TOWN OF BROOKLINE

Department of Public Works
333 Washington Street
Brookline, MA 02445

Right Turn On Red Restriction

For

Boylston Street at Washington Street and High Street

Date: October, 2011
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The purpose of this study is to determine if the right turn restriction on the northbound, southbound and eastbound approaches to the Boylston Street at Washington Street and High Street intersection are warranted. The study location can be seen in **Figure 1.** Recommendations will be based on the guidelines found in the latest version of the Manual of Uniform Traffic Control Devices (MUTCD). The MUTCD suggests the following factors should be considered for the implementation of a NO TURN ON RED restriction:

1. Sight distance of vehicles approaching from the Left;
2. Geometric or operational characteristics of the intersection that might result in unexpected conflicts;
3. An exclusive ("Barn Dance") pedestrian phase;
4. An unacceptable number of pedestrian conflicts with right-turn-on-red maneuvers, especially involving children, older pedestrians, or persons with disabilities;
5. More than three (3) right-turn-on-red accidents reported in a 12 month period for the particular approach.

According to our files the Transportation Board, or it's predecessor the Traffic Council, implemented the NO TURN ON RED restriction based on the fact that there was an exclusive "barn dance" pedestrian phase.

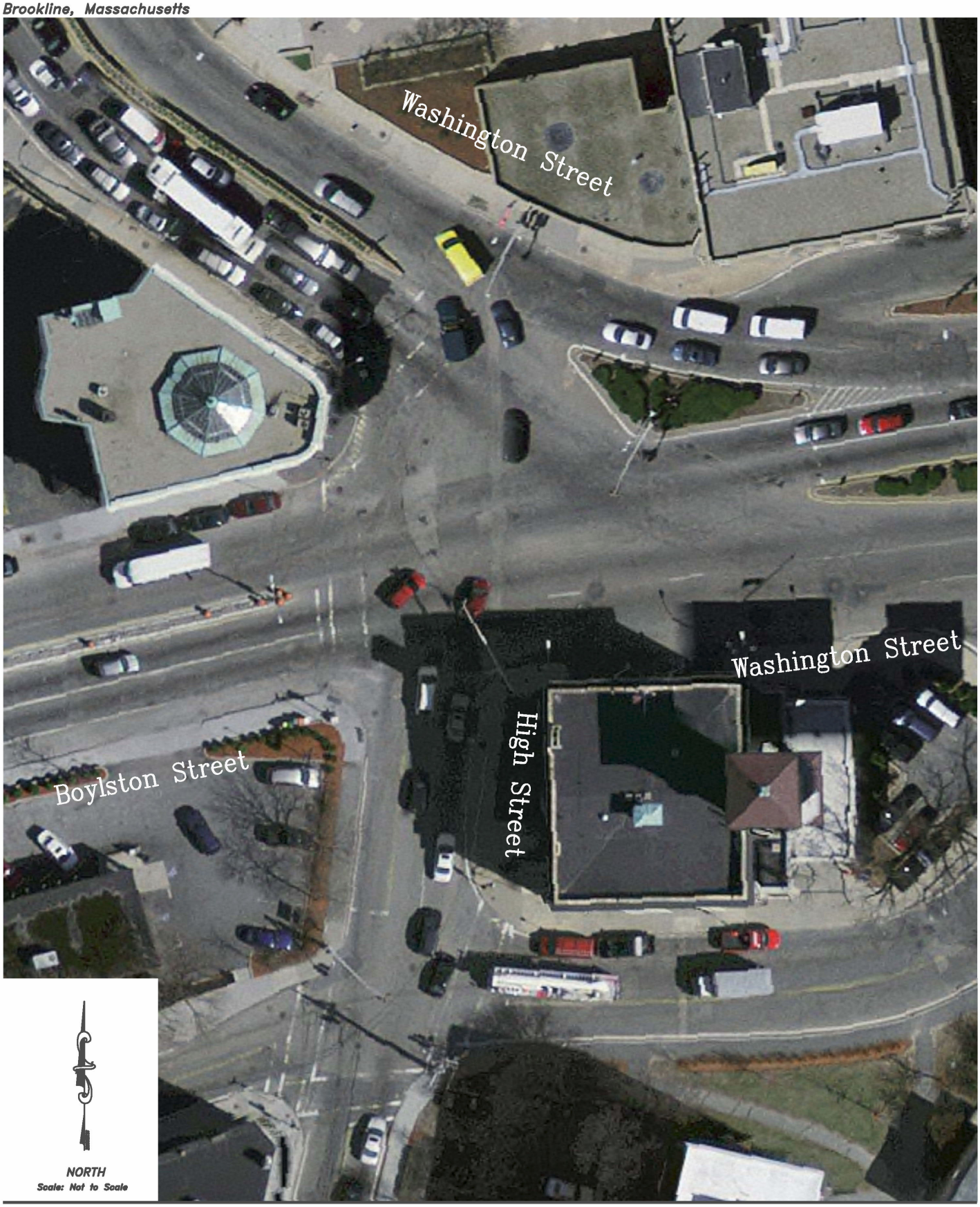

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Figure 1

Study Location

SIGHT DISTANCE

The American Association of State and Transportation Officials (AASHTO) standards reference two types of sight distances which are relevant for the intersection at Boylston Street at Washington Street and High Street: stopping sight distance (SSD) and intersection sight distance (ISD). Stopping sight distance pertains to roadway segments and intersection sight distance, as the name implies, relates specifically to intersections. Sight lines for right turning vehicle movements at the intersection of Beacon Street at Washington Street are compared to minimum safe stopping sight distance (SSD) and intersection sight distance (ISD) guidelines for the regulatory speed limit below in **Table 1**. Sight line calculations are provided in the **Appendix.**

Table 1
Sight Distance

Approach /Travel Direction	Available Sight Distance		AASHTO Recommended [1] Posted Speed (30 mph)
Stopping Sight Distance			
Washington Street Southbound	>400’		200’
High Street Northbound	>400’		200’
Boylston Street Eastbound	115’		210’
Intersection Sight Distance - Stop Control			
	Behind Stop line	At Crosswalk	
Washington Street Looking Eastbound	<100’	<100’	290’
High Street Looking Westbound	<100’	210’	290’
Boylston Street Looking Northbound	<100’	110’	290’

[1]Recommended sight distance based on A Policy on Geometric Design of Highways and Streets, AASHTO, 4th edition 2001. Based on driver height of eye of 3.5 feet to object height of 2.0 feet for SSD or 3.5 feet for ISD and adjustments for roadway grade.

The existing stopping sight distance is adequate on the southbound approach, and northbound approach. The Eastbound approach has deficient stopping sight distance. The approaches to the intersection have deficient intersection sight distance from behind the crosswalk. Because of the high pedestrian activity it would not be desirable to have vehicles pulling beyond the stop line into the crosswalk for better visibility. The MUTCD recommends no turn on red when the sight lines are restricted.

GEOMETRIC AND OPERATIONAL CHARACTERSTICS

Washington Street meets Boylston Street at 44 degrees and High Street meets Boylston Street at 110 degrees to form a four way signalized intersection. The High Street northbound approach provides one through-left turn lane and one right-through lane. Washington Street Southbound provides one through-Right turn lane and three left turn lanes. Washington Street eastbound provides two through lanes and two exclusive right turn lanes. Boylston Street westbound provides one through-right turn lane and one through lane. Land use at the intersection is primarily commercial, educational and public use.

PEDESTRAIN CONFLICTS AND SIGNAL PHASING

Pedestrian activity at the Boylston Street at Washington Street and High Street intersection is significant. In close proximity the intersection is the New England Institute of Art, Dunking Donuts, Brookline Bank and Fire station. The signal timing provides concurrent pedestrian phasing crossing Boylston Street and protect pedestrian phase for pedestrian crossing Washington Street. The signal also has an exclusive fire preemption phase used by the fire station during which time all non emergency vehicles should be stopped The MUTCD recommends no turn on red when an exclusive pedestrian phase is used.

CRASH ANAYLISIS

In order to identify accident trends and safety characteristics for the study intersection accident reports were obtained from MassDOT Highway Crash Database for a three-year period covering 2007 through 2009. This data can be found in the **Appendix**. A summary of the crash data for the study intersection is detailed in **Table 2**.

Table 2
Accident Summary

Data Category	Boylston St at Washington St and High St
Year:	
2007	7
2008	1
2009	4
Total	12
Type:	
Angle	5
Rear-End	3
Right-Turn	0
Head-On	0
Sideswipe	2
Pedestrian	0
Unknown/Other	2
Severity:	
P. Damage Only	7
Personal Injury	5
Fatality	0
Unknown/Other	0
Conditions:	
Dry	9
Wet	3
Snow/Ice	0
Other/Unreported	0
Time:	
7:00 AM to 9 AM	3
4:00 AM to 6 PM	1
Rest of Day	8

As summarized in **Table 2**, a total of twelve crashes were reported for the Boylston Street at Washington Street and High Street intersection for the three-year period studied from 2007 to 2009. None of the reported crashes were from vehicles taking a right turn at the intersection. However right turn on red maneuvers are currently restricted on all approaches. The MUTCD warrants a right-turn-on-red restriction if three (3) or more accidents were caused by right turn on red maneuvers within 12 months.

CONCLUSIONS

The northbound, southbound and eastbound approaches to the Boylston Street at Washington Street and High Street signalized intersection have restricted sight lines; heavy pedestrian usage with an exclusive pedestrian phase and a fire preemption phase at which time all vehicles should be stopped and pedestrians allowed to begin crossing and a skewed geometry. Using the MUTCD guidelines 1, 2, 3, and 4 the removal of the right turn on red restrictions would not be recommended.

Appendix

- Sight Line Calculations
- Accident Data

Sight Line Calculations

Boylston Street Eastbound and Westbound Approach

Intersection Sight Distance	Speed		
	Posted	Average	85th
Looking North			
Stop Control Left Turning	331	0	0
Stop Control Right Turning/Crossing	287	0	0
Yield Control Left Turning	353	0	0
Yield Control Right Turning/Crossing	309	0	0
Looking South			
Stop Control Left Turning	331	0	0
Stop Control Right Turning/Crossing	287	0	0
Yield Control Left Turning	353	0	0
Yield Control Right Turning/Crossing	309	0	0

Stopping Sight Distance	Speed		
	Posted	Average	85th
North Stopping Sight Distance	205	0	0
South Stopping Sight Distance	208	0	0

	North Bound			South Bound		
Inputs	Posted	Average	85th	Posted	Average	85th
Speed:	30			30		
Grade:	-3	0	0	-4	0	0

Sight Distance Formulas - Source: AASHTO

Intersection Sight Distance = 1.47 x V x t

Stopping Sight Distance = (1.47 x V x s) + V^2/(30 x ((a/32.2)+(G/100)))

Where:

s = Reaction Time (sec) = 2.5 s

V= Travel Speed (mph)

G= Roadway Grade

a = Deceleration Rate (ft/sec^2) = 11.2 ft/s^2

t= Time Gap (sec) =
- Stop Control Left Turning = 7.5 s
- Stop Control Right Turning = 6.5 s
- Yield Control Left Turning = 8 s
- Yield Control Right Turning = 7 s

Sight Line Calculations

High Street Norhtbound and Washington Street Southbound Approach

Intersection Sight Distance	Speed		
	Posted	Average	85th
Looking East			
Stop Control Left Turning	386	0	0
Stop Control Right Turning/Crossing	334	0	0
Yield Control Left Turning	412	0	0
Yield Control Right Turning/Crossing	360	0	0
Looking West			
Stop Control Left Turning	331	0	0
Stop Control Right Turning/Crossing	287	0	0
Yield Control Left Turning	353	0	0
Yield Control Right Turning/Crossing	309	0	0

Stopping Sight Distance	Speed		
	Posted	Average	85th
East Stopping Sight Distance	192	0	0
West Stopping Sight Distance	270	0	0

	East Bound			West Bound		
Inputs	Posted	Average	85th	Posted	Average	85th
Speed:	30			35		
Grade:	2	0	0	-6	0	0

Sight Distance Formulas - Source: AASHTO

Intersection Sight Distance = 1.47 x V x t

Stopping Sight Distance = (1.47 x V x s) + V^2/(30 x ((a/32.2)+(G/100)))

Where:

s = Reaction Time (sec) = 2.5 s

V= Travel Speed (mph)

G= Roadway Grade

a = Deceleration Rate (ft/sec^2) = 11.2 ft/s^2

t= Time Gap (sec) =
- Stop Control Left Turning = 7.5 s
- Stop Control Right Turning = 6.5 s
- Yield Control Left Turning = 8 s
- Yield Control Right Turning = 7 s

MassHighway Crash Report for Brookline in the year 2007

Crash Number	City/Town Name	Crash Date	Crash Time	Crash Severity	Number of Vehicles	Total Nonfatal Injuries	Total Fatal Injuries	Manner of Collision	Vehicle Action Prior to Crash	Vehicle Travel Directions	Most Harmful Events	Vehicle Configuration	Road Surface Condition	Ambient Light	Weather Condition	At Roadway Intersection	Distance from Nearest Roadway Intersection	Distance from Nearest Milemarker	Distance from Nearest Exit	Distance from Nearest Landmark	Non Motorist Type
2149387	BROOKLINE	03-Feb-2007	10:20 AM	Non-fatal injury	4	1	0	Angle	V1: Making U-turn / V2:Travelling straight ahead / V3:Travelling straight ahead / V4:Travelling straight ahead	V1:Eastbound / V2:Eastbound / V3:Westbound / V4:Westbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic / V3: Collision with motor vehicle in traffic / V4: Collision with motor vehicle in traffic	V1: Not reported / V2:Passenger car / V3:Not reported / V4:Passenger car	Dry	Daylight	Clear		140 WASHINGTON STREET / HIGH STREET				
2155887	BROOKLINE	25-Feb-2007	7:40 AM	Non-fatal injury	2	1	0	Angle	V1: Travelling straight ahead / V2:Travelling straight ahead	V1:Southbound / V2:Westbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	V1: Passenger car / V2:Passenger car	Wet	Daylight	Clear/Clear		BOYLSTON STREET / WASHINGTON STREET			STATION ONE BROOKLINE FIRE DEPT	
2163646	BROOKLINE	15-Mar-2007	6:02 PM	Non-fatal injury	2	1	0	Single vehicle crash	V1: Travelling straight ahead / V2:Travelling straight ahead	V1:Southbound / V2:Southbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	V1: Passenger car / V2:Passenger car	Wet	Daylight	Rain/Rain		WASHINGTON STREET / BOYLSTON STREET			FIRE STATION	
2166317	BROOKLINE	18-Mar-2007	10:00 AM	Property damage only (none injured)	2	0	0	Single vehicle crash	V1: Travelling straight ahead / V2:Travelling straight ahead	V1:Eastbound / V2:Eastbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	V1: Passenger car / V2:Passenger car	Dry	Daylight	Clear	BOYLSTON STREET Rte 9 / HIGH STREET					
2183889	BROOKLINE	26-Apr-2007	2:44 PM	Non-fatal injury	2	2	0	Angle	V1: Travelling straight ahead / V2:Travelling straight ahead	V1:Not reported / V2:Not reported	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	V1: Light truck(van, mini-van, panel, pickup, sport utility) with only four tires / V2:Passenger car	Dry	Daylight	Clear	WASHINGTON STREET / BOYLSTON STREET					
2190232	BROOKLINE	27-May-2007	4:00 PM	Property damage only (none injured)	2	0	0	Sideswipe, opposite direction	V1: Travelling straight ahead / V2:Travelling straight ahead	V1:Westbound / V2:Not reported	V1: Not reported / V2: Collision with motor vehicle in traffic	V1: Passenger car / V2:Passenger car	Dry	Daylight	Clear/Clear	WASHINGTON STREET / HIGH STREET / BOYLSTON STREET					
2197578	BROOKLINE	08-Jun-2007	10:05 AM	Property damage only (none injured)	2	0	0	Angle	V1: Travelling straight ahead / V2:Travelling straight ahead	V1:Southbound / V2:Eastbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	V1: Passenger car / V2:Passenger car	Dry	Daylight	Clear/Clear	BOYLSTON STREET Rte 9 / HIGH STREET					

MassHighway Crash Report for Brookline in the year 2008

Crash Number	City/Town Name	Crash Date	Crash Time	Crash Severity	Number of Vehicles	Total Nonfatal Injuries	Total Fatal Injuries	Manner of Collision	Vehicle Action Prior to Crash	Vehicle Travel Directions	Most Harmful Events	Vehicle Configuration	Road Surface Condition	Ambient Light	Weather Condition	At Roadway Intersection	Distance from Nearest Roadway Intersection	Distance from Nearest Milemarker	Distance from Nearest Exit	Distance from Nearest Landmark	Non Motorist Type
2481814	BROOKLINE	13-Aug-2008	3:00 AM	Property damage only (none injured)	2	0	0	Rear-end	V1: Slowing or stopped in traffic / V2:Slowing or stopped in traffic	V1:Southbound / V2:Southbound	V1: Not reported / V2: Not reported	V1: Passenger car / V2:Light truck(van, mini-van, panel, pickup, sport utility) with only four tires	Dry	Daylight	Clear	WASHINGTON STREET / BOYLSTON STREET					

MassHighway Crash Report for Brookline in the year 2008

Crash Number	City/Town Name	Crash Date	Crash Time	Crash Severity	Number of Vehicles	Total Nonfatal Injuries	Total Fatal Injuries	Manner of Collision	Vehicle Action Prior to Crash	Vehicle Travel Directions	Most Harmful Events	Vehicle Configuration	Road Surface Condition	Ambient Light	Weather Condition	At Roadway Intersection	Distance from Nearest Roadway Intersection	Distance from Nearest Milemarker	Distance from Nearest Exit	Distance from Nearest Landmark	Non Motorist Type
2594692	BROOKLINE	09-Jan-2009	7:55 AM	Non-fatal injury	2	1	0	Sideswipe, same direction	V1: Slowing or stopped in traffic / V2:Not reported	V1:Northbound / V2:Northbound	V1: Not reported / V2: Not reported	V1: Passenger car / V2:Passenger car	Dry	Daylight	Clear	HIGH STREET / WALNUT STREET / BOYLSTON STREET Rte 9					
2515641	BROOKLINE	01-Sep-2009	10:00 PM	Property damage only (none injured)	2	0	0	Angle	V1: Travelling straight ahead / V2:Travelling straight ahead	V1:Eastbound / V2:Southbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	V1: Light truck(van, mini-van, panel, pickup, sport utility) with only four tires / V2:Passenger car	Dry	Dark - lighted roadway	Clear	BOYLSTON STREET Rte 9 E / HIGH STREET					
2601247	BROOKLINE	10-Sep-2009	8:20 AM	Property damage only (none injured)	2	0	0	Rear-end	V1: Slowing or stopped in traffic / V2:Travelling straight ahead	V1:Southbound / V2:Eastbound	V1: Not reported / V2: Not reported	V1: Passenger car / V2:Passenger car	Dry	Daylight	Clear	BOYLSTON STREET Rte 9 / HIGH STREET					
2550184	BROOKLINE	15-Dec-2009	00:00 AM	Property damage only (none injured)	3	0	0	Rear-end	V1: Slowing or stopped in traffic / V2:Travelling straight ahead / V3:Slowing or stopped in traffic	V1:Eastbound / V2:Eastbound / V3:Eastbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic / V3: Collision with motor vehicle in traffic	V1: Passenger car / V2:Passenger car / V3:Passenger car	Wet	Dark - lighted roadway	Clear	WASHINGTON STREET / BOYLSTON STREET / HIGH STREET					