



TOWN OF BROOKLINE

Department of Public Works
333 Washington Street
Brookline, MA 02445

Right Turn On Red Restriction

For

Harvard Street at School Street and Aspinwall Avenue

The purpose of this study is to determine if the right turn restriction on the approaches to the Harvard Street at Aspinwall Avenue and School Street intersection are warranted. The study location can be seen in **Figure 1**. Recommendations will be based on the guidelines found in the latest edition 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 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 Harvard Street at Aspinwall Avenue and School 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 Harvard Street at Aspinwall Avenue and School 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** below. 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			
Harvard Street Southbound	>400'	200'	
Harvard Street Northbound	>400'	205'	
School Street Eastbound	>400'	205'	
Aspinwall Avenue Westbound	>400'	205'	
Intersection Sight Distance - Stop Control			
	Behind Stop line	At Crosswalk	
Harvard Street Southbound	<100'	265'	290'
Harvard Street Northbound	150'	250'	290'
School Street Eastbound	>400'	>400'	290'
Aspinwall Avenue Westbound	<100	110'	290'

¹Recommended 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 all approaches. The Harvard Street Southbound approach has deficient intersection sight distance sight triangles are obstructed by vegetation, a building corner, and a signal control cabinet. Harvard Street Northbound approach has deficient intersection sight distance sight triangles are obstructed by concrete fencing and vegetation. The School Street eastbound approach has adequate intersection sight distance. The Aspinwall Avenue westbound approach has restricted intersection sight distance, sight triangles are obstructed by on street parking and a building corner. The MUTCD suggest restricting right turn on red movements when sight distance of vehicles approaching from the left are restricted.

GEOMETRIC AND OPERATIONAL CHARACTERISTICS

Harvard Street meets Aspinwall Avenue and School Street at 90 degrees to form a four way signalized intersection. The Harvard Street northbound approach provides one right-through lane and one left turn lane with on street parking. Harvard Street Southbound provides one right-through lane and one left turn lane with no on street parking. Aspinwall Avenue and School Street eastbound both provide one right-through lane and a left turn lanes with no on street parking permitted.

Stop lines and the crosswalks have been pulled back on the westbound and southbound approach because of truck turning radiuses that encroach on the adjacent lane. It would not be desirable to have cars pulling beyond the stop bar on red and potentially impeding trucks ability to maneuver the intersection.

PEDESTRAIN CONFLICTS AND SIGNAL PHASING

Pedestrian activity at the Aspinwall Avenue and School Street at Harvard Street intersection is high. The signal timing provides an exclusive pedestrian phase during which time all vehicles should be stopped so pedestrians can cross. The MBTA has bus stops adjacent to the intersection. The MUTCD recommends no turn on red when an exclusive pedestrian phase is used. Land use at the intersection is primarily commercial.

CRASH ANALYSIS

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

<u>Data Category</u>	<u>Fuller St at Harvard St</u>
Year:	
2007	5
2008	2
2009	4
Total	11
Type:	
Angle	3
Rear-End	3
Right-On-Red	0
Head-On	0
Sideswipe	1
Pedestrian	2
Unknown/Other	2
Severity:	
P. Damage Only	7
Personal Injury	2
Fatality	0
Unknown/Other	2
Conditions:	
Dry	8
Wet	2
Snow/Ice	1
Other/Unreported	0
Time:	
7:00 AM to 9 AM	2
4:00 AM to 6 PM	2
Rest of Day	9

As summarized in **Table 2**, a total of eleven crashes were reported for Aspinwall Avenue and School Street at Harvard Street intersection for the three-year period studied from 2007 to 2009. None of the reported crashes were from vehicles making 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 or more accidents were caused by right turn on red maneuvers within 12 months.

CONCLUSIONS

The northbound, southbound, and westbound approaches at the Aspinwall Avenue and School Street at Harvard Street intersection have restricted sight lines, heavy pedestrian usage with an exclusive pedestrian phase at which time all vehicles should be stopped and pedestrians allowed to cross, and geometric constraints that require vehicles to stay behind the stop line. 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

Aspinwall Avenue Westbound Approach

Intersection Sight Distance	Speed		
	<u>Posted</u>	<u>Average</u>	<u>85th</u>
<u>Looking North</u>			
Stop Control Left Turning	0	0	0
Stop Control Right Turning/Crossing	0	0	0
Yield Control Left Turning	0	0	0
Yield Control Right Turning/Crossing	0	0	0
<u>Looking South</u>			
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		
	<u>Posted</u>	<u>Average</u>	<u>85th</u>
Northbound Stopping Sight Distance	205	0	0
Southbound Stopping Sight Distance	0	0	0

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

Sight Distance Formulas - Source: AASHTO

$$\text{Intersection Sight Distance} = 1.47 \times V \times t$$

$$\text{Stopping Sight Distance} = (1.47 \times V \times s) + \frac{V^2}{(30 \times ((a/32.2) + (G/100)))}$$

Where:

s = Reaction Time (sec) = 2.5 s

V = Travel Speed (mph)

G = Roadway Grade

a = Deceleration Rate (ft/sec²) = 11.2 ft/s²

- 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

School Street Eastbound Approach

Intersection Sight Distance	Speed		
	<u>Posted</u>	<u>Average</u>	<u>85th</u>
<u>Looking North</u>			
Stop Control Left Turning	331	0	0
Stop Control Right Turning/Crossi	287	0	0
Yield Control Left Turning	353	0	0
Yield Control Right Turning/Crossi	309	0	0
<u>Looking South</u>			
Stop Control Left Turning	0	0	0
Stop Control Right Turning/Crossi	0	0	0
Yield Control Left Turning	0	0	0
Yield Control Right Turning/Crossi	0	0	0
Stopping Sight Distance	Speed		
	<u>Posted</u>	<u>Average</u>	<u>85th</u>
Northbound Stopping Sight Distan	0	0	0
Southbound Stopping Sight Distan	205	0	0

<u>Inputs</u>	North Bound			South Bound		
	Posted	Average	85th	Posted	Average	85th
Speed:				30		
Grade:				-3		

Sight Distance Formulas - Source: AASHTO

Intersection Sight Distance = $1.47 \times V \times t$

Stopping Sight Distance = $(1.47 \times V \times s) + \frac{V^2}{(30 \times ((a/32.2) + (G/100)))}$

Where:

s = Reaction Time (sec) = 2.5 s

V= Travel Speed (mph)

G= Roadway Grade

a = Deceleration Rate (ft/sec²) = 11.2 ft/s²

- 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

Harvard Street Northbound

Intersection Sight Distance	Speed		
	<u>Posted</u>	<u>Average</u>	<u>85th</u>
<u>Looking East</u>			
Stop Control Left Turning	0	0	0
Stop Control Right Turning/Crossi	0	0	0
Yield Control Left Turning	0	0	0
Yield Control Right Turning/Crossi	0	0	0
<u>Looking West</u>			
Stop Control Left Turning	331	0	0
Stop Control Right Turning/Crossi	287	0	0
Yield Control Left Turning	353	0	0
Yield Control Right Turning/Crossi	309	0	0
Stopping Sight Distance	Speed		
	<u>Posted</u>	<u>Average</u>	<u>85th</u>
Eastbound Stopping Sight Distance	202	0	0
Westbound Stopping Sight Distan	0	0	0

<u>Inputs</u>	East Bound			West Bound		
	Posted	Average	85th	Posted	Average	85th
Speed:	30					
Grade:	-2					

Sight Distance Formulas - Source: AASHTO

Intersection Sight Distance = $1.47 \times V \times t$

Stopping Sight Distance = $(1.47 \times V \times s) + \frac{V^2}{(30 \times ((a/32.2) + (G/100)))}$

Where:

s = Reaction Time (sec) = 2.5 s

V= Travel Speed (mph)

G= Roadway Grade

a = Deceleration Rate (ft/sec²) = 11.2 ft/s²

- 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

Harvard Street Southbound Approach

Intersection Sight Distance	Speed		
	<u>Posted</u>	<u>Average</u>	<u>85th</u>
<u>Looking East</u>			
Stop Control Left Turning	331	0	0
Stop Control Right Turning/Crossi	287	0	0
Yield Control Left Turning	353	0	0
Yield Control Right Turning/Crossi	309	0	0
<u>Looking West</u>			
Stop Control Left Turning	0	0	0
Stop Control Right Turning/Crossi	0	0	0
Yield Control Left Turning	0	0	0
Yield Control Right Turning/Crossi	0	0	0
Stopping Sight Distance	Speed		
	<u>Posted</u>	<u>Average</u>	<u>85th</u>
Eastbound Stopping Sight Distanc	0	0	0
Westbound Stopping Sight Distanc	199	0	0

<u>Inputs</u>	East Bound			West Bound		
	Posted	Average	85th	Posted	Average	85th
Speed:				30		
Grade:				-1		

Sight Distance Formulas - Source: AASHTO

Intersection Sight Distance = $1.47 \times V \times t$

Stopping Sight Distance = $(1.47 \times V \times s) + \frac{V^2}{(30 \times ((a/32.2) + (G/100)))}$

Where:

s = Reaction Time (sec) = 2.5 s

V= Travel Speed (mph)

G= Roadway Grade

a = Deceleration Rate (ft/sec²) = 11.2 ft/s²

- 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
2316209	BROOKLINE	28-Jan-2007	12:00 PM	Non-fatal injury	2	2	0	Rear-end	V1: Slowing or stopped in traffic / V2: Travelling straight ahead	V1: Northbound / V2: Northbound	V1: Not reported / V2: Not reported	V1: Passenger car / V2: Passenger car	Dry	Daylight	Clear		HARVARD STREET / SCHOOL STREET			NEAR WALGREENS	
2357730	BROOKLINE	09-May-2007	5:45 AM	Property damage only (none injured)	2	0	0	Sideswipe, same direction	V1: Travelling straight ahead / V2: Entering traffic lane	V1: Northbound / V2: Northbound	V1: Not reported / V2: Not reported	V1: Passenger car / V2: Bus (seats for more than 15 people, including driver)	Dry	Daylight	Clear		HARVARD STREET / SCHOOL STREET				
2370054	BROOKLINE	09-Aug-2007	7:45 AM	Not Reported	2	0	0	Rear-end	V1: Parked / V2: Unknown	V1: Not reported / V2: Not reported	V1: Not reported / V2: Not reported	V1: Passenger car / V2: Passenger car	Dry	Daylight	Clear		ASPINWALL AVENUE / HARVARD AVENUE			CLOSE OT WALGREEN NEAR BROK VIL	
2359937	BROOKLINE	20-Sep-2007	5:50 AM	Property damage only (none injured)	2	0	0	Angle	V1: Turning left / V2: Travelling straight ahead	V1: Northbound / V2: Northbound	V1: Not reported / V2: Not reported	V1: Passenger car / V2: Passenger car	Wet	Daylight	Clear		99 HARVARD STREET / ASPINWALL AVENUE				
2241120	BROOKLINE	14-Oct-2007	10:24 AM	Property damage only (none injured)	1	0	0	Single vehicle crash	V1: Turning left	V1: Not reported	V1: Collision with motor vehicle in traffic	V1: Passenger car	Dry	Daylight	Clear/Clear	SCHOOL STREET / HARVARD STREET					P2: Pedal cyclist (bicycle, bicycle, unicycle, pedal car)

**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
2278061	BROOKLINE	17-Jan-2008	7:00 AM	Property damage only (none injured)	1	0	0	Single vehicle crash	V1: Turning right	V1:Northbound	V1: Collision with light pole or other post/support	V1: Truck/trailer	Dry	Daylight	Clear	HARVARD STREET / ASPINWALL AVENUE					
2530487	BROOKLINE	05-Mar-2008	12:00 PM	Property damage only (none injured)	2	0	0	Angle	V1: Travelling straight ahead / V2:Entering traffic lane	V1:Eastbound / V2:Westbound	V1: Not reported / V2: Not reported	V1: Not reported / V2:Not reported	Dry	Daylight	Cloudy	ASPINWALL AVENUE / HARVARD STREET					

**MassHighway Crash Report for Brookline in the year 2009**

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
2424626	BROOKLINE	06-Jan-2009	11:25 PM	Property damage only (none injured)	1	0	0	Single vehicle crash	V1: Travelling straight ahead	V1: Southbound	V1: Collision with light pole or other post/support	V1: Passenger car	Ice	Dark - lighted roadway	Cloudy		100 feet N from Intersection 99 HARVARD STREET / ASPINWALL AVENUE				
2572665	BROOKLINE	27-Feb-2009	4:30 PM	Non-fatal injury	2	2	0	Rear-end	V1: Slowing or stopped in traffic / V2: Travelling straight ahead	V1: Not reported / V2: Not reported	V1: Not reported / V2: Not reported	V1: Passenger car / V2: Passenger car	Dry	Daylight	Clear		40 ASPINWALL AVENUE / HARVARD AVENUE				
2485619	BROOKLINE	29-Jun-2009	5:12 PM	Not Reported Property damage only (none injured)	1	0	0	Single vehicle crash	V1: Not reported	V1: Not reported	V1: Not reported	V1: Passenger car	Dry	Daylight	Clear		85 HARVARD STREET / SCHOOL STREET				P2: Pedestrian
2534793	BROOKLINE	29-Oct-2009	00:00 AM	Property damage only (none injured)	2	0	0	Angle	V1: Travelling straight ahead / V2: Travelling straight ahead	V1: Not reported / V2: Not reported	V1: Not reported / V2: Not reported	V1: Passenger car / V2: Passenger car	Wet	Dark - lighted roadway	Rain/Rain	HARVARD STREET / SCHOOL STREET					