomfort and intersection performance with respect to vehicular capacity and quality of service provided to road users. Delay refers to total average stopped delay experienced by motorists at the referenced intersection. The level of service is classified into six different levels, ranging from A to F, and is detailed in *Table 8.1* for signalized intersections and *8.2* for unsignalized intersections. Capacity analysis reports from Synchro can be found in *Appendix C*.

Table 8.1: Signalized Level of Service Classification

Level of Service	Description	Delay
A	Very low delay	<10 seconds per vehicle
B	Good progression	10-20 seconds per vehicle
C	Limit of acceptable delay	20-35 seconds per vehicle
D	Start of traffic breakdown	35-55 seconds per vehicle
E	High delay	55-80 seconds per vehicle
F	Congested conditions, unacceptable delay	>80 seconds per vehicle

Table 8.2: Unsignalized Level of Service Classification

Level of Service	Description	Delay
A	Very low delay	<10 seconds per vehicle
B	Good progression	10-15 seconds per vehicle
C	Limit of acceptable delay	15-25 seconds per vehicle
D	Start of traffic breakdown	25-35 seconds per vehicle
E	High delay	35-50 seconds per vehicle
F	Congested conditions, unacceptable delay	>50 seconds per vehicle

The figures and table below show the results for the model for each scenario analyzed. Each scenario was analyzed using existing signal timing plans for consistency. The growth was applied for 2020 and 2040 volumes and newly generated and redistributed volumes are also applied for the build scenarios. The intersection control (stop or signal) is available in the far right column. The complete table and reports are available in *Appendix H*.

Table 8.3: Overall Intersection Delay/LOS Results

Peak	Intersection	2018		2020					2040					Signal or Stop Sign
		Existing		No Build		Build		Δ	No Build		Build		Δ	
		LOS	Delay	LOS	Delay	LOS	Delay	Delay	LOS	Delay	LOS	Delay	Delay	
AM Peak	3rd St/Putnam St	C	27.0	C	27.0	C	27.1	0.1	C	27.8	C	27.9	0.1	Signal
	3rd St/Butler St	B	10.8	B	10.8	B	10.7	-0.1	B	10.9	B	10.8	-0.1	Signal
	3rd St/SR 7	A	6.9	A	6.9	A	6.9	0.0	A	7.3	A	7.1	-0.2	Signal
	4th St/Putnam St	B	10.6	B	10.6	B	10.1	-0.5	B	11.0	B	10.5	-0.5	Signal
	4th St/Butler St	A	5.3	A	5.3	A	2.6	-2.7	A	5.6	A	2.8	-2.8	Stop
	4th St/ SR 7	A	6.1	A	6.1	A	7.6	1.5	A	6.3	A	8.2	1.9	Signal
	5th St/Putnam St	A	0.9	A	0.9	A	0.8	-0.1	A	1.0	A	0.8	-0.2	Stop
	6th St/Putnam St	A	0.4	A	0.4	A	0.5	0.1	A	0.4	A	2.3	1.9	Stop
	7th St/ Putnam St	D	40.2	D	40.4	D	42.8	2.4	D	45.0	D	49.1	4.1	Signal
	7th St/Butler St	A	1.8	A	1.9	A	0.4	-1.5	A	1.9	A	0.3	-1.6	Stop
	SR 7/Williamstown	B	16.7	B	16.8	B	17.4	0.6	B	18.1	B	18.8	0.7	Signal
	7th St/Greene St	C	30.5	C	30.5	C	29.2	-1.3	C	31.9	C	29.5	-2.4	Signal
	7th/SR 7	B	11.3	B	11.3	B	12.5	1.2	B	12.1	B	12.9	0.8	Signal
MID Peak	3rd St/Putnam St	C	26.7	C	26.9	C	27.2	0.3	C	27.7	C	28.2	0.5	Signal
	3rd St/Butler St	B	10.8	B	10.4	B	10.4	0.0	B	10.6	B	10.5	-0.1	Signal
	3rd St/SR 7	B	11.3	B	11.3	B	11.9	0.6	B	12.1	B	12.2	0.1	Signal
	4th St/Putnam St	B	11.5	B	11.5	B	10.8	-0.7	B	12.2	B	12.0	-0.2	Signal
	4th St/Butler St	A	5.6	A	5.6	A	2.8	-2.8	A	6.0	A	2.9	-3.1	Stop
	4th St/ SR 7	B	11.7	B	11.7	B	13.9	2.2	B	12.1	B	14.8	2.7	Signal
	5th St/Putnam St	A	1.5	A	1.5	A	1.3	-0.2	A	1.6	A	1.4	-0.2	Stop
	6th St/Putnam St	A	0.6	A	0.6	A	0.2	-0.4	A	0.6	A	0.5	-0.1	Stop
	7th St/ Putnam St	C	32.6	C	32.8	C	33.1	0.3	D	36.3	D	36.6	0.3	Signal
	7th St/Butler St	A	2.1	A	2.1	A	0.3	-1.8	A	2.1	A	0.4	-1.7	Stop
	SR 7/Williamstown	B	17.5	B	17.8	B	18.7	0.9	C	21.4	C	23.3	1.9	Signal
	7th St/Greene St	C	32.8	C	32.5	C	31.1	-1.4	C	32.5	C	29.4	-3.1	Signal
	7th/SR 7	B	12.9	B	13.0	B	13.8	0.8	B	13.1	B	14.1	1.0	Signal
PM Peak	3rd St/Putnam St	C	24.6	C	24.6	C	25.2	0.6	C	26.6	C	27.2	0.6	Signal
	3rd St/Butler St	B	11.8	B	11.9	B	11.9	0.0	B	11.9	B	11.9	0.0	Signal
	3rd St/SR 7	B	17.8	B	17.8	B	17.2	-0.6	B	18.2	B	17.5	-0.7	Signal
	4th St/Putnam St	B	11.8	B	11.8	B	10.8	-1.0	B	12.3	B	13.9	1.6	Signal
	4th St/Butler St	A	7.3	A	7.3	A	4.7	-2.6	A	8.0	A	4.9	-3.1	Stop
	4th St/ SR 7	B	14.0	B	14.0	B	19.5	5.5	B	15.0	C	21.4	6.4	Signal
	5th St/Putnam St	A	1.5	A	1.5	A	1.3	-0.2	A	1.6	A	1.4	-0.2	Stop
	6th St/Putnam St	A	0.6	A	0.6	A	0.6	0.0	A	0.6	A	0.6	0.0	Stop
	7th St/ Putnam St	D	39.0	D	39.5	D	41.2	1.7	D	48.3	E	57.7	9.4	Signal
	7th St/Butler St	A	2.7	A	2.7	A	0.4	-2.3	A	2.8	A	0.3	-2.5	Stop
	SR 7/Williamstown	C	21.0	C	21.4	C	25.1	3.7	C	25.4	D	39.4	14.0	Signal
	7th St/Greene St	C	32.5	C	32.5	C	31.2	-1.3	C	33.3	C	31.5	-1.8	Signal
	7th/SR 7	B	14.3	B	14.6	B	15.2	0.6	B	16.2	B	17.1	0.9	Signal
Special Event Peak	3rd St/Putnam St	C	24.0	C	24.0	C	25.0	1.0	C	24.2	C	25.1	0.9	Signal
	3rd St/Butler St	A	9.1	A	9.0	A	9.0	0.0	A	9.1	A	9.1	0.0	Signal
	3rd St/SR 7	A	7.2	A	7.2	A	7.1	-0.1	A	7.4	A	7.2	-0.2	Signal
	4th St/Putnam St	A	8.6	B	10.4	A	9.3	-1.1	B	10.7	A	9.9	-0.8	Signal
	4th St/Butler St	A	5.0	A	5.0	A	3.4	-1.6	A	5.2	A	3.5	-1.7	Stop

4th St/ SR 7	A	9.8	A	9.8	B	12.0	**2.2**	B	10.0	B	12.3	**2.3**	Signal
5th St/Putnam St	A	1.5	A	1.5	A	1.2	**-0.3**	A	1.5	A	1.3	**-0.2**	Stop
6th St/Putnam St	A	1.1	A	1.1	A	1.4	**0.3**	A	1.1	A	1.5	**0.4**	Stop
7th St/ Putnam St	C	21.0	C	21.1	C	22.5	**1.4**	C	22.3	C	25.9	**3.6**	Signal
7th St/Butler St	A	2.0	A	2.0	A	0.4	**-1.6**	A	2.0	A	0.5	**-1.5**	Stop
SR 7/Williamstown	B	13.3	B	13.4	B	15.3	**1.9**	B	14.5	B	16.5	**2.0**	Signal
7th St/Greene St	C	28.7	C	28.7	C	25.8	**-2.9**	C	28.8	C	26.3	**-2.5**	Signal
7th/SR 7	A	8.9	A	9.0	B	10.5	**1.5**	A	9.1	B	10.6	**1.5**	Signal

Figure 8.1: Approach LOS - AM Peak

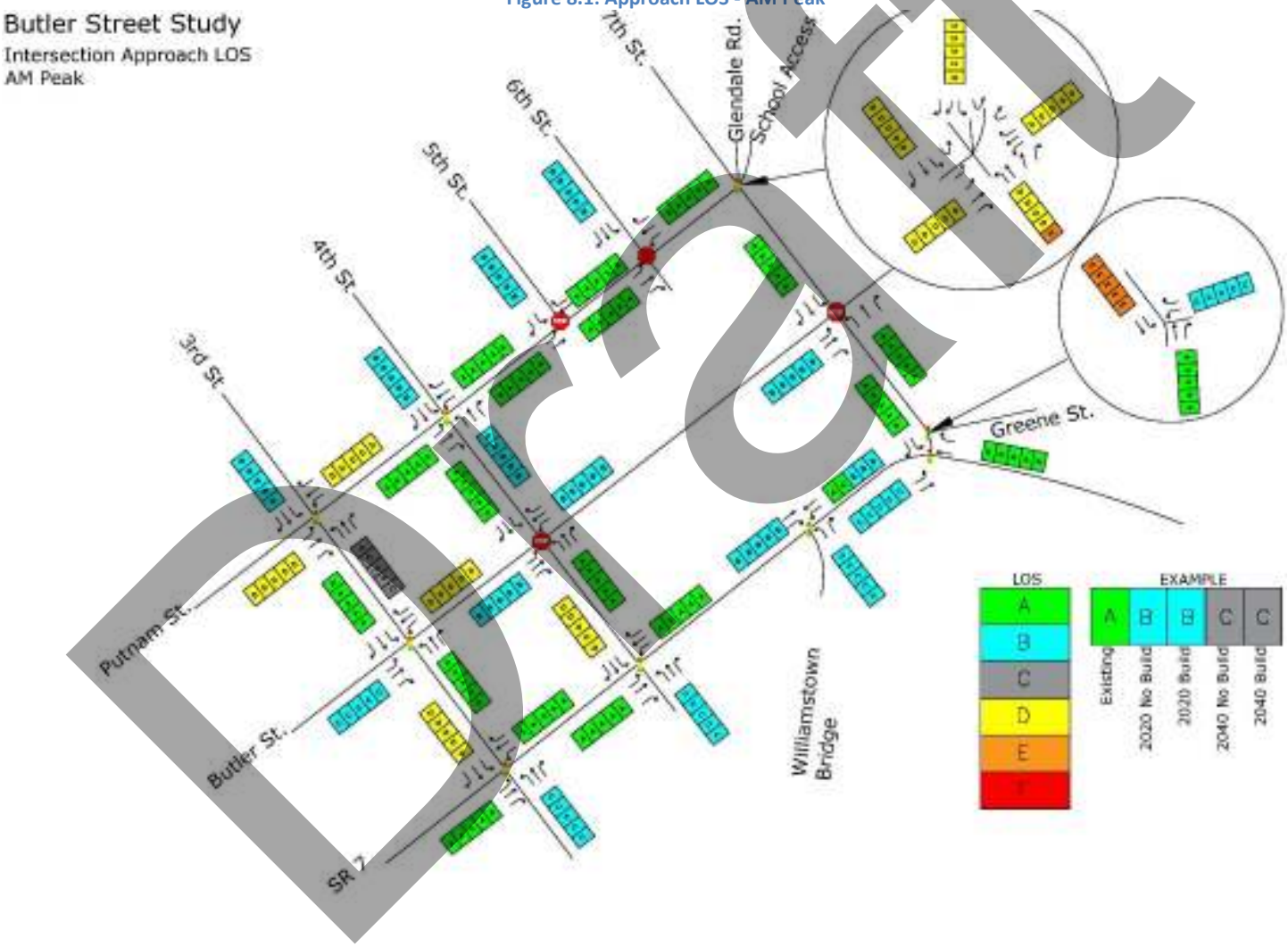


Figure 8.2: Approach LOS - MID Peak

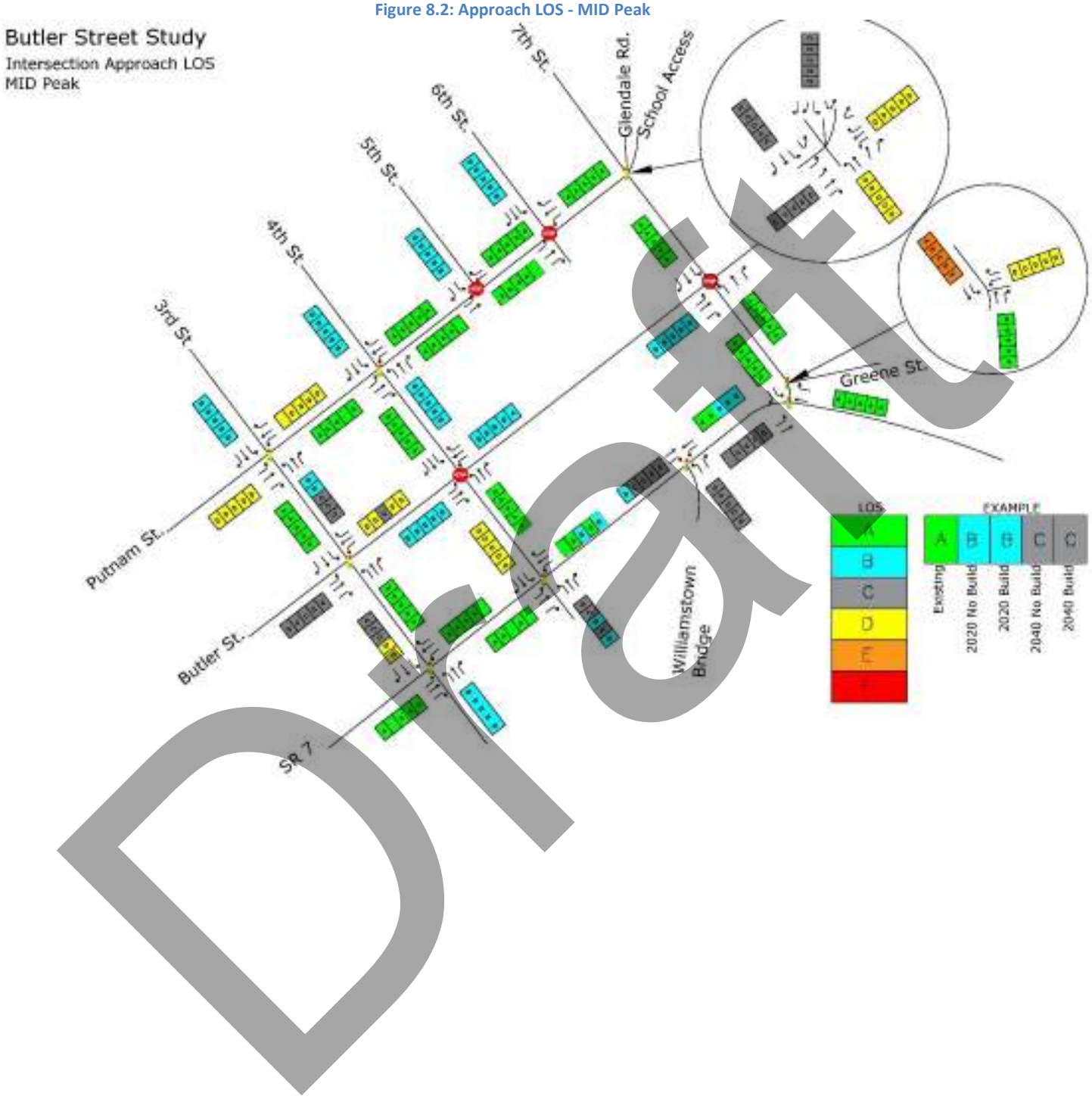


Figure 8.3: Approach LOS - PM Peak

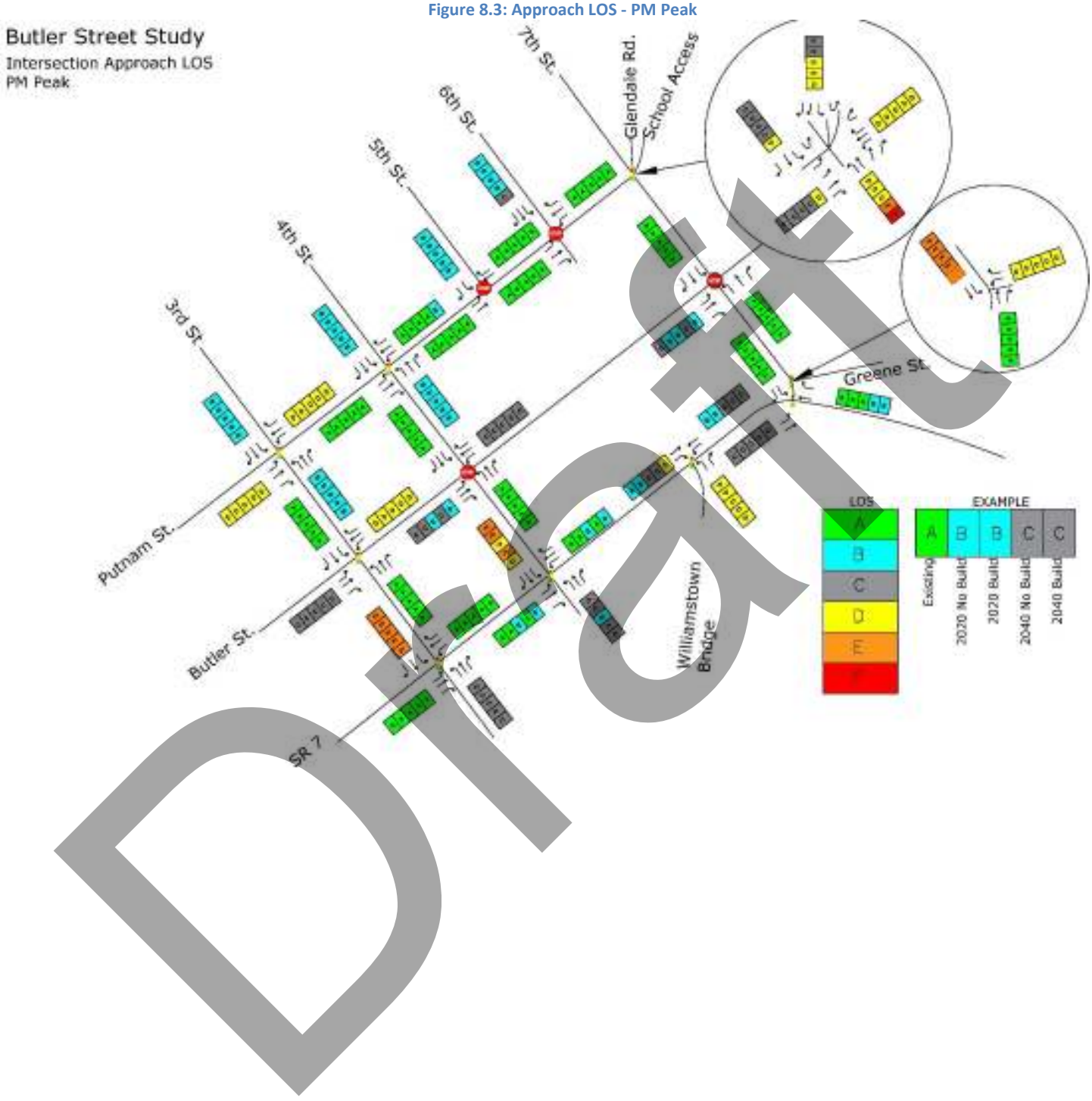
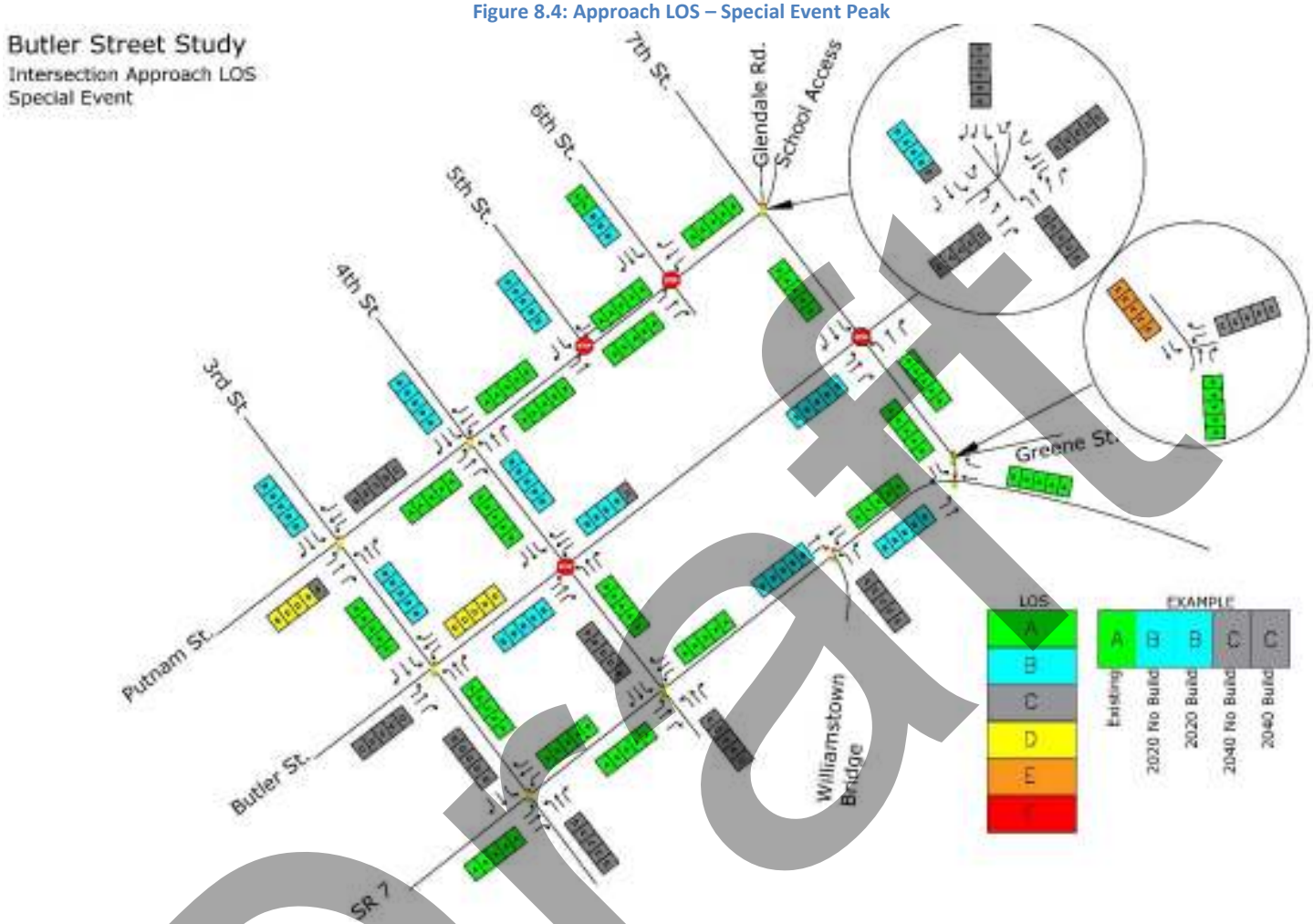


Figure 8.4: Approach LOS – Special Event Peak



As seen in the table and figures above, the newly added traffic and redistributed traffic added less than 6 seconds delay to the build scenarios at most intersections. The greatest increase is 14 seconds of over all delay add to SR 7 and the Williamstown Bridge in the PM peak in the 2040 scenario. The intersection of 7th Street and Putnam increases 9 seconds in this peak as well. These two intersections will be further discussed in the recommendation section of this report.

Some intersections will show an improvement in delay. This is due to traffic redistributing based on movements becoming restricted in the build scenario. When left-turning volumes become through volumes, delay per vehicle is lowered.

9. Queue Analysis

In a grid system, one concern is that delay at one intersection will cause a backup, or queue, which extends far enough to interfere with other intersections. A queue analysis is done to evaluate this possibility. The 95th Percentile Queue lengths were reviewed to determine the impact the Marietta College Enhancement Plan would have on the entire transportation network. The analysis was performed using a widely accepted modeling software called *SimTraffic*. A 60-minute simulation was run with 15 minutes being the "peak hour factor" and 45 minutes using the "anti-peak hour factors" to closely represent actual field conditions. Existing signal timing was applied to all scenarios.

Most changes in queue length are within a car length or two or experienced a reduction in queue. However, some approaches did increase by multiple car lengths. Please refer to *Appendix I* for complete queue analysis results.

10. Storage Lane Capacity Analysis

The storage lane lengths were reviewed to determine if future no-build or build traffic volumes would create field conditions of queues extending beyond storage. Storage lane lengths were calculated based upon ODOT's *Location & Design Manual, Volume 1 – Roadway Design, Form 401-9E*. The calculation was performed for the highest peak hour volumes (the worst-case scenario) for the 5 analysis periods examined. The maximum 95th percentile queue length per approach was also determined. The following table presents the results. The complete table can be found in *Appendix J*.

Table 10.1: Storage Lane Capacity Results

Intersection	Approach	Ex. Length w/ Taper	*Design Speed	Is existing length sufficient?					Max Calculated Length	Max Queue Length (*Sim Traffic*)*	Notes
				Existing	No Build 2020	Build 2020	No Build 2040	Build 2040			
3rd & Greene St	SBL	185	30	NO	NO	NO	NO	NO	400	207	Existing is striped for 135' but could allow for up to approx. 485' of storage including taper
3rd & Butler St	EBL	195	30	YES	YES	YES	YES	YES	100	76	-
	EBR	195	30	YES	YES	YES	YES	YES	100	92	-
	WBL	140	30	YES	YES	YES	YES	YES	100	85	-
	NBL	270	30	YES	YES	YES	YES	YES	100	51	-
	SBL	465	30	YES	YES	YES	YES	YES	100	51	-
3rd & Putnam St	EBL	145	30	YES	YES	YES	YES	YES	100	79	-
	WBL	165	30	YES	YES	YES	YES	YES	100	69	-
	NBL	305	30	YES	YES	YES	YES	YES	150	72	-
	SBL	165	30	YES	YES	YES	YES	YES	100	90	-
4th & SR 7	EBL	100	40	NO	NO	NO	NO	NO	165	413	Calculated lengths could be achieved by restriping and beginning taper just past Rite Aid Entrance
	WBL	100	40	NO	NO	NO	NO	NO	165	78	Calculated lengths could be achieved by restriping and beginning taper just past KFC Entrance
	NBL	150	30	YES	YES	YES	YES	YES	150	117	-
	SBL	140	30	NO	NO	NO	NO	NO	375	429	Calculated lengths could be achieved by restriping which may require restricting parking in some areas
4th & Putnam St	EBL	175	30	YES	YES	YES	YES	YES	100	39	-
SR 7 & Williamstown Bridge	WBL	375	40	NO	NO	NO	NO	NO	440	381	Based upon max queue lengths, the existing striping is recommended to remain
	NBR	325	45	NO	NO	NO	NO	NO	475	295	Lengths cannot be achieved without significant cost due to constraints of bridge. Existing striping is recommended to remain.
SR 7 & Greene St	EBL (Dual)	745	40	YES	YES	YES	YES	YES	365	459	-

	WBR	440	40	YES	YES	YES	YES	YES	440	88	-
7th St & Greene St	SBL	230	30	NO	NO	YES	NO	NO	250	232	Existing is striped for 180' of storage and could allow for calculated lengths
	WBL	155	30	NO	NO	NO	NO	NO	225	221	Calculated lengths could be achieved by restriping
7th & Butler St	EBT/L	130	30	YES	YES	YES	YES	YES	100	50	-
	NBL	150	30	YES	NO	YES	NO	YES	200	66	Calculated lengths could be achieved by restriping
7th & Putnam St	EBT/L	135	30	NO	NO	NO	NO	NO	300	303	Calculated lengths could be achieved by restriping which may require restricting parking in some areas
	NBL	185	30	YES	YES	NO	NO	NO	250	307	Calculated lengths could be achieved by restriping. Nearly 800' of storage is available.
	SBL	285	30	YES	YES	YES	YES	YES	100	14	-
*Based upon PM analysis											

As seen in the table, the only location where build volumes would cause the storage length requirements to extend beyond existing limits is the northbound left-turn lane at 7th Street and Putnam St. All other scenarios that do not provide enough storage are *not a result of build volumes*.

Most scenarios can achieve calculated lengths with simple restriping. The only exception to that is the northbound right-turn lane at SR 7 and the Williamstown Bridge. Achieving the calculated storage would require widening of the bridge. Alternative methods for this intersection to improve capacity are available in the recommendations section of this report.

The locations which would require parking restrictions should be reviewed in the field to verify if the turn lane should be lengthened to the calculated value. The recommendation for the extending the westbound left-turn lane at the SR 7 and Williamstown Bridge to calculated lengths would require reducing storage for eastbound left turns for SR 7 and 7th Street. However, the queue analysis presented in the previous section of this report resulted in 95th percentile queue lengths of a maximum on 351'. Therefore, it is recommended that the westbound left turn remain at the current length.

11. Signal Warrant

Signal warrant studies were performed at 4th Street/Butler Street and 7th Street/Butler Street to determine if signalization of these intersections is required. Peak-hour warrants were used based upon available data for build scenarios. The results show neither intersection warrants signalization.

Table 11.1: Signal Warrant Results

Intersection	Is Peak Hour Signal Warrant Met?				
	Existing	2020 No Build	2020 Build	2040 No Build	2040 Build
4th Street & Butler Street	NO	NO	NO	NO	NO
7th Street & Butler Street	NO	NO	NO	NO	NO

Signal warrants can be found in *Appendix K*.

12. Public Input

TEC Engineering hosted public meetings and created a survey with the intention of receiving public input, in hopes of getting insight from residents, students, City employees, and others who would be directly affected by the Marietta College Enhancement Plan.

Two public meetings were held on December 12, 2018 at 2:00pm and 7:00pm. This allowed the public an opportunity to voice concerns related to the Plan. There was a significant turnout. The meetings were attended by TEC Engineering Vice President, Edward Williams, who recorded comments and observations. Those comments and observations were taken into consideration as a part of this study.

An initial online survey was provided on Google Forms until it was discovered some people could not access the form and some could take the survey multiple times. There were 361 completed surveys on Google Forms. The survey was then made available at SurveyMonkey.com which resulted in 572 survey results. This prevented duplicate entries. A paper copy of the survey was also made available to the public at the City Building, the public meeting and the Port Authority. TEC Engineering received 28 paper copies of the survey.

The following figures include the results of the combination of all three surveys.

Figure 12.1: Survey Source

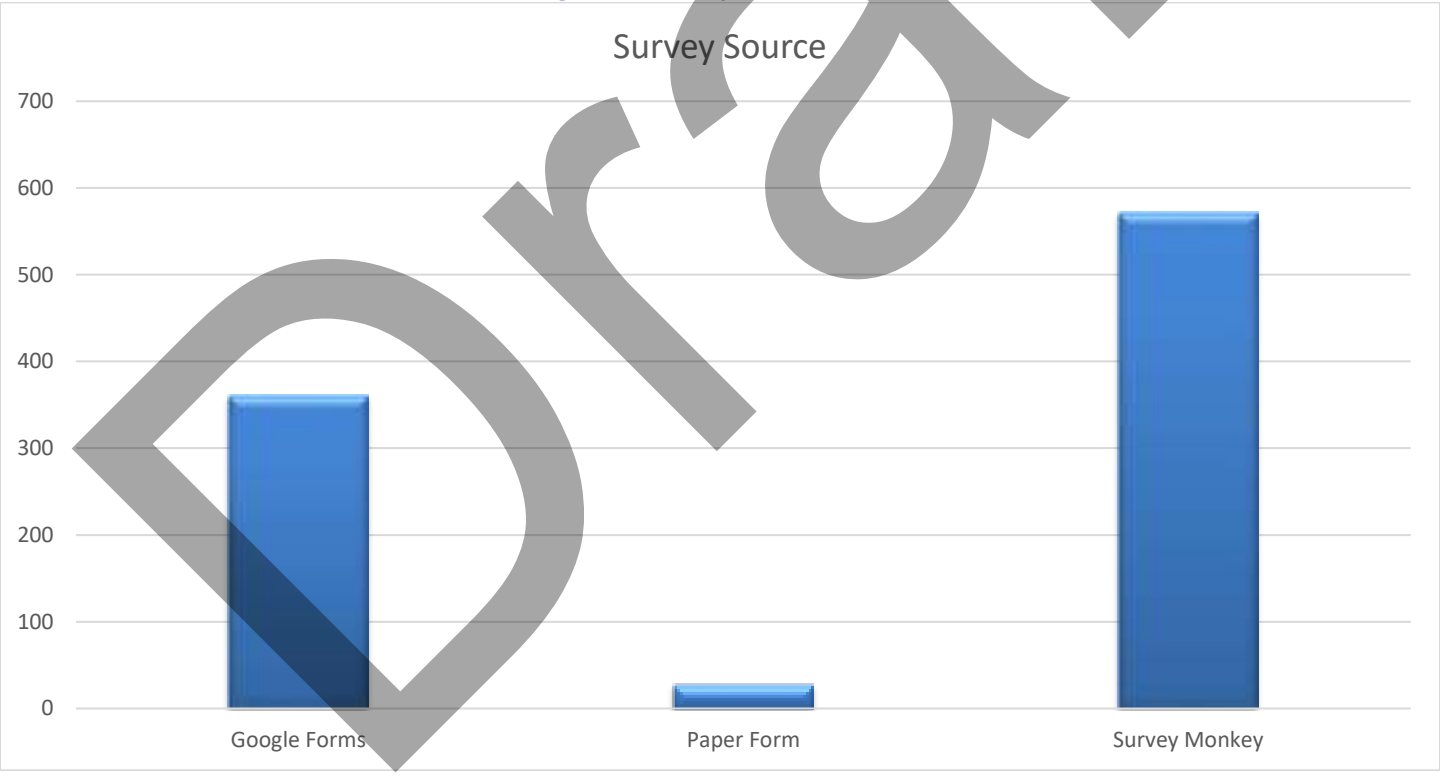


Figure 12.2: Survey Question Result

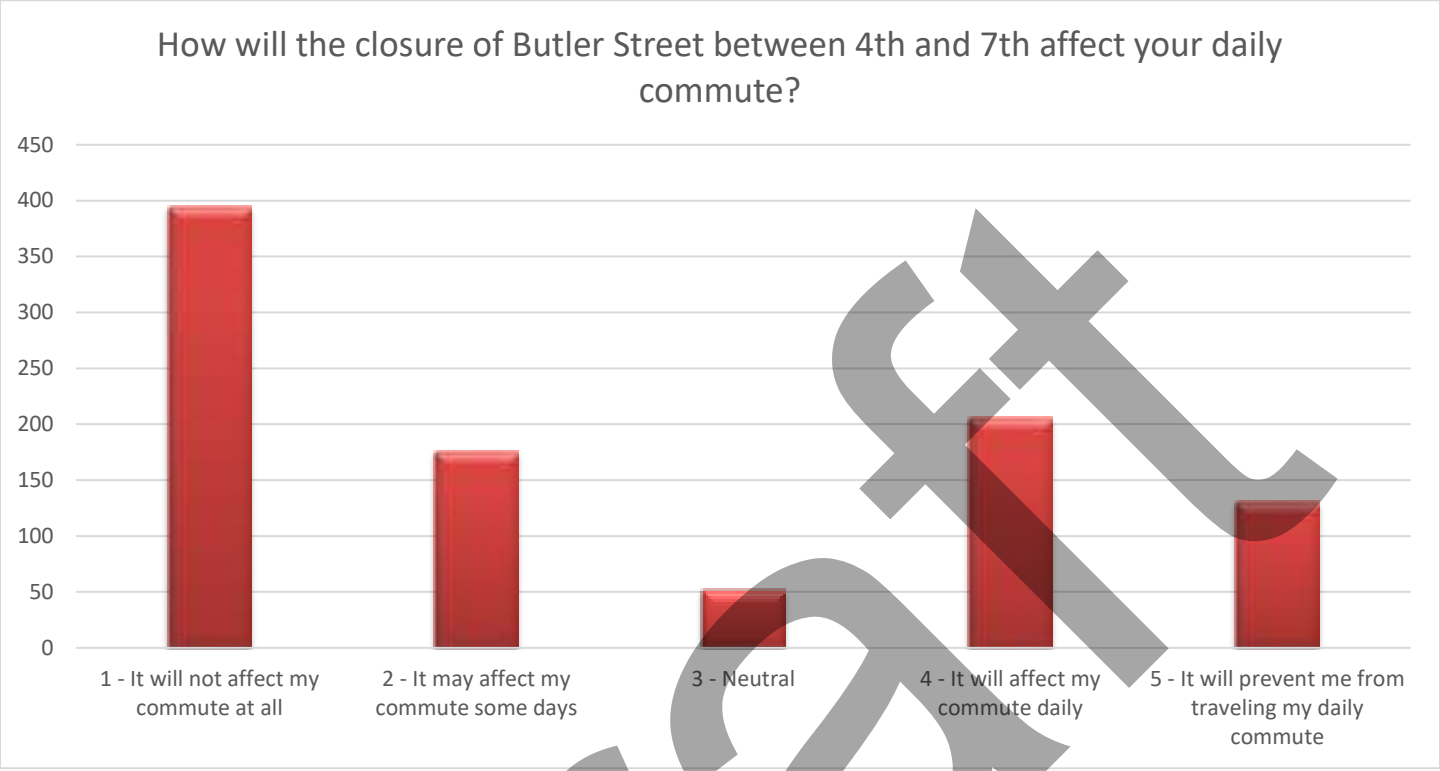


Figure 12.3: Survey Question Result

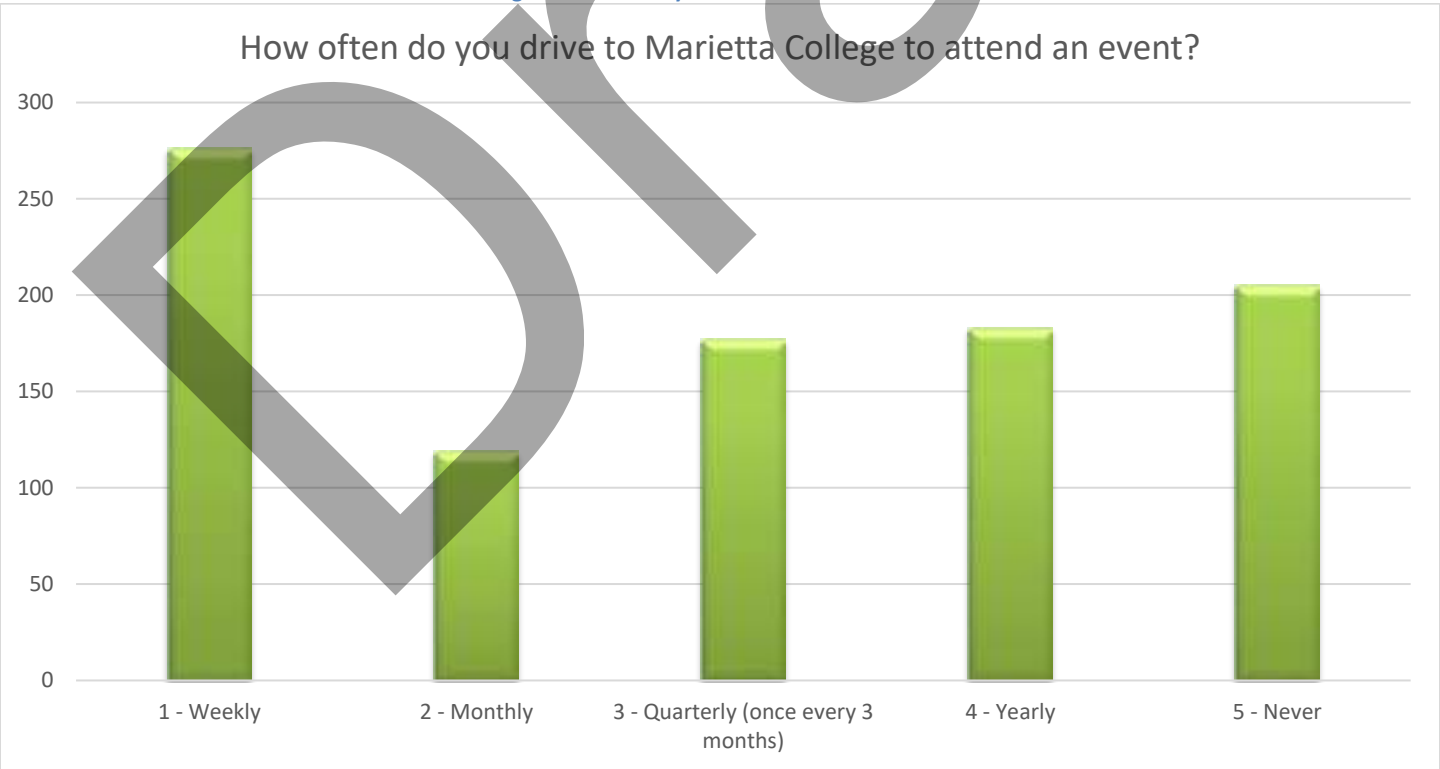


Figure 12.4: Survey Question Result

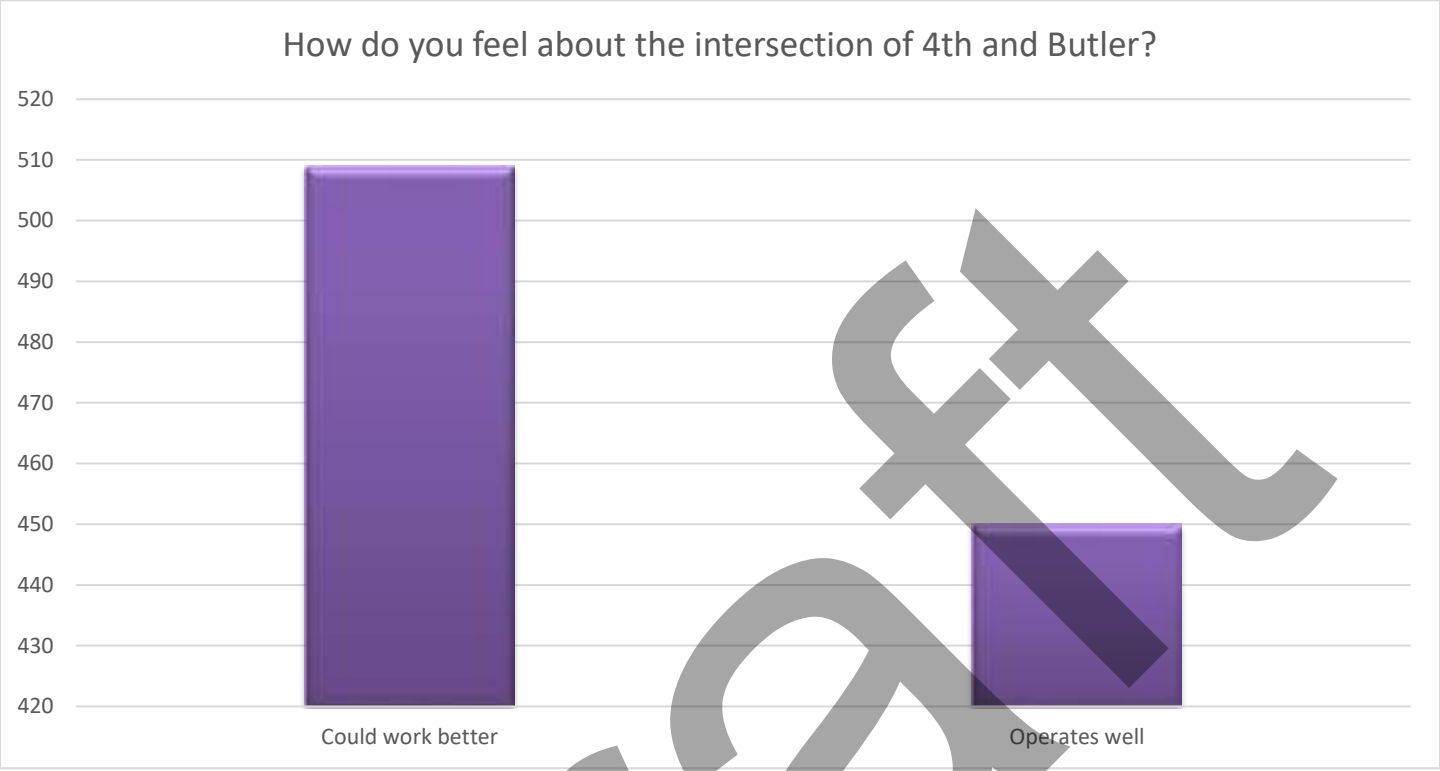


Figure 12.5: Survey Question Result

Figure 12.6: Survey Question Result

To further analyze the data, the median and average was determined for two of the questions. For the question stating "How will the closure of Butler Street between 4th Street and 7th Street affect your daily commute?," the responses were given a numeric value of 1-5, 1 being not effected and 5 preventing the daily route. The average response was a 2.5 and the median (middle) response was 2. For the question "Should Butler Street be closed to provide space for Marietta College improvements?," the responses were given a numeric value of 1-4, 1 being absolutely for the closing and 4 being fully against the closing. The average response was a 2.6 and the median response was 3. These results show that the percentage of people effected by the potential closing is less than neutral (not effected by the closure) while the percentage of people against the closing is higher than neutral.

In addition to these questions, a comment field was provided for general input about the project. While some comments were not beneficial or directly related to the project, there were many comments that raised concern about safety of pedestrians, traffic during flooding, congestion on adjacent streets, routes of emergency vehicles, etc. These comments are addressed in the following sections of this study. A complete summary of the surveys can be found in *Appendix L.*

13. Safety Analysis

Crash patterns were analyzed as part of this study to determine any potential safety concerns that would be affected by the closure of Butler Street. When reviewing crash trends, the most recent 3 years of complete data is analyzed. Since volume and environmental conditions tend to change over time, reviewing recent crash trends is generally the acceptable standard. According to the Ohio Department of Transportation's (ODOT) GIS Crash Analysis Tool (GCAT), during the most recent 3 years of complete data between 2015 and 2017, there were 13 crashes on Butler Street between and including the approaches to the intersections of 4th Street and 7th Street. Most occurred at or near the intersections, with 6 occurring at a driveway or midblock.

No crashes resulted in a fatality. No crashes involved a pedestrian. The following tables present data.

Table 13.1: Butler Street Crash Severity Results

Crash Severity	Number	%
Injury Crash	2	15.4%
Property Damage Crash	11	84.6%
Grand Total	**13**	**100.0%**

Table 13.2: Butler Street Crash Year Results

Crash Year	Number	%
2015	6	46.2%
2016	4	30.8%
2017	3	23.1%
Grand Total	**13**	**100.0%**

Table 13.3: Butler Street Crash Type Results

Type of Crash	Number	%
Angle	7	53.8%
Left Turn	2	15.4%
Rear End	2	15.4%
Fixed Object	1	7.7%
Right Turn	1	7.7%
Grand Total	**13**	**100.0%**

This data does not record near crashes. In the public survey, there was frequent mention of near crashes involving pedestrians, likely Marietta College students, in the roadway, at unmarked locations, or drivers unable to see pedestrians even when in marked crosswalks, due to inattention or poor visibility. This will be taken into account in the recommendations if Butler Street is to remain open.

Crashes at surrounding intersections were also analyzed to determine if there would be a need for improvements within the study area. These results are presented in the following tables.

Table 13.4: Intersection Crash Severity Results

Crash Severity	7th/Putnam	7th/Pike	Greene/ Williamstown Bridge	3rd/Greene	4th/Greene	4th/Putnam
Injury Crash	4	3	4	3	3	1
Property Damage	8	33	24	20	28	13
Grand Total	**12**	**36**	**28**	**23**	**31**	**14**

Table 13.5: Intersection Crash Year Results

Crash Year	7th/Putnam	7th/Pike	Greene/ Williamstown Bridge	3rd/Greene	4th/Greene	4th/Putnam
2015	4	13	10	6	12	5
2016	5	17	13	9	12	4
2017	3	6	5	8	7	5
Grand Total	**12**	**36**	**28**	**23**	**31**	**14**

Table 13.6: Intersection Crash Type Results

Type of Crash	7th/Putnam	7th/Pike	Greene/ Williamstown Bridge	3rd/Greene	4th/Greene	4th/Putnam
Rear End	6	16	19	10	13	4
Left Turn	2	10	2	4	7	-
Fixed Object	2	1	-	-	1	-
Sideswipe-Passing	1	6	5	4	3	2
Backing	-	1	-	-	-	-
Angle	-	1	1	2	6	6
Right Tur	-	-	1	1	-	-
Animal	-	-	-	-	-	1
Head On	1	-	-	1	-	-
Parked Vehicle	-	-	-	1	-	1
Pedalcycle	-	1	-	-	1	-
Grand Total	**12**	**36**	**28**	**23**	**31**	**14**

The crash analysis shows the majority of crashes are rear end crashes. Typically, rear end crashes are related to congestion or inadequate clearance intervals. This will be addressed in the recommendations discussed later in this study.

14. Pedestrian Analysis

Pedestrian safety was a concern from the public, especially college students and middle school students. On the day that turning movement counts were performed, there were only a handful of pedestrians crossing at 7th Street and Putnam during any given peak hour. Butler Street experiences more pedestrian activity.

There is concern from drivers on Butler Street that college students are not paying attention when crossing the street and crossing at unmarked crossings. There is also concern from college students that drivers are not able to see them crossing or not paying attention. These concerns will be addressed in the recommendations section of this study. The following table presents the volume of pedestrians at each location of concern.

Table 14.1: Pedestrian Volumes

Intersection	AM Peak	MID Peak	PM Peak	Special Event Peak
4th/Butler	17	17	17	9
7th/Butler	4	14	13	14
7th/Putnam	4	5	6	8

15. Emergency Vehicles

Emergency vehicle routing was analyzed to ensure safety is not compromised if Butler Street is closed to through traffic. Data was provided by the Marietta Police Department and the Marietta Fire Department regarding emergency calls between November 5th and November 16th of 2018.

The Police Chief and Fire Chief both indicated that Butler Street between 4th Street and 7th Street is a preferred route and frequently used when deploying emergency vehicles from the 301 Putnam Street Station. Butler Street is preferred over Putnam Street or SR 7 due to lack of traffic signals, lower traffic volumes, and smoother/asphalt street surface.

The Police Chief indicated that during the study time, there were 37 emergencies and, if leaving from the station, they would have used Butler Street between 4th Street and 7th Street. The Fire Chief indicated that the Fire Department passed through the general area being affected 56 times on 30 different emergency calls during that time frame.

Field data collection included video from the 4th Street and Butler Street intersection on November 8th from 6:45am-5:45pm and November 9th from 5:45pm-9:45pm. During that time, there were 8 police cruisers and 4 ambulances that passed through the intersection, nearly all traveled onto Butler Street. However, none had emergency lights on. Therefore, it could not be verified that emergency vehicles utilized Butler Street during emergencies based on the time period of our field data collection.

Emergency vehicle routing needs to be considered if Butler Street is closed. Possible measures are discussed in the recommendations section of this study.

16. Flooding

Ohio River flooding is a concern for some parts of the downtown Marietta area. Butler Street is in the 10-Year Flood Zone. In the online survey, there was concern of traffic congestion if SR 7 was closed due to flooding. However, with similar elevation of 606' and 607', if SR 7 is closed due to flooding, it is likely that Butler Street also would be closed. With a 10% chance of flooding reaching Butler Street each year, it would not be reasonable to recommend that Butler Street remain open just based on flooding events alone.

17. Norwood Traffic

There is a large residential area east of Downtown Marietta referred to as Norwood. Public input indicated a concern of drivers getting to and from the Norwood area to Downtown. According to the Bluetooth data, 20% of the traffic from Greene Street used Butler Street to access the downtown area. The Bluetooth results that present this distribution can be found in *Appendix F*.

Google Maps was used to determine the additional time it would take for a vehicle to travel from the intersection of Greene Street and Phillips Street in the Norwood area to the intersection of 2nd Street and Butler Street in the

Downtown area. According to Google Maps, if a vehicle departed at 5:00pm, there is a 0.1 mile difference in driving distance between using the SR 7 route and the Butler Street route. Both routes resulted in a 5 minute travel time. Google's preferred route is to utilize SR 7. This route was ran through various other applications and traffic simulation models with similar results. The below figure shows the two routes and travel times. The following table present the times from various direction applications.

Figure 17.1: Google Maps Travel Time Estimates

Table 17.1: Driving Direction Time Estimates (minutes)

Application	SR 7 Route	Butler Street Route
Google Maps	5	5
Bing Maps	4	5
Waze	3	3
Apple Maps	5	5
MapQuest	3	3
SimTraffic	1.76*	1.74*

**Results from Simtraffic are from the Greene St/7th intersection to the 3rd/Butler St intersection. These travel times do not include time on Greene St or Butler St between 3rd and 2nd.*

As seen in the table above, various driving direction applications all resulted in travel times within 1 minute. The travel time derived from traffic simulation (*SimTraffic)* models are lower than other mapping applications because the distance is much shorter (i.e. the simulation may not include the approaches to the intersections in the same way that the driving directions do). The simulation does not include Greene Street or Butler Street between 3rd and 2nd. However, with the travel times in the simulation being just over 1 second apart, it verifies that traffic simulations mimic existing conditions because the various mapping applications also show very similar travel time results.

With the *Simtraffic* travel time for no build scenarios verified, the build result was analyzed to determine the increase in travel time if Butler Street were to close to drivers traveling from Greene Street to the downtown area.

The travel time in the PM Build scenario resulted in a travel time of 2.06 minutes when traveling SR 7. This is a 17 second increase from existing conditions. The PM peak was chosen as the analysis peak since it is the worse-case scenario. Other peaks are assumed to have less of an impact if Butler Street were to close.

There was also a concern of turning left from Quarry Street onto 7th Street. According to the volume diagrams in *Appendix G*, the volume would actually slightly decrease on 7th Street based upon rerouting. Since Butler Street would not be open to parking areas near the 4th Street and Butler Street intersection from 7th Street, vehicles that would have accessed Butler Street via 7th Street would be rerouted to Putnam or SR 7 to 4th Street. While the volumes do not show much of decrease, the volume on Seventh Street seems to be decreasing based upon recent counts. This combined with a decrease in traffic due to the redirection of traffic if Butler Street is closed, would potentially result in a small improvement in delay.

18. Recommendations

Based upon this study, the following recommendations are presented:

Recommendation to Remain Open or Implement Plan

The decision to implement the Marietta College Improvement Plans or to keep Butler Street open is for the City of Marietta to make. The purpose of this study is to present facts based upon existing conditions and predicted traffic. The previous sections of this report have included facts and predictions related to the impact of closing Butler Street. While that decision is not part of this study, the following two sections of this report include recommendations for the transportation network based upon the two scenarios of remaining open or closing Butler Street.

18.1 No-Build Recommendations (if Butler Street remains open)

1. **Install Midblock Pedestrian Flashing Beacon (Short Term - $40,000):** A common complaint in the online survey was near crashes between pedestrians and vehicles in the midblock section of Butler Street between 4th Street and 7th Street. Therefore, it is recommended that a minimum of one pedestrian signalized flashing beacon location be installed in this stretch of Butler Street where the signed crossing currently exists. A second location is recommended near the brick paver area.
2. **Increase Storage Lane Lengths (Short Term - $32,000):** In Section 10 of this study, the storage lane lengths were analyzed. While most existing lengths were sufficient, some required longer turn lane bays. All required lengths can be achieved within the existing roadway limits. The existing striping would be removed and reapplied at the appropriate lengths. In some locations, parking would be prohibited to allow drivable lane widths. The following table presents the recommended lengths.

Intersection	Approach	Existing Length w/ Taper	Max Calculated Length	Max Queue Length (*SimTraffic*)	Recommendation
3rd & Greene St	SBL	185	400	207	Restripe to 400' of storage + taper
4th & SR 7	EBL	100	165	413	Restripe to 165' beginning taper just past Rite Aid Entrance
	WBL	100	165	78	Restripe to 165' beginning taper just past KFC Entrance
	SBL	140	375	429	Restripe to 375' which may require restricting parking
SR 7 & Williamstown Bridge	WBL	375	440	381	Existing striping is recommended to remain
	NBR	325	475	295	Existing striping is recommended to remain
7th St & Greene St	SBL	230	250	232	Existing is striped for 180' of storage and could allow for

					calculated lengths
	WBL	155	225	221	Restripe to 225' of storage + taper
7th & Butler St	NBL	150	200	66	Restripe to 200' of storage + taper
7th & Putnam St	EBT/L	135	300	303	Restripe to 300' which may require restricting parking
	NBL	185	250	307	Restripe to 410' of storage + taper

3. **General Lane Width Improvements (Short Term - $120,000):** The lane configurations and widths should be evaluated for the entire downtown Marietta grid. Multiple areas have wide and poorly defined lane widths. Some locations may allow for additional lanes or longer storage lanes. Narrow lanes can create an increase in safety due to vehicles traveling at a slower speed. It also helps drivers understand the intended use of the lanes. A general pavement marking review should be conducted and lane widths, marking and storage lengths should be installed according to ODOT's Manual of Uniform Traffic Control Devices.
4. **Retiming Traffic Signals (Mid Term - $32,000):** The traffic signals should be reviewed on a regular schedule to ensure changes in traffic trends are accounted for. The Institute of Transportation Engineers recommends retiming a corridor every 3-5 years.
5. **Eastbound right-turn Lane at Williamstown Bridge (Mid Term - $9,000):** This recommendation should be considered regardless if Butler Street remains open or closed. The eastbound approach on Greene Street at the Williamstown Bridge experiences significant delay in the peak hour due to lane imbalance. The right shared lane is used for through and right turning vehicle. To improve lane balance, there are multiple options that can resolve this issue:
    a. Move eastbound stop bar forward 1 to 1.5 car lengths so right turning traffic is not prevent from turning right on red by a through vehicle. A raised concrete island should be installed to control traffic flow. This can be accomplished within existing roadway limits. This was selected as the proposed solution in the recommendation section.

    b. Convert right shared lane to an exclusive right turn lane, with the left lane becoming an exclusive through lane. This would allow for a right turn overlap during northbound operation. This would mean changing the striping on the east side of the intersection to redirect the one through lane into two through lanes. This recommendation is mainly made because of the lane bias of most drivers in Marietta. Throughout Greene/Pike Street, drivers tend to the right most lane, which the left lane is clear.
    c. A "Green T" can be installed which allows for a westbound continuous through movement. The through movement can be achieved by installing a very narrow median

and a signal head improvement. This would drastically improve the operation of the intersection. Consideration would need to be given to pedestrian traffic, however. This solution is not ideal for pedestrian traffic, and this intersection is used for stadium pedestrian traffic.

6. **Repair Butler Street (Long Term - $580,000):** Butler Street is in need of repair. There are failing pavement areas and the brick portion of the road is unstable. Signage and pavement markings need updated. The storm sewer system needs updated. The curb and sidewalk are also in need of repair. If this road is to remain open, repairs must be made to the roadway. During the design process, the City should consider narrowing Butler Street. It currently does not carry a lot of traffic. Narrowing the road would decrease the crossing length for pedestrians, reducing the exposure time. Narrowing the road could also help to reduce the speeds along Butler Street. If the Butler Street is overturned to the College, it would be their responsibility to upgrade Butler Street. There would be an annual maintenance cost as well.
7. **7th Street and Putnam Improvements (Mid - $112,000):** This recommendation should be considered regardless if Butler Street remains open or closes. This intersection is a 5-legged intersection with extra phasing to account for the additional traffic approach. An additional lane should be added to the Glendale Road approach to service more vehicles and cycle the signal faster on that approach. While the benefit is not as great as eliminating an approach, the additional lane on Glendale Road reduces the overall delay up to 28 seconds in the 2040 PM Build scenario, bringing it within an acceptable level of service of "C". Widening Glendale Road could be done without much interference with significant grading on either side of the road. The road could be widened to the existing sidewalk which could allow for 10' lanes and curb.

   In general 5-legged intersections are not desirable, however at this intersection there are several limitations that would prohibit eliminating one leg of the intersection, including significant grading concerns on the Glendale approach. While it is not a final recommendation, if a conversion from 5-leg to 4-leg is to be pursued, the School Access Drive could be vacated, resulting in a 4-legged intersection. Developments are being considered to consolidate schools within the City to another location, resulting in vacating the Middle School. This approach could then be eliminated if access is not needed. If a future development occupies this site, the access would be provided via Quarry Street. A model was analyzed with the removal of this leg and standard phasing, which showed significant delay improvements. A traditional 4-legged intersection allows for evenly distributed phasing and improves safety and delay. In addition to other constraints for improvements, the cost for such an improvement is $5,650,000.

   As seen in recommendation 18.1.2, the northbound and eastbound storage lanes are recommended to be lengthened. These are considered to be short term improvements that can be accomplished within roadway limits by restriping. These improvements should be considered along with the widening of Glendale Road specified above.

18.2 Build Recommendations (if Butler Street is closed)

1. **Increase Storage Lane Lengths (Short Term - $32,000):** This recommendation is included in the No-Build section as well. Regardless if Butler Street is closed, surrounding storage lane lengths should be restriped to meet calculated lengths. Section 18.1 presents recommendations for storage lengths.
2. **General Lane Width Improvements (Short Term - $120,000):** This recommendation is included in the No-Build section as well. Regardless if Butler Street if Butler Street closes or remains open, lane configurations and widths should be evaluated to ensure lanes are per ODOT's OMUTCD handbook. Please refer to Section 18.1 for further discussion.

3. **Retiming Traffic Signals (Mid Term - $32,000):** This recommendation is included in the No-Build section as well. However, with a closure of a street within the roadway network, the need for signal retiming becomes greater. The traffic signals should be retimed and include coordination for the generated and redistributed traffic volumes in the event Butler Street is closed. This would include evaluating all traffic signals within the study area and maintaining coordination along SR 7.
4. **Implement Special Event Signal Timing Plans (Mid Term - $32,000):** Typical weekday traffic signal timing patterns can operate based on a set schedule. However, when a special event occurs such as a College event, flooding, road closure, etc, a timing plan should be readily available to ensure traffic is not congested. When an event occurs, a signal technician or a City Engineer can remotely implement a new timing plan. The ongoing WAS Marietta Fiber project will improve the signal system infrastructure and also looks to add a central based signal system. Central Based Signal Systems make system wide plan changes much easier.
5. **Provide College Access for Emergency Vehicles (Mid Term - $32,000):** Emergency responders must be able to access all points of the campus. This can be achieved by providing a drivable area within the closed section of Butler Street that would be accessible by emergency vehicles only. Bendable markers or moveable bollards can be installed in the roadway that would allow an emergency vehicle to pass over without damage to the vehicle. This would provide access for emergency vehicles while limiting access to through vehicles. There are a variety of options of bendable markers and moveable bollards including remote control bollards, locking bollards, or moveable gate that could be controlled by emergency vehicles. Moveable bollards are included in the estimated cost. The cut sheet for these bollards is provided in *Appendix N.*
6. **Eastbound right-turn Lane at Williamstown Bridge (Mid Term - $9,000):** This recommendation is also included in the No-Build recommendation section of this report and should be considered regardless if Butler Street is to close or remain open. Please refer to Section 18.1 of the report for further discussion on the recommendations for the eastbound right turn lane at Greene Street and Williamstown Bridge Rd.
7. **Provide Pre-Emption for Emergency Vehicles (Long Term - $350,000):** The police and fire departments reported that both frequently use Butler Street between 4th Street and 7th Street to avoid traffic signals. With pre-emption installed, the emergency vehicles can move traffic along in the route they are traveling and stop traffic in opposing directions, creating a safer traveling environment for all drivers. The preemption would allow for a green light in the direction of the Emergency Vehicle, while provide a red light for all other approaches. The system could even be programmed to clear out any intersection queueing if needed.
8. **7th Street and Putnam Improvements (Mid Term - $112,000):** This recommendation is discussed in the No-Build recommendation section of this report. However, with the closure of Butler Street and traffic rerouting through 7th Street/Putnam, is it important to consider improvements to this intersection. Based upon the increase in traffic through the 7th Street and Putnam Street intersection, improvements must be made. Additional capacity should be added to the Glendale Road approach. Please refer to Section 18.1 of this report for recommendations for further discussion on this recommendation.

18.3 Recommendations Capacity Analysis Results

The following analyses evaluate the effects of the proposed recommendations. The "with recommendations" columns assume that storage lanes were increased to recommended lengths, signal timing and coordination were optimized, the eastbound right turn at the Williamstown Bridge was widened to allow cars to turn right on red, and the 7th Street and Putnam Street intersection was reconfigured to create a 4-legged intersection. The changes at 7th Street and Putnam Street assumed Glendale Rd traffic would be routed to Ephraim Cutler Street and volumes were redistributed accordingly. This significantly improved the operation of this intersection. The capacity analysis results for no-build and build with recommendations are presented in the following table. The capacity analysis and queuing reports can be found in *Appendix M*.

Table 18.1: LOS and Delay Results for With and Without Recommendations

Peak	Intersection	2020 without Recommendations				2020 with Recommendations				2040 without Recommendations				2040 with Recommendations			
		No Build		Build		No Build		Build		No Build		Build		No Build		Build	
		LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
AM Peak	3rd St/Putnam St	C	27.0	C	27.1	C	21.9	C	21.1	C	27.8	C	27.9	C	22.6	C	21.9
	3rd St/Butler St	B	10.8	B	10.7	A	8.7	A	8.0	B	10.9	B	10.8	A	8.7	A	8.3
	3rd St/SR 7	A	6.9	A	6.9	A	7.4	A	8.0	A	7.3	A	7.1	A	7.5	A	8.2
	4th St/Putnam St	B	10.6	B	10.1	B	14.0	B	13.5	B	11.0	B	10.5	B	14.3	B	13.9
	4th St/Butler St	A	5.3	A	2.6	A	5.3	A	2.6	A	5.6	A	2.8	A	5.6	A	2.8
	4th St/ SR 7	A	6.1	A	7.6	A	5.3	A	6.0	A	6.3	A	8.2	A	5.3	A	6.1
	5th St/Putnam St	A	0.9	A	0.8	A	0.9	A	0.8	A	1.0	A	0.8	A	1.0	A	0.8
	6th St/Putnam St	A	0.4	A	0.5	A	0.4	A	0.5	A	0.4	A	2.3	A	0.4	A	2.3
	7th St/ Putnam St	D	40.4	D	42.8	C	33.7	D	35.3	D	45.0	D	49.1	D	36.8	D	39.1
	7th St/Butler St	A	1.9	A	0.4	A	1.9	A	0.4	A	1.9	A	0.3	A	1.9	A	0.3
	SR 7/Williamstown	B	16.8	B	17.4	B	14.2	B	15.0	B	18.1	B	18.8	B	15.5	B	15.4
	7th St/Greene St	C	30.5	C	29.2	B	18.9	B	18.6	C	31.9	C	29.5	C	20.9	B	19.0
	7th/SR 7	B	11.3	B	12.5	A	8.6	A	9.0	B	12.1	B	12.9	A	9.2	A	9.9
MID Peak	3rd St/Putnam St	C	26.9	C	27.2	C	20.2	C	22.1	C	27.7	C	28.2	C	20.8	C	22.6
	3rd St/Butler St	B	10.4	B	10.4	B	10.3	B	10.4	B	10.6	B	10.5	B	10.6	A	8.9
	3rd St/SR 7	B	11.3	B	11.9	B	11.3	B	11.8	B	12.1	B	12.2	B	11.3	B	10.2
	4th St/Putnam St	B	11.5	B	10.8	B	18.2	B	15.1	B	12.2	B	12.0	B	19.0	B	16.9
	4th St/Butler St	A	5.6	A	2.8	A	5.6	A	2.8	A	6.0	A	2.9	A	6.0	A	2.9
	4th St/ SR 7	B	11.7	B	13.9	A	6.7	B	10.4	B	12.1	B	14.8	A	7.3	B	11.0
	5th St/Putnam St	A	1.5	A	1.3	A	1.5	A	1.3	A	1.6	A	1.4	A	1.6	A	1.4
	6th St/Putnam St	A	0.6	A	0.2	A	0.6	A	0.5	A	0.6	A	0.5	A	0.6	A	0.5
	7th St/ Putnam St	C	32.8	C	33.1	C	26.4	C	26.7	D	36.3	D	36.6	C	28.5	C	28.9
	7th St/Butler St	A	2.1	A	0.3	A	2.1	A	0.3	A	2.1	A	0.4	A	2.2	A	0.4
	SR 7/Williamstown	B	17.8	B	18.7	B	15.8	B	14.8	C	21.4	C	23.3	B	18.1	B	16.5
	7th St/Greene St	C	32.5	C	31.1	C	20.9	B	19.4	C	32.5	C	29.4	C	20.6	B	18.7
	7th/SR 7	B	13.0	B	13.8	A	9.5	A	9.8	B	13.1	B	14.1	A	9.7	B	10.0
PM Peak	3rd St/Putnam St	C	24.6	C	25.2	C	20.3	C	23.0	C	26.6	C	27.2	C	21.8	C	22.9
	3rd St/Butler St	B	11.9	B	11.9	B	11.4	A	9.7	B	11.9	B	11.9	B	10.8	A	9.6
	3rd St/SR 7	B	17.8	B	17.2	B	10.8	A	9.5	B	18.2	B	17.5	A	9.7	A	9.5
	4th St/Putnam St	B	11.8	B	10.8	B	17.1	B	14.3	B	12.3	B	13.9	B	17.0	B	15.4
	4th St/Butler St	A	7.3	A	4.7	A	7.3	A	4.7	A	8.0	A	4.9	A	4.9	A	4.9
	4th St/ SR 7	B	14.0	B	19.5	A	7.0	B	12.1	B	15.0	C	20.9	B	14.8	B	14.2

	5th St/Putnam St	A	1.5	A	1.3	A	1.5	A	1.3	A	1.6	A	1.4	A	1.4	A	1.4
	6th St/Putnam St	A	0.6	A	0.6	A	0.6	A	0.6	A	0.6	A	0.6	A	0.6	A	0.6
	7th St/ Putnam St	D	39.5	D	41.2	C	31.3	C	32.9	D	48.3	E	57.7	C	33.5	C	29.9
	7th St/Butler St	A	2.7	A	0.4	A	2.7	A	0.4	A	2.8	A	0.3	A	0.3	A	0.3
	SR 7/Williamstown	C	21.4	C	25.1	B	19.8	C	20.3	C	25.4	D	39.4	C	26.2	C	26.5
	7th St/Greene St	C	32.5	C	31.2	C	21.8	C	20.0	C	33.3	C	31.5	C	23.2	C	23.6
	7th/SR 7	B	14.6	B	15.2	B	11.3	B	11.7	B	16.2	B	17.1	B	12.3	B	12.6
Special Event Peak	3rd St/Putnam St	C	24.0	C	25.0	B	17.8	B	19.4	C	24.2	C	25.1	B	19.2	C	22.1
	3rd St/Butler St	A	9.0	A	9.0	A	7.9	A	7.5	A	9.1	A	9.1	A	9.3	A	7.8
	3rd St/SR 7	A	7.2	A	7.1	A	7.9	A	7.4	A	7.4	A	7.2	A	7.0	A	6.7
	4th St/Putnam St	B	10.4	A	9.3	B	15.1	B	11.8	B	10.7	A	9.9	B	17.0	B	13.6
	4th St/Butler St	A	5.0	A	3.4	A	5.0	A	3.4	A	5.2	A	3.5	A	5.2	A	3.5
	4th St/ SR 7	A	9.8	B	12.0	A	5.7	A	8.4	B	10.0	B	12.3	A	6.4	A	8.3
	5th St/Putnam St	A	1.5	A	1.2	A	1.5	A	1.2	A	1.5	A	1.3	A	1.5	A	1.3
	6th St/Putnam St	A	1.1	A	1.4	A	1.1	A	1.4	A	1.1	A	1.5	A	1.1	A	1.5
	7th St/ Putnam St	C	21.1	C	22.5	B	19.2	C	20.1	C	22.3	C	25.9	C	20.0	C	21.2
	7th St/Butler St	A	2.0	A	0.4	A	2.0	A	0.4	A	2.0	A	0.5	A	2.0	A	0.5
	SR 7/Williamstown	B	13.4	B	15.3	B	11.9	B	12.2	B	14.5	B	16.5	B	12.3	B	13.5
	7th St/Greene St	C	28.7	C	25.8	B	19.5	B	18.0	C	28.8	C	26.3	B	18.9	B	17.5
	7th/SR 7	A	9.0	B	10.5	A	7.5	A	9.1	A	9.1	B	10.6	A	7.7	A	8.9

Figure 18.1: Approach LOS - AM Peak with Recommendations

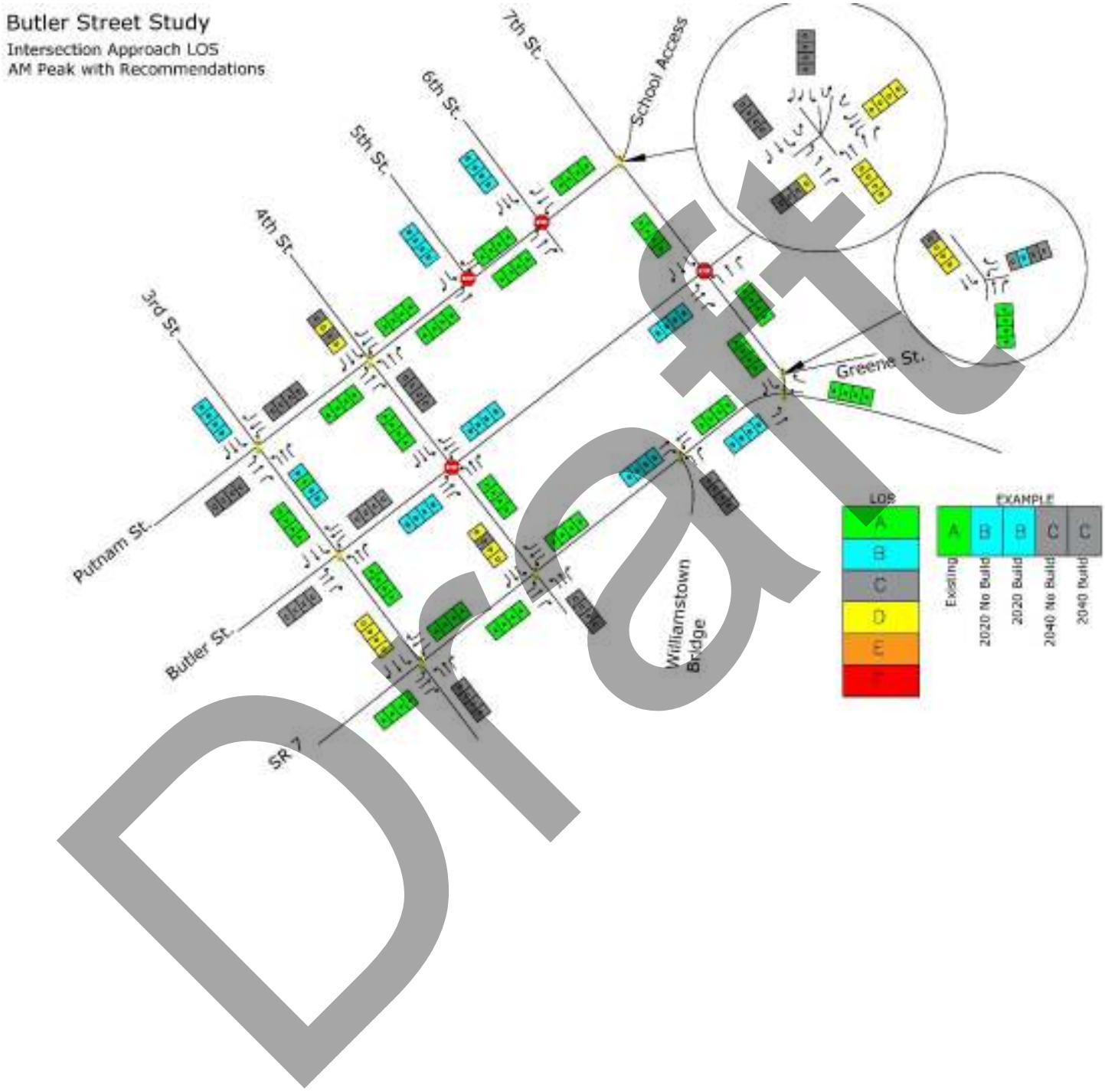


Figure 18.2: Approach LOS - MID Peak with Recommendations

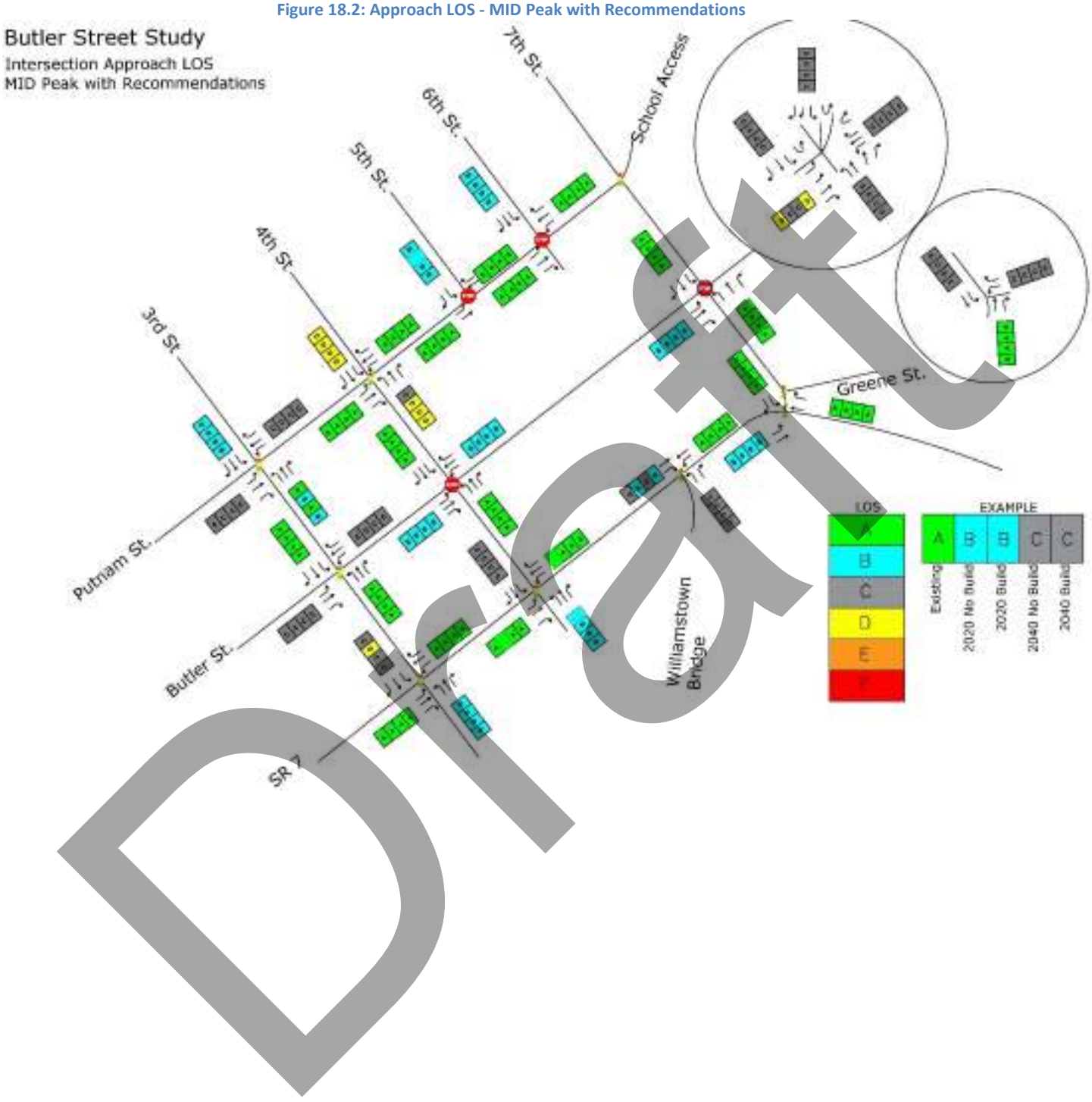


Figure 18.3: Approach LOS - PM Peak with Recommendations

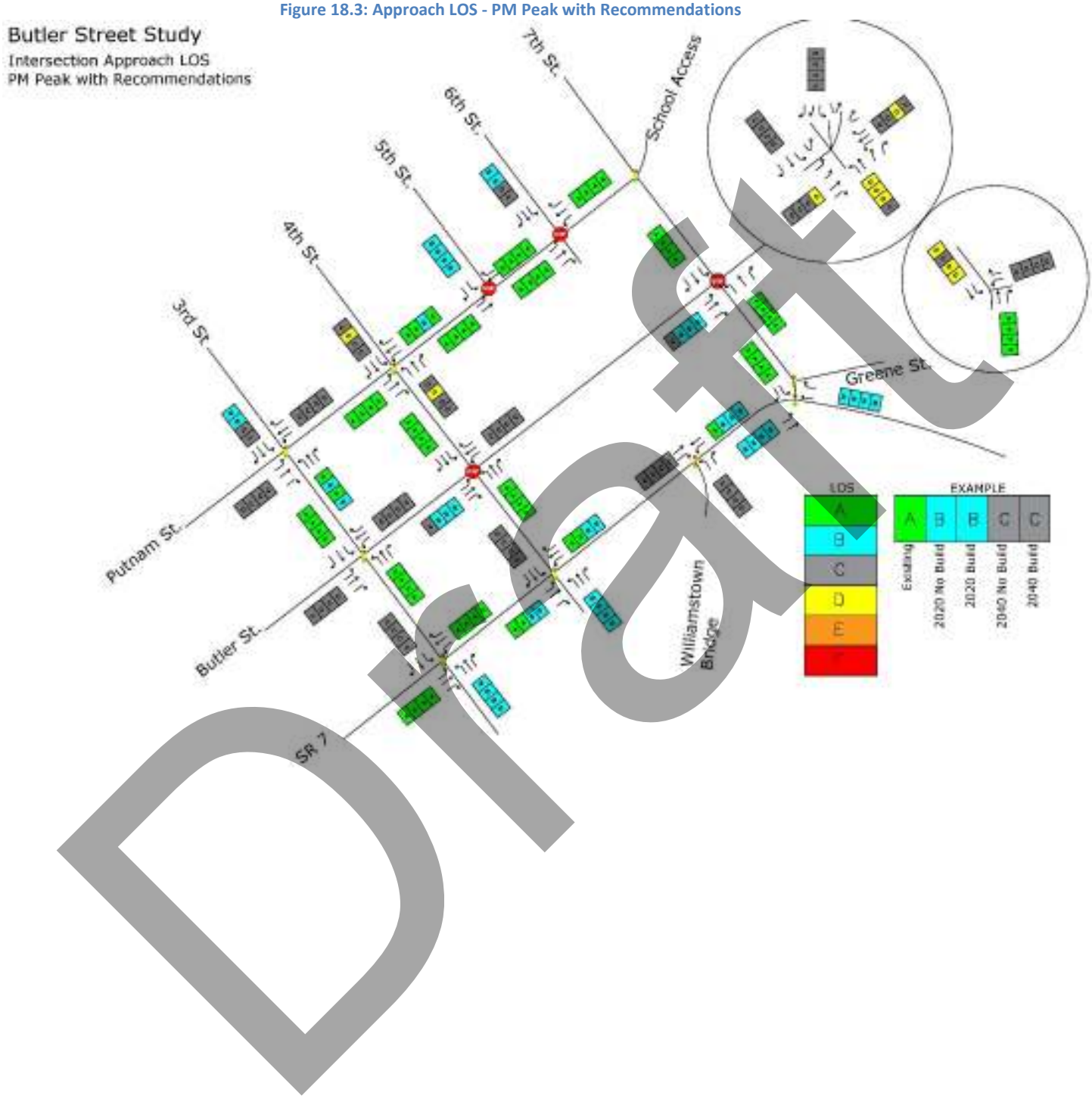
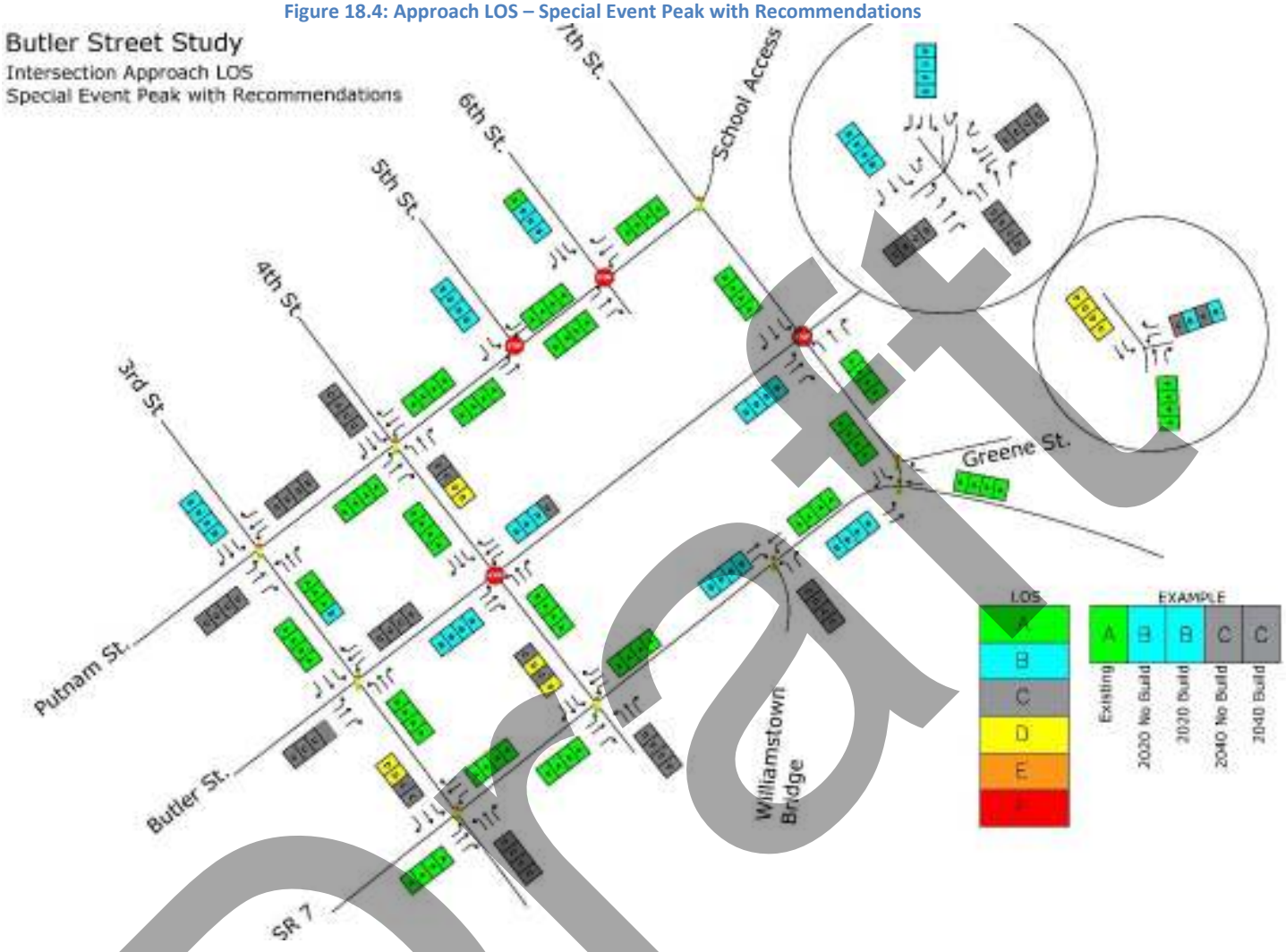


Figure 18.4: Approach LOS – Special Event Peak with Recommendations



19. Summary of Findings

In conclusion, TEC Engineering has presented traffic data and information pertaining to the study area surrounding Marietta College in the City of Marietta, Ohio. This study focused on the impact of the Marietta College Enhancement Plan on the transportation network surrounding the campus. Part of the Enhancement Plan includes closing Butler Street between 4th Street and 7th Street to through vehicles. Access to parking lots will still be available from Butler Street.

The traffic data showed 2,937 vehicles per day on Butler Street between 4th Street and 7th Street. Peak hour (worst-case) traffic volumes were redistributed based upon existing travel patterns collected from Bluetooth data. Assuming growth in the college and new trips coming to and from the campus with Enhancements, new volumes were added to the transportation network in the build model. Transportation network models were created using *Synchro* and *SimTraffic*. Results showed that intersection approach delay changed by less than 4 seconds for most intersection approaches. Multiple approaches resulted in a decrease in delay based upon the volume redistribution.

Various concerns were evaluated and addressed in recommendations including emergency vehicles, flooding, pedestrian safety, and vehicular safety. These concerns as well as general transportation upgrades are summarized in the following table.

Table 19.1: Recommendations

No Build Recommendations	Term Length*	Est. Cost	Build Recommendations	Term Length*	Est. Cost
Install Midblock Pedestrian Flashing Beacon	Short	$40,000	Increase Storage Lane Lengths	Short	$32,000
Increase Storage Lane Lengths	Short	$32,000	Retiming Traffic Signals	Mid	$32,000
General Lane Width Improvements	Short	$120,000	General Lane Width Improvements	Short	$120,000
Retiming Traffic Signals	Mid	$32,000	Implement Special Event Signal Timing Plans	Mid	$32,000
EBR Lane at Williamstown Bridge	Mid	$9,000	EBR Lane at Williamstown Bridge	Mid	$9,000
Repair Butler Street	Long	$580,000	Provide Access for Emergency Vehicles	Mid	$32,600
7th Street and Putnam Improvements	Mid	$112,000	Provide Pre-Emption for Emergency Vehicles	Long	$350,000
			7th Street and Putnam Improvements	Mid	$112,000
			Short (1-2 years), Mid (2-5 years), Long (5+ years)		

"Build" recommendations are to be considered if the Enhancement Plan is implemented. Additional "No Build" recommendations are available in the recommendation section of this study that should be considered to improve safety and capacity throughout the Marietta College study area.

TEC Engineering recommends a temporary closure of Butler Street before a permanent closure to fully examine the effects on the surrounding system and to compare simulation models. There are several reasons to move forward with the temporary closure:

1. Butler Street carries a relatively small volume of traffic.
2. The increased delay at each intersection due to the closure is minor.
3. Minor improvements can alleviate much of the increased delay.

Temporarily closing Butler Street will give the City and residents a chance to evaluate the true impact of diverted traffic on the City's network. If closed temporarily, it should remain closed for a month. The first two weeks will allow for drivers to establish traffic routines. The second half of the temporary closure can be used for analysis. Traffic counts and routing can be collected during that time period to fully analyze the effects of a permanent closure and to make final "build" recommendations if implementation is to occur.

These recommendations come at a high cost. There are potential funding sources available which would aid the City. SR 7 is a Federal Aid Route. This is the only roadway in the study area that is considered a Federal Aid Route; Butler Street is not. For Federal Aid Routes, Federal funds are available through the Congestion Mitigation and Air Quality Improvement Program (CMAQ), Surface Transportation Program (STP) or Highway Safety Plan (HSP) funding sources. The non-federal aid routes that intersect with SR 7 could potentially be covered under these funding sources. For local streets (Butler Street, Putnam Street, 7th Street, etc.), the funding source would be the Ohio Public Works Commission (OPWC). TEC could help the City in the funding application process if any of theses recommendations are considered for implementation.