

Traffic Diversion Analysis Study

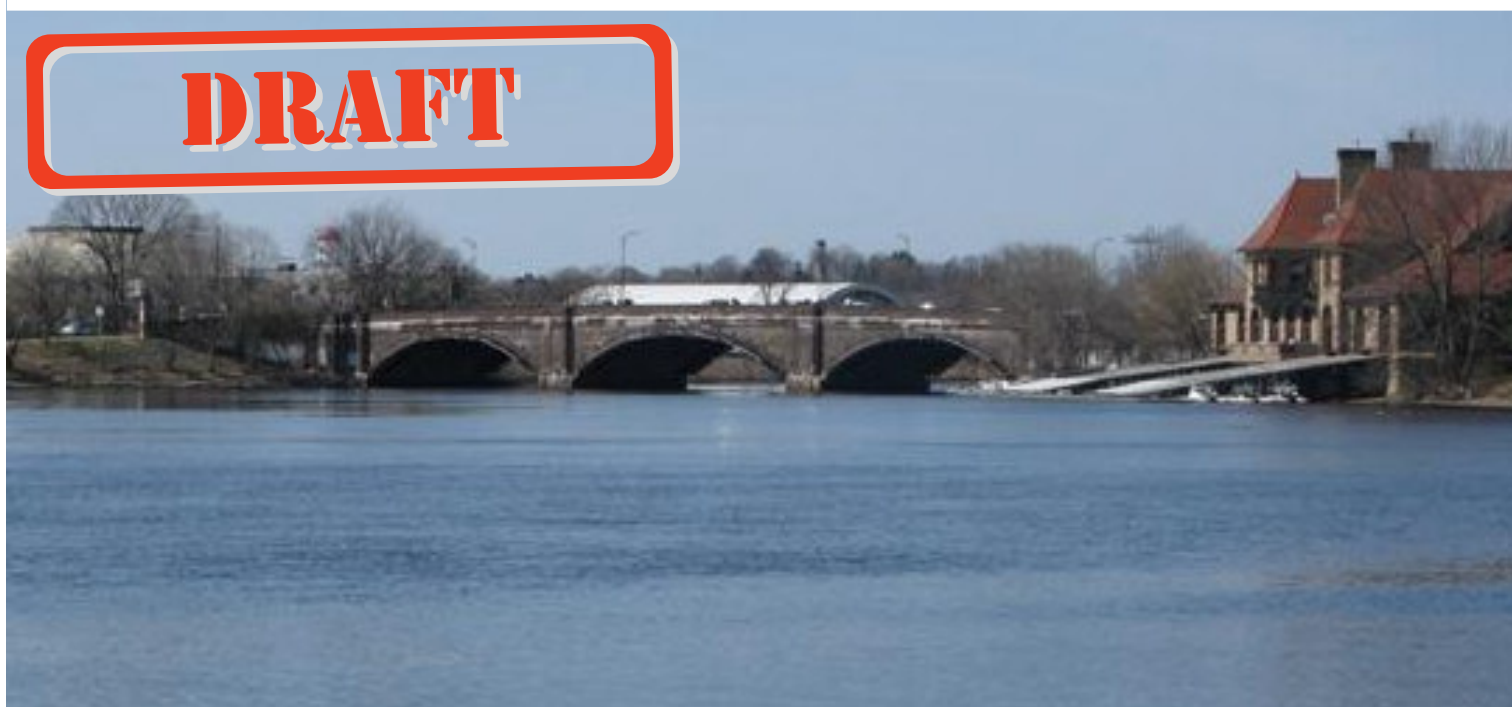


Rehabilitation of Anderson Memorial Bridge

Boston & Cambridge, MA



DRAFT



Prepared for MassDOT

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January 2011

1.0 INTRODUCTION

1.1 General

The Anderson Memorial Bridge Rehabilitation Project is part of the Commonwealth's Accelerated Bridge Program. The Massachusetts Department of Transportation Highway Division (MassDOT) has hired the consulting firm of Fay, Spofford & Thorndike (FST) to design the rehabilitation of the bridge. The Anderson Memorial Bridge spans the Charles River and connects North Harvard Street to the south in the City of Boston, and to JFK Street to the north in the City of Cambridge, Massachusetts. As part the project, FST was requested by MassDOT to study the feasibility of altering the turn restrictions at the Memorial Drive and JFK Street intersection.

The current proposal is to prohibit all left turns at the Memorial Drive and JFK Street intersections. With the restrictions of left turns, MassDOT has requested that a sensitivity analysis be performed to determine where the restricted movements will relocate and how the additional traffic will affect the intersection's operation.

1.3 Scope of the Traffic Diversion Analysis Study

The scope of the Traffic Diversion Analysis Study is to assess the following key points:

1. The impact of the restricted movements additional volumes to the study area intersections.
2. The needs of the study area intersections in terms of geometric layout, signal timings and phasing, etc.

The study area for this diversion analysis is shown in Figure 1 and includes the following intersections:

- Memorial Drive/Hawthorn Street;
- Memorial Drive/Dewolf Street.

The study area was defined upon discussions with the Cities of Cambridge, Boston and MassDOT.

2.0 HISTORICAL BACKGROUND

2.1 Previous Studies

The basis for restricting the left turns at Memorial Drive and JFK Street is to improve overall intersection operations and enhance overall safety at the

intersection. See Figure 2 for existing conditions. The Jacobs Engineering Group, Inc. initially prepared a memorandum¹ that summarized the impacts of various traffic alternatives along the North Harvard Street-JFK Street Corridor. These alternatives explored various closure,; turn restrictions, and lane eliminations.

2.2 Jacobs Study Methodology and FST Review

The Jacobs memo cited previously, used 2008 data that had been projected to the build-out year of 2026 by utilizing a general annual background growth rate of 0.25% per year and included traffic from other Harvard-approved projects such as the First Science Complex and other known BRA-approved projects. This resulted in an approximate growth rate of 5% compounded from the 2008 peak hour data to the 2026 future conditions.

To be consistent with previous area-wide analyses, FST will be utilizing this traffic volume data, along with the Synchro traffic analysis files used by Jacobs in their study.

2.3 Functional Design Report

In August 2009, FST submitted a Functional Design Report (FDR) with the 25% Design Submission. Two alternatives were considered for the FDR. One alternative restricted left turns onto JFK Street and southbound left turns onto Memorial Drive. The other alternative restricted all left turns at the Memorial Drive/JFK Street intersection. Of the two alternatives considered in the FDR prepared by FST, the alternative restricting all left turns was considered the best candidate for intersection operations and safety.

2.4 Key Analysis Parameters and Safety Concerns with Traffic Diversion

The following are key safety/operational issues with the diverted traffic; turn prohibitions, and geometric modifications to be assessed as part of this study:

- Length of vehicle queue southbound on Hawthorn Street so as not to block the Mt. Auburn Street intersection. Approximately 315 feet is available;

3.0 DATA COLLECTION AND TRAFFIC PROJECTIONS

3.1 Geometrics

FST conducted field reconnaissance of the study area intersections on December 15, 2010 and January 4, 2011 to observe traffic operations, bicycle

¹ Memorandum-North Harvard Street-JFK Corridor Traffic Analysis; Jacobs Engineering Group Inc.; October 14, 2009

and pedestrian activity, collect roadway and intersection measurements, note signing and pavement markings, and record traffic signal timing and phasing.

Memorial Drive/Hawthorn Street

This three-way unsignalized intersection consists of Memorial Drive running in an east/west direction with Hawthorn Street approaching from the north. The southbound approach on Hawthorn Street is approximately 20 feet wide with one left turn lane and one right turn lane. The lanes are not striped for two lanes but it is wide enough for two cars and operates as two lanes. A raised delta-shaped island separates the north and southbound legs on Hawthorn Street. The Memorial Drive westbound leg is approximately 45 feet wide with two through lanes and a channelized right-turn lane. The eastbound leg has a width of 45 feet with two through lanes. Memorial Drive lanes are separated by a double yellow centerline (DYCL). Hawthorn Street also has a DYCL. There are crosswalks across Hawthorn Street at the intersection on the west side of the intersection on Memorial Drive. There is on street parking on the north side of Memorial Drive, 500 feet west of the intersection except for the hours of 7AM – 10AM and 4PM – 6PM. There is on street parking for residents only on the east side of Hawthorn Street.

Land use at the intersection consists of an apartment building on the northeast corner. Northwest of the intersection is Longfellow Park and south of the intersection is the Charles River. The intersection is under the jurisdiction of the Department of Recreation and Conservation.



Memorial Drive/Dewolf Street

This three-way signalized intersection consists of Memorial Drive running in an east/west direction with Dewolf Street, a one-way street, approaching from the north. The southbound approach on Dewolf Street is approximately 34 feet wide

with a left turn only and a right turn only lane. The Memorial Drive west leg is approximately 39 feet wide with two through lanes. The east leg has a width of 44 feet with two through lanes. Memorial Drive is separated by a DYCL. There are crosswalks at all three approaches along with signalized pedestrian accommodations.

Land use at the intersection consists of Harvard University dormitories and buildings along with additional green space. South of the intersection is the John W. Weeks Pedestrian Bridge that crosses over the Charles River.



In order to evaluate traffic operating conditions at the study area intersections in Cambridge, a traffic count program was conducted on Wednesday December 1, 2010. This traffic count program consisted of manual turning-movement counts (TMCs) during the weekday peak periods.

TMCs were taken at the Memorial Drive/Hawthorn Street intersection for two hours during the AM peak period (7-9 AM) and two hours during the PM peak period (4-6 PM). From the data, peak-hour traffic volumes for the study area intersections were determined. Peak hours were 7:30-8:30 AM and 4:15-5:15 PM. TMCs for the Memorial Drive/Dewolfe Street intersection were taken from previous counts performed by Vanasse Hangen Brustlin, Inc. (VHB) in October 2008. It was determined that counts from VHB for both study area intersections were to be used in the analyses. Research indicates that the 2008 counts were higher than the 2010 counts, thus to be conservative, the 2008 data was used. Table 1 presents a comparison of the FST traffic count program to the VHB counts. See Figure 3 for a graphic of the existing traffic volumes.

Table 1 – Comparison of 2008 & 2010 TMCs at Memorial Dr & Hawthorn St

October 2008		December 2010	
AM 2021*	PM 1907*	AM 1732*	PM 1548*

* Total peak hour volume entering the intersection

3.2 Accident History

As part of the study, FST investigated recent accident trends in the study area. As part of this effort, the accident history for the study area intersections were investigated for the three-year period of 2006, 2007, and 2008 from the MassDOT database for these three years. Table 2 summarizes the accidents over the three-year period.

Table 2 – 3-Year Crash History

Condition	Memorial Drive & Hawthorn Street	Memorial Drive & Dewolfe Street	Total
	No	Yes	
<u>Signalized?</u>			
<u>Year</u>			
2006	3	3	6
2007	0	3	3
<u>2008</u>	<u>1</u>	<u>1</u>	<u>2</u>
Total	4	7	11
<u>Collision Type</u>			
Angle	0	1	1
Head-on	0	0	0
Rear-end	3	0	3
Sideswipe	0	1	1
Single Vehicle	0	4	4
<u>Unknown</u>	<u>1</u>	<u>1</u>	<u>2</u>
Total	4	7	11
<u>Severity</u>			
Fatality	0	0	0
Injury	2	1	3
Property	2	3	5
Bicyclist	0	1	1
Pedestrian	0	1	1
<u>Unknown</u>	<u>0</u>	<u>1</u>	<u>1</u>
Total	4	7	11
<u>Time of Day</u>			
7:00 AM – 9:00 AM	2	0	2
9:01 AM – 3:59 PM	1	3	4
4:00 PM – 6:00 PM	0	1	1
<u>6:01 PM – 6:59 AM</u>	<u>1</u>	<u>3</u>	<u>4</u>
Total	4	7	11
<u>Pavement Conditions</u>			
Dry	3	4	7
Wet	1	2	3
Snow	0	1	1
Ice	0	0	0
Other	0	0	0
<u>Unknown</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total	4	7	11
Intersection Crash Rate	0.24	0.34	
MHD Crash Rate	0.62	0.82	
Above MHD Crash Rate?	No	No	

Although the number of accidents alone is important, the actual exposure or potential for an individual driver being involved in an accident is reflected in the crash rate. The crash rate is defined as the number of accidents per million entering vehicles at an intersection. Using MassDOT's Crash Rate Worksheet, neither intersection was found to be a high accident location.

3.3 Traffic Operations

Level of Service (LOS) is an expression of the quality of flow of traffic. LOS is a commonly used and accepted measure of the effectiveness of peak-hour traffic operating conditions. It takes into account automobile and truck volumes, roadway width, speed, grade, parking restrictions, pedestrian activity, and traffic control devices.

LOS is designated in a range from Level "A", which is the optimal condition where roadway operations are at their best, to Level "F" which indicates excessive delays. Levels "A" through "D" are typically associated with acceptable levels of peak hour traffic operations. At level "E", the ratio of the approach volume to capacity, or v/c ratio, of an intersection is between 90 and 100 percent of its theoretical capacity. Traffic congestion is considered to be unacceptable at Level of Service "E" or "F".

All capacity analysis for the study area intersections in Cambridge were performed in accordance with the methodologies set forth in the 2000 Highway Capacity Manual. LOS at signalized and unsignalized intersections is based on estimates of delay per vehicle. Table 3 presents a summary of the level of service criteria for signalized and unsignalized intersections.

Table 3 - Intersection Level of Service Criteria

Level of Service	Unsignalized Delay (sec/veh.)	Signalized Delay (sec/veh)
A	≤10	≤10
B	>10 to 15	>10 to 20
C	>15 to 25	>20 to 35
D	>25 to 35	>35 to 55
E	>35 to 50	>55 to 80
F	>50	>80

Source: Highway Capacity Manual, 2000

Table 4 presents a summary of existing 2008 traffic operating conditions at the study area intersections. Where applicable, vehicle queues are also noted in Table 4.

TABLE 4 – Existing Weekday Peak Hour Intersection Level of Service

Memorial Drive (EB/WB) Intersection	Movement	AM Peak					PM Peak					
		Delay ¹	LOS	v/c ²	Queue ³ 50% 95%		Delay ¹	LOS	v/c ²	Queue ³ 50% 95%		Obs ⁴
<i>Signalized Intersections</i>												
<u>Dewolfe Street</u>												
	Southbound Lt	11.7	B	0.54	51	100	12.0	B	0.56	56	108	
	Southbound Rt	9.1	A	0.07	0	20	9.1	A	0.08	0	21	
	Southeast Th	12.0	B	0.76	89	212	9.7	A	0.61	67	128	
	Northwest Th	8.4	A	0.50	50	102	10.0	A	0.63	70	135	
	OVERALL	10.7	B	0.67			10.1	B	0.60			
<i>Unsignalized Intersection</i>												
<u>Hawthorn Street</u>												
	Southbound Lt	61.1	F	0.94		276 100	40.2	E	0.79		171 75	
	Southbound Rt	12.9	B	0.43		54	11.5	B	0.25		25	

1. Delay in seconds per vehicle.
2. Volume to capacity ratio.
3. Queue in feet per lane (25 feet per vehicle).
4. Observed queues in feet (25 feet per vehicle).

The Memorial Drive/Hawthorn Street intersection has a LOS F with long delays for the southbound movement only (from Hawthorn Street) in both peak periods. This unsignalized operation is not uncommon for many of the side street intersections onto Memorial Drive.

3.4 Traffic Signal Warrant Analysis

A signal warrant analysis was conducted for the Memorial Drive/Hawthorn Street intersection based on existing traffic volumes and procedures found in the Manual on Uniform Traffic Control Devices (MUTCD). In order to justify installation of traffic signals at an intersection, one or more of the following eight signal warrants should be met.

- Warrant 1 – Eight-Hour Vehicular Volume
- Warrant 2 – Four-Hour Vehicular Volume
- Warrant 3 – Peak Hour
- Warrant 4 – Pedestrian Volume
- Warrant 5 – School Crossings
- Warrant 6 – Coordinated Signal System
- Warrant 7 – Crash Experience
- Warrant 8 – Roadway Network

Research of the applicable signal warrants indicates the Eight-Hour Vehicular Volume, Four-Hour Vehicular Volume, and Peak Hour warrants are technically satisfied.

Thus preliminary assessment indicates a traffic signal is technically warranted at this intersection. An outline of geometric improvements will be discussed in a later section of this study.

4.0 FUTURE CONDITIONS

4.1 Sensitivity Analysis

As a result of implementing the preferred alternative for the Memorial Drive/JFK Street intersection, the change in traffic patterns will affect turn movements at several locations. A graphic depicting these affected or eliminated traffic movements is shown in Figure 4.

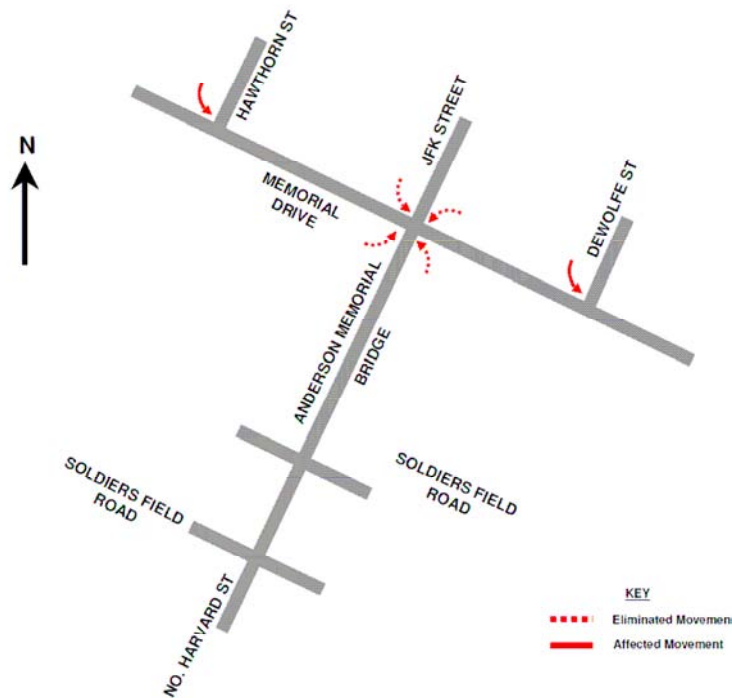


Figure 4 – Affected/Eliminated Traffic Movements

A diversion analysis was performed for the future Build morning and afternoon peak hour traffic volumes based on the proposed configuration of the Memorial Drive/JFK Street intersection. Nine alternatives based on various volume assignments for the southbound left turn from JFK Street to Memorial Drive were analyzed. These movements (or diversion of turns) were split between use of the two intersections as follows: 90/10, 80/20, 70/30, 60/40, 50/50, 40/60, 30/70, 20/80 and 10/90 splits. Specifically, the volumes were diverted to the Memorial Drive/Hawthorn Street and Memorial Drive/Dewolfe Street intersections from the JFK Street southbound left turn movement with the distribution patterns noted previously.

4.2 Traffic Operations

For the traffic analysis, the future year conditions are the 2026 conditions defined in previous studies. The 2026 No Build condition serves as the baseline condition, i.e., no turn restrictions are proposed. See Figure 5 for a graphic of the 2026 No Build traffic volumes and Table 5 for the No Build analysis results.

TABLE 5 – 2026 No Build Weekday Peak Hour Intersection Level of Service

Memorial Drive (EB/WB) Intersection Movement	AM Peak					PM Peak					
	Delay ¹	LOS	v/c ²	Queue ³ 50% 95%		Delay ¹	LOS	v/c ²	Queue ³ 50% 95%		
<i>Signalized Intersections</i>											
<u>Dewolfe Street</u>											
Southbound Lt	12.0	B	0.56	54	106	12.1	B	0.57	56	110	
Southbound Rt	9.1	A	0.07	0	21	9.1	A	0.08	0	22	
Southeast Th	19.4	B	0.91	120	272	10.0	B	0.64	72	137	
Northwest Th	8.8	A	0.53	55	108	10.0	A	0.64	71	136	
OVERALL	14.7	B	0.75			10.3	B	0.61			
<i>Unsignalized Intersections</i>											
<u>Hawthorn Street</u>											
Southbound Lt	137.2	F	1.19		465	57.3	F	0.90		232	
Southbound Rt	14.3	B	0.50		71	11.8	B	0.27		28	

1. Delay in seconds per vehicle.
2. Volume to capacity ratio.
3. Queue in feet per lane (25 feet per vehicle).

From the results, the Memorial Drive/Hawthorn Street intersection will experience more than 75 more seconds of delay in the morning and more than 15 more seconds in the evening. The Memorial Drive/Dewolfe Street intersection experiences a very minimal increase in delay.

As part of the diversion analysis, analysis results for study area intersections, including representative vehicle queues and delays for key movements are shown for each alternative (Build condition). Tables 3-11 show the nine 2026 Build alternatives. See Figures 6-14 for graphics of the 2026 Build traffic volumes.

TABLE 6 – 2026 Build 90/10 Distribution Weekday Peak Hour Intersection Level of Service

Memorial Drive (EB/WB) Intersection Movement	AM Peak					PM Peak				
	Delay ¹	LOS	v/c ²	Queue ³		Delay ¹	LOS	v/c ²	Queue ³	
				50%	95%				50%	95%
<i>Signalized Intersections</i>										
<u>Dewolfe Street</u>										
Southbound Lt	12.1	B	0.57	56	110	12.2	B	0.58	58	114
<i>Unsignalized Intersections</i>										
<u>Hawthorn Street</u>										
Southbound Lt	229.6	F	1.42		703	130.6	F	1.17		439

1. Delay in seconds per vehicle.
2. Volume to capacity ratio.
3. Queue in feet per lane (25 feet per vehicle).

TABLE 7 – 2026 Build 80/20 Distribution Weekday Peak Hour Intersection Level of Service

Memorial Drive (EB/WB) Intersection Movement	AM Peak					PM Peak				
	Delay ¹	LOS	v/c ²	Queue ³		Delay ¹	LOS	v/c ²	Queue ³	
				50%	95%				50%	95%
<i>Signalized Intersections</i>										
<u>Dewolfe Street</u>										
Southbound Lt	12.2	B	0.58	58	113	12.3	B	0.59	61	117
<i>Unsignalized Intersections</i>										
<u>Hawthorn Street</u>										
Southbound Lt	218.8	F	1.39		676	120.3	F	1.14		413

1. Delay in seconds per vehicle.
2. Volume to capacity ratio.
3. Queue in feet per lane (25 feet per vehicle).

TABLE 8 – 2026 Build 70/30 Distribution Weekday Peak Hour Intersection Level of Service

Memorial Drive (EB/WB) Intersection Movement	AM Peak					PM Peak				
	Delay ¹	LOS	v/c ²	Queue ³		Delay ¹	LOS	v/c ²	Queue ³	
				50%	95%				50%	95%
<i>Signalized Intersections</i>										
<u>Dewolfe Street</u>										
Southbound Lt	12.3	B	0.59	60	117	12.4	B	0.60	63	123
<i>Unsignalized Intersections</i>										
<u>Hawthorn Street</u>										
Southbound Lt	208.2	F	1.37		648	110.4	F	1.11		387

1. Delay in seconds per vehicle.
2. Volume to capacity ratio.
3. Queue in feet per lane (25 feet per vehicle).

TABLE 9 – 2026 Build 60/40 Distribution Weekday Peak Hour Intersection Level of Service

Memorial Drive (EB/WB) Intersection Movement	AM Peak					PM Peak				
	Delay ¹	LOS	v/c ²	Queue ³		Delay ¹	LOS	v/c ²	Queue ³	
				50%	95%				50%	95%
<i>Signalized Intersections</i>										
<u>Dewolfe Street</u>										
Southbound Lt	12.4	B	0.60	63	121	12.4	B	0.60	66	126
<i>Unsignalized Intersections</i>										
<u>Hawthorn Street</u>										
Southbound Lt	197.6	F	1.34		621	101.0	F	1.08		362

1. Delay in seconds per vehicle.
2. Volume to capacity ratio.
3. Queue in feet per lane (25 feet per vehicle).

TABLE 10 – 2026 Build 50/50 Distribution Weekday Peak Hour Intersection Level of Service

Memorial Drive (EB/WB) Intersection Movement	AM Peak					PM Peak				
	Delay ¹	LOS	v/c ²	Queue ³		Delay ¹	LOS	v/c ²	Queue ³	
				50%	95%				50%	95%
<i>Signalized Intersections</i>										
<u>Dewolfe Street</u>										
Southbound Lt	12.4	B	0.60	65	124	12.4	B	0.61	68	131
<i>Unsignalized Intersections</i>										
<u>Hawthorn Street</u>										
Southbound Lt	187.1	F	1.32		594	92.1	F	1.05		338

1. Delay in seconds per vehicle.
2. Volume to capacity ratio.
3. Queue in feet per lane (25 feet per vehicle).

TABLE 11 – 2026 Build 40/60 Distribution Weekday Peak Hour Intersection Level of Service

Memorial Drive (EB/WB) Intersection Movement	AM Peak					PM Peak				
	Delay ¹	LOS	v/c ²	Queue ³		Delay ¹	LOS	v/c ²	Queue ³	
				50%	95%				50%	95%
<i>Signalized Intersections</i>										
<u>Dewolfe Street</u>										
Southbound Lt	12.4	B	0.60	67	128	12.4	B	0.62	71	135
<i>Unsignalized Intersections</i>										
<u>Hawthorn Street</u>										
Southbound Lt	176.8	F	1.29		567	83.8	F	1.02		315

1. Delay in seconds per vehicle.
2. Volume to capacity ratio.
3. Queue in feet per lane (25 feet per vehicle).

TABLE 12 – 2026 Build 30/70 Distribution Weekday Peak Hour Intersection Level of Service

Memorial Drive (EB/WB) Intersection Movement	AM Peak					PM Peak				
	Delay ¹	LOS	v/c ²	Queue ³		Delay ¹	LOS	v/c ²	Queue ³	
				50%	95%				50%	95%
<i>Signalized Intersections</i>										
<u>Dewolfe Street</u>										
Southbound Lt	12.4	B	0.61	69	132	12.5	B	0.62	73	139
<i>Unsignalized Intersections</i>										
<u>Hawthorn Street</u>										
Southbound Lt	166.6	F	1.26		541	76.2	F	0.99		292

1. Delay in seconds per vehicle.
2. Volume to capacity ratio.
3. Queue in feet per lane (25 feet per vehicle).

TABLE 13 – 2026 Build 20/80 Distribution Weekday Peak Hour Intersection Level of Service

Memorial Drive (EB/WB) Intersection Movement	AM Peak					PM Peak				
	Delay ¹	LOS	v/c ²	Queue ³		Delay ¹	LOS	v/c ²	Queue ³	
				50%	95%				50%	95%
<i>Signalized Intersections</i>										
<u>Dewolfe Street</u>										
Southbound Lt	12.4	B	0.62	71	137	12.5	B	0.63	76	144
<i>Unsignalized Intersections</i>										
<u>Hawthorn Street</u>										
Southbound Lt	156.6	F	1.24		575	69.2	F	0.96		271

1. Delay in seconds per vehicle.
2. Volume to capacity ratio.
3. Queue in feet per lane (25 feet per vehicle).

TABLE 14 – 2026 Build 10/90 Distribution Weekday Peak Hour Intersection Level of Service

Memorial Drive (EB/WB) Intersection Movement	AM Peak					PM Peak				
	Delay ¹	LOS	v/c ²	Queue ³		Delay ¹	LOS	v/c ²	Queue ³	
				50%	95%				50%	95%
<i>Signalized Intersections</i>										
<u>Dewolfe Street</u>										
Southbound Lt	12.5	B	0.62	74	141	12.6	B	0.64	78	149
<i>Unsignalized Intersections</i>										
<u>Hawthorn Street</u>										
Southbound Lt	146.8	F	1.21		490	62.9	F	0.93		251

1. Delay in seconds per vehicle.
2. Volume to capacity ratio.
3. Queue in feet per lane (25 feet per vehicle).

A single general summary table showing the changes in delay compared to the No Build analysis for each movement, for each distribution pattern is shown in Table 15.

Table 15 – Changes in Delay

	<u>Hawthorn St SB Left</u>		<u>DeWolfe St SB Left</u>	
	<u>AM</u>	<u>PM</u>	<u>AM</u>	<u>PM</u>
No Build	137.2	57.3	12.0	12.1
90/10	+92.4	+73.3	+0.1	+0.1
80/20	+81.6	+63.0	+0.2	+0.2
70/30	+71.0	+53.1	+0.3	+0.3
60/40	+60.4	+43.7	+0.4	+0.3
50/50	+49.9	+34.8	+0.4	+0.3
40/60	+39.6	+26.5	+0.4	+0.3
30/70	+29.4	+18.9	+0.4	+0.4
20/80	+19.4	+11.9	+0.4	+0.4
10/90	+9.6	+5.6	+0.5	+0.5

From the tables, the following key changes in Level of Service (LOS) are noted from No Build to the Build conditions.

Memorial Drive/Hawthorn Street

The delay increases for all alternatives, but the smallest increase occurs with the 10/90-distribution pattern. Level of Service will remain the same in both the AM and PM peak periods from No Build to Build conditions.

Memorial Drive/Dewolfe Street

The Level of Service remains a LOS B for all scenarios with the delay increasing a maximum of 0.5 seconds from No Build to Build.

5.0 INTERSECTION IMPROVEMENTS

5.1 Memorial Drive/Hawthorn Street

In a previous section, the intersection at the Memorial Drive/Hawthorn Street was determined to satisfy traffic signal warrants. It was determined to meet three of the eight traffic signal warrants. While meeting signal warrants does not always mean a signal should be installed, FST tested the scenario with the worst delay for the unsignalized condition and assumed a traffic signal in place. The results are shown in Table 16.

**TABLE 16 – 2026 Build 90/10 Diversion with Mitigation Weekday Peak Hour
Intersection Level of Service**

Memorial Drive (EB/WB) Intersection Movement	AM Peak					PM Peak				
	Delay ¹	LOS	v/c ²	Queue ³		Delay ¹	LOS	v/c ²	Queue ³	
			50%	95%				50%	95%	
<i>Signalized Intersections</i>										
<u>Hawthorn Street</u>										
Eastbound Th	31.6	C	0.79	145	227	13.3	B	0.44	65	102
Westbound Th	27.7	C	0.68	120	172	14.3	B	0.54	82	125
Westbound Rt	0.1	A	0.18	0	0	0.1	A	0.22	0	0
Southbound Lt/Rt	29.7	C	0.95	307	588	21.5	C	0.86	133	300
OVERALL	26.3	C	0.91			13.9	B	0.72		

1. Delay in seconds per vehicle.
2. Volume to capacity ratio.
3. Queue in feet per lane (25 feet per vehicle).

Thus it can be seen that with a traffic signal in place there are improvements in delay, however, there are now delays for the Memorial Drive approaches that had none in the existing or No Build conditions.

In addition, the improvement plan to prohibit vehicle turns at the JFK Street and Memorial Drive intersection was intended to “clean-up” the intersection by minimizing conflicts while enhancing pedestrian mobility and better processing traffic along Memorial Drive. Adding a signal to this location will now cause a disruption in flow along Memorial Drive, as the two signals cannot be interconnected as they are two far apart and traffic may possibly be diverted to an alternate location such as Ash Street, which is unsignalized.

Pedestrian accommodations may be enhanced at Hawthorn Street with a signal, but the overall benefits do not outweigh the costs, increases in delay along Memorial Drive or operational benefits along the corridor. Besides pedestrians, the signal would only serve the left turns out as left turns in from Memorial Drive are prohibited.

Therefore the following are recommendations for the Memorial Drive/Hawthorn Street intersection:

- Maintain the intersection as an unsignalized condition;
- Upgrade the existing signing to include retroreflective signing;
- Add MUTCD compliant crosswalk signing with arrow plates east and west of the intersection;
- Upgrade the pavement markings at the intersection;
- Create consistent crosswalk markings at the intersection;
- Reconstruct the handicap ramps and include pedestrian detectable warning panels at the intersection; and

- Erect a “Keep Right”: (MUTCD designation R407) on the delta island facing southbound traffic.

5.2 Memorial Drive/Dewolfe Street

The following are recommended improvements to the Memorial Drive/Dewolfe Street intersection:

- Upgrade the pavement markings at the intersection;
- Upgrade the existing signing to include retroreflective signing;
- Revisit the signal timing at least twice a year to assure appropriate timing are provided to process southbound turning traffic and pedestrian volumes;
- Reconstruct the handicap ramps and include pedestrian detectable warning panels at the intersection; and
- Install pedestrian countdown signal heads.

6.0 SUMMARY OF FINDINGS

Accident analysis indicates that both study area intersections are not high accident locations.

The Hawthorn Street intersection with Memorial Drive presently operates with long delays (LOS F) as do other unsignalized locations onto Memorial Drive during the peak periods. Long queues were observed in the field, but the intersection was also observed to operate as if there were two approach lanes at Memorial Drive, thus processing more vehicles through the intersection. With diverted traffic through this intersection long delays will still continue. This location was not observed to be a high pedestrian location. A traffic signal is not recommended at this location, as the benefits do not outweigh the costs along the Memorial Drive corridor.

The Memorial Drive/Dewolfe Street intersection presently operates at an overall LOS B. During the peak periods, some long vehicle queues were observed on Dewolfe Street. With the addition of diverted traffic to this location under any one of the Build scenarios, acceptable Level of Service will still be provided and this intersection can absorb the addition of diverted left turn from JFK Street.