



emorandum

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403 Belmont Street
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Date: September 10, 2008

Project No.: 09787.08

From: Valerie Lenhardt, E.I.T.
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Re: Main Street (Route 117) – Two Locations
Bolton, MA

This Technical Memo has been prepared at the request of the MassHighway District 3 office to assess traffic signal system operations at two intersections along Main Street (Route 117) in Bolton, Massachusetts. Existing conditions, traffic counts, crash data and capacity analyses are summarized herein. This information is reviewed and discussed further in this memo; with respect to improving overall operation and reducing vehicle delay/queuing at the following intersections:

- Main Street (Route 117) at I-495 Northbound Ramps
- Main Street (Route 117) at I-495 Southbound Ramps/Sugar Road

EXISTING CONDITIONS

Roadway Geometry and Traffic Control

Main Street at I-495 Northbound Ramps: I-495 Northbound Ramps intersects Main Street from the north to form a three-legged, unsignalized intersection. The Main Street eastbound approach consists of an exclusive left-turn lane and a through lane. The Main Street westbound approach consists of a through lane and a channelized right-turn lane under "YIELD" control. The I-495 NB Off-Ramp approach consists of an exclusive left lane under "STOP" control and a channelized right-turn lane under "YIELD" control. There are no sidewalks or crosswalks present on any of the approaches. Land-uses at the intersection include wetlands on the north side of the Main Street eastbound approach, a cemetery on the northeast corner of the intersection and a retail development on the south side of the Main Street westbound approach. This intersection is owned/maintained by MassHighway and is classified as a rural minor arterial.

Main Street at I-495 Southbound Ramps/Sugar Road: I-495 Southbound Ramps and Sugar Road intersect Main Street from the north and south to form a four-way, fully-actuated, signalized intersection. The Main Street eastbound approach consists of an exclusive left-turn lane, a through lane and a channelized right-turn lane under "YIELD" control. The Main Street westbound approach consists of an exclusive left-turn lane and a shared

consists of a general purpose lane. There is no sidewalk or crosswalks present on any of the approaches. This intersection currently runs as a three phase operation that includes a protected westbound lead phase. Land-uses at the intersection include wetlands on both sides of the Main Street westbound approach, commercial use on the northwest corner and residential on the southwest corner. This intersection is owned/maintained by MassHighway and is classified as a rural minor arterial.

Traffic Volumes

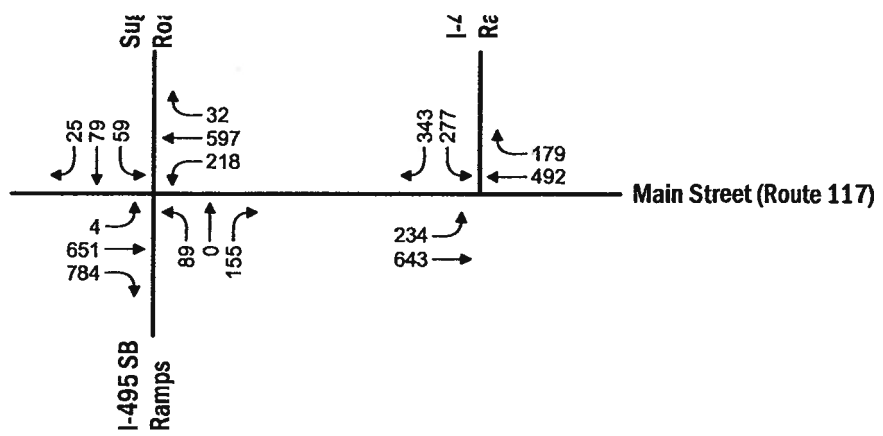
Traffic volume information for the study area intersections was collected by MassHighway, to provide a basis from which to evaluate traffic conditions. Turning Movement Counts (TMCs) were collected manually on a non-holiday weekday from 7:00 to 9:00 AM and 4:00 to 6:00 PM during June 2008. These two time periods represent the typical peak commuter periods and were studied herein to define intersection operations. In addition to the TMCs, Automatic Traffic Recorder counts (ATRs) were collected in June 2008 for a period of 48-hours along Main Street (Route 117), I-495 SB Off-Ramp and I-495 NB Off-Ramp. The 2008 existing condition traffic volume networks are presented in Figure 1 for the weekday morning and weekday evening peak periods. ATR and TMC data is included in Appendix A of this document.

Future traffic volumes were projected to a design year of 2018 utilizing a yearly growth factor of 0.5% for a 10 year period. A growth factor of 0.5% was determined to present a conservative growth in the area, even though a permanent count station on Route 117 (S002) in Bolton shows a decrease in traffic between 2000 and 2003. The 2018 future condition traffic volume networks are presented in Figure 2 for the weekday morning and weekday evening peak periods.

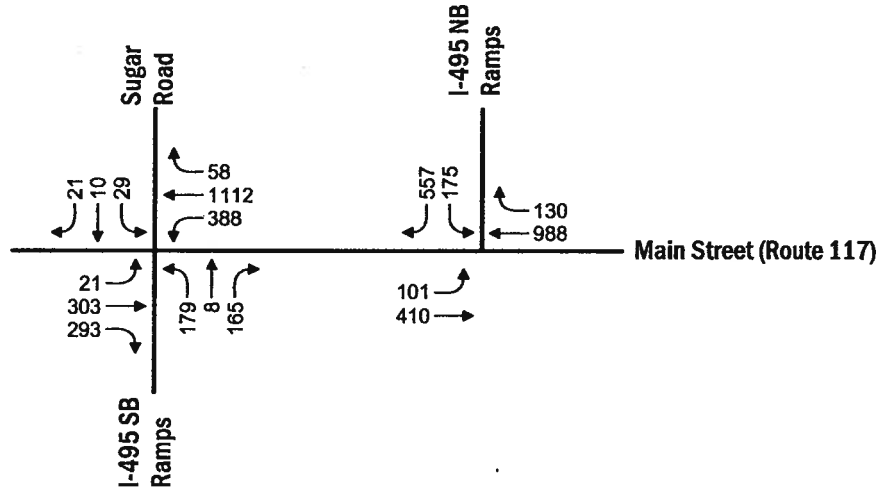
Crash Data

Crash data for the study intersections on Main Street were obtained from the MassHighway Department records for the most recent three-year period: January 2004 through December 2006. There have been a total of 42 crashes during this time period. A summary of the crash data by location is presented in Table 1.

- Main Street at I-495 SB Ramps/Sugar Road experienced 13 crashes during the three-year period. There were seven angle type accidents at this intersection. Most of the crashes occurred Monday through Friday during off-peak hours.
- Main Street at I-495 NB Ramps experienced 13 crashes during the three-year period. There were eleven rear-end type crashes at this intersection. A majority of the crashes occurred Monday through Friday during non-peak periods.
- In addition, there are sixteen (16) additional crashes that occurred in the area, but the crash data did not specify if the crashes occurred at the Northbound Ramps or the Southbound Ramps. A majority of these crashes were rear-end type accidents (11 of 16) and occurred Monday through Friday during non-peak periods. Also, the intersection of Main Street (Route 117) and I-495 appears on the MassHighway top 1000 crash locations between the years of 1999 and 2001. The report does not specify which intersection.



Weekday Morning



Weekday Evening

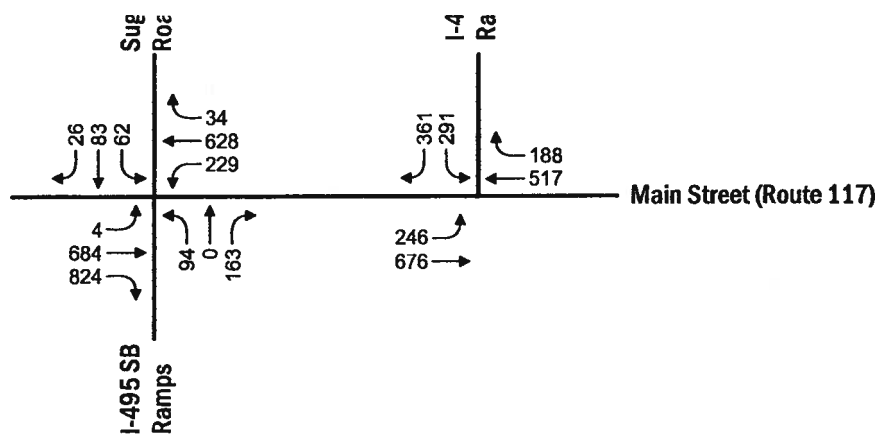


Not to Scale

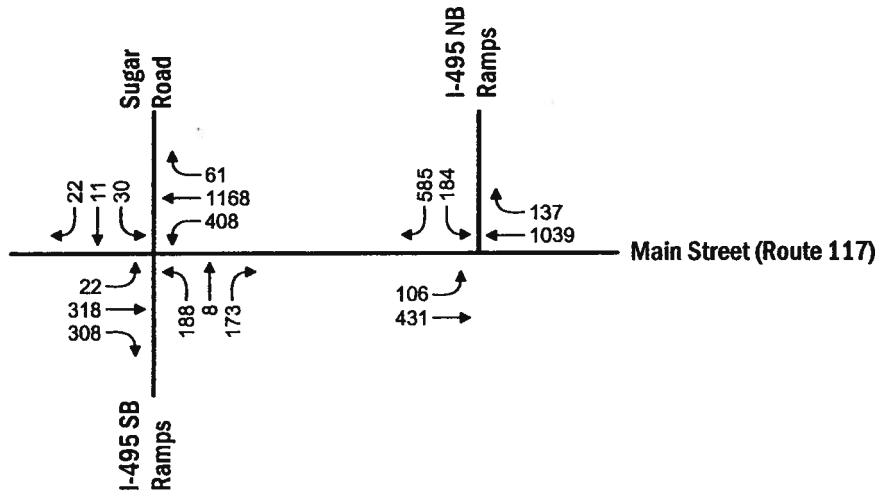
Vanasse Hangen Brustlin, Inc.

2008 Existing Conditions
Peak Hour Traffic Volumes

Figure 1



Weekday Morning



Weekday Evening



Not to Scale

Vanasse Hangen Brustlin, Inc.

2018 Future Conditions
Peak Hour Traffic Volumes

Figure 2

intersections and 0.79 for unsignalized intersections). District 3 is the MassHighway designation for Bolton.

Table 1
Intersection Crash Summary – January 2004 through December 2006

	Main Street (Route 117) at:		
	I-495 NB Ramps	I-495 SB Ramps	I-495 (Unspecified)
Year			
2004	6	6	5
2005	6	4	6
<u>2006</u>	<u>1</u>	<u>3</u>	<u>5</u>
Total:	13	13	16
Type			
Angle	2	7	5
Rear-end	11	3	11
Rear-to-rear	0	1	0
<u>Sideswipe</u>	<u>0</u>	<u>2</u>	<u>0</u>
Total:	13	13	16
Severity			
Personal Injury	4	4	2
<u>Property Damage Only</u>	<u>9</u>	<u>9</u>	<u>14</u>
Total:	13	13	16
Pavement Condition			
Dry	10	7	11
Wet	3	6	4
<u>Ice/Slush</u>	<u>0</u>	<u>0</u>	<u>1</u>
Total:	13	13	16
Time			
Weekday: 7:00 AM - 9:00 AM	0	0	2
Weekday: 4:00 PM - 6:00 PM	2	3	2
Saturday: 11:00 AM – 2:00 PM	2	0	0
Weekday: other time	8	7	9
<u>Weekend: other time</u>	<u>1</u>	<u>3</u>	<u>3</u>
Total:	13	13	16
MassHighway Crash Rate*	0.49	0.45	--

Source: MassHighway Department.

* The MassHighway Crash Rate worksheets are included in Appendix B.

and/or justification for traffic signal control at the intersection of Main Street/I-495 NB Ramps. The methodology used to determine if traffic signal controls are warranted are based on the criteria set in the Manual on Uniform Traffic Control Devices (MUTCD)¹. There are eight warrants defined in the MUTCD. A traffic signal should not be installed unless one or more of these warrants is met. Satisfaction of any one warrant does not necessarily mean that a signal should be installed at a given location, but does indicate that a signal *could* be installed.

Traffic signal warrants analyses were conducted for the weekday condition using the existing turning movement traffic count data for the intersection (with the removal of the free right-turn movements). This study focused on Warrants 1, 2, 3 and 7 to determine the need for signalization. These warrants are described below:

- **Warrant 1 (Eight-Hour Vehicular Volume):** Warrant 1 is satisfied if either of Condition A or B is met. In addition, Warrant 1 can be satisfied by 80 percent satisfaction of both Condition A and Condition B.

Condition A (Minimum Vehicular Volume): Satisfied when the volume of intersecting traffic (major and minor streets) exceeds MUTCD thresholds for eight or more hours.

Condition B (Interruption of Continuous Traffic): Satisfied when the volume of major street traffic is so heavy that minor street traffic suffers excessive delay in entering or crossing the major street for eight or more hours.

- **Warrant 2 (Four-Hour Vehicular Volume):** Satisfied when volumes (major and minor streets) exceed MUTCD thresholds for four or more hours.
- **Warrant 3 (Peak Hour):** Satisfied when for the peak hour of a typical day, major and minor street traffic exceeds MUTCD thresholds.
- **Warrant 7 (Crash Experience):** Satisfied when the severity and frequency of crashes exceeds MUTCD thresholds (five or more crashes within a 12-month period).

Based on the results presented in Table 2, the intersection of Main Street at I-495 NB Ramps does meet warrant signalization under 2008 existing conditions. The traffic signal warrants analysis worksheet is located in Appendix C.

¹ Manual on Uniform Traffic Control Devices; Part 4 – Highway Traffic Signals; U.S. Department of Transportation/Federal Highway Administration; November 2003.

Condition	Warrant 1 ^a Met	Warrant 2 ^b Met	Warrant 3 ^c Met	Warrant 7 ^d Met
2008 Existing	No	Yes	Yes	No

^aEight-hour volume warrant.

^bFour-hour volume warrant.

^cPeak hour volume warrant.

^dCrash experience warrant.

TRAFFIC PERFORMANCE MEASURES

Using the traffic volume counts collected in June 2008, weekday morning and weekday evening peak hour analyses of these two locations was conducted to evaluate traffic operations. Along with evaluating Existing Conditions, No-Build Condition and Build Condition were also evaluated. The following scenarios were considered for analysis:

- Existing Conditions (2008)
- Existing Volumes w/Proposed Geometry (2008 Build)
- Future Volumes w/Existing Geometry (2018 No-Build)
- Future Volumes w/Proposed Geometry (2018 Build):

All conditions were analyzed utilizing Synchro 6. To accurately model the intersections, under signalized conditions, short lane methodology was utilized. The "Yield" controlled channelized right-turn movements are restricted (blocked) by the through movements. To represent conditions more accurately, the lane grouping combined the channelized right-turn movements with the through movement. However, the right-turn volume was reduced by the number of cars that are blocked times the number of cycles per hour.

Existing Conditions: To establish a base for comparison, MassHighway conducted weekday morning and evening peak hour traffic analyses of the study intersections under 2008 existing conditions. As summarized in Table 3 and 4, the study intersection of Main Street/I-495 SB Ramps/Sugar Road operates at a LOS of F during the weekday morning and a LOS C during the weekday evening peak periods, while the intersection of the Main Street/I-495 NB Ramps critical movement (southbound left-turn) operates at an overall LOS F during the weekday morning and weekday evening peak periods. Detailed capacity analyses for this condition are included in Appendix D.

No-Build Conditions: VHB projected the weekday morning and evening peak hour traffic volumes to a design year of 2018, using a one-half (0.5%) percent growth. A growth rate of one-half percent was utilized to be conservative, even though a permanent ATR on Main Street (Station S002) shows a decrease in traffic from 2000 to 2003. These volumes were then applied to the existing traffic controls at the two intersections and analyzed. As summarized in Table 3 and 4, the intersection of Main Street/I-495 SB Ramps/Sugar Road operates at a LOS F during the weekday morning and a LOS C during the weekday evening peak periods, while the intersection of the Main Street/I-495 NB Ramps critical movement (southbound left-turn) operates at an overall LOS F during the weekday morning and weekday evening peak periods. Detailed capacity analyses for this condition are included in Appendix D.

minor timing changes and coordination (time-of-day) programming. As summarized in Table 4, the intersection of Main Street/I-495 SB Ramps/Sugar Road operates at a LOS F during the weekday morning and at a LOS C during the weekday evening peak periods. While the intersection of Main Street/I-495 NB Ramps operates at an overall LOS B during the weekday morning and evening peak periods. Detailed capacity analyses for this condition are included in Appendix D.

2018 Build Conditions: The 2018 build condition includes signalization of the intersection of Main Street and I-495 NB Ramps and the coordination of both intersections. The phasing at Main Street and I-495 SB Ramps/Sugar Road will remain the same with minor timing changes and coordination (time-of-day) programming. As summarized in Table 4, the intersection of Main Street/I-495 SB Ramps/Sugar Road will continue to operate at a LOS F during the weekday morning and at a LOS C during the weekday evening peak periods. While the intersection of Main Street/I-495 NB Ramps operates at an overall LOS B during the weekday morning and evening peak periods. Detailed capacity analyses for this condition are included in Appendix D.

The 95th percentile queues reported in Table 5 indicate, for 2018 Build Conditions, that the majority of vehicle queuing at the intersection of Main Street and I-495 SB Ramps/Sugar Road will remain the same. The intersection of Main Street and I-495 NB Ramps will improve the queues on the Off-Ramp, while queues on the Main Street approaches will increase.

Table 3
Unsignalized Intersection Capacity Analysis Summary

<i>Unsignalized Condition</i>	Weekday Morning			Weekday Evening		
	V/C*	Delay**	LOS***	V/C*	Delay**	LOS***
Main St at I-495 NB						
2008 Existing Volumes/ Existing Geometry	•	>500	F	•	>500	F
2018 Future Volumes/ Existing Geometry	•	>500	F	•	>500	F

Source: Vanasse Hangen Brustlin, Inc.; based on turning movement counts conducted June 2008.

- V/C -- Volume-to-capacity ratio.
- ** Delay of critical side street or mainline left-turn, expressed in seconds per vehicle.
- *** LOS -- Level-of-Service.
- V/C is greater than 1.5.

Signalized Intersection Capacity Analysis Summary

<i>Intersection/Condition</i>	Weekday Morning			Weekday Evening		
	<i>V/C*</i>	<i>Delay**</i>	<i>LOS***</i>	<i>V/C*</i>	<i>Delay**</i>	<i>LOS***</i>
Main St at I-495 NB						
2008 Existing Volumes/ Future Geometry	.059	11.9	B	0.78	13.7	B
2018 Future Volumes/ Future Geometry	0.62	12.9	B	0.82	15.6	B
Main St at I-495 SB/Sugar Rd						
2008 Existing Volumes/ Existing Geometry	1.17	116.5	F	0.92	24.7	C
2008 Existing Volumes/ Future Geometry	1.16	85.7	F	0.91	21.4	C
2018 Future Volumes/ Existing Geometry	1.25	138.3	F	0.97	32.8	C
2018 Future Volumes/ Future Geometry	1.24	105.6	F	0.96	26.7	C

Source: Vanasse Hangen Brustlin, Inc.; based on turning movement counts conducted June 2008.

* V/C -- Volume -to-capacity ratio.

** Average intersection delay, expressed in seconds per vehicle.

*** LOS -- Level-of-Service.

<i>Signalized Condition</i>	2008 Existing Conditions		2008 Build Conditions		2018 No-Build Conditions		2018 Build Conditions	
	AM	PM	AM	PM	AM	PM	AM	PM
Main St @ I-495 SB Ramps/ Sugar Rd								
EB Left	7	22	5	33	7	28	5	34
EB Thru	#1456	243	#1281	291	#1563	270	#1387	317
WB Left	164	101	#271	m71	174	108	#290	m96
WB Thru	200	656	48	#974	217	#780	52	m#1049
NB Thru	#204	#367	#231	#286	#223	#399	#248	#317
SB Thru	174	56	#211	50	#193	59	#225	52
Main St @ I-495 NB Ramps								
EB Left	23	17	m36	m53	25	19	m36	m58
EB Thru	0	0	m135	m43	0	0	m135	m42
WB Thru	0	0	391	#758	0	0	449	#953
WB Right	0	0	N/A	N/A	0	0	N/A	N/A
SB Left	*	439	248	177	*	*	260	186
SB Right	111	1060	0	0	133	1202	0	0

Source: VHB; based on turning movement counts conducted June 2008

95th percentile volume exceeds capacity, queue may be longer

m 95th percentile volume is metered by upstream signal

*Queue is too large for Synchro 6 to calculate.

N/A Not Applicable

Queue length shown in feet

Proposed improvements at Main Street at I-495 SB Ramps/ Sugar Road and Main Street at I-495 NB Ramps are detailed in the design plans prepared along with this technical memo. There are no geometric improvements proposed. The majority of the improvements related to the traffic control devices which will enable the intersections to accommodate future traffic volumes and to provide more efficient operations and reduce vehicle queuing. Specific improvements for each study intersection are as follows:

Main Street at I-495 NB Ramps

- Install a new fully-actuated traffic signal assembly with appropriate timing and phasing for peak hour volume requirements.
- Provide a protected lead phase for the Main Street eastbound approach.
- Install a master controller with appropriate time of day settings.
- Provide coordination, via hardwire interconnect along Main Street.
- Provide video detection.
- Provide queue detection for the I-495 NB Off-Ramp.
- Where applicable, upgrade existing signs and pavement markings to meet with the proposed design.

Main Street at I-495 SB Ramps/ Sugar Road

- Modify existing traffic signal controller and cabinet with appropriate timing to accommodate peak hour volumes.
- Provide coordination, via hardwire interconnect along Main Street.
- Test and repair existing loop detectors, if found to be applicable, during construction.

Please note that roadway geometrics, including wheelchair ramps, have not been included as part of this evaluation.