September 10, 2019

Mr. Christopher Gallagher, P.E.
Foxborough Town Engineer
40 South Street
Foxborough, MA 02035

Re: **Town of Foxborough**
Town Common Traffic Circulation Improvements
Foxborough, Massachusetts
Pare Project No. 19070.00

Dear Mr. Gallagher,

Pare Corporation (Pare) has completed a traffic analysis of the roadway network surrounding the Foxborough Town Common (the Common). On April 10, 2019, Pare met with multiple representatives from the Town of Foxborough (the Town) to discuss traffic issues surrounding the Common. The Town had developed conceptual geometric modifications at several intersections around the Common that they were interested in implementing on a trial basis. Pare was tasked with analyzing the existing traffic conditions surrounding the Common, determining the expected impact the proposed geometric improvements would have on traffic conditions, and developing a plan for the temporary implementation of the proposed geometric modifications.

Additionally, in August 2019, Pare's scope was expanded to include an assessment and review of the potential traffic impacts associated with a proposed development adjacent to the Common at 40 South Street/21 Market Street. The intent of this assessment was to perform an independent review of the proposed development's traffic impacts and determine how they would interact with the proposed geometric modifications at the Common.

This report is divided into three sections. Section 1 discusses the existing traffic conditions of the Common. Included within this section are a summary of the existing traffic operations, the data collection process, review of existing traffic volumes, and an assessment of crash data. Traffic operations at the Common have been modeled to establish existing conditions for comparison to future alternatives.

Under Section 2, future geometric improvements to the Common are evaluated. This section includes a capacity analysis of the intersections surrounding the Common under future build and no-build conditions. Advantages and disadvantages associated with implementation of geometric modifications are discussed and the temporary traffic control plan for trial implementation is developed.

Section 3 includes the evaluation and review of the proposed development at 40 South Street/21 Market Street. This includes trip generation calculations for the proposed development, a capacity analysis of the future condition with and without the geometric improvements at the Common, and a discussion of additional traffic related impacts the development is expected to have on the adjacent roadway network.

Section 1 – Existing Conditions

The Foxborough Town Common is formed by the convergence of seven (7) streets, forming a rotary style layout with two circulating lanes. The Town Common, which is approximately two (2) acres of landscaped park space, is located within the rotary. Parking is also located along the circulating travel lanes in several locations including a combination of parallel and diagonal parking spaces. Study area figures are provided on page 3 and page 4.

Traffic Observations

As part of this traffic assessment, Pare performed traffic observations at the Common during peak traffic periods. The observations focused on gathering information including:

- Areas experiencing congestion and extensive delay
- Vehicle queue lengths
- Driver behavior
- Opportunities for safety improvements

A summary of the field observations is described below:

- Vehicle queues for the southbound approach to the Common on Main Street (Route 140) are extensive throughout the p.m. peak period observations (4:00 p.m. – 5:30 p.m.). Maximum queue lengths at this time stretched approximately 2,400 feet. The delay associated with this approach was also field measured. Travel time from the rear of the queue to the Town Common reaches a maximum of approximately 4 minutes.

- The approach to the Common from Mechanic Street experiences moderate vehicle delay and queue lengths during the p.m. peak period. Field measurements of vehicle queues reached a maximum length of approximately 550 feet (22-vehicles).

- The northbound approach from Central Street (Route 140) entering the Common experiences moderate vehicle delay and queuing during the p.m. peak hour. A maximum vehicle queue of approximately 250 feet (10 vehicles) is typical. The queues at this approach tends to either dissipate or reduce down to one or two vehicles after several minutes.

- No other extensive queue lengths were observed at any other intersection approach, nor did any other approach appear to operate over capacity.

- When traveling through the Common, the majority of drivers utilized the outer travel lane within the rotary as opposed to the inner travel lane. This is likely due to the fact that no entry or exit movements can be made from the inner travel lane and vehicles would be forced to change lanes within a short distance if and when using the inner lane.

PROJECT NO. 19070.00 DATE: SEPTEMBER 2019

FIGURE No. 1

Foxborough Town Common Traffic Circulation Improvements

Study Area Map

Foxborough, MA

PARE CORPORATION
ENGINEERS - SCIENTISTS - PLANNERS
8 BLACKSTONE VALLEY PLACE
LINCOLN, RI 02865
401-334-4100

PROJECT NO. 19070.00 DATE: SEPTEMBER 2019

FIGURE No. 2

Foxborough Town Common Traffic Circulation Improvements

Study Area Map

Foxborough, MA

PARE CORPORATION
ENGINEERS - SCIENTISTS - PLANNERS
8 BLACKSTONE VALLEY PLACE
LINCOLN, RI 02865
401-334-4100

- In general, driver behavior while travelling through the Common is aggressive. Drivers frequently accelerate quickly to enter narrow gaps in the traffic stream when entering the Common. Although vehicle speeds within the Common were not measured, speeds appeared to be relatively high based on visual observation.

- Several traffic calming and pedestrian safety improvements appear to have been implemented at several locations within the Common. These include:
    - A rectangular rapid flash beacon (RRFB) for the pedestrian crossing at Bird Street.
    - Curb bump outs at the pedestrian crossing between Rockhill Street and South Street.
    - Curb bump outs for pedestrian crossings along the east side of the Town Common.
    - Signed and striped pedestrian crosswalks.

- Vehicles entering and exiting the parking spaces alongside the Common did not appear to have a significant impact on traffic within the rotary. However, utilization of the parking spaces was relatively low as only approximately 5 to 10 of the parking spaces were occupied at one time.

Traffic Counts

Existing traffic volume data was collected through turning movement counts (TMCs) at each of the intersections surrounding the Common. TMCs were performed during the morning (7:00 to 9:00 a.m.) and afternoon (4:00 to 6:00 p.m.) peak periods on Wednesday, May 8, 2019 at the following intersections:

- Mechanic Street/Cocasset Street/South Street
- Bird Street/Cocasset Street
- Main Street/School Street/Rockhill Street
- School Street/South Street/Central Street.

The data obtained was used to complete the capacity analysis of these intersections for both the existing conditions and the proposed conditions. Additionally, Automatic Traffic Recorder (ATR) counts were conducted on three roadways surrounding the Common. The ATR data was collected over a 48-hour period from May 7, 2019 through May 8, 2019. The locations collected included:

- Market Street south of Rockhill Street
- Baker Street north of Bird Street
- Railroad Avenue south of Bird Street

The traffic count data collected was evaluated for the potential of seasonal traffic volume fluctuation. The month of May was compared to the 2011 MassDOT Weekday Seasonal Factor Group 6 (urban arterials, collectors, and rural arterials) data. This data indicates that traffic volumes during the month of May are typically higher than the annual average. The May count data was therefore not adjusted to represent average conditions.

Crash Data

Crash data for the roadway network in the vicinity of the project site was requested and received from the Foxborough Police Department for the latest 3-year period (May 2016 through May 2019). Crash data was reviewed to determine the presence of safety concerns within the study area.

According to the data received there were 35 total incidents that occurred in the study area. A total of 32 incidents occurred at or approaching a study area intersection. Of these incidents, five (5) resulted in non-fatal injuries with a total of six (6) injured persons and none resulted in fatal injuries. Two (2) incidents involved bicycles. A breakdown of the incidents by type and number of injuries can be seen below in Table 1.

Table 1: Crash Summary for Study Area Intersections

Intersection	Total Crashes	Crash Severity			Type of Crash				
		Property Damage Only	Non-Fatal Injuries	Fatal Injuries	Angle	Object	Bicycle	Rear-End	Side-Swipe
Main Street (Rte. 140) & Bird Street	14	12	2	0	0	1	0	13	0
Central Street (Rte. 140), South Street, & School Street	8	8	0	0	2	1	0	2	3
Cocasset Street/ Bird Street	1	0	1	0	1	0	0	0	0
Cocasset Street /Mechanic St /South Street	8	6	2	0	4	0	1	2	1
School Street/ Bank of America	1	1	0	0	1	0	1	0	0

Three (3) incidents occurred on study area roadways at unspecified locations within the Common. Of these incidents, none resulted in non-fatal injuries or fatal injuries. A breakdown of the incidents by type and number of injuries can be seen below in Table 2.

Table 2: Crash Summary for Study Area Roadways

Roadway	Total Crashes	Crash Severity			Type of Crash	
		Property Damage Only	Non-Fatal Injuries	Fatal Injuries	Angle	Rear-End
Cocasset Street	2	2	0	0	0	2
School Street	1	1	0	0	1	0

Several trends in the crash data were identified. The most frequent type and location of crashes were rear ends on Main Street (Rte. 140) approaching the Common. The type and frequency of this pattern can be attributed to the frequent congestion experienced on this approach. Rear end collisions are common on high volume intersection approaches that expected frequent congestion due to the stop-and-go nature of traffic.

Another trend observed in the data was rear end crashes that occurred when a vehicle had stopped to allow a pedestrian to cross in a marked crosswalk. Three rear ends, each at a different location in the Common, occurred while a pedestrian was crossing.

Additionally, several side swipe collisions were the result of vehicles attempting to change lanes within the Common when attempting to exit. This crash type occurred at the School Street to Central Street maneuver on three (3) occasions. It also occurred once at the South Street to Mechanic Street maneuver.

Several angle crashes were the result of run stop signs. A run stop sign caused an angle collision twice at the Cocasset Street approach to the intersection and one time each at the Central Street (Rte. 140), South Street, and Mechanic Street approaches.

It should also be noted that two collisions with bicyclists were reported. No bicycle accommodations are provided through the Common and the Common is generally difficult to navigate on a bicycle. One bicycle crash occurred while a bicyclist was riding on the sidewalk at the Bank of America driveway with the second occurred when a bicyclist was struck in the marked crosswalk at the Cocasset Street approach to the Common.

Existing Capacity Analysis

A capacity analysis was completed for the existing a.m. peak hour and p.m. peak hour conditions. Capacity analysis characterizes intersections based on their level of service (LOS). LOS is a quality measure describing operational conditions within a traffic stream, generally in terms of service measures such as speed, travel times, traffic interruptions, etc. As described in the Highway Capacity Manual (HCM), six LOS are defined for each type of facility, from A to F, with A representing the best operating condition and F representing the worst operating condition. LOS at intersecting streets is determined by vehicle delay in the amount of delay in seconds per vehicle. The LOS criteria for unsignalized intersections are provided in Table 3 below.

Table 3: LOS Criteria for Unsignalized Intersections

	Unsignalized Intersections
LOS	Delay Time (sec/veh)
A	0-10
B	> 10-15
C	> 15-25
D	> 25-35
E	> 35-50
F	> 50

There are several methodologies that can be used to calculate vehicle delay. In general, these methodologies can be split into two groups: macroscopic and microscopic. Macroscopic methodologies use a set of standardized calculations developed from empirical data to establish vehicle delay and LOS. The most common macroscopic methodology used are those found in the HCM. Microscopic methodologies simulate traffic conditions using software to obtaining data from each individual simulated vehicle to calculate average vehicle delay at each intersection as the vehicle travels through the modeled network. Microscopic analyses require the roadway network to be model and calibrated to assure accurate results.

Each methodology has advantages and disadvantages associated with them, making one analysis method preferable over another given various characteristics of the intersection(s) being analyzed and the purpose of the study. Given complex and unique nature of the intersections and traffic movements through the Common, an analysis of traffic conditions utilizing Sim Traffic, a microscopic traffic simulation software, was conducted. Table 4 shown below summarizes the capacity analysis results for existing conditions for the a.m. peak hour and p.m. peak hour. The traffic model generated was calibrated to match field observed queue lengths.

Table 4: Capacity Analysis Results – 2019 Existing Conditions

Approaching Street	Morning Peak Hour			Afternoon Peak Hour		
	LOS	Delay[1]	Queue Length[2]	LOS	Delay[1]	Queue Length[2]
South Street	A	8.6	93	A	8.1	70
Central Street (Rte. 140)	D	31.4	517	B	12.4	57
Cocasset Street	E	45.7	286	D	32.7	232
Mechanic Street	A	7.3	95	F	84.0	943
Bird Street	B	16.7	95	E	47.3	228
Main Street (Rte. 140)	A	6.8	185	F	535	2,276
Rockhill Street	A	1.1	15	A	1.2	5

1. Delay is measured in seconds per vehicle.
2. Queue Length shown represents the 95th percentile queue length in feet.

As indicated in the results shown in Table 4 above, and confirmed with field observation, the most significant delay experiences at the intersection surrounding the Common are during the p.m. peak period. The southbound approach to the Common from Main Street (Rte. 140) experiences the greatest delay, operating well over capacity. Additionally, the westbound approach to the Common from Mechanic Street experiences significant delay and operates above capacity during the p.m. peak hour.

Section 2 – Proposed Geometric Improvements

The Town of Foxborough has expressed interest in pursuing geometric modifications to several of the intersection surrounding the Common in an attempt to improve vehicular circulation and reduce vehicle delay. Based on coordination between Pare and the Town, the improvements that the Town wishes to pursue primarily involve the addition of the traffic splitter islands at several intersection approaches and converting two roadways that intersect the Common into one-way roadways. The specific details of the proposed improvements are detailed below.

Main Street (Rte. 140)/Bird Street/Rockhill Street

The intersection of Main Street (Rte. 140) with Rockhill Street/Bird Street currently experience the greatest vehicle delay of all approaches to the Common, particularly during the p.m. peak period. As noted in the observations section of this report, the southbound queue approaching the common typically reach 2,000 feet during the typical weekday afternoon. This queue results from southbound drivers entering the Common being unable to find gaps in the traffic stream circulating the Common. Drivers circulating the Common tend to utilize the outer travel lane as opposed to evenly dispersing between the two circulating lanes. This leads to fewer available gaps to southbound drivers to enter the Common. Additionally, it can be difficult for a southbound driver to determine whether a vehicle circulating the Common is exiting to continue on Main Street (Rte. 140) northbound, or continuing through the Common. This leads to drivers missing potential gaps in the travel stream and extended vehicle delay. This can partially be attributed to the intersection geometry but also in part to drivers' lack of turn-signal usage.

The proposed improvement at this intersection splits the two lanes circulating the Common into a right-only lane and a through lane. The southbound movement into the Common would then enter into its own lane,

minimizing conflict with vehicles circulating the Common and thus reducing southbound vehicle delay. This modification is also anticipated to allow southbound drivers entering the common to better judge when vehicles are departing the Common.

To accomplish this geometric modification, the entrance to Rockhill Street from the Common would require closure and Rockhill Street would be converted to one-way, entering the Common only. This is required to eliminate the potentially hazardous weave from a vehicle circulating on the inner lane of the Common attempting to enter Rockhill Street. A driver attempting this maneuver would cut directly in front of southbound vehicle entering the Common with no vehicle controls in place.

Additionally, the Town is interested in converting Bird Street from a two-way roadway to one-way, away from the Common only. Closing Bird Street's access to the Common would eliminate the potential movement of a vehicle from Bird Street, across two lanes of traffic and into the inner lane of the Common. Bird Street traffic would most likely utilize Railroad Avenue and Mechanic Street to access the Common.

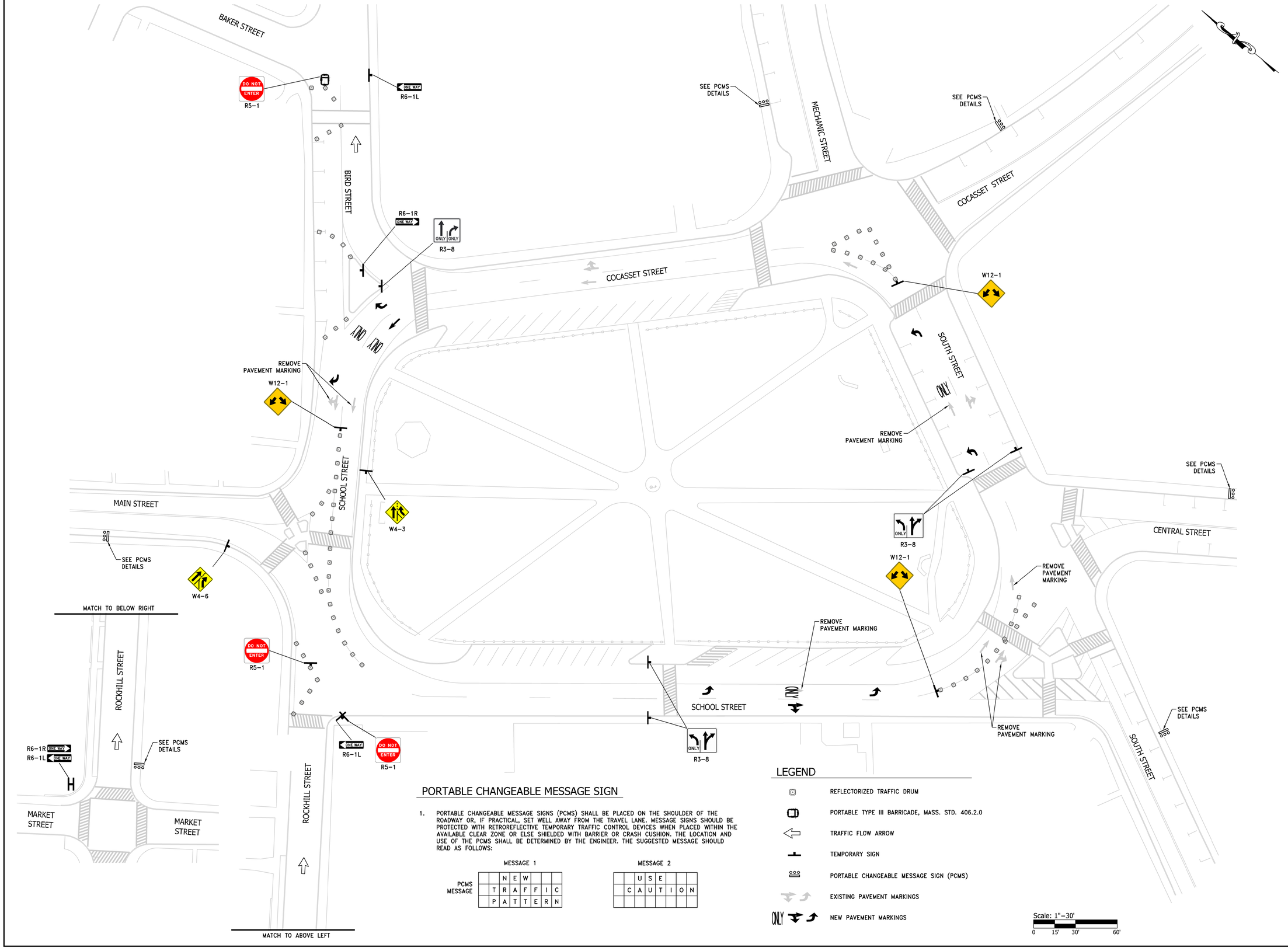
School Street/South Street/Central Street (Rte. 140)

The proposed improvements at School Street, South Street, and Central Street (Rte. 140) include the introduction of the splitter island on the southbound approach on School Street. The splitter island would split the two lanes that approach south street into a left lane (continuing through the Common) and a through lane (continuing onto Central Street). It is expected that this geometric modification would help reduce vehicle delay associated with the northbound approach from Central Street (Rte. 140). Similar to the condition at the Main Street (Rte. 140) approach to the Common, drivers can occasionally have difficulty determining when there will be an appropriate gap in traffic due to the geometry of the roadway and some drivers' lack of turn-signal usage. The addition of the splitter island physically forces vehicles into an assigned lane, eliminating the question of whether an oncoming vehicle will exit the Common or continue through.

South Street/Cocasset Street/Mechanic Street

The proposed improvements at South Street, Cocasset Street and Mechanic Street also include the introduction of a splitter island. An island on the South Street approach would split the two approaching lanes into a left-turn only lane and through/right lane. Similar to the other proposed locations, the introduction of the islands would allow vehicles attempting to enter the Common from Cocasset Street and Mechanic Street to better anticipate driver movements through the Common, more easily identify gaps in the traffic stream, and reduce vehicle delay entering the Common.

Based on coordination with the Town, there is an interest in pursuing these geometric modifications as a trial, utilizing temporary traffic control devices (barrels, cones, signing & striping) to revise traffic patterns. The trial would be in place for several weeks. Data and observations of the revised traffic would be collected and used to determine if these modifications should be permanently implemented. The temporary traffic control plan for the proposed intersection modifications has been provided in Figure 3.



PORTABLE CHANGEABLE MESSAGE SIGN

1. PORTABLE CHANGEABLE MESSAGE SIGNS (PCMS) SHALL BE PLACED ON THE SHOULDER OF THE ROADWAY OR, IF PRACTICAL, SET WELL AWAY FROM THE TRAVEL LANE. MESSAGE SIGNS SHOULD BE PROTECTED WITH RETROREFLECTIVE TEMPORARY TRAFFIC CONTROL DEVICES WHEN PLACED WITHIN THE AVAILABLE CLEAR ZONE OR ELSE SHIELDED WITH BARRIER OR CRASH CUSHION. THE LOCATION AND USE OF THE PCMS SHALL BE DETERMINED BY THE ENGINEER. THE SUGGESTED MESSAGE SHOULD READ AS FOLLOWS:

PCMS MESSAGE	MESSAGE 1	MESSAGE 2
	NEW	USE
	TRAFFIC	CAUTION
	PATTERN	

LEGEND

- REFLECTORIZED TRAFFIC DRUM
- PORTABLE TYPE III BARRICADE, MASS. STD. 406.2.0
- TRAFFIC FLOW ARROW
- TEMPORARY SIGN
- PORTABLE CHANGEABLE MESSAGE SIGN (PCMS)
- EXISTING PAVEMENT MARKINGS
- NEW PAVEMENT MARKINGS

Scale: 1"=30'
0 15' 30' 60'

PARE
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8 BLACKSTONE VALLEY PLACE
LINCOLN, RI 02865
401-334-4100

SCALE ADJUSTMENT GUIDE
0" 1"
BAR IS ONE INCH ON ORIGINAL DRAWING

Town of Foxborough
Common Circulation Improvements
Foxborough, Massachusetts

REVISIONS:

PROJECT NO.:	19070.00
DATE:	MAY 2019
SCALE:	1" = 30'
DESIGNED BY:	TT
CHECKED BY:	TT
DRAWN BY:	AWB
APPROVED BY:	JPS

DRAWING TITLE:
TEMPORARY TRAFFIC CONTROL PLAN

DRAWING NO.: C1.0

SHEET NO. 1 OF 1

A future scenario where the geometric improvements described above were implemented was then established. This scenario included extrapolating traffic volumes from existing (2019) to future (2026) traffic volumes and analyzing roadway geometric conditions with the proposed modifications. A seven-year future time frame was established based on MassDOT Standards. Additionally, traffic was redistributed to account for the modification of Rockhill Street and Bird Street from two-way to one-way.

To determine future (2026) traffic volumes, an annual background growth rate was determined and applied to existing traffic volumes. Pare obtained 2014 traffic volumes for all intersections surrounding the Common. These 2014 traffic volumes were then compared to the 2019 traffic volumes collected under this study. The results of the comparison indicated that traffic volumes increase approximately 1% annually between 2014 and 2019. Therefore, a 1% annual growth was applied to project future (2026) traffic volumes from existing (2019) traffic volumes.

With the conversion of Rockhill Street to one-way entering the Common only, all traffic that currently enters Rockhill Street from the Common was redirected to Market Street. Additionally, with the conversion of Bird Street to one-way, all traffic that currently enter the Common from Bird Street was redirected to Railroad Avenue and Mechanic Street.

A capacity analysis was then completed for two future scenarios including a Future (2026) No-Build scenario and a Future (2026) Build – Geometric Improvements. The results for the future scenarios are shown in Table 5 and Table 6 and compared to existing conditions.

Table 5: AM Peak Hour Capacity Analysis Results – 2019 Existing Conditions vs. 2026 Future Conditions

	Existing (2019)			Future (2026) No-Build			Future (2026) Geometric Improvements		
Approaching Street	LOS	Delay[1]	Queue Length[2]	LOS	Delay[1]	Queue Length[2]	LOS	Delay[1]	Queue Length[2]
South Street	A	8.6	93	B	10.1	96	B	106	106
Central Street (Rte. 140)	D	31.4	517	F	106.9	1,334	F	163.1	2,196
Cocasset Street	E	45.7	286	F	127.2	538	C	15.6	23
Mechanic Street	A	7.3	95	A	9.1	114	A	6.5	161
Bird Street	B	16.7	95	C	20.5	104	-	-	-
Main Street (Rte. 140)	A	6.8	185	A	9.0	237	A	6.8	10
Rockhill Street	A	1.1	15	A	1.1	10	A	1.3	10

1. Delay is measured in seconds per vehicle.
2. Queue Length shown represents the 95th percentile queue length in vehicles.

Table 6: PM Peak Hour Capacity Analysis Results – 2019 Existing Conditions vs. 2026 Future Conditions

Approaching Street	Existing (2019)			Future (2026) No-Build			Future (2026) Geometric Improvements		
	LOS	Delay[1]	Queue Length[2]	LOS	Delay[1]	Queue Length[2]	LOS	Delay[1]	Queue Length[2]
South Street	A	8.1	70	A	8.8	69	F	51.0	114
Central Street (Rte. 140)	B	12.4	57	B	14.6	204	F	51.0	254
Cocasset Street	D	32.7	232	F	66.9	438	B	10.7	108
Mechanic Street	F	84.0	943	F	236.0	2,221	F	486.7	4,806
Bird Street	E	47.3	228	F	54.7	84	-	-	-
Main Street (Rte. 140)	F	535	2,276	F	680	3,041	A	0.4	4
Rockhill Street	A	1.2	5	A	1.2	5	A	1.3	5

1. Delay is measured in seconds per vehicle.
2. Queue Length shown represents the 95th percentile queue length in vehicles.

As shown in the results above, there are several approaches to the Common that experience a reduction in delay associated with the revised traffic patterns. The most significant improvement is at the southbound approach to the Common from Main Street (Rte. 140). This movement operates at LOS 'F' during the p.m. peak hour under existing conditions and Future (2026) No-Build Conditions. Under the revised intersection configuration, the approach improves to LOS 'A'. This is primarily due to the removal of the existing yield control at this approach. Vehicles approaching the Common from Main Street are freely able to enter the outer lane of the Common without yielding to another vehicle circulating through the Common.

Additionally, there is an improvement in LOS for Cocasset Street during the a.m. peak hour and p.m. peak hour. The revised configuration at this intersection reduces the number of conflicts a driver entering the Common from Cocasset Street contends with, increasing the availability of gaps in the traffic stream.

While the approaches discussed above achieve an improvement in LOS under the proposed condition, the LOS associated with several other approaches worsens. Most notably, the westbound approach from Mechanic Street experiences a significant increase in delay. With the conversion of Bird Street to one-way exiting the Common only, the volume entering the Common at Mechanic Street increased significantly. It was assumed that the traffic that currently enters the Common from Bird Street would be diverted to Railroad Avenue then enter the Common from Mechanic Street. This increase in volume on Mechanic Street strains an approach to the Common that already experiences significant delay. While the proposed geometric modifications are targeted at improving the capacity of this intersection, the additional volume on Mechanic Street appears to eliminate any potential benefits.

The northbound approach from Central Street (Rte. 140) also worsens under the proposed condition. This is likely due to the fact that the proposed condition concentrates eastbound vehicles from South Street into one lane.

While the analysis performed for the proposed condition shows a reduction in vehicle delay for several approaches to the Common, potential safety implications of the revised intersection geometry must also be considered. The implementation of the revised intersection geometries at the Common intersection would result in a significant increase in vehicle weaving activity within the rotary. Pare acknowledges that there is

currently weaving or lane-changing activity that occurs within the rotary, however, any existing weaving that occurs is voluntary and not required for any combination of entry point and exit point. The underutilization of the inner travel lane in the rotary is evidence that drivers generally feel comfortable driving in the outer travel lane throughout the rotary for simplicity and in order to avoid changing lanes. Under the current geometry, a vehicle can enter and exit anywhere at the rotary without leaving the outer travel lane. Under the revised intersection configurations, vehicles will be forced to change lanes twice for many paths through the rotary.

There are several traffic safety concerns associated with forcing vehicles to weave within the rotary. The most significant concern is the potential for increasing sideswipe crashes within the rotary. The lane changing would be forced to occur within short distances under heavy volumes, a combination reduces driver reaction time and force quick decision making, which can ultimately lead to sideswipe crashes. Under the reconfiguration alternative, there are three locations where the forced weave movement occurs: (1) School Street between Rockhill Street and South Street (~350 feet), (2) South Street between Central Street (Rte. 140) and Cocasset Street (~130 feet), and (3) Cocasset Street between Mechanic Street and Bird Street (~250 feet).

The addition of the forced weaving maneuvers may also have an impact on pedestrian safety within the Common. When performing the weaving maneuver, drivers' attention is likely inclined to be focused on the lane changing activity, reducing their awareness of pedestrian activity or crossings within the Common. While crosswalk locations can be repositioned away from the area requiring weaving, this may limit crossing options, thus reducing pedestrian connectivity through the Town Common.

The addition of the weave in areas where on-street parking is permitted may also present some concerns. The weave section on South Street is located in an area with parallel parking on both sides. This may present additional conflicts between drivers exiting parking spaces and weaving vehicles. A driver exiting the parking space could attempt to pull into the rotary expecting an approaching vehicle to remain in its lane, only to find that vehicle has been forced to weave into the adjacent lane.

Section 3 – Proposed Development at 40 South Street/21 Market Street

An independent assessment of the potential traffic impacts associated with the proposed development at 40 South Street/21 Market Street has also been prepared. Pare understands that a mixed-use development is currently proposed, consisting of 4,600 sf brew pub/restaurant and 19 residential units. This assessment of the proposed development includes development of trip generation calculations for the development and an assessment of the future traffic impacts associated with the development with and without the proposed geometric improvements throughout the Common.

The proposed site location is on the southeast side of Rockhill Street, between Market Street and School Street. Access to and egress from the site are expected to occur via two driveways accessing Rockhill Street approximately 125 feet northeast of Market Street and Market Street approximately 40 feet southeast of Rockhill Street.

Trip Generation & Distribution

Trip generation for the proposed development was completed using the industry standard Institute of Transportation Engineers (ITE) *Trip Generation, 10th Edition*. The proposed development was analyzed with Land Use Code (LUC) 220, Multifamily Housing and LUC 932, High Turnover Restaurant. Based on coordination with the Town, the brew pub is not expected to be open during the weekday a.m. peak hour. However, to provide a conservative analysis, traffic volumes associated with the brew pub were calculated for the a.m. peak hour and included in the analysis.

A summary of the trips generated by the development is provided in Table 7.

Table 7: Trip Generation Summary

Land Use		Weekday, AM Peak Hour	Weekday, PM Peak Hour	Weekday 24-Hour Total
LUC 220 – Multifamily Housing (19 Units)	Entering	3	8	70
	Exiting	8	5	70
	Total	11	13	140
LUC 932 – High Turnover Restaurant (134 seats)	Entering	47[1]	51	289[2]
	Exiting	32[1]	47	289[2]
	Total	79[1]	98	578[2]
Site Total	Entering	50	59	359
	Exiting	48	52	359
	Total	98	111	718

1. These values will be significantly lower if the Brew Pub is not open for business during the morning.
2. These values may be lower if the Brew Pub is not open for business during the morning.

Trips generated by the proposed development were distributed throughout the existing traffic roadway network based on the existing travel patterns. Given that the site driveways are proposed on Rockhill Street and Market Street, all site traffic was anticipated to enter and exit via these driveways. This assumption presents the most conservative approach for assessing impacts to Rockhill Street and Market Street. However, it is acknowledged that a portion of the traffic access the brew pub will likely utilize on street parking, including spaces within the interior of the Common, never traveling on Rockhill Street and Market Street.

Capacity Analysis

A capacity analysis was then run for the two future scenarios with the proposed development. One analysis was conducted with the additional traffic volumes on the existing intersection geometry throughout the Common. The second analysis was conducted with the additional traffic volumes incorporated into the Common intersections with the proposed geometric improvements in place. The results of the analysis are summarized in Table 8 and Table 9 and shown alongside the results of the previous analyses.

Table 8: AM Peak Hour Capacity Analysis Results – 40 South Street/21 Market Street Comparison

	Existing (2019)			Future (2026) No-Build			Future (2026) Geometric Improvements Only			Future (2026) Development Only Improvements			Future (2026) Development & Geometric Improvements		
Approaching Street	LOS	Delay[1]	Queue Length[2]	LOS	Delay[1]	Queue Length[2]	LOS	Delay[1]	Queue Length[2]	LOS	Delay[1]	Queue Length[2]	LOS	Delay[1]	Queue Length[2]
South Street	A	8.6	93	B	10.1	96	B	106	106	B	10.9	96	B	11.5	106
Central Street (Rte. 140)	D	31.4	517	F	106.9	1,334	F	163.1	2,196	F	88.0	1,148	F	159.7	2,193
Cocasset Street	E	45.7	286	F	127.2	538	C	15.6	23	F	296.2	1,260	B	14.3	189
Mechanic Street	A	7.3	95	A	9.1	114	A	6.5	161	A	9.6	119	A	8.2	120
Bird Street	B	16.7	95	C	20.5	104	-	-	-	C	22.3	113	-	-	-
Main Street (Rte. 140)	A	6.8	185	A	9.0	237	A	6.8	10	A	11.5	291	A	6.6	10
Rockhill Street	A	1.1	15	A	1.1	10	A	1.3	10	A	1.3	10	A	1.3	10

3. Delay is measured in seconds per vehicle.
4. Queue Length shown represents the 95th percentile queue length in vehicles.

Table 9: PM Peak Hour Capacity Analysis Results – 40 South Street/21 Market Street Comparison

	Existing (2019)			Future (2026) No-Build			Future (2026) Geometric Improvements			Future (2026) Development Only Improvements			Future (2026) Development & Geometric Improvements		
Approaching Street	LOS	Delay[1]	Queue Length[2]	LOS	Delay[1]	Queue Length[2]	LOS	Delay[1]	Queue Length[2]	LOS	Delay[1]	Queue Length[2]	LOS	Delay[1]	Queue Length[2]
South Street	A	8.1	70	A	8.8	69	F	79.0	114	A	8.7	73	F	63.5	345
Central Street (Rte. 140)	B	12.4	57	B	14.6	204	D	29.5	254	B	14.8	216	E	38.2	351
Cocasset Street	D	32.7	232	F	66.9	438	B	10.7	108	F	56.0	343	B	10.7	105
Mechanic Street	F	84.0	943	F	236.0	2,221	F	486.7	4,806	F	271.1	2,369	F	540.6	6,205
Bird Street	E	47.3	228	F	54.7	84	-	-	-	F	77.6	353	-	-	-
Main Street (Rte. 140)	F	535	2,276	F	680	3,041	A	0.4	4	F	829	3,642	A	0.4	4
Rockhill Street	A	1.2	5	A	1.2	5	A	1.3	5	A	1.4	8	A	1.5	5

1. Delay is measured in seconds per vehicle.
2. Queue Length shown represents the 95th percentile queue length in vehicles.

In general, the traffic volumes generated by the proposed development are not anticipated to have a significant impact on the future roadway network through the Common. The results of the analysis indicate that delay at the intersections surrounding the Common with the proposed development is comparable to the same geometric condition without the development. The introduction of traffic associated with the proposed development increases delay, however, does not exacerbate capacity constraints in the future.

Traffic volumes on Rockhill Street and Market Street are expected to increase as a result of the proposed development. Tables 10 through Table 13 below summarizes the traffic volumes on Rockhill Street and Market Street and the anticipated traffic volume increase associated with the proposed development. Table 10 and Table 11 summarize the increases in traffic volume with the existing intersection geometric layout, including Rockhill Street as a two-way roadway. Table 12 and Table 13 summarize the increase in traffic volumes with Rockhill Street as a one-way roadway with traffic traveling into the Common only.

Table 10: Traffic Volume Summary- Rockhill Street Two-way-AM Peak Hour

	Future No-Build AM Peak Hour Volume		AM Peak Hour Volume Generated by Proposed Development		Total AM Peak Hour Future Volume	
	EB/NB	WB/SB	EB/NB	WB/SB	EB/NB	WB/SB
Rockhill Street	8	14	31	28	39	32
Market Street	21	21	27	4	48	25

Table 11: Traffic Volume Summary- Rockhill Street Two-way-PM Peak Hour

	Future No-Build PM Peak Hour Volume		PM Peak Hour Volume Generated by Proposed Development		Total Future PM Peak Hour Volume	
	EB/NB	WB/SB	EB/NB	WB/SB	EB/NB	WB/SB
Rockhill Street	21	31	42	38	63	69
Market Street	28	69	21	10	49	79

Table 12: Traffic Impact Summary-Rockhill Street as One-way-AM Peak Hour

	Future No-Build AM Peak Hour Volume		AM Peak Hour Volume Generated by Proposed Development		Total AM Peak Hour Future Volume	
	EB/NB	WB/SB	EB/NB	WB/SB	EB/NB	WB/SB
Rockhill Street	8	0	31	0	39	0
Market Street	35	21	56	4	91	25

Table 13: Traffic Impact Summary-Rockhill Street as One-way-PM Peak Hour

	Future No-Build PM Peak Hour Volume		PM Peak Hour Volume Generated by Proposed Development		Total Future PM Peak Hour Volume	
	EB/NB	WB/SB	EB/NB	WB/SB	EB/NB	WB/SB
Rockhill Street	21	0	42	0	63	0
Market Street	59	69	59	10	118	79

As indicated in the tables above, the proposed development is expected to significantly increase traffic volume on Rockhill Street and Market Street. However, traffic volumes on both Rockhill Street and Market Street are low under existing conditions. While traffic volumes are expected to increase on the roadways, it is our opinion that the traffic volume increase on Rockhill Street and Market Street can be accommodated by the existing roadways. It should also be noted that the volumes shown in the tables above assume all traffic entering and exit the site will use Rockhill Street and Market Street. It is expected that the volumes will be slightly lower as a portion of traffic visiting the brew pub will utilize parking on the Common.

CONCLUSIONS & RECOMMENDATIONS

Upon completion of the analysis of the Common several conclusions and recommendations can be made.

- Under existing conditions, the two approaches to the Common that experience the most significant delay include the southbound approach from Main Street (Rte. 140) and the westbound approach from Mechanic Street during the p.m. peak period. The delay associated with the southbound approach from Main Street is extensive, with existing queue lengths in excess of 2,000 feet. The delays associated with Mechanic Street are not as severe, however, this approach to the Common operates above capacity during the p.m. peak hour.

- Several trends in the crash history of the Common were identified including the following:
    - Rear end collisions on Main Street (Rte. 140) entering the common
    - Sideswipe collisions involving vehicles changing lanes when attempting to exit the Common rotary from an inside lane.
    - Rear end collisions occurring while pedestrians are actively crossing
    - Run stop sign resulting in broadside collisions
    - Motor vehicle versus bicycle collision when a bicyclist is in a protected pedestrian zone (sidewalk & crosswalk)

- Multiple driver behavior characteristics were observed throughout the Common. Several of the key observations include:
    - Drivers' tendency to utilize the outer travel lane to allow for easier departure from the Common.
    - Lack of turn-signal use indicating departure from the Common
    - Aggressive driving and willingness to accept shorter than typical gaps when entering the Common.

- Based on the results of the analysis of the proposed geometric improvements several conclusions can be made:
    - The proposed geometric improvements significantly improve conditions for the southbound approach to the Common from Main Street (Rte. 140). This can be attributed to the fact the southbound movement is allowed free movement into the Common.
    - The conversion of Bird Street to one-way is expected to increase traffic volume entering the Common from Mechanic Street. This is expected to increase delay for the Mechanic Street approach to the Common.
    - The proposed geometric modifications at School Street, South Street and Central Street (Rte. 140) do not appear to reduce delay based on the results of the traffic analysis.

- The addition of traffic associated with the proposed development at 40 South Street /21 Market Street is not anticipated to have significant impact to the traffic conditions at the Common under the existing roadway geometry or the proposed modifications. The proposed development will increase traffic volumes on Rockhill Street and Market Street. However, given the low volume of traffic on these roadways under existing conditions, the additional traffic generated by the development can be accommodated by the existing roadways.

Recommendations

- Implementation of a trial of the proposed improvements at the Main Street (Rte. 140), Rockhill Street, and Bird Street intersection is recommended with one modification. It is recommended that Bird Street remain two-way given the anticipated impact to Mechanic Street. During the p.m. peak hour, 175 vehicles currently enter the Common from Bird Street. If this entrance to Common is closed, these vehicles will be forced to find a new route to enter the Common rotary. While some drivers may use Baker Street, it is anticipated that the majority will use Railroad Avenue and enter the Common from Mechanic Street. The Mechanic Street approach is over capacity during the p.m. peak hour under existing conditions. An influx of additional traffic during this time period is expected to further increase delay.

  It is understood that the conversion of Bird Street to one-way away from the Common only was to eliminate the movement where a vehicle entering the Common from Bird Street is forced to cross the outer lane of the Common to reach the inner lane if wishing to continue around the rotary. It is our opinion that this movement can be performed safely and does not warrant the conversion of Bird Street to one-way given the potential impact it could have on Mechanic Street.

  The modification of Rockhill Street to one-way is expected to have far less impact than converting Bird Street to one-way would have. During the p.m. peak hour, only 20 vehicles currently enter the Common from Rockhill Street. With the conversion of Rockhill to one-way, it is expected that these vehicles will use Market Street and South Street to enter the Common. The redistribution of 20 vehicles to Market Street is not expected to have a significant impact to the intersection surrounding the Common.

  It should be noted that this modification will increase weaving maneuvers for vehicles traveling through the Common which can lead to an increase in sideswipe collisions. Pare recommends traffic behavior and crash patterns be strictly monitored during the trial implementation period to mitigate any crash pattern that may develop.

- Implementation of the temporary trial of geometric modification at School Street, South Street, and Central Street (Rte. 140) is not immediately recommended in conjunction with the modifications at the Main Street (Rte. 140) approach. Based on the results of the analysis, the geometric modifications at this location are not expected to significantly improve operations and decrease delay. Additionally, it should be noted that the approaches to the Common in this area (South Street and Central Street (Rte. 140)) do not currently experience significant delays.

  The introduction of the geometric modifications at this location will also significantly increase vehicle weaving on School Street. As previously noted, an increase in vehicle weaving can lead to an increase in sideswipe collisions. Pare recommends a trial of geometric improvement at this location only be considered after a successful implementation of the revised geometry at Main Street (Rte. 140)

- The implementation of the temporary trial of geometric improvements at South Street, Cocasset Street, and Mechanic Street is recommended. While the results of the analysis indicated significant delay at this location for the Mechanic Street approach, that can primarily be attributed to the increase in volume from converting Bird Street to one-way.

- Installation of additional traffic calming and pedestrian safety measures can be considered. Several of these measures include:
    - Additional RRFB at existing crosswalk location(s).
    - Install pedestrian crossing warning signage at existing crosswalk locations.
    - Consider "PED X-ING" pavement marking at major pedestrian crossing locations.

We are available to discuss this report with you at your convenience. Please feel free to contact me or Tim Thomson if you have any questions or need additional information.

Sincerely,

John Shevlin, P.E.
Senior Vice President

JPS/TT