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June 5, 2014

Paul LeBeau
Town Administrator
Town of Holliston
703 Washington Street
Holliston, MA, 01746

RE: Holliston Washington Street Corridor
Additional Analysis

Dear Mr. LeBeau:

As a result of discussions at a meeting with town officials and citizens on April 17, 2014, McMahon was asked to evaluate several alternatives for the Washington Street Corridor project. The alternatives include:

- Alternative A: Providing concurrent pedestrian phasing at the study area intersections
- Alternative B: Providing one through lane on Washington Street (Route 16/126) northbound. This would allow for additional parking along Washington Street (Route 16/126) to be maintained.
- Alternative C: Providing a protected northbound left turn phase at the intersection of Washington Street (Route 16/126) at Hollis Street.

Previously, McMahon submitted a Conceptual Design Report to the town for the Holliston Washington Street Corridor project. The preferred alternative shown in the report incorporated exclusive pedestrian phasing, an additional northbound through lane through a portion of the corridor, and permissive left turns at the intersection of Washington Street (Route 16/126) at Hollis Street. See attached graphic, labeled Alternative 1 – Modified Lane Usage.

The alternatives are described below.

<u>Alternative A</u>
This alternative investigates the use of concurrent pedestrian signal phasing. The prior alternatives included exclusive pedestrian signal phasing. Exclusive pedestrian phasing had been proposed to prioritize pedestrian safety, and due to the unique signal phasing at the intersections of Washington Street (Route 16/126) at Central Street and Washington Street at Green Street/Exchange Street. These two intersections would be controlled by a single traffic controller, and exclusive pedestrian phasing was proposed to minimize conflicts between

vehicles and pedestrians and enhance pedestrian safety. For concurrent pedestrian phasing, pedestrians would cross the minor approaches when the northbound and southbound Washington Street (Route 16/126) traffic is running.

The westbound approach from Central Street and the eastbound and westbound phase from Green Street and Exchange Street currently operate on split phasing. Pedestrians would cross Washington Street (Route 16/126) at Central Street at the crosswalk to the north of the intersection when the Central Street approach is running. The right turns from Central Street will need to yield to pedestrians in the crosswalk. Pedestrians will cross Washington Street (Route 16/126) at Green Street/Exchange Street at the crosswalk to the south of the intersections when the Green Street and Exchange Street approaches are running. Movements from these approaches turning south will have to yield to pedestrians in the crosswalk. For this alternative, the minimum times for each phase have increased to allow adequate time for a pedestrian to cross the roadway. The capacity analysis results are shown in Table 1 below.

Table 1: Alternative A Capacity Analysis Comparison Summary

			Preferred Alternative						Alternative A					
			Weekday AM			Weekday PM			Weekday AM			Weekday PM		
Intersection	Movement		LOS[1]	Delay[2]	V/C[3]	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C
Washington Street (Route 16/126)	EB	L	E	75.4	0.88	F	115.6	0.99	E	75.9	0.85	E	64.2	0.69
at Hollis Street/Charles Street		R	C	21.3	0.59	F	82.6	0.83	C	28.5	0.61	D	42.8	0.88
	NB	L	A	5.4	0.54	E	63.4	0.95	A	6.3	0.54	F	88.0	0.97
		TR	B	19.4	0.91	A	5.2	0.56	C	23.0	0.90	B	11.1	0.58
	SB	L	A	3.7	0.04	A	1.7	0.02	A	4.2	0.04	A	6.7	0.02
		TR	A	7.7	0.61	D	44.4	0.95	A	8.3	0.60	F	100.4	1.15
	Overall		B	19.8		D	44.4		C	22.3		E	64.2	
Washington Street (Route 16/126)	WB	LR	F	105.2	1.01	E	66.1	0.94	C	32.0	0.75	E	56.8	0.83
at Central Street	NB	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		R	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		TR	A	1.7	0.62	A	2.8	0.62	A	2.2	0.61	A	1.0	0.44
	SB	L	C	20.3	0.56	B	17.5	0.56	D	43.4	0.79	C	32.4	0.81
		T	A	6.7	0.48	E	70.4	0.98	B	18.6	0.60	F	95.7	1.12
	Overall		B	17.6		D	40.5		B	14		D	51.2	
Washington Street (Route 16/126)	EB	LTR	A	3.1	0.21	D	41.6	0.46	A	2.7	0.11	C	31.7	0.23
at Green Street/Exchange Street	WB	LTR	C	33.1	0.64	F	132.0	1.06	B	18.7	0.37	E	55.0	0.61
	NB	LTR	C	21.5	0.73	C	30.0	0.68	D	38.1	0.86	D	35.1	0.70
	SB	LTR	A	1.0	0.25	A	5.8	0.46	A	1.6	0.28	C	28.0	0.45
	Overall		B	15.3		C	23.2		C	24.9		C	32.4	

1 Level-of-Service
2 Average vehicle delay in seconds
3 Volume to capacity ratio
n/a Not Applicable

As seen in Table 1, the levels-of-service decrease overall with the implementation of concurrent pedestrian phasing. The intersection of Washington Street/Hollis Street/Charles Street declines

overall by one level of service in each the morning and afternoon peak hours. The overall LOS does not change for the intersections of Washington Street at Central Street and Washington Street at Green Street/Exchange Street. The decrease overall is due to the higher minimum timings required on each phase to allow pedestrians to complete concurrent crossing maneuvers. The benefit of concurrent pedestrians is to facilitate traffic without exclusively stopping all vehicular phases for a pedestrian crossing. In contrast, the benefit of the exclusive pedestrian phasing is to help protect pedestrians by stopping vehicular movements. In this comparison, traffic operations are fairly comparable for concurrent and exclusive pedestrian signal phasing.

Alternative B

This alternative investigates the feasibility of providing a single northbound through lane on the Washington Street corridor. In the preferred alternative, a second northbound lane begins approximately 50 feet south of the intersection of Washington Street (Route 16/126) at Green Street/Exchange Street and extends through the intersection of Washington Street/Central Street, after which the northbound through lanes taper back to one lane approaching Hollis Street.

The two lane approach raised concerns that the lanes may not be equally utilized since motorists would eventually merge back to the left lane downstream. Also, the two-lane approach impacts on-street parking, particularly north of Central Street, where on-street parking is popular due to its proximity to Fiske's General Store. Alternative B proposes one northbound lane through the corridor. The analysis of this alternative is shown in Table 2 on the next page with a comparison to the preferred alternative.

As shown in Table 2, substantial delays at the northbound approach of Washington Street (Route 16/126) at Green Street/Exchange Street during the weekday morning peak hour. Additionally, the northbound approach at this location has a 50th percentile queue length of over 1,000 feet which will cause further delays for northbound through traffic as well as impact driveway access and on-street parking along this portion of Washington Street (Route 15/126). In order to maintain acceptable levels of service at this intersection, it is necessary to have two northbound through lanes. Additionally, the two northbound through lanes at this location need to be extended to avoid a downstream right turn trap at Central Street. Based on this analysis, we do not recommend Washington Street (Route 16/126) be restricted to a single northbound through lane.

Table 2: Alternative B Capacity Analysis Comparison Summary

			Preferred Alternative						Alternative B					
			Weekday AM			Weekday PM			Weekday AM			Weekday PM		
Intersection	Movement		LOS[1]	Delay[2]	V/C[3]	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C
Washington Street (Route 16/126)	EB	L	E	75.4	0.88	F	115.6	0.99	E	75.4	0.88	F	115.6	0.99
at Hollis Street/Charles Street		R	C	21.3	0.59	F	82.6	0.83	C	21.3	0.59	F	82.4	0.83
	NB	L	A	5.4	0.54	E	63.4	0.95	A	4.1	0.54	E	58.0	0.95
		TR	B	19.4	0.91	A	5.2	0.56	A	9.5	0.91	A	5.4	0.56
	SB	L	A	3.7	0.04	A	1.7	0.02	A	3.7	0.04	A	1.7	0.02
		TR	A	7.7	0.61	D	44.4	0.95	A	7.7	0.61	D	39.7	0.95
	Overall		B	19.8		D	44.4		B	15.3		D	42	
Washington Street (Route 16/126)	WB	LR	F	105.2	1.01	E	66.1	0.94	F	96.9	1.07	E	79.3	0.99
at Central Street	NB	T	N/A	N/A	N/A	N/A	N/A	N/A	D	51.1	0.99	A	3.8	0.59
		R	N/A	N/A	N/A	N/A	N/A	N/A	E	67.1	0.23	A	3.8	0.18
		TR	A	1.7	0.62	A	2.8	0.62	N/A	N/A	N/A	N/A	N/A	N/A
	SB	L	C	20.3	0.56	B	17.5	0.56	C	29.3	0.56	F	262.2	1.50
		T	A	6.7	0.48	E	70.4	0.98	A	6.3	0.48	E	69.2	0.97
	Overall		B	17.6		D	40.5		D	45.0		E	73.0	
Washington Street (Route 16/126)	EB	LTR	A	3.1	0.21	D	41.6	0.46	A	3.3	0.21	D	41.6	0.46
at Green Street/Exchange Street	WB	LTR	C	33.1	0.64	F	132.0	1.06	C	34.8	0.64	F	132.0	1.05
	NB	LTR	C	21.5	0.73	C	30.0	0.68	F	263.9	1.52	C	23.5	0.78
	SB	LTR	A	1.0	0.25	A	5.8	0.46	A	1.0	0.25	A	5.2	0.42
	Overall		B	15.3		C	23.2		F	163.2		C	20.3	

1 Level-of-Service

2 Average vehicle delay in seconds

3 Volume to capacity ratio

n/a Not Applicable

Alternative C

This alternative investigates the addition of a protected northbound left turn phase at the intersection of Washington Street (Route 16/126) at Hollis Street. While the preferred alternative does provide exclusive left turn lanes, the northbound and southbound left turn movements on Washington Street (Route 16/126) at Hollis Street intersection are permissive. The southbound left turn is a low volume, and does not necessitate a protected signal phase. However, the northbound left turn volume is much higher. Though the northbound left turn operates with acceptable levels of service (LOS A during the weekday morning peak hour and LOS E during the weekday afternoon peak hour), a protected left turn would increase safety and minimize conflicts. The capacity analysis results for Alternative C are shown in Table 3 below.

Table 3: Alternative C Capacity Analysis Results Summary

			Preferred Alternative						Alternative C					
			Weekday AM			Weekday PM			Weekday AM			Weekday PM		
Intersection	Movement		LOS[1]	Delay[2]	V/C[3]	LOS	Delay	V/C	LOS	Delay	V/C	LOS	Delay	V/C
Washington Street (Route 16/126)	EB	L	E	75.4	0.88	F	115.6	0.99	E	75.4	0.88	F	197.6	1.24
at Hollis Street/Charles Street		R	C	21.3	0.59	F	82.6	0.83	C	21.3	0.59	F	90.9	0.90
	NB	L	A	5.4	0.54	E	63.4	0.95	B	18.4	0.48	C	20.5	0.50
		TR	B	19.4	0.91	A	5.2	0.56	C	23.1	0.91	A	5.0	0.55
	SB	L	A	3.7	0.04	A	1.7	0.02	B	12.2	0.04	A	7.0	0.02
		TR	A	7.7	0.61	D	44.4	0.95	C	33.3	0.87	F	149.7	1.27
	Overall		B	19.8		D	44.4		C	29.8		F	94.3	
Washington Street (Route 16/126)	WB	LR	F	105.2	1.01	E	66.1	0.94	F	105.2	1.01	E	65.7	0.94
at Central Street	NB	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		R	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		TR	A	1.7	0.62	A	2.8	0.62	A	1.7	0.62	A	1.5	0.40
	SB	L	C	20.3	0.56	B	17.5	0.56	C	23.4	0.56	F	255.3	1.50
		T	A	6.7	0.48	E	70.4	0.98	A	7.5	0.48	E	64.9	0.98
	Overall		B	17.6		D	40.5		B	18.1		E	67.9	
Washington Street (Route 16/126)	EB	LTR	A	3.1	0.21	D	41.6	0.46	A	3.1	0.21	D	41.6	0.46
at Green Street/Exchange Street	WB	LTR	C	33.1	0.64	F	132.0	1.06	C	33.1	0.64	F	132.0	1.05
	NB	LTR	C	21.5	0.73	C	30.0	0.68	C	21.5	0.73	B	14.2	0.44
	SB	LTR	A	1.0	0.25	A	5.8	0.46	A	1.1	0.25	A	5.8	0.42
	Overall		B	15.3		C	23.2		B	15.3		B	17.1	

1 Level-of-Service
2 Average vehicle delay in seconds
3 Volume to capacity ratio
n/a Not Applicable

With the addition of the protected phase, the northbound left turn movement operates at LOS B during the weekday morning peak hour and LOS C during the weekday afternoon peak hour. The intersection of Washington Street (Route 16/126) at Hollis Street operates at an overall LOS C during the weekday morning, but operates at LOS F during the weekday afternoon overall. The northbound left turn conflicts with the southbound through movement. Since time is taken from the southbound through movement to allow the northbound left, operations of the southbound through movement diminish. While this alternative primarily affects the intersection of Washington Street (Route 16/126) at Hollis Street, the other study area intersections are affected due to the optimization of the coordinated system. Since the Washington Street (Route 16/126) at Hollis Street intersection operates over capacity and decreases to failing levels of service overall, we do not recommend the implementation of an exclusive northbound left turn phase at Hollis Street.

Revised Preferred Alternative

The town expressed concerns regarding the elimination of parking spaces in front of Fiske's General Store on the eastern side of Washington Street (Route 16/126) adjacent to Central Street. In an effort to maintain the highly utilized parking areas on Washington Street a revised

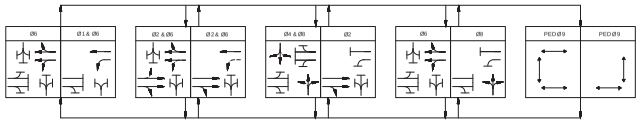
alternative is proposed as seen in the attached graphic labeled Revised Alternative 1: Modified Lane Usage. This alternative reduces the northbound lane drop taper north of Central Street from 25:1 to 20:1 and begins the lane drop taper at the stop bar south of Central Street as opposed to continuing two full lanes through the intersection. Additionally, the widths of several on-street parking spaces have been reduced to 7 feet, as show in the attached plan. The centerline of Washington Street (Route 16/126) has also been shifted slightly to the west to minimize the lane shift and associated taper needed in the northbound direction. This allows for the addition of one parking space adjacent to the removed midblock crosswalk in addition to the three spaces maintained in front of Fiske's General Store.

Conclusion

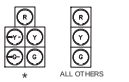
In conclusion, three additional alternatives have been reviewed for the Washington Street Corridor project: concurrent pedestrian phasing, a single northbound through lane, and protected northbound left turns at the Washington Street (Route 16/126) at Hollis Street signal. Each alternative was analyzed and the results compared to the preferred alternative presented in the Conceptual Design Report. Based on the analysis, we do not recommend Alternative B: Single Northbound through lane or Alternative C: Protected northbound left turn lane be implemented. Alternative A: Concurrent Pedestrian Phasing has been compared to the preferred alternative. The operations of exclusive pedestrian signal phasing and concurrent pedestrian signal phasing are fairly comparable and there are advantages to each. Concurrent phasing allows more time for vehicular traffic movement but does pose conflicts between pedestrians and turning traffic. Exclusive pedestrian phasing poses no conflicts to pedestrians, but does stop all traffic at an intersection while the pedestrian phase is operating. Note that the required signal equipment is the same for exclusive pedestrian signal phasing and concurrent pedestrian signal phasing. As such, a change in the future can be accomplished by re-programming the traffic signal controller.

The roadway geometry for the preferred alternative has been revised to maintain three of the existing parking spaces in front of Fiske's General store by reducing the taper and lane length of the northbound through lanes at the intersection of Washington Street (Route 16/126) at Central Street. Overall, the parking is able to be maintained with the minor geometric changes and the width reduction of a few on-street parking spaces.

PREFERENTIAL PHASING SEQUENCE
(WASHINGTON ST/EXCHANGE ST/GREEN ST AND WASHINGTON ST/CENTRAL ST)



SIGNAL IDENTIFICATION



PREFERENTIAL PHASING SEQUENCE
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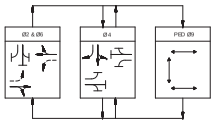

LEGEND

- EXISTING PARKING SPACE TO BE REMOVED
- PROPOSED PARKING SPACE
- PROPOSED CROSSWALK

PARKING INVENTORY

	SOUTH LIMIT TO GREEN STREET	GREEN STREET TO CENTRAL STREET	CENTRAL STREET TO NORTH LIMIT	TOTAL
SPACES LOST	10	1	6	17
SPACES GAINED	0	0	2	2
NET LOSS	10	1	4	15

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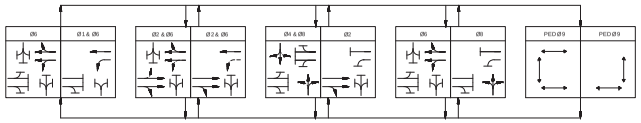
ALTERNATIVE 1 - MODIFIED LANE USAGE

WASHINGTON STREET CORRIDOR IMPROVEMENTS

HOLLISTON, MA

PREFERENTIAL PHASING SEQUENCE
(WASHINGTON ST/EXCHANGE ST/GREEN ST AND WASHINGTON ST/CENTRAL ST)



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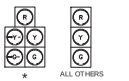
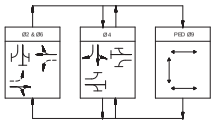


PREFERENTIAL PHASING SEQUENCE
(WASHINGTON ST/HOLLIS ST/ CHARLES ST)



LEGEND

- EXISTING PARKING SPACE TO BE REMOVED
- PROPOSED PARKING SPACE
- PROPOSED CROSSWALK

PARKING INVENTORY

	SOUTH LIMIT TO GREEN STREET	GREEN STREET TO CENTRAL STREET	CENTRAL STREET TO NORTH LIMIT	TOTAL
SPACES LOST	10	1	3	14
SPACES GAINED	0	0	3	3
NET LOSS	10	1	0	11

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REVISED ALTERNATIVE 1 - MODIFIED LANE USAGE

WASHINGTON STREET
CORRIDOR IMPROVEMENTS

HOLLISTON, MA