

TIP Project Impacts Before-After Evaluation

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1 BACKGROUND

This study evaluated the effectiveness of proposed safety and operational improvements for selected Transportation Improvement Program (TIP) projects. It is important to assess whether strategies employed in these projects would be successful and suitable in similar situations. In addition, federal regulation requires before-and-after evaluations as part of the mandatory Congestion Management Process (CMP). In 2012, MPO staff completed another study that compared before-and-after conditions at two TIP projects in Arlington and Westwood.

In this report, MPO staff selected four new TIP projects that were constructed in federal fiscal years 2009 and 2010 to evaluate the effectiveness of several mitigation measures to improve intersection safety and operations. Before-and-after data, such as traffic volumes and crashes, were collected to analyze 11 intersections in four different communities. The years 2009 and 2010 were selected for project completion to allow roadway users to become familiar with the updated operations, and for travel demand to normalize in the area. MPO staff gathered the before data and effectiveness measures from existing functional design reports (FDRs) and traffic studies; it then collected recent traffic counts and crash data to analyze the after conditions and compare them to the before conditions reported in the FDR.

2 INTRODUCTION

This memorandum summarizes the before-and-after effects of safety and operations at 11 intersection locations from four TIP projects funded by the Boston Region MPO. Project locations were Belmont—FDR “Pleasant Street, Belmont MA,” Canton—FDR “Route 138 – Two Locations, Canton MA,” Franklin—FDR “King Street at Interstate 495 (Union Street/Upper Union Street/Constitution Boulevard), Town of Franklin, MA,” and Hanover—FDR “Washington Street (Route 53) at Old Washington Street Safety Improvement Project, Hanover, MA.”

The 11 intersections studied in this report are:

- Pleasant Street (Route 60) at Concord Avenue – Belmont
- Pleasant Street (Route 60) at Clifton/Leonard Street – Belmont
- Pleasant Street (Route 60) at Brighton Street – Belmont
- Turnpike Street (Route 138) at Randolph Street – Canton
- Turnpike Street (Route 138) at Washington Street – Canton
- Constitution Boulevard at Upper Union Street – Franklin
- King Street at Constitution Boulevard – Franklin
- King Street at I-495 Southbound Ramps – Franklin
- King Street at I-495 Northbound Ramps – Franklin

- King Street at Union Street – Franklin
- Route 53 (Washington Street) at Old Washington/Pond Street – Hanover

The projects cited above were selected from the Massachusetts Department of Transportation (MassDOT) Project Information website.¹

Staff used the following steps to select the projects:

1. Compiled a list of all *completed* projects in the Boston Region MPO area that were cited on MassDOT's Project Information website; 473 projects were listed as complete.
2. Narrowed the list to projects that were funded in the TIP and completed by 2009 and 2010; this reduced the list to 13 projects.
3. Further reduced the list by eliminating bridge, highway-only, and resurfacing projects; this resulted in 12 potential projects.
4. Obtained FDRs for these 12 projects, of which only six reports were available in electronic or paper format.
5. Reviewed the six reports; selected four projects that included corridor or intersection-related improvements, which included 11 study intersections.

Staff used the following measures of effectiveness (MOEs) to evaluate each project:

- Level of service (LOS)
- Traffic volumes
- Intersection and approach delays
- Queue lengths
- Pedestrian and bicycle accommodations
- Number of crashes by type and severity
- Crash rate

¹ MassDOT Project Information Website:
<http://www.mhd.state.ma.us//default.asp?pgid=content/projectsRoot&sid=wrapper&iid=http://www.mhd.state.ma.us//ProjectInfo/>

3 INFORMATION SOURCES FOR THE SELECTED PROJECTS

Belmont

For the three intersections in Belmont, staff extracted data from the FDR “Pleasant Street, Belmont MA,” completed in December 1999 by The BSC Group, Inc.

The Belmont project involved reconstructing more than 1.8 miles of roadway; new sidewalks, guardrail, drainage systems, fieldstone walls; three signalized intersections; and installing traffic signs and pavement markings. Construction began in winter 2004 and finished in summer 2008. The estimated cost was \$7,674,231, and the actual construction contract cost was \$8,568,684.

Canton

For the two intersections in Canton, staff extracted data from the FDR “Route 138 – Two Locations, Canton MA,” completed in October 2001 by Vanasse Hangen Brustlin, Inc.

The Canton project involved roadway improvements—associated in part with the construction of Reebok World Headquarters—that consisted of roadway widening, new sidewalks, bicycle accommodations, traffic signal modifications, and improved pavement markings and drainage. Construction began in winter 2005 and finished in spring 2009. The estimated cost was \$1,623,183, and the actual construction contract cost was \$2,990,582.

Franklin

For the five intersections in Franklin, staff extracted data from the FDR “King Street at Interstate 495 (Union Street/Upper Union Street/Constitution Boulevard), Town of Franklin, MA,” completed in September 2001 by Bruce Campbell and Associates, Inc.

The Franklin project focused on safety and traffic improvements, extending along King Street from Union Street to Upper Union Street, including Upper Union Street from King Street to Constitution Boulevard, and all four I-495 ramps. The project primarily involved widening King Street to provide two lanes in each direction and realigning Upper Union Street to make Constitution Boulevard the major traffic movement. The construction included new traffic signals and coordinating the King Street traffic signals, drainage improvements, new sidewalks, pavement markings, signing, and landscaping. Construction began in summer 2009 and finished in summer 2010. The estimated cost was \$4,453,800, and the actual construction contract cost was \$3,420,413.

Hanover

For the one intersection in Hanover, staff extracted data from the FDR “Washington Street (Route 53) at Old Washington Street Safety Improvement Project, Hanover, MA,” completed in August 2005 by Vanasse Hangen Brustlin, Inc. This FDR was included as part of phase 1B in a larger reconstruction project along Route 53 in Hanover.

The Hanover project involved widening Route 53 to a five-lane cross section and upgrading the traffic signal system at the Old Washington Street intersection. In addition, Pond Street was relocated to align with Old Washington Street. Reconstruction also included new curbs, sidewalks, and pavement markings. Construction began in winter 2007 and finished in autumn 2010. The estimated cost was \$5,336,698, and the actual construction cost was \$6,233,125.

4 PLEASANT STREET (ROUTE 60)—BELMONT

Pleasant Street (Route 60) is an east-west roadway that is classified as an urban principal arterial. Pleasant Street begins to the west near the Waltham city line at Trapelo Road, traverses through the Town of Belmont, and ends beyond Route 2 to the east at the Arlington town line. Mixtures of residential, commercial, governmental, and institutional uses exist along Pleasant Street, including the Belmont Police Station and Belmont Town Hall, which are adjacent to the intersection of Pleasant Street at Concord Avenue. The Belmont study locations are illustrated in Figure 1.

The following sections provide a summary of the before-and-after conditions, along with a comparison of the crash data, traffic volumes, and traffic analysis at three signalized intersections along the Pleasant Street corridor.

4.1 Summary of Conditions Before and After Improvements

Pleasant Street at Concord Avenue—Before Improvements

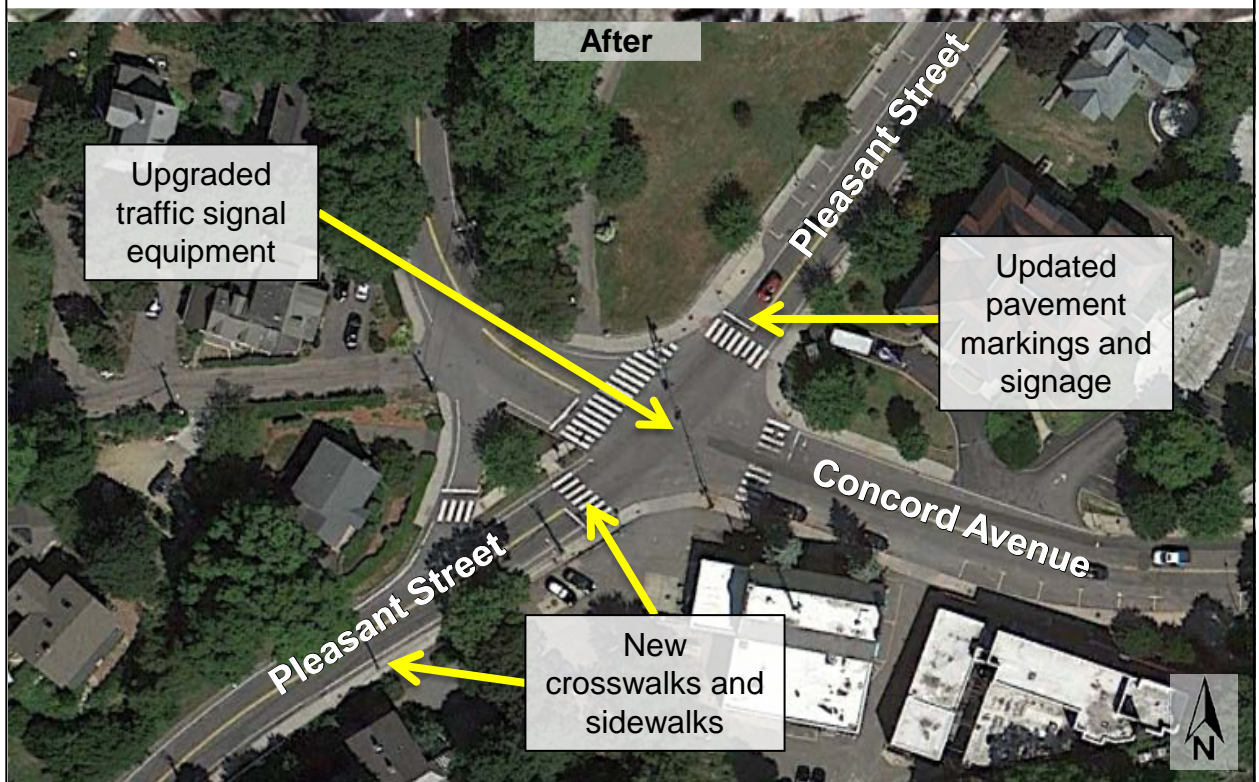
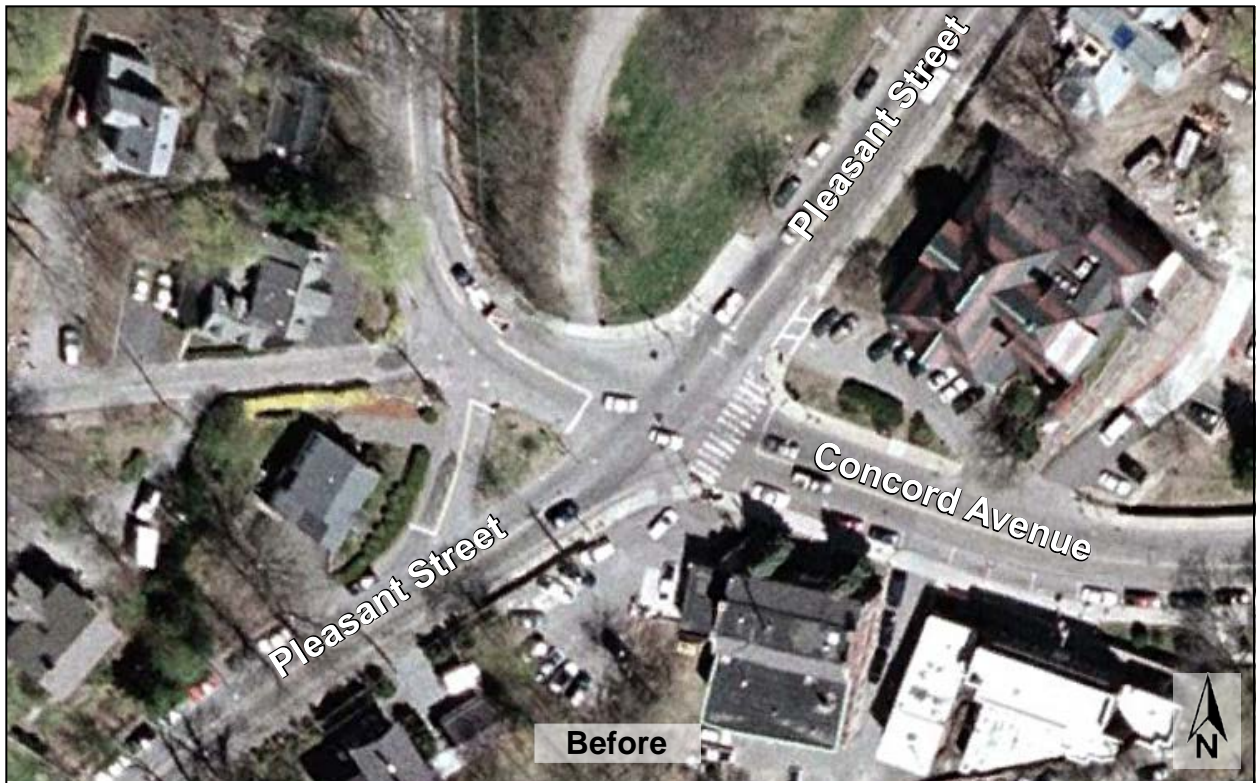
The intersection of Pleasant Street at Concord Avenue was a four-legged signalized intersection with post-mounted signal heads at Belmont Center. A steep downgrade existed on the southbound Concord Avenue approach. Crosswalks were provided on the westbound Pleasant Street and northbound Concord Avenue approaches with pushbutton-actuated pedestrian signals. Sidewalks were provided on both sides of the westbound and northbound approaches and the south side of the eastbound approach. No bicycle accommodations were provided. The eastbound and westbound Pleasant Street approaches had a single travel lane. Approximately 100 feet west of the intersection, dedicated lanes were provided for westbound left turns from

Pleasant Street onto Concord Avenue and for southbound right turns from Concord Avenue onto Pleasant Street, as shown in Figure 2.

The crash rate before reconstruction of the intersection was 0.60 crashes per million entering vehicles. According to the FDR, eight of the 14 crashes were rear-end collisions, and five were angle collisions. Six people were injured in these crashes.

The intersection operated at an overall LOS C in the AM peak hour and LOS B during the PM peak hour, with an average delay of 25.2 seconds per vehicle (sec/veh) and 17.9 sec/veh, respectively.





BOSTON REGION MPO

FIGURE 2
Before-and-After Reconstruction of Pleasant Street at Concord Avenue Belmont, MA

TIP Project Impacts
 Before-After Evaluation

Source: Central Transportation Planning Staff.

Pleasant Street at Concord Avenue—After Improvements

The intersection was reconstructed to improve traffic operations and safety, full depth pavement reconstruction and replacement of existing traffic control equipment. Pleasant Street was constructed with a uniform pavement cross section of 28 feet (36 feet where parking is permitted).

Improvements to this intersection included installation of a modern fully actuated traffic signal controller, with two new traffic signal mast arms located in the northeast and southwest corners of the intersection. Sidewalks now are provided on both sides of all approaches except the east side of the southbound approach and north side of the eastbound approach. A shared shoulder for bicycle travel is located on all directions of travel along Pleasant Street and Concord Avenue; and bicycle detection is provided on all approaches. Traffic signal phasing was updated to include an advanced left-turn phase for the northbound Concord Avenue approach with an overhead mounted five-section signal head to improve traffic operations for the northbound approach. In addition, pavement markings and signage were updated on all approaches, which included providing crosswalks on all intersection approaches with pedestrian signal heads and a pushbutton-activated exclusive pedestrian phase.

The crash rate for the years 2008 to 2012 is 0.44 crashes per million entering vehicles, which is considerably lower than the current MassDOT District 4 average rate of 0.77 crashes per million entering vehicles for signalized intersections. Analysis of current existing conditions shows that the intersection operates at an LOS C in the AM peak period and an LOS D in the PM peak period, with delays of 30.8 sec/veh and 45.2 sec/veh, respectively.

Pleasant Street at Clifton/Leonard Street—Before Improvements

The intersection of Pleasant Street at Clifton/Leonard Street was a fully actuated four-legged signalized intersection. Crosswalks were provided on all approaches, and the pedestrian signals were pushbutton actuated. Sidewalks, but no bicycle accommodations, were provided on both sides of all approaches at this intersection. The eastbound Pleasant Street approach had a single travel lane, and the westbound Pleasant Street approach had an exclusive left-turn lane and a shared through-right lane, as shown in Figure 3. Clifton Street runs to the north and intersects with Prospect Street; Leonard Street runs to the south through Belmont Center. The southbound Clifton Street approach had a single lane that accommodated all traffic movements, and the northbound Leonard Street had an exclusive right-turn lane and a shared left-through lane. Parking was permitted on the south side of the eastbound Pleasant Street approach.

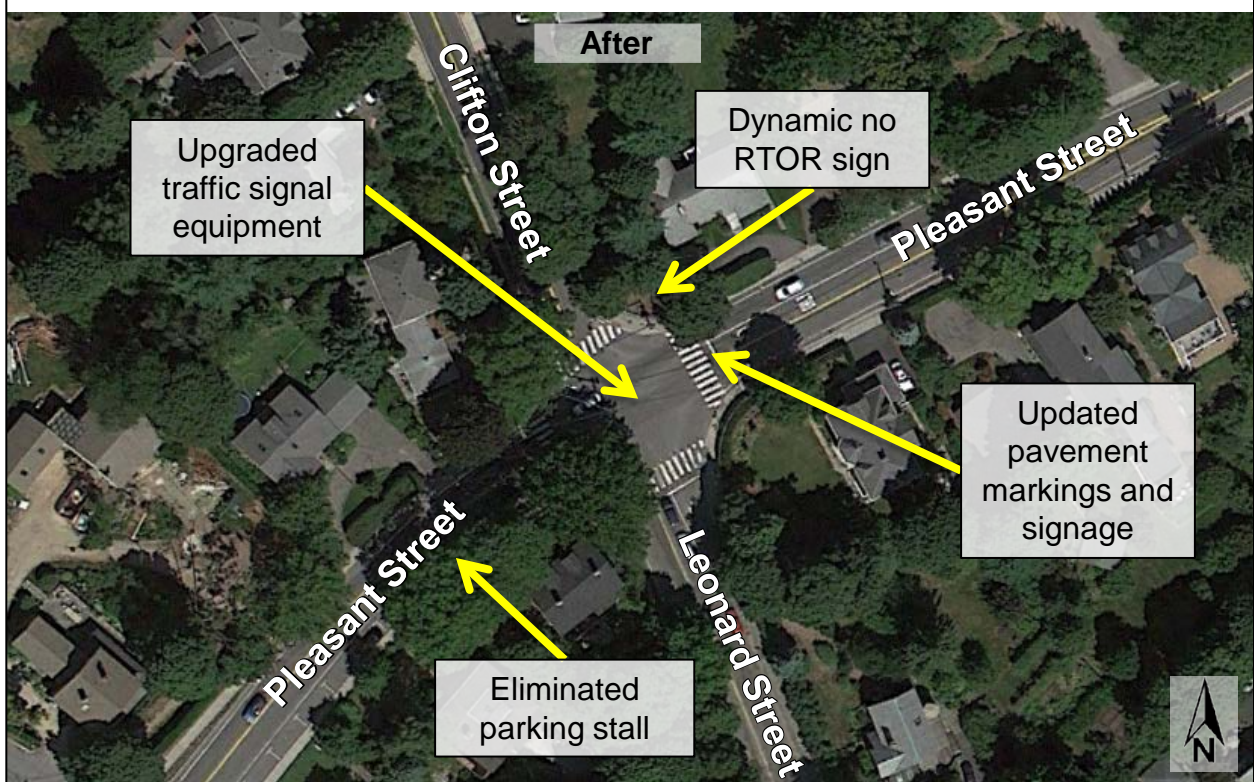


FIGURE 3
Before-and-After Reconstruction of
Pleasant Street at Clifton / Leonard Street
Belmont, MA

BOSTON REGION MPO

TIP Project Impacts
 Before-After
 Evaluation

Source: Central Transportation Planning Staff.

The crash rate before reconstruction of the Pleasant Street at Clifton/Leonard Street intersection was 0.75 crashes per million entering vehicles. According to the FDR, nine of the 20 crashes were angle collisions, and six of the 20 crashes were rear-end collisions. Four personal injuries were reported at this intersection during the 1994-1996 analysis period.

The intersection operated at an overall LOS E in the AM peak hour and LOS D in PM peak hour, primarily because of considerable delays and long queues on the eastbound Pleasant Street approach. Thus, it was necessary to reconstruct the intersection to improve overall traffic operations.

Pleasant Street at Clifton/Leonard Street—After Improvements

Widening Pleasant Street at this intersection was infeasible because of right-of-way restrictions. The majority of improvements at this intersection were traffic signal operations related, such as modifying traffic signal timings and eliminating a parking stall nearest to the intersection on the eastbound approach.

A modern, fully actuated traffic signal controller was installed at this intersection, and the signal phasing was modified to allow a leading advanced westbound left-turn phase on Pleasant Street with a concurrent overlapping right turn from Leonard Street onto Pleasant Street. This phasing change was made to improve traffic operations for the westbound left-turn movement. In order to improve right turn on red (RTOR) safety and operations, a dynamic no RTOR sign was installed in the northeast corner of the intersection for northbound right-turn movements, as shown in Figure 4. Two new signal mast arms were installed at the northeast and northwest corners of the intersection. A shared shoulder for bicycle travel was provided for all directions of travel along Pleasant Street and Leonard/Clifton Street. Bicycle detection was provided on all approaches; and construction included improved pavement markings and signage on all approaches.

FIGURE 4
Dynamic No-RTOR Sign at Leonard/Clifton Street

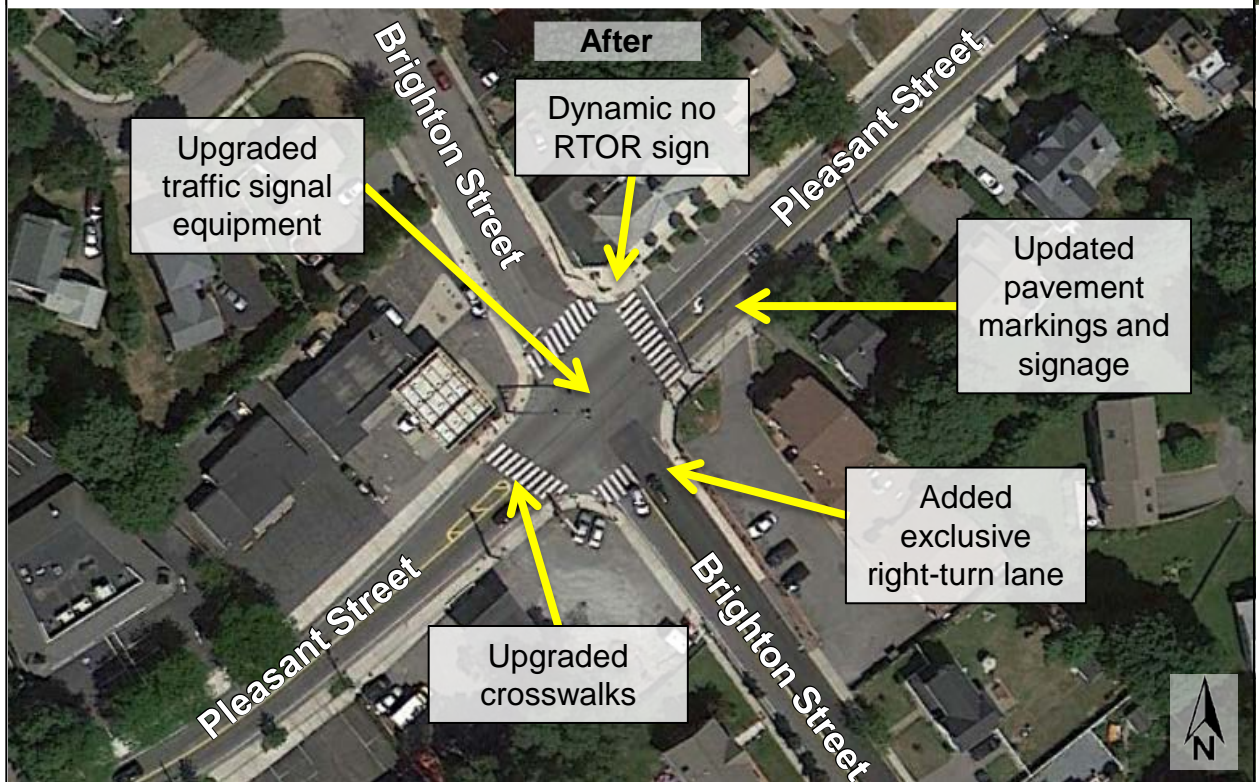


Source: Central Transportation Planning Staff.

For 2008 to 2012, the crash rate was 0.40 crashes per million entering vehicles. This rate is lower than the crash rate before the improvements were made and is below the current MassDOT District 4 average rate of 0.77 at signalized intersections. The analysis of current existing conditions shows an improvement of traffic operations to LOS C in the AM and PM peak hours, with delays of 27.4 sec/veh and 30.9 sec/veh, respectively. Therefore, the optimized traffic signal timings and phasing improved the intersection operations to LOS C, significantly reducing vehicular delays and queues.

Pleasant Street at Brighton Street—Before Improvements

The intersection of Pleasant Street at Brighton Street was a fully actuated four-legged signalized intersection. Crosswalks were provided on all approaches, and pedestrian signals were pushbutton actuated. Sidewalks were provided on both sides of all approaches to the intersection; however, bicycle accommodations were not provided. The eastbound Pleasant Street approach had a single travel lane for all movements, and the westbound Pleasant Street approach had an exclusive left-turn lane and a shared through-right lane, as shown in Figure 5. Brighton Street runs north south and is approximately 1/10 of a mile west of Route 2. Both the northbound and southbound Brighton Street approaches provide a single lane to accommodate all traffic movements; however, although the northbound approach is striped as a single lane, it operates as two lanes.



BOSTON REGION MPO

FIGURE 5
Before-and-After Reconstruction of Pleasant Street at Brighton Street Belmont, MA

TIP Project Impacts
Before-After Evaluation

Source: Central Transportation Planning Staff.

The crash rate before reconstructing the intersection was 0.94 crashes per million entering vehicles. According to the FDR, 17 of the 27 crashes were angle collisions, and eight were rear-end collisions. Five personal-injury crashes were reported at this intersection during the three-year analysis period.

The intersection operated at an overall LOS C in the AM peak hour and LOS B in the PM peak hour, with the eastbound Pleasant Street approach incurring the highest delays. Thus, it was necessary to reconstruct the intersection to improve overall safety operations.

Pleasant Street at Brighton Street—After Improvements

The reconstruction of the Pleasant Street at Brighton Street intersection included adding an exclusive right-turn lane on the northbound Brighton Street approach. Although the before conditions operated with this configuration, providing signage and striping to meet necessary Manual on Uniform Traffic Control Devices (MUTDC) standards improved traffic operations and safety.

A modern, fully actuated traffic signal controller also was installed at this intersection, and the signal phasing was modified to allow an advanced westbound left-turn phase on Pleasant Street with a concurrent overlapping right-turn phase from Brighton Street onto Pleasant Street. This phasing change was made to improve traffic operations for northbound right-turn movements and westbound left-turn movements. A dynamic RTOR sign was installed on the northeast corner of the intersection to improve safety of northbound right-turn operations, as illustrated in Figure 6. A shared shoulder for bicycle travel was provided on all approaches of Pleasant Street and Brighton Street, including bicycle detection. Two new overhead mast arms at the northwest and southeast corners of the intersection, upgraded pedestrian traffic signals, and improved signage and pavement markings were installed.

FIGURE 6
Dynamic No-RTOR Sign at Brighton Street



Source: Central Transportation Planning Staff.

The crash rate for 2008 to 2012 is 0.39 crashes per million entering vehicles, which is nearly one-third lower than before the improvements were made, and is below the current MassDOT District 4 average rate of 0.77 at signalized intersections. Analysis of current existing conditions shows improvement of traffic operations to LOS B in the AM and PM peak hours, with delays of 17.8 sec/veh and 15.5 sec/veh, respectively. Therefore, the optimized traffic signal timings and phasing improved the intersection operations significantly by reducing vehicular delays and queues.

4.2 Comparisons of Crash Data, Traffic Volumes, and Traffic Analyses

Crash Data

Crash data from the Belmont FDR were compared to current MassDOT Registry of Motor Vehicles Division (RMV) data from 2008 to 2012, which is the most recent five-year period available. Tables 1-3 summarize the crashes by year for the three study intersections. The total and average number of crashes in the five-year after period only includes crashes that occurred after construction was complete, in the summer of 2008. Appendix C includes collision diagrams for the three intersections.

Fourteen crashes occurred at the intersection of Pleasant Street at Concord Avenue during the three-year before period, averaging 4.7 crashes per year. During the after period between 2008 and 2012, there were 16 crashes with an average of 3.5 crashes per year. In addition, the crash rate is an effective tool for examining the relative safety at a particular location. Crash rates are estimated based on crash frequency and vehicle exposure (traffic volumes or miles traveled). The crash rate for the before period was 0.60 crashes per million entering vehicles, and 0.44 in the after period. The District 4 average for signalized intersections is 0.77 crashes per million entering vehicles. Crash rate calculation forms are included in Appendix B.

Twenty crashes occurred at the intersection of Pleasant Street at Clifton/Leonard Street between 1994 and 1996, as reported in the FDR. An average of 6.7 crashes occurred per year during this period. Between 2008 and 2012 (the most recent data period), there were 16 crashes, averaging 3.5 crashes per year. The average number of angle crashes decreased from 5.7 crashes per year to 1.3 crashes per year. The crash rate in the before conditions was 0.75 crashes per million entering vehicles, decreasing to 0.40 crashes per million vehicles in the after conditions. The crash rate for the most recent data available is less than the District 4 average for signalized intersections.

At the intersection of Pleasant Street at Brighton Street, there were 27 reported crashes between 1994 and 1996, as reported in the FDR, with an average of nine crashes per year. Between 2008 and 2012 (the most recent data period), there were 14 crashes, averaging 3.1 crashes per year. The average number of angle crashes decreased from 5.7 crashes per year to 0.9 crashes per year. The crash rate in the before conditions was 0.94 crashes per million entering vehicles, decreasing to 0.39 crashes per million vehicles in the after conditions. The crash rate for the most recent data available is less than the District 4 average crash rate for signalized intersections.

TABLE 1
Crash Summary – Pleasant Street at Concord Avenue

Crash Category	1994	1995	1996	Total	Average	2008²	2009	2010	2011	2012	Total	Average³
Crash severity												
Property damage only	0	6	3	9	3	1	1	2	1	3	8	1.8
Personal injury	4	0	1	5	1.7	0	1	0	0	1	2	0.4
Fatality	0	0	0	0	0	0	0	0	0	0	0	0
Collision type												
Not reported	0	0	0	0	0	0	0	0	0	0	0	0
Angle	2	3	0	5	1.7	0	1	1	0	0	2	0.4
Rear-end	1	3	4	8	2.7	1	0	0	4	2	7	1.5
Side-swipe	—	—	—	—	—	0	1	1	0	0	2	0.4
Head-on	1	0	0	1	0.3	0	0	0	0	2	2	0.4
Single-vehicle	—	—	—	—	—	0	0	3	0	0	3	0.7
Roadway conditions												
Not reported	0	0	0	0	0	0	0	0	0	1	1	0.2
Wet or icy pavement	2	1	2	5	1.7	0	0	3	1	2	6	1.3
Weather conditions												
Dark/lighted	2	0	2	4	1.3	0	0	3	1	0	4	0.9
Clear	—	—	—	—	—	0	1	3	2	1	7	1.5
Cloudy	—	—	—	—	—	0	1	0	0	1	2	0.4
Rain	—	—	—	—	—	1	0	1	0	2	4	0.9
Snow	—	—	—	—	—	0	0	1	1	0	2	0.4
Crashes during weekday peak periods ¹	2	2	1	5	1.7	0	1	0	3	1	5	1.1
Crashes involving pedestrian(s)	—	—	—	—	—	0	0	0	0	0	0	0
Crashes involving bicyclist(s)	—	—	—	—	—	0	0	0	0	0	0	0
Total crashes	4	6	4	14	4.7	1	2	5	4	4	16	3.5

¹ Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM. ² The number of crashes in 2008 only includes crashes that occurred after construction was complete in summer 2008. ³ The average number of crashes in the after period is averaged across 4.58 years.

Source: Central Transportation Planning Staff.

TABLE 2
Crash Summary – Pleasant Street at Clifton/Leonard Street

Crash Category	1994	1995	1996	Total	Average	2008²	2009	2010	2011	2012	Total	Average³
Crash severity												
Property damage only	1	6	9	16	5.3	3	2	1	4	1	11	2.4
Personal injury	1	2	1	4	1.3	1	0	1	1	0	3	0.7
Fatality	0	0	0	0	0	0	0	0	0	0	0	0
Collision type												
Not reported	1	1	2	4	1.3	0	0	0	0	0	0	0
Angle	0	5	4	9	3.0	1	1	1	3	0	6	1.3
Rear-end	1	2	3	6	2.0	2	2	0	2	0	6	1.3
Side-swipe	—	—	—	—	—	0	0	1	1	1	3	0.7
Head-on	0	0	1	1	0.3	1	0	0	0	0	1	0.2
Single-vehicle	—	—	—	—	—	0	0	0	0	0	0	0
Roadway conditions												
Not reported	0	0	0	0	0	0	0	0	0	1	1	0.2
Wet or icy pavement	1	5	4	10	3.3	1	2	0	1	0	4	0.9
Weather conditions												
Dark/lighted	1	1	2	4	1.3	0	1	2	1	1	5	1.1
Clear	—	—	—	—	—	3	2	1	4	0	10	2.2
Cloudy	—	—	—	—	—	0	0	1	2	0	3	0.7
Rain	—	—	—	—	—	0	1	0	0	0	1	0.2
Snow	—	—	—	—	—	1	0	0	0	0	1	0.2
Crashes during weekday peak periods ¹	2	4	5	11	3.7	0	0	0	0	0	0	0
Crashes involving pedestrian(s)	—	—	—	—	—	0	0	0	0	0	0	0
Crashes involving bicyclist(s)	—	—	—	—	—	0	0	0	1	0	1	0.2
Total crashes	2	8	10	20	6.7	4	3	2	6	1	16	3.5

¹ Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM. ² The number of crashes in 2008 only includes crashes that occurred after construction was complete in summer 2008. ³ The average number of crashes in the after period is averaged across 4.58 years.

Source: Central Transportation Planning Staff.

TABLE 3
Crash Summary – Pleasant Street at Brighton Street

Crash Category	1994	1995	1996	Total	Average	2008²	2009	2010	2011	2012	Total	Average³
Crash severity												
Property damage only	8	9	6	23	7.7	5	1	1	4	0	11	2.4
Personal injury	2	1	1	4	1.3	0	1	0	2	0	3	0.7
Fatality	0	0	0	0	0	0	0	0	0	0	0	0
Collision type												
Not reported	1	1	0	2	0.7	0	1	0	0	0	1	0.2
Angle	6	6	5	17	5.7	1	0	0	3	0	4	0.9
Rear-end	3	3	2	8	2.7	2	0	1	2	0	5	1.1
Side-swipe	—	—	—	—	—	2	0	0	1	0	3	0.7
Head-on	0	0	0	0	0	0	0	0	0	0	0	0
Single-vehicle	—	—	—	—	—	0	1	0	0	0	1	0.2
Roadway conditions												
Not reported	0	0	0	0	0	0	0	0	0	0	0	0
Wet or icy pavement	0	4	1	5	1.7	3	1	0	1	0	5	1.1
Weather conditions												
Dark/lighted	3	2	1	6	2	0	1	0	1	0	2	0.4
Clear	—	—	—	—	—	3	2	0	5	0	10	2.2
Cloudy	—	—	—	—	—	1	0	1	0	0	2	0.4
Rain	—	—	—	—	—	1	0	0	1	0	2	0.4
Snow	—	—	—	—	—	0	0	0	0	0	0	0
Crashes during weekday peak periods ¹	4	6	2	12	4	3	0	0	3	0	6	1.3
Crashes involving pedestrian(s)	—	—	—	—	—	0	0	0	0	0	0	0
Crashes involving bicyclist(s)	—	—	—	—	—	0	0	0	0	0	0	0
Total crashes	10	10	7	27	9	5	2	1	6	0	14	3.1

¹ Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM. ² The number of crashes in 2008 only includes crashes that occurred after construction was complete in summer 2008. ³ The average number of crashes in the after period is averaged across 4.58 years.

Source: Central Transportation Planning Staff.

Traffic Volumes

MPO staff collected turning-movement counts at the three intersections on June 19, 2014, while school was still in session. The data were recorded in 15-minute intervals for the morning peak period from 7:00 to 9:00 AM and the evening peak period from 4:00 to 6:00 PM. See Appendix A for traffic count summaries. Tables 4 through 6 compare traffic volumes for three separate years for each intersection; representing the following scenarios:

- 1997 FDR before existing conditions
- 2020 FDR projected build conditions
- 2014 after conditions

Comparing the before and projected conditions to after conditions indicates that in general, the expected traffic growth did not occur at the three study intersections. In fact, from 1997 to 2014, overall traffic volumes either remained relatively the same or decreased slightly, except for the PM peak hour at Pleasant Street/Concord Avenue, where volumes increased slightly. However, some of the individual turning movements did increase.

At the intersection of Pleasant Street/Concord Avenue, there was a 13% decrease in total traffic volumes in the AM peak hour and a 13% increase in the PM peak hour. At Pleasant Street at Leonard/Clifton Street, total traffic volumes decreased by 17% and 2% in the AM and PM peak hours, respectively. Pleasant Street at Brighton Street experienced a 2% increase in total volumes in the AM peak hour and a 7% decrease in the PM peak hour.

TABLE 4
Traffic Volume Comparisons

Intersection of Pleasant Street (EB/WB) at Concord Avenue (NB/SB)

Scenario	EB			WB			NB			SB			Total
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM - 1997 (Before)	16	333	121	40	521	49	169	167	35	49	359	15	1,874
AM - 2017 (Projected)	18	368	134	44	576	54	187	185	28	54	397	16	2,061
AM - 2014 (After)	34	260	82	39	469	46	156	152	15	37	346	—	1,636
PM - 1997 (Before)	18	495	155	30	370	21	138	269	35	23	160	12	1,726
PM - 2017 (Projected)	20	547	171	33	409	23	152	297	39	25	171	13	1,900
PM - 2014 (After)	61	440	142	40	431	27	118	350	31	33	284	—	1,957

Intersection of Pleasant Street (EB/WB) at Clifton/Leonard Street (NB/SB)

Scenario	EB			WB			NB			SB			Total
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM - 1997 (Before)	37	452	12	389	521	8	10	272	205	3	502	116	2,527
AM - 2017 (Projected)	41	499	13	430	576	9	11	301	227	3	555	128	2,793
AM - 2014 (After)	54	252	5	206	620	11	17	225	157	10	400	136	2,093
PM - 1997 (Before)	82	486	9	202	310	7	18	472	220	11	320	41	2,178
PM - 2017 (Projected)	91	537	10	223	342	8	20	522	243	12	354	45	2,407
PM - 2014 (After)	84	348	13	203	423	39	17	416	138	9	364	79	2,133

Intersection of Pleasant Street (EB/WB) at Brighton Street (NB/SB)

Scenario	EB			WB			NB			SB			Total
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM - 1997 (Before)	6	482	39	477	719	12	68	10	237	23	20	11	2,104
AM - 2017 (Projected)	7	533	43	527	794	13	75	11	262	25	22	12	2,324
AM - 2014 (After)	1	422	23	366	768	18	41	23	426	23	31	5	2,147
PM - 1997 (Before)	3	621	26	332	515	24	58	25	460	17	15	4	2,100
PM - 2017 (Projected)	3	686	29	367	569	27	64	28	508	19	17	4	2,321
PM - 2014 (After)	5	424	31	408	583	13	37	26	373	19	18	8	1,945

Source: Central Transportation Planning Staff.

Intersection Capacity Analysis

Staff analyzed intersection capacity and traffic operations with the intersection analysis program Synchro². The 1997 before existing conditions, 2020 projected conditions, and 2014 after conditions were analyzed using the turning-movement counts and signal timing data. The FDR analysis was updated to be consistent with the most recent Highway Capacity Manual (HCM). The HCM was significantly updated in 2010 to incorporate current methodologies that engineers and planners use to assess traffic and environmental effects of highway projects. Both AM and PM peak hours were studied for the three study intersections. Both the delay and LOS results are illustrated in Tables 5-7.

As shown in Table 5, the intersection of Pleasant Street at Concord Avenue was projected to operate at LOS D in the AM peak hour and LOS C in the PM peak hour using the HCM 2010 methodology. The FDR projected that the intersection would operate at LOS D in the AM peak hour and LOS B in the PM peak hour. The intersection currently operates at LOS C in the AM peak hour and LOS D in the PM peak hour. The eastbound approach on Pleasant Street operates at a LOS F in the PM peak hour because of the diversion of eastbound left turns to the primary intersection; whereas eastbound left turns in the before condition occurred approximately 100 feet west of the intersection.

The intersection of Pleasant Street at Clifton/Leonard Street was projected to operate at LOS E in the AM peak hour and LOS D in the PM peak hour. The intersection currently operates at LOS C in both the AM and PM peak hours. Both peak hours operate at less than the projected level of service, which may be a result of the less-than-expected traffic growth at this intersection.

The intersection capacity analysis for the intersection of Pleasant Street at Brighton Street is shown in Table 7. This intersection was projected to operate at LOS B in the AM peak hour and LOS C in the PM peak hour. Pleasant Street at Brighton Street currently operates at LOS B in both the AM and PM peak hours.

² Synchro Version 8 was used for these analyses. This software is developed and distributed by Trafficware Ltd. It can perform capacity analysis and traffic simulation (when combined with SimTraffic) for an individual intersection or a series of intersections.

TABLE 5
LOS Comparison – Intersection of Pleasant Street at Concord Avenue

Intersection / Approach	Movement	Before ¹			Projected ²			After ³		
		LOS	Delay ⁴	95% Q ⁵	LOS	Delay	95% Q	LOS	Delay	95% Q
AM Peak Period										
Pleasant St. – EB	TR (LTR)	B	17.2	292	B	16.1	285	B	18.2	234
Pleasant St. – WB	LTR	C	22.0	453	C	25.2	491	C	22.9	394
Concord Ave. – NB	L	E	68.9	#196	D	49.6	#174	D	39.3	#114
Concord Ave. – NB	TR	B	17.9	117	B	19.2	139	B	19.2	113
Concord Ave. – SB	L	B	16.4	40	C	29.3	60	C	30.7	41
Concord Ave. – SB	TR	C	24.2	236	E	79.9	#427	E	62.3	#373
Overall	—	C	25.2	—	D	35.9	—	C	30.8	—
PM Peak Period										
Pleasant St. – EB	TR (LTR)	B	15.0	412	B	18.0	467	F	80.3	#688
Pleasant St. – WB	LTR	B	11.9	234	B	15.0	277	C	28.9	400
Concord Ave. – NB	L	C	25.2	103	C	24.4	110	B	17.8	76
Concord Ave. – NB	TR	C	26.9	200	C	26.0	241	C	20.3	247
Concord Ave. – SB	L	B	18.4	25	C	29.7	35	C	26.8	37
Concord Ave. – SB	TR	C	20.5	105	D	38.2	161	D	36.4	236
Overall	—	B	17.9	—	C	21.4	—	D	45.2	—

¹ 1997 “before” existing traffic volumes from FDR. ² 2017 “projected” future traffic volumes with build conditions from FDR. ³ 2014 “after” existing traffic volumes. ⁴ Delay is measured in seconds. ⁵ Queue length is measured in feet.

Notes: (x) Turning lane configuration in Projected/After conditions. # = 95th percentile volume exceeds capacity; queues may be longer.

Source: Central Transportation Planning Staff.

TABLE 6
LOS Comparison – Intersection of Pleasant Street at Clifton/Leonard Street

Intersection / Approach	Movement	Before ¹			Projected ²			After ³		
		LOS	Delay ⁴	95% Q ⁵	LOS	Delay	95% Q	LOS	Delay	95% Q
AM Peak Period										
Pleasant St. – EB	(L)	—	—	—	C	28.9	50	D	44.8	#76
Pleasant St. – EB	LTR (TR)	F	228.6	#685	F	135.7	#611	D	39.5	#244
Pleasant St. – WB	L	E	67.5	#419	F	81.4	#446	B	16.5	120
Pleasant St. – WB	TR	C	20.0	353	B	18.1	356	C	24.5	460
Leonard St. – NB	LT	C	24.1	207	D	39.3	#315	C	20.7	167
Leonard St. – NB	R	A	3.9	44	A	5.4	67	A	1.3	19
Clifton St. – SB	LTR	D	43.9	#587	E	58.1	#667	D	37.8	#506
Overall	—	E	76.1	—	E	61.7	—	C	27.4	—
PM Peak Period										
Pleasant St. – EB	(L)	—	—	—	C	23.7	84	C	31.0	80
Pleasant St. – EB	LTR (TR)	E	60.1	#627	E	66.9	#610	D	43.0	#368
Pleasant St. – WB	L	B	12.7	90	C	26.8	#157	B	12.9	97
Pleasant St. – WB	TR	B	10.4	138	B	13.1	177	B	13.3	243
Leonard St. – NB	LT	E	69.0	#566	D	45.8	#552	D	38.5	#393
Leonard St. – NB	R	B	14.5	119	A	6.1	78	A	1.7	11
Clifton St. – SB	LTR	F	101.3	#483	D	39.3	#406	D	51.0	#449
Overall	—	D	53.8	—	D	38.3	—	C	30.9	—

¹ 1997 “before” existing traffic volumes from FDR. ² 2017 “projected” future traffic volumes with Build Conditions from FDR. ³ 2014 “after” existing traffic volumes. ⁴ Delay is measured in seconds. ⁵ Queue length is measured in feet.

Notes: (x) Turning lane configuration in Projected/After conditions. # = 95th percentile volume exceeds capacity; queues may be longer.

Source: Central Transportation Planning Staff.

TABLE 7
LOS Comparison – Intersection of Pleasant Street at Brighton Street

Intersection / Approach	Movement	Before ¹			Projected ²			After ³		
		LOS	Delay ⁴	95% Q ⁵	LOS	Delay	95% Q	LOS	Delay	95% Q
<i>AM Peak Period</i>										
Pleasant St. – EB	LTR	D	35.3	#540	C	33.4	#518	C	28.5	354
Pleasant St. – WB	L	B	12.6	244	B	16.8	277	A	7.8	114
Pleasant St. – WB	TR	A	7.2	311	A	8.6	336	B	13.1	399
Brighton St. – NB	L (TL)	D	41.5	81	D	47.6	98	D	47.8	88
Brighton St. – NB	TR (R)	B	12.7	67	A	7.2	87	B	12.9	26
Brighton St. – SB	LTR	F	95.0	#75	C	32.6	61	D	41.1	50
Overall	—	C	20.0	—	B	18.8	—	B	17.8	—
<i>PM Peak Period</i>										
Pleasant St. – EB	LTR	C	23.5	490	C	32.8	#605	C	26.4	356
Pleasant St. – WB	L	A	9.2	118	B	16.2	189	B	13.4	163
Pleasant St. – WB	TR	A	6.4	213	A	8.2	235	A	8.2	284
Brighton St. – NB	L (TL)	D	35.6	65	D	35.6	94	D	36.6	75
Brighton St. – NB	TR (R)	B	16.8	136	B	18.0	280	B	10.1	75
Brighton St. – SB	LTR	E	64.1	48	C	28.9	45	C	27.6	50
Overall	—	B	16.4	—	C	20.6	—	B	15.5	—

¹ 1997 “Before” existing traffic volumes from FDR. ² 2017 “-Projected” future traffic volumes with Build Conditions from FDR. ³ 2014 “After” existing traffic volumes. ⁴ Delay is measured in seconds. ⁵ Queue length is measured in feet.

Notes: (x) Turning lane configuration in Projected/After conditions. # 95th percentile volume exceeds capacity, queues may be longer.

Source: Central Transportation Planning Staff.

5 TURNPIKE STREET (ROUTE 138), TWO LOCATIONS—CANTON

Route 138 is an urban principal arterial that runs north-south connecting Canton with Stoughton to the south and I-93 to the north. The surrounding land use includes residential, commercial, recreational, and educational institutions. Randolph Street is an urban minor arterial that runs east west, connecting the Town of Canton with the Town of Randolph to the east. Route 138 intersects with Washington Street approximately three-quarter miles north of Randolph Street. Washington Street is a primary route that connects residents of Canton with I-93 to access downtown Boston. The roadway improvements in the Canton FDR were associated with construction of the Reebok World Headquarters, which included building approximately 460,000 square feet of corporate office space. The development occurred approximately one mile north of Washington Street in Canton, along Route 138 between Royall Street and I-93. The study area is illustrated in Figure 7.

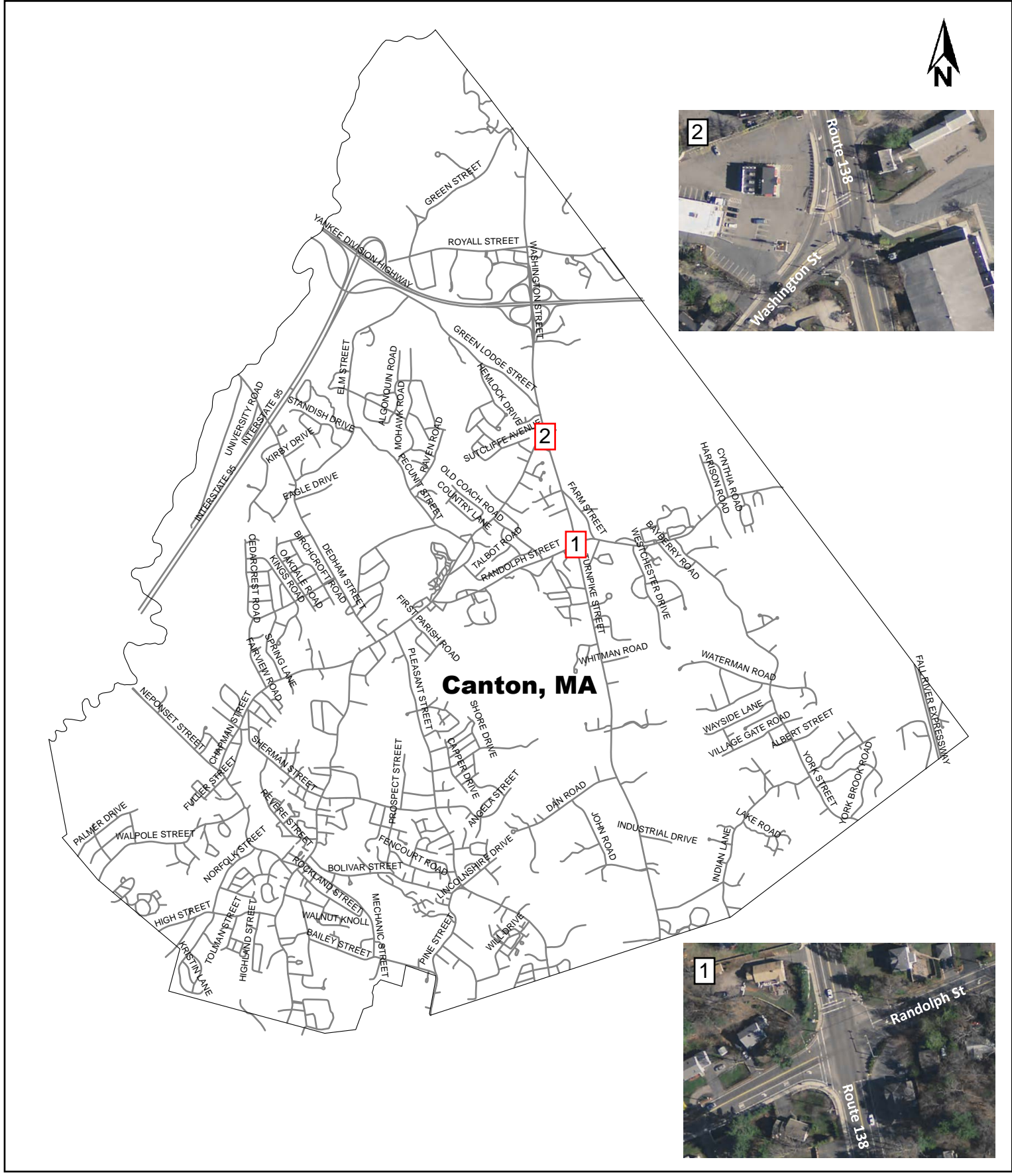
The following sections provide a summary of the before-and-after conditions, along with a comparison of crash data, traffic volumes, and traffic analysis at these two signalized intersections along the Route 138 corridor.

5.1 Summary of Conditions Before and After Improvements

Route 138 at Randolph Street—Before Improvements

Route 138 at Randolph Street was a four-legged intersection controlled by a three-phase traffic signal with an exclusive pedestrian phase. Crosswalks existed on the Route 138 approach and the westbound Randolph Street approach, but no other bicycle or pedestrian facilities existed. Route 138 and Randolph Street were both marked as two-lane roadways, with a single lane to accommodate all traffic movements on each approach, as shown in Figure 8. The speed limit along Route 138 is 40 miles per hour (mph), and the speed limit along Randolph Street is 25 mph near this intersection. Steep grades existed on all approaches to the intersection, and traffic signal heads were located on overhead mast arms at each corner of the intersection.

The crash rate before reconstruction of the intersection was 1.58 crashes per million entering vehicles, which is higher than the MassDOT District 6 average crash rate of 0.76. According to the FDR, an average of 20 crashes occurred per year at this intersection during the three-year analysis period. The intersection operated at an overall LOS F in the AM and PM peak hours. Because of the high crash rate and poor intersection operations at this location, the recommendations aimed to improve intersection safety and traffic operations.



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FIGURE 7
Canton Study Locations

TIP Project Impacts
Before-After
Evaluation

Source: Central Transportation Planning Staff.

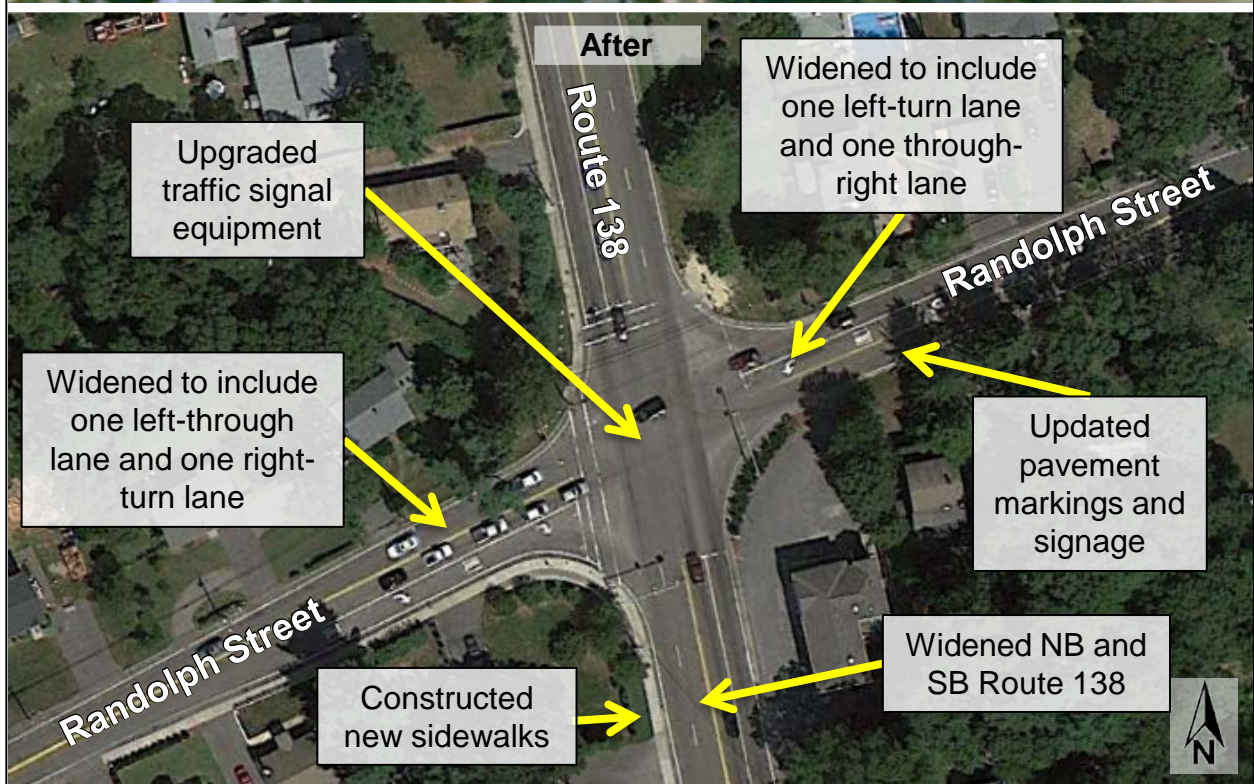


FIGURE 8
Before-and-After Reconstruction of
Route 138 (Turnpike Street) at Randolph Street
Canton, MA

BOSTON REGION MPO

TIP Project Impacts Before-After Evaluation

Source: Central Transportation Planning Staff.

Route 138 at Randolph Street—After Improvements

Reconstruction at Route 138 at Randolph Street included widening and restriping the northbound and southbound approaches of Route 138 to provide two 11.5-foot travel lanes. Both the northbound and southbound approaches currently provide a shared left-through lane and a shared through-right lane. The reconstruction also included widening and restriping the eastbound Randolph Street approach to provide one 11.5-foot shared left-through lane and one 11.5-foot exclusive right-turn lane. In addition, widening and restriping the Randolph Street westbound approach now provides for one exclusive 11.5-foot left-turn lane and one 11.5-foot shared through-right lane. Lastly, a sidewalk on the west side of Route 138 was constructed and a shared bicycle shoulder was provided on both sides of Route 138.

Traffic control at this intersection was upgraded to accommodate the modified geometry on all four approaches. A protected lead southbound left-turn phase was provided for the Route 138 approach and a leading westbound left-turn phase was provided for the Randolph Street approach to allow more green time to the respective approaches. The pushbutton-activated exclusive pedestrian phase remained as it was prior to reconstruction. Existing signs and pavement markings were updated to match the reconfigured intersection geometry.

The crash rate for the years 2008 to 2012 is 0.75 crashes per million entering vehicles, which is half that before the improvements were made, and is below the MassDOT District 6 average rate of 0.76 at signalized intersections. The analysis of current conditions shows an improvement of traffic operations in the AM peak hour from LOS F to LOS E. Although an LOS F remains in the PM peak hour, the average intersection delay was reduced by half. Thus, the modified geometry and traffic signals improved both safety and operations at this intersection.

Route 138 at Washington Street—Before Improvements

Route 138 at Washington Street was a four-legged intersection, with Washington Street intersecting Route 138 from the southwest, and the MDC Ponkapoag Golf Course exit driveway intersecting from the east. Several driveways provide access to Crowell's Market immediately to the west of the intersection. Route 138 provides access to I-93 approximately one mile north of this intersection. A crosswalk was provided on the northbound Route 138 approach, but no additional bicycle or pedestrian accommodations were provided at this intersection. The southbound Route 138 approach provided one general-purpose lane, but operated as a through lane with a short right-turn lane. The other three approaches at the intersection operated with a single lane accommodating all traffic movements, as shown in Figure 9.

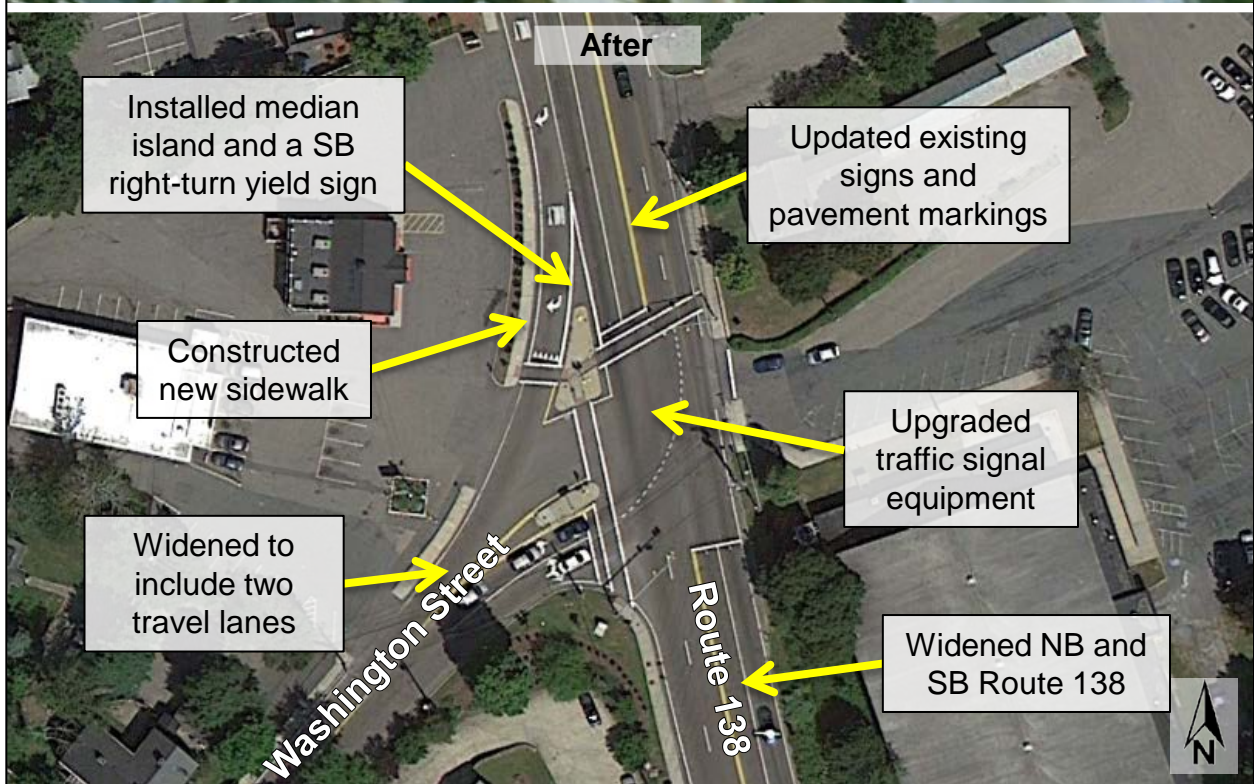


FIGURE 9
Before-and-After Reconstruction of
Route 138 (Turnpike Street) at Washington Street
Canton, MA

BOSTON REGION MPO

TIP Project Impacts
 Before-After
 Evaluation

Source: Central Transportation Planning Staff.

The crash rate before reconstructing the intersection was 1.51 crashes per million entering vehicles, with an average of 21.7 crashes per year over three years; this was higher than the MassDOT District 6 average crash rate of 0.76. The intersection operated at an overall LOS F in the AM and PM peak hours. Because of the high crash rate at this location and poor intersection operations, the intersection recommendations were made to improve safety and traffic operations.

Route 138 at Washington Street—After Improvements

Reconstruction at Route 138 at Washington Street included widening and restriping of the northbound and southbound Route 138 approaches to provide two 11.5-foot travel lanes. After the improvements, the northbound approach operates with two lanes, with the left-most lane as a shared left-through. The southbound approach operates with two through lanes and an exclusive right-turn lane. The right-turn lane operates with yield control. Reconstruction also included widening and restriping the eastbound Washington Street approach to provide one 11.5-foot exclusive left-turn lane and one 11.5-foot shared left- and right-turn lane. Sidewalks were constructed on the west side of Route 138, and a shared shoulder for bicycle travel was provided on both sides of Route 138.

Traffic control at this intersection was upgraded to accommodate the modified geometry on the reconfigured approaches. The minor street approaches on Washington Street were converted to split phasing because of the high volume of minor street left turns. An exclusive pushbutton-activated pedestrian phase was provided on the eastbound Washington Street and southbound Route 138 approaches. Existing signs and pavement markings were updated to match the modified intersection geometry.

The crash rate for the years 2008 to 2012 is 0.57 crashes per million entering vehicles, which is well below the crash rate before the intersection improvements; the current rate is below the MassDOT District 6 average rate of 0.76 at signalized intersections. Analysis of current conditions shows an improvement of traffic operations in both the AM and PM peak hours. In the AM peak hour, LOS improved from LOS F to LOS C, and in the PM peak hour, it improved from LOS F to LOS B. Analysis shows that the modified geometry and traffic signal upgrades improved both safety and operations at this intersection.

5.2 Comparisons of Crash Data, Traffic Volumes, and Traffic Analyses

Crash Data

Crash data from the Canton FDR (1997-99) were compared to current MassDOT RMV data for the most recent available five-year period, from 2008 to 2012. Tables 8 and 9 provide a summary of the crashes at the Route 138 at Randolph Street and Route 138 at Washington Street. Appendix C includes the collision diagrams for the two study intersections for the after period.

Sixty crashes occurred at the intersection of Route 138 at Randolph Street between 1997 and 1999. An average of 20 crashes occurred per year during this period. The total and average number of crashes in the after period, as shown in Tables 8 and 9, only include crashes that occurred after construction was complete in 2009. During this time, there were 27 total crashes, averaging 7.2 crashes per year. The average number of angle crashes decreased from 9.3 crashes per year to 2.1 crashes per year. The crash rate during before conditions was 1.58 crashes per million entering vehicles; whereas the crash rate decreased to 0.75 crashes per million vehicles in the after conditions. The crash rate for the years 2008 to 2012 is less than the District 6 average for signalized intersections.

Sixty-five crashes occurred at the intersection of Route 138 at Washington Street before reconstruction of the intersection. An average of 21.3 crashes occurred per year during this time. Twenty-seven crashes occurred in the after period, averaging 7.2 crashes per year. The average number of angle crashes decreased from 9.7 to 2.9 crashes per year, and rear-end crashes decreased from 8.3 to 2.1 crashes per year. The crash rate during the before conditions was 1.51 crashes per million entering vehicles and decreased to 0.57 crashes per million vehicles after reconstruction. The crash rate for the years 2008 to 2012 is less than the District 6 average for signalized intersections.

Traffic Volumes

MPO staff collected turning-movement counts at the two Canton intersections on June 25, 2014, when school was still in session. Data were recorded in 15-minute intervals for the morning peak period from 7:00 to 9:00 AM and in the evening peak period from 4:00 to 6:00 PM. Please see Appendix A for traffic count summaries. See Table 10 for a comparison of the traffic volumes for three separate years for each intersection, represented by the following analytic scenarios:

- 1997 FDR before existing conditions
- 2007 FDR projected build conditions
- 2014 after conditions

TABLE 8
Crash Summary – Route 138 at Randolph Street

Crash Category	1997-1999 Total	1997-1999 Average	2008	2009²	2010	2011	2012	Total³	Average⁴
Crash severity									
Property damage only	44	14.7	10	7	2	6	9	24	6.4
Personal injury	16	5.3	1	2	4	1	3	10	2.7
Fatality	0	0	0	0	0	0	0	0	0
Collision type									
Not reported	9	3	1	0	0	0	0	0	0
Angle	28	9.3	4	2	3	1	2	8	2.1
Rear-end	22	7.3	3	3	1	4	7	15	4
Side-swipe	—	—	1	2	2	2	2	8	2.1
Head-on	1	0.3	0	2	0	0	0	2	0.5
Single-vehicle	—	—	2	0	0	0	1	1	0.3
Roadway conditions									
Not reported	0	0	1	0	0	0	0	0	0
Wet or icy pavement	16	5.3	0	2	2	3	5	12	3.2
Weather conditions									
Dark/lighted	—	—	4	3	2	2	4	11	2.9
Clear	—	—	9	7	4	4	7	22	5.9
Cloudy	—	—	2	1	1	3	0	5	1.3
Rain	13	4.3	0	2	0	2	5	9	2.4
Snow	3	1	0	0	1	1	0	2	0.5
Crashes during weekday peak periods ¹	30	10	1	3	2	2	6	13	3.5
Crashes involving pedestrian(s)	—	—	0	0	0	0	0	0	0
Crashes involving bicyclist(s)	—	—	0	0	0	0	0	0	0
Total crashes	60	20	11	9	6	7	12	34	9.1

¹ Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM. ² The number of crashes in year 2009 only includes crashes that occurred after construction was complete in Spring 2009. ³ Represents the total number of crashes in the After Period. ⁴ The crashes in the After Period are averaged across 3.75 years.

Source: Central Transportation Planning Staff.

TABLE 9
Crash Summary – Route 138 at Washington Street

Crash Category	1997-1999 Total	1997-1999 Average	2008	2009²	2010	2011	2012	Total³	Average⁴
Crash severity									
Property damage only	34	11.3	9	2	10	9	3	24	6.4
Personal injury	31	10.3	4	0	1	1	1	3	0.8
Fatality	0	0	0	0	0	0	0	0	0
Collision type									
Not reported	11	3.7	1	0	0	0	0	0	0
Angle	29	9.7	1	0	5	5	1	11	2.9
Rear-end	25	8.3	8	1	2	3	2	8	2.1
Side-swipe	—	—	2	1	4	2	1	8	2.1
Head-on	0	0	0	0	0	0	0	0	0
Single-vehicle	—	—	1	0	0	0	0	0	0
Roadway conditions									
Not reported	4	1.3	0	0	0	0	0	0	0
Wet or icy pavement	8	2.7	5	0	1	3	0	4	1.1
Weather conditions									
Dark/lighted	—	—	4	0	0	3	1	4	1.1
Clear	—	—	6	2	9	8	4	23	6.1
Cloudy	—	—	3	0	2	0	0	2	0.5
Rain	8	2.7	3	0	0	3	0	3	0.8
Snow	0	0	0	0	0	0	0	0	0
Crashes during weekday peak periods ¹	31	10.3	4	2	7	3	1	13	3.5
Crashes involving pedestrian(s)	—	—	1	0	0	0	0	0	0
Crashes involving bicyclist(s)	—	—	0	0	1	0	0	1	0.3
Total crashes	65	21.3	13	2	11	10	4	27	7.2

¹ Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM. ² The number of crashes in 2009 only includes crashes that occurred after construction was complete in spring 2009. ³ Represents the total number of crashes in the after period. ⁴ The crashes in the after period are averaged across 3.75 years.

Source: Central Transportation Planning Staff.

As shown in Table 10, overall traffic volumes grew slightly between the years 1997 and 2014, not as much, however, as predicted by the FDR. As illustrated in the table, some traffic movements, such as the eastbound Randolph Street through movement in the PM peak hour, grew significantly, while other movements, such as southbound through volumes at the Route 138/ Randolph Street intersection decreased significantly. Overall volumes grew by 6% and 14% in the AM peak hour, respectively, at Route 138 at Randolph Street. Overall volumes also grew at Washington Street, with an increase of 8% and 15% in the AM and PM peak hour, respectively.

TABLE 10
Traffic Volume Comparison

Intersection of Route 138 (NB/SB) at Randolph Street (EB/WB)

Scenario	EB			WB			NB			SB			Total
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM - 1997 (Before)	45	260	240	185	295	40	85	420	75	35	735	105	2,520
AM - 2007 (Projected)	56	267	246	190	302	82	87	641	77	41	825	108	2,922
AM - 2014 (After)	20	257	166	168	370	115	141	552	91	98	645	44	2,667
PM - 1997 (Before)	65	245	265	195	300	45	100	460	75	105	720	45	2,620
PM - 2007 (Projected)	67	251	272	200	208	51	103	543	77	144	928	51	2,895
PM - 2014 (After)	14	400	57	123	298	102	142	619	195	384	639	14	2,987

Intersection of Route 138 (NB/SB) at Washington Street (EB/WB)

Scenario	EB			WB			NB			SB			Total
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM - 1997 (Before)	695	15	10	—	—	10	10	780	—	—	875	305	2,700
AM - 2007 (Projected)	830	15	10	—	—	10	10	1,061	—	—	974	333	3,243
AM - 2014 (After)	624	2	10	3	—	8	8	1,047	1	—	892	316	2,911
PM - 1997 (Before)	485	10	15	10	25	5	35	795	5	5	795	510	2,695
PM - 2007 (Projected)	538	10	15	10	26	5	36	892	36	9	1,046	615	3,238
PM - 2014 (After)	379	1	43	6	8	24	21	810	—	—	1,201	600	3,093

Source: Central Transportation Planning Staff.

Intersection Capacity Analysis

Staff analyzed the 1997 before, 2007 projected, and 2014 after conditions based on recently collected turning-movement counts and signal timing data. Please see Tables 11 and 12 for a summary of Route 138 at Randolph Street and Route 138 at Washington Street analyses, respectively.

TABLE 11
LOS Comparison – Intersection of Route 138 at Randolph Street

Intersection / Approach	Movement	Before ¹			Projected ²			After ³		
		LOS	Delay ⁴	95% Q ⁵	LOS	Delay	95% Q	LOS	Delay	95% Q
AM Peak Period										
Randolph St. – EB	LTR (LT)	F	151.8	#541	E	55.7	#333	E	70.4	#330
Randolph St. – EB	(R)	—	—	—	B	16.1	124	A	6.1	35
Randolph St. – WB	(L)	—	—	—	D	36.0	#146	D	40.5	#121
Randolph St. – WB	LTR (TR)	F	887.6	#591	C	24.4	260	D	37.9	#433
Route 138 – NB	L	F	130.7	#138	—	—	—	—	—	—
Route 138 – NB	TR (LTR)	B	16.5	263	C	30.3	#305	F	114.6	#458
Route 138 – SB	L	A	7.2	19	—	—	—	—	—	—
Route 138 – SB	TR (LTR)	B	18.5	473	B	15.7	260	C	27.7	#342
Overall	—	F	229.8	—	C	26.7	—	E	59.4	—
PM Peak Period										
Randolph St. – EB	LTR (LT)	F	206.6	#589	D	49.5	#314	E	58.6	#433
Randolph St. – EB	(R)	—	—	—	C	21.4	163	A	7.8	27
Randolph St. – WB	(L)	—	—	—	C	35.0	#149	D	40.6	#99
Randolph St. – WB	LTR (TR)	F	925.0	#616	C	23.0	237	C	26.8	285
Route 138 – NB	L	F	94.3	#147	—	—	—	—	—	—
Route 138 – NB	TR (LTR)	B	17.6	295	D	37.6	#323	F	219.9	#570
Route 138 – SB	L	B	13.4	65	—	—	—	—	—	—
Route 138 – SB	TR (LTR)	B	15.0	387	D	47.9	#506	F	98.6	#520
Overall	—	F	248.1	—	D	39.3	—	F	119.0	—

¹ 1997 “before” existing traffic volumes from FDR. ² 2007 “projected” future traffic volumes with build conditions from FDR. ³ 2014 “after” existing traffic volumes. ⁴ Delay is measured in seconds. ⁵ Queue length is measured in feet.

Notes: (x) Turning lane configuration in Projected/After conditions. # = 95th percentile volume exceeds capacity; queues may be longer.

Source: Central Transportation Planning Staff.

TABLE 12
LOS Comparison – Intersection of Route 138 at Washington Street

Intersection / Approach	Movement	Before ¹			Projected ²			After ³		
		LOS	Delay ⁴	95% Q ⁵	LOS	Delay	95% Q	LOS	Delay	95% Q
AM Peak Period										
Washington St. – EB	(L)	—	—	—	D	41.9	#420	D	41.1	#317
Washington St. – EB	LTR	F	170.2	#676	D	40.2	#412	D	41.4	#322
Washington St. – WB	LTR	A	9.0	11	C	20.9	18	C	24.5	27
Route 138 – NB	LTR	F	195.5	#733	B	15.1	306	B	19.2	355
Route 138 – SB	TL (T)	D	36.3	#639	B	13.4	257	B	14.8	247
Route 138 – SB	R	A	0.2	0	A	0.3	0	A	0.3	0
Overall	—	F	114.4	—	B	19.8	—	C	20.8	—
PM Peak Period										
Washington St. – EB	(L)	—	—	—	D	37.0	235	D	35.8	175
Washington St. – EB	LTR	E	66.7	#477	D	35.6	227	C	32.4	164
Washington St. – WB	LTR	B	13.7	31	D	35.0	51	C	28.3	22
Route 138 – NB	LTR	F	704.1	#810	B	17.1	287	B	15.7	235
Route 138 – SB	TL (T)	D	35.1	#620	B	16.1	306	B	17.9	344
Route 138 – SB	R	A	0.5	0	A	0.9	0	A	0.8	0
Overall	—	F	241.5	—	B	17.2	—	B	16.5	—

¹ 1997 “before” existing traffic volumes from FDR. ² 2007 “projected” future traffic volumes with build conditions from FDR. ³ 2014 “after” existing traffic volumes. ⁴ Delay is measured in seconds. ⁵ Queue length is measured in feet.

Notes: (x) Turning lane configuration in projected/after conditions. # = 95th percentile volume exceeds capacity; queues may be longer.

Source: Central Transportation Planning Staff.

Route 138 at Randolph Street was projected to operate at LOS C in the AM peak hour and LOS D in the PM peak hour. The intersection is currently operating at LOS E in the AM peak hour and LOS F in the PM peak hour. The northbound Route 138 approach operates poorly in both peak hours based on the high number of northbound left turns and opposing southbound through volumes.

The intersection of Route 138 at Washington Street was projected to operate at LOS B in both the morning and evening peak hours. The intersection is currently operating at LOS C in the AM peak hour and LOS B in the PM peak hour.

6 KING STREET AT INTERSTATE 495 (UNION STREET/UPPER UNION STREET/CONSTITUTION BOULEVARD)—FRANKLIN

King Street is an urban minor arterial that runs southwest-northeast connecting Franklin with Medway and Norfolk to the north and Woonsocket, Rhode Island to the south. For simplicity, we refer to King Street as an east-west roadway throughout this report. King Street intersects with I-495 within the project limits; and the speed limit is posted at 30 mph. The surrounding lane use is primarily commercial, with some residential usage in the vicinity. Please see Figure 10 for an illustration of the study area.

This project widened King Street to accommodate a consistent cross section of four lanes, with two lanes in both the east- and westbound directions. Concrete sidewalks and granite curbing was installed along the south side of King Street within the project limits. The pavement on King Street also was upgraded, along with new pavement markings and signage. The purpose of the Franklin FDR was to address existing and projected traffic safety and operational deficiencies experienced in the project area.

The following sections provide a summary of the before-and-after conditions, along with a comparison of crash data, traffic volumes, and traffic analysis at five intersections along the King Street corridor.

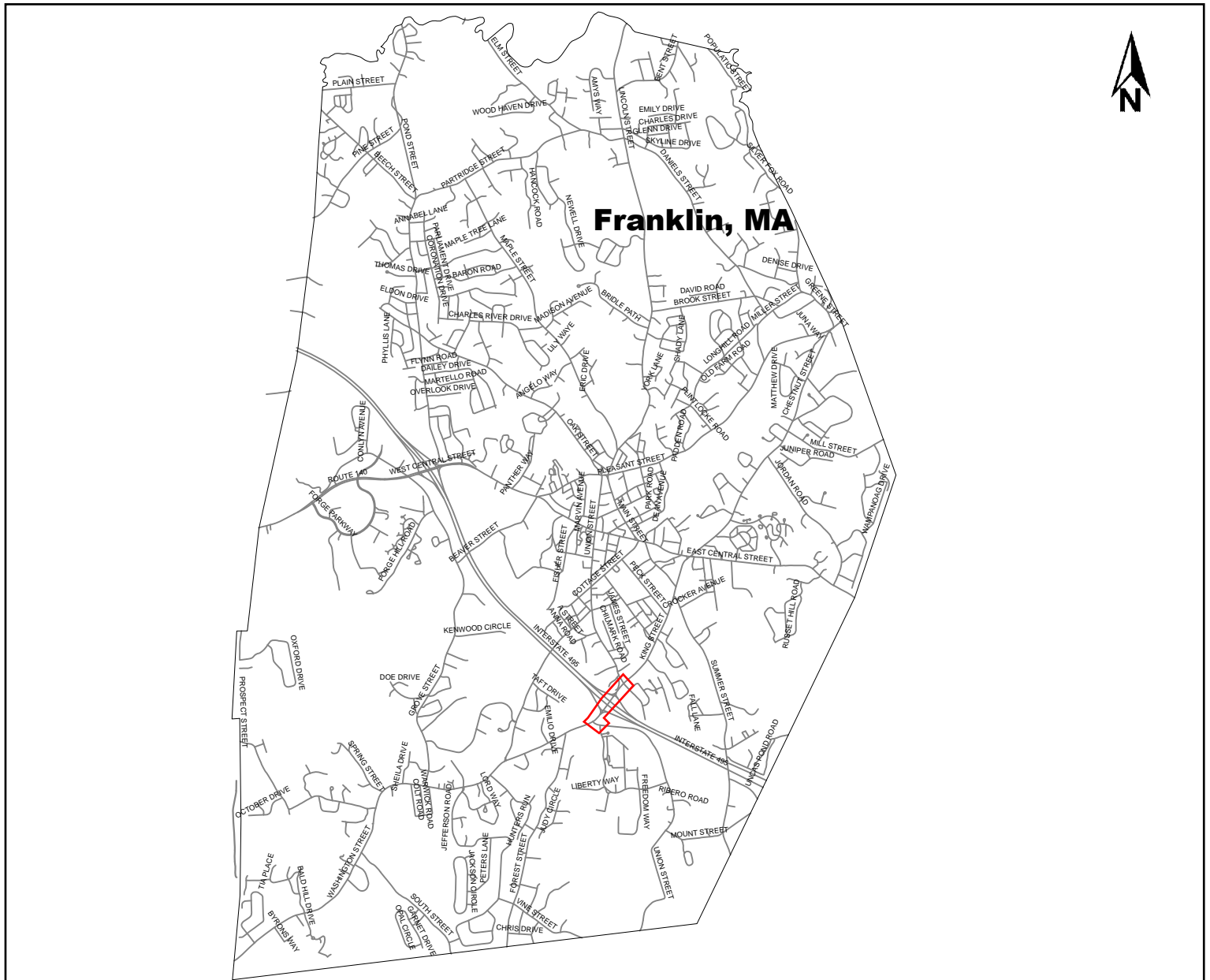
6.1 Summary of Conditions Before and After Improvements

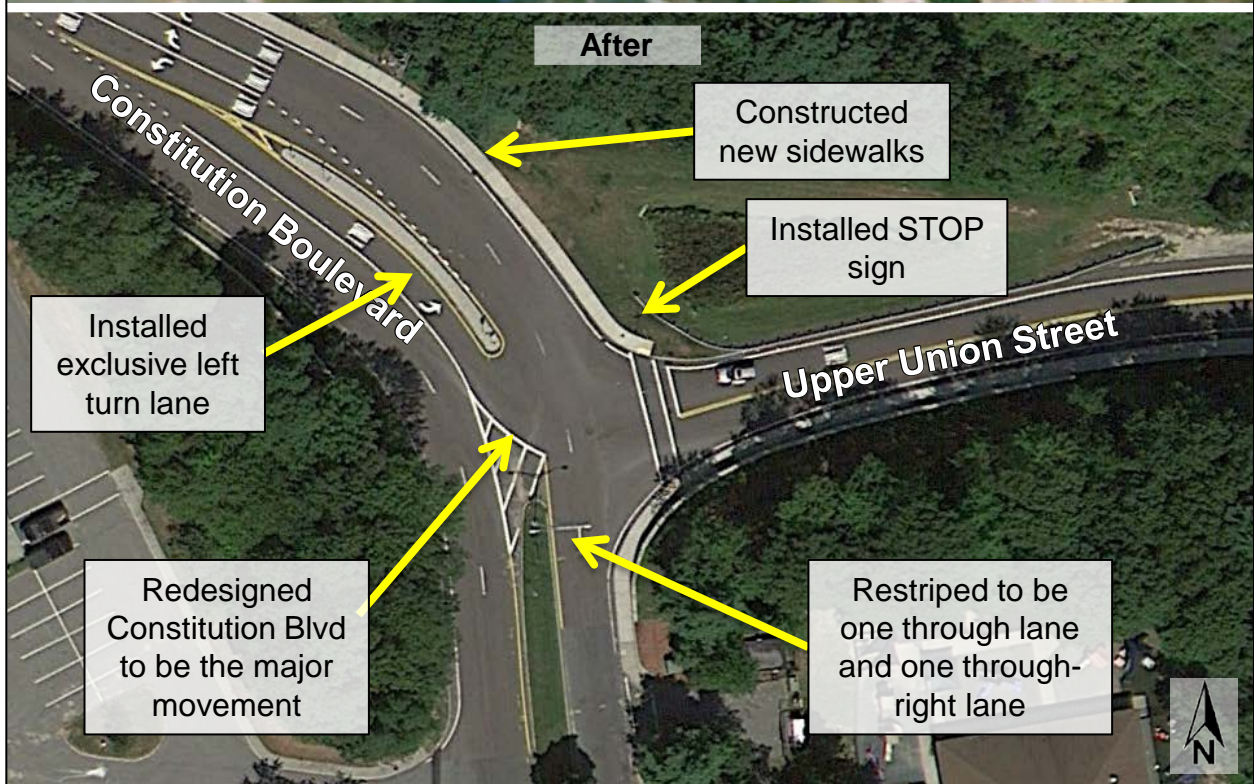
Constitution Boulevard at Upper Union Street—Before Conditions

Upper Union Street intersected with Constitution Boulevard to form a three-way intersection, with the eastbound Constitution Boulevard approach controlled by a stop sign. This intersection is the main entrance to the Franklin Industrial Park. Both the north- and southbound Upper Union Street approaches have one general-purpose lane, as shown in Figure 11. The eastbound Constitution Boulevard approach also has one general-purpose lane with a raised median

separating traffic flows along Constitution Boulevard. There were no pedestrian or bicycle accommodations at this intersection.

The crash rate before reconstructing the intersection was 0.45 crashes per million entering vehicles, which was below the District 3 average of 0.74 for unsignalized intersections. The eastbound Constitution Boulevard approach operated with LOS D and LOS F in the AM and PM peak hours, respectively.





BOSTON REGION MPO **FIGURE 11** **TIP Project Impacts**
Before-and-After Reconstruction of
Constitution Boulevard at Upper Union Street
Franklin, MA **Before-After**
Evaluation

Source: Central Transportation Planning Staff.

Constitution Boulevard at Upper Union Street—After Improvements

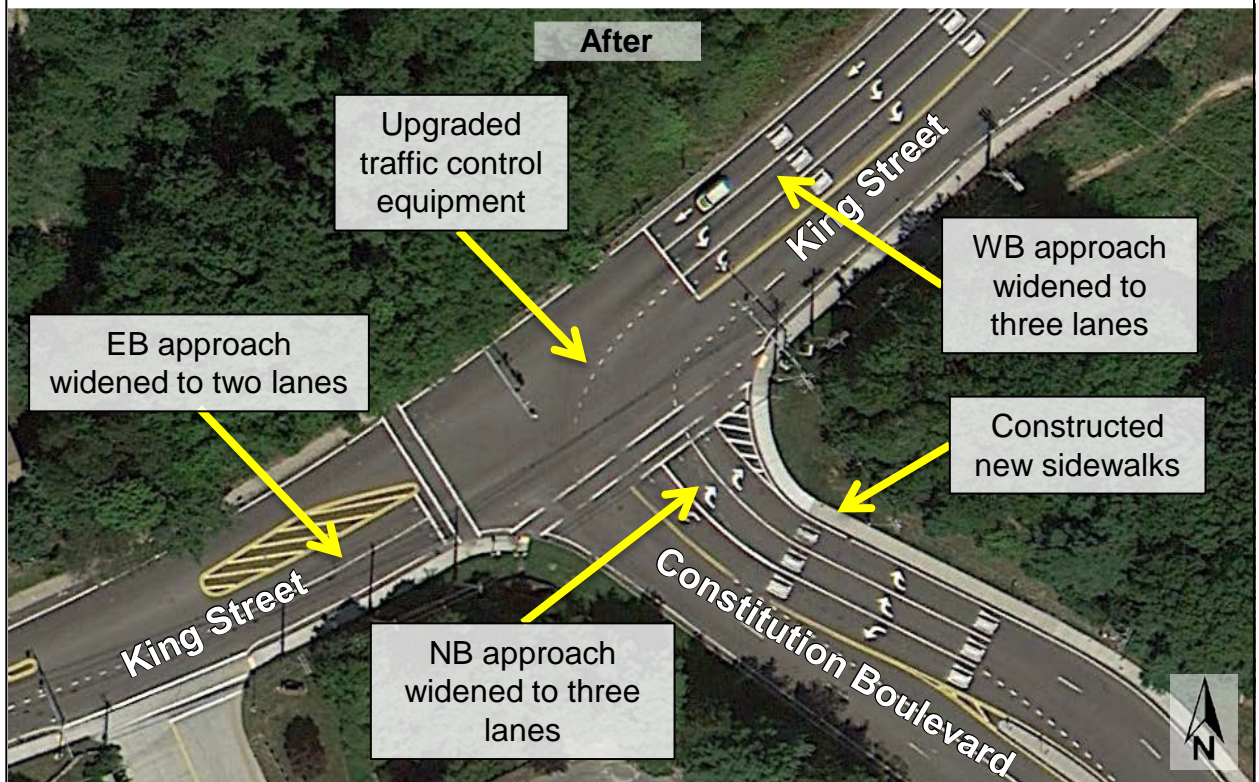
Upper Union Street at Constitution Boulevard was reconfigured such that Constitution Boulevard operates as the major traffic movement. After the improvements, the northbound Constitution Boulevard approach operates freely with one through lane and one through-right lane. The southbound Constitution Boulevard approach operates freely with two through lanes and one exclusive left-turn lane. The westbound Upper Union Street approach is stop sign controlled, with one right-turn only lane. A six-foot wide concrete sidewalk was constructed that extends along the east side of Constitution Boulevard from King Street to the south of Upper Union Street.

The crash rate for the years 2008 to 2012 is 0.27 crashes per million entering vehicles, which is well below the crash rate before the intersection improvements; the current rate is below the MassDOT District 3 average rate of 0.66 at unsignalized intersections. Analysis of current conditions shows improvement in traffic operations in both the AM and PM peak hours. The westbound Upper Union Street approach operates at LOS B in the AM peak hour, and the southbound Constitution Boulevard approach operates at LOS D in the PM peak hour.

King Street at Constitution Boulevard—Before Improvements

Before reconstruction, King Street intersected with Upper Union Street to form a three-way signalized intersection. The eastbound King Street approach operated with one through lane and one exclusive right-turn lane onto Upper Union Street. Westbound King Street had one lane and one exclusive left-turn lane onto Upper Union Street. The northbound Upper Union Street approach had one exclusive left-turn lane and one exclusive right-turn lane. The driveway to Franklin Fire Station #2 is located roughly 100 feet west of this intersection and is controlled by a separate traffic signal with emergency preemption. Sidewalks were present on the south side of King Street along both approaches and on the north side of the eastbound King Street approach, as shown in Figure 12.

The crash rate before reconstruction was 0.19 crashes per million entering vehicles, which was below the District 3 average of 0.89 for signalized intersections. The eastbound Constitution Boulevard approach operated with LOS F in the AM peak hour and LOS E in the PM peak hour.



BOSTON REGION MPO **FIGURE 12** **TIP Project Impacts**
Before-and-After Reconstruction of **Before-After**
King Street at Constitution Boulevard **Evaluation**
Franklin, MA

Source: Central Transportation Planning Staff.

King Street at Constitution Boulevard—After Improvements

After reconstruction, the northbound approach is referred to and signed as Constitution Boulevard. The eastbound King Street approach was widened to two lanes and striped as one through lane and one through-right lane. The westbound King Street approach also was widened and now has one through lane and two exclusive left-turn lanes. The northbound Constitution Boulevard approach was widened to accommodate an exclusive left-turn lane and two exclusive right-turn lanes. The sidewalks in the before period were reconstructed; however, no new bicycle or pedestrian facilities were installed. In addition, the traffic signal was upgraded to accommodate the modified geometry and signal coordination along King Street. The crash rate in the after period is 0.31 crashes per million entering vehicles; analysis of current conditions shows that the intersection is operating at LOS D in both the AM and PM peak hours.

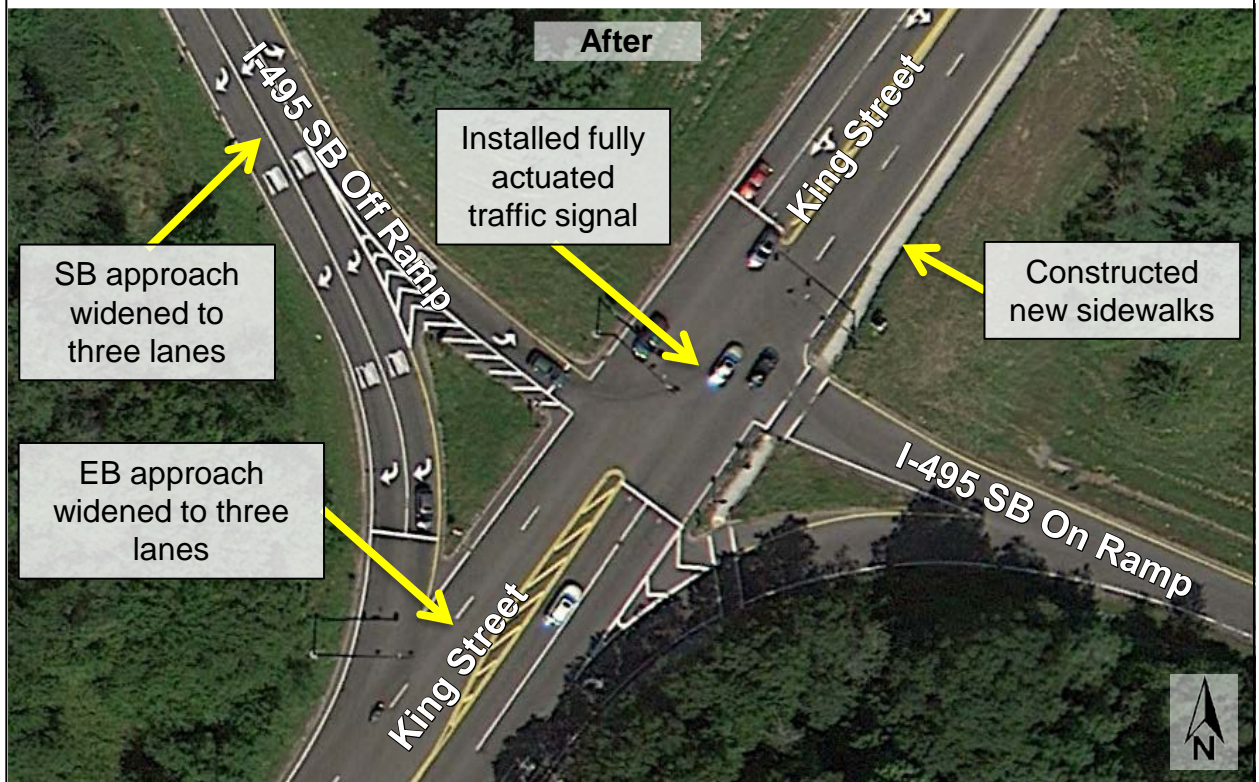
King Street at I-495 Southbound Ramps—Before Improvements

Prior to improvements, King Street intersected with the I-495 southbound ramps to form a four-way unsignalized intersection. The eastbound King Street approach operated with one through lane and one channelized limited-storage right-turn lane onto the I-495 southbound on-ramp. The westbound King Street approach had one through lane and one exclusive left-turn lane onto the I-495 southbound on-ramp. The I-495 southbound off ramp had one lane that split into one exclusive left- and right-turn lane, as shown in Figure 13. Sidewalks were present on the south side of King Street.

The crash rate at this intersection could not be calculated in the FDR as crashes around the I-495 Southbound Ramps were grouped together because of insufficient location data. This intersection operated at LOS F in both the AM and PM peak hours based on the high volumes on King Street; which caused departing vehicles from the I-495 southbound off ramp to experience high delays as they queued to wait for acceptable gaps on the unsignalized approach.



Before



After

SB approach widened to three lanes

EB approach widened to three lanes

Installed fully actuated traffic signal

Constructed new sidewalks

BOSTON REGION MPO

FIGURE 13
Before-and-After Reconstruction of King Street at I-495 SB Ramps Franklin, MA

TIP Project Impacts Before-After Evaluation

Source: Central Transportation Planning Staff.

King Street at Constitution Boulevard—After Improvements

The King Street approaches at the I-495 Southbound Ramps were widened to accommodate one shared left-through lane, one dedicated through lane on the westbound approach, and two through lanes and one exclusive right-turn lane on the eastbound approach. The eastbound right-turn lane operates under yield-sign control. The southbound I-495 off ramp also was widened to accommodate one exclusive left-turn lane and two exclusive right-turn lanes. The sidewalks along the south side of King Street were reconstructed, but additional bicycle or pedestrian facilities were not provided. This intersection was converted to signalized operations, with the installation of a fully actuated traffic signal and mast arm-mounted traffic signal equipment. The crash rate in the after period is 0.21 crashes per million entering vehicles, and the analysis of current conditions shows that the intersection is operating at LOS C in both the AM and PM peak hours.

King Street at I-495 Northbound Ramps—Before Improvements

King Street intersected with the I-495 northbound ramps to form a four-way unsignalized intersection before reconstruction. The eastbound King Street approach had one through lane and one exclusive left-turn lane, and the westbound King Street approach had one shared through-right lane. The channelized westbound right turn operated with yield-sign control and had limited storage. The I-495 northbound off ramp had one lane that split into one exclusive left- and right-turn lane, as shown in Figure 14. The northbound approach was controlled by a stop sign. Sidewalks were present along the south side of King Street. The crash rate at this location could not be calculated in the FDR because of data restraints. The intersection operated at LOS F in both the AM and PM peak hours because of the unsignalized could not accommodate northbound demand.

King Street at I-495 Northbound Ramps—After Improvements

The westbound King Street approach was widened to accommodate one through lane and one shared through-right lane. The eastbound King Street approach also was widened to include one exclusive left-turn lane and one dedicated through lane. The northbound I-495 off ramp was widened to accommodate two exclusive left-turn lanes and one exclusive right-turn lane. The northbound right-turn lane operates under yield control. The sidewalks along the south side of King Street were reconstructed, but new accommodations were not provided. A fully actuated traffic signal was installed with mast arm-mounted traffic signal equipment to address the operations issues at this intersection. The crash rate in the after period was 0.39 crashes per million entering vehicles, and analysis of

current conditions shows that the intersection is operating at LOS E in both the AM and PM peak hours.

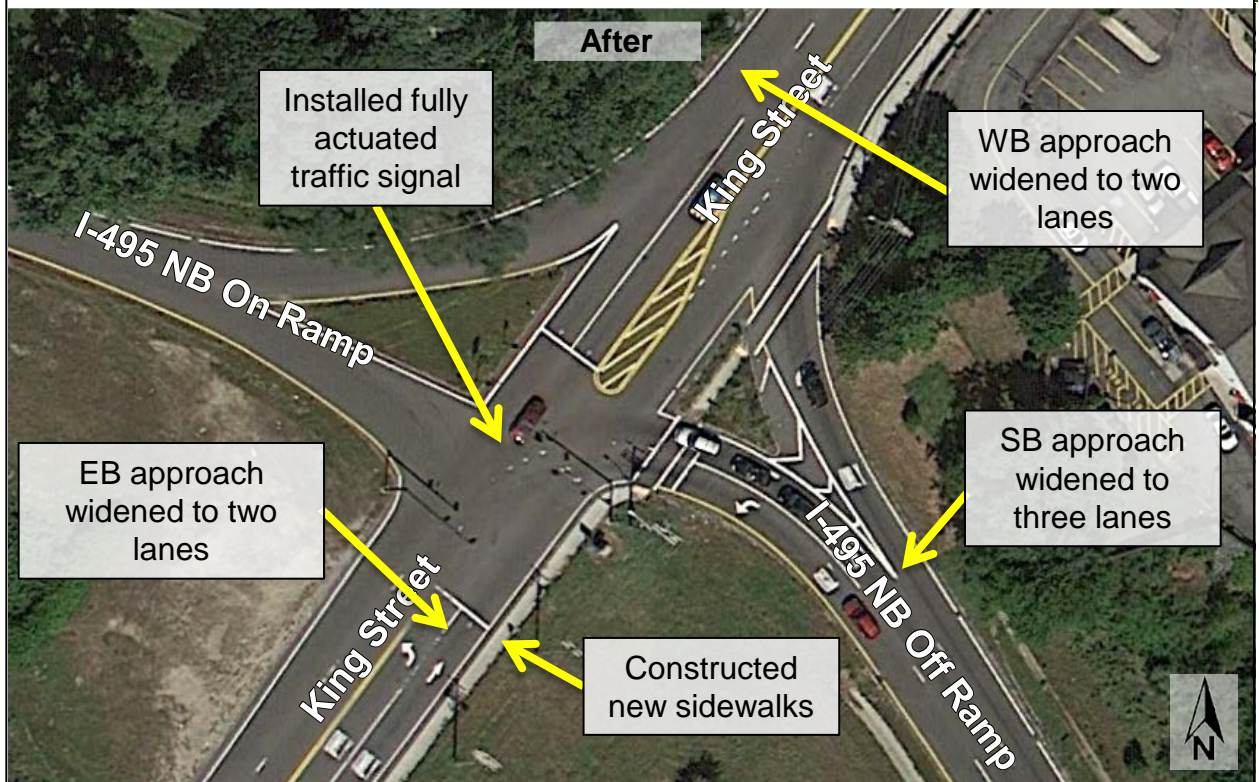


FIGURE 14
Before-and-After Reconstruction of
King Street at I-495 NB Ramps
Franklin, MA

BOSTON REGION MPO

TIP Project Impacts
 Before-After
 Evaluation

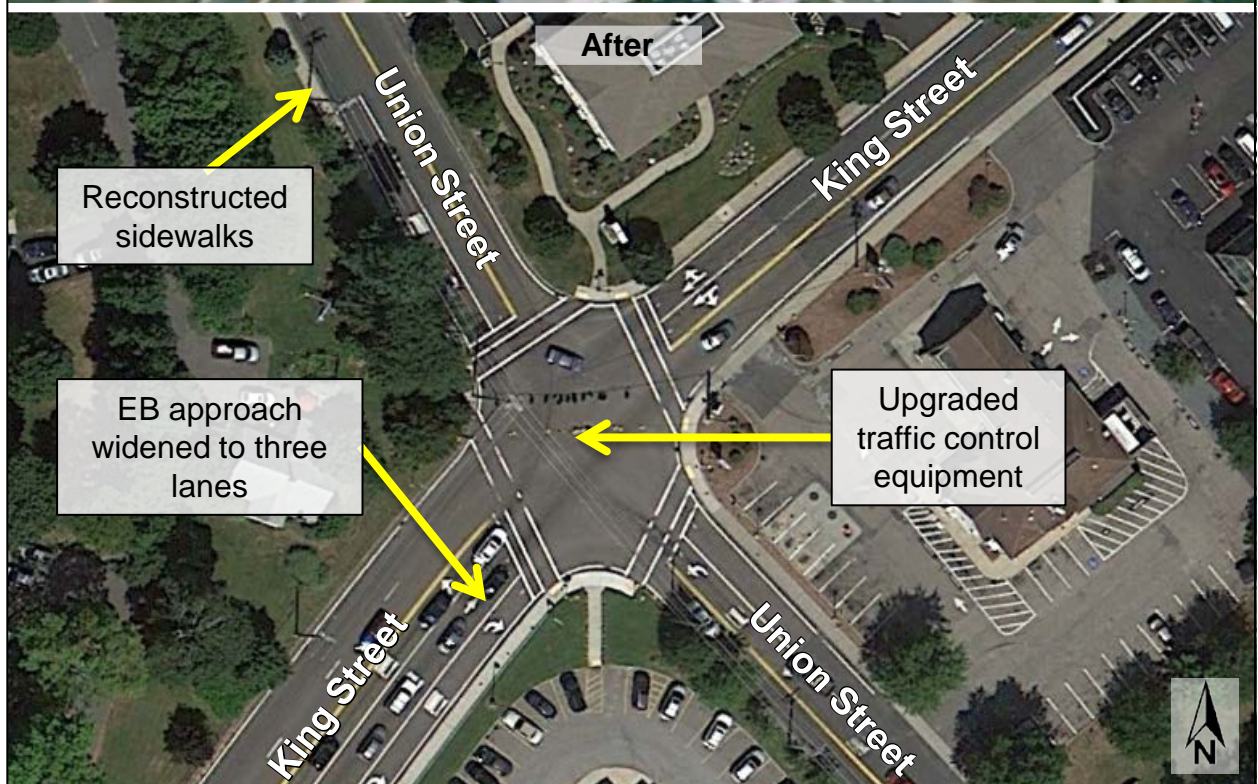
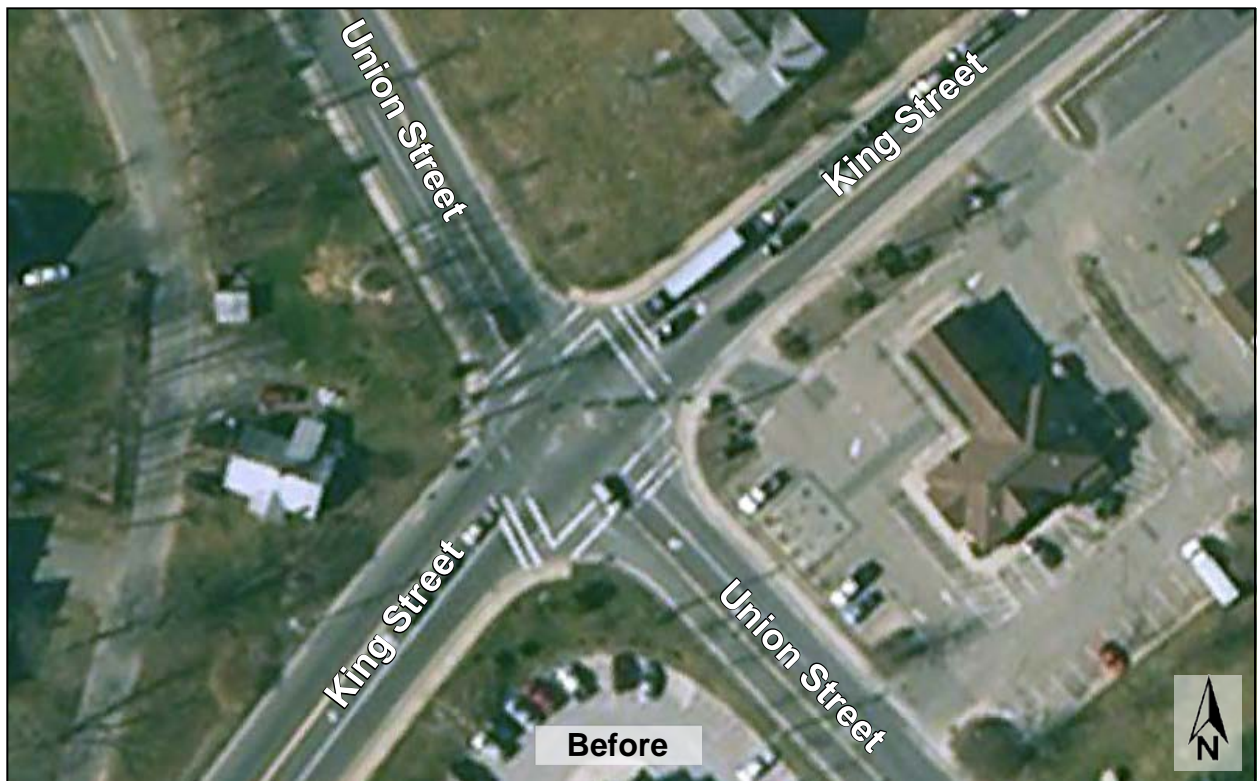
Source: Central Transportation Planning Staff.

King Street at Union Street—Before Improvements

King Street intersected with Union Street to form a four-way signalized intersection just east of the I-495 ramps. The westbound and eastbound King Street approaches consisted of one left-turn lane and one shared through-right lane. The northbound Union Street approach had one left-turn lane and one shared through-right lane, and the southbound Union Street approach had one shared left-through lane and one right-turn lane. Please see Figure 15 for an illustration of the intersection. Sidewalks were present on the south side of the eastbound approach, the east side of the northbound approach, both sides of the westbound approach, and the west side of the southbound approach. A gas station was located at the southeast corner of the intersection, and a small shopping center existed at the southwest corner of the intersection. The crash rate was 0.71 crashes per million entering vehicles, which was slightly below the 2001 MassDOT District 3 average of 0.85 for signalized intersections. The intersection operated at LOS C and LOS D in the AM and PM peak hours, respectively.

King Street at Union Street—After Improvements

King Street was widened to accommodate one eastbound exclusive left-turn lane, one through lane, and one exclusive right-turn lane. The westbound approach also was widened to accommodate two general-purpose lanes. Sidewalks were reconstructed, but additional pedestrian and bicycle accommodations were not provided. Traffic signals were modified for the updated geometry, and the signal was coordinated with adjacent signals along King Street within the project limits. The crash rate in the after period was 0.08 crashes per million entering vehicles. The intersection operates at LOS D in both the AM and PM peak hours, as projected by the FDR analysis.



BOSTON REGION MPO
FIGURE 15
TIP Project Impacts
Before-and-After Reconstruction of
Before-After
King Street at Union Street
Evaluation
Franklin, MA

Source: Central Transportation Planning Staff.

6.2 Comparisons of Crash Data, Traffic Volumes, and Traffic Analyses

Crash Data

Crash data from the Franklin FDR (1997-99) were compared to current MassDOT RMV data for the most recent available five-year period, from 2008 to 2012. Tables 13-17 provide a summary of the crashes at the five intersection locations within the study area. Collision diagrams based on the after period data are located in Appendix C.

One crash occurred at the intersection of Constitution Boulevard at Upper Union Street between 1997 and 1999. The total and average number of crashes in the after period only includes crashes that occurred after construction was complete in 2010. There were four crashes during the after period, averaging 1.6 crashes per year. The crash rate in the before conditions was 0.45 crashes per million entering vehicles, decreasing to 0.27 crashes per million vehicles in the after conditions, which was significantly less than the District 3 average for unsignalized intersections.

Six crashes occurred at the intersection of King Street at Constitution Boulevard before reconstruction, averaging two crashes per year during this time. Nine crashes occurred in the after period, averaging 3.5 crashes per year. A greater number of rear-end collisions occurred in the after period. The crash rate increased from 0.19 to 0.31 crashes per million entering vehicles after reconstruction. The crash rate for 2008 to 2012 is less than the District 3 average for signalized intersections.

Because the crash data analyzed in the Franklin FDR only allowed an aggregate crash summary of the King Street at I-495 south- and northbound ramps, a before-and-after comparison could not be conducted. However, in the after period crash data still could be summarized. During the after period, seven crashes occurred with an average of 2.7 crashes per year at the I-495 southbound ramps. Angle and rear-end crashes were the most common crash type in this period. The crash rate was calculated to be 0.21 crashes per million entering vehicles. The King Street at I-495 northbound ramps experienced 12 crashes, averaging 4.7 crashes per year. Nearly 75% of the crashes were angle collisions; the crash rate was calculated to be 0.39 crashes per million entering vehicles.

Twenty crashes occurred at the intersection of King Street at Union Street before the intersection was reconfigured. Only two crashes occurred in the 2.58 years of available data after the construction was complete in 2010. The crash rate decreased from 0.71 to 0.08 crashes per million entering vehicles.

TABLE 13
Crash Summary – Constitution Boulevard at Upper Union Street

Crash Category	1997	1998	1999	Total	Average	2008	2009	2010²	2011	2012	Total³	Average⁴
Crash severity												
Property damage only	0	0	1	1	0.3	0	1	0	4	0	4	1.6
Personal injury	0	0	0	0	0	0	0	0	0	0	0	0
Fatality	0	0	0	0	0	0	0	0	0	0	0	0
Collision type												
Not reported	0	0	1	1	0.3	0	0	0	0	0	0	0
Angle	0	0	0	0	0	0	1	0	2	0	2	0.8
Rear-end	0	0	0	0	0	0	0	0	1	0	1	0.4
Side-swipe	—	—	—	—	—	0	0	0	0	0	0	0
Head-on	0	0	0	0	0	0	0	0	0	0	0	0
Single-vehicle	—	—	—	—	—	0	0	0	1	0	1	0.4
Roadway conditions												
Not reported	—	—	—	—	—	0	0	0	1	0	1	0.4
Wet or icy pavement	—	—	—	—	—	0	0	0	0	0	0	0
Weather conditions												
Dark/lighted	—	—	—	—	—	0	0	0	1	0	1	0.4
Clear	—	—	—	—	—	0	1	0	2	0	2	0.8
Cloudy	—	—	—	—	—	0	0	0	2	0	2	0.8
Rain	—	—	—	—	—	0	0	0	0	0	0	0
Snow	—	—	—	—	—	0	0	0	0	0	0	0
Crashes during weekday peak periods ¹	—	—	—	—	—	0	1	0	3	0	3	1.2
Crashes involving pedestrian(s)	—	—	—	—	—	0	0	0	0	0	0	0
Crashes involving bicyclist(s)	—	—	—	—	—	0	0	0	0	0	0	0
Total crashes	0	0	1	1	0.3	0	1	0	4	0	4	1.6

¹ Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM. ² The number of crashes in 2010 only includes crashes that occurred after construction was complete in summer 2010. ³ Represents total number of crashes in the after period. ⁴ Crashes in the after period are averaged across 2.58 years.

Source: Central Transportation Planning Staff.

TABLE 14
Crash Summary – King Street at Constitution Boulevard

Crash Category	1997	1998	1999	Total	Average	2008	2009	2010²	2011	2012	Total³	Average⁴
Crash severity												
Property damage only	0	3	1	4	1.3	7	1	1	2	3	6	2.3
Personal injury	0	2	0	2	0.7	0	2	1	2	0	3	1.2
Fatality	0	0	0	0	0	0	0	0	0	0	0	0
Collision type												
Not reported	0	1	0	1	0.3	0	0	0	0	0	0	0
Angle	0	3	0	3	1	3	1	1	0	0	1	0.4
Rear-end	0	1	1	2	0.7	1	2	1	4	2	7	2.7
Side-swipe	—	—	—	—	—	1	0	0	0	1	1	0.4
Head-on	0	0	0	0	0	0	0	0	0	0	0	0
Single-vehicle	—	—	—	—	—	2	0	0	0	0	0	0
Roadway conditions												
Not reported	—	—	—	—	—	0	0	0	1	0	1	0.4
Wet or icy pavement	—	—	—	—	—	0	0	0	0	0	0	0
Weather conditions												
Dark/lighted	—	—	—	—	—	2	1	0	1	0	1	0.4
Clear	—	—	—	—	—	4	3	1	4	3	8	3.1
Cloudy	—	—	—	—	—	3	0	1	0	0	1	0.4
Rain	—	—	—	—	—	0	0	0	0	0	0	0
Snow	—	—	—	—	—	0	0	0	0	0	0	0
Crashes during weekday peak periods ¹	—	—	—	—	—	2	0	0	1	1	2	0.8
Crashes involving pedestrian(s)	—	—	—	—	—	0	0	0	0	0	0	0
Crashes involving bicyclist(s)	—	—	—	—	—	0	0	0	0	0	0	0
Total crashes	0	5	1	6	2	7	3	2	4	3	9	3.5

¹ Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM. ² The number of crashes in 2010 only includes crashes that occurred after construction was complete in summer 2010. ³ Represents total number of crashes in the after period. ⁴ Crashes in the after period are averaged across 2.58 years.

Source: Central Transportation Planning Staff.

TABLE 15
Crash Summary – King Street at I-495 SB Ramps

Crash Category	2008	2009	2010²	2011	2012	Total³	Average⁴
Crash severity							
Property damage only	2	0	0	3	2	5	1.9
Personal injury	0	0	0	1	0	1	0.4
Fatality	0	0	0	0	0	0	0
Collision type							
Not reported	0	0	0	0	0	0	0
Angle	0	0	0	2	2	4	1.6
Rear-end	2	0	0	2	0	2	0.8
Side-swipe	0	0	0	0	0	0	0
Head-on	0	0	0	1	0	1	0.4
Single-vehicle	0	0	0	0	0	0	0
Roadway conditions							
Not reported	0	0	0	4	0	4	1.6
Wet or icy pavement	0	0	0	0	0	0	0
Weather conditions							
Dark/lighted	0	0	0	1	0	1	0.4
Clear	2	0	0	4	2	6	2.3
Cloudy	0	0	0	0	0	0	0
Rain	0	0	0	1	0	1	0.4
Snow	0	0	0	1	0	1	0.4
Crashes during weekday peak periods ¹	1	0	0	3	0	3	1.2
Crashes involving pedestrian(s)	0	0	0	0	0	0	0
Crashes involving bicyclist(s)	0	0	0	0	0	0	0
Total crashes	2	0	0	5	2	7	2.7

¹ Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM. ² The number of crashes in 2010 only includes crashes that occurred after construction was complete in summer 2010. ³ Represents total number of crashes in the after period. ⁴ Crashes in the after period are averaged across 2.58 years.

Source: Central Transportation Planning Staff.

TABLE 16
Crash Summary – King Street at I-495 NB Ramps

Crash Category	2008	2009	2010²	2011	2012	Total³	Average⁴
Crash severity							
Property damage only	1	2	1	6	4	11	4.3
Personal injury	0	1	0	1	0	1	0.4
Fatality	0	0	0	0	0	0	0
Collision type							
Not reported	0	0	0	0	0	0	0
Angle	0	1	0	5	3	8	3.1
Rear-end	1	2	0	2	1	3	1.2
Side-swipe	0	0	0	0	0	0	0
Head-on	0	0	0	0	0	0	0
Single-vehicle	0	0	1	0	0	1	0.4
Roadway conditions							
Not reported	0	0	0	5	0	5	1.9
Wet or icy pavement	1	1	0	0	2	2	0.8
Weather conditions							
Dark/lighted	0	0	0	1	3	4	1.6
Clear	0	2	1	5	2	8	3.1
Cloudy	1	1	0	2	1	3	1.2
Rain	0	1	0	0	1	1	0.4
Snow	1	0	0	0	0	0	0
Crashes during weekday peak periods ¹	0	1	0	3	3	6	2.3
Crashes involving pedestrian(s)	0	0	0	0	0	0	0
Crashes involving bicyclist(s)	0	0	0	0	0	0	0
Total crashes	1	3	1	7	4	12	4.7

¹ Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM. ² The number of crashes in 2010 only includes crashes that occurred after construction was complete in summer 2010. ³ Represents total number of crashes in the after period. ⁴

Crashes in the after period are averaged across 2.58 years.

Source: Central Transportation Planning Staff.

TABLE 17
Crash Summary – King Street at Union Street

Crash Category	1997	1998	1999	Total	Average	2008	2009	2010²	2011	2012	Total³	Average⁴
Crash severity												
Property damage only	4	5	1	10	3.3	3	2	0	0	1	1	0.4
Personal injury	6	3	1	10	3.3	0	1	0	1	0	1	0.4
Fatality	0	0	0	0	0	0	0	0	0	0	0	0
Collision type												
Not reported	0	0	0	0	0	0	0	0	0	0	0	0
Angle	6	5	1	12	4	2	1	0	0	0	0	0
Rear-end	2	3	1	6	2	1	1	0	1	1	2	0.8
Side-swipe	--	--	--	--	--	0	0	0	0	0	0	0
Head-on	2	0	0	2	0.7	0	1	0	0	0	0	0
Single-vehicle	--	--	--	--	--	0	0	0	0	0	0	0
Roadway conditions												
Not reported	--	--	--	--	--	0	0	0	0	0	0	0
Wet or icy pavement	--	--	--	--	--	1	2	0	1	0	1	0.4
Weather conditions												
Dark/lighted	--	--	--	--	--	1	1	0	0	0	0	0
Clear	--	--	--	--	--	2	1	0	0	1	1	0.4
Cloudy	--	--	--	--	--	1	2	0	1	0	1	0.4
Rain	--	--	--	--	--	0	2	0	1	0	1	0.4
Snow	--	--	--	--	--	0	0	0	0	0	0	0
Crashes during weekday peak periods ¹	--	--	--	--	--	2	1	0	1	0	1	0.4
Crashes involving pedestrian(s)	--	--	--	--	--	0	0	0	0	0	0	0
Crashes involving bicyclist(s)	--	--	--	--	--	0	0	0	0	0	0	0
Total crashes	10	8	2	20	6.7	3	3	0	1	1	2	0.8

¹ Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM. ² The number of crashes in 2010 only includes crashes that occurred after construction was complete in summer 2010. ³ Represents total number of crashes in the after period. ⁴ Crashes in the after period are averaged across 2.58 years.

Source: Central Transportation Planning Staff.

Traffic Volumes

MPO staff collected turning-movement counts at the five intersections in Franklin on June 17-18, 2014, while school was still in session. Data were recorded in 15-minute intervals for the morning peak period from 7:00 to 9:00 AM and the evening peak period from 4:00 to 6:00 PM. Please see Appendix A for traffic count summaries. Table 18 compares traffic volumes for three separate years for each intersection, representing the following scenarios:

- 2000 FDR before existing conditions
- 2010 FDR projected build conditions
- 2014 after conditions

As shown in Table 18, overall traffic volumes grew slightly between the years 2000 and 2014, but not as much as predicted by the FDR. The largest increase in volumes occurred in the AM peak hour at the intersection of King Street at Constitution Boulevard. However, there actually was a decrease in traffic volumes in the PM peak hour at the intersection of King Street at Union Street.

TABLE 18
Traffic Volume Comparison

Intersection of Constitution Boulevard (NB) at Upper Union Street (EB/WB)

Scenario	EB		WB		NB		Total
	LT	TH	TH	RT	LT	RT	
AM - 2000 (Before)	45	260	295	40	85	75	2,520
AM - 2010 (Projected)	56	267	302	82	87	77	2,922
AM - 2014 (After)	20	257	370	115	141	91	2,667
PM - 2000 (Before)	65	245	300	45	100	75	2,620
PM - 2010 (Projected)	67	251	208	51	103	77	2,895
PM - 2014 (After)	14	400	298	102	142	195	2,987

Intersection of King Street (EB/WB) at Constitution Boulevard (NB)

Scenario	EB		WB		NB		Total
	TH	RT	LT	TH	LT	RT	
AM - 2000 (Before)	871	100	644	336	46	353	2,350
AM - 2010 (Projected)	982	198	1,002	385	57	471	3,095
AM - 2014 (After)	918	153	858	428	48	380	2,785
PM - 2000 (Before)	682	36	371	858	104	583	2,634
PM - 2010 (Projected)	764	45	474	942	183	940	3,348
PM - 2014 (After)	421	36	327	970	168	873	2,795

Intersection of King Street (EB/WB) at I-495 SB Ramps (NB)

Scenario	EB		WB		SB		Total
	TH	RT	LT	TH	LT	RT	
AM - 2000 (Before)	848	376	319	572	82	408	2,605
AM - 2010 (Projected)	1,022	431	371	878	109	509	3,320
AM - 2014 (After)	858	440	328	725	152	561	3,064
PM - 2000 (Before)	885	380	292	758	245	471	3,031
PM - 2010 (Projected)	1,223	481	334	892	285	524	3,739
PM - 2014 (After)	891	403	282	801	382	496	3,255

Intersection of King Street (EB/WB) at I-495 NB Ramps

Scenario	EB		WB		NB		Total
	LT	TH	TH	RT	LT	RT	
AM - 2000 (Before)	512	418	615	368	276	360	2,549
AM - 2010 (Projected)	582	549	889	413	360	417	3,210
AM - 2014 (After)	472	538	719	332	334	180	2,575
PM - 2000 (Before)	434	696	817	190	233	409	2,779
PM - 2010 (Projected)	508	1,000	964	223	262	466	3,423
PM - 2014 (After)	529	744	703	232	380	326	2,914

Intersection of King Street (EB/WB) at Union Street (NB/SB)

Scenario	EB			WB			NB			SB			Total
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM - 2000 (Before)	219	522	37	13	552	21	126	29	21	44	17	305	1,906
AM - 2010 (Projected)	246	591	129	47	698	23	231	42	51	48	32	373	2,511
AM - 2014 (After)	167	489	62	57	541	8	257	65	31	20	47	253	1,997
PM - 2000 (Before)	291	707	107	33	577	30	186	30	32	57	35	244	2,329
PM - 2010 (Projected)	371	902	193	57	647	33	266	42	59	63	47	274	2,954
PM - 2014 (After)	263	723	84	50	560	45	179	38	39	39	38	196	2,254

Source: Central Transportation Planning Staff.

Intersection Capacity Analysis

The 2000 before, 2010 projected, and 2014 after conditions were analyzed based on the turning-movement counts and signal timing data gathered by MPO staff. Tables 19-23 summarize the analysis for five study intersections.

The intersection of Upper Union Street at Constitution Boulevard was projected to operate at LOS A in the AM peak hour and LOS B in the PM peak hour. The intersection is currently operating at LOS B in the AM peak hour and LOS C in the PM peak hour. The FDR assumed this intersection would be converted to a fully actuated signalized intersection, but it remained unsignalized. However, the geometric modifications improved morning operations from LOS D to LOS B, and in the evening peak hour from LOS F to LOS D in the before conditions.

The intersection of King Street at Constitution Boulevard was projected to operate at LOS C in both the AM and PM peak hours. The intersection is currently operating at LOS D both the AM and PM peak hours. This is mostly because of high delays on the northbound Constitution Boulevard approach in the AM peak hour. Compared to the before conditions, widening King Street improved intersection operations in the AM peak hour from LOS F to LOS D and in the PM peak hour from LOS E to LOS D.

The intersection of King Street at the I-495 southbound ramps was projected to operate at LOS C in both the AM and PM peak hours, and the intersection currently is operating as expected. Widening King Street, combined with converting it to signalized control, greatly improved intersection operations in both the AM and PM peak hours.

The intersection of King Street at the I-495 northbound ramps was projected to operate at LOS E in the AM peak hour and LOS C in the PM peak hour. Although the intersection is operating as projected in the AM peak hour, it is operating at LOS E in the PM peak hour. Widening and converting the signal at King Street and the I-495 northbound ramps improved intersection operations LOS F to LOS E in both peak hours compared to the unsignalized conditions before reconstruction.

The intersection of King Street at Union Street was projected to operate at LOS D in the AM and PM peak hours; the intersection currently is operating as projected, although high delays are experienced on the eastbound and westbound King Street approaches.

TABLE 19
LOS Comparison – Intersection of Constitution Boulevard at Upper Union Street

Intersection / Approach ⁶	Movement	Before ¹			Projected ²			After ³		
		LOS	Delay ⁴	95% Q ⁵	LOS	Delay	95% Q	LOS	Delay	95% Q
AM Peak Period										
Constitution Blvd. – EB	LR (L)	D	27.1	105	D	40.4	115	A	7.9	8
Constitution Blvd. – EB	(T)	—	—	—	—	—	—	—	—	—
Upper Union St. – NB	TL	A	0.5	1	A	4.6	41	B	10.8	41
Upper Union St. – SB	TR ¹ (T)	—	—	—	—	—	—	—	—	—
Upper Union St. – SB	(R)	—	—	—	—	—	—	—	—	—
Overall	—	—	—	—	A	8.0	—	—	—	—
PM Peak Period										
Constitution Blvd. – EB	LR	F	90.1	455	A	9.0	139	D	30.8	131
Constitution Blvd. – EB	(T)	—	—	—	—	—	—	—	—	—
Upper Union St. – NB	TL	A	0.1	0	D	36.6	180	C	19.4	39
Upper Union St. – SB	TR ¹ (T)	—	—	—	B	11.6	m179	—	—	—
Upper Union St. – SB	(R)	—	—	—	—	—	m0	—	—	—
Overall	—	—	—	—	B	18.1	--	—	—	—

¹ 2000 “before” existing traffic volumes from FDR. ² 2010 “projected” future traffic volumes with build conditions from FDR. ³ 2014 “after” existing traffic volumes. ⁴ Delay is measured in seconds. ⁵ Queue length is measured in feet. ⁶ Constitution Boulevard runs north/south and Upper Union Street runs east/west in the after conditions.

Notes: (x) Turning lane configuration in Projected/After conditions. m = Volume for 95th percentile queue is metered by upstream signal.

Source: Central Transportation Planning Staff.

TABLE 20
LOS Comparison – Intersection of King Street at Constitution Boulevard

Intersection / Approach ⁶	Movement	Before ¹			Projected ²			After ³		
		LOS	Delay ⁴	95% Q ⁵	LOS	Delay	95% Q	LOS	Delay	95% Q
AM Peak Period										
King St. – EB	T (TR)	F	196.9	#1061	D	43.1	#496	D	49.1	#474
King St. – EB	R	A	9.4	51	—	—	—	—	—	—
King St. – WB	L	F	212.2	#729	D	36.9	#422	D	46.3	m329
King St. – WB	T	A	4.3	83	A	2.2	m52	A	1.9	m39
Upper Union St. – NB	L	D	42.5	63	F	92.5	#99	F	188.2	#85
Upper Union St. – NB	R	B	18.6	211	B	10.4	148	B	16.2	121
Overall	—	F	132.1	—	C	31.9	—	D	40.3	—
PM Peak Period										
King St. – EB	T (TR)	F	159.0	#776	C	30.8	277	C	22.3	154
King St. – EB	R	A	9.9	23	—	—	—	—	—	—
King St. – WB	L	C	26.8	291	D	43.3	m152	C	34.0	m134
King St. – WB	T	A	8.5	358	D	36.7	m450	E	73.9	m572
Upper Union St. – NB	L	D	53.3	120	C	24.9	157	D	35.9	150
Upper Union St. – NB	R	E	65.8	447	B	17.5	363	C	34.3	299
Overall	—	E	67.7	—	C	30.2	—	D	44.3	—

¹ 2000 “before” existing traffic volumes from FDR. ² 2010 “projected” future traffic volumes with build conditions from FDR. ³ 2014 “after” existing traffic volumes. ⁴ Delay is measured in seconds. ⁵ Queue length is measured in feet. ⁶ This intersection is signed as King Street at Constitution Boulevard in after conditions

Notes: (x) Turning lane configuration in Projected/After conditions. # = 95th percentile volume exceeds capacity; queues may be longer. m = Volume for 95th percentile queue is metered by upstream signal.

Source: Central Transportation Planning Staff.

TABLE 21
LOS Comparison – Intersection of King Street at I-495 SB Ramps

Intersection / Approach	Movement	Before ¹			Projected ²			After ³		
		LOS	Delay ⁴	95% Q ⁵	LOS	Delay	95% Q	LOS	Delay	95% Q
AM Peak Period										
King St. – EB	TR (T)	—	—	—	D	49.8	m#399	D	44.3	m333
King St. – EB	(R)	—	—	—	A	0.3	m0	A	0.6	0
King St. – WB	L	C	17.6	85	—	—	—	—	—	—
King St. – WB	T (TL)	—	—	—	A	5.3	m46	B	12.6	m88
I-495 SB Off-Ramp	L	F	*	*	D	37.7	101	C	32.1	138
I-495 SB Off-Ramp	R	F	*	*	C	25.6	122	F	83.8	#331
Overall	—	—	—	—	C	22.5	—	C	32.3	—
PM Peak Period										
King St. – EB	TR (T)	—	—	—	B	15.1	292	B	16.8	m288
King St. – EB	(R)	—	—	—	A	0.4	0	A	0.4	0
King St. – WB	L	C	17.7	78	—	—	—	—	—	—
King St. – WB	T (TL)	—	—	—	C	29.3	m#171	C	32.4	m92
I-495 SB Off-Ramp	L	F	*	*	D	49.3	245	E	70.7	#422
I-495 SB Off-Ramp	R	F	*	*	B	19.3	126	E	57.2	#280
Overall	—	—	—	—	C	21.1	—	C	30.9	—

¹ 2000 “before” existing traffic volumes from FDR. ² 2010 “projected” future traffic volumes with build conditions from FDR. ³ 2014 “after” existing traffic volumes. ⁴ Delay is measured in seconds. ⁵ Queue length is measured in feet.

Notes: (x) Turning lane configuration in Projected/After conditions. # = 95th percentile volume exceeds capacity; queues may be longer. m = Volume for 95th percentile queue is metered by upstream signal, * = Volume greatly exceeds capacity, the methods could not compute delay or queue length.

Source: Central Transportation Planning Staff.

TABLE 22
LOS Comparison – Intersection of King Street at I-495 NB Ramps

Intersection / Approach	Movement	Before ¹			Projected ²			After ³		
		LOS	Delay ⁴	95% Q ⁵	LOS	Delay	95% Q	LOS	Delay	95% Q
AM Peak Period										
King St. – EB	L	C	16.4	120	D	43.0	m#370	B	16.2	m20
King St. – EB	T	—	—	—	A	4.6	m0	A	3.3	m0
King St. – WB	TR	—	—	—	E	56.5	m#465	D	35.7	m381
I-495 NB Off-Ramp	L	F	*	*	F	217.1	#237	F	370.9	#218
I-495 NB Off-Ramp	R	F	*	*	A	0.4	0	A	0.2	0
Overall	—	—	—	—	E	55.9	—	E	78.9	—
PM Peak Period										
King St. – EB	L	C	24.5	160	C	25.5	#414	D	47.2	m#417
King St. – EB	T	—	—	—	C	21.2	726	B	10.5	m409
King St. – WB	TR	—	—	—	C	25.9	m196	B	15.9	m131
I-495 NB Off-Ramp	L	F	*	*	F	134.3	#173	F	323.5	#267
I-495 NB Off-Ramp	R	F	*	*	A	0.4	0	A	0.3	0
Overall	—	—	—	—	C	29.3	—	E	58.1	—

¹ 2000 “before” existing traffic volumes from FDR. ² 2010 “projected” future traffic volumes with build conditions from FDR. ³ 2014 “after” existing traffic volumes. ⁴ Delay is measured in seconds. ⁵ Queue length is measured in feet.

Notes: * = Volume greatly exceeds capacity, the methods could not compute delay or queue length. (x) Turning lane configuration in Projected/After conditions. m = Volume for 95th percentile queue is metered by upstream signal. # = 95th percentile volume exceeds capacity; queues may be longer.

Source: Central Transportation Planning Staff.

TABLE 23
LOS Comparison – Intersection of King Street at Union Street

Intersection / Approach	Movement	Before ¹			Projected ²			After ³		
		LOS	Delay ⁴	95% Q ⁵	LOS	Delay	95% Q	LOS	Delay	95% Q
AM Peak Period										
Union St. – SB	L	D	46.9	220	D	52.3	#389	C	21.9	146
Union St. – SB	TR (T)	B	15.3	417	C	29.9	663	B	19.3	382
Union St. – SB	(R)	—	—	—	A	1.7	26	A	4.9	26
Union St. – NB	L	D	47.8	30	—	—	—	—	—	—
Union St. – NB	TR (LTR)	D	44.9	#691	E	56.3	#351	D	44.3	#278
King St. – EB	L	D	37.6	135	F	130.9	#292	F	117.8	#292
King St. – EB	TR	B	19.6	49	B	15.1	62	C	23.3	82
King St. – WB	TL	D	52.1	83	F	203.6	#188	F	117.1	#112
King St. –WB	R	B	13.0	132	B	18.0	162	C	21.3	#86
Overall	—	C	30.1	—	D	51.4	—	D	43.5	—
PM Peak Period										
Union St. – SB	L	D	53.3	305	E	57.0	m#376	D	41.3	204
Union St. – SB	TR (T)	C	32.2	#867	B	13.5	#542	A	9.6	141
Union St. – SB	(R)	—	—	—	A	0.3	m0	A	0.7	m2
Union St. – NB	L	D	52.1	57	—	—	—	—	—	—
Union St. – NB	TR (LTR)	F	92.0	#790	E	58.8	#354	E	66.9	#352
King St. – EB	L	D	42.3	184	F	139.4	#295	E	66.0	#166
King St. – EB	TR	B	18.2	52	B	15.0	62	B	14.9	58
King St. – WB	TL	E	67.8	120	F	218.8	#189	F	122.2	#144
King St. –WB	R	B	15.9	121	B	17.9	162	C	20.8	#85
Overall	—	D	50.1	—	D	48.8	—	D	39.2	—

¹ 2000 “before” existing traffic volumes from FDR. ² 2010 “projected” future traffic volumes with build conditions from FDR. ³ 2014 “after” existing traffic volumes. ⁴ Delay is measured in seconds. ⁵ Queue length is measured in feet.

Notes: (x) Turning lane configuration in Projected/After conditions. # = 95th percentile volume exceeds capacity, queues may be longer. m = Volume for 95th percentile queue is metered by upstream signal.

Source: Central Transportation Planning Staff.

7 WASHINGTON STREET (ROUTE 53) AT OLD WASHINGTON STREET SAFETY IMPROVEMENT PROJECT—HANOVER

The intersection of Route 53 at Old Washington Street is currently a four-way intersection, with Route 53 running north south and Old Washington/Pond Street running east west. Prior to reconstruction, Pond Street intersected Route 53 from the east approximately 100 feet south of Old Washington Street. However, it was realigned to intersect with Route 53 at Old Washington Street as part of this TIP project. Widening Route 53 from four to five lanes was included in the reconstruction, with two travel lanes in each direction and a two-way left-turn lane. The surrounding land use is a mixture of retail and commercial, but homes also exist along Old Washington Street. Figure 16 illustrates the study area..

The following sections provide a summary of the before-and-after conditions, along with a comparison of the crash data, traffic volumes, and traffic analysis.

7.1 Summary of Conditions Before and After Improvements

Route 53 at Old Washington/Pond Street—Before Improvements

Route 53 and Old Washington Street formed a three-way intersection controlled by a semi-actuated traffic signal. Northbound Route 53 consisted of two multi-purpose lanes, and southbound Route 53 consisted of two through lanes and one exclusive right-turn lane onto Old Washington Street. Old Washington Street consisted of a single multi-purpose lane that operated as one short left-turn lane and one exclusive right-turn lane. No bicycle or pedestrian facilities existed at this intersection. As previously mentioned, Route 53 intersected with Pond Street approximately 100 feet south of Old Washington Street and was controlled by a stop sign.

The crash rate before the intersection reconstruction was 0.38 crashes per million entering vehicles, which was below the District 6 average of 0.77 crashes per million entering vehicles for signalized intersections. The intersection operated at an acceptable LOS of B in both the morning and evening peak hours. It was necessary to reconstruct this intersection to accommodate future traffic growth along Route 53 and Old Washington Street and to provide safe and efficient traffic operations.

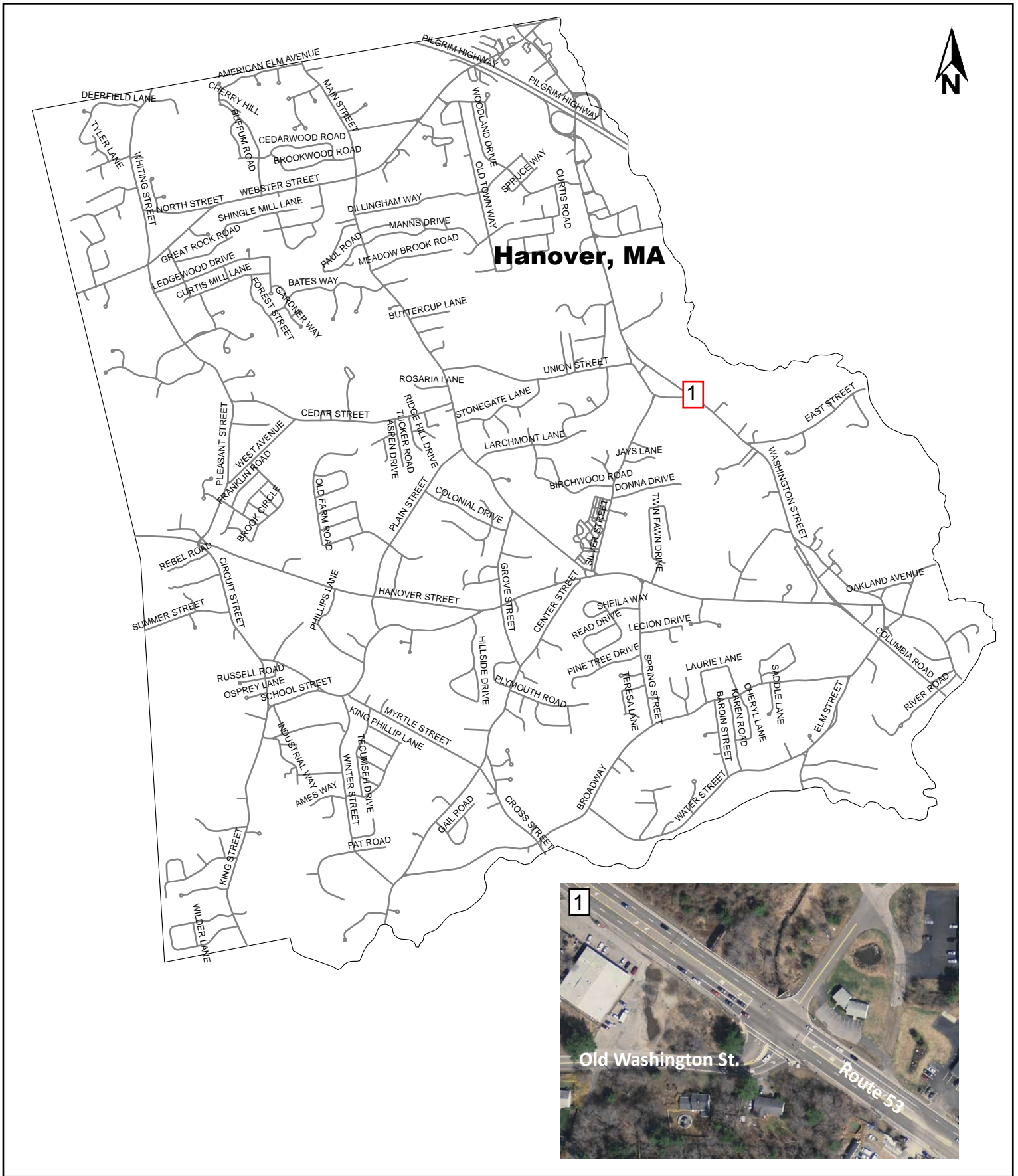
Route 53 at Old Washington/Pond Street—After Improvements

The reconstruction at Route 53 at Old Washington Street included widening and restriping the north- and southbound Route 53 approaches to maintain a five-lane cross section. The new lane configuration provides one exclusive left-turn lane, one through lane, and one through-right lane. Pond Street was realigned to

form a four-way intersection with Old Washington Street and Route 53, as illustrated in Figure 17. Sidewalks on the south side of route 53 were constructed, and wheelchair ramps were installed to meet current Americans with Disabilities Act of 1990 (ADA) and MassDOT standards. In addition, a shared shoulder for bicycles was installed on all approaches with bicycle detection.

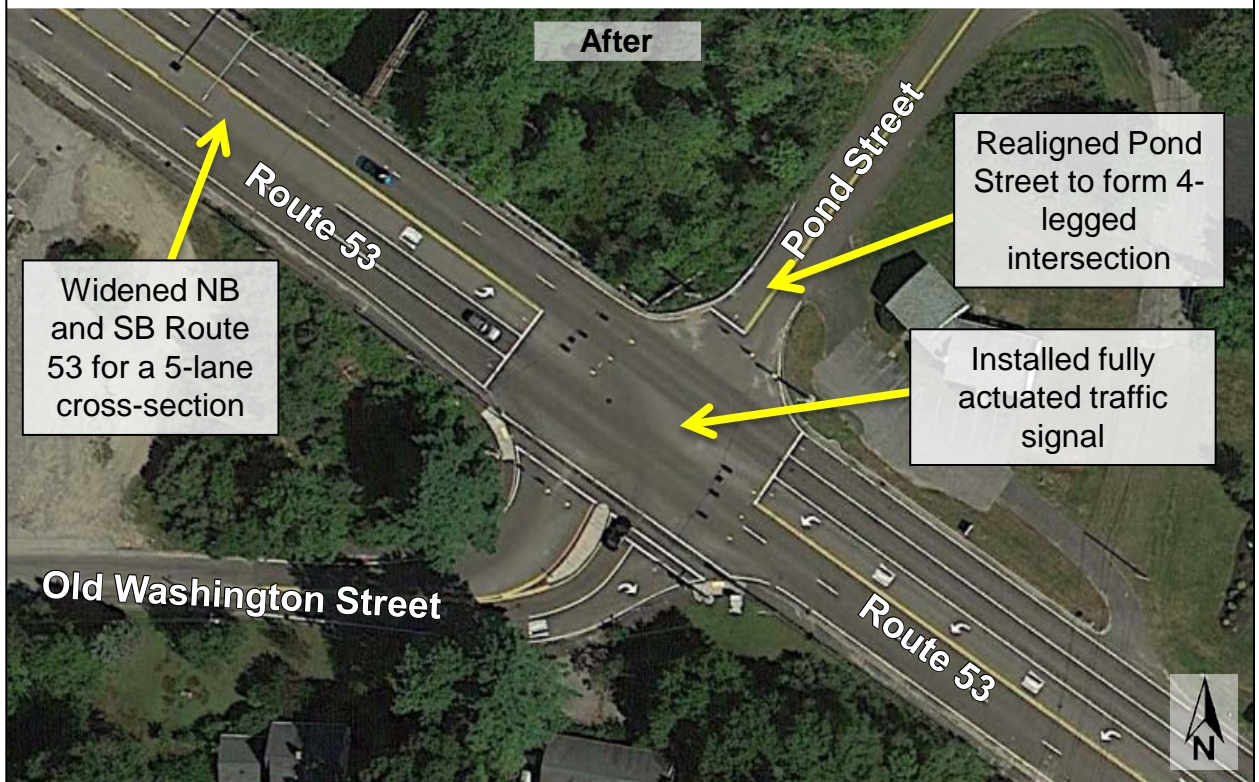
Traffic control at this intersection was upgraded to accommodate projected traffic growth near Route 53. A fully actuated traffic signal was installed with optimal signal timings selected for peak hour traffic demand. An exclusive pushbutton-activated pedestrian phase was provided on the eastbound Old Washington Street approach. Existing signs and pavement markings were upgraded to match the updated intersection lane configurations.

The crash rate for the years 2008 to 2012 is 0.13 crashes per million entering vehicles, which is well below the current MassDOT District 6 average rate of 0.76 crashes per million entering vehicles at signalized intersections. Analysis of the after conditions matches the projected conditions discussed in the FDR. The intersection currently operates at LOS B in the AM peak hour and LOS C in the PM peak hour. Analysis shows that the modified geometry and traffic signal upgrades improved both safety and operations at this intersection.





Before



After

Widened NB and SB Route 53 for a 5-lane cross-section

Realigned Pond Street to form 4-legged intersection

Installed fully actuated traffic signal

FIGURE 17
Before-and-After Reconstruction of
Route 53 (Washington Street) at Old Washington Street
Hanover, MA

BOSTON
 REGION
 MPO

TIP Project Impacts
 Before-After
 Evaluation

Source: Central Transportation Planning Staff.

7.2 Comparisons of Crash Data, Traffic Volumes, and Traffic Analyses

Crash Data

Crash data from the Hanover FDR (2001-03) were compared to current MassDOT RMV data for the most recent available five-year period, from 2008 to 2012. Table 24 provides a summary of crashes at Route 53 at Old Washington Street. A collision diagram based on the after-period data is located in Appendix C.

Only one crash occurred at the intersection of Route 53 at Old Washington Street between 2001 and 2003, with an average of 0.3 crashes per year. There were three crashes during the after period, averaging 1.3 crashes per year. The total and average number of crashes in the after period includes crashes that occurred after construction was complete in 2010. The crash rate of 0.13 crashes per million vehicles is less than the District 6 average for signalized intersections.

Since the Route 53 corridor was widened to a five-lane cross section as part of this project, crash data also were collected along Route 53 from Mill Street to Old Washington/Pond Street. Table 5 summarizes the frequency and type of crashes along Route 53 within the project limits. Forty-one crashes occurred between 2001 and 2003, with an average of 11.7 crashes per year, the majority of which were rear-end and sideswipe crashes. Thirty-one crashes occurred between 2010 and 2012, with an average of 13.3 crashes per year. The number of angle crashes increased in the after period, with 6.4 angle crashes per year. Although the crash modification factors (CMF) from previous studies show that adding a two-way left-turn lane may reduce crashes, crashes along Route 53 increased in the after period compared to the before period.

Traffic Volumes

MPO staff collected turning-movement counts at the intersection of Route 53 at Old Washington Street on June 26, 2014 while school was still in session. Data were recorded in 15-minute intervals for the morning peak period from 7:00 to 9:00 AM, and the evening peak period from 4:00 to 6:00 PM. Traffic count summaries are located in Appendix A. Table 26 compares the traffic volumes for three separate years for each intersection, represented by the following scenarios:

- 2005 FDR before existing conditions
- 2015 FDR projected build conditions
- 2014 after conditions

TABLE 24
Crash Summary – Route 53 at Old Washington/Pond Street

Crash Category	2001	2002	2003	Total	Average	2008	2009	2010²	2011	2012	Total³	Average⁴
Crash severity												
Property damage only	0	0	0	0	0	0	1	0	3	0	3	1.3
Personal injury	0	0	1	1	0.3	0	0	0	0	0	0	0
Fatality	0	0	0	0	0	0	0	0	0	0	0	0
Collision type												
Not reported	0	0	0	0	0	0	0	0	0	0	0	0
Angle	0	0	0	0	0	0	0	0	2	0	2	0.9
Rear-end	0	0	1	1	0.3	0	1	0	1	0	1	0.4
Side-swipe	—	0	0	0	0	0	0	0	0	0	0	0
Head-on	0	0	0	0	0	0	0	0	0	0	0	0
Single-vehicle	—	0	0	0	0	0	0	0	0	0	0	0
Roadway conditions												
Not reported	0	0	0	0	0	0	0	0	0	0	0	0
Wet or icy pavement	0	0	0	0	0	0	0	0	2	0	2	0.9
Weather conditions												
Dark/lighted	0	0	0	0	0	0	1	0	0	0	0	0
Clear	0	0	1	1	0.3	0	1	0	2	0	2	0.9
Cloudy	0	0	0	0	0	0	0	0	1	0	1	0.4
Rain	0	0	0	0	0	0	0	0	0	0	0	0
Snow	0	0	0	0	0	0	0	0	0	0	0	0
Crashes during weekday peak periods ¹	0	0	0	0	0	0	0	0	1	0	1	0.4
Crashes involving pedestrian(s)	0	0	1	1	0.3	0	0	0	0	0	0	0
Crashes involving bicyclist(s)	0	0	0	0	0	0	0	0	0	0	0	0
Total crashes	0	0	1	1	0.3	0	1	0	3	0	3	1.3

¹ Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM. ² The number of crashes in 2010 only includes crashes that occurred after construction was complete in autumn 2010. ³ Represents total number of crashes in the after period. ⁴ Crashes in the after period are averaged across 2.33 years.

Source: Central Transportation Planning Staff.

TABLE 25
Crash Summary – Route 53 between Mill Street and Pond Street

Crash Category	2001	2002	2003	Total	Average	2008	2009	2010²	2011	2012	Total³	Average⁴
Crash severity												
Property damage only	12	6	14	32	10.7	7	21	2	12	7	21	9.0
Personal injury	2	6	4	12	4	8	4	3	3	4	10	4.3
Fatality	0	0	0	0	0	0	0	0	0	0	0	0
Collision type												
Not reported	3	0	4	7	2.3	0	0	0	0	0	0	0
Angle	3	4	10	17	5.7	3	10	3	6	6	15	6.4
Rear-end	7	8	1	16	5.3	12	12	2	4	4	10	4.3
Side-swipe	--	2	1	3	1	0	4	0	1	1	2	0.9
Head-on	1	1	0	2	0.7	0	0	0	1	0	1	0.4
Single-vehicle	--	0	1	1	0.3	0	0	0	1	0	1	0.4
Roadway conditions												
Not reported	1	0	1	2	0.7	0	0	0	0	0	0	0
Wet or icy pavement	4	5	6	15	5	3	5	1	5	2	8	3.4
Weather conditions												
Dark/lighted	3	1	1	5	1.7	2	5	2	2	2	6	2.6
Clear	8	10	11	29	9.7	10	17	4	8	9	21	9
Cloudy	1	3	4	8	2.7	3	5	1	4	0	5	2.1
Rain	3	2	4	9	3	1	4	0	2	2	4	1.7
Snow	0	0	2	2	0.7	2	0	0	1	0	1	0.4
Crashes during weekday peak periods ¹	2	2	4	8	2.7	5	5	2	4	3	9	3.9
Crashes involving pedestrian(s)	2	0	0	0	0	0	0	0	0	0	0	0
Crashes involving bicyclist(s)	0	0	0	0	0	0	0	0	0	0	0	0
Total crashes	14	15	22	41	11.7	15	26	5	15	11	31	13.3

¹ Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM. ² The number of crashes in 2010 only includes crashes that occurred after construction was complete in autumn 2010. ³ Represents the total number of crashes in the after period. ⁴ The crashes in the after period are averaged across 2.33 years.

Source: Central Transportation Planning Staff.

As shown in Table 26, overall traffic volumes remained similar between 1997 and 2014. Traffic volumes did not grow as predicted in the AM peak hour, but the PM peak hour volumes grew as predicted. In general, volumes remained relatively the same from 2005 to 2014, with individual increases and decreases in some turning movements. Overall traffic volumes decreased by 10% in the AM peak hour and increased by 6% in the PM peak hour.

TABLE 26
Traffic Volume Comparison

Intersection of Route 53 (NB/SB) at Old Washington/Pond Street (EB/WB)

Scenario	EB			WB			NB			SB			Total
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM - 2005 (Before)	258	—	105	—	—	—	61	795	—	—	442	77	1,738
AM - 2015 (Projected)	271	5	110	5	5	5	64	836	5	81	465	81	1,933
AM - 2014 (After)	223	6	51	5	4	1	32	741	1	2	399	98	1,563
PM - 2005 (Before)	185	—	90	—	—	—	92	651	—	—	1042	250	2,310
PM - 2015 (Projected)	194	5	95	5	5	5	97	684	5	5	1095	263	2,458
PM - 2014 (After)	236	—	85	1	—	—	65	608	1	—	1127	342	2,465

Source: Central Transportation Planning Staff.

Intersection Capacity Analysis

Staff analyzed the 2005 before, 2015 projected, and 2014 after conditions based on the turning-movement counts and signal timing data. Table 27 summarizes the results for Route 53 at Old Washington Street.

The intersection was projected to operate at LOS B in the AM peak hour and LOS C in the PM peak hour. The intersection currently is operating as projected in the FDR. All approaches along this intersection operate at acceptable levels of service.

TABLE 27
LOS Comparison – Intersection of Route 53 at Old Washington/Pond Street

Intersection / Approach	Movement	Before ¹			Projected ²			After ³		
		LOS	Delay ⁴	95% Q ⁵	LOS	Delay	95% Q	LOS	Delay	95% Q
AM Peak Period										
Old Washington St. – EB	L (TL)	C	30.9	168	C	33.5	#206	D	35.5	83
Old Washington St. – EB	R	A	5.6	31	A	5.4	31	A	2.6	4
Pond St. – WB	(LTR)	—	—	—	B	12.9	14	B	13.2	10
Rte. 53 – NB	LT (L)	B	11.4	202	A	8.2	28	A	8.0	15
Rte. 53 – NB	(TR)	—	—	—	B	14.7	#234	B	13.7	185
Rte. 53 – SB	(L)	—	—	—	A	7.4	5	A	7.5	2
Rte. 53 – SB	T (TR)	A	8.6	88	B	15.0	125	B	15.3	113
Rte. 53 – SB	R	A	2.8	19	—	—	—	—	—	—
Overall	—	B	12.9	—	B	16.8	—	B	16.9	—
PM Peak Period										
Old Washington St. – EB	L (TL)	C	29.0	123	D	36.8	#159	D	35.3	#170
Old Washington St. – EB	R	B	13.1	47	A	6.9	33	B	10.5	41
Pond St. – WB	(LTR)	—	—	—	B	16.2	16	B	18.0	8
Rte. 53 – NB	LT (L)	B	10.4	163	B	10.1	36	A	8.4	24
Rte. 53 – NB	(TR)	—	—	—	A	10.0	162	A	7.0	90
Rte. 53 – SB	(L)	—	—	—	A	5.8	4	—	—	—
Rte. 53 – SB	T (TR)	A	9.3	199	C	30.8	#446	D	43.3	#516
Rte. 53 – SB	R	A	2.7	39	—	—	—	—	—	—
Overall	—	B	10.7	—	C	23.5	—	C	30.8	—

¹ 2005 “before” existing traffic volumes from FDR. ² 2015 “projected” future traffic volumes with build conditions from FDR. ³ 2014 “after” existing traffic volumes. ⁴ Delay is measured in seconds. ⁵ Queue length is measured in feet.

Notes: (x) Turning lane configuration in Projected/After conditions. # = 95th percentile volume exceeds capacity, queues may be longer.

Source: Central Transportation Planning Staff.

8 CONCLUSIONS

Based upon data provided in the FDRs, reviewing the project studies, and analyzing the 11 study intersections post-reconstruction, we conclude the following, which should be taken into consideration in future transportation projects:

- Providing advanced left-turn traffic signal phases to high left-turn volume approaches reduced overall intersection delay along Pleasant Street in Belmont and Route 138 in Canton.
- Installing a right-turn overlap phase with a non-conflicting protected left-turn phase improved traffic flow through several intersections, especially at locations with high left-turn volumes.
- Providing exclusive left-turn lanes and necessary phase changes reduced the number of angle collisions at the center of several study intersections.
- Proper signal timings and phasing was an important factor to improve the safety and efficiency of traffic operations for all four TIP projects.
- Converting stop-sign controlled intersections to signalized intersections along King Street in Franklin improved traffic operations, but this might result in an increased number of rear-end crashes.
- Implementing improvements at the majority of study locations decreased the overall number of crashes.
- Route 53 experienced a slight increase in crashes after installing a two-way left-turn lane; although national rates suggest a decrease in crashes instead.
- Providing interconnectivity and coordinating adjacent traffic signals along King Street in Franklin greatly improved traffic flow and reduced queues and delays.
- In general, traffic volumes did not grow as projected from the before-period conditions 2014; in fact, traffic volumes actually decreased at several intersections.
- Upgrading pedestrian traffic signals and sidewalk facilities at study intersections indicate considerable effort to accommodate and improve pedestrian travel.
- Several intersections accommodated bicycle travel by adding shared bicycle shoulders.

Crash modification factors may be used to quantify the safety benefits associated with several operational and safety countermeasures implemented at study locations. Recently, CMFs were developed in order to understand and quantify

the operational and environmental effects of design decisions. Crash modification factors measure the safety efficacy of a particular treatment or design element, and are used to compute the expected number of crashes after implementing a given countermeasure at a specific site. Table 28 outlines the CMF associated with improvements of the projects cited in this report.

TABLE 28
Crash Modification Factors by Improvement

Improvement	CMF	Crash Type	Severity
Install left-turn lane	0.79	All	Fatal, Serious Injury, Minor Injury
	0.80	All	PDO
Install right-turn lane	0.91	All	Fatal, Serious Injury, Minor Injury
Install traffic signal	0.83	All	All
	1.48	Rear-end	All
Improve signal visibility	0.71	All	Fatal, Serious Injury, Minor Injury
Install crosswalk	0.35	All	All
Install pedestrian countdown timer	0.30	Veh/ped	All
Install two-way left-turn lane	0.92	All	All
Convert phasing from permissive to protected	0.99	All	All

Source: Central Transportation Planning Staff.

Although there was sufficient data to compare vehicular turning-movement volumes and traffic analysis, crash data for several study intersections was limited. As a result, staff could not compute the actual number of crashes that were reduced because of the reconstruction. In addition, because of the lack of requisite data at the studied intersections in the before period, it was not possible to analyze bicycle and pedestrian operations comprehensively.

ASN/asn

APPENDIX A

Turning-Movement Counts (TMCs) for the Study Area Intersections

Pleasant Street at Brighton Street

6/19/2014

AM PEAK PERIOD

	PLEASANT STREET								BRIGHTON STREET								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:00	0	73	3	0	136	128	6	0	4	0	48	1	7	4	4	0	413
7:15	0	87	3	2	102	158	0	1	17	3	51	1	8	7	1	1	437
7:30	2	91	6	0	114	172	0	0	12	6	81	2	8	0	2	1	494
7:45	2	105	5	1	83	175	3	0	9	0	73	3	5	6	3	1	469
8:00	0	93	1	2	95	185	6	1	7	6	81	0	10	4	2	0	490
8:15	1	107	7	0	89	223	6	0	16	6	100	0	2	5	0	3	562
8:30	0	107	12	0	102	199	3	0	11	4	104	0	7	4	2	0	555
8:45	0	115	3	0	80	161	3	0	7	7	141	0	4	18	1	1	540
	5	778	40	5	801	1401	27	2	83	32	679	7	51	48	15	7	

AM PEAK HOUR

	PLEASANT STREET								BRIGHTON STREET								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
8:00	0	93	1	2	95	185	6	1	7	6	81	0	10	4	2	0	490
8:15	1	107	7	0	89	223	6	0	16	6	100	0	2	5	0	3	562
8:30	0	107	12	0	102	199	3	0	11	4	104	0	7	4	2	0	555
8:45	0	115	3	0	80	161	3	0	7	7	141	0	4	18	1	1	540
	1	422	23	2	366	768	18	1	41	23	426	0	23	31	5	4	2147

PHF: 0.25 0.92 0.48 0.90 0.86 0.75 0.64 0.82 0.76 0.58 0.43 0.63 0.96

PM PEAK PERIOD

	PLEASANT STREET								BRIGHTON STREET								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
4:00	0	116	15	0	64	99	3	0	8	10	92	0	1	5	5	0	418
4:15	1	112	5	1	63	115	5	1	10	3	82	1	1	6	4	2	407
4:30	1	105	8	0	79	116	2	0	7	6	88	0	3	6	3	2	424
4:45	1	106	7	0	94	160	5	0	6	6	101	0	2	1	4	1	493
5:00	1	108	14	0	106	154	3	1	14	6	89	0	8	5	1	1	509
5:15	2	105	2	1	129	153	3	0	10	8	95	2	6	6	0	3	519
5:30	0	70	3	0	102	136	3	0	12	1	77	0	3	6	2	0	415
5:45	0	70	1	1	101	143	7	1	10	6	106	1	6	5	1	2	456
	6	792	55	3	738	1076	31	3	77	46	730	4	30	40	20	11	

PM PEAK HOUR

	PLEASANT STREET								BRIGHTON STREET								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
4:30	1	105	8	0	79	116	2	0	7	6	88	0	3	6	3	2	424
4:45	1	106	7	0	94	160	5	0	6	6	101	0	2	1	4	1	493
5:00	1	108	14	0	106	154	3	1	14	6	89	0	8	5	1	1	509
5:15	2	105	2	1	129	153	3	0	10	8	95	2	6	6	0	3	519
	5	424	31	1	408	583	13	1	37	26	373	2	19	18	8	7	1945

PHF: 0.63 0.98 0.55 0.79 0.91 0.65 0.66 0.81 0.92 0.59 0.75 0.50 0.94

Pleasant Street at Clifton / Leonard Street

6/19/2014

AM PEAK PERIOD

	PLEASANT STREET								CLIFTON / LEONARD STREET								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:00	7	46	0	1	63	92	0	0	3	30	35	0	1	115	17	0	409
7:15	3	64	0	4	48	130	2	0	2	43	19	1	2	125	27	1	465
7:30	9	54	0	2	71	133	2	1	3	50	36	0	1	112	26	0	497
7:45	13	56	2	0	59	142	2	0	6	56	42	0	1	102	37	0	518
8:00	13	58	1	0	42	149	3	0	3	48	41	0	1	110	23	0	492
8:15	14	68	1	0	56	176	1	1	5	56	40	0	4	95	31	0	547
8:30	14	70	1	0	49	153	5	1	3	65	34	2	4	93	45	2	536
8:45	16	67	1	0	45	125	3	0	8	72	23	0	1	89	34	0	484
	89	483	6	7	433	1100	18	3	33	420	270	3	15	841	240	3	

AM PEAK HOUR

	PLEASANT STREET								CLIFTON / LEONARD STREET								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:45	13	56	2	0	59	142	2	0	6	56	42	0	1	102	37	0	518
8:00	13	58	1	0	42	149	3	0	3	48	41	0	1	110	23	0	492
8:15	14	68	1	0	56	176	1	1	5	56	40	0	4	95	31	0	547
8:30	14	70	1	0	49	153	5	1	3	65	34	2	4	93	45	2	536
	54	252	5	0	206	620	11	2	17	225	157	2	10	400	136	2	2093

PHF: 0.96 0.90 0.63 0.87 0.88 0.55 0.71 0.87 0.93 0.63 0.91 0.76 0.96

PM PEAK PERIOD

	PLEASANT STREET								CLIFTON / LEONARD STREET								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
4:00	23	82	4	0	46	67	4	2	4	87	36	0	3	55	18	0	429
4:15	18	89	1	4	36	96	2	1	4	118	43	1	2	58	20	0	487
4:30	19	79	0	1	35	89	4	1	4	100	41	1	5	61	11	0	448
4:45	21	80	2	1	57	102	5	0	5	96	29	0	4	72	21	0	494
5:00	15	94	3	6	45	111	7	1	4	101	47	4	1	73	18	1	519
5:15	29	93	2	0	60	97	10	0	6	118	31	0	1	88	22	0	557
5:30	25	89	1	1	40	96	13	1	3	89	24	0	4	104	17	1	505
5:45	15	72	7	2	58	119	9	1	4	108	36	0	3	99	22	1	552
	165	678	20	15	377	777	54	7	34	817	287	6	23	610	149	3	

PM PEAK HOUR

	PLEASANT STREET								CLIFTON / LEONARD STREET								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
5:00	15	94	3	6	45	111	7	1	4	101	47	4	1	73	18	1	519
5:15	29	93	2	0	60	97	10	0	6	118	31	0	1	88	22	0	557
5:30	25	89	1	1	40	96	13	1	3	89	24	0	4	104	17	1	505
5:45	15	72	7	2	58	119	9	1	4	108	36	0	3	99	22	1	552
	84	348	13	9	203	423	39	3	17	416	138	4	9	364	79	3	2133

PHF: 0.72 0.93 0.46 0.85 0.89 0.75 0.71 0.88 0.73 0.56 0.88 0.90 0.96

Pleasant Street at Concord Avenue

6/19/2014

AM PEAK PERIOD

	PLEASANT STREET								CONCORD AVENUE								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:00	0	47	7	2	1	83	4	0	12	15	3	0	5	47	0	0	224
7:15	6	69	19	1	10	94	3	0	20	17	1	0	7	94	0	1	340
7:30	1	69	13	1	14	117	6	1	30	31	3	1	7	69	0	1	360
7:45	8	65	25	1	12	124	7	0	22	30	1	0	9	72	0	0	375
8:00	3	59	17	1	14	116	3	0	32	34	1	1	6	95	0	0	380
8:15	10	60	26	2	8	111	17	1	48	29	4	0	5	82	0	2	400
8:30	13	63	18	3	8	135	14	0	34	47	5	0	15	86	0	0	438
8:45	8	78	21	3	9	107	12	0	42	42	5	1	11	83	0	0	418
	49	510	146	14	76	887	66	2	240	245	23	3	65	628	0	4	

AM PEAK HOUR

	PLEASANT STREET								CONCORD AVENUE								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
8:00	3	59	17	1	14	116	3	0	32	34	1	1	6	95	0	0	380
8:15	10	60	26	2	8	111	17	1	48	29	4	0	5	82	0	2	400
8:30	13	63	18	3	8	135	14	0	34	47	5	0	15	86	0	0	438
8:45	8	78	21	3	9	107	12	0	42	42	5	1	11	83	0	0	418
	34	260	82	9	39	469	46	1	156	152	15	2	37	346	0	2	1636

PHF: 0.65 0.83 0.79 0.70 0.87 0.68 0.81 0.81 0.75 0.62 0.91 0.93

PM PEAK PERIOD

	PLEASANT STREET								CONCORD AVENUE								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
4:00	7	96	29	0	12	73	8	0	28	76	12	0	11	37	0	0	389
4:15	9	100	39	0	8	91	8	1	27	75	7	0	8	33	0	2	405
4:30	14	84	33	0	3	89	6	1	31	82	15	3	6	44	0	1	407
4:45	15	115	30	0	14	103	7	0	28	62	7	0	9	37	0	1	427
5:00	15	115	43	3	9	108	12	0	31	82	7	4	5	47	0	0	474
5:15	11	127	33	0	10	102	7	1	29	96	5	0	12	67	0	1	499
5:30	23	114	28	0	8	95	4	3	24	95	9	2	6	86	0	0	492
5:45	12	84	38	0	13	126	4	2	34	77	10	0	10	84	0	0	492
	106	835	273	3	77	787	56	8	232	645	72	9	67	435	0	5	

PM PEAK HOUR

	PLEASANT STREET								CONCORD AVENUE								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
5:00	15	115	43	3	9	108	12	0	31	82	7	4	5	47	0	0	474
5:15	11	127	33	0	10	102	7	1	29	96	5	0	12	67	0	1	499
5:30	23	114	28	0	8	95	4	3	24	95	9	2	6	86	0	0	492
5:45	12	84	38	0	13	126	4	2	34	77	10	0	10	84	0	0	492
	61	440	142	3	40	431	27	6	118	350	31	6	33	284	0	1	1957

PHF: 0.66 0.87 0.83 0.77 0.86 0.56 0.87 0.91 0.78 0.69 0.83 0.98

Route 138 at Randolph Street

6/25/2014

AM PEAK PERIOD

	RANDOLPH STREET								ROUTE 138								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:00	2	60	37	0	26	73	26	0	41	160	20	0	20	100	6	0	571
7:15	8	58	39	0	32	110	23	0	39	124	22	0	20	108	7	0	590
7:30	2	70	45	3	40	103	24	2	28	126	32	1	30	139	9	0	648
7:45	4	53	22	0	53	108	37	1	33	152	15	0	19	166	8	0	670
8:00	7	66	52	0	44	94	23	0	29	139	22	0	17	170	16	0	679
8:15	7	68	47	1	31	65	31	2	51	135	22	0	32	170	11	0	670
8:30	8	58	43	0	22	57	20	0	45	120	16	0	34	141	6	0	570
8:45	6	52	45	1	38	55	19	0	19	118	9	0	24	147	15	0	547
	44	485	330	5	286	665	203	5	285	1074	158	1	196	1141	78	0	

AM PEAK HOUR

	RANDOLPH STREET								ROUTE 138								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:30	2	70	45	3	40	103	24	2	28	126	32	1	30	139	9	0	648
7:45	4	53	22	0	53	108	37	1	33	152	15	0	19	166	8	0	670
8:00	7	66	52	0	44	94	23	0	29	139	22	0	17	170	16	0	679
8:15	7	68	47	1	31	65	31	2	51	135	22	0	32	170	11	0	670
	20	257	166	4	168	370	115	5	141	552	91	1	98	645	44	0	2667

PHF: 0.71 0.92 0.80 0.79 0.86 0.78 0.69 0.91 0.71 0.77 0.95 0.69 0.98

PM PEAK PERIOD

	RANDOLPH STREET								ROUTE 138								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
4:00	5	100	24	0	19	46	29	0	42	158	47	0	81	153	4	0	708
4:15	6	87	26	0	18	64	33	0	39	144	37	0	84	177	6	0	721
4:30	8	80	5	0	22	68	18	0	39	143	47	0	98	147	12	0	687
4:45	4	90	11	0	23	59	36	0	40	138	36	0	82	180	8	0	707
5:00	7	95	17	0	31	67	21	0	47	167	36	0	96	168	9	0	761
5:15	0	95	13	0	28	88	26	0	31	148	52	0	94	145	1	0	721
5:30	1	104	16	0	32	64	26	0	32	163	46	0	99	162	2	0	747
5:45	6	106	11	0	32	79	29	0	32	141	61	0	95	164	2	0	758
	37	757	123	0	205	535	218	0	302	1202	362	0	729	1296	44	0	

PM PEAK HOUR

	RANDOLPH STREET								ROUTE 138								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
5:00	7	95	17	0	31	67	21	0	47	167	36	0	96	168	9	0	761
5:15	0	95	13	0	28	88	26	0	31	148	52	0	94	145	1	0	721
5:30	1	104	16	0	32	64	26	0	32	163	46	0	99	162	2	0	747
5:45	6	106	11	0	32	79	29	0	32	141	61	0	95	164	2	0	758
	14	400	57	0	123	298	102	0	142	619	195	0	384	639	14	0	2987

PHF: 0.50 0.94 0.84 0.96 0.85 0.88 0.76 0.93 0.80 0.97 0.95 0.39 0.98

Route 138 at Washington Street

6/19/2014

AM PEAK PERIOD

	WASHINGTON STREET								ROUTE 138								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:00	170	0	1	0	0	1	2	0	1	283	0	0	0	122	56	2	636
7:15	171	1	0	4	0	0	1	0	5	292	1	0	0	187	87	1	745
7:30	173	0	3	0	1	0	0	0	1	261	0	0	0	239	75	0	753
7:45	139	1	3	0	0	0	4	0	0	275	0	0	0	233	73	1	728
8:00	141	0	4	0	2	0	3	0	2	219	0	0	0	233	81	0	685
8:15	165	0	1	0	1	1	4	0	7	205	0	0	0	261	85	0	730
8:30	151	1	3	2	0	1	4	0	13	178	0	0	0	204	72	0	627
8:45	124	0	2	0	5	2	6	0	1	198	0	0	0	197	65	0	600
	1234	3	17	6	9	5	24	0	30	1911	1	0	0	1676	594	4	

AM PEAK HOUR

	WASHINGTON STREET								ROUTE 138								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:15	171	1	0	4	0	0	1	0	5	292	1	0	0	187	87	1	745
7:30	173	0	3	0	1	0	0	0	1	261	0	0	0	239	75	0	753
7:45	139	1	3	0	0	0	4	0	0	275	0	0	0	233	73	1	728
8:00	141	0	4	0	2	0	3	0	2	219	0	0	0	233	81	0	685
	624	2	10	4	3	0	8	0	8	1047	1	0	0	892	316	2	2911

PHF: 0.90 0.50 0.63 0.38 0.50 0.40 0.90 0.25 0.93 0.91 0.97

PM PEAK PERIOD

	WASHINGTON STREET								ROUTE 138								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
4:00	118	0	7	0	0	1	5	0	6	222	0	0	0	249	131	0	739
4:15	90	0	6	0	2	0	4	0	11	200	0	0	0	311	144	0	768
4:30	84	0	8	0	1	5	8	0	4	193	0	0	0	313	131	7	747
4:45	88	0	7	0	2	0	1	0	5	186	0	0	0	268	145	0	702
5:00	101	0	9	0	4	1	4	1	6	218	0	0	0	307	157	0	807
5:15	85	0	13	0	0	2	9	0	4	200	0	0	0	304	155	0	772
5:30	96	0	13	0	2	1	3	0	5	176	0	0	0	283	135	0	714
5:45	97	1	8	0	0	4	8	0	6	216	0	0	0	307	153	0	800
	759	1	71	0	11	14	42	1	47	1611	0	0	0	2342	1151	7	

PM PEAK HOUR

	WASHINGTON STREET								ROUTE 138								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
5:00	101	0	9	0	4	1	4	1	6	218	0	0	0	307	157	0	807
5:15	85	0	13	0	0	2	9	0	4	200	0	0	0	304	155	0	772
5:30	96	0	13	0	2	1	3	0	5	176	0	0	0	283	135	0	714
5:45	97	1	8	0	0	4	8	0	6	216	0	0	0	307	153	0	800
	379	1	43	0	6	8	24	1	21	810	0	0	0	1201	600	0	3093

PHF: 0.94 0.25 0.83 0.38 0.50 0.67 0.88 0.93 0.98 0.96 0.96

King Street at Union Street

6/17/2014

AM PEAK PERIOD

	KING STREET								UNION STREET								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:00	43	95	16	0	15	142	2	1	54	20	7	0	4	9	40	0	447
7:15	33	126	11	0	9	112	3	0	56	14	9	0	4	12	69	0	458
7:30	29	116	13	1	18	127	2	0	60	17	3	0	4	16	70	0	475
7:45	41	91	14	0	15	127	1	0	71	14	12	0	8	10	58	0	462
8:00	37	96	7	0	13	104	8	0	62	16	9	4	7	14	51	0	424
8:15	33	111	17	0	23	121	2	1	52	15	18	0	14	12	62	0	480
8:30	40	79	15	0	15	109	3	1	54	12	10	0	8	11	49	0	405
8:45	34	116	14	0	14	97	9	0	37	11	12	0	3	8	30	0	385
	290	830	107	1	122	939	30	3	446	119	80	4	52	92	429	0	

AM PEAK HOUR

	KING STREET								UNION STREET								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:00	43	95	16	0	15	142	2	1	54	20	7	0	4	9	40	0	447
7:15	33	126	11	0	9	112	3	0	56	14	9	0	4	12	69	0	458
7:30	29	116	13	1	18	127	2	0	60	17	3	0	4	16	70	0	475
7:45	41	91	14	0	15	127	1	0	71	14	12	0	8	10	58	0	462
	146	428	54	1	57	508	8	1	241	65	31	0	20	47	237	0	1842

PHF: 0.85 0.85 0.84 0.79 0.89 0.67 0.85 0.81 0.65 0.63 0.73 0.85 0.97

PM PEAK PERIOD

	KING STREET								UNION STREET								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
4:00	49	92	16	0	11	139	3	0	37	4	4	0	6	4	49	0	414
4:15	55	140	22	0	16	123	6	0	33	6	5	0	16	5	59	0	486
4:30	50	170	26	0	14	105	13	0	31	5	9	0	4	9	36	0	472
4:45	61	154	20	1	8	146	2	0	33	7	7	0	6	7	42	0	493
5:00	90	219	20	1	8	135	10	0	32	11	4	0	12	9	51	0	601
5:15	46	199	21	1	23	140	11	0	45	10	10	0	8	10	47	0	570
5:30	75	198	24	1	8	126	12	2	50	8	16	0	11	10	41	0	579
5:45	70	157	24	0	11	113	12	0	37	9	9	0	8	9	41	0	500
	496	1329	173	4	99	1027	69	2	298	60	64	0	71	63	366	0	

PM PEAK HOUR

	KING STREET								UNION STREET								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
5:00	90	219	20	1	8	135	10	0	32	11	4	0	12	9	51	0	601
5:15	46	199	21	1	23	140	11	0	45	10	10	0	8	10	47	0	570
5:30	75	198	24	1	8	126	12	2	50	8	16	0	11	10	41	0	579
5:45	70	157	24	0	11	113	12	0	37	9	9	0	8	9	41	0	500
	281	773	89	3	50	514	45	2	164	38	39	0	39	38	180	0	2250

PHF: 0.78 0.88 0.93 0.54 0.92 0.94 0.82 0.86 0.61 0.81 0.95 0.88 0.94

King Street at I-495 SB Ramps

6/17/2014

AM PEAK PERIOD

	KING STREET								I-495 SB RAMP				
	EASTBOUND				WESTBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:00	0	208	94	0	77	141	0	0	27	2	94	7	643
7:15	0	196	145	1	97	128	0	0	33	8	114	0	721
7:30	0	203	104	4	77	167	0	0	44	10	110	0	715
7:45	0	232	93	2	79	202	0	0	34	7	144	1	791
8:00	0	173	71	0	75	168	0	0	41	0	145	0	673
8:15	0	179	81	0	81	149	0	0	24	0	158	0	672
8:30	0	128	72	1	59	154	0	0	40	0	87	0	540
8:45	0	132	56	0	57	153	0	0	30	1	89	0	518
0	0	1451	716	8	602	1262	0	0	273	28	941	8	

AM PEAK HOUR

	KING STREET								I-495 SB RAMP				
	EASTBOUND				WESTBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:15	0	196	145	1	97	128	0	0	33	8	114	0	721
7:30	0	203	104	4	77	167	0	0	44	10	110	0	715
7:45	0	232	93	2	79	202	0	0	34	7	144	1	791
8:00	0	173	71	0	75	168	0	0	41	0	145	0	673
0	0	804	413	7	328	665	0	0	152	25	513	1	2900

PHF: 0.87 0.71 0.85 0.82 0.86 0.63 0.88 0.92

PM PEAK PERIOD

	KING STREET								I-495 SB RAMP				
	EASTBOUND				WESTBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
4:00	0	171	88	1	98	164	0	0	48	0	88	0	657
4:15	0	160	84	0	81	147	0	0	64	0	79	0	615
4:30	0	223	114	0	65	150	0	0	73	3	112	0	740
4:45	0	240	102	1	63	172	0	0	98	0	120	0	795
5:00	0	338	182	1	87	217	0	0	81	0	111	0	1016
5:15	0	293	136	1	79	199	0	0	106	0	129	0	942
5:30	0	246	85	1	53	213	0	0	97	0	136	0	830
5:45	0	212	75	2	57	170	0	0	78	0	110	0	702
0	0	1883	866	7	583	1432	0	0	645	3	885	0	

PM PEAK HOUR

	KING STREET								I-495 SB RAMP				
	EASTBOUND				WESTBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
4:45	0	240	102	1	63	172	0	0	98	0	120	0	795
5:00	0	338	182	1	87	217	0	0	81	0	111	0	1016
5:15	0	293	136	1	79	199	0	0	106	0	129	0	942
5:30	0	246	85	1	53	213	0	0	97	0	136	0	830
0	0	1117	505	4	282	801	0	0	382	0	496	0	3583

PHF: 0.83 0.69 0.81 0.92 0.90 0.91 0.88

King Street at Constitution Boulevard

6/18/2014

AM PEAK PERIOD

	KING STREET								CONSTITUTION BOULEVARD				
	EASTBOUND				WESTBOUND				NORTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:00	0	209	40	0	185	99	0	0	8	0	108	0	649
7:15	0	270	35	0	168	126	0	0	7	0	90	0	696
7:30	0	195	33	0	264	86	0	0	14	0	83	1	675
7:45	0	244	59	0	317	117	0	0	19	0	99	0	855
8:00	0	170	65	4	228	92	0	0	17	0	72	1	644
8:15	0	234	29	0	235	72	0	0	12	0	68	0	650
8:30	0	146	34	0	181	66	0	0	9	0	74	2	510
8:45	0	151	29	0	190	74	0	0	14	0	55	0	513
0	0	1619	324	4	1768	732	0	0	100	0	649	4	

AM PEAK HOUR

	KING STREET								CONSTITUTION BOULEVARD				
	EASTBOUND				WESTBOUND				NORTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:00	0	209	40	0	185	99	0	0	8	0	108	0	649
7:15	0	270	35	0	168	126	0	0	7	0	90	0	696
7:30	0	195	33	0	264	86	0	0	14	0	83	1	675
7:45	0	244	59	0	317	117	0	0	19	0	99	0	855
0	0	918	167	0	934	428	0	0	48	0	380	1	2875

PHF: 0.85 0.71 0.74 0.85 0.63 0.88 0.84

PM PEAK PERIOD

	KING STREET								CONSTITUTION BOULEVARD				
	EASTBOUND				WESTBOUND				NORTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
4:00	0	88	5	0	43	165	0	0	39	0	143	0	483
4:15	0	87	13	0	57	162	0	0	19	0	113	0	451
4:30	0	111	7	0	47	161	0	0	49	0	191	0	566
4:45	0	89	9	0	47	160	0	0	32	0	183	0	520
5:00	0	104	8	0	40	136	0	0	55	0	315	0	658
5:15	0	117	12	1	77	167	0	0	32	0	184	0	589
5:30	0	111	6	0	62	157	0	0	31	0	162	0	529
5:45	0	91	9	0	71	244	0	0	19	0	105	0	539
0	0	798	69	1	444	1352	0	0	276	0	1396	0	

PM PEAK HOUR

	KING STREET								CONSTITUTION BOULEVARD				
	EASTBOUND				WESTBOUND				NORTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
4:30	0	111	7	0	47	161	0	0	49	0	191	0	566
4:45	0	89	9	0	47	160	0	0	32	0	183	0	520
5:00	0	104	8	0	40	136	0	0	55	0	315	0	658
5:15	0	117	12	1	77	167	0	0	32	0	184	0	589
0	0	421	36	1	211	624	0	0	168	0	873	0	2333

PHF: 0.90 0.75 0.69 0.93 0.76 0.69 0.89

Route 53 at Old Washington / Pond Street

6/25/2014

AM PEAK PERIOD

	OLD WASHINGTON / POND STREET								ROUTE 53								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
7:00	44	0	9	0	1	0	0	0	11	145	1	0	1	48	15	0	275
7:15	58	4	12	1	0	0	0	0	6	179	0	0	0	48	24	0	331
7:30	59	0	13	1	1	0	0	0	7	169	2	0	2	69	11	0	333
7:45	78	2	18	0	0	0	0	0	10	199	0	0	0	74	22	0	403
8:00	0	0	0	0	0	0	0	0	6	133	1	0	0	91	20	1	251
8:15	72	1	24	0	0	2	0	0	9	193	0	0	2	79	13	0	395
8:30	75	3	11	0	2	0	1	0	5	179	0	0	0	103	27	0	406
8:45	76	2	16	0	3	2	0	0	12	236	0	0	0	126	38	0	511
	462	12	103	2	7	4	1	0	66	1433	4	0	5	638	170	1	

AM PEAK HOUR

	OLD WASHINGTON / POND STREET								ROUTE 53								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
8:00	0	0	0	0	0	0	0	0	6	133	1	0	0	91	20	1	251
8:15	72	1	24	0	0	2	0	0	9	193	0	0	2	79	13	0	395
8:30	75	3	11	0	2	0	1	0	5	179	0	0	0	103	27	0	406
8:45	76	2	16	0	3	2	0	0	12	236	0	0	0	126	38	0	511
	223	6	51	0	5	4	1	0	32	741	1	0	2	399	98	1	1563

PHF: 0.73 0.50 0.53 0.42 0.50 0.25 0.67 0.78 0.25 0.25 0.79 0.64 0.76

PM PEAK PERIOD

	OLD WASHINGTON / POND STREET								ROUTE 53								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
4:00	66	0	14	0	6	3	1	3	10	190	0	0	0	289	88	0	667
4:15	58	2	27	0	0	1	0	0	13	199	0	0	0	251	68	0	619
4:30	51	0	14	0	2	1	1	0	17	139	1	0	1	220	75	0	522
4:45	60	0	17	0	0	0	0	0	11	153	0	0	0	274	73	0	588
5:00	59	0	21	0	0	0	0	0	22	181	0	0	0	245	90	0	618
5:15	57	0	21	0	1	0	0	0	14	134	1	0	0	306	101	0	635
5:30	60	0	26	0	0	0	0	0	18	140	0	0	0	302	78	0	624
5:45	55	0	20	0	0	0	1	1	14	141	0	0	1	262	86	0	580
	466	2	160	0	9	5	3	4	119	1277	2	0	2	2149	659	0	

PM PEAK HOUR

	OLD WASHINGTON / POND STREET								ROUTE 53								
	EASTBOUND				WESTBOUND				NORTHBOUND				SOUTHBOUND				
	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	L	T	R	PEDS	
4:45	60	0	17	0	0	0	0	0	11	153	0	0	0	274	73	0	588
5:00	59	0	21	0	0	0	0	0	22	181	0	0	0	245	90	0	618
5:15	57	0	21	0	1	0	0	0	14	134	1	0	0	306	101	0	635
5:30	60	0	26	0	0	0	0	0	18	140	0	0	0	302	78	0	624
	236	0	85	0	1	0	0	0	65	608	1	0	0	1127	342	0	2465

PHF: 0.98 0.82 0.25 0.74 0.84 0.25 0.92 0.85 0.97

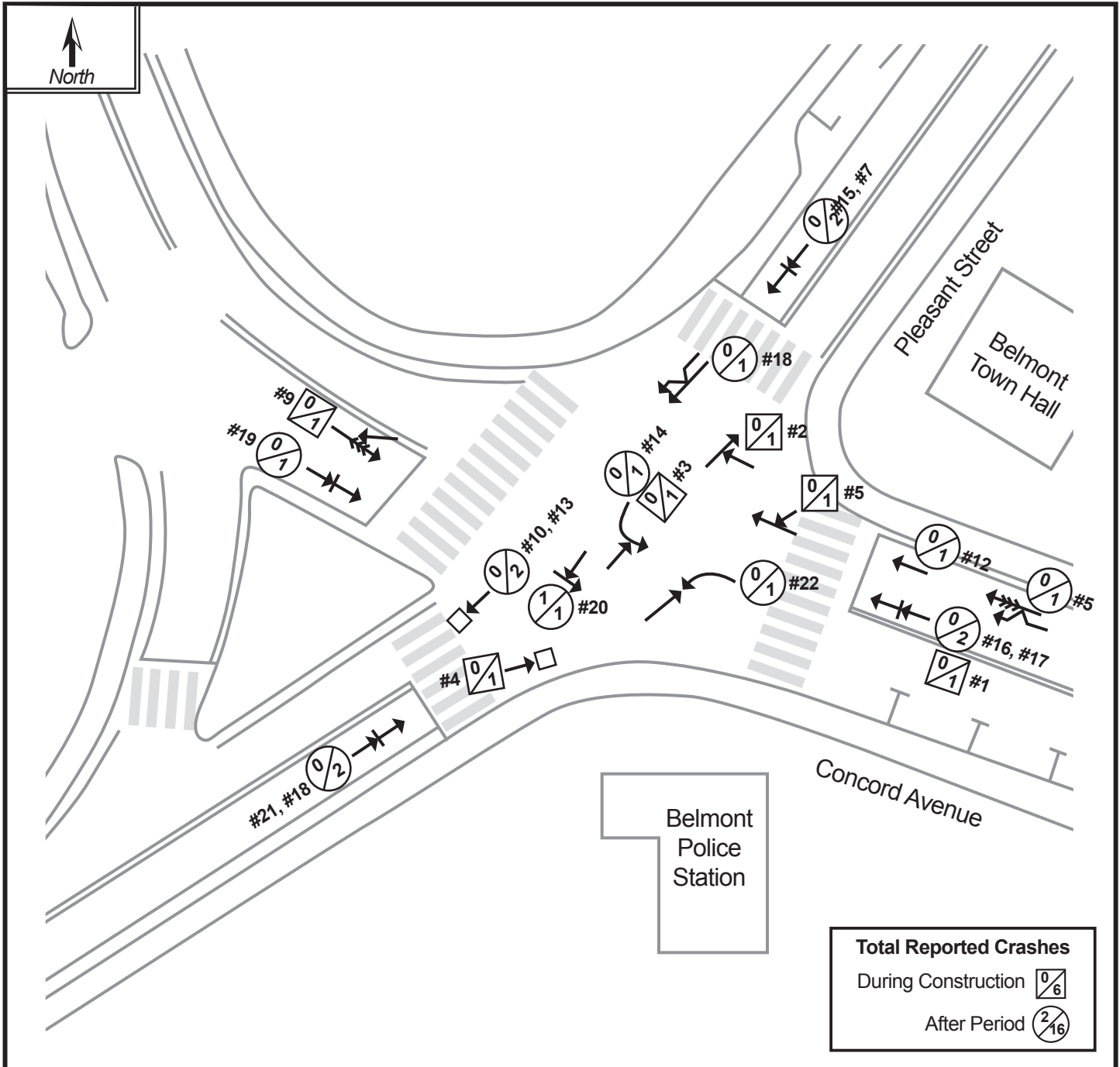
APPENDIX B

Calculation of Crash Rates

APPENDIX C

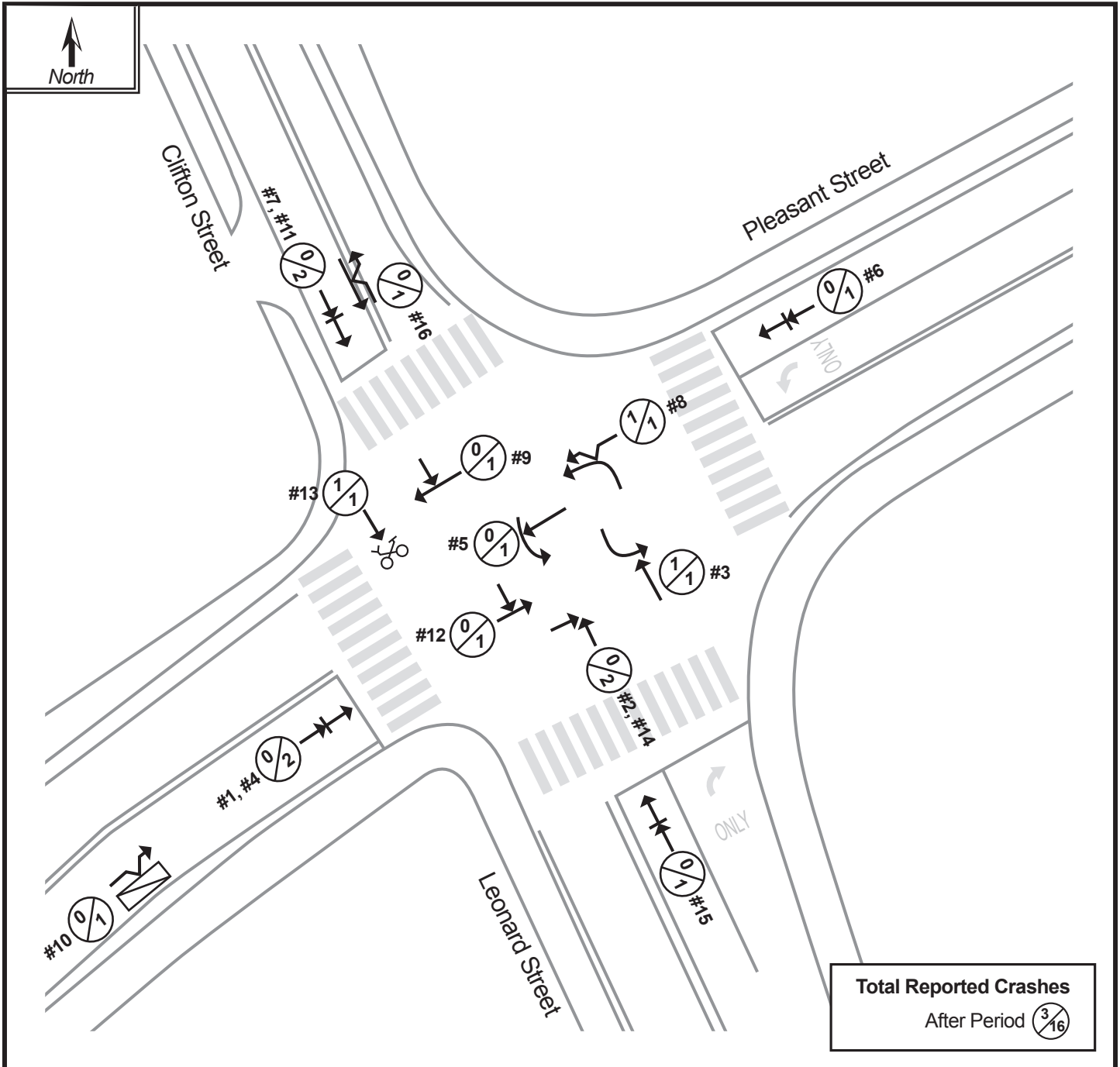
Collision Diagrams

Collision Diagram, MassDOT Crash Reports 1/1/2008–12/31/2012 Pleasant Street at Concord Avenue, Belmont, MA



SYMBOLS	CRASH TYPE	SEVERITY
<ul style="list-style-type: none"> Moving vehicle Backing vehicle Non-involved vehicle Pedestrian Parked vehicle Fixed object Bicycle Animal 	<ul style="list-style-type: none"> Head-on Angle Rear-end Sideswipe Out-of-control 	<div style="display: flex; flex-direction: column; align-items: flex-start;"> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> $\frac{A}{B}$ </div> <div> During Construction (0.42 years) </div> </div> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> $\frac{A}{B}$ </div> <div> After Period (4.58 years) </div> </div> <div style="margin-bottom: 10px;"> A Number of injury crashes </div> <div style="margin-bottom: 10px;"> B Total number of crashes </div> <div> #1, ... Crash ID Number </div> </div>

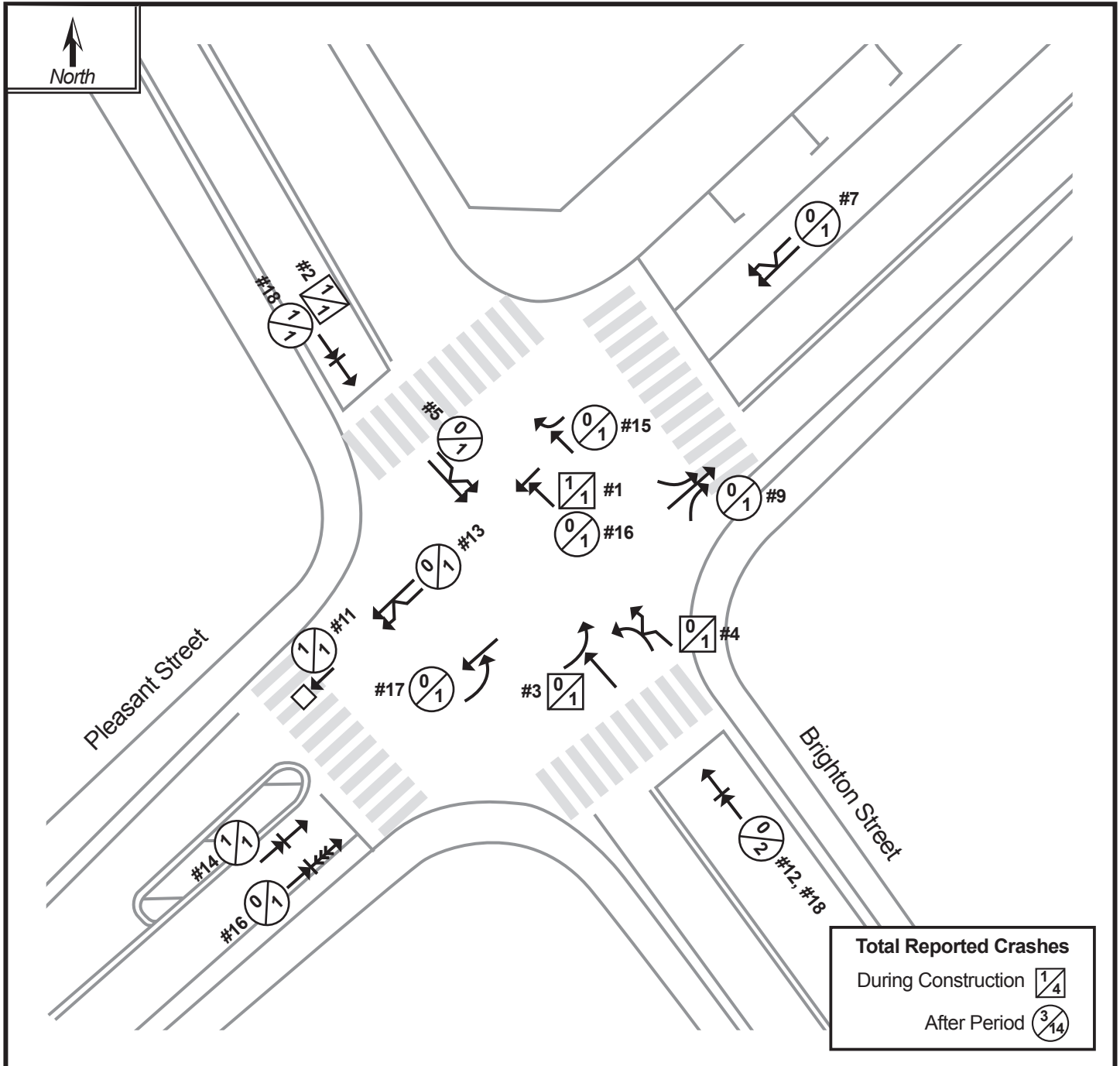
Collision Diagram, MassDOT Crash Reports 1/1/2008–12/31/2012 Pleasant Street at Clifton Street / Leonard Street, Belmont, MA



SYMBOLS	CRASH TYPE	SEVERITY
<ul style="list-style-type: none"> Moving vehicle Backing vehicle Non-involved vehicle Pedestrian Parked vehicle Fixed object Bicycle Animal 	<ul style="list-style-type: none"> Head-on Angle Rear-end Sideswipe Out-of-control 	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> During Construction (0.42 years) </div> <div style="border: 1px solid black; padding: 5px; display: inline-block;"> After Period (4.58 years) </div> <p>A Number of injury crashes B Total number of crashes #1, ... Crash ID Number</p>

Collision Diagram, MassDOT Crash Reports 1/1/2008–12/31/2012

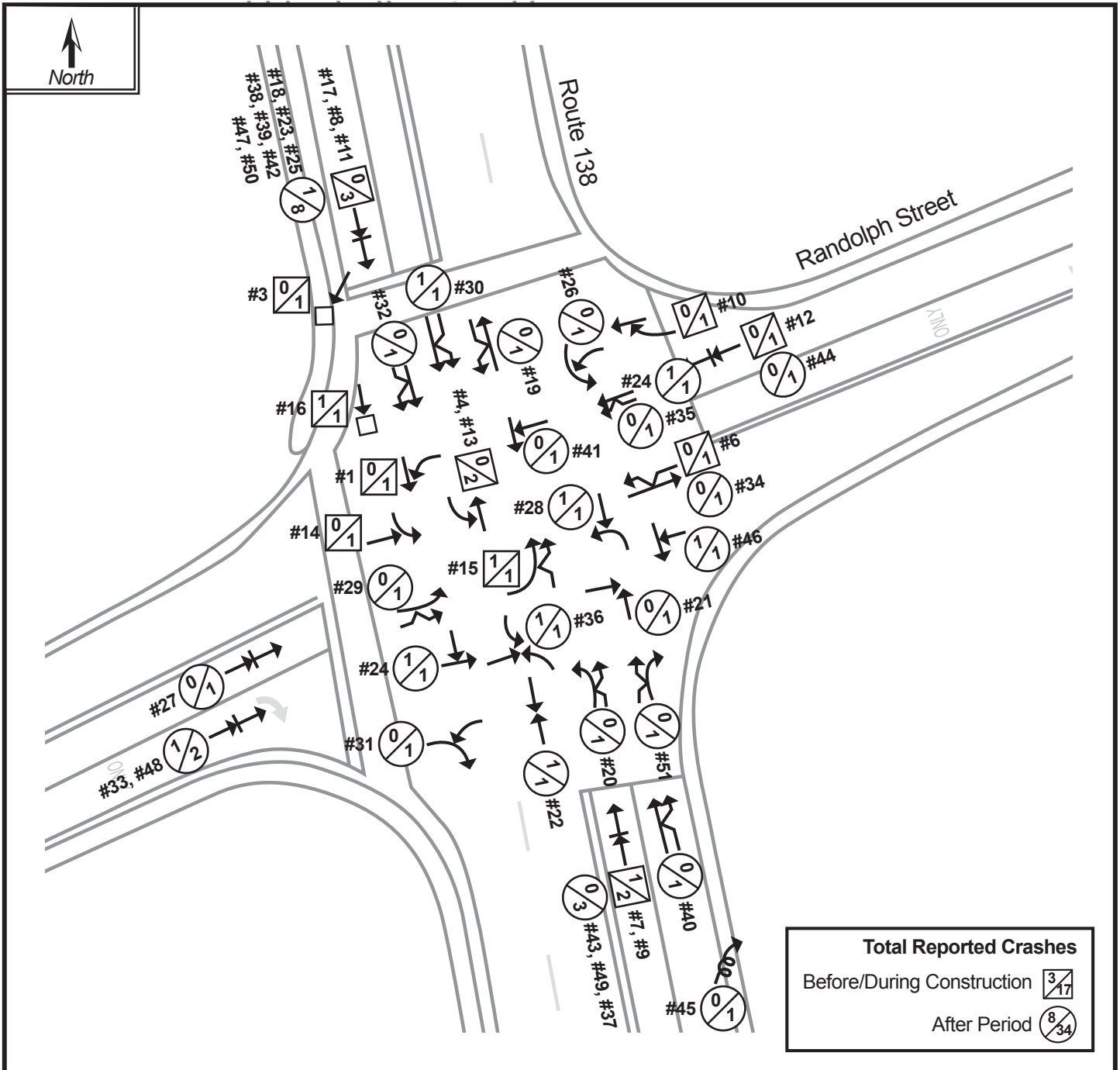
Pleasant Street at Brighton Street, Belmont, MA



SYMBOLS	CRASH TYPE	SEVERITY
<ul style="list-style-type: none"> Moving vehicle Backing vehicle Non-involved vehicle Pedestrian Parked vehicle Fixed object Bicycle Animal 	<ul style="list-style-type: none"> Head-on Angle Rear-end Sideswipe Out-of-control 	<div style="display: flex; flex-direction: column; align-items: flex-start;"> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> $\frac{A}{B}$ </div> <div> <p>During Construction (0.42 years)</p> </div> </div> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> $\frac{A}{B}$ </div> <div> <p>After Period (4.58 years)</p> </div> </div> <p>A Number of injury crashes</p> <p>B Total number of crashes</p> <p>#1, ... Crash ID Number</p> </div>

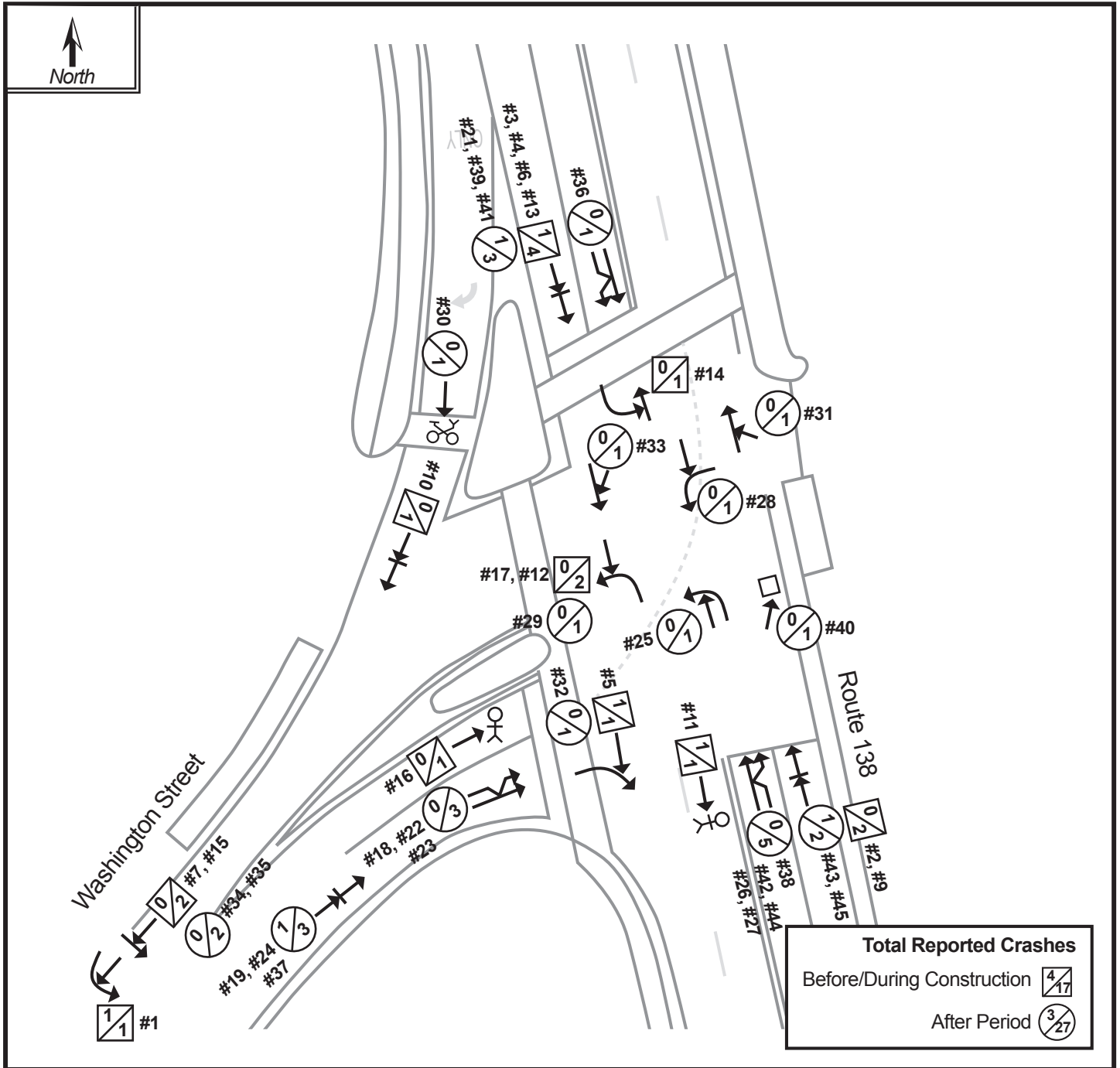
Collision Diagram, MassDOT Crash Reports 1/1/2008–12/31/2012

Route 138 at Randolph Street, Canton, MA



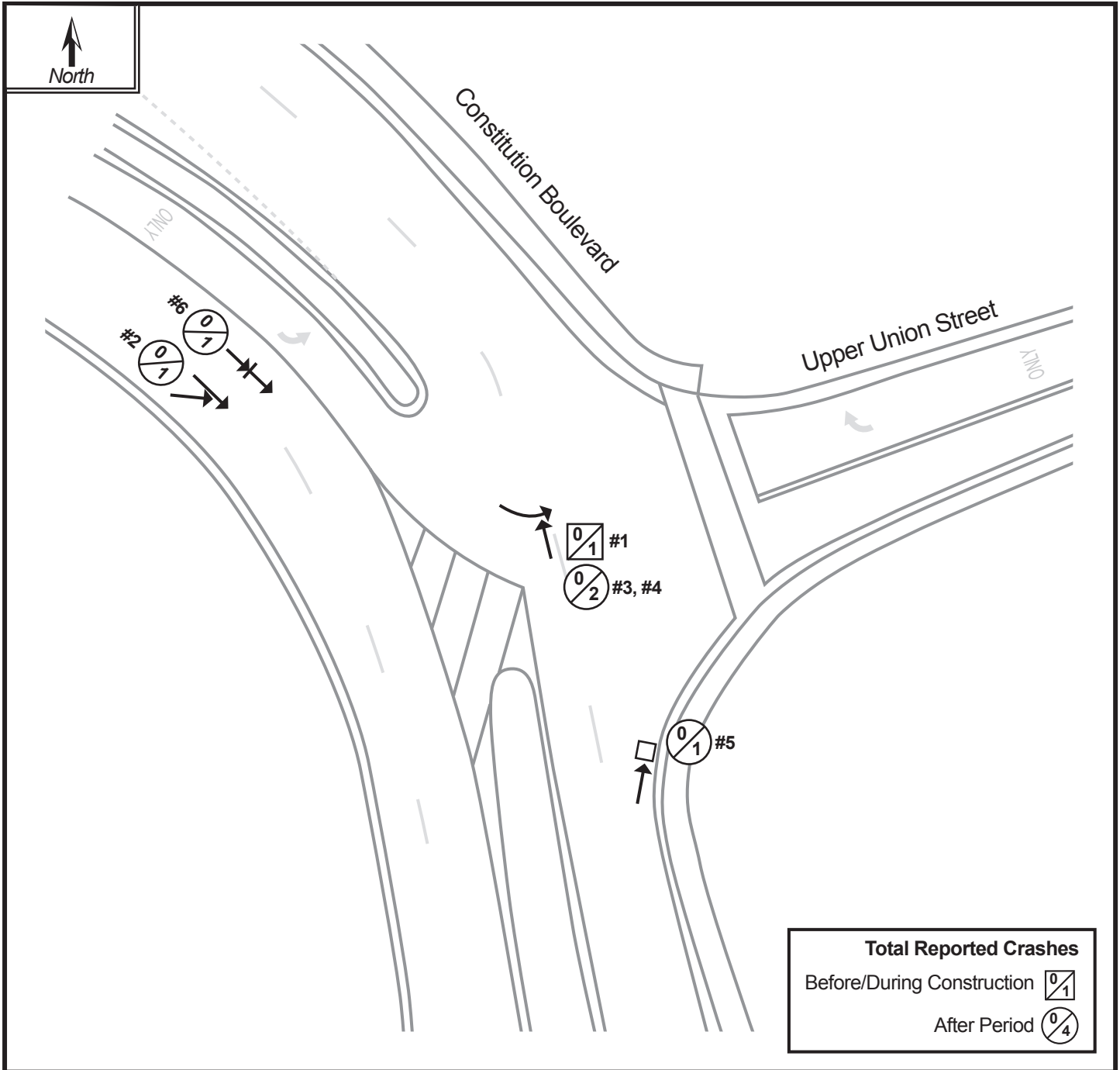
SYMBOLS	CRASH TYPE	SEVERITY
<p>→ Moving vehicle</p> <p>← Backing vehicle</p> <p>- - - Non-involved vehicle</p> <p>→ Pedestrian</p> <p>→ Parked vehicle</p> <p>→ Fixed object</p> <p>→ Bicycle</p> <p>→ Animal</p>	<p>↔ Head-on</p> <p>↘ ↙ Angle</p> <p>→ Rear-end</p> <p>↔ Sideswipe</p> <p>↻ Out-of-control</p>	<p>A B During Construction (1.25 years)</p> <p>A B After Period (3.75 years)</p> <p>A Number of injury crashes</p> <p>B Total number of crashes</p> <p>#1, ... Crash ID Number</p>

Collision Diagram, MassDOT Crash Reports 1/1/2008–12/31/2012 Route 138 at Washington Street, Canton, MA



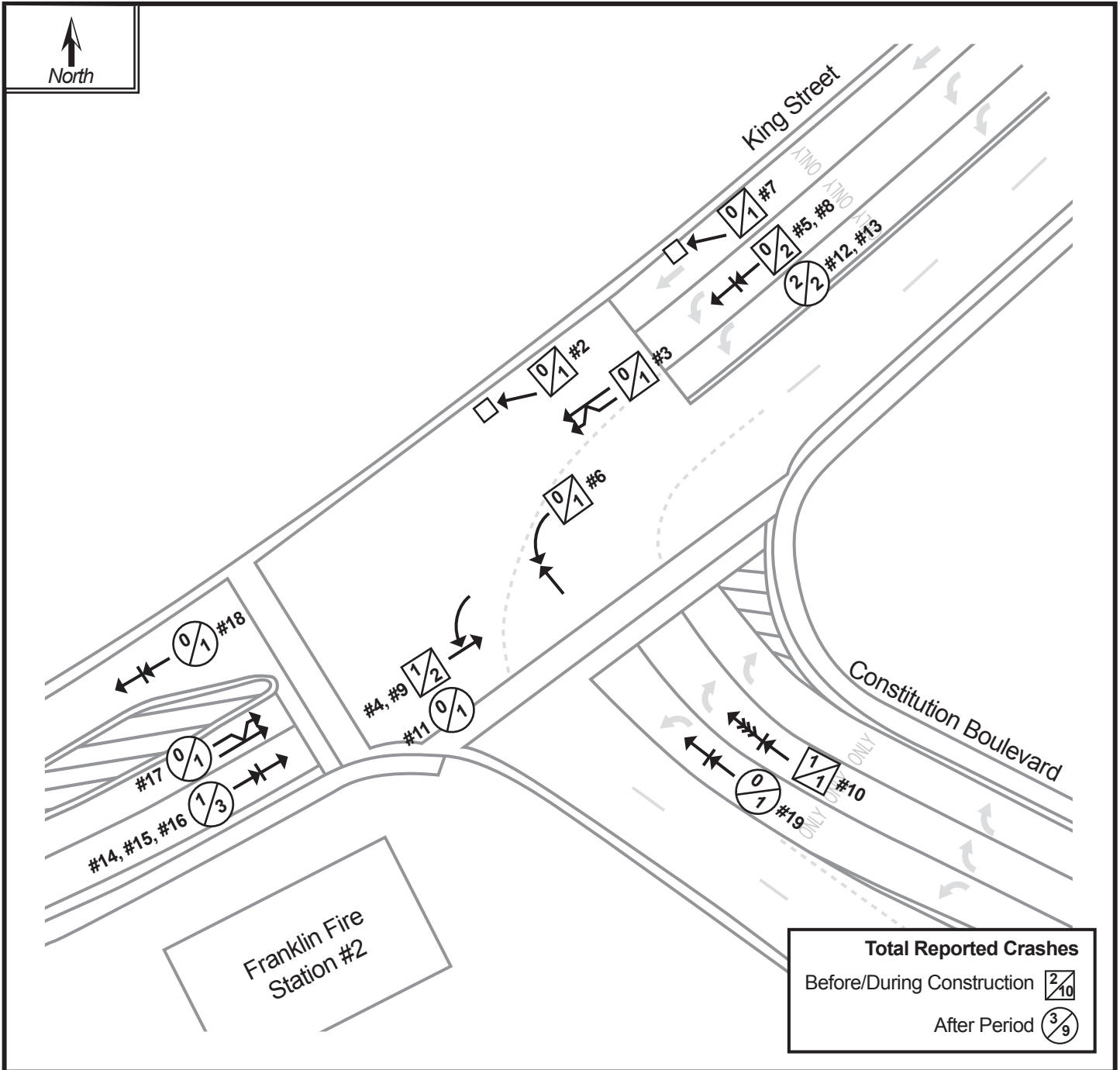
SYMBOLS	CRASH TYPE	SEVERITY				
<ul style="list-style-type: none"> Moving vehicle Backing vehicle Non-involved vehicle Pedestrian Parked vehicle Fixed object Bicycle Animal 	<ul style="list-style-type: none"> Head-on Angle Rear-end Sideswipe Out-of-control 	<div style="display: flex; flex-direction: column; align-items: flex-start;"> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> <table style="border-collapse: collapse; text-align: center;"> <tr><td style="width: 20px; height: 20px;">A</td></tr> <tr><td style="width: 20px; height: 20px;">B</td></tr> </table> </div> <div> <p>During Construction (1.25 years)</p> </div> </div> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> <table style="border-collapse: collapse; text-align: center;"> <tr><td style="width: 20px; height: 20px;">A</td></tr> <tr><td style="width: 20px; height: 20px;">B</td></tr> </table> </div> <div> <p>After Period (3.75 years)</p> </div> </div> <div style="margin-top: 10px;"> <p>A Number of injury crashes</p> <p>B Total number of crashes</p> <p>#1, ... Crash ID Number</p> </div> </div>	A	B	A	B
A						
B						
A						
B						

Collision Diagram, MassDOT Crash Reports 1/1/2008–12/31/2012 Upper Union Street at Constitution Boulevard, Franklin, MA



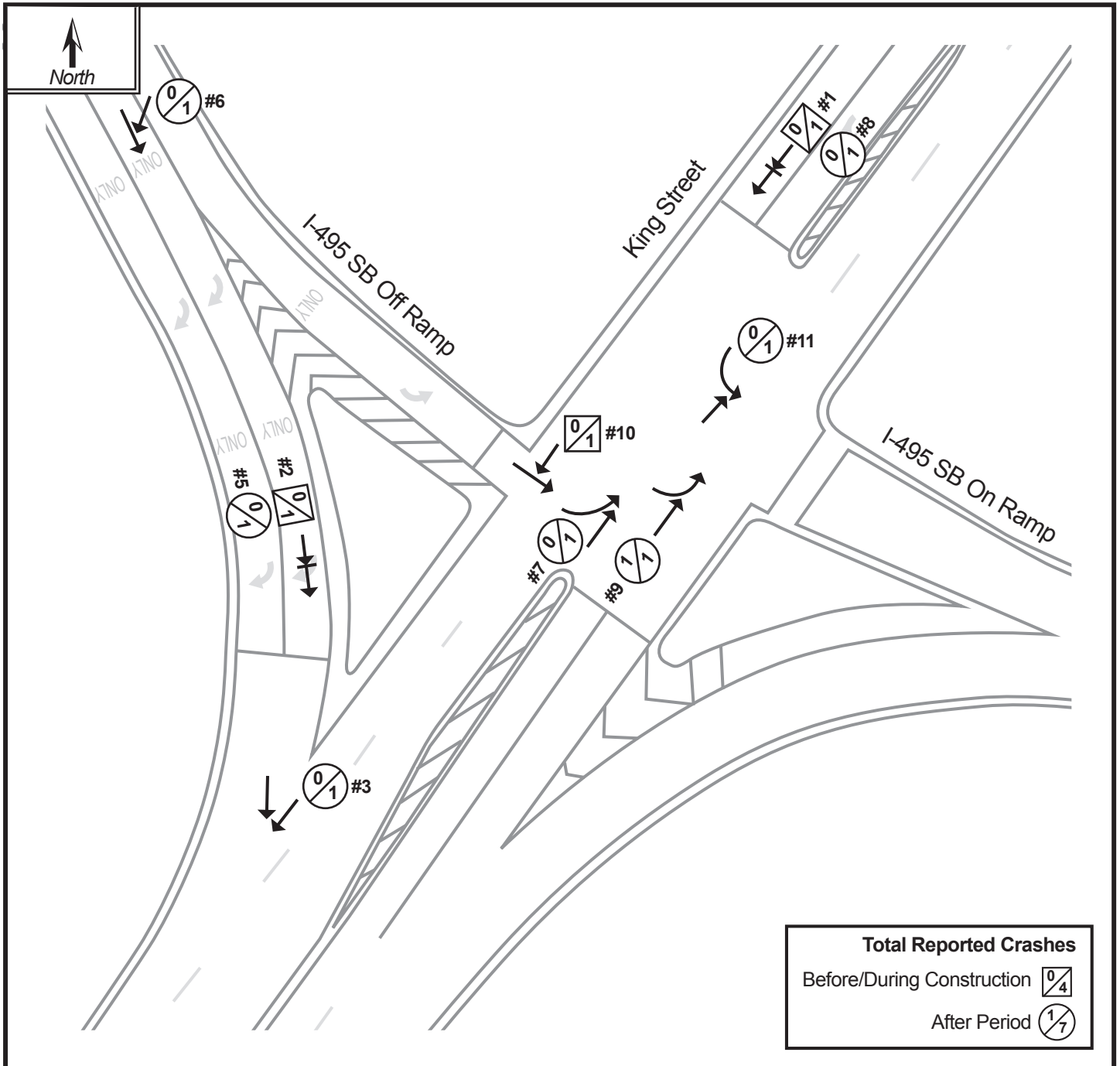
SYMBOLS	CRASH TYPE	SEVERITY
<ul style="list-style-type: none"> Moving vehicle Backing vehicle Non-involved vehicle Pedestrian Parked vehicle Fixed object Bicycle Animal 	<ul style="list-style-type: none"> Head-on Angle Rear-end Sideswipe Out-of-control 	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center;">During Construction (2.42 years)</p> <p style="text-align: center;">$\frac{A}{B}$</p> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center;">After Period (2.58 years)</p> <p style="text-align: center;">$\frac{A}{B}$</p> </div> <p>A Number of injury crashes B Total number of crashes #1, ... Crash ID Number</p>

Collision Diagram, MassDOT Crash Reports 1/1/2008–12/31/2012 King Street at Constitution Boulevard, Franklin, MA



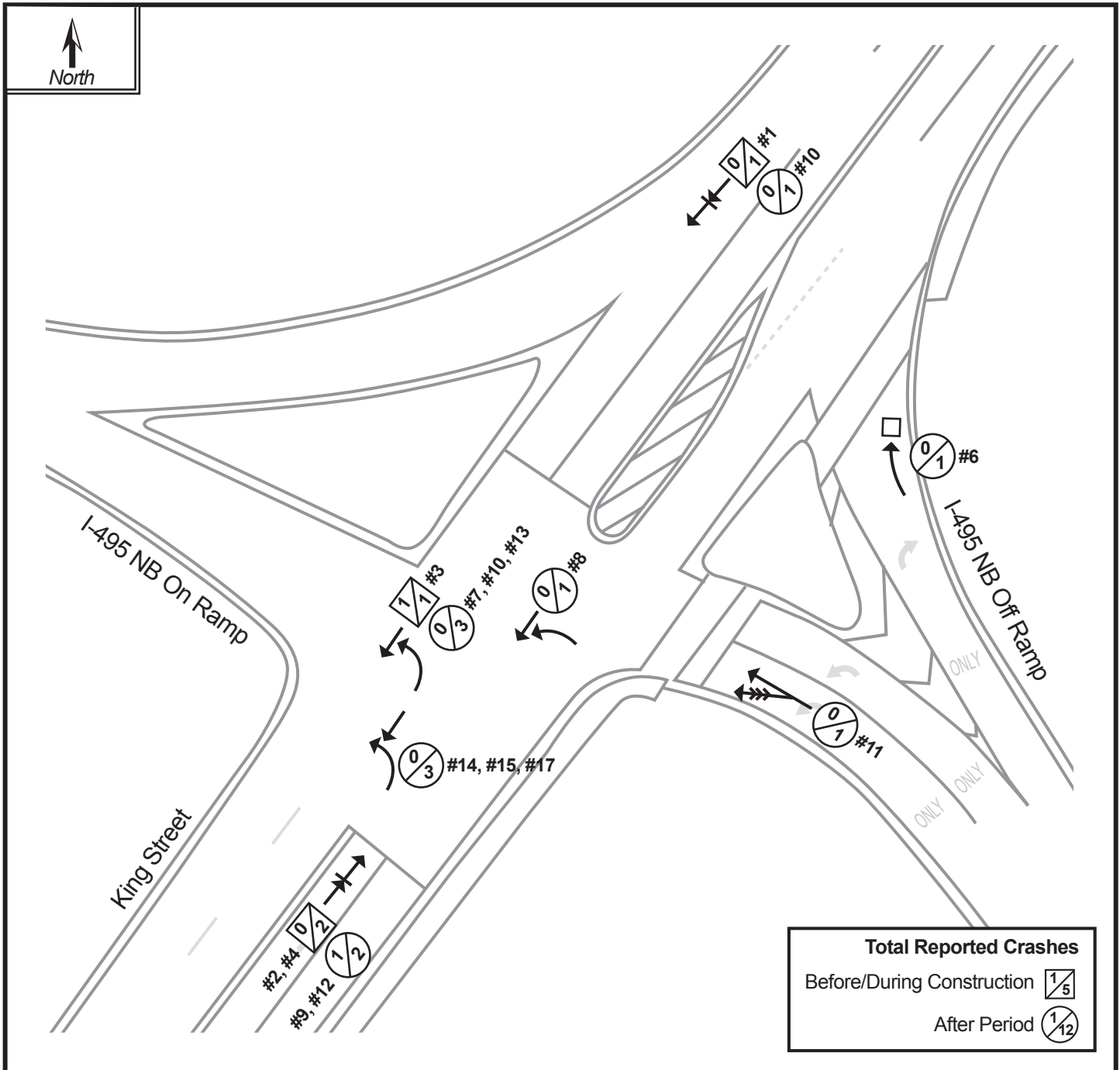
SYMBOLS	CRASH TYPE	SEVERITY						
<ul style="list-style-type: none"> Moving vehicle Backing vehicle Non-involved vehicle Pedestrian Parked vehicle Fixed object Bicycle Animal 	<ul style="list-style-type: none"> Head-on Angle Rear-end Sideswipe Out-of-control 	<div style="display: flex; flex-direction: column; align-items: flex-start;"> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> <table style="border-collapse: collapse; text-align: center;"> <tr><td style="border: none;">A</td><td style="border: none;">/</td><td style="border: none;">B</td></tr> </table> </div> <div> <p>During Construction (2.42 years)</p> </div> </div> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> <table style="border-collapse: collapse; text-align: center;"> <tr><td style="border: none;">A</td><td style="border: none;">/</td><td style="border: none;">B</td></tr> </table> </div> <div> <p>After Period (2.58 years)</p> </div> </div> <p>A Number of injury crashes B Total number of crashes #1, ... Crash ID Number</p> </div>	A	/	B	A	/	B
A	/	B						
A	/	B						

Collision Diagram, MassDOT Crash Reports 1/1/2008–12/31/2012 King Street at I-495 SB Ramps, Franklin, MA



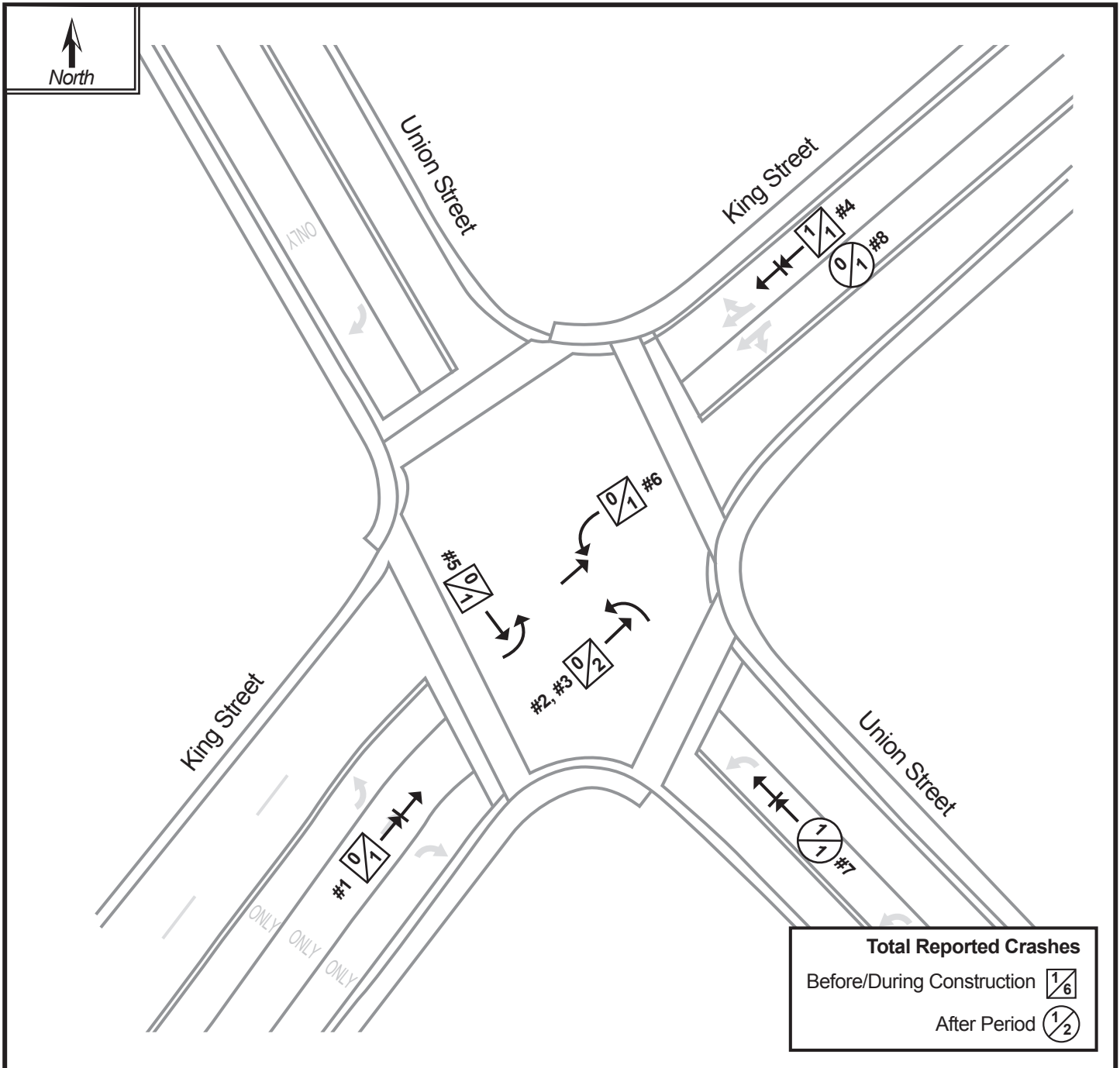
SYMBOLS	CRASH TYPE	SEVERITY												
<ul style="list-style-type: none"> Moving vehicle Backing vehicle Non-involved vehicle Pedestrian Parked vehicle Fixed object Bicycle Animal 	<ul style="list-style-type: none"> Head-on Angle Rear-end Sideswipe Out-of-control 	<div style="border: 1px solid black; padding: 5px; display: inline-block; margin-bottom: 10px;"> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="border: 1px solid black; width: 30px; height: 30px; text-align: center; vertical-align: middle;">A</td> <td rowspan="2" style="padding: 0 5px;">/</td> <td style="border: 1px solid black; width: 30px; height: 30px; text-align: center; vertical-align: middle;">B</td> </tr> <tr> <td colspan="3" style="text-align: center; padding: 2px;">During Construction (2.42 years)</td> </tr> </table> </div> <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-bottom: 10px;"> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="border: 1px solid black; width: 30px; height: 30px; text-align: center; vertical-align: middle;">A</td> <td rowspan="2" style="padding: 0 5px;">/</td> <td style="border: 1px solid black; width: 30px; height: 30px; text-align: center; vertical-align: middle;">B</td> </tr> <tr> <td colspan="3" style="text-align: center; padding: 2px;">After Period (2.58 years)</td> </tr> </table> </div> <p>A Number of injury crashes B Total number of crashes #1, ... Crash ID Number</p>	A	/	B	During Construction (2.42 years)			A	/	B	After Period (2.58 years)		
A	/	B												
During Construction (2.42 years)														
A	/	B												
After Period (2.58 years)														

Collision Diagram, MassDOT Crash Reports 1/1/2008–12/31/2012 King Street at I-495 NB Ramps, Franklin, MA



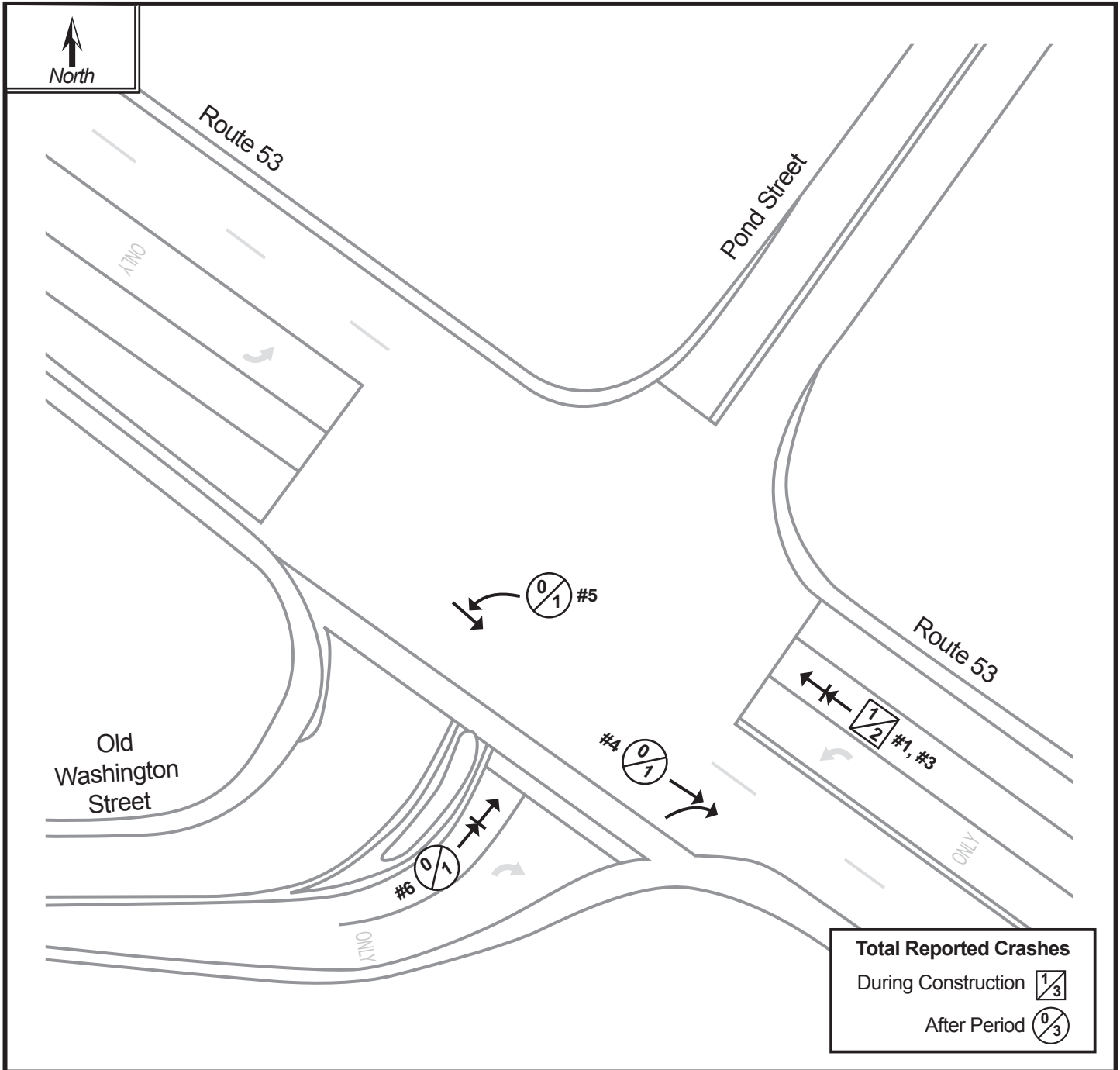
SYMBOLS	CRASH TYPE	SEVERITY
<ul style="list-style-type: none"> Moving vehicle Backing vehicle Non-involved vehicle Pedestrian Parked vehicle Fixed object Bicycle Animal 	<ul style="list-style-type: none"> Head-on Angle Rear-end Sideswipe Out-of-control 	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center;">Total Reported Crashes</p> <p>Before/During Construction </p> <p>After Period </p> </div> <ul style="list-style-type: none"> During Construction (2.42 years) After Period (2.58 years) A Number of injury crashes B Total number of crashes #1, ... Crash ID Number

Collision Diagram, MassDOT Crash Reports 1/1/2008–12/31/2012 King Street at Union Street, Franklin, MA



SYMBOLS	CRASH TYPE	SEVERITY				
<ul style="list-style-type: none"> Moving vehicle Backing vehicle Non-involved vehicle Pedestrian Parked vehicle Fixed object Bicycle Animal 	<ul style="list-style-type: none"> Head-on Angle Rear-end Sideswipe Out-of-control 	<div style="display: flex; flex-direction: column; align-items: flex-start;"> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> <table style="border-collapse: collapse;"> <tr><td style="text-align: center;">A</td></tr> <tr><td style="text-align: center;">B</td></tr> </table> </div> <div> <p>During Construction (2.42 years)</p> </div> </div> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> <table style="border-collapse: collapse;"> <tr><td style="text-align: center;">A</td></tr> <tr><td style="text-align: center;">B</td></tr> </table> </div> <div> <p>After Period (2.58 years)</p> </div> </div> <div style="margin-top: 10px;"> <p>A Number of injury crashes</p> <p>B Total number of crashes</p> <p>#1, ... Crash ID Number</p> </div> </div>	A	B	A	B
A						
B						
A						
B						

Collision Diagram, MassDOT Crash Reports 1/1/2008–12/31/2012 Route 53 at Old Washington Street/Pond Street, Hanover, MA



SYMBOLS	CRASH TYPE	SEVERITY								
<ul style="list-style-type: none"> Moving vehicle Backing vehicle Non-involved vehicle Pedestrian Parked vehicle Fixed object Bicycle Animal 	<ul style="list-style-type: none"> Head-on Angle Rear-end Sideswipe Out-of-control 	<div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center; width: 50%;">A</td> <td style="width: 50%;"></td> </tr> <tr> <td style="text-align: center; width: 50%;"></td> <td style="width: 50%;">B</td> </tr> </table> </div> <div> <p>During Construction (2.67 years)</p> </div> </div> <div style="display: flex; align-items: center; margin-top: 10px;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center; width: 50%;">A</td> <td style="width: 50%;"></td> </tr> <tr> <td style="text-align: center; width: 50%;"></td> <td style="width: 50%;">B</td> </tr> </table> </div> <div> <p>After Period (2.33 years)</p> </div> </div> <p>A Number of injury crashes B Total number of crashes #1, ... Crash ID Number</p>	A			B	A			B
A										
	B									
A										
	B									

APPENDIX D

Highway Capacity Manual (HCM) Synchro Reports

TIP Before and After Evaluations - Belmont
 1: Brighton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕		↗	↖		↗	↖			↕	
Volume (vph)	6	482	39	477	719	12	68	10	237	23	20	11
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	16	12	11	14	12	10	10	12	12	16	12
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.990			0.997			0.856				0.972
Flt Protected		0.999		0.950			0.950					0.979
Satd. Flow (prot)	0	2088	0	1711	1684	0	1668	1503	0	0	2009	0
Flt Permitted		0.990		0.259			0.801					0.257
Satd. Flow (perm)	0	2069	0	466	1684	0	1406	1503	0	0	527	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		4			2			272				12
Link Speed (mph)		30			30			30				30
Link Distance (ft)		456			495			486				464
Travel Time (s)		10.4			11.3			11.0				10.5
Peak Hour Factor	0.91	0.91	0.91	0.95	0.95	0.95	0.87	0.87	0.87	0.79	0.79	0.79
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	2%	2%	2%
Parking (#/hr)					10							
Adj. Flow (vph)	7	530	43	502	757	13	78	11	272	29	25	14
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	580	0	502	770	0	78	283	0	0	68	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		2		1	1 2			5				5
Permitted Phases	2			1 2			5			5		
Detector Phase	2	2		1	1 2		5	5		5		5
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0			4.0	4.0		4.0		4.0
Minimum Split (s)	21.0	21.0		9.0			21.0	21.0		21.0		21.0
Total Split (s)	35.0	35.0		38.0			25.0	25.0		25.0		25.0
Total Split (%)	35.7%	35.7%		38.8%			25.5%	25.5%		25.5%		25.5%
Maximum Green (s)	30.0	30.0		35.0			20.0	20.0		20.0		20.0
Yellow Time (s)	4.0	4.0		3.0			4.0	4.0		4.0		4.0
All-Red Time (s)	1.0	1.0		0.0			1.0	1.0		1.0		1.0
Lost Time Adjust (s)		0.0		0.0			0.0	0.0				0.0
Total Lost Time (s)		5.0		3.0			5.0	5.0				5.0
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0			3.0	3.0		3.0		3.0
Recall Mode	Max	Max		None			None	None		None		None
Act Effect Green (s)		30.5		62.1	65.2		11.5	11.5				11.5
Actuated g/C Ratio		0.36		0.73	0.77		0.14	0.14				0.14
v/c Ratio		0.78		0.65	0.59		0.41	0.65				0.83
Control Delay		35.3		12.6	7.2		41.5	12.7				95.0
Queue Delay		0.0		0.0	0.0		0.0	0.0				0.0
Total Delay		35.3		12.6	7.2		41.5	12.7				95.0
LOS		D		B	A		D	B				F
Approach Delay		35.3			9.3			18.9				95.0
Approach LOS		D			A			B				F
Stops (vph)		426		198	293		58	37				43

TIP Before and After Evaluations - Belmont

1: Brighton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Fuel Used(gal)		8		4	6		1	2				1
CO Emissions (g/hr)		561		291	385		81	124				103
NOx Emissions (g/hr)		109		57	75		16	24				20
VOC Emissions (g/hr)		130		67	89		19	29				24
Dilemma Vehicles (#)		0		0	0		0	0				0
Queue Length 50th (ft)		297		93	132		41	6				32
Queue Length 95th (ft)		#540		244	311		81	67				#75
Internal Link Dist (ft)		376			415			406				384
Turn Bay Length (ft)												
Base Capacity (vph)		747		872	1295		337	567				135
Starvation Cap Reductn		0		0	0		0	0				0
Spillback Cap Reductn		0		0	0		0	0				0
Storage Cap Reductn		0		0	0		0	0				0
Reduced v/c Ratio		0.78		0.58	0.59		0.23	0.50				0.50

Intersection Summary

Area Type: Other
 Cycle Length: 98
 Actuated Cycle Length: 84.8
 Natural Cycle: 60
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 0.83
 Intersection Signal Delay: 20.0
 Intersection LOS: C
 Intersection Capacity Utilization 101.0%
 ICU Level of Service G
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Brighton St & Pleasant St



TIP Before and After Evaluations - Belmont

1: Brighton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕		↗	↖		↗	↖			↕	
Volume (vph)	3	621	26	332	515	24	58	25	460	17	15	4
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	16	12	11	14	12	10	10	12	12	16	12
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.995			0.993			0.858				0.986
Flt Protected				0.950			0.950					0.977
Satd. Flow (prot)	0	2121	0	1711	1677	0	1685	1522	0	0	2034	0
Flt Permitted		0.998		0.291			0.726					0.228
Satd. Flow (perm)	0	2117	0	524	1677	0	1287	1522	0	0	475	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		3			6			456				5
Link Speed (mph)		30			30			30				30
Link Distance (ft)		456			495			486				464
Travel Time (s)		10.4			11.3			11.0				10.5
Peak Hour Factor	0.92	0.92	0.92	0.90	0.90	0.90	0.96	0.96	0.96	0.75	0.75	0.75
Heavy Vehicles (%)	1%	1%	1%	2%	2%	2%	0%	0%	0%	2%	2%	2%
Parking (#/hr)					10							
Adj. Flow (vph)	3	675	28	369	572	27	60	26	479	23	20	5
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	706	0	369	599	0	60	505	0	0	48	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		2		1	1 2			5				5
Permitted Phases	2			1 2			5			5		
Detector Phase	2	2		1	1 2		5	5		5		5
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0			4.0	4.0		4.0		4.0
Minimum Split (s)	21.0	21.0		9.0			21.0	21.0		21.0		21.0
Total Split (s)	45.0	45.0		23.0			25.0	25.0		25.0		25.0
Total Split (%)	48.4%	48.4%		24.7%			26.9%	26.9%		26.9%		26.9%
Maximum Green (s)	40.0	40.0		20.0			20.0	20.0		20.0		20.0
Yellow Time (s)	4.0	4.0		3.0			4.0	4.0		4.0		4.0
All-Red Time (s)	1.0	1.0		0.0			1.0	1.0		1.0		1.0
Lost Time Adjust (s)		0.0		0.0			0.0	0.0				0.0
Total Lost Time (s)		5.0		3.0			5.0	5.0				5.0
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0			3.0	3.0		3.0		3.0
Recall Mode	Max	Max		None			None	None		None		None
Act Effect Green (s)		40.5		60.3	63.3		13.0	13.0				13.0
Actuated g/C Ratio		0.48		0.71	0.75		0.15	0.15				0.15
v/c Ratio		0.69		0.59	0.48		0.30	0.81				0.62
Control Delay		23.5		9.2	6.4		35.6	16.8				64.1
Queue Delay		0.0		0.0	0.0		0.0	0.0				0.0
Total Delay		23.5		9.2	6.4		35.6	16.8				64.1
LOS		C		A	A		D	B				E
Approach Delay		23.5			7.5			18.8				64.1
Approach LOS		C			A			B				E
Stops (vph)		497		109	198		48	91				32

TIP Before and After Evaluations - Belmont

1: Brighton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Fuel Used(gal)		8		3	4		1	4			1	
CO Emissions (g/hr)		571		175	271		63	280			54	
NOx Emissions (g/hr)		111		34	53		12	54			11	
VOC Emissions (g/hr)		132		41	63		15	65			13	
Dilemma Vehicles (#)		0		0	0		0	0			0	
Queue Length 50th (ft)		295		50	98		29	24			22	
Queue Length 95th (ft)		490		118	213		65	136			48	
Internal Link Dist (ft)		376			415			406			384	
Turn Bay Length (ft)												
Base Capacity (vph)		1016		666	1256		308	711			118	
Starvation Cap Reductn		0		0	0		0	0			0	
Spillback Cap Reductn		0		0	0		0	0			0	
Storage Cap Reductn		0		0	0		0	0			0	
Reduced v/c Ratio		0.69		0.55	0.48		0.19	0.71			0.41	

Intersection Summary

Area Type:	Other
Cycle Length:	93
Actuated Cycle Length:	84.4
Natural Cycle:	60
Control Type:	Semi Act-Uncoord
Maximum v/c Ratio:	0.81
Intersection Signal Delay:	16.4
Intersection LOS:	B
Intersection Capacity Utilization	104.4%
ICU Level of Service	G
Analysis Period (min)	15

Splits and Phases: 1: Brighton St & Pleasant St



TIP Before and After Evaluations - Belmont

1: Brighton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕		↖	↗			↖	↗		↕	
Volume (vph)	7	533	43	527	794	13	75	11	262	25	22	12
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	16	12	11	12	12	10	10	12	12	15	12
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.990			0.998				0.850			0.973
Flt Protected		0.999		0.950				0.958				0.979
Satd. Flow (prot)	0	2088	0	1711	1580	0	0	1682	1599	0	1952	0
Flt Permitted		0.989		0.250				0.735				0.842
Satd. Flow (perm)	0	2067	0	450	1580	0	0	1290	1599	0	1679	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		5			3				133			12
Link Speed (mph)		30			30			30				30
Link Distance (ft)		456			495			486				464
Travel Time (s)		10.4			11.3			11.0				10.5
Peak Hour Factor	0.91	0.91	0.91	0.95	0.95	0.95	0.87	0.87	0.87	0.79	0.79	0.79
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	2%	2%	2%
Parking (#/hr)					10							
Adj. Flow (vph)	8	586	47	555	836	14	86	13	301	32	28	15
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	641	0	555	850	0	0	99	301	0	75	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	custom	Perm	NA	
Protected Phases		2		1	1 2			5				5
Permitted Phases	2			1 2			5		1 5	5		
Detector Phase	2	2		1	1 2		5	5	1 5	5		5
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0			4.0	4.0		4.0		4.0
Minimum Split (s)	21.0	21.0		9.0			12.0	12.0		12.0		12.0
Total Split (s)	38.0	38.0		33.0			19.0	19.0		19.0		19.0
Total Split (%)	42.2%	42.2%		36.7%			21.1%	21.1%		21.1%		21.1%
Maximum Green (s)	33.0	33.0		30.0			15.0	15.0		15.0		15.0
Yellow Time (s)	4.0	4.0		3.0			3.0	3.0		3.0		3.0
All-Red Time (s)	1.0	1.0		0.0			1.0	1.0		1.0		1.0
Lost Time Adjust (s)		0.0		0.0				0.0				0.0
Total Lost Time (s)		5.0		3.0				4.0				4.0
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0			3.0	3.0		3.0		3.0
Recall Mode	Max	Max		None			None	None		None		None
Act Effect Green (s)		33.1		64.0	67.0			11.7	44.5			11.7
Actuated g/C Ratio		0.39		0.75	0.78			0.14	0.52			0.14
v/c Ratio		0.80		0.73	0.69			0.56	0.34			0.31
Control Delay		33.4		16.8	8.6			47.6	7.2			32.6
Queue Delay		0.0		0.0	0.0			0.0	0.0			0.0
Total Delay		33.4		16.8	8.6			47.6	7.2			32.6
LOS		C		B	A			D	A			C
Approach Delay		33.4			11.9			17.2				32.6
Approach LOS		C			B			B				C
Stops (vph)		481		257	373			78	77			44

TIP Before and After Evaluations - Belmont

1: Brighton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Fuel Used(gal)		9		5	7			2	2			1
CO Emissions (g/hr)		608		368	461			111	126			59
NOx Emissions (g/hr)		118		72	90			22	25			12
VOC Emissions (g/hr)		141		85	107			26	29			14
Dilemma Vehicles (#)		0		0	0			0	0			0
Queue Length 50th (ft)		314		135	178			51	46			31
Queue Length 95th (ft)		#518		277	336			98	87			61
Internal Link Dist (ft)		376			415			406				384
Turn Bay Length (ft)												
Base Capacity (vph)		802		783	1236			227	914			305
Starvation Cap Reductn		0		0	0			0	0			0
Spillback Cap Reductn		0		0	0			0	0			0
Storage Cap Reductn		0		0	0			0	0			0
Reduced v/c Ratio		0.80		0.71	0.69			0.44	0.33			0.25

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 85.7
 Natural Cycle: 60
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 0.80
 Intersection Signal Delay: 18.8
 Intersection LOS: B
 Intersection Capacity Utilization 94.4%
 ICU Level of Service F
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Brighton St & Pleasant St



TIP Before and After Evaluations - Belmont
 1: Brighton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕		↖	↗			↖	↗		↕	
Volume (vph)	3	686	29	367	569	27	64	28	508	19	17	4
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	16	12	11	12	12	10	10	12	12	15	12
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.994			0.993				0.850		0.987	
Flt Protected				0.950				0.966			0.977	
Satd. Flow (prot)	0	2119	0	1711	1572	0	0	1713	1615	0	1976	0
Flt Permitted		0.998		0.226				0.777			0.861	
Satd. Flow (perm)	0	2115	0	407	1572	0	0	1378	1615	0	1741	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		3			7				112			5
Link Speed (mph)		30			30			30				30
Link Distance (ft)		456			495			486				464
Travel Time (s)		10.4			11.3			11.0				10.5
Peak Hour Factor	0.92	0.92	0.92	0.90	0.90	0.90	0.96	0.96	0.96	0.75	0.75	0.75
Heavy Vehicles (%)	1%	1%	1%	2%	2%	2%	0%	0%	0%	2%	2%	2%
Parking (#/hr)					10							
Adj. Flow (vph)	3	746	32	408	632	30	67	29	529	25	23	5
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	781	0	408	662	0	0	96	529	0	53	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	custom	Perm	NA	
Protected Phases		2		1	1 2			5			5	
Permitted Phases	2			1 2			5		1 5	5		
Detector Phase	2	2		1	1 2		5	5	1 5	5	5	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0			4.0	4.0		4.0	4.0	
Minimum Split (s)	21.0	21.0		9.0			12.0	12.0		12.0	12.0	
Total Split (s)	44.0	44.0		24.0			22.0	22.0		22.0	22.0	
Total Split (%)	48.9%	48.9%		26.7%			24.4%	24.4%		24.4%	24.4%	
Maximum Green (s)	39.0	39.0		21.0			18.0	18.0		18.0	18.0	
Yellow Time (s)	4.0	4.0		3.0			3.0	3.0		3.0	3.0	
All-Red Time (s)	1.0	1.0		0.0			1.0	1.0		1.0	1.0	
Lost Time Adjust (s)		0.0		0.0				0.0			0.0	
Total Lost Time (s)		5.0		3.0				4.0			4.0	
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0			3.0	3.0		3.0	3.0	
Recall Mode	Max	Max		None			None	None		None	None	
Act Effect Green (s)		39.0		62.0	65.0			17.2	42.2		17.2	
Actuated g/C Ratio		0.44		0.70	0.73			0.19	0.47		0.19	
v/c Ratio		0.84		0.69	0.58			0.36	0.64		0.16	
Control Delay		32.8		16.2	8.2			35.6	18.0		28.9	
Queue Delay		0.0		0.0	0.0			0.0	0.0		0.0	
Total Delay		32.8		16.2	8.2			35.6	18.0		28.9	
LOS		C		B	A			D	B		C	
Approach Delay		32.8			11.3			20.7			28.9	
Approach LOS		C			B			C			C	
Stops (vph)		600		163	261			78	302		32	

TIP Before and After Evaluations - Belmont

1: Brighton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Fuel Used(gal)		11		4	5			1	5			1
CO Emissions (g/hr)		746		247	331			101	381			39
NOx Emissions (g/hr)		145		48	64			20	74			8
VOC Emissions (g/hr)		173		57	77			23	88			9
Dilemma Vehicles (#)		0		0	0			0	0			0
Queue Length 50th (ft)		385		82	149			47	170			23
Queue Length 95th (ft)		#605		189	235			94	280			45
Internal Link Dist (ft)		376			415			406				384
Turn Bay Length (ft)												
Base Capacity (vph)		927		590	1148			278	823			355
Starvation Cap Reductn		0		0	0			0	0			0
Spillback Cap Reductn		0		0	0			0	0			0
Storage Cap Reductn		0		0	0			0	0			0
Reduced v/c Ratio		0.84		0.69	0.58			0.35	0.64			0.15

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 89.2
 Natural Cycle: 60
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 0.84
 Intersection Signal Delay: 20.6
 Intersection LOS: C
 Intersection Capacity Utilization 89.3%
 ICU Level of Service E
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Brighton St & Pleasant St



TIP Before and After Evaluations - Belmont

1: Brighton St & Pleasant St

6/30/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕		↖	↗			↖	↗		↕	
Volume (vph)	1	422	23	366	768	18	41	23	426	23	31	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	16	12	11	12	12	10	10	12	12	15	12
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.987			0.996				0.850			0.991
Flt Protected				0.950				0.966				0.984
Satd. Flow (prot)	0	2005	0	1678	1547	0	0	1679	1583	0	1979	0
Flt Permitted		0.994		0.316				0.691			0.857	
Satd. Flow (perm)	0	1993	0	558	1547	0	0	1201	1583	0	1723	0
Right Turn on Red			Yes			No			Yes			Yes
Satd. Flow (RTOR)		7							561			3
Link Speed (mph)		30			30			30				30
Link Distance (ft)		456			495			486				464
Travel Time (s)		10.4			11.3			11.0				10.5
Peak Hour Factor	0.25	0.92	0.48	0.90	0.86	0.75	0.64	0.82	0.76	0.58	0.43	0.63
Heavy Vehicles (%)	6%	6%	6%	4%	4%	4%	2%	2%	2%	3%	3%	3%
Parking (#/hr)					10							
Adj. Flow (vph)	4	459	48	407	893	24	64	28	561	40	72	8
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	511	0	407	917	0	0	92	561	0	120	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2		1	1 2			5				5
Permitted Phases	2			1 2			5		5	5		
Detector Phase	2	2		1	1 2		5	5	5	5		5
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0			4.0	4.0	4.0	4.0		4.0
Minimum Split (s)	21.0	21.0		9.0			12.0	12.0	12.0	12.0		12.0
Total Split (s)	38.0	38.0		33.0			19.0	19.0	19.0	19.0		19.0
Total Split (%)	42.2%	42.2%		36.7%			21.1%	21.1%	21.1%	21.1%		21.1%
Maximum Green (s)	33.0	33.0		29.0			14.0	14.0	14.0	14.0		14.0
Yellow Time (s)	4.0	4.0		4.0			4.0	4.0	4.0	4.0		4.0
All-Red Time (s)	1.0	1.0		0.0			1.0	1.0	1.0	1.0		1.0
Lost Time Adjust (s)		0.0		0.0				0.0	0.0			0.0
Total Lost Time (s)		5.0		4.0				5.0	5.0			5.0
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0			3.0	3.0	3.0	3.0		3.0
Recall Mode	Max	Max		None			None	None	None	None		None
Act Effect Green (s)		33.1		62.2	66.2			12.4	12.4			12.4
Actuated g/C Ratio		0.38		0.71	0.76			0.14	0.14			0.14
v/c Ratio		0.68		0.54	0.78			0.54	0.80			0.49
Control Delay		28.5		7.8	13.1			47.8	12.9			41.1
Queue Delay		0.0		0.0	0.0			0.0	0.0			0.0
Total Delay		28.5		7.8	13.1			47.8	12.9			41.1
LOS		C		A	B			D	B			D
Approach Delay		28.5			11.5			17.8				41.1
Approach LOS		C			B			B				D
Stops (vph)		360		122	471			58	46			51

TIP Before and After Evaluations - Belmont

1: Brighton St & Pleasant St

6/30/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Fuel Used(gal)		6		3	8			1	3			1
CO Emissions (g/hr)		431		187	541			83	209			69
NOx Emissions (g/hr)		84		36	105			16	41			13
VOC Emissions (g/hr)		100		43	125			19	48			16
Dilemma Vehicles (#)		0		0	0			0	0			0
Queue Length 50th (ft)		239		63	266			48	0			61
Queue Length 95th (ft)		354		114	399			88	26			50
Internal Link Dist (ft)		376			415			406				384
Turn Bay Length (ft)												
Base Capacity (vph)		757		773	1169			193	725			279
Starvation Cap Reductn		0		0	0			0	0			0
Spillback Cap Reductn		0		0	0			0	0			0
Storage Cap Reductn		0		0	0			0	0			0
Reduced v/c Ratio		0.68		0.53	0.78			0.48	0.77			0.43

Intersection Summary

Area Type:	Other
Cycle Length:	90
Actuated Cycle Length:	87.6
Natural Cycle:	55
Control Type:	Semi Act-Uncoord
Maximum v/c Ratio:	0.80
Intersection Signal Delay:	17.8
Intersection LOS:	B
Intersection Capacity Utilization:	86.7%
ICU Level of Service:	E
Analysis Period (min):	15

Splits and Phases: 1: Brighton St & Pleasant St



TIP Before and After Evaluations - Belmont

1: Brighton St & Pleasant St

6/30/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕		↖	↗			↖	↗		↕	
Volume (vph)	5	424	31	408	583	13	37	26	373	19	18	8
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	16	12	11	12	12	10	10	12	12	15	12
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.985			0.995				0.850			0.970
Flt Protected		0.999		0.950				0.969				0.978
Satd. Flow (prot)	0	2077	0	1711	1575	0	0	1701	1599	0	1906	0
Flt Permitted		0.989		0.335				0.813				0.832
Satd. Flow (perm)	0	2057	0	603	1575	0	0	1427	1599	0	1622	0
Right Turn on Red			Yes			No			Yes			Yes
Satd. Flow (RTOR)		8							405			15
Link Speed (mph)		30			30			30				30
Link Distance (ft)		456			495			486				464
Travel Time (s)		10.4			11.3			11.0				10.5
Peak Hour Factor	0.63	0.98	0.55	0.79	0.91	0.65	0.66	0.81	0.92	0.59	0.75	0.50
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	4%	4%	4%
Parking (#/hr)					10							
Adj. Flow (vph)	8	433	56	516	641	20	56	32	405	32	24	16
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	497	0	516	661	0	0	88	405	0	72	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2		1	1 2			5				5
Permitted Phases	2			1 2			5		5	5		
Detector Phase	2	2		1	1 2		5	5	5	5		5
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0			4.0	4.0	4.0	4.0		4.0
Minimum Split (s)	21.0	21.0		9.0			12.0	12.0	12.0	12.0		12.0
Total Split (s)	35.0	35.0		30.0			25.0	25.0	25.0	25.0		25.0
Total Split (%)	38.9%	38.9%		33.3%			27.8%	27.8%	27.8%	27.8%		27.8%
Maximum Green (s)	30.0	30.0		26.0			20.0	20.0	20.0	20.0		20.0
Yellow Time (s)	4.0	4.0		4.0			4.0	4.0	4.0	4.0		4.0
All-Red Time (s)	1.0	1.0		0.0			1.0	1.0	1.0	1.0		1.0
Lost Time Adjust (s)		0.0		0.0				0.0	0.0			0.0
Total Lost Time (s)		5.0		4.0				5.0	5.0			5.0
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0			3.0	3.0	3.0	3.0		3.0
Recall Mode	Max	Max		None			None	None	None	None		None
Act Effect Green (s)		30.4		54.7	58.8			12.3	12.3			12.3
Actuated g/C Ratio		0.38		0.68	0.73			0.15	0.15			0.15
v/c Ratio		0.63		0.70	0.57			0.40	0.69			0.28
Control Delay		26.4		13.4	8.2			36.6	10.1			27.6
Queue Delay		0.0		0.0	0.0			0.0	0.0			0.0
Total Delay		26.4		13.4	8.2			36.6	10.1			27.6
LOS		C		B	A			D	B			C
Approach Delay		26.4			10.5			14.8				27.6
Approach LOS		C			B			B				C
Stops (vph)		363		178	264			52	44			31

TIP Before and After Evaluations - Belmont

1: Brighton St & Pleasant St

6/30/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Fuel Used(gal)		6		4	5			1	2			1
CO Emissions (g/hr)		427		257	333			70	169			41
NOx Emissions (g/hr)		83		50	65			14	33			8
VOC Emissions (g/hr)		99		59	77			16	39			10
Dilemma Vehicles (#)		0		0	0			0	0			0
Queue Length 50th (ft)		207		79	122			42	0			26
Queue Length 95th (ft)		356		163	284			75	75			50
Internal Link Dist (ft)		376			415			406				384
Turn Bay Length (ft)												
Base Capacity (vph)		784		785	1146			360	706			421
Starvation Cap Reductn		0		0	0			0	0			0
Spillback Cap Reductn		0		0	0			0	0			0
Storage Cap Reductn		0		0	0			0	0			0
Reduced v/c Ratio		0.63		0.66	0.58			0.24	0.57			0.17

Intersection Summary

Area Type:	Other
Cycle Length:	90
Actuated Cycle Length:	80.2
Natural Cycle:	55
Control Type:	Semi Act-Uncoord
Maximum v/c Ratio:	0.70
Intersection Signal Delay:	15.5
Intersection LOS:	B
Intersection Capacity Utilization	76.8%
ICU Level of Service	D
Analysis Period (min)	15

Splits and Phases: 1: Brighton St & Pleasant St



TIP Before and After Evaluations - Belmont
 1: Leonard St/Clifton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕		↖	↗			↖	↗		↕	
Volume (vph)	37	452	12	389	521	8	10	272	205	3	502	116
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	14	12	11	13	12	12	12	12	12	12	12
Grade (%)		-3%			0%			0%				-5%
Storage Length (ft)	0		0	175		0	0		125	0		0
Storage Lanes	0		0	1		0	0		1	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fr _t		0.997			0.998				0.850		0.975	
Fl _t Protected		0.996		0.950				0.998				
Satd. Flow (prot)	0	1735	0	1728	1940	0	0	1859	1583	0	1880	0
Fl _t Permitted		0.920		0.160				0.975			0.999	
Satd. Flow (perm)	0	1603	0	291	1940	0	0	1816	1583	0	1878	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1			1				218			14
Link Speed (mph)		30			30			20				30
Link Distance (ft)		714			621			626				485
Travel Time (s)		16.2			14.1			21.3				11.0
Peak Hour Factor	0.87	0.87	0.87	0.93	0.93	0.93	0.94	0.94	0.94	0.94	0.94	0.94
Heavy Vehicles (%)	3%	3%	3%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Parking (#/hr)		5										
Adj. Flow (vph)	43	520	14	418	560	9	11	289	218	3	534	123
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	577	0	418	569	0	0	300	218	0	660	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2		1	1 2			5				5
Permitted Phases	2			1 2			5		5	5		
Detector Phase	2	2		1	1 2		5	5	5	5		5
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0			4.0	4.0	4.0	4.0		4.0
Minimum Split (s)	21.0	21.0		9.0			21.0	21.0	21.0	21.0		21.0
Total Split (s)	30.0	30.0		25.0			45.0	45.0	45.0	45.0		45.0
Total Split (%)	30.0%	30.0%		25.0%			45.0%	45.0%	45.0%	45.0%		45.0%
Maximum Green (s)	25.0	25.0		20.0			40.0	40.0	40.0	40.0		40.0
Yellow Time (s)	4.0	4.0		5.0			4.0	4.0	4.0	4.0		4.0
All-Red Time (s)	1.0	1.0		0.0			1.0	1.0	1.0	1.0		1.0
Lost Time Adjust (s)		0.0		0.0				0.0	0.0			0.0
Total Lost Time (s)		5.0		5.0				5.0	5.0			5.0
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0			3.0	3.0	3.0	3.0		3.0
Recall Mode	Max	Max		None			None	None	None	None		None
Act Effect Green (s)		25.0		45.1	50.1			38.1	38.1			38.1
Actuated g/C Ratio		0.25		0.46	0.51			0.39	0.39			0.39
v/c Ratio		1.41		0.98	0.57			0.43	0.29			0.89
Control Delay		228.6		67.5	20.0			24.1	3.9			43.9
Queue Delay		0.0		0.0	0.0			0.0	0.0			0.0
Total Delay		228.6		67.5	20.0			24.1	3.9			43.9

TIP Before and After Evaluations - Belmont
 1: Leonard St/Clifton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS		F		E	C			C	A		D	
Approach Delay		228.6			40.1			15.6			43.9	
Approach LOS		F			D			B			D	
Stops (vph)		377		262	358			197	20		530	
Fuel Used(gal)		28		9	7			4	1		11	
CO Emissions (g/hr)		1974		606	468			246	99		756	
NOx Emissions (g/hr)		384		118	91			48	19		147	
VOC Emissions (g/hr)		458		141	109			57	23		175	
Dilemma Vehicles (#)		0		0	0			0	0		0	
Queue Length 50th (ft)		-506		217	246			135	0		373	
Queue Length 95th (ft)		#685		#419	353			207	44		#587	
Internal Link Dist (ft)		634			541			546			405	
Turn Bay Length (ft)				175					125			
Base Capacity (vph)		410		426	990			740	775		774	
Starvation Cap Reductn		0		0	0			0	0		0	
Spillback Cap Reductn		0		0	0			0	0		0	
Storage Cap Reductn		0		0	0			0	0		0	
Reduced v/c Ratio		1.41		0.98	0.57			0.41	0.28		0.85	

Intersection Summary

Area Type: Other
 Cycle Length: 100
 Actuated Cycle Length: 98.2
 Natural Cycle: 90
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 1.41
 Intersection Signal Delay: 76.1
 Intersection LOS: E
 Intersection Capacity Utilization 102.9%
 ICU Level of Service G
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Leonard St/Clifton St & Pleasant St



TIP Before and After Evaluations - Belmont
 1: Leonard St/Clifton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕		↖	↗			↖	↗		↕	
Volume (vph)	82	486	9	202	310	7	18	472	220	11	320	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	14	12	11	13	12	12	12	12	12	12	12
Grade (%)		-3%			0%			0%				-5%
Storage Length (ft)	0		0	175		0	0		125	0		0
Storage Lanes	0		0	1		0	0		1	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fr _t		0.998			0.997				0.850		0.985	
Fl _t Protected		0.993		0.950				0.998			0.999	
Satd. Flow (prot)	0	1732	0	1728	1938	0	0	1859	1583	0	1897	0
Fl _t Permitted		0.896		0.309				0.975			0.663	
Satd. Flow (perm)	0	1563	0	562	1938	0	0	1816	1583	0	1259	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1			2				138			6
Link Speed (mph)		30			30			20				30
Link Distance (ft)		714			621			626				485
Travel Time (s)		16.2			14.1			21.3				11.0
Peak Hour Factor	0.93	0.93	0.93	0.98	0.98	0.98	0.90	0.90	0.90	0.89	0.89	0.89
Heavy Vehicles (%)	3%	3%	3%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Parking (#/hr)		5										
Adj. Flow (vph)	88	523	10	206	316	7	20	524	244	12	360	46
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	621	0	206	323	0	0	544	244	0	418	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2		1	1 2			5			5	
Permitted Phases	2			1 2			5		5	5		
Detector Phase	2	2		1	1 2		5	5	5	5	5	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0			4.0	4.0	4.0	4.0	4.0	
Minimum Split (s)	21.0	21.0		9.0			21.0	21.0	21.0	21.0	21.0	
Total Split (s)	45.0	45.0		20.0			35.0	35.0	35.0	35.0	35.0	
Total Split (%)	45.0%	45.0%		20.0%			35.0%	35.0%	35.0%	35.0%	35.0%	
Maximum Green (s)	40.0	40.0		15.0			30.0	30.0	30.0	30.0	30.0	
Yellow Time (s)	4.0	4.0		5.0			4.0	4.0	4.0	4.0	4.0	
All-Red Time (s)	1.0	1.0		0.0			1.0	1.0	1.0	1.0	1.0	
Lost Time Adjust (s)		0.0		0.0				0.0	0.0		0.0	
Total Lost Time (s)		5.0		5.0				5.0	5.0		5.0	
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0			3.0	3.0	3.0	3.0	3.0	
Recall Mode	Max	Max		None			None	None	None	None	None	
Act Effect Green (s)		40.0		53.2	58.2			30.0	30.0		30.0	
Actuated g/C Ratio		0.41		0.54	0.59			0.31	0.31		0.31	
v/c Ratio		0.97		0.45	0.28			0.98	0.42		1.07	
Control Delay		60.1		12.7	10.4			69.0	14.5		101.3	
Queue Delay		0.0		0.0	0.0			0.0	0.0		0.0	
Total Delay		60.1		12.7	10.4			69.0	14.5		101.3	

TIP Before and After Evaluations - Belmont
 1: Leonard St/Clifton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS		E		B	B			E	B			F
Approach Delay		60.1			11.3			52.1				101.3
Approach LOS		E			B			D				F
Stops (vph)		482		93	144			418	78			300
Fuel Used(gal)		13		2	3			11	2			11
CO Emissions (g/hr)		906		141	210			754	149			751
NOx Emissions (g/hr)		176		27	41			147	29			146
VOC Emissions (g/hr)		210		33	49			175	35			174
Dilemma Vehicles (#)		0		0	0			0	0			0
Queue Length 50th (ft)		382		55	91			342	50			~298
Queue Length 95th (ft)		#627		90	138			#566	119			#483
Internal Link Dist (ft)		634			541			546				405
Turn Bay Length (ft)				175					125			
Base Capacity (vph)		638		493	1124			555	580			389
Starvation Cap Reductn		0		0	0			0	0			0
Spillback Cap Reductn		0		0	0			0	0			0
Storage Cap Reductn		0		0	0			0	0			0
Reduced v/c Ratio		0.97		0.42	0.29			0.98	0.42			1.07

Intersection Summary

Area Type: Other
 Cycle Length: 100
 Actuated Cycle Length: 98.2
 Natural Cycle: 80
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 1.07
 Intersection Signal Delay: 53.8
 Intersection LOS: D
 Intersection Capacity Utilization 92.6%
 ICU Level of Service F
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Leonard St/Clifton St & Pleasant St



TIP Before and After Evaluations - Belmont
 1: Leonard St/Clifton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	41	499	13	430	576	9	11	301	227	0	555	128
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	14	12	11	13	12	12	12	12	12	12	12
Grade (%)		-3%			0%			0%				-5%
Storage Length (ft)	0		0	175		0	0		125	0		0
Storage Lanes	1		0	1		0	0		1	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fr _t		0.996			0.998				0.850			0.975
Fl _t Protected	0.950			0.950				0.998				
Satd. Flow (prot)	1779	1741	0	1728	1940	0	0	1859	1583	0	1880	0
Fl _t Permitted	0.426			0.148				0.596				
Satd. Flow (perm)	798	1741	0	269	1940	0	0	1110	1583	0	1880	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1			1				74			14
Link Speed (mph)		30			30			20				30
Link Distance (ft)		153			621			626				485
Travel Time (s)		3.5			14.1			21.3				11.0
Peak Hour Factor	0.87	0.87	0.87	0.93	0.93	0.93	0.94	0.94	0.94	0.94	0.94	0.94
Heavy Vehicles (%)	3%	3%	3%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Parking (#/hr)		5										
Adj. Flow (vph)	47	574	15	462	619	10	12	320	241	0	590	136
Shared Lane Traffic (%)												
Lane Group Flow (vph)	47	589	0	462	629	0	0	332	241	0	726	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	custom		NA	
Protected Phases		2		1	1 2			5			5	
Permitted Phases	2			1 2			5		1 5			
Detector Phase	2	2		1	1 2		5	5	1 5			5
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0			4.0	4.0				4.0
Minimum Split (s)	21.0	21.0		9.0			21.0	21.0				21.0
Total Split (s)	31.0	31.0		23.0			41.0	41.0				41.0
Total Split (%)	32.6%	32.6%		24.2%			43.2%	43.2%				43.2%
Maximum Green (s)	27.0	27.0		20.0			37.0	37.0				37.0
Yellow Time (s)	3.0	3.0		3.0			3.0	3.0				3.0
All-Red Time (s)	1.0	1.0		0.0			1.0	1.0				1.0
Lost Time Adjust (s)	0.0	0.0		0.0				0.0				0.0
Total Lost Time (s)	4.0	4.0		3.0				4.0				4.0
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0			3.0	3.0				3.0
Recall Mode	Max	Max		None			None	None				None
Act Effect Green (s)	27.0	27.0		48.0	51.0			37.0	61.0			37.0
Actuated g/C Ratio	0.28	0.28		0.51	0.54			0.39	0.64			0.39
v/c Ratio	0.21	1.19		1.04	0.60			0.77	0.23			0.98
Control Delay	28.9	135.7		81.4	18.1			39.3	5.4			58.1
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0			0.0
Total Delay	28.9	135.7		81.4	18.1			39.3	5.4			58.1

TIP Before and After Evaluations - Belmont
 1: Leonard St/Clifton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	F		F	B			D	A		E	
Approach Delay		127.8			44.9			25.0			58.1	
Approach LOS		F			D			C			E	
Stops (vph)	32	416		289	387			260	60		574	
Fuel Used(gal)	1	19		11	7			5	2		14	
CO Emissions (g/hr)	44	1329		755	498			347	121		966	
NOx Emissions (g/hr)	8	259		147	97			68	24		188	
VOC Emissions (g/hr)	10	308		175	116			80	28		224	
Dilemma Vehicles (#)	0	0		0	0			0	0		0	
Queue Length 50th (ft)	22	-434		-252	245			171	36		418	
Queue Length 95th (ft)	50	#611		#446	356			#315	67		#667	
Internal Link Dist (ft)		73			541			546			405	
Turn Bay Length (ft)				175					125			
Base Capacity (vph)	227	496		443	1042			432	1043		741	
Starvation Cap Reductn	0	0		0	0			0	0		0	
Spillback Cap Reductn	0	0		0	0			0	0		0	
Storage Cap Reductn	0	0		0	0			0	0		0	
Reduced v/c Ratio	0.21	1.19		1.04	0.60			0.77	0.23		0.98	

Intersection Summary

Area Type: Other
 Cycle Length: 95
 Actuated Cycle Length: 95
 Natural Cycle: 90
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 1.19
 Intersection Signal Delay: 61.7
 Intersection LOS: E
 Intersection Capacity Utilization 97.9%
 ICU Level of Service F
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Leonard St/Clifton St & Pleasant St



TIP Before and After Evaluations - Belmont
 1: Leonard St/Clifton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	91	537	10	223	342	8	20	522	243	12	354	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	10	10	12	11	13	12	12	12	12	12	13	12
Grade (%)		-3%			0%			0%			-5%	
Storage Length (ft)	0		0	175		0	0		125	0		0
Storage Lanes	1		0	1		0	0		1	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.997			0.997				0.850		0.985	
Flt Protected	0.950			0.950				0.998			0.999	
Satd. Flow (prot)	1660	1524	0	1728	1938	0	0	1859	1583	0	1961	0
Flt Permitted	0.548			0.151				0.978			0.782	
Satd. Flow (perm)	958	1524	0	275	1938	0	0	1822	1583	0	1535	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1			2				148			7
Link Speed (mph)		30			30			20			30	
Link Distance (ft)		153			621			626			485	
Travel Time (s)		3.5			14.1			21.3			11.0	
Peak Hour Factor	0.93	0.93	0.93	0.98	0.98	0.98	0.90	0.90	0.90	0.89	0.89	0.89
Heavy Vehicles (%)	3%	3%	3%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Parking (#/hr)		5										
Adj. Flow (vph)	98	577	11	228	349	8	22	580	270	13	398	51
Shared Lane Traffic (%)												
Lane Group Flow (vph)	98	588	0	228	357	0	0	602	270	0	462	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	custom	Perm	NA	
Protected Phases		2		1	1 2			5			5	
Permitted Phases	2			1 2			5		1 5	5		
Detector Phase	2	2		1	1 2		5	5	1 5	5	5	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0			4.0	4.0		4.0	4.0	
Minimum Split (s)	21.0	21.0		9.0			21.0	21.0		21.0	21.0	
Total Split (s)	42.0	42.0		16.0			42.0	42.0		42.0	42.0	
Total Split (%)	42.0%	42.0%		16.0%			42.0%	42.0%		42.0%	42.0%	
Maximum Green (s)	38.0	38.0		13.0			38.0	38.0		38.0	38.0	
Yellow Time (s)	3.0	3.0		3.0			3.0	3.0		3.0	3.0	
All-Red Time (s)	1.0	1.0		0.0			1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0	0.0		0.0				0.0			0.0	
Total Lost Time (s)	4.0	4.0		3.0				4.0			4.0	
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0			3.0	3.0		3.0	3.0	
Recall Mode	Max	Max		None			None	None		None	None	
Act Effect Green (s)	38.1	38.1		51.5	54.5			36.5	52.9		36.5	
Actuated g/C Ratio	0.39	0.39		0.53	0.56			0.37	0.54		0.37	
v/c Ratio	0.26	0.99		0.70	0.33			0.89	0.29		0.80	
Control Delay	23.7	66.9		26.8	13.1			45.8	6.1		39.3	
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	
Total Delay	23.7	66.9		26.8	13.1			45.8	6.1		39.3	

TIP Before and After Evaluations - Belmont
 1: Leonard St/Clifton St & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	E		C	B			D	A		D	
Approach Delay		60.8			18.5			33.5			39.3	
Approach LOS		E			B			C			D	
Stops (vph)	62	455		120	181			470	56		345	
Fuel Used(gal)	1	13		3	4			9	2		7	
CO Emissions (g/hr)	87	889		207	254			656	130		472	
NOx Emissions (g/hr)	17	173		40	49			128	25		92	
VOC Emissions (g/hr)	20	206		48	59			152	30		109	
Dilemma Vehicles (#)	0	0		0	0			0	0		0	
Queue Length 50th (ft)	42	~381		71	118			350	36		253	
Queue Length 95th (ft)	84	#610		#157	177			#552	78		#406	
Internal Link Dist (ft)		73			541			546			405	
Turn Bay Length (ft)				175					125			
Base Capacity (vph)	372	593		339	1078			708	932		601	
Starvation Cap Reductn	0	0		0	0			0	0		0	
Spillback Cap Reductn	0	0		0	0			0	0		0	
Storage Cap Reductn	0	0		0	0			0	0		0	
Reduced v/c Ratio	0.26	0.99		0.67	0.33			0.85	0.29		0.77	

Intersection Summary

Area Type: Other
 Cycle Length: 100
 Actuated Cycle Length: 98
 Natural Cycle: 80
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.99
 Intersection Signal Delay: 38.3
 Intersection LOS: D
 Intersection Capacity Utilization 87.5%
 ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Leonard St/Clifton St & Pleasant St



TIP Before and After Evaluations - Belmont
 1: Leonard St/Clifton St & Pleasant St

6/30/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	54	252	5	206	620	11	17	225	157	10	400	136
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	14	12	11	13	12	12	12	12	12	12	12
Grade (%)		-3%			0%			0%				-5%
Storage Length (ft)	0		0	175		0	0		125	0		0
Storage Lanes	1		0	1		0	0		1	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fr _t		0.996			0.996				0.850			0.962
Fl _t Protected	0.950			0.950				0.996				0.999
Satd. Flow (prot)	1728	1691	0	1694	1899	0	0	1802	1538	0	1835	0
Fl _t Permitted	0.257			0.387				0.933				0.989
Satd. Flow (perm)	468	1691	0	690	1899	0	0	1688	1538	0	1817	0
Right Turn on Red			No			No			Yes			No
Satd. Flow (RTOR)									169			
Link Speed (mph)		30			30			20				30
Link Distance (ft)		153			621			626				485
Travel Time (s)		3.5			14.1			21.3				11.0
Peak Hour Factor	0.96	0.90	0.63	0.87	0.88	0.55	0.71	0.87	0.93	0.63	0.91	0.76
Heavy Vehicles (%)	6%	6%	6%	3%	3%	3%	5%	5%	5%	2%	2%	2%
Parking (#/hr)		5										
Adj. Flow (vph)	56	280	8	237	705	20	24	259	169	16	440	179
Shared Lane Traffic (%)												
Lane Group Flow (vph)	56	288	0	237	725	0	0	283	169	0	635	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	custom	Perm	NA	
Protected Phases		2		1	1 2			5			5	
Permitted Phases	2			1 2			5		1 5	5		
Detector Phase	2	2		1	1 2		5	5	1 5	5	5	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0			4.0	4.0		4.0	4.0	
Minimum Split (s)	21.0	21.0		9.0			21.0	21.0		21.0	21.0	
Total Split (s)	27.0	27.0		20.0			43.0	43.0		43.0	43.0	
Total Split (%)	30.0%	30.0%		22.2%			47.8%	47.8%		47.8%	47.8%	
Maximum Green (s)	22.0	22.0		17.0			38.0	38.0		38.0	38.0	
Yellow Time (s)	4.0	4.0		3.0			4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		0.0			1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0	0.0		0.0				0.0			0.0	
Total Lost Time (s)	5.0	5.0		3.0				5.0			5.0	
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0			3.0	3.0		3.0	3.0	
Recall Mode	Max	Max		None			None	None		None	None	
Act Effect Green (s)	22.1	22.1		41.1	44.1			35.3	57.3		35.3	
Actuated g/C Ratio	0.25	0.25		0.47	0.50			0.40	0.66		0.40	
v/c Ratio	0.47	0.67		0.46	0.76			0.42	0.16		0.87	
Control Delay	44.8	39.5		16.5	24.5			20.7	1.3		37.8	
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	
Total Delay	44.8	39.5		16.5	24.5			20.7	1.3		37.8	

TIP Before and After Evaluations - Belmont
 1: Leonard St/Clifton St & Pleasant St

6/30/2014

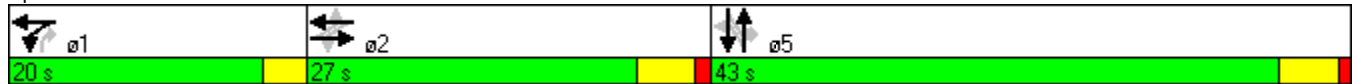


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	D	D		B	C			C	A		D	
Approach Delay		40.4			22.5			13.4			37.8	
Approach LOS		D			C			B			D	
Stops (vph)	48	224		117	493			164	9		465	
Fuel Used(gal)	1	5		2	9			3	1		9	
CO Emissions (g/hr)	72	321		163	624			199	69		619	
NOx Emissions (g/hr)	14	63		32	121			39	13		120	
VOC Emissions (g/hr)	17	74		38	145			46	16		143	
Dilemma Vehicles (#)	0	0		0	0			0	0		0	
Queue Length 50th (ft)	27	150		76	326			109	0		312	
Queue Length 95th (ft)	#76	#244		120	460			167	19		#506	
Internal Link Dist (ft)		73			541			546			405	
Turn Bay Length (ft)				175					125			
Base Capacity (vph)	118	427		520	958			736	1063		792	
Starvation Cap Reductn	0	0		0	0			0	0		0	
Spillback Cap Reductn	0	0		0	0			0	0		0	
Storage Cap Reductn	0	0		0	0			0	0		0	
Reduced v/c Ratio	0.47	0.67		0.46	0.76			0.38	0.16		0.80	

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 87.4
 Natural Cycle: 60
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.87
 Intersection Signal Delay: 27.4
 Intersection LOS: C
 Intersection Capacity Utilization 85.9%
 ICU Level of Service E
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Leonard St/Clifton St & Pleasant St



TIP Before and After Evaluations - Belmont

1: Leonard St/Clifton St & Pleasant St

6/30/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	84	348	13	203	423	39	17	416	138	9	364	79
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	10	10	12	11	13	12	12	12	12	12	13	12
Grade (%)		-3%			0%			0%				-5%
Storage Length (ft)	0		0	175		0	0		125	0		0
Storage Lanes	1		0	1		0	0		1	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.990			0.985				0.850			0.977
Flt Protected	0.950			0.950				0.998				0.998
Satd. Flow (prot)	1710	1559	0	1728	1915	0	0	1896	1615	0	1943	0
Flt Permitted	0.468			0.297				0.957				0.860
Satd. Flow (perm)	842	1559	0	540	1915	0	0	1818	1615	0	1674	0
Right Turn on Red			No			No			Yes			No
Satd. Flow (RTOR)									189			
Link Speed (mph)		30			30			20				30
Link Distance (ft)		153			621			626				485
Travel Time (s)		3.5			14.1			21.3				11.0
Peak Hour Factor	0.72	0.93	0.46	0.85	0.89	0.75	0.71	0.88	0.73	0.56	0.88	0.90
Heavy Vehicles (%)	0%	0%	0%	1%	1%	1%	0%	0%	0%	1%	1%	1%
Parking (#/hr)		5										
Adj. Flow (vph)	117	374	28	239	475	52	24	473	189	16	414	88
Shared Lane Traffic (%)												
Lane Group Flow (vph)	117	402	0	239	527	0	0	497	189	0	518	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	custom	Perm	NA	
Protected Phases		2		1	1 2			5			5	
Permitted Phases	2			1 2			5		1 5	5		
Detector Phase	2	2		1	1 2		5	5	1 5	5	5	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0			4.0	4.0		4.0	4.0	
Minimum Split (s)	21.0	21.0		9.0			21.0	21.0		21.0	21.0	
Total Split (s)	33.0	33.0		21.0			36.0	36.0		36.0	36.0	
Total Split (%)	36.7%	36.7%		23.3%			40.0%	40.0%		40.0%	40.0%	
Maximum Green (s)	28.0	28.0		18.0			31.0	31.0		31.0	31.0	
Yellow Time (s)	4.0	4.0		3.0			4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		0.0			1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0	0.0		0.0				0.0			0.0	
Total Lost Time (s)	5.0	5.0		3.0				5.0			5.0	
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0			3.0	3.0		3.0	3.0	
Recall Mode	Max	Max		None			None	None		None	None	
Act Effect Green (s)	28.1	28.1		47.2	50.2			29.8	52.0		29.8	
Actuated g/C Ratio	0.32	0.32		0.54	0.57			0.34	0.59		0.34	
v/c Ratio	0.44	0.81		0.46	0.48			0.81	0.18		0.91	
Control Delay	31.0	43.0		12.9	13.3			38.5	1.7		51.0	
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	
Total Delay	31.0	43.0		12.9	13.3			38.5	1.7		51.0	

TIP Before and After Evaluations - Belmont
 1: Leonard St/Clifton St & Pleasant St

6/30/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS	C	D		B	B			D	A		D	
Approach Delay		40.3			13.2			28.4			51.0	
Approach LOS		D			B			C			D	
Stops (vph)	67	309		99	260			373	9		389	
Fuel Used(gal)	1	7		2	5			7	1		9	
CO Emissions (g/hr)	92	467		144	344			479	61		598	
NOx Emissions (g/hr)	18	91		28	67			93	12		116	
VOC Emissions (g/hr)	21	108		33	80			111	14		139	
Dilemma Vehicles (#)	0	0		0	0			0	0		0	
Queue Length 50th (ft)	53	211		64	167			252	0		276	
Queue Length 95th (ft)	80	#368		97	243			#393	11		#449	
Internal Link Dist (ft)		73			541			546			405	
Turn Bay Length (ft)				175					125			
Base Capacity (vph)	268	497		537	1092			641	1046		591	
Starvation Cap Reductn	0	0		0	0			0	0		0	
Spillback Cap Reductn	0	0		0	0			0	0		0	
Storage Cap Reductn	0	0		0	0			0	0		0	
Reduced v/c Ratio	0.44	0.81		0.45	0.48			0.78	0.18		0.88	

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 88.1
 Natural Cycle: 60
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.91
 Intersection Signal Delay: 30.9
 Intersection LOS: C
 Intersection Capacity Utilization 73.4%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Leonard St/Clifton St & Pleasant St

 ø1	 ø2	 ø5
21 s	33 s	36 s

TIP Before and After Evaluations - Belmont

1: Concord Ave & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	333	121	40	521	49	169	167	25	49	359	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	15	12	12	16	12	10	11	12	10	10	12
Grade (%)		0%			0%			6%			-6%	
Storage Length (ft)	0		0	0		0	200		0	100		0
Storage Lanes	0		0	0		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.964			0.989			0.980				
Flt Protected					0.997		0.950			0.950		
Satd. Flow (prot)	0	1975	0	0	2102	0	1618	1729	0	1718	1808	0
Flt Permitted					0.945		0.340			0.568		
Satd. Flow (perm)	0	1975	0	0	1993	0	579	1729	0	1027	1808	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		26			6			11				
Link Speed (mph)		30			30			20				20
Link Distance (ft)		620			546			606				523
Travel Time (s)		14.1			12.4			20.7				17.8
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.84	0.84	0.84	0.85	0.85	0.85
Heavy Vehicles (%)	2%	2%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Adj. Flow (vph)	0	370	134	44	579	54	201	199	30	58	422	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	504	0	0	677	0	201	229	0	58	422	0
Turn Type		NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		1			1			5				5
Permitted Phases				1			5			5		
Detector Phase		1		1	1		5	5		5		5
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0		4.0	4.0		4.0		4.0
Minimum Split (s)		21.0		21.0	21.0		21.0	21.0		21.0		21.0
Total Split (s)		45.0		45.0	45.0		45.0	45.0		45.0		45.0
Total Split (%)		50.0%		50.0%	50.0%		50.0%	50.0%		50.0%		50.0%
Maximum Green (s)		40.0		40.0	40.0		40.0	40.0		40.0		40.0
Yellow Time (s)		4.0		4.0	4.0		4.0	4.0		4.0		4.0
All-Red Time (s)		1.0		1.0	1.0		1.0	1.0		1.0		1.0
Lost Time Adjust (s)		0.0			0.0		0.0	0.0		0.0		0.0
Total Lost Time (s)		5.0			5.0		5.0	5.0		5.0		5.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0		3.0
Recall Mode		Max		Max	Max		None	None		None		None
Act Effect Green (s)		40.6			40.6		30.7	30.7		30.7		30.7
Actuated g/C Ratio		0.50			0.50		0.38	0.38		0.38		0.38
v/c Ratio		0.51			0.68		0.92	0.35		0.15		0.62
Control Delay		17.2			22.0		68.9	17.9		16.4		24.2
Queue Delay		0.0			0.0		0.0	0.0		0.0		0.0
Total Delay		17.2			22.0		68.9	17.9		16.4		24.2
LOS		B			C		E	B		B		C

TIP Before and After Evaluations - Belmont
 1: Concord Ave & Pleasant St

6/11/2014

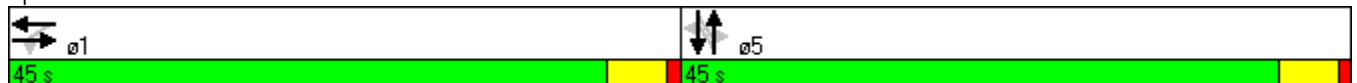


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		17.2			22.0			41.7				23.2
Approach LOS		B			C			D				C
Stops (vph)		286			454		142	116		29		265
Fuel Used(gal)		5			8		4	2		0		4
CO Emissions (g/hr)		375			547		257	145		33		292
NOx Emissions (g/hr)		73			107		50	28		6		57
VOC Emissions (g/hr)		87			127		60	34		8		68
Dilemma Vehicles (#)		0			0		0	0		0		0
Queue Length 50th (ft)		177			283		94	76		19		168
Queue Length 95th (ft)		292			453		#196	117		40		236
Internal Link Dist (ft)		540			466			526				443
Turn Bay Length (ft)							200			100		
Base Capacity (vph)		997			996		288	867		511		901
Starvation Cap Reductn		0			0		0	0		0		0
Spillback Cap Reductn		0			0		0	0		0		0
Storage Cap Reductn		0			0		0	0		0		0
Reduced v/c Ratio		0.51			0.68		0.70	0.26		0.11		0.47

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 81.5
 Natural Cycle: 55
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 0.92
 Intersection Signal Delay: 25.2
 Intersection LOS: C
 Intersection Capacity Utilization 102.4%
 ICU Level of Service G
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Concord Ave & Pleasant St



TIP Before and After Evaluations - Belmont

1: Concord Ave & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	495	155	30	370	21	138	269	35	23	160	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	15	12	12	16	12	10	11	12	10	10	12
Grade (%)		0%			0%			6%			-6%	
Storage Length (ft)	0		0	0		0	200		0	100		0
Storage Lanes	0		0	0		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.968			0.993			0.983				
Flt Protected					0.996		0.950			0.950		
Satd. Flow (prot)	0	2003	0	0	2109	0	1618	1734	0	1718	1808	0
Flt Permitted					0.932		0.629			0.383		
Satd. Flow (perm)	0	2003	0	0	1973	0	1071	1734	0	693	1808	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		23			4			9				
Link Speed (mph)		30			30			20				20
Link Distance (ft)		620			546			606				523
Travel Time (s)		14.1			12.4			20.7				17.8
Peak Hour Factor	0.93	0.93	0.93	0.94	0.94	0.94	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Adj. Flow (vph)	0	532	167	32	394	22	153	299	39	26	178	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	699	0	0	448	0	153	338	0	26	178	0
Turn Type		NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		1			1			5				5
Permitted Phases				1			5			5		
Detector Phase		1		1	1		5	5		5		5
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0		4.0	4.0		4.0		4.0
Minimum Split (s)		21.0		21.0	21.0		21.0	21.0		21.0		21.0
Total Split (s)		45.0		45.0	45.0		45.0	45.0		45.0		45.0
Total Split (%)		50.0%		50.0%	50.0%		50.0%	50.0%		50.0%		50.0%
Maximum Green (s)		40.0		40.0	40.0		40.0	40.0		40.0		40.0
Yellow Time (s)		4.0		4.0	4.0		4.0	4.0		4.0		4.0
All-Red Time (s)		1.0		1.0	1.0		1.0	1.0		1.0		1.0
Lost Time Adjust (s)		0.0			0.0		0.0	0.0		0.0		0.0
Total Lost Time (s)		5.0			5.0		5.0	5.0		5.0		5.0
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0		3.0
Recall Mode		Max		Max	Max		None	None		None		None
Act Effct Green (s)		40.5			40.5		21.4	21.4		21.4		21.4
Actuated g/C Ratio		0.56			0.56		0.30	0.30		0.30		0.30
v/c Ratio		0.62			0.40		0.48	0.65		0.13		0.33
Control Delay		15.0			11.9		25.2	26.9		18.4		20.5
Queue Delay		0.0			0.0		0.0	0.0		0.0		0.0
Total Delay		15.0			11.9		25.2	26.9		18.4		20.5
LOS		B			B		C	C		B		C

TIP Before and After Evaluations - Belmont
 1: Concord Ave & Pleasant St

6/11/2014

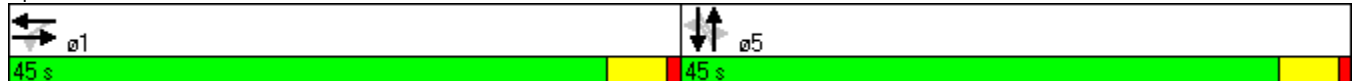


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		15.0			11.9			26.4				20.2
Approach LOS		B			B			C				C
Stops (vph)		416			229		101	236		18		110
Fuel Used(gal)		7			4		2	4		0		2
CO Emissions (g/hr)		519			285		122	278		17		120
NOx Emissions (g/hr)		101			55		24	54		3		23
VOC Emissions (g/hr)		120			66		28	64		4		28
Dilemma Vehicles (#)		0			0		0	0		0		0
Queue Length 50th (ft)		177			99		55	124		8		60
Queue Length 95th (ft)		412			234		103	200		25		105
Internal Link Dist (ft)		540			466			526				443
Turn Bay Length (ft)							200			100		
Base Capacity (vph)		1136			1111		602	979		390		1016
Starvation Cap Reductn		0			0		0	0		0		0
Spillback Cap Reductn		0			0		0	0		0		0
Storage Cap Reductn		0			0		0	0		0		0
Reduced v/c Ratio		0.62			0.40		0.25	0.35		0.07		0.18

Intersection Summary

Area Type:	Other
Cycle Length:	90
Actuated Cycle Length:	72
Natural Cycle:	50
Control Type:	Semi Act-Uncoord
Maximum v/c Ratio:	0.65
Intersection Signal Delay:	17.9
Intersection LOS:	B
Intersection Capacity Utilization:	77.8%
ICU Level of Service:	D
Analysis Period (min):	15

Splits and Phases: 1: Concord Ave & Pleasant St



TIP Before and After Evaluations - Belmont
 1: Concord Ave & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	368	134	44	576	54	187	185	28	54	397	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	14	12	12	14	12	10	11	12	10	10	12
Grade (%)		0%			0%			6%			-6%	
Storage Length (ft)	0		0	0		0	200		0	100		0
Storage Lanes	0		0	0		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.964			0.989			0.980				
Flt Protected					0.997		0.950			0.950		
Satd. Flow (prot)	0	1915	0	0	1979	0	1618	1729	0	1718	1808	0
Flt Permitted					0.908		0.174			0.602		
Satd. Flow (perm)	0	1915	0	0	1802	0	296	1729	0	1089	1808	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		30			7			10				
Link Speed (mph)		30			30			20				20
Link Distance (ft)		620			546			606				523
Travel Time (s)		14.1			12.4			20.7				17.8
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.84	0.84	0.84	0.85	0.85	0.85
Heavy Vehicles (%)	2%	2%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Adj. Flow (vph)	0	409	149	49	640	60	223	220	33	64	467	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	558	0	0	749	0	223	253	0	64	467	0
Turn Type		NA		Perm	NA		pm+pt	NA		Perm	NA	
Protected Phases		1			1		5	5 6			6	
Permitted Phases				1			5 6			6		
Detector Phase		1		1	1		5	5 6		6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0		4.0			4.0	4.0	
Minimum Split (s)		21.0		21.0	21.0		12.0			21.0	21.0	
Total Split (s)		51.0		51.0	51.0		12.0			27.0	27.0	
Total Split (%)		56.7%		56.7%	56.7%		13.3%			30.0%	30.0%	
Maximum Green (s)		47.0		47.0	47.0		10.0			23.0	23.0	
Yellow Time (s)		3.0		3.0	3.0		2.0			3.0	3.0	
All-Red Time (s)		1.0		1.0	1.0		0.0			1.0	1.0	
Lost Time Adjust (s)		0.0			0.0		0.0			0.0	0.0	
Total Lost Time (s)		4.0			4.0		2.0			4.0	4.0	
Lead/Lag							Lead			Lag	Lag	
Lead-Lag Optimize?							Yes			Yes	Yes	
Vehicle Extension (s)		3.0		3.0	3.0		3.0			3.0	3.0	
Recall Mode		Max		Max	Max		None			None	None	
Act Effct Green (s)		47.0			47.0		35.0	37.0		23.0	23.0	
Actuated g/C Ratio		0.52			0.52		0.39	0.41		0.26	0.26	
v/c Ratio		0.55			0.79		0.85	0.35		0.23	1.01	
Control Delay		16.1			25.2		49.6	19.2		29.3	79.9	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		16.1			25.2		49.6	19.2		29.3	79.9	
LOS		B			C		D	B		C	E	

TIP Before and After Evaluations - Belmont
 1: Concord Ave & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		16.1			25.2			33.5				73.8
Approach LOS		B			C			C				E
Stops (vph)		309			527		114	137		42		337
Fuel Used(gal)		6			9		3	2		1		9
CO Emissions (g/hr)		404			646		226	166		48		646
NOx Emissions (g/hr)		79			126		44	32		9		126
VOC Emissions (g/hr)		94			150		52	39		11		150
Dilemma Vehicles (#)		0			0		0	0		0		0
Queue Length 50th (ft)		190			326		85	93		29		~271
Queue Length 95th (ft)		285			491		#174	139		60		#427
Internal Link Dist (ft)		540			466			526				443
Turn Bay Length (ft)							200			100		
Base Capacity (vph)		1014			944		262	717		278		462
Starvation Cap Reductn		0			0		0	0		0		0
Spillback Cap Reductn		0			0		0	0		0		0
Storage Cap Reductn		0			0		0	0		0		0
Reduced v/c Ratio		0.55			0.79		0.85	0.35		0.23		1.01

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Natural Cycle: 90
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 1.01
 Intersection Signal Delay: 35.9
 Intersection LOS: D
 Intersection Capacity Utilization 108.1%
 ICU Level of Service G
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Concord Ave & Pleasant St



TIP Before and After Evaluations - Belmont

1: Concord Ave & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	547	171	33	409	23	152	297	39	25	177	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	14	12	12	14	12	10	11	12	10	10	12
Grade (%)		0%			0%			6%			-6%	
Storage Length (ft)	0		0	0		0	200		0	100		0
Storage Lanes	0		0	0		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.968			0.993			0.983				
Flt Protected					0.996		0.950			0.950		
Satd. Flow (prot)	0	1942	0	0	1985	0	1618	1734	0	1718	1808	0
Flt Permitted					0.824		0.456			0.540		
Satd. Flow (perm)	0	1942	0	0	1642	0	777	1734	0	977	1808	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		26			4			9				
Link Speed (mph)		30			30			20				20
Link Distance (ft)		620			546			606				523
Travel Time (s)		14.1			12.4			20.7				17.8
Peak Hour Factor	0.93	0.93	0.93	0.94	0.94	0.94	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Adj. Flow (vph)	0	588	184	35	435	24	169	330	43	28	197	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	772	0	0	494	0	169	373	0	28	197	0
Turn Type		NA		Perm	NA		pm+pt	NA		Perm	NA	
Protected Phases		1			1		5	5 6			6	
Permitted Phases				1			5 6			6		
Detector Phase		1		1	1		5	5 6		6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0		4.0			4.0	4.0	
Minimum Split (s)		21.0		21.0	21.0		7.0			21.0	21.0	
Total Split (s)		51.0		51.0	51.0		13.0			26.0	26.0	
Total Split (%)		56.7%		56.7%	56.7%		14.4%			28.9%	28.9%	
Maximum Green (s)		47.0		47.0	47.0		10.0			22.0	22.0	
Yellow Time (s)		3.0		3.0	3.0		3.0			3.0	3.0	
All-Red Time (s)		1.0		1.0	1.0		0.0			1.0	1.0	
Lost Time Adjust (s)		0.0			0.0		0.0			0.0	0.0	
Total Lost Time (s)		4.0			4.0		3.0			4.0	4.0	
Lead/Lag							Lead			Lag	Lag	
Lead-Lag Optimize?							Yes			Yes	Yes	
Vehicle Extension (s)		3.0		3.0	3.0		3.0			3.0	3.0	
Recall Mode		Max		Max	Max		None			None	None	
Act Effct Green (s)		47.1			47.1		26.6	29.6		15.6	15.6	
Actuated g/C Ratio		0.56			0.56		0.32	0.35		0.19	0.19	
v/c Ratio		0.70			0.53		0.49	0.60		0.15	0.59	
Control Delay		18.0			15.0		24.4	26.0		29.7	38.2	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		18.0			15.0		24.4	26.0		29.7	38.2	
LOS		B			B		C	C		C	D	

TIP Before and After Evaluations - Belmont
 1: Concord Ave & Pleasant St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		18.0			15.0			25.5				37.1
Approach LOS		B			B			C				D
Stops (vph)		496			282		104	255		21		153
Fuel Used(gal)		9			5		2	4		0		3
CO Emissions (g/hr)		618			346		131	302		23		183
NOx Emissions (g/hr)		120			67		25	59		4		36
VOC Emissions (g/hr)		143			80		30	70		5		42
Dilemma Vehicles (#)		0			0		0	0		0		0
Queue Length 50th (ft)		266			151		63	154		12		95
Queue Length 95th (ft)		467			277		110	241		35		161
Internal Link Dist (ft)		540			466			526				443
Turn Bay Length (ft)							200			100		
Base Capacity (vph)		1104			925		347	752		257		476
Starvation Cap Reductn		0			0		0	0		0		0
Spillback Cap Reductn		0			0		0	0		0		0
Storage Cap Reductn		0			0		0	0		0		0
Reduced v/c Ratio		0.70			0.53		0.49	0.50		0.11		0.41

Intersection Summary

Area Type:	Other
Cycle Length:	90
Actuated Cycle Length:	83.8
Natural Cycle:	60
Control Type:	Semi Act-Uncoord
Maximum v/c Ratio:	0.70
Intersection Signal Delay:	21.4
Intersection LOS:	C
Intersection Capacity Utilization:	81.6%
ICU Level of Service:	D
Analysis Period (min):	15

Splits and Phases: 1: Concord Ave & Pleasant St



TIP Before and After Evaluations - Belmont

1: Concord Ave & Pleasant St

6/30/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕		↗	↘		↗	↘	
Volume (vph)	34	260	82	39	469	46	156	152	15	37	346	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	14	12	12	14	12	10	11	12	10	10	12
Grade (%)		0%			0%			6%			-6%	
Storage Length (ft)	0		0	0		0	200		0	100		0
Storage Lanes	0		0	0		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.970			0.986			0.986				
Flt Protected		0.994			0.996		0.950			0.950		
Satd. Flow (prot)	0	1935	0	0	1971	0	1634	1757	0	1735	1827	0
Flt Permitted		0.885			0.926		0.207			0.628		
Satd. Flow (perm)	0	1723	0	0	1832	0	356	1757	0	1147	1827	0
Right Turn on Red			No			No			Yes			No
Satd. Flow (RTOR)								7				
Link Speed (mph)		30			30			20			20	
Link Distance (ft)		620			546			606			523	
Travel Time (s)		14.1			12.4			20.7			17.8	
Peak Hour Factor	0.65	0.83	0.79	0.70	0.87	0.68	0.81	0.81	0.75	0.62	0.91	0.92
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%
Adj. Flow (vph)	52	313	104	56	539	68	193	188	20	60	380	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	469	0	0	663	0	193	208	0	60	380	0
Turn Type	Perm	NA		Perm	NA		pm+pt	NA		Perm	NA	
Protected Phases		1			1		5	5 6			6	
Permitted Phases	1			1			5 6			6		
Detector Phase	1	1		1	1		5	5 6		6	6	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0			4.0	4.0	
Minimum Split (s)	21.0	21.0		21.0	21.0		12.0			21.0	21.0	
Total Split (s)	51.0	51.0		51.0	51.0		12.0			27.0	27.0	
Total Split (%)	56.7%	56.7%		56.7%	56.7%		13.3%			30.0%	30.0%	
Maximum Green (s)	45.0	45.0		45.0	45.0		9.0			21.0	21.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		3.0			4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		0.0			2.0	2.0	
Lost Time Adjust (s)		0.0			0.0		0.0			0.0	0.0	
Total Lost Time (s)		6.0			6.0		3.0			6.0	6.0	
Lead/Lag							Lead			Lag	Lag	
Lead-Lag Optimize?							Yes			Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0			3.0	3.0	
Recall Mode	Max	Max		Max	Max		None			None	None	
Act Effect Green (s)		45.0			45.0		32.3	35.3		20.3	20.3	
Actuated g/C Ratio		0.50			0.50		0.36	0.40		0.23	0.23	
v/c Ratio		0.54			0.72		0.75	0.30		0.23	0.91	
Control Delay		18.2			22.9		39.3	19.2		30.7	62.3	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		18.2			22.9		39.3	19.2		30.7	62.3	
LOS		B			C		D	B		C	E	

TIP Before and After Evaluations - Belmont

1: Concord Ave & Pleasant St

6/30/2014

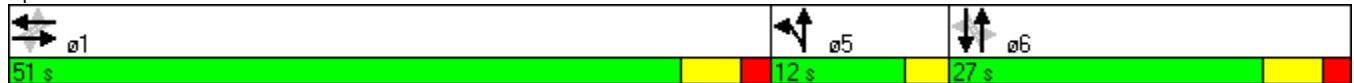


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		18.2			22.9			28.9				58.0
Approach LOS		B			C			C				E
Stops (vph)		249			422		102	106		30		303
Fuel Used(gal)		5			7		2	2		0		7
CO Emissions (g/hr)		321			509		167	130		34		477
NOx Emissions (g/hr)		62			99		32	25		7		93
VOC Emissions (g/hr)		74			118		39	30		8		111
Dilemma Vehicles (#)		0			0		0	0		0		0
Queue Length 50th (ft)		175			282		73	76		28		210
Queue Length 95th (ft)		234			394		#114	113		41		#373
Internal Link Dist (ft)		540			466			526				443
Turn Bay Length (ft)							200			100		
Base Capacity (vph)		868			923		257	700		270		429
Starvation Cap Reductn		0			0		0	0		0		0
Spillback Cap Reductn		0			0		0	0		0		0
Storage Cap Reductn		0			0		0	0		0		0
Reduced v/c Ratio		0.54			0.72		0.75	0.30		0.22		0.89

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 89.3
 Natural Cycle: 65
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.91
 Intersection Signal Delay: 30.8
 Intersection LOS: C
 Intersection Capacity Utilization 76.9%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Concord Ave & Pleasant St



TIP Before and After Evaluations - Belmont

1: Concord Ave & Pleasant St

6/30/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕		↗	↘		↗	↘	
Volume (vph)	61	440	142	40	431	27	118	350	31	33	284	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	14	12	12	14	12	10	11	12	10	10	12
Grade (%)		0%			0%			6%			-6%	
Storage Length (ft)	0		0	0		0	200		0	100		0
Storage Lanes	0		0	0		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.970			0.989			0.986				
Flt Protected		0.994			0.996		0.950			0.950		
Satd. Flow (prot)	0	1916	0	0	1977	0	1618	1739	0	1718	1808	0
Flt Permitted		0.824			0.874		0.329			0.515		
Satd. Flow (perm)	0	1588	0	0	1734	0	560	1739	0	931	1808	0
Right Turn on Red			No			No			Yes			No
Satd. Flow (RTOR)								8				
Link Speed (mph)		30			30			20			20	
Link Distance (ft)		620			546			606			523	
Travel Time (s)		14.1			12.4			20.7			17.8	
Peak Hour Factor	0.66	0.87	0.83	0.77	0.86	0.56	0.87	0.91	0.78	0.69	0.83	0.92
Heavy Vehicles (%)	2%	2%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Adj. Flow (vph)	92	506	171	52	501	48	136	385	40	48	342	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	769	0	0	601	0	136	425	0	48	342	0
Turn Type	Perm	NA		Perm	NA		pm+pt	NA		Perm	NA	
Protected Phases		1			1		5	5 6			6	
Permitted Phases	1			1			5 6			6		
Detector Phase	1	1		1	1		5	5 6		6	6	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0			4.0	4.0	
Minimum Split (s)	21.0	21.0		21.0	21.0		7.0			21.0	21.0	
Total Split (s)	45.0	45.0		45.0	45.0		13.0			32.0	32.0	
Total Split (%)	50.0%	50.0%		50.0%	50.0%		14.4%			35.6%	35.6%	
Maximum Green (s)	39.0	39.0		39.0	39.0		10.0			26.0	26.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		3.0			4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		0.0			2.0	2.0	
Lost Time Adjust (s)		0.0			0.0		0.0			0.0	0.0	
Total Lost Time (s)		6.0			6.0		3.0			6.0	6.0	
Lead/Lag							Lead			Lag	Lag	
Lead-Lag Optimize?							Yes			Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0			3.0	3.0	
Recall Mode	Max	Max		Max	Max		None			None	None	
Act Effect Green (s)		39.1			39.1		35.3	38.3		22.2	22.2	
Actuated g/C Ratio		0.45			0.45		0.41	0.44		0.26	0.26	
v/c Ratio		1.07			0.77		0.39	0.55		0.20	0.74	
Control Delay		80.3			28.9		17.8	20.3		26.8	39.4	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		80.3			28.9		17.8	20.3		26.8	39.4	
LOS		F			C		B	C		C	D	

TIP Before and After Evaluations - Belmont
 1: Concord Ave & Pleasant St

6/30/2014

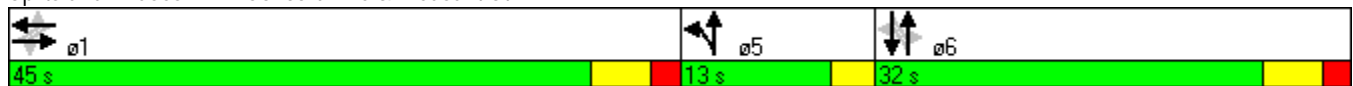


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		80.3			28.9			19.7				37.9
Approach LOS		F			C			B				D
Stops (vph)		506			399		67	262		25		250
Fuel Used(gal)		16			7		1	4		0		4
CO Emissions (g/hr)		1147			507		88	307		28		300
NOx Emissions (g/hr)		223			99		17	60		5		58
VOC Emissions (g/hr)		266			117		20	71		7		69
Dilemma Vehicles (#)		0			0		0	0		0		0
Queue Length 50th (ft)		-497			282		43	161		20		170
Queue Length 95th (ft)		#688			400		76	247		37		236
Internal Link Dist (ft)		540			466			526				443
Turn Bay Length (ft)							200			100		
Base Capacity (vph)		719			785		351	852		281		545
Starvation Cap Reductn		0			0		0	0		0		0
Spillback Cap Reductn		0			0		0	0		0		0
Storage Cap Reductn		0			0		0	0		0		0
Reduced v/c Ratio		1.07			0.77		0.39	0.50		0.17		0.63

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 86.4
 Natural Cycle: 75
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 1.07
 Intersection Signal Delay: 45.2
 Intersection LOS: D
 Intersection Capacity Utilization 85.2%
 ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Concord Ave & Pleasant St



TIP Before and After Evaluations - Canton

1: Route 138 & Randolph St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕		↗	↘		↗	↘	
Volume (vph)	45	260	240	185	295	40	85	420	75	35	735	105
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	10	12	12	10	12	12
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.941			0.990			0.977			0.981	
Flt Protected		0.996			0.983		0.950			0.950		
Satd. Flow (prot)	0	1763	0	0	1831	0	1685	1856	0	1685	1864	0
Flt Permitted		0.901			0.366		0.105			0.286		
Satd. Flow (perm)	0	1595	0	0	682	0	186	1856	0	507	1864	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		44			5			13			13	
Link Speed (mph)		25			25			40			40	
Link Distance (ft)		751			763			548			556	
Travel Time (s)		20.5			20.8			9.3			9.5	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%
Adj. Flow (vph)	51	292	270	208	331	45	96	472	84	39	826	118
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	613	0	0	584	0	96	556	0	39	944	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		5			5			2			1 2	
Permitted Phases	5			5			2			1 2		
Detector Phase	5	5		5	5		2	2		1 2	1 2	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0		20.0	20.0		20.0	20.0				
Total Split (s)	27.0	27.0		27.0	27.0		44.0	44.0				
Total Split (%)	31.0%	31.0%		31.0%	31.0%		50.6%	50.6%				
Maximum Green (s)	22.0	22.0		22.0	22.0		38.0	38.0				
Yellow Time (s)	4.0	4.0		4.0	4.0		5.0	5.0				
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0				
Lost Time Adjust (s)		0.0			0.0		0.0	0.0				
Total Lost Time (s)		5.0			5.0		6.0	6.0				
Lead/Lag	Lag	Lag		Lag	Lag		Lag	Lag				
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes				
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0				
Recall Mode	None	None		None	None		Max	Max				
Act Effct Green (s)		22.0			22.0		38.0	38.0		47.0	47.0	
Actuated g/C Ratio		0.29			0.29		0.50	0.50		0.62	0.62	
v/c Ratio		1.24			2.91		1.03	0.59		0.12	0.82	
Control Delay		151.8			887.6		130.7	16.5		7.2	18.5	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		151.8			887.6		130.7	16.5		7.2	18.5	
LOS		F			F		F	B		A	B	
Approach Delay		151.8			887.6			33.3			18.1	
Approach LOS		F			F			C			B	
Stops (vph)		407			439		58	331		15	603	
Fuel Used(gal)		22			99		3	7		0	12	

TIP Before and After Evaluations - Canton
 1: Route 138 & Randolph St

6/11/2014

Lane Group	ø1	ø3
Lane Configurations		
Volume (vph)		
Ideal Flow (vphpl)		
Lane Width (ft)		
Lane Util. Factor		
Frt		
Flt Protected		
Satd. Flow (prot)		
Flt Permitted		
Satd. Flow (perm)		
Right Turn on Red		
Satd. Flow (RTOR)		
Link Speed (mph)		
Link Distance (ft)		
Travel Time (s)		
Peak Hour Factor		
Heavy Vehicles (%)		
Adj. Flow (vph)		
Shared Lane Traffic (%)		
Lane Group Flow (vph)		
Turn Type		
Protected Phases	1	3
Permitted Phases		
Detector Phase		
Switch Phase		
Minimum Initial (s)	1.0	4.0
Minimum Split (s)	5.0	11.0
Total Split (s)	5.0	11.0
Total Split (%)	6%	13%
Maximum Green (s)	3.0	4.0
Yellow Time (s)	2.0	7.0
All-Red Time (s)	0.0	0.0
Lost Time Adjust (s)		
Total Lost Time (s)		
Lead/Lag	Lead	Lead
Lead-Lag Optimize?	Yes	Yes
Vehicle Extension (s)	3.0	3.0
Recall Mode	None	None
Act Effct Green (s)		
Actuated g/C Ratio		
v/c Ratio		
Control Delay		
Queue Delay		
Total Delay		
LOS		
Approach Delay		
Approach LOS		
Stops (vph)		
Fuel Used(gal)		

TIP Before and After Evaluations - Canton
 1: Route 138 & Randolph St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
CO Emissions (g/hr)		1533			6922		220	472		23	857	
NOx Emissions (g/hr)		298			1347		43	92		5	167	
VOC Emissions (g/hr)		355			1604		51	109		5	199	
Dilemma Vehicles (#)		0			0		0	33		0	54	
Queue Length 50th (ft)		-354			-493		-50	172		7	301	
Queue Length 95th (ft)		#541			#592		#138	263		19	474	
Internal Link Dist (ft)		671			683			468			476	
Turn Bay Length (ft)												
Base Capacity (vph)		493			201		93	935		314	1158	
Starvation Cap Reductn		0			0		0	0		0	0	
Spillback Cap Reductn		0			0		0	0		0	0	
Storage Cap Reductn		0			0		0	0		0	0	
Reduced v/c Ratio		1.24			2.91		1.03	0.59		0.12	0.82	

Intersection Summary

Area Type: Other
 Cycle Length: 87
 Actuated Cycle Length: 76
 Natural Cycle: 110
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 2.91
 Intersection Signal Delay: 229.8
 Intersection LOS: F
 Intersection Capacity Utilization 125.5%
 ICU Level of Service H
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Route 138 & Randolph St



Lane Group	ø1	ø3
CO Emissions (g/hr)		
NOx Emissions (g/hr)		
VOC Emissions (g/hr)		
Dilemma Vehicles (#)		
Queue Length 50th (ft)		
Queue Length 95th (ft)		
Internal Link Dist (ft)		
Turn Bay Length (ft)		
Base Capacity (vph)		
Starvation Cap Reductn		
Spillback Cap Reductn		
Storage Cap Reductn		
Reduced v/c Ratio		
Intersection Summary		

TIP Before and After Evaluations - Canton

1: Route 138 & Randolph St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕		↗	↘		↗	↘	
Volume (vph)	65	245	265	195	300	45	100	460	75	105	720	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	10	12	12	10	12	12
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.938			0.989			0.979			0.991	
Flt Protected		0.994			0.982		0.950			0.950		
Satd. Flow (prot)	0	1754	0	0	1827	0	1685	1860	0	1685	1883	0
Flt Permitted		0.855			0.370		0.134			0.254		
Satd. Flow (perm)	0	1509	0	0	688	0	238	1860	0	450	1883	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		47			5			12			6	
Link Speed (mph)		25			25			40			40	
Link Distance (ft)		751			763			548			556	
Travel Time (s)		20.5			20.8			9.3			9.5	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%
Adj. Flow (vph)	73	275	298	219	337	51	112	517	84	118	809	51
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	646	0	0	607	0	112	601	0	118	860	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		5			5			2			1 2	
Permitted Phases	5			5			2			1 2		
Detector Phase	5	5		5	5		2	2		1 2	1 2	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0		20.0	20.0		20.0	20.0				
Total Split (s)	27.0	27.0		27.0	27.0		44.0	44.0				
Total Split (%)	31.0%	31.0%		31.0%	31.0%		50.6%	50.6%				
Maximum Green (s)	22.0	22.0		22.0	22.0		38.0	38.0				
Yellow Time (s)	4.0	4.0		4.0	4.0		5.0	5.0				
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0				
Lost Time Adjust (s)		0.0			0.0		0.0	0.0				
Total Lost Time (s)		5.0			5.0		6.0	6.0				
Lead/Lag	Lag	Lag		Lag	Lag		Lag	Lag				
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes				
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0				
Recall Mode	None	None		None	None		Max	Max				
Act Effect Green (s)		22.0			22.0		38.0	38.0		47.0	47.0	
Actuated g/C Ratio		0.29			0.29		0.50	0.50		0.62	0.62	
v/c Ratio		1.37			2.99		0.94	0.64		0.42	0.74	
Control Delay		206.6			925.0		94.3	17.6		13.4	15.0	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		206.6			925.0		94.3	17.6		13.4	15.0	
LOS		F			F		F	B		B	B	
Approach Delay		206.6			925.0			29.7			14.8	
Approach LOS		F			F			C			B	
Stops (vph)		417			463		72	373		58	515	
Fuel Used(gal)		29			107		3	8		1	10	

TIP Before and After Evaluations - Canton
 1: Route 138 & Randolph St

6/11/2014

Lane Group	ø1	ø3
Lane Configurations		
Volume (vph)		
Ideal Flow (vphpl)		
Lane Width (ft)		
Lane Util. Factor		
Frt		
Flt Protected		
Satd. Flow (prot)		
Flt Permitted		
Satd. Flow (perm)		
Right Turn on Red		
Satd. Flow (RTOR)		
Link Speed (mph)		
Link Distance (ft)		
Travel Time (s)		
Peak Hour Factor		
Heavy Vehicles (%)		
Adj. Flow (vph)		
Shared Lane Traffic (%)		
Lane Group Flow (vph)		
Turn Type		
Protected Phases	1	3
Permitted Phases		
Detector Phase		
Switch Phase		
Minimum Initial (s)	1.0	4.0
Minimum Split (s)	5.0	11.0
Total Split (s)	5.0	11.0
Total Split (%)	6%	13%
Maximum Green (s)	3.0	4.0
Yellow Time (s)	2.0	7.0
All-Red Time (s)	0.0	0.0
Lost Time Adjust (s)		
Total Lost Time (s)		
Lead/Lag	Lead	Lead
Lead-Lag Optimize?	Yes	Yes
Vehicle Extension (s)	3.0	3.0
Recall Mode	None	None
Act Effct Green (s)		
Actuated g/C Ratio		
v/c Ratio		
Control Delay		
Queue Delay		
Total Delay		
LOS		
Approach Delay		
Approach LOS		
Stops (vph)		
Fuel Used(gal)		

TIP Before and After Evaluations - Canton
 1: Route 138 & Randolph St

6/11/2014

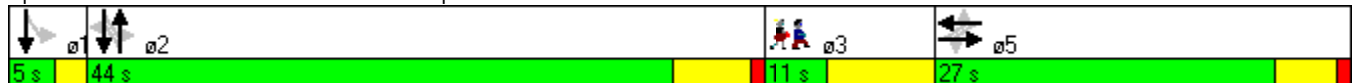


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
CO Emissions (g/hr)		2059			7478		210	530		88	718	
NOx Emissions (g/hr)		401			1455		41	103		17	140	
VOC Emissions (g/hr)		477			1733		49	123		20	166	
Dilemma Vehicles (#)		0			0		0	35		0	51	
Queue Length 50th (ft)		-398			-515		47	193		26	251	
Queue Length 95th (ft)		#589			#616		#147	295		65	387	
Internal Link Dist (ft)		671			683			468			476	
Turn Bay Length (ft)												
Base Capacity (vph)		470			203		119	936		278	1167	
Starvation Cap Reductn		0			0		0	0		0	0	
Spillback Cap Reductn		0			0		0	0		0	0	
Storage Cap Reductn		0			0		0	0		0	0	
Reduced v/c Ratio		1.37			2.99		0.94	0.64		0.42	0.74	

Intersection Summary

Area Type: Other
 Cycle Length: 87
 Actuated Cycle Length: 76
 Natural Cycle: 90
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 2.99
 Intersection Signal Delay: 248.1
 Intersection LOS: F
 Intersection Capacity Utilization 124.8%
 ICU Level of Service H
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Route 138 & Randolph St



Lane Group	ø1	ø3
CO Emissions (g/hr)		
NOx Emissions (g/hr)		
VOC Emissions (g/hr)		
Dilemma Vehicles (#)		
Queue Length 50th (ft)		
Queue Length 95th (ft)		
Internal Link Dist (ft)		
Turn Bay Length (ft)		
Base Capacity (vph)		
Starvation Cap Reductn		
Spillback Cap Reductn		
Storage Cap Reductn		
Reduced v/c Ratio		
Intersection Summary		

TIP Before and After Evaluations - Canton

1: Route 138 & Randolph St

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗	↖	↘			↕			↕	
Volume (vph)	56	267	246	190	302	82	87	641	77	41	825	108
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		175	250		0	0		0	0		0
Storage Lanes	0		1	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	0.95	0.95	0.95	0.95
Frt			0.850		0.968			0.986			0.983	
Flt Protected		0.991		0.950				0.995			0.998	
Satd. Flow (prot)	0	1864	1599	1787	1821	0	0	3507	0	0	3506	0
Flt Permitted		0.798		0.308				0.685			0.841	
Satd. Flow (perm)	0	1501	1599	579	1821	0	0	2414	0	0	2955	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			143		18			15			24	
Link Speed (mph)		25			25			40			40	
Link Distance (ft)		751			763			548			556	
Travel Time (s)		20.5			20.8			9.3			9.5	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Adj. Flow (vph)	59	281	259	200	318	86	92	675	81	43	868	114
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	340	259	200	404	0	0	848	0	0	1025	0
Turn Type	Perm	NA	Perm	pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		6		5	5 6			2			1 2	
Permitted Phases	6		6	5 6			2			1 2		
Detector Phase	6	6	6	5	5 6		2	2		1 2	1 2	
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0			4.0	4.0				
Minimum Split (s)	21.0	21.0	21.0	9.0			20.0	20.0				
Total Split (s)	29.0	29.0	29.0	9.0			43.0	43.0				
Total Split (%)	32.2%	32.2%	32.2%	10.0%			47.8%	47.8%				
Maximum Green (s)	24.0	24.0	24.0	6.0			38.0	38.0				
Yellow Time (s)	4.0	4.0	4.0	3.0			4.0	4.0				
All-Red Time (s)	1.0	1.0	1.0	0.0			1.0	1.0				
Lost Time Adjust (s)		0.0	0.0	0.0				0.0				
Total Lost Time (s)		5.0	5.0	3.0				5.0				
Lead/Lag							Lag	Lag				
Lead-Lag Optimize?							Yes	Yes				
Vehicle Extension (s)	3.0	3.0	3.0	3.0			3.0	3.0				
Recall Mode	None	None	None	None			Max	Max				
Act Effct Green (s)		23.2	23.2	31.2	34.2			38.0			49.0	
Actuated g/C Ratio		0.26	0.26	0.35	0.38			0.43			0.55	
v/c Ratio		0.87	0.50	0.71	0.57			0.82			0.63	
Control Delay		55.7	16.1	36.0	24.4			30.3			15.7	
Queue Delay		0.0	0.0	0.0	0.0			0.0			0.0	
Total Delay		55.7	16.1	36.0	24.4			30.3			15.7	
LOS		E	B	D	C			C			B	
Approach Delay		38.6			28.3			30.3			15.7	
Approach LOS		D			C			C			B	

TIP Before and After Evaluations - Canton
 1: Route 138 & Randolph St

6/11/2014

Lane Group	ø1
Lane Configurations	
Volume (vph)	
Ideal Flow (vphpl)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Peak Hour Factor	
Heavy Vehicles (%)	
Adj. Flow (vph)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	1
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	1.0
Minimum Split (s)	5.0
Total Split (s)	9.0
Total Split (%)	10%
Maximum Green (s)	6.0
Yellow Time (s)	3.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	Lead
Lead-Lag Optimize?	Yes
Vehicle Extension (s)	3.0
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	

TIP Before and After Evaluations - Canton
 1: Route 138 & Randolph St

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Stops (vph)		283	94	135	281			666				625
Fuel Used(gal)		7	3	3	5			15				13
CO Emissions (g/hr)		476	191	220	383			1015				904
NOx Emissions (g/hr)		93	37	43	75			197				176
VOC Emissions (g/hr)		110	44	51	89			235				210
Dilemma Vehicles (#)		0	0	0	0			44				54
Queue Length 50th (ft)		183	52	77	168			215				195
Queue Length 95th (ft)		#333	124	#146	260			#305				260
Internal Link Dist (ft)		671			683			468				476
Turn Bay Length (ft)			175	250								
Base Capacity (vph)		404	535	283	726			1037				1635
Starvation Cap Reductn		0	0	0	0			0				0
Spillback Cap Reductn		0	0	0	0			0				0
Storage Cap Reductn		0	0	0	0			0				0
Reduced v/c Ratio		0.84	0.48	0.71	0.56			0.82				0.63

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 89.2
 Natural Cycle: 70
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 0.87
 Intersection Signal Delay: 26.7
 Intersection LOS: C
 Intersection Capacity Utilization 103.2%
 ICU Level of Service G
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Route 138 & Randolph St



Lane Group	ø1
Stops (vph)	
Fuel Used(gal)	
CO Emissions (g/hr)	
NOx Emissions (g/hr)	
VOC Emissions (g/hr)	
Dilemma Vehicles (#)	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	
Intersection Summary	

TIP Before and After Evaluations - Canton
 1: Route 138 & Randolph St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗	↖	↘			↕			↕	
Volume (vph)	67	251	272	200	308	51	103	543	77	144	928	51
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		175	250		0	0		0	0		0
Storage Lanes	0		1	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	0.95	0.95	0.95	0.95
Frt			0.850		0.979			0.984			0.993	
Flt Protected		0.990		0.950				0.993			0.994	
Satd. Flow (prot)	0	1862	1599	1787	1842	0	0	3492	0	0	3528	0
Flt Permitted		0.804		0.326				0.581			0.615	
Satd. Flow (perm)	0	1512	1599	613	1842	0	0	2043	0	0	2183	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			111		11			17			8	
Link Speed (mph)		25			25			40			40	
Link Distance (ft)		751			763			548			556	
Travel Time (s)		20.5			20.8			9.3			9.5	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Adj. Flow (vph)	71	264	286	211	324	54	108	572	81	152	977	54
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	335	286	211	378	0	0	761	0	0	1183	0
Turn Type	Perm	NA	Perm	pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		6		5	5 6			2			1 2	
Permitted Phases	6		6	5 6			2			1 2		
Detector Phase	6	6	6	5	5 6		2	2		1 2	1 2	
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0			4.0	4.0				
Minimum Split (s)	20.0	20.0	20.0	7.0			20.0	20.0				
Total Split (s)	30.0	30.0	30.0	9.0			42.0	42.0				
Total Split (%)	33.3%	33.3%	33.3%	10.0%			46.7%	46.7%				
Maximum Green (s)	25.0	25.0	25.0	6.0			37.0	37.0				
Yellow Time (s)	4.0	4.0	4.0	3.0			4.0	4.0				
All-Red Time (s)	1.0	1.0	1.0	0.0			1.0	1.0				
Lost Time Adjust (s)		0.0	0.0	0.0				0.0				
Total Lost Time (s)		5.0	5.0	3.0				5.0				
Lead/Lag							Lag	Lag				
Lead-Lag Optimize?							Yes	Yes				
Vehicle Extension (s)	3.0	3.0	3.0	3.0			3.0	3.0				
Recall Mode	None	None	None	None			Max	Max				
Act Effct Green (s)		23.7	23.7	31.7	34.7			37.0			48.1	
Actuated g/C Ratio		0.27	0.27	0.36	0.39			0.42			0.54	
v/c Ratio		0.83	0.56	0.71	0.52			0.88			1.00	
Control Delay		49.5	21.4	35.0	23.0			37.6			47.9	
Queue Delay		0.0	0.0	0.0	0.0			0.0			0.0	
Total Delay		49.5	21.4	35.0	23.0			37.6			47.9	
LOS		D	C	C	C			D			D	
Approach Delay		36.6			27.3			37.6			47.9	
Approach LOS		D			C			D			D	

TIP Before and After Evaluations - Canton
 1: Route 138 & Randolph St

6/11/2014

Lane Group	ø1
Lane Configurations	
Volume (vph)	
Ideal Flow (vphpl)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Peak Hour Factor	
Heavy Vehicles (%)	
Adj. Flow (vph)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	1
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	7.0
Total Split (s)	9.0
Total Split (%)	10%
Maximum Green (s)	6.0
Yellow Time (s)	3.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	Lead
Lead-Lag Optimize?	Yes
Vehicle Extension (s)	3.0
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	

TIP Before and After Evaluations - Canton
 1: Route 138 & Randolph St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Stops (vph)		277	144	142	256			603			917	
Fuel Used(gal)		6	3	3	5			14			24	
CO Emissions (g/hr)		440	243	228	349			989			1692	
NOx Emissions (g/hr)		86	47	44	68			192			329	
VOC Emissions (g/hr)		102	56	53	81			229			392	
Dilemma Vehicles (#)		0	0	0	0			39			58	
Queue Length 50th (ft)		176	82	80	154			203			~347	
Queue Length 95th (ft)		#314	163	#149	237			#323			#506	
Internal Link Dist (ft)		671			683			468			476	
Turn Bay Length (ft)			175	250								
Base Capacity (vph)		426	530	298	754			862			1185	
Starvation Cap Reductn		0	0	0	0			0			0	
Spillback Cap Reductn		0	0	0	0			0			0	
Storage Cap Reductn		0	0	0	0			0			0	
Reduced v/c Ratio		0.79	0.54	0.71	0.50			0.88			1.00	

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 88.8
 Natural Cycle: 75
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 1.00
 Intersection Signal Delay: 39.3
 Intersection LOS: D
 Intersection Capacity Utilization 103.1%
 ICU Level of Service G
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Route 138 & Randolph St



Lane Group	ø1
Stops (vph)	
Fuel Used(gal)	
CO Emissions (g/hr)	
NOx Emissions (g/hr)	
VOC Emissions (g/hr)	
Dilemma Vehicles (#)	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	
Intersection Summary	

TIP Before and After Evaluations - Canton

1: Route 138 & Randolph St

7/9/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗	↖	↘			↕			↕	
Volume (vph)	20	257	166	168	370	115	141	552	91	98	645	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		175	250		0	0		0	0		0
Storage Lanes	0		1	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	0.95	0.95	0.95	0.95
Frt			0.850		0.962			0.980			0.989	
Flt Protected		0.995		0.950				0.989			0.993	
Satd. Flow (prot)	0	1835	1568	1752	1775	0	0	3181	0	0	3345	0
Flt Permitted		0.666		0.369				0.616			0.566	
Satd. Flow (perm)	0	1229	1568	681	1775	0	0	1981	0	0	1906	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			206		22			23			14	
Link Speed (mph)		25			25			40			40	
Link Distance (ft)		751			763			548			556	
Travel Time (s)		20.5			20.8			9.3			9.5	
Peak Hour Factor	0.71	0.92	0.80	0.79	0.86	0.78	0.69	0.91	0.71	0.77	0.95	0.69
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	10%	10%	10%	6%	6%	6%
Adj. Flow (vph)	28	279	208	213	430	147	204	607	128	127	679	64
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	307	208	213	577	0	0	939	0	0	870	0
Turn Type	Perm	NA	Perm	pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		6		5	5 6			2			1 2	
Permitted Phases	6		6	5 6			2			1 2		
Detector Phase	6	6	6	5	5 6		2	2		1 2	1 2	
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0			4.0	4.0				
Minimum Split (s)	21.0	21.0	21.0	9.0			20.0	20.0				
Total Split (s)	29.0	29.0	29.0	9.0			43.0	43.0				
Total Split (%)	32.2%	32.2%	32.2%	10.0%			47.8%	47.8%				
Maximum Green (s)	24.0	24.0	24.0	5.0			36.0	36.0				
Yellow Time (s)	4.0	4.0	4.0	4.0			4.0	4.0				
All-Red Time (s)	1.0	1.0	1.0	0.0			3.0	3.0				
Lost Time Adjust (s)		0.0	0.0	0.0				0.0				
Total Lost Time (s)		5.0	5.0	4.0				7.0				
Lead/Lag							Lag	Lag				
Lead-Lag Optimize?							Yes	Yes				
Vehicle Extension (s)	3.0	3.0	3.0	3.0			3.0	3.0				
Recall Mode	None	None	None	None			Max	Max				
Act Effct Green (s)		24.0	24.0	30.0	34.0			36.0			48.0	
Actuated g/C Ratio		0.27	0.27	0.33	0.38			0.40			0.53	
v/c Ratio		0.94	0.37	0.74	0.84			1.17			0.85	
Control Delay		70.4	6.1	40.5	37.9			114.6			27.7	
Queue Delay		0.0	0.0	0.0	0.0			0.0			0.0	
Total Delay		70.4	6.1	40.5	37.9			114.6			27.7	
LOS		E	A	D	D			F			C	
Approach Delay		44.4			38.6			114.6			27.7	
Approach LOS		D			D			F			C	

TIP Before and After Evaluations - Canton
 1: Route 138 & Randolph St

7/9/2014

Lane Group	ø1
Lane Configurations	
Volume (vph)	
Ideal Flow (vphpl)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Peak Hour Factor	
Heavy Vehicles (%)	
Adj. Flow (vph)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	1
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	1.0
Minimum Split (s)	5.0
Total Split (s)	9.0
Total Split (%)	10%
Maximum Green (s)	5.0
Yellow Time (s)	4.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	Lead
Lead-Lag Optimize?	Yes
Vehicle Extension (s)	3.0
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	

TIP Before and After Evaluations - Canton

1: Route 138 & Randolph St

7/9/2014

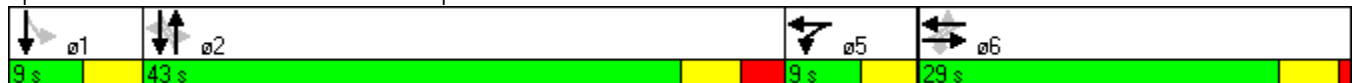


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Stops (vph)		234	22	132	401			632			622	
Fuel Used(gal)		7	1	3	8			27			14	
CO Emissions (g/hr)		464	95	209	589			1917			944	
NOx Emissions (g/hr)		90	18	41	115			373			184	
VOC Emissions (g/hr)		108	22	48	136			444			219	
Dilemma Vehicles (#)		0	0	0	0			36			43	
Queue Length 50th (ft)		170	1	84	285			~334			206	
Queue Length 95th (ft)		#330	35	#121	#433			#458			#342	
Internal Link Dist (ft)		671			683			468			476	
Turn Bay Length (ft)			175	250								
Base Capacity (vph)		328	569	287	684			806			1023	
Starvation Cap Reductn		0	0	0	0			0			0	
Spillback Cap Reductn		0	0	0	0			0			0	
Storage Cap Reductn		0	0	0	0			0			0	
Reduced v/c Ratio		0.94	0.37	0.74	0.84			1.17			0.85	

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Natural Cycle: 110
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 1.17
 Intersection Signal Delay: 59.4
 Intersection LOS: E
 Intersection Capacity Utilization 102.1%
 ICU Level of Service G
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Route 138 & Randolph St



Lane Group	ø1
Stops (vph)	
Fuel Used(gal)	
CO Emissions (g/hr)	
NOx Emissions (g/hr)	
VOC Emissions (g/hr)	
Dilemma Vehicles (#)	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	
Intersection Summary	

TIP Before and After Evaluations - Canton
 1: Route 138 & Randolph St

7/9/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗	↖	↘			↕			↕	
Volume (vph)	14	400	57	123	298	102	142	619	195	384	639	14
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		175	250		0	0		0	0		0
Storage Lanes	0		1	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	0.95	0.95	0.95	0.95
Frt			0.850		0.963			0.967			0.995	
Flt Protected		0.997		0.950				0.992			0.982	
Satd. Flow (prot)	0	1857	1583	1770	1794	0	0	3395	0	0	3425	0
Flt Permitted		0.951		0.162				0.560			0.531	
Satd. Flow (perm)	0	1771	1583	302	1794	0	0	1917	0	0	1852	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			66		22			48			6	
Link Speed (mph)		25			25			40			40	
Link Distance (ft)		751			763			548			556	
Travel Time (s)		20.5			20.8			9.3			9.5	
Peak Hour Factor	0.50	0.94	0.84	0.96	0.85	0.88	0.76	0.93	0.80	0.97	0.95	0.39
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%
Adj. Flow (vph)	28	426	68	128	351	116	187	666	244	396	673	36
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	454	68	128	467	0	0	1097	0	0	1105	0
Turn Type	Perm	NA	Perm	pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		6		5	5 6			2			1 2	
Permitted Phases	6		6	5 6			2			1 2		
Detector Phase	6	6	6	5	5 6		2	2		1 2	1 2	
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0			4.0	4.0				
Minimum Split (s)	20.0	20.0	20.0	8.0			20.0	20.0				
Total Split (s)	30.0	30.0	30.0	9.0			42.0	42.0				
Total Split (%)	33.3%	33.3%	33.3%	10.0%			46.7%	46.7%				
Maximum Green (s)	25.0	25.0	25.0	5.0			35.0	35.0				
Yellow Time (s)	4.0	4.0	4.0	4.0			4.0	4.0				
All-Red Time (s)	1.0	1.0	1.0	0.0			3.0	3.0				
Lost Time Adjust (s)		0.0	0.0	0.0				0.0				
Total Lost Time (s)		5.0	5.0	4.0				7.0				
Lead/Lag							Lag	Lag				
Lead-Lag Optimize?							Yes	Yes				
Vehicle Extension (s)	3.0	3.0	3.0	3.0			3.0	3.0				
Recall Mode	None	None	None	None			Max	Max				
Act Effct Green (s)		25.0	25.0	31.0	35.0			35.0			47.0	
Actuated g/C Ratio		0.28	0.28	0.34	0.39			0.39			0.52	
v/c Ratio		0.92	0.14	0.69	0.66			1.42			4.21dl	
Control Delay		58.6	7.8	40.6	26.8			219.9			98.6	
Queue Delay		0.0	0.0	0.0	0.0			0.0			0.0	
Total Delay		58.6	7.8	40.6	26.8			219.9			98.6	
LOS		E	A	D	C			F			F	
Approach Delay		52.0			29.7			219.9			98.6	
Approach LOS		D			C			F			F	

TIP Before and After Evaluations - Canton
 1: Route 138 & Randolph St

7/9/2014

Lane Group	ø1
Lane Configurations	
Volume (vph)	
Ideal Flow (vphpl)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Peak Hour Factor	
Heavy Vehicles (%)	
Adj. Flow (vph)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	1
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	8.0
Total Split (s)	9.0
Total Split (%)	10%
Maximum Green (s)	5.0
Yellow Time (s)	4.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	Lead
Lead-Lag Optimize?	Yes
Vehicle Extension (s)	3.0
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	

TIP Before and After Evaluations - Canton
 1: Route 138 & Randolph St

7/9/2014

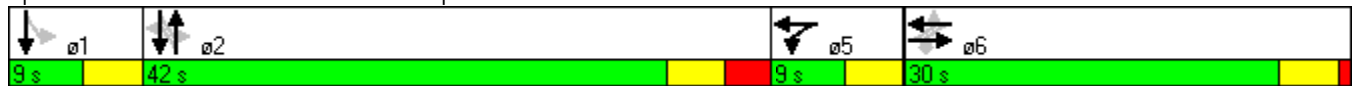


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Stops (vph)		357	12	79	307			710			844	
Fuel Used(gal)		9	1	2	6			53			33	
CO Emissions (g/hr)		626	35	148	416			3731			2310	
NOx Emissions (g/hr)		122	7	29	81			726			449	
VOC Emissions (g/hr)		145	8	34	97			865			535	
Dilemma Vehicles (#)		0	0	0	0			38			49	
Queue Length 50th (ft)		250	1	47	204			~441			~391	
Queue Length 95th (ft)		#433	27	#99	285			#570			#520	
Internal Link Dist (ft)		671			683			468			476	
Turn Bay Length (ft)			175	250								
Base Capacity (vph)		492	487	186	711			775			970	
Starvation Cap Reductn		0	0	0	0			0			0	
Spillback Cap Reductn		0	0	0	0			0			0	
Storage Cap Reductn		0	0	0	0			0			0	
Reduced v/c Ratio		0.92	0.14	0.69	0.66			1.42			1.14	

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Natural Cycle: 90
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 1.42
 Intersection Signal Delay: 119.0
 Intersection LOS: F
 Intersection Capacity Utilization 117.1%
 ICU Level of Service H
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Splits and Phases: 1: Route 138 & Randolph St



Lane Group	ø1
Stops (vph)	
Fuel Used(gal)	
CO Emissions (g/hr)	
NOx Emissions (g/hr)	
VOC Emissions (g/hr)	
Dilemma Vehicles (#)	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	
Intersection Summary	

TIP Before and After Evaluations - Canton
 1: Route 138 & Washington St

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	↕
Volume (vph)	695	15	10	1	1	10	10	780	1	1	875	305
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	15	12	12	12	12	12	15	12	12	15	15
Storage Length (ft)	0		0	0		0	0		0	0		225
Storage Lanes	0		0	0		0	0		0	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.998			0.887							0.850
Flt Protected		0.954			0.996			0.999				
Satd. Flow (prot)	0	1932	0	0	1679	0	0	1970	0	0	2029	1725
Flt Permitted		0.725			0.967			0.632				
Satd. Flow (perm)	0	1468	0	0	1630	0	0	1246	0	0	2029	1725
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1			10							
Link Speed (mph)		25			20			40				40
Link Distance (ft)		661			278			568				606
Travel Time (s)		18.0			9.5			9.7				10.3
Peak Hour Factor	0.97	0.92	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Heavy Vehicles (%)	3%	3%	3%	0%	0%	0%	6%	6%	6%	3%	3%	3%
Adj. Flow (vph)	716	16	10	1	1	10	10	804	1	1	902	314
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	742	0	0	12	0	0	815	0	0	903	314
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	custom
Protected Phases		5			5			1				1
Permitted Phases	5			5			1			1		15
Detector Phase	5	5		5	5		1	1		1	1	15
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Minimum Split (s)	21.0	21.0		21.0	21.0		21.0	21.0		21.0	21.0	
Total Split (s)	35.0	35.0		35.0	35.0		42.0	42.0		42.0	42.0	
Total Split (%)	45.5%	45.5%		45.5%	45.5%		54.5%	54.5%		54.5%	54.5%	
Maximum Green (s)	30.0	30.0		30.0	30.0		37.0	37.0		37.0	37.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)		0.0			0.0			0.0			0.0	
Total Lost Time (s)		5.0			5.0			5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Act Effct Green (s)		30.0			30.0			37.0			37.0	77.0
Actuated g/C Ratio		0.39			0.39			0.48			0.48	1.00
v/c Ratio		1.29			0.02			1.36			0.93	0.18
Control Delay		170.2			9.0			195.5			36.3	0.2
Queue Delay		0.0			0.0			0.0			0.0	0.0
Total Delay		170.2			9.0			195.5			36.3	0.2
LOS		F			A			F			D	A
Approach Delay		170.2			9.0			195.5			27.0	

TIP Before and After Evaluations - Canton
 1: Route 138 & Washington St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		F			A			F			C	
Stops (vph)		565			6			610			721	0
Fuel Used(gal)		31			0			41			17	1
CO Emissions (g/hr)		2176			5			2833			1199	89
NOx Emissions (g/hr)		423			1			551			233	17
VOC Emissions (g/hr)		504			1			657			278	21
Dilemma Vehicles (#)		0			0			37			54	0
Queue Length 50th (ft)		-467			1			-523			385	0
Queue Length 95th (ft)		#676			11			#733			#639	0
Internal Link Dist (ft)		581			198			488			526	
Turn Bay Length (ft)												225
Base Capacity (vph)		573			641			599			975	1725
Starvation Cap Reductn		0			0			0			0	0
Spillback Cap Reductn		0			0			0			0	0
Storage Cap Reductn		0			0			0			0	0
Reduced v/c Ratio		1.29			0.02			1.36			0.93	0.18

Intersection Summary

Area Type: Other
 Cycle Length: 77
 Actuated Cycle Length: 77
 Natural Cycle: 140
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 1.36
 Intersection Signal Delay: 114.4
 Intersection LOS: F
 Intersection Capacity Utilization 104.0%
 ICU Level of Service G
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Route 138 & Washington St



TIP Before and After Evaluations - Canton
 1: Route 138 & Washington St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	↕
Volume (vph)	485	10	15	10	25	5	35	795	5	5	795	510
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	15	12	12	12	12	12	15	12	12	15	15
Storage Length (ft)	0		0	0		0	0		0	0		225
Storage Lanes	0		0	0		0	0		0	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.996			0.982			0.999				0.850
Flt Protected		0.955			0.988			0.998				
Satd. Flow (prot)	0	1968	0	0	1843	0	0	2043	0	0	2049	1742
Flt Permitted		0.704			0.879			0.380			0.994	
Satd. Flow (perm)	0	1451	0	0	1640	0	0	778	0	0	2037	1742
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2			6			1				
Link Speed (mph)		25			20			40				40
Link Distance (ft)		661			278			568				606
Travel Time (s)		18.0			9.5			9.7				10.3
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Heavy Vehicles (%)	1%	1%	1%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Adj. Flow (vph)	545	11	17	11	28	6	39	893	6	6	893	573
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	573	0	0	45	0	0	938	0	0	899	573
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	custom
Protected Phases		5			5			1				1
Permitted Phases	5			5			1			1		15
Detector Phase	5	5		5	5		1	1		1	1	15
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Minimum Split (s)	21.0	21.0		21.0	21.0		21.0	21.0		21.0	21.0	
Total Split (s)	35.0	35.0		35.0	35.0		42.0	42.0		42.0	42.0	
Total Split (%)	45.5%	45.5%		45.5%	45.5%		54.5%	54.5%		54.5%	54.5%	
Maximum Green (s)	30.0	30.0		30.0	30.0		37.0	37.0		37.0	37.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)		0.0			0.0			0.0			0.0	
Total Lost Time (s)		5.0			5.0			5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Act Effct Green (s)		30.0			30.0			37.0			37.0	77.0
Actuated g/C Ratio		0.39			0.39			0.48			0.48	1.00
v/c Ratio		1.01			0.07			2.51			0.92	0.33
Control Delay		66.7			13.7			704.1			35.1	0.5
Queue Delay		0.0			0.0			0.0			0.0	0.0
Total Delay		66.7			13.7			704.1			35.1	0.5
LOS		E			B			F			D	A
Approach Delay		66.7			13.7			704.1			21.6	

TIP Before and After Evaluations - Canton
 1: Route 138 & Washington St

6/11/2014

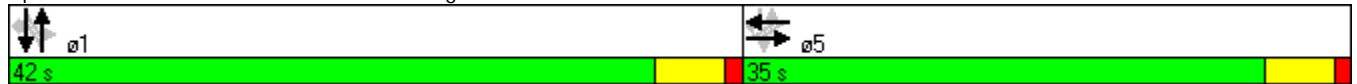


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		E			B			F			C	
Stops (vph)		421			23			649			659	0
Fuel Used(gal)		11			0			129			15	2
CO Emissions (g/hr)		798			19			9037			1082	150
NOx Emissions (g/hr)		155			4			1758			211	29
VOC Emissions (g/hr)		185			4			2094			251	35
Dilemma Vehicles (#)		0			0			21			49	0
Queue Length 50th (ft)		-274			11			-598			380	0
Queue Length 95th (ft)		#477			31			#810			#620	0
Internal Link Dist (ft)		581			198			488			526	
Turn Bay Length (ft)												225
Base Capacity (vph)		567			643			374			979	1742
Starvation Cap Reductn		0			0			0			0	0
Spillback Cap Reductn		0			0			0			0	0
Storage Cap Reductn		0			0			0			0	0
Reduced v/c Ratio		1.01			0.07			2.51			0.92	0.33

Intersection Summary

Area Type: Other
 Cycle Length: 77
 Actuated Cycle Length: 77
 Natural Cycle: 150
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 2.51
 Intersection Signal Delay: 241.5
 Intersection LOS: F
 Intersection Capacity Utilization 113.9%
 ICU Level of Service H
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Route 138 & Washington St



TIP Before and After Evaluations - Canton
 1: Route 138 & Washington St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	830	0	10	1	1	10	10	1061	0	0	974	333
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	15	12	12	12	12	12	12	12
Storage Length (ft)	0		125	0		0	0		0	0		250
Storage Lanes	1		1	0		0	0		0	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	1.00	0.95	0.95	1.00	1.00	0.95	1.00
Frt		0.996			0.886							0.850
Flt Protected	0.950	0.954			0.996							
Satd. Flow (prot)	1698	1698	0	0	1844	0	0	3539	0	0	3539	1583
Flt Permitted	0.950	0.954			0.996			0.943				
Satd. Flow (perm)	1698	1698	0	0	1844	0	0	3337	0	0	3539	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2			11							322
Link Speed (mph)		25			20			40				40
Link Distance (ft)		661			278			568				606
Travel Time (s)		18.0			9.5			9.7				10.3
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	1%	1%	1%	0%	0%	0%	2%	2%	0%	0%	2%	2%
Adj. Flow (vph)	874	0	11	1	1	11	11	1117	0	0	1025	351
Shared Lane Traffic (%)	49%											
Lane Group Flow (vph)	446	439	0	0	13	0	0	1128	0	0	1025	351
Turn Type	Split	NA		Split	NA		Perm	NA			NA	Free
Protected Phases	5	5		6	6			1			1	
Permitted Phases							1					Free
Detector Phase	5	5		6	6		1	1			1	
Switch Phase												
Minimum Initial (s)	4.0	4.0		2.0	2.0		4.0	4.0			4.0	
Minimum Split (s)	21.0	21.0		7.0	7.0		21.0	21.0			21.0	
Total Split (s)	27.0	27.0		11.0	11.0		42.0	42.0			42.0	
Total Split (%)	33.8%	33.8%		13.8%	13.8%		52.5%	52.5%			52.5%	
Maximum Green (s)	22.0	22.0		6.0	6.0		37.0	37.0			37.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0			1.0	
Lost Time Adjust (s)	0.0	0.0			0.0			0.0			0.0	
Total Lost Time (s)	5.0	5.0			5.0			5.0			5.0	
Lead/Lag	Lead	Lead		Lag	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Recall Mode	None	None		None	None		Max	Max			Max	
Act Effct Green (s)	21.9	21.9			5.7			37.1			37.1	71.0
Actuated g/C Ratio	0.31	0.31			0.08			0.52			0.52	1.00
v/c Ratio	0.85	0.84			0.08			0.65			0.55	0.22
Control Delay	41.9	40.2			20.9			15.1			13.4	0.3
Queue Delay	0.0	0.0			0.0			0.0			0.0	0.0
Total Delay	41.9	40.2			20.9			15.1			13.4	0.3
LOS	D	D			C			B			B	A
Approach Delay		41.1			20.9			15.1			10.1	

TIP Before and After Evaluations - Canton
 1: Route 138 & Washington St

6/11/2014

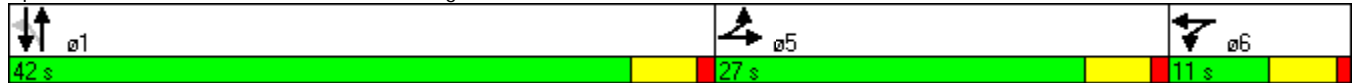


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		D			C			B			B	
Stops (vph)	348	340			8			733			618	0
Fuel Used(gal)	7	7			0			15			13	1
CO Emissions (g/hr)	513	494			7			1022			891	97
NOx Emissions (g/hr)	100	96			1			199			173	19
VOC Emissions (g/hr)	119	114			2			237			206	23
Dilemma Vehicles (#)	0	0			0			75			68	0
Queue Length 50th (ft)	181	176			1			162			137	0
Queue Length 95th (ft)	#420	#412			18			306			257	0
Internal Link Dist (ft)		581			198			488			526	
Turn Bay Length (ft)												250
Base Capacity (vph)	528	530			166			1745			1851	1583
Starvation Cap Reductn	0	0			0			0			0	0
Spillback Cap Reductn	0	0			0			0			0	0
Storage Cap Reductn	0	0			0			0			0	0
Reduced v/c Ratio	0.84	0.83			0.08			0.65			0.55	0.22

Intersection Summary

Area Type: Other
 Cycle Length: 80
 Actuated Cycle Length: 71
 Natural Cycle: 60
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 0.85
 Intersection Signal Delay: 19.8
 Intersection LOS: B
 Intersection Capacity Utilization 74.6%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Route 138 & Washington St



TIP Before and After Evaluations - Canton

1: Route 138 & Washington St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	538	0	15	10	26	5	36	892	0	0	1046	615
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	15	12	12	12	12	12	12	12
Storage Length (ft)	0		125	0		0	0		0	0		250
Storage Lanes	1		1	0		0	0		0	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	1.00	0.95	0.95	1.00	1.00	0.95	1.00
Frt		0.992			0.982							0.850
Flt Protected	0.950	0.955			0.988			0.998				
Satd. Flow (prot)	1698	1693	0	0	2028	0	0	3532	0	0	3539	1583
Flt Permitted	0.950	0.955			0.988			0.850				
Satd. Flow (perm)	1698	1693	0	0	2028	0	0	3008	0	0	3539	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		4			6							553
Link Speed (mph)		25			20			40				40
Link Distance (ft)		661			278			568				606
Travel Time (s)		18.0			9.5			9.7				10.3
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Heavy Vehicles (%)	1%	1%	1%	0%	0%	0%	2%	2%	2%	2%	2%	2%
Adj. Flow (vph)	604	0	17	11	29	6	40	1002	0	0	1175	691
Shared Lane Traffic (%)	48%											
Lane Group Flow (vph)	314	307	0	0	46	0	0	1042	0	0	1175	691
Turn Type	Split	NA		Split	NA		Perm	NA			NA	Free
Protected Phases	5	5		6	6			1			1	
Permitted Phases							1					Free
Detector Phase	5	5		6	6		1	1			1	
Switch Phase												
Minimum Initial (s)	4.0	4.0		2.0	2.0		4.0	4.0			4.0	
Minimum Split (s)	21.0	21.0		7.0	7.0		21.0	21.0			21.0	
Total Split (s)	27.0	27.0		11.0	11.0		42.0	42.0			42.0	
Total Split (%)	33.8%	33.8%		13.8%	13.8%		52.5%	52.5%			52.5%	
Maximum Green (s)	22.0	22.0		6.0	6.0		37.0	37.0			37.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0			1.0	
Lost Time Adjust (s)	0.0	0.0			0.0			0.0			0.0	
Total Lost Time (s)	5.0	5.0			5.0			5.0			5.0	
Lead/Lag	Lead	Lead		Lag	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Recall Mode	None	None		None	None		Max	Max			Max	
Act Effct Green (s)	17.9	17.9			6.0			37.8			37.8	71.8
Actuated g/C Ratio	0.25	0.25			0.08			0.53			0.53	1.00
v/c Ratio	0.74	0.72			0.26			0.66			0.63	0.44
Control Delay	37.0	35.6			35.0			17.1			16.1	0.9
Queue Delay	0.0	0.0			0.0			0.0			0.0	0.0
Total Delay	37.0	35.6			35.0			17.1			16.1	0.9
LOS	D	D			D			B			B	A
Approach Delay		36.3			35.0			17.1			10.5	

TIP Before and After Evaluations - Canton
 1: Route 138 & Washington St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		D			D			B			B	
Stops (vph)	242	233			35			654			716	0
Fuel Used(gal)	5	4			0			13			15	3
CO Emissions (g/hr)	322	308			34			925			1032	184
NOx Emissions (g/hr)	63	60			7			180			201	36
VOC Emissions (g/hr)	75	71			8			214			239	43
Dilemma Vehicles (#)	0	0			0			64			73	0
Queue Length 50th (ft)	146	140			19			211			233	0
Queue Length 95th (ft)	235	227			51			287			306	0
Internal Link Dist (ft)		581			198			488			526	
Turn Bay Length (ft)												250
Base Capacity (vph)	531	532			178			1582			1861	1583
Starvation Cap Reductn	0	0			0			0			0	0
Spillback Cap Reductn	0	0			0			0			0	0
Storage Cap Reductn	0	0			0			0			0	0
Reduced v/c Ratio	0.59	0.58			0.26			0.66			0.63	0.44

Intersection Summary

Area Type:	Other
Cycle Length:	80
Actuated Cycle Length:	71.8
Natural Cycle:	60
Control Type:	Semi Act-Uncoord
Maximum v/c Ratio:	0.74
Intersection Signal Delay:	17.2
Intersection LOS:	B
Intersection Capacity Utilization:	81.4%
ICU Level of Service:	D
Analysis Period (min):	15

Splits and Phases: 1: Route 138 & Washington St



TIP Before and After Evaluations - Canton
 1: Route 138 & Washington St

7/9/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	624	0	10	3	0	8	8	1047	0	0	892	316
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	15	12	12	12	12	12	12	12
Storage Length (ft)	0		125	0		0	0		0	0		250
Storage Lanes	1		1	0		0	0		0	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	1.00	0.95	0.95	1.00	1.00	0.95	1.00
Frt		0.993			0.910							0.850
Flt Protected	0.950	0.954			0.984			0.999				
Satd. Flow (prot)	1665	1660	0	0	1717	0	0	3370	0	0	3406	1524
Flt Permitted	0.950	0.954			0.984			0.928				
Satd. Flow (perm)	1665	1660	0	0	1717	0	0	3131	0	0	3406	1524
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		3			16							340
Link Speed (mph)		25			20			40				40
Link Distance (ft)		661			278			568				606
Travel Time (s)		18.0			9.5			9.7				10.3
Peak Hour Factor	0.90	0.92	0.63	0.38	0.92	0.50	0.40	0.90	0.92	0.92	0.93	0.91
Heavy Vehicles (%)	3%	0%	3%	9%	9%	9%	7%	7%	0%	0%	6%	6%
Adj. Flow (vph)	693	0	16	8	0	16	20	1163	0	0	959	347
Shared Lane Traffic (%)	49%											
Lane Group Flow (vph)	353	356	0	0	24	0	0	1183	0	0	959	347
Turn Type	Split	NA		Split	NA		Perm	NA			NA	Free
Protected Phases	5	5		6	6			1			1	
Permitted Phases							1					Free
Detector Phase	5	5		6	6		1	1			1	
Switch Phase												
Minimum Initial (s)	4.0	4.0		2.0	2.0		4.0	4.0			4.0	
Minimum Split (s)	21.0	21.0		8.0	8.0		21.0	21.0			21.0	
Total Split (s)	27.0	27.0		11.0	11.0		42.0	42.0			42.0	
Total Split (%)	33.8%	33.8%		13.8%	13.8%		52.5%	52.5%			52.5%	
Maximum Green (s)	21.0	21.0		5.0	5.0		36.0	36.0			36.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lost Time Adjust (s)	0.0	0.0			0.0			0.0			0.0	
Total Lost Time (s)	6.0	6.0			6.0			6.0			6.0	
Lead/Lag	Lead	Lead		Lag	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Recall Mode	None	None		None	None		Max	Max			Max	
Act Effct Green (s)	18.8	18.8			5.1			36.4			36.4	71.3
Actuated g/C Ratio	0.26	0.26			0.07			0.51			0.51	1.00
v/c Ratio	0.80	0.81			0.18			0.74			0.55	0.23
Control Delay	41.1	41.4			24.5			19.2			14.8	0.3
Queue Delay	0.0	0.0			0.0			0.0			0.0	0.0
Total Delay	41.1	41.4			24.5			19.2			14.8	0.3
LOS	D	D			C			B			B	A
Approach Delay		41.3			24.5			19.2			11.0	

TIP Before and After Evaluations - Canton
 1: Route 138 & Washington St

7/9/2014

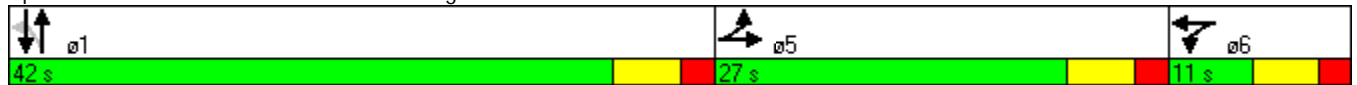


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		D			C			B			B	
Stops (vph)	268	264			7			780			581	0
Fuel Used(gal)	5	5			0			16			12	1
CO Emissions (g/hr)	383	381			7			1108			844	92
NOx Emissions (g/hr)	75	74			1			216			164	18
VOC Emissions (g/hr)	89	88			2			257			196	21
Dilemma Vehicles (#)	0	0			0			73			62	0
Queue Length 50th (ft)	137	137			3			187			132	0
Queue Length 95th (ft)	#317	#322			27			355			247	0
Internal Link Dist (ft)		581			198			488			526	
Turn Bay Length (ft)												250
Base Capacity (vph)	496	497			136			1599			1739	1524
Starvation Cap Reductn	0	0			0			0			0	0
Spillback Cap Reductn	0	0			0			0			0	0
Storage Cap Reductn	0	0			0			0			0	0
Reduced v/c Ratio	0.71	0.72			0.18			0.74			0.55	0.23

Intersection Summary

Area Type: Other
 Cycle Length: 80
 Actuated Cycle Length: 71.3
 Natural Cycle: 60
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 0.81
 Intersection Signal Delay: 20.8
 Intersection LOS: C
 Intersection Capacity Utilization 68.8%
 ICU Level of Service C
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Route 138 & Washington St



TIP Before and After Evaluations - Canton

1: Route 138 & Washington St

7/9/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	379	0	43	6	8	24	21	810	0	0	1201	600
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	15	12	12	12	12	12	12	12
Storage Length (ft)	0		125	0		0	0		0	0		250
Storage Lanes	1		1	0		0	0		0	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	1.00	0.95	0.95	1.00	1.00	0.95	1.00
Frt		0.965			0.929							0.850
Flt Protected	0.950	0.963			0.988			0.999				
Satd. Flow (prot)	1681	1644	0	0	1862	0	0	3536	0	0	3505	1568
Flt Permitted	0.950	0.963			0.988			0.895				
Satd. Flow (perm)	1681	1644	0	0	1862	0	0	3168	0	0	3505	1568
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		18			36							480
Link Speed (mph)		25			20			40				40
Link Distance (ft)		661			278			568				606
Travel Time (s)		18.0			9.5			9.7				10.3
Peak Hour Factor	0.94	0.92	0.83	0.38	0.50	0.67	0.88	0.93	0.92	0.92	0.98	0.96
Heavy Vehicles (%)	2%	0%	2%	3%	3%	3%	2%	2%	0%	0%	3%	3%
Adj. Flow (vph)	403	0	52	16	16	36	24	871	0	0	1226	625
Shared Lane Traffic (%)	43%											
Lane Group Flow (vph)	230	225	0	0	68	0	0	895	0	0	1226	625
Turn Type	Split	NA		Split	NA		Perm	NA			NA	Free
Protected Phases	5	5		6	6			1			1	
Permitted Phases							1					Free
Detector Phase	5	5		6	6		1	1			1	
Switch Phase												
Minimum Initial (s)	4.0	4.0		2.0	2.0		4.0	4.0			4.0	
Minimum Split (s)	21.0	21.0		8.0	8.0		21.0	21.0			21.0	
Total Split (s)	27.0	27.0		11.0	11.0		42.0	42.0			42.0	
Total Split (%)	33.8%	33.8%		13.8%	13.8%		52.5%	52.5%			52.5%	
Maximum Green (s)	21.0	21.0		5.0	5.0		36.0	36.0			36.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lost Time Adjust (s)	0.0	0.0			0.0			0.0			0.0	
Total Lost Time (s)	6.0	6.0			6.0			6.0			6.0	
Lead/Lag	Lead	Lead		Lag	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Recall Mode	None	None		None	None		Max	Max			Max	
Act Effct Green (s)	15.2	15.2			5.1			36.6			36.6	72.3
Actuated g/C Ratio	0.21	0.21			0.07			0.51			0.51	1.00
v/c Ratio	0.65	0.63			0.41			0.56			0.69	0.40
Control Delay	35.8	32.4			28.3			15.7			17.9	0.8
Queue Delay	0.0	0.0			0.0			0.0			0.0	0.0
Total Delay	35.8	32.4			28.3			15.7			17.9	0.8
LOS	D	C			C			B			B	A
Approach Delay		34.1			28.3			15.7			12.1	

TIP Before and After Evaluations - Canton
 1: Route 138 & Washington St

7/9/2014

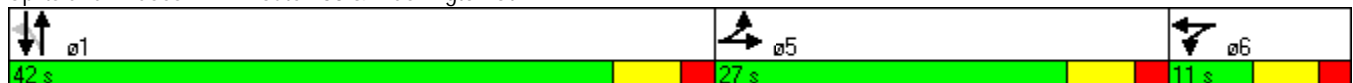


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		C			C			B			B	
Stops (vph)	185	162			21			552			882	0
Fuel Used(gal)	3	3			0			11			18	3
CO Emissions (g/hr)	245	220			26			788			1257	179
NOx Emissions (g/hr)	48	43			5			153			245	35
VOC Emissions (g/hr)	57	51			6			183			291	41
Dilemma Vehicles (#)	0	0			0			57			83	0
Queue Length 50th (ft)	103	92			15			151			228	0
Queue Length 95th (ft)	175	164			22			235			344	0
Internal Link Dist (ft)		581			198			488			526	
Turn Bay Length (ft)												250
Base Capacity (vph)	496	498			164			1603			1773	1568
Starvation Cap Reductn	0	0			0			0			0	0
Spillback Cap Reductn	0	0			0			0			0	0
Storage Cap Reductn	0	0			0			0			0	0
Reduced v/c Ratio	0.46	0.45			0.41			0.56			0.69	0.40

Intersection Summary

Area Type:	Other
Cycle Length:	80
Actuated Cycle Length:	72.3
Natural Cycle:	60
Control Type:	Semi Act-Uncoord
Maximum v/c Ratio:	0.69
Intersection Signal Delay:	16.5
Intersection LOS:	B
Intersection Capacity Utilization:	65.9%
ICU Level of Service:	C
Analysis Period (min):	15

Splits and Phases: 1: Route 138 & Washington St



TIP Before and After Evaluations - Franklin

1: Union St & King St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	219	522	37	13	552	21	126	29	21	44	17	305
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	14	12	10	12	12	10	11	12	12	11	11
Storage Length (ft)	300		0	250		0	175		0	0		275
Storage Lanes	1		0	1		0	1		0	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.990			0.995			0.937				0.850
Flt Protected	0.950			0.950			0.950				0.965	
Satd. Flow (prot)	1752	1923	0	1604	1837	0	1636	1721	0	0	1710	1546
Flt Permitted	0.950			0.950			0.445				0.749	
Satd. Flow (perm)	1752	1923	0	1604	1837	0	766	1721	0	0	1327	1546
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		4			2			24				157
Link Speed (mph)		40			40			30				30
Link Distance (ft)		642			804			617				675
Travel Time (s)		10.9			13.7			14.0				15.3
Peak Hour Factor	0.81	0.81	0.81	0.95	0.95	0.95	0.89	0.89	0.89	0.98	0.98	0.98
Heavy Vehicles (%)	3%	4%	9%	5%	3%	0%	3%	0%	0%	5%	0%	1%
Adj. Flow (vph)	270	644	46	14	581	22	142	33	24	45	17	311
Shared Lane Traffic (%)												
Lane Group Flow (vph)	270	690	0	14	603	0	142	57	0	0	62	311
Turn Type	Prot	NA		Prot	NA		pm+pt	NA		Perm	NA	pm+ov
Protected Phases	5	2		1	6		3	8			4	5
Permitted Phases							8			4		4
Detector Phase	5	2		1	6		3	8		4	4	5
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	10.0		9.0	10.0		9.0	9.0		9.0	9.0	9.0
Total Split (s)	35.0	55.0		20.0	40.0		15.0	35.0		20.0	20.0	35.0
Total Split (%)	31.8%	50.0%		18.2%	36.4%		13.6%	31.8%		18.2%	18.2%	31.8%
Maximum Green (s)	30.0	49.0		15.0	34.0		10.0	30.0		15.0	15.0	30.0
Yellow Time (s)	4.0	5.0		4.0	5.0		4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0		5.0	6.0		5.0	5.0		5.0	5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag		Lead			Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes			Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	3.0
Recall Mode	None	Min		None	Min		None	None		None	None	None
Act Effct Green (s)	19.5	57.3		6.5	34.9		21.6	21.6			9.8	31.5
Actuated g/C Ratio	0.21	0.62		0.07	0.38		0.23	0.23			0.11	0.34
v/c Ratio	0.73	0.58		0.12	0.87		0.53	0.14			0.44	0.49
Control Delay	46.9	15.3		47.8	44.9		37.6	19.6			52.1	13.0
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0			0.0	0.0
Total Delay	46.9	15.3		47.8	44.9		37.6	19.6			52.1	13.0
LOS	D	B		D	D		D	B			D	B
Approach Delay		24.2			44.9			32.4			19.5	

TIP Before and After Evaluations - Franklin
 1: Union St & King St

6/11/2014

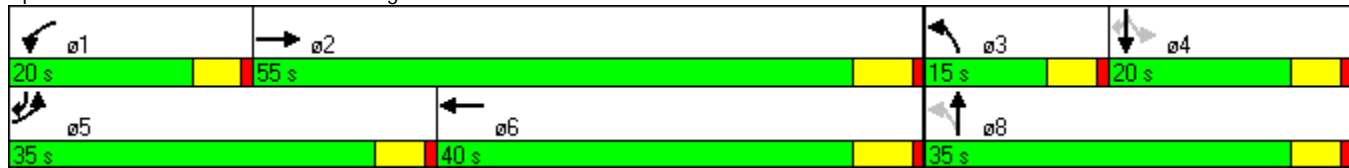


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		C			D			C			B	
Stops (vph)	193	326		15	447		95	24			55	104
Fuel Used(gal)	5	7		0	13		2	1			1	3
CO Emissions (g/hr)	345	516		24	891		146	41			89	209
NOx Emissions (g/hr)	67	100		5	173		28	8			17	41
VOC Emissions (g/hr)	80	120		6	207		34	9			21	48
Dilemma Vehicles (#)	0	23		0	28		0	0			0	0
Queue Length 50th (ft)	152	221		8	337		69	15			36	64
Queue Length 95th (ft)	220	417		30	#691		135	49			83	132
Internal Link Dist (ft)		562			724			537			595	
Turn Bay Length (ft)	300			250			175					275
Base Capacity (vph)	583	1194		267	694		281	589			221	799
Starvation Cap Reductn	0	0		0	0		0	0			0	0
Spillback Cap Reductn	0	0		0	0		0	0			0	0
Storage Cap Reductn	0	0		0	0		0	0			0	0
Reduced v/c Ratio	0.46	0.58		0.05	0.87		0.51	0.10			0.28	0.39

Intersection Summary

Area Type: Other
 Cycle Length: 110
 Actuated Cycle Length: 92.4
 Natural Cycle: 65
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.87
 Intersection Signal Delay: 30.1
 Intersection LOS: C
 Intersection Capacity Utilization 69.5%
 ICU Level of Service C
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Union St & King St



TIP Before and After Evaluations - Franklin

1: Union St & King St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	291	707	107	33	577	30	186	30	32	57	35	244
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	14	12	10	12	12	10	11	12	12	11	11
Storage Length (ft)	300		0	250		0	175		0	0		275
Storage Lanes	1		0	1		0	1		0	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.980			0.993			0.923				0.850
Flt Protected	0.950			0.950			0.950				0.970	
Satd. Flow (prot)	1752	1964	0	1685	1849	0	1668	1669	0	0	1782	1531
Flt Permitted	0.950			0.950			0.454				0.772	
Satd. Flow (perm)	1752	1964	0	1685	1849	0	797	1669	0	0	1418	1531
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		9			2			34				114
Link Speed (mph)		40			40			30				30
Link Distance (ft)		642			804			617				675
Travel Time (s)		10.9			13.7			14.0				15.3
Peak Hour Factor	0.90	0.90	0.90	0.91	0.91	0.91	0.95	0.95	0.95	0.74	0.74	0.74
Heavy Vehicles (%)	3%	1%	2%	0%	2%	3%	1%	0%	3%	0%	0%	2%
Adj. Flow (vph)	323	786	119	36	634	33	196	32	34	77	47	330
Shared Lane Traffic (%)												
Lane Group Flow (vph)	323	905	0	36	667	0	196	66	0	0	124	330
Turn Type	Prot	NA		Prot	NA		pm+pt	NA		Perm	NA	pm+ov
Protected Phases	5	2		1	6		3	8			4	5
Permitted Phases							8			4		4
Detector Phase	5	2		1	6		3	8		4	4	5
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	10.0		9.0	10.0		9.0	10.0		10.0	10.0	9.0
Total Split (s)	35.0	55.0		20.0	40.0		15.0	35.0		20.0	20.0	35.0
Total Split (%)	31.8%	50.0%		18.2%	36.4%		13.6%	31.8%		18.2%	18.2%	31.8%
Maximum Green (s)	30.0	49.0		15.0	34.0		10.0	29.0		14.0	14.0	30.0
Yellow Time (s)	4.0	5.0		4.0	5.0		4.0	5.0		5.0	5.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0		5.0	6.0		5.0	6.0			6.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag		Lead			Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes			Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None		None	None		None	Min		Min	Min	None
Act Effect Green (s)	23.3	54.6		7.7	34.2		28.4	27.4			12.4	41.8
Actuated g/C Ratio	0.23	0.54		0.08	0.34		0.28	0.27			0.12	0.41
v/c Ratio	0.81	0.86		0.28	1.07		0.64	0.14			0.72	0.47
Control Delay	53.3	32.2		52.1	92.0		42.3	18.2			67.8	15.9
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0			0.0	0.0
Total Delay	53.3	32.2		52.1	92.0		42.3	18.2			67.8	15.9
LOS	D	C		D	F		D	B			E	B
Approach Delay		37.7			89.9			36.2			30.1	

TIP Before and After Evaluations - Franklin

1: Union St & King St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		D			F			D			C	
Stops (vph)	265	632		32	482		148	27			82	109
Fuel Used(gal)	7	15		1	19		3	1			2	3
CO Emissions (g/hr)	491	1055		59	1357		232	48			154	187
NOx Emissions (g/hr)	96	205		11	264		45	9			30	36
VOC Emissions (g/hr)	114	244		14	314		54	11			36	43
Dilemma Vehicles (#)	0	29		0	25		0	0			0	0
Queue Length 50th (ft)	204	549		23	-508		105	16			79	97
Queue Length 95th (ft)	305	#867		57	#790		184	52			120	121
Internal Link Dist (ft)		562			724			537			595	
Turn Bay Length (ft)	300			250			175					275
Base Capacity (vph)	519	1056		249	622		307	502			196	790
Starvation Cap Reductn	0	0		0	0		0	0			0	0
Spillback Cap Reductn	0	0		0	0		0	0			0	0
Storage Cap Reductn	0	0		0	0		0	0			0	0
Reduced v/c Ratio	0.62	0.86		0.14	1.07		0.64	0.13			0.63	0.42

Intersection Summary

Area Type: Other
 Cycle Length: 110
 Actuated Cycle Length: 102
 Natural Cycle: 90
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 1.07
 Intersection Signal Delay: 50.1
 Intersection LOS: D
 Intersection Capacity Utilization 79.4%
 ICU Level of Service D
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Union St & King St



TIP Before and After Evaluations - Franklin

1: Union St & King St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	371	902	193	57	647	33	266	42	59	63	47	274
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	10	11	10	11	11	12	10	11	12	12	11	10
Storage Length (ft)	260		250	230		0	160		0	0		275
Storage Lanes	1		1	1		0	1		0	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850		0.993			0.912				0.850
Flt Protected	0.950				0.996		0.950				0.972	
Satd. Flow (prot)	1636	1818	1478	0	3387	0	1668	1646	0	0	1785	1478
Flt Permitted	0.950				0.785		0.341				0.764	
Satd. Flow (perm)	1636	1818	1478	0	2670	0	599	1646	0	0	1403	1478
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			203		5			62				63
Link Speed (mph)		40			40			30				30
Link Distance (ft)		642			804			617				675
Travel Time (s)		10.9			13.7			14.0				15.3
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	3%	1%	2%	0%	2%	3%	1%	0%	3%	0%	0%	2%
Adj. Flow (vph)	391	949	203	60	681	35	280	44	62	66	49	288
Shared Lane Traffic (%)												
Lane Group Flow (vph)	391	949	203	0	776	0	280	106	0	0	115	288
Turn Type	Prot	NA	pm+ov	pm+pt	NA		pm+pt	NA		Perm	NA	pm+ov
Protected Phases	5	2	3	1	6		3	8			4	5
Permitted Phases			2	6			8			4		4
Detector Phase	5	2	3	1	6		3	8		4	4	5
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	10.0	10.0	10.0	10.0	10.0		10.0	10.0		10.0	10.0	10.0
Total Split (s)	30.0	53.0	15.0	10.0	33.0		15.0	27.0		12.0	12.0	30.0
Total Split (%)	33.3%	58.9%	16.7%	11.1%	36.7%		16.7%	30.0%		13.3%	13.3%	33.3%
Maximum Green (s)	24.0	47.0	9.0	4.0	27.0		9.0	21.0		6.0	6.0	24.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0		0.0		0.0	0.0			0.0	0.0
Total Lost Time (s)	6.0	6.0	6.0		6.0		6.0	6.0			6.0	6.0
Lead/Lag	Lead	Lead	Lead	Lag	Lag		Lead			Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes			Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Recall Mode	C-Max	C-Max	None	None	None		None	Min		Min	Min	C-Max
Act Effct Green (s)	24.0	57.0	72.0		27.0		21.0	21.0			6.0	36.0
Actuated g/C Ratio	0.27	0.63	0.80		0.30		0.23	0.23			0.07	0.40
v/c Ratio	0.90	0.82	0.17		0.96		1.13	0.25			1.22	0.46
Control Delay	52.3	27.0	1.7		56.3		130.9	15.1			203.6	18.0
Queue Delay	0.0	3.0	0.0		0.0		0.0	0.0			0.0	0.0
Total Delay	52.3	29.9	1.7		56.3		130.9	15.1			203.6	18.0
LOS	D	C	A		E		F	B			F	B
Approach Delay		31.9			56.3			99.1			71.0	

TIP Before and After Evaluations - Franklin

1: Union St & King St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS	C			E			F			E		
Stops (vph)	331	789	27	640			194	39	79			154
Fuel Used(gal)	9	17	1	19			9	1	6			3
CO Emissions (g/hr)	616	1163	82	1311			660	71	386			231
NOx Emissions (g/hr)	120	226	16	255			128	14	75			45
VOC Emissions (g/hr)	143	269	19	304			153	16	90			53
Dilemma Vehicles (#)	0	31	0	38			0	0	0			0
Queue Length 50th (ft)	226	496	14	226			~170	20	~82			90
Queue Length 95th (ft)	#389	663	26	#351			#292	62	#188			162
Internal Link Dist (ft)	562			724			537			595		
Turn Bay Length (ft)	260	250		160			275					
Base Capacity (vph)	436	1151	1223	805			247	432	94			629
Starvation Cap Reductn	0	117	0	0			0	0	0			0
Spillback Cap Reductn	0	0	0	0			0	0	0			0
Storage Cap Reductn	0	0	0	0			0	0	0			0
Reduced v/c Ratio	0.90	0.92	0.17	0.96			1.13	0.25	1.22			0.46

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 0 (0%), Referenced to phase 2:EBT and 5:EBL, Start of Green, Master Intersection
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.22
 Intersection Signal Delay: 51.4
 Intersection LOS: D
 Intersection Capacity Utilization 104.5%
 ICU Level of Service G
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Union St & King St



TIP Before and After Evaluations - Franklin

1: Union St & King St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	371	902	193	57	647	33	266	42	59	63	47	274
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	10	11	10	11	11	12	10	11	12	12	11	10
Storage Length (ft)	260		250	230		0	160		0	0		275
Storage Lanes	1		1	1		0	1		0	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850		0.993			0.912				0.850
Flt Protected	0.950				0.996		0.950				0.972	
Satd. Flow (prot)	1636	1766	1383	0	3350	0	1636	1675	0	0	1735	1492
Flt Permitted	0.950				0.785		0.341				0.764	
Satd. Flow (perm)	1636	1766	1383	0	2640	0	587	1675	0	0	1364	1492
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			203		5			62				63
Link Speed (mph)		40			40			30				30
Link Distance (ft)		642			804			617				675
Travel Time (s)		10.9			13.7			14.0				15.3
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	3%	4%	9%	5%	3%	0%	3%	0%	0%	5%	0%	1%
Adj. Flow (vph)	391	949	203	60	681	35	280	44	62	66	49	288
Shared Lane Traffic (%)												
Lane Group Flow (vph)	391	949	203	0	776	0	280	106	0	0	115	288
Turn Type	Prot	NA	pm+ov	pm+pt	NA		pm+pt	NA		Perm	NA	pm+ov
Protected Phases	5	2	3	1	6		3	8			4	5
Permitted Phases			2	6			8			4		4
Detector Phase	5	2	3	1	6		3	8		4	4	5
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	10.0	10.0	10.0	10.0	10.0		10.0	10.0		10.0	10.0	10.0
Total Split (s)	30.0	53.0	15.0	10.0	33.0		15.0	27.0		12.0	12.0	30.0
Total Split (%)	33.3%	58.9%	16.7%	11.1%	36.7%		16.7%	30.0%		13.3%	13.3%	33.3%
Maximum Green (s)	24.0	47.0	9.0	4.0	27.0		9.0	21.0		6.0	6.0	24.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0		0.0		0.0	0.0			0.0	0.0
Total Lost Time (s)	6.0	6.0	6.0		6.0		6.0	6.0			6.0	6.0
Lead/Lag	Lead	Lead	Lead	Lag	Lag		Lead			Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes			Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Recall Mode	C-Max	C-Max	None	None	None		None	Min		Min	Min	C-Max
Act Effct Green (s)	24.0	57.0	72.0		27.0		21.0	21.0			6.0	36.0
Actuated g/C Ratio	0.27	0.63	0.80		0.30		0.23	0.23			0.07	0.40
v/c Ratio	0.90	0.85	0.18		0.97		1.16	0.24			1.26	0.45
Control Delay	57.0	13.4	0.3		58.8		139.4	15.0			218.8	17.9
Queue Delay	0.0	0.1	0.0		0.0		0.0	0.0			0.0	0.0
Total Delay	57.0	13.5	0.3		58.8		139.4	15.0			218.8	17.9
LOS	E	B	A		E		F	B			F	B
Approach Delay		22.8			58.8			105.2			75.3	

TIP Before and After Evaluations - Franklin

1: Union St & King St

6/11/2014

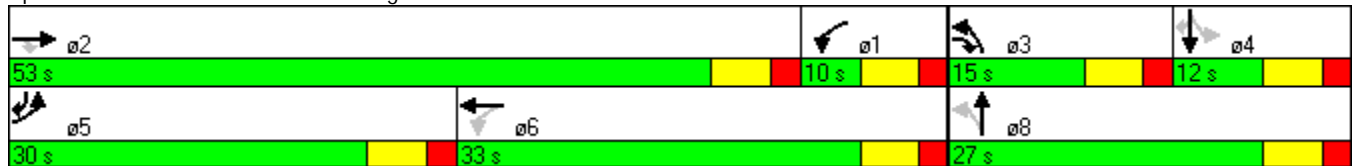


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS	C			E			F			E		
Stops (vph)	296	338	0	639			192	39	80			154
Fuel Used(gal)	9	10	1	19			10	1	6			3
CO Emissions (g/hr)	617	679	60	1336			691	71	410			230
NOx Emissions (g/hr)	120	132	12	260			134	14	80			45
VOC Emissions (g/hr)	143	157	14	310			160	16	95			53
Dilemma Vehicles (#)	0	47	0	38			0	0	0			0
Queue Length 50th (ft)	190	80	0	227			-174	20	-83			90
Queue Length 95th (ft)	m#376	#542	m0	#354			#295	62	#189			162
Internal Link Dist (ft)	562			724			537			595		
Turn Bay Length (ft)	260	250		160			275					
Base Capacity (vph)	436	1118	1147	796			242	438	91			635
Starvation Cap Reductn	0	7	0	0			0	0	0			0
Spillback Cap Reductn	0	0	0	0			0	0	0			0
Storage Cap Reductn	0	0	0	0			0	0	0			0
Reduced v/c Ratio	0.90	0.85	0.18	0.97			1.16	0.24	1.26			0.45

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 0 (0%), Referenced to phase 2:EBT and 5:EBL, Start of Green, Master Intersection
 Natural Cycle: 100
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.26
 Intersection Signal Delay: 48.8
 Intersection LOS: D
 Intersection Capacity Utilization 104.5%
 ICU Level of Service G
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 1: Union St & King St



TIP Before and After Evaluations - Franklin

1: Union St & King St

7/3/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	167	489	62	57	541	8	257	65	31	20	47	253
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	10	11	10	11	11	12	10	11	12	12	11	10
Storage Length (ft)	260		250	230		0	160		0	0		275
Storage Lanes	1		1	1		0	1		0	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850		0.997			0.944				0.850
Flt Protected	0.950				0.995		0.950					0.984
Satd. Flow (prot)	1652	1801	1478	0	3394	0	1668	1717	0	0	1807	1507
Flt Permitted	0.950				0.812		0.347					0.839
Satd. Flow (perm)	1652	1801	1478	0	2770	0	609	1717	0	0	1541	1507
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			74		2			31				298
Link Speed (mph)		40			40			30				30
Link Distance (ft)		642			804			617				675
Travel Time (s)		10.9			13.7			14.0				15.3
Peak Hour Factor	0.85	0.85	0.84	0.79	0.89	0.67	0.85	0.81	0.65	0.63	0.73	0.85
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	0%	0%	0%
Adj. Flow (vph)	196	575	74	72	608	12	302	80	48	32	64	298
Shared Lane Traffic (%)												
Lane Group Flow (vph)	196	575	74	0	692	0	302	128	0	0	96	298
Turn Type	Prot	NA	Perm	pm+pt	NA		pm+pt	NA		Perm	NA	Perm
Protected Phases	5	2		1	6		3	8				4
Permitted Phases			2	6			8			4		4
Detector Phase	5	2	2	1	6		3	8		4	4	4
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	10.0	10.0	10.0	10.0	10.0		10.0	10.0		10.0	10.0	10.0
Total Split (s)	30.0	53.0	53.0	10.0	33.0		15.0	27.0		12.0	12.0	12.0
Total Split (%)	33.3%	58.9%	58.9%	11.1%	36.7%		16.7%	30.0%		13.3%	13.3%	13.3%
Maximum Green (s)	24.0	47.0	47.0	4.0	27.0		9.0	21.0		6.0	6.0	6.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0		0.0		0.0	0.0			0.0	0.0
Total Lost Time (s)	6.0	6.0	6.0		6.0		6.0	6.0			6.0	6.0
Lead/Lag	Lead	Lead	Lead	Lag	Lag		Lead			Lag	Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes			Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Recall Mode	C-Max	C-Max	C-Max	None	None		None	Min		Min	Min	Min
Act Effct Green (s)	24.0	55.6	55.6		25.6		22.4	22.4			6.0	6.0
Actuated g/C Ratio	0.27	0.62	0.62		0.28		0.25	0.25			0.07	0.07
v/c Ratio	0.44	0.52	0.08		0.88		1.10	0.28			0.93	0.79
Control Delay	21.9	19.3	4.9		44.3		117.8	23.3			117.1	21.3
Queue Delay	0.0	0.0	0.0		0.0		0.0	0.0			0.0	0.0
Total Delay	21.9	19.3	4.9		44.3		117.8	23.3			117.1	21.3
LOS	C	B	A		D		F	C			F	C
Approach Delay		18.7			44.3			89.7			44.7	

TIP Before and After Evaluations - Franklin
 1: Union St & King St

7/3/2014

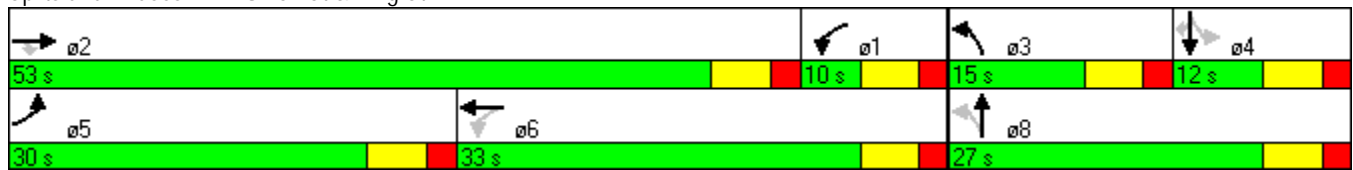


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		B				D				F		
Stops (vph)	142	424	22		543		176	59			53	26
Fuel Used(gal)	3	8	1		14		8	1			2	3
CO Emissions (g/hr)	200	574	38		986		585	87			157	180
NOx Emissions (g/hr)	39	112	7		192		114	17			30	35
VOC Emissions (g/hr)	46	133	9		229		136	20			36	42
Dilemma Vehicles (#)	0	9	0		30		0	0			0	0
Queue Length 50th (ft)	101	302	14		191		~163	45			56	0
Queue Length 95th (ft)	146	382	26		#278		#292	82			#112	#86
Internal Link Dist (ft)		562			724			537			595	
Turn Bay Length (ft)	260		250				160					275
Base Capacity (vph)	441	1112	941		832		275	451			103	379
Starvation Cap Reductn	0	0	0		0		0	0			0	0
Spillback Cap Reductn	0	0	0		0		0	0			0	0
Storage Cap Reductn	0	0	0		0		0	0			0	0
Reduced v/c Ratio	0.44	0.52	0.08		0.83		1.10	0.28			0.93	0.79

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 0 (0%), Referenced to phase 2:EBT and 5:EBL, Start of Green, Master Intersection
 Natural Cycle: 75
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.10
 Intersection Signal Delay: 43.5
 Intersection LOS: D
 Intersection Capacity Utilization 78.5%
 ICU Level of Service D
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Union St & King St



TIP Before and After Evaluations - Franklin

1: Union St & King St

7/3/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	263	723	84	50	560	45	179	38	39	39	38	196
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	10	11	10	11	11	12	10	11	12	12	11	10
Storage Length (ft)	260		250	230		0	160		0	0		275
Storage Lanes	1		1	1		0	1		0	0		1
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850		0.990			0.911				0.850
Flt Protected	0.950				0.994		0.950					0.973
Satd. Flow (prot)	1668	1818	1492	0	3367	0	1668	1657	0	0	1769	1492
Flt Permitted	0.950				0.729		0.350					0.772
Satd. Flow (perm)	1668	1818	1492	0	2469	0	615	1657	0	0	1404	1492
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			90		8			64				223
Link Speed (mph)		40			40			30				30
Link Distance (ft)		642			804			617				675
Travel Time (s)		10.9			13.7			14.0				15.3
Peak Hour Factor	0.78	0.88	0.93	0.54	0.92	0.94	0.82	0.86	0.61	0.81	0.95	0.88
Heavy Vehicles (%)	1%	1%	1%	2%	2%	2%	1%	1%	1%	1%	1%	1%
Adj. Flow (vph)	337	822	90	93	609	48	218	44	64	48	40	223
Shared Lane Traffic (%)												
Lane Group Flow (vph)	337	822	90	0	750	0	218	108	0	0	88	223
Turn Type	Prot	NA	Perm	pm+pt	NA		pm+pt	NA		Perm	NA	Perm
Protected Phases	5	2		1	6		3	8				4
Permitted Phases			2	6			8			4		4
Detector Phase	5	2	2	1	6		3	8		4	4	4
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	10.0	10.0	10.0	10.0	10.0		10.0	10.0		10.0	10.0	10.0
Total Split (s)	30.0	53.0	53.0	10.0	33.0		15.0	27.0		12.0	12.0	12.0
Total Split (%)	33.3%	58.9%	58.9%	11.1%	36.7%		16.7%	30.0%		13.3%	13.3%	13.3%
Maximum Green (s)	24.0	47.0	47.0	4.0	27.0		9.0	21.0		6.0	6.0	6.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0		0.0		0.0	0.0			0.0	0.0
Total Lost Time (s)	6.0	6.0	6.0		6.0		6.0	6.0			6.0	6.0
Lead/Lag	Lead	Lead	Lead	Lag	Lag		Lead			Lag	Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes			Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Recall Mode	C-Max	C-Max	C-Max	None	None		None	Min		Min	Min	Min
Act Effct Green (s)	24.0	57.0	57.0		27.0		21.0	21.0			6.0	6.0
Actuated g/C Ratio	0.27	0.63	0.63		0.30		0.23	0.23			0.07	0.07
v/c Ratio	0.76	0.71	0.09		1.01		0.88	0.25			0.94	0.72
Control Delay	41.3	9.5	0.7		66.9		66.0	14.9			122.2	20.8
Queue Delay	0.0	0.1	0.0		0.0		0.0	0.0			0.0	0.0
Total Delay	41.3	9.6	0.7		66.9		66.0	14.9			122.2	20.8
LOS	D	A	A		E		E	B			F	C
Approach Delay		17.5			66.9			49.0			49.5	

TIP Before and After Evaluations - Franklin

1: Union St & King St

7/3/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		B			E			D			D	
Stops (vph)	197	296	2		562		140	29			60	26
Fuel Used(gal)	5	7	0		18		4	1			3	2
CO Emissions (g/hr)	370	521	28		1261		282	53			185	140
NOx Emissions (g/hr)	72	101	5		245		55	10			36	27
VOC Emissions (g/hr)	86	121	6		292		65	12			43	32
Dilemma Vehicles (#)	0	46	0		33		0	0			0	0
Queue Length 50th (ft)	133	111	1		-223		110	20			51	0
Queue Length 95th (ft)	204	141	m2		#352		#166	58			#144	#85
Internal Link Dist (ft)		562			724			537			595	
Turn Bay Length (ft)	260		250				160					275
Base Capacity (vph)	445	1151	978		746		249	436			94	308
Starvation Cap Reductn	0	12	0		0		0	0			0	0
Spillback Cap Reductn	0	0	0		0		0	0			0	0
Storage Cap Reductn	0	0	0		0		0	0			0	0
Reduced v/c Ratio	0.76	0.72	0.09		1.01		0.88	0.25			0.94	0.72

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 0 (0%), Referenced to phase 2:EBT and 5:EBL, Start of Green, Master Intersection
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.01
 Intersection Signal Delay: 39.2
 Intersection LOS: D
 Intersection Capacity Utilization 88.0%
 ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 1: Union St & King St



TIP Before and After Evaluations - Franklin
 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St

6/11/2014



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	512	418	0	0	615	368	276	0	360	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	557	454	0	0	668	400	300	0	391	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)									5			
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)		1304			642							
pX, platoon unblocked	0.65						0.65	0.65		0.65	0.65	0.65
vC, conflicting volume	668			454			2436	2236	454	2436	2436	868
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	228			454			2931	2625	454	2931	2931	534
tC, single (s)	4.1			4.1			7.2	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.3	3.5	4.0	3.3
p0 queue free %	36			100			0	100	35	100	100	100
cM capacity (veh/h)	865			1117			3	6	599	1	4	357

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	557	454	1068	691
Volume Left	557	0	0	300
Volume Right	0	0	400	391
cSH	865	1700	1700	6
Volume to Capacity	0.64	0.27	0.63	106.52
Queue Length 95th (ft)	120	0	0	Err
Control Delay (s)	16.4	0.0	0.0	Err
Lane LOS	C			F
Approach Delay (s)	9.0		0.0	Err
Approach LOS				F

Intersection Summary			
Average Delay		2498.1	
Intersection Capacity Utilization		108.5%	ICU Level of Service
Analysis Period (min)		15	G

TIP Before and After Evaluations - Franklin
 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St

6/11/2014



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	434	696	0	0	817	190	233	0	409	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	472	757	0	0	888	207	253	0	445	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)									5			
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)		1304			642							
pX, platoon unblocked	0.59						0.59	0.59		0.59	0.59	0.59
vC, conflicting volume	888			757			2691	2588	757	2691	2691	991
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	465			757			3516	3341	757	3516	3516	639
tC, single (s)	4.1			4.1			7.2	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.0	3.3	3.5	4.0	3.3
p0 queue free %	27			100			0	100	0	0	100	100
cM capacity (veh/h)	642			863			1	1	409	0	1	281

Direction, Lane #	EB 1	EB 2	WB 1	NB 1
Volume Total	472	757	1095	698
Volume Left	472	0	0	253
Volume Right	0	0	207	445
cSH	642	1700	1700	2
Volume to Capacity	0.73	0.45	0.64	325.43
Queue Length 95th (ft)	160	0	0	Err
Control Delay (s)	24.5	0.0	0.0	Err
Lane LOS	C			F
Approach Delay (s)	9.4		0.0	Err
Approach LOS				F

Intersection Summary			
Average Delay		2313.8	
Intersection Capacity Utilization		109.5%	ICU Level of Service
Analysis Period (min)		15	H

TIP Before and After Evaluations - Franklin
 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	582	549	0	0	889	413	360	0	417	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	12	11	12	11	12	16	12	12	12
Storage Length (ft)	0		0	0		0	250		300	0		0
Storage Lanes	1		0	0		0	1		1	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95	0.95	0.97	1.00	1.00	1.00	1.00	1.00
Frt					0.952				0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1662	1685	0	0	3235	0	3134	0	1743	0	0	0
Flt Permitted	0.095						0.950					
Satd. Flow (perm)	166	1685	0	0	3235	0	3134	0	1743	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					101				439			
Link Speed (mph)		40			40			30			30	
Link Distance (ft)		725			642			964			947	
Travel Time (s)		12.4			10.9			21.9			21.5	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	5%	9%	0%	0%	3%	2%	8%	0%	5%	0%	0%	0%
Adj. Flow (vph)	613	578	0	0	936	435	379	0	439	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	613	578	0	0	1371	0	379	0	439	0	0	0
Turn Type	pm+pt	NA			NA		Prot		Free			
Protected Phases	5	2			6		3					
Permitted Phases	2								Free			
Detector Phase	5	2			6		3					
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0					
Minimum Split (s)	10.0	10.0			10.0		10.0					
Total Split (s)	34.0	76.0			42.0		14.0					
Total Split (%)	37.8%	84.4%			46.7%		15.6%					
Maximum Green (s)	28.0	70.0			36.0		8.0					
Yellow Time (s)	4.0	4.0			4.0		4.0					
All-Red Time (s)	2.0	2.0			2.0		2.0					
Lost Time Adjust (s)	0.0	0.0			0.0		0.0					
Total Lost Time (s)	6.0	6.0			6.0		6.0					
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0					
Recall Mode	None	Min			C-Max		None					
Act Effct Green (s)	70.0	70.0			36.0		8.0		90.0			
Actuated g/C Ratio	0.78	0.78			0.40		0.09		1.00			
v/c Ratio	1.03	0.44			1.01		1.36		0.25			
Control Delay	43.0	4.5			56.5		217.1		0.3			
Queue Delay	0.0	0.1			0.0		0.0		0.0			
Total Delay	43.0	4.6			56.5		217.1		0.4			
LOS	D	A			E		F		A			
Approach Delay		24.4			56.5							

TIP Before and After Evaluations - Franklin
 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St

6/11/2014

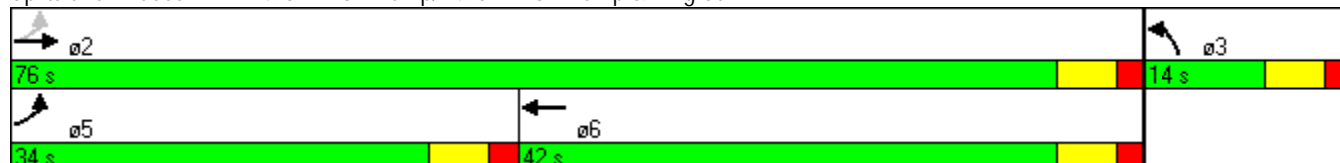


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		C			E							
Stops (vph)	354	369			1148		278		0			
Fuel Used(gal)	11	7			32		20		3			
CO Emissions (g/hr)	800	477			2231		1409		221			
NOx Emissions (g/hr)	156	93			434		274		43			
VOC Emissions (g/hr)	185	111			517		326		51			
Dilemma Vehicles (#)	0	0			14		0		0			
Queue Length 50th (ft)	~336	0			-430		~147		0			
Queue Length 95th (ft)	m#370	m0			m#465		#237		0			
Internal Link Dist (ft)		645			562			884			867	
Turn Bay Length (ft)							250		300			
Base Capacity (vph)	595	1311			1355		279		1743			
Starvation Cap Reductn	0	0			0		0		0			
Spillback Cap Reductn	0	151			0		0		157			
Storage Cap Reductn	0	0			0		0		0			
Reduced v/c Ratio	1.03	0.50			1.01		1.36		0.28			

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 89 (99%), Referenced to phase 6:WBT, Start of Green
 Natural Cycle: 120
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.36
 Intersection Signal Delay: 55.9
 Intersection LOS: E
 Intersection Capacity Utilization 93.6%
 ICU Level of Service F
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St



TIP Before and After Evaluations - Franklin
 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↘	↑			↑↑		↘↘		↘			
Volume (vph)	508	1000	0	0	964	223	262	0	466	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	12	11	12	11	12	16	12	12	12
Storage Length (ft)	0		0	0		0	250		300	0		0
Storage Lanes	1		0	0		0	1		1	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95	0.95	0.97	1.00	1.00	1.00	1.00	1.00
Frt					0.972				0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1678	1818	0	0	3313	0	3164	0	1812	0	0	0
Flt Permitted	0.095						0.950					
Satd. Flow (perm)	168	1818	0	0	3313	0	3164	0	1812	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					37				277			
Link Speed (mph)		40			40			30				30
Link Distance (ft)		725			642			964				947
Travel Time (s)		12.4			10.9			21.9				21.5
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	4%	1%	0%	0%	2%	4%	7%	0%	1%	0%	0%	0%
Adj. Flow (vph)	535	1053	0	0	1015	235	276	0	491	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	535	1053	0	0	1250	0	276	0	491	0	0	0
Turn Type	pm+pt	NA			NA		Prot		Free			
Protected Phases	5	2			6		3					
Permitted Phases	2								Free			
Detector Phase	5	2			6		3					
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0					
Minimum Split (s)	10.0	10.0			10.0		10.0					
Total Split (s)	35.0	77.0			42.0		13.0					
Total Split (%)	38.9%	85.6%			46.7%		14.4%					
Maximum Green (s)	29.0	71.0			36.0		7.0					
Yellow Time (s)	4.0	4.0			4.0		4.0					
All-Red Time (s)	2.0	2.0			2.0		2.0					
Lost Time Adjust (s)	0.0	0.0			0.0		0.0					
Total Lost Time (s)	6.0	6.0			6.0		6.0					
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0					
Recall Mode	C-Max	C-Max			None		None					
Act Effct Green (s)	71.0	71.0			36.0		7.0		90.0			
Actuated g/C Ratio	0.79	0.79			0.40		0.08		1.00			
v/c Ratio	0.86	0.73			0.93		1.12		0.27			
Control Delay	25.5	16.4			25.9		134.3		0.4			
Queue Delay	0.0	4.8			0.0		0.0		0.0			
Total Delay	25.5	21.2			25.9		134.3		0.4			
LOS	C	C			C		F		A			
Approach Delay		22.6			25.9							

TIP Before and After Evaluations - Franklin
 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St

6/11/2014

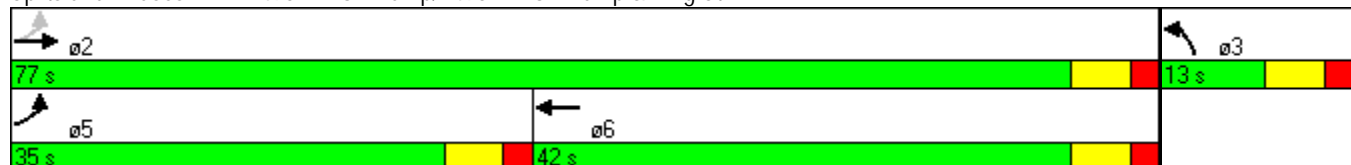


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		C			C							
Stops (vph)	409	890			714		214		0			
Fuel Used(gal)	9	17			18		10		4			
CO Emissions (g/hr)	640	1188			1290		721		247			
NOx Emissions (g/hr)	124	231			251		140		48			
VOC Emissions (g/hr)	148	275			299		167		57			
Dilemma Vehicles (#)	0	27			67		0		0			
Queue Length 50th (ft)	197	534			184		-94		0			
Queue Length 95th (ft)	#414	726			m196		#173		0			
Internal Link Dist (ft)		645			562			884			867	
Turn Bay Length (ft)							250		300			
Base Capacity (vph)	619	1434			1347		246		1812			
Starvation Cap Reductn	0	309			0		0		0			
Spillback Cap Reductn	0	45			0		0		45			
Storage Cap Reductn	0	0			0		0		0			
Reduced v/c Ratio	0.86	0.94			0.93		1.12		0.28			

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 85 (94%), Referenced to phase 2:EBTL and 5:EBL, Start of Green
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.12
 Intersection Signal Delay: 29.3
 Intersection LOS: C
 Intersection Capacity Utilization 82.7%
 ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St



TIP Before and After Evaluations - Franklin
 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St

7/3/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	472	538	0	0	719	332	334	0	180	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	12	11	12	11	12	16	12	12	12
Storage Length (ft)	0		0	0		0	250		300	0		0
Storage Lanes	1		0	0		0	1		1	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95	0.95	0.97	1.00	1.00	1.00	1.00	1.00
Frt					0.951				0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1631	1717	0	0	3161	0	3105	0	1679	0	0	0
Flt Permitted	0.113						0.950					
Satd. Flow (perm)	194	1717	0	0	3161	0	3105	0	1679	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					108				228			
Link Speed (mph)		40			40			30			30	
Link Distance (ft)		725			642			964			947	
Travel Time (s)		12.4			10.9			21.9			21.5	
Peak Hour Factor	0.97	0.96	0.92	0.92	0.95	0.91	0.70	0.92	0.79	0.92	0.92	0.92
Heavy Vehicles (%)	7%	7%	0%	0%	5%	5%	9%	0%	9%	0%	0%	0%
Adj. Flow (vph)	487	560	0	0	757	365	477	0	228	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	487	560	0	0	1122	0	477	0	228	0	0	0
Turn Type	pm+pt	NA			NA		Prot		Free			
Protected Phases	5	2			6		3					
Permitted Phases	2								Free			
Detector Phase	5	2			6		3					
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0					
Minimum Split (s)	10.0	10.0			10.0		10.0					
Total Split (s)	34.0	76.0			42.0		14.0					
Total Split (%)	37.8%	84.4%			46.7%		15.6%					
Maximum Green (s)	28.0	70.0			36.0		8.0					
Yellow Time (s)	4.0	4.0			4.0		4.0					
All-Red Time (s)	2.0	2.0			2.0		2.0					
Lost Time Adjust (s)	0.0	0.0			0.0		0.0					
Total Lost Time (s)	6.0	6.0			6.0		6.0					
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0					
Recall Mode	None	Min			C-Max		None					
Act Effct Green (s)	70.0	70.0			38.9		8.0		90.0			
Actuated g/C Ratio	0.78	0.78			0.43		0.09		1.00			
v/c Ratio	0.88	0.42			0.79		1.73		0.14			
Control Delay	16.2	3.3			35.7		370.9		0.2			
Queue Delay	0.0	0.0			0.0		0.0		0.0			
Total Delay	16.2	3.3			35.7		370.9		0.2			
LOS	B	A			D		F		A			
Approach Delay		9.3			35.7							

TIP Before and After Evaluations - Franklin
 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St

7/3/2014

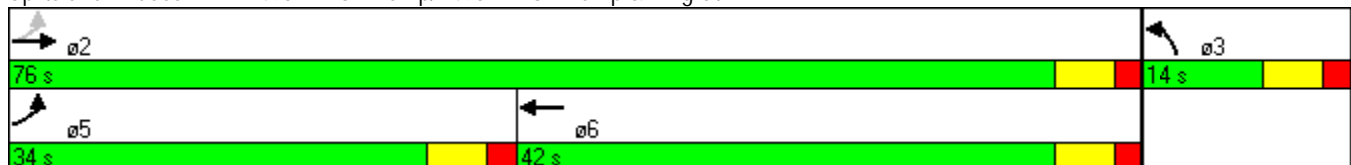


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		A			D							
Stops (vph)	191	274			949		246		0			
Fuel Used(gal)	6	6			22		29		1			
CO Emissions (g/hr)	402	398			1506		2033		95			
NOx Emissions (g/hr)	78	77			293		396		18			
VOC Emissions (g/hr)	93	92			349		471		22			
Dilemma Vehicles (#)	0	0			13		0		0			
Queue Length 50th (ft)	6	0			334		-208		0			
Queue Length 95th (ft)	m20	m0			m381		#218		0			
Internal Link Dist (ft)		645			562			884			867	
Turn Bay Length (ft)							250		300			
Base Capacity (vph)	598	1335			1426		276		1679			
Starvation Cap Reductn	0	0			0		0		0			
Spillback Cap Reductn	0	0			0		0		0			
Storage Cap Reductn	0	0			0		0		0			
Reduced v/c Ratio	0.81	0.42			0.79		1.73		0.14			

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 89 (99%), Referenced to phase 6:WBT, Start of Green
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.73
 Intersection Signal Delay: 78.9
 Intersection LOS: E
 Intersection Capacity Utilization 79.5%
 ICU Level of Service D
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St



TIP Before and After Evaluations - Franklin
 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St

7/3/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	529	744	0	0	703	232	380	0	326	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	12	11	12	11	12	16	12	12	12
Storage Length (ft)	0		0	0		0	250		300	0		0
Storage Lanes	1		0	0		0	1		1	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95	0.95	0.97	1.00	1.00	1.00	1.00	1.00
Frt					0.960				0.850			
Flt Protected	0.950						0.950					
Satd. Flow (prot)	1728	1818	0	0	3253	0	3286	0	1777	0	0	0
Flt Permitted	0.132						0.950					
Satd. Flow (perm)	240	1818	0	0	3253	0	3286	0	1777	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					68				374			
Link Speed (mph)		40			40			30			30	
Link Distance (ft)		725			642			964			947	
Travel Time (s)		12.4			10.9			21.9			21.5	
Peak Hour Factor	0.80	0.94	0.92	0.92	0.95	0.87	0.92	0.92	0.85	0.92	0.92	0.92
Heavy Vehicles (%)	1%	1%	0%	0%	3%	3%	3%	0%	3%	0%	0%	0%
Adj. Flow (vph)	661	791	0	0	740	267	413	0	384	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	661	791	0	0	1007	0	413	0	384	0	0	0
Turn Type	pm+pt	NA			NA		Prot		Free			
Protected Phases	5	2			6		3					
Permitted Phases	2								Free			
Detector Phase	5	2			6		3					
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0					
Minimum Split (s)	10.0	10.0			10.0		10.0					
Total Split (s)	35.0	77.0			42.0		13.0					
Total Split (%)	38.9%	85.6%			46.7%		14.4%					
Maximum Green (s)	29.0	71.0			36.0		7.0					
Yellow Time (s)	4.0	4.0			4.0		4.0					
All-Red Time (s)	2.0	2.0			2.0		2.0					
Lost Time Adjust (s)	0.0	0.0			0.0		0.0					
Total Lost Time (s)	6.0	6.0			6.0		6.0					
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Vehicle Extension (s)	3.0	3.0			3.0		3.0					
Recall Mode	C-Max	C-Max			None		None					
Act Effct Green (s)	71.0	71.0			36.0		7.0		90.0			
Actuated g/C Ratio	0.79	0.79			0.40		0.08		1.00			
v/c Ratio	0.99	0.55			0.75		1.61		0.22			
Control Delay	47.2	9.8			15.9		323.5		0.3			
Queue Delay	0.0	0.7			0.0		0.0		0.0			
Total Delay	47.2	10.5			15.9		323.5		0.3			
LOS	D	B			B		F		A			
Approach Delay		27.2			15.9							

TIP Before and After Evaluations - Franklin
 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St

7/3/2014

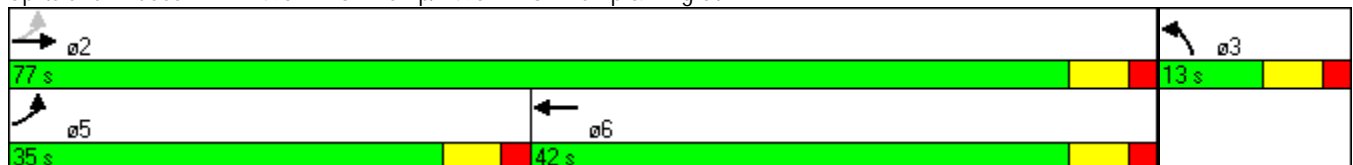


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		C			B							
Stops (vph)	510	519			351		284		0			
Fuel Used(gal)	13	10			11		29		2			
CO Emissions (g/hr)	888	716			738		2059		173			
NOx Emissions (g/hr)	173	139			144		401		34			
VOC Emissions (g/hr)	206	166			171		477		40			
Dilemma Vehicles (#)	0	0			61		0		0			
Queue Length 50th (ft)	352	341			114		~175		0			
Queue Length 95th (ft)	m#417	m409			m131		#267		0			
Internal Link Dist (ft)		645			562			884			867	
Turn Bay Length (ft)							250		300			
Base Capacity (vph)	669	1434			1342		256		1777			
Starvation Cap Reductn	0	321			0		0		0			
Spillback Cap Reductn	0	6			0		0		6			
Storage Cap Reductn	0	0			0		0		0			
Reduced v/c Ratio	0.99	0.71			0.75		1.61		0.22			

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 85 (94%), Referenced to phase 2:EBTL and 5:EBL, Start of Green
 Natural Cycle: 75
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.61
 Intersection Signal Delay: 58.1
 Intersection LOS: E
 Intersection Capacity Utilization 80.3%
 ICU Level of Service D
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 2: I-495 NB Off Ramp/I-495 NB On Ramp & King St



TIP Before and After Evaluations - Franklin
 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St

6/11/2014



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↻		↻	↻					↻		↻
Volume (veh/h)	0	848	376	319	572	0	0	0	0	82	0	408
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	922	409	347	622	0	0	0	0	89	0	443
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												5
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)		579										
pX, platoon unblocked				0.62			0.62	0.62	0.62	0.62	0.62	
vC, conflicting volume	622			922			2441	2441	1126	2441	2237	622
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	622			573			3009	3009	901	3009	2681	622
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			45			100	100	100	0	100	8
cM capacity (veh/h)	969			627			0	4	210	3	6	483

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	1330	347	622	533
Volume Left	0	347	0	89
Volume Right	409	0	0	443
cSH	1700	627	1700	16
Volume to Capacity	0.78	0.55	0.37	32.45
Queue Length 95th (ft)	0	85	0	Err
Control Delay (s)	0.0	17.6	0.0	Err
Lane LOS		C		F
Approach Delay (s)	0.0	6.3		Err
Approach LOS				F

Intersection Summary			
Average Delay		1883.0	
Intersection Capacity Utilization		108.5%	ICU Level of Service
Analysis Period (min)		15	G

TIP Before and After Evaluations - Franklin
 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St

6/11/2014



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↗		↖	↖					↖		↖
Volume (veh/h)	0	885	380	292	758	0	0	0	0	245	0	471
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	962	413	317	824	0	0	0	0	266	0	512
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												5
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)		579										
pX, platoon unblocked				0.62			0.62	0.62	0.62	0.62	0.62	
vC, conflicting volume	824			962			2627	2627	1168	2627	2421	824
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	824			638			3307	3307	969	3307	2976	824
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			47			0	100	100	0	100	0
cM capacity (veh/h)	815			596			0	2	192	2	4	375

Direction, Lane #	EB 1	WB 1	WB 2	SB 1
Volume Total	1375	317	824	778
Volume Left	0	317	0	266
Volume Right	413	0	0	512
cSH	1700	596	1700	5
Volume to Capacity	0.81	0.53	0.48	148.04
Queue Length 95th (ft)	0	78	0	Err
Control Delay (s)	0.0	17.7	0.0	Err
Lane LOS		C		F
Approach Delay (s)	0.0	4.9		Err
Approach LOS				F

Intersection Summary			
Average Delay		2363.7	
Intersection Capacity Utilization		109.5%	ICU Level of Service
Analysis Period (min)		15	H

TIP Before and After Evaluations - Franklin
 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↗		↖					↘		↗↖
Volume (vph)	0	1022	431	371	878	0	0	0	0	109	0	509
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	11	11	11	11	12	12	12	12	16	12	11
Storage Length (ft)	0		450	0		0	0		0	0		125
Storage Lanes	0		1	0		0	0		0	1		2
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00	0.88
Frt			0.850									0.850
Flt Protected					0.985					0.950		
Satd. Flow (prot)	0	3388	1487	0	3289	0	0	0	0	1948	0	2642
Flt Permitted					0.539					0.950		
Satd. Flow (perm)	0	3388	1487	0	1800	0	0	0	0	1948	0	2642
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			454									315
Link Speed (mph)		40			40			30			30	
Link Distance (ft)		579			725			1446			1006	
Travel Time (s)		9.9			12.4			32.9			22.9	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	0%	3%	5%	1%	6%	0%	0%	0%	0%	5%	0%	4%
Adj. Flow (vph)	0	1076	454	391	924	0	0	0	0	115	0	536
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1076	454	0	1315	0	0	0	0	115	0	536
Turn Type		NA	Free	pm+pt	NA					custom		custom
Protected Phases		2		1	6							
Permitted Phases			Free	6						7		4
Detector Phase		2		1	6					7		4
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0		4.0
Minimum Split (s)		20.0		10.0	20.0					10.0		26.0
Total Split (s)		36.0		27.0	63.0					27.0		27.0
Total Split (%)		40.0%		30.0%	70.0%					30.0%		30.0%
Maximum Green (s)		30.0		21.0	57.0					21.0		21.0
Yellow Time (s)		4.0		4.0	4.0					4.0		4.0
All-Red Time (s)		2.0		2.0	2.0					2.0		2.0
Lost Time Adjust (s)		0.0			0.0					0.0		0.0
Total Lost Time (s)		6.0			6.0					6.0		6.0
Lead/Lag		Lag		Lead								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		3.0		3.0	3.0					3.0		2.0
Recall Mode		None		C-Max	C-Max					None		None
Act Effect Green (s)		30.0	90.0		64.9					13.1		13.1
Actuated g/C Ratio		0.33	1.00		0.72					0.15		0.15
v/c Ratio		0.95	0.31		0.74					0.41		0.82
Control Delay		49.8	0.3		5.3					37.7		25.6
Queue Delay		0.0	0.0		0.0					0.0		0.0
Total Delay		49.8	0.3		5.3					37.7		25.6
LOS		D	A		A					D		C
Approach Delay		35.1			5.3							

TIP Before and After Evaluations - Franklin
 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St

6/11/2014

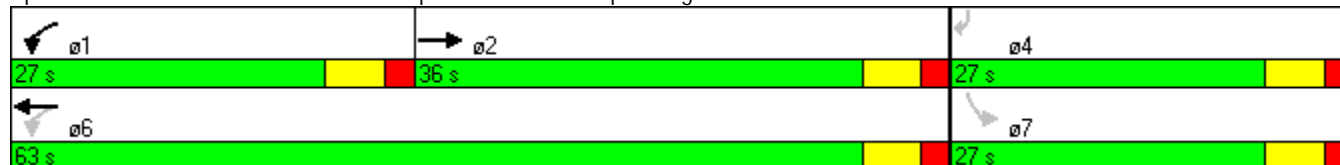


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		D			A							
Stops (vph)		966	0		405					94		209
Fuel Used(gal)		24	2		11					2		8
CO Emissions (g/hr)		1668	120		803					155		545
NOx Emissions (g/hr)		325	23		156					30		106
VOC Emissions (g/hr)		387	28		186					36		126
Dilemma Vehicles (#)		10	0		127					0		0
Queue Length 50th (ft)		348	0		73					60		68
Queue Length 95th (ft)		m#399	m0		m46					101		122
Internal Link Dist (ft)		499			645			1366			926	
Turn Bay Length (ft)			450									125
Base Capacity (vph)		1129	1487		1777					455		858
Starvation Cap Reductn		0	0		0					0		0
Spillback Cap Reductn		0	0		0					0		0
Storage Cap Reductn		0	0		0					0		0
Reduced v/c Ratio		0.95	0.31		0.74					0.25		0.62

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 12 (13%), Referenced to phase 1:WBL and 6:WBTL, Start of Green
 Natural Cycle: 110
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.95
 Intersection Signal Delay: 22.5
 Intersection LOS: C
 Intersection Capacity Utilization 82.7%
 ICU Level of Service E
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St



TIP Before and After Evaluations - Franklin
 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↗		↖					↘		↗
Volume (vph)	0	1223	481	334	892	0	0	0	0	285	0	524
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	11	11	11	11	12	12	12	12	16	12	11
Storage Length (ft)	0		450	0		0	0		0	0		125
Storage Lanes	0		1	0		0	0		0	1		2
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00	0.88
Frt			0.850									0.850
Flt Protected					0.987					0.950		
Satd. Flow (prot)	0	3455	1516	0	3395	0	0	0	0	2006	0	2592
Flt Permitted					0.505					0.950		
Satd. Flow (perm)	0	3455	1516	0	1737	0	0	0	0	2006	0	2592
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			506									324
Link Speed (mph)		40			40			30			30	
Link Distance (ft)		579			725			1446			1006	
Travel Time (s)		9.9			12.4			32.9			22.9	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	0%	1%	3%	0%	2%	0%	0%	0%	0%	2%	0%	6%
Adj. Flow (vph)	0	1287	506	352	939	0	0	0	0	300	0	552
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1287	506	0	1291	0	0	0	0	300	0	552
Turn Type		NA	Free	pm+pt	NA					custom		custom
Protected Phases		2		1	6							
Permitted Phases			Free	6						7		4
Detector Phase		2		1	6					7		4
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0		4.0
Minimum Split (s)		10.0		10.0	10.0					10.0		26.0
Total Split (s)		43.0		21.0	64.0					26.0		26.0
Total Split (%)		47.8%		23.3%	71.1%					28.9%		28.9%
Maximum Green (s)		37.0		15.0	58.0					20.0		20.0
Yellow Time (s)		4.0		4.0	4.0					4.0		4.0
All-Red Time (s)		2.0		2.0	2.0					2.0		2.0
Lost Time Adjust (s)		0.0			0.0					0.0		0.0
Total Lost Time (s)		6.0			6.0					6.0		6.0
Lead/Lag		Lag		Lead								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		3.0		3.0	3.0					3.0		2.0
Recall Mode		C-Max		Min	Min					None		None
Act Effct Green (s)		49.1	90.0		60.6					17.4		17.4
Actuated g/C Ratio		0.55	1.00		0.67					0.19		0.19
v/c Ratio		0.68	0.33		1.46dl					0.77		0.72
Control Delay		15.1	0.4		29.3					48.2		19.3
Queue Delay		0.0	0.0		0.0					1.2		0.0
Total Delay		15.1	0.4		29.3					49.3		19.3
LOS		B	A		C					D		B
Approach Delay		11.0			29.3							

TIP Before and After Evaluations - Franklin
 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St

6/11/2014

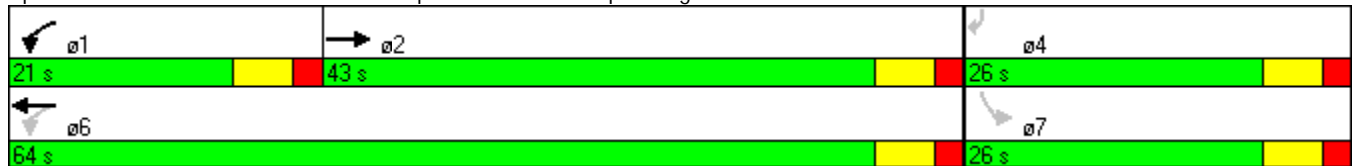


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		B			C							
Stops (vph)		697	0		598					263		208
Fuel Used(gal)		15	2		19					6		7
CO Emissions (g/hr)		1077	135		1344					453		512
NOx Emissions (g/hr)		210	26		261					88		100
VOC Emissions (g/hr)		250	31		311					105		119
Dilemma Vehicles (#)		48	0		136					0		0
Queue Length 50th (ft)		236	0		-137					161		65
Queue Length 95th (ft)		292	0		m#171					245		126
Internal Link Dist (ft)		499			645			1366			926	
Turn Bay Length (ft)			450									125
Base Capacity (vph)		1885	1516		1271					446		828
Starvation Cap Reductn		0	0		0					0		0
Spillback Cap Reductn		25	0		0					39		0
Storage Cap Reductn		0	0		0					0		0
Reduced v/c Ratio		0.69	0.33		1.02					0.74		0.67

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 69 (77%), Referenced to phase 2:EBT, Start of Green
 Natural Cycle: 110
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.02
 Intersection Signal Delay: 21.1
 Intersection LOS: C
 Intersection Capacity Utilization 97.3%
 ICU Level of Service F
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.
 dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Splits and Phases: 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St



TIP Before and After Evaluations - Franklin
 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St

7/3/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↗		↑↑					↘		↗↗
Volume (vph)	0	858	440	328	725	0	0	0	0	152	0	561
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	11	11	11	11	12	12	12	12	16	12	11
Storage Length (ft)	0		450	0		0	0		0	0		125
Storage Lanes	0		1	0		0	0		0	1		2
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00	0.88
Frt			0.850									0.850
Flt Protected					0.985					0.950		
Satd. Flow (prot)	0	3292	1473	0	3274	0	0	0	0	1948	0	2617
Flt Permitted					0.533					0.950		
Satd. Flow (perm)	0	3292	1473	0	1771	0	0	0	0	1948	0	2617
Right Turn on Red			Yes			Yes			Yes			No
Satd. Flow (RTOR)			620									
Link Speed (mph)		40			40			30			30	
Link Distance (ft)		579			725			1446			1006	
Travel Time (s)		9.9			12.4			32.9			22.9	
Peak Hour Factor	0.92	0.87	0.71	0.85	0.82	0.92	0.92	0.92	0.92	0.86	0.92	0.88
Heavy Vehicles (%)	0%	6%	6%	5%	5%	0%	0%	0%	0%	5%	0%	5%
Adj. Flow (vph)	0	986	620	386	884	0	0	0	0	177	0	638
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	986	620	0	1270	0	0	0	0	177	0	638
Turn Type		NA	Free	pm+pt	NA					custom		custom
Protected Phases		2		1	6							
Permitted Phases			Free	6						7		4
Detector Phase		2		1	6					7		4
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0		4.0
Minimum Split (s)		20.0		10.0	20.0					10.0		26.0
Total Split (s)		36.0		27.0	63.0					27.0		27.0
Total Split (%)		40.0%		30.0%	70.0%					30.0%		30.0%
Maximum Green (s)		30.0		21.0	57.0					21.0		21.0
Yellow Time (s)		4.0		4.0	4.0					4.0		4.0
All-Red Time (s)		2.0		2.0	2.0					2.0		2.0
Lost Time Adjust (s)		0.0			0.0					0.0		0.0
Total Lost Time (s)		6.0			6.0					6.0		6.0
Lead/Lag		Lag		Lead								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		3.0		3.0	3.0					3.0		2.0
Recall Mode		None		C-Max	C-Max					None		None
Act Effect Green (s)		30.0	90.0		57.0					21.0		21.0
Actuated g/C Ratio		0.33	1.00		0.63					0.23		0.23
v/c Ratio		0.90	0.42		0.86					0.39		1.04
Control Delay		44.3	0.6		12.6					32.1		83.8
Queue Delay		0.0	0.0		0.0					0.0		0.0
Total Delay		44.3	0.6		12.6					32.1		83.8
LOS		D	A		B					C		F
Approach Delay		27.4			12.6							

TIP Before and After Evaluations - Franklin
 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St

7/3/2014

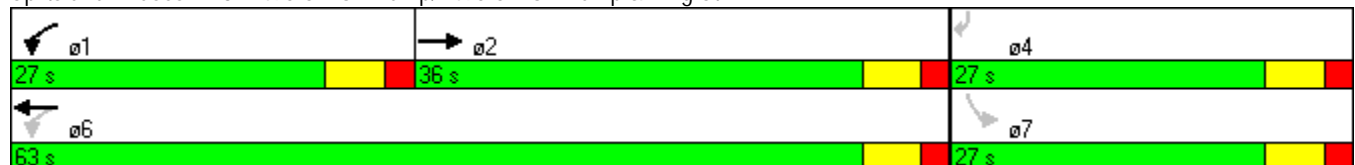


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		C				B						
Stops (vph)		814	0		821					126		480
Fuel Used(gal)		19	2		16					3		17
CO Emissions (g/hr)		1336	124		1115					202		1162
NOx Emissions (g/hr)		260	24		217					39		226
VOC Emissions (g/hr)		310	29		258					47		269
Dilemma Vehicles (#)		15	0		76					0		0
Queue Length 50th (ft)		312	0		109					85		-226
Queue Length 95th (ft)		m333	0		m88					138		#331
Internal Link Dist (ft)		499			645			1366			926	
Turn Bay Length (ft)			450									125
Base Capacity (vph)		1097	1473		1472					455		611
Starvation Cap Reductn		0	0		0					0		0
Spillback Cap Reductn		0	0		0					0		0
Storage Cap Reductn		0	0		0					0		0
Reduced v/c Ratio		0.90	0.42		0.86					0.39		1.04

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 12 (13%), Referenced to phase 1:WBL and 6:WBTL, Start of Green
 Natural Cycle: 140
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.04
 Intersection Signal Delay: 32.3
 Intersection LOS: C
 Intersection Capacity Utilization 75.0%
 ICU Level of Service D
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St



TIP Before and After Evaluations - Franklin
 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St

7/3/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↗		↑↑					↖		↗↗
Volume (vph)	0	891	403	282	801	0	0	0	0	382	0	496
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	11	11	11	11	12	12	12	12	16	12	11
Storage Length (ft)	0		450	0		0	0		0	0		125
Storage Lanes	0		1	0		0	0		0	1		2
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00	0.88
Frt			0.850									0.850
Flt Protected					0.986					0.950		
Satd. Flow (prot)	0	3421	1531	0	3341	0	0	0	0	1986	0	2668
Flt Permitted					0.507					0.950		
Satd. Flow (perm)	0	3421	1531	0	1718	0	0	0	0	1986	0	2668
Right Turn on Red			Yes			Yes			Yes			No
Satd. Flow (RTOR)			584									
Link Speed (mph)		40			40			30			30	
Link Distance (ft)		579			725			1446			1006	
Travel Time (s)		9.9			12.4			32.9			22.9	
Peak Hour Factor	0.92	0.83	0.69	0.81	0.92	0.92	0.92	0.92	0.92	0.90	0.92	0.91
Heavy Vehicles (%)	0%	2%	2%	3%	3%	0%	0%	0%	0%	3%	0%	3%
Adj. Flow (vph)	0	1073	584	348	871	0	0	0	0	424	0	545
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1073	584	0	1219	0	0	0	0	424	0	545
Turn Type		NA	Free	pm+pt	NA					custom		custom
Protected Phases		2		1	6							
Permitted Phases			Free	6						7		4
Detector Phase		2		1	6					7		4
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0		4.0
Minimum Split (s)		10.0		10.0	10.0					10.0		26.0
Total Split (s)		43.0		21.0	64.0					26.0		26.0
Total Split (%)		47.8%		23.3%	71.1%					28.9%		28.9%
Maximum Green (s)		37.0		15.0	58.0					20.0		20.0
Yellow Time (s)		4.0		4.0	4.0					4.0		4.0
All-Red Time (s)		2.0		2.0	2.0					2.0		2.0
Lost Time Adjust (s)		0.0			0.0					0.0		0.0
Total Lost Time (s)		6.0			6.0					6.0		6.0
Lead/Lag		Lag		Lead								
Lead-Lag Optimize?		Yes		Yes								
Vehicle Extension (s)		3.0		3.0	3.0					3.0		2.0
Recall Mode		C-Max		Min	Min					None		None
Act Effct Green (s)		46.5	90.0		58.0					20.0		20.0
Actuated g/C Ratio		0.52	1.00		0.64					0.22		0.22
v/c Ratio		0.61	0.38		1.26dl					0.96		0.92
Control Delay		16.8	0.4		20.8					70.7		57.2
Queue Delay		0.0	0.0		11.6					0.0		0.0
Total Delay		16.8	0.4		32.4					70.7		57.2
LOS		B	A		C					E		E
Approach Delay		11.0			32.4							

TIP Before and After Evaluations - Franklin
 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St

7/3/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		B			C							
Stops (vph)		688	0		504					330		438
Fuel Used(gal)		13	2		15					10		12
CO Emissions (g/hr)		930	113		1038					722		845
NOx Emissions (g/hr)		181	22		202					140		164
VOC Emissions (g/hr)		216	26		241					167		196
Dilemma Vehicles (#)		13	0		83					0		0
Queue Length 50th (ft)		267	0		~99					240		172
Queue Length 95th (ft)		m288	0		m92					#422		#280
Internal Link Dist (ft)		499			645			1366			926	
Turn Bay Length (ft)			450									125
Base Capacity (vph)		1768	1531		1206					441		593
Starvation Cap Reductn		0	0		0					0		0
Spillback Cap Reductn		0	0		41					0		0
Storage Cap Reductn		0	0		0					0		0
Reduced v/c Ratio		0.61	0.38		1.05					0.96		0.92

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 69 (77%), Referenced to phase 2:EBT, Start of Green
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.01
 Intersection Signal Delay: 30.9
 Intersection LOS: C
 Intersection Capacity Utilization 89.5%
 ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.
 dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Splits and Phases: 3: I-495 SB On Ramp/I-495 SB Off Ramp & King St



TIP Before and After Evaluations - Franklin
4: Upper Union St & King St

6/11/2014



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↑	↑	↑	↑	↑
Volume (vph)	871	100	644	336	46	353
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	12	11	12	11	12
Storage Length (ft)		250	325		0	0
Storage Lanes		1	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.850				0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	1801	1495	1616	1863	1711	1495
Flt Permitted			0.089		0.950	
Satd. Flow (perm)	1801	1495	151	1863	1711	1495
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		71				41
Link Speed (mph)	40			40	30	
Link Distance (ft)	1412			579	333	
Travel Time (s)	24.1			9.9	7.6	
Peak Hour Factor	0.93	0.93	0.76	0.76	0.75	0.75
Heavy Vehicles (%)	2%	8%	8%	2%	2%	8%
Adj. Flow (vph)	937	108	847	442	61	471
Shared Lane Traffic (%)						
Lane Group Flow (vph)	937	108	847	442	61	471
Turn Type	NA	Perm	pm+pt	NA	NA	pt+ov
Protected Phases	4		3	8	2	2 3
Permitted Phases		4	8			
Detector Phase	4	4	3	8	2	2 3
Switch Phase						
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	
Minimum Split (s)	12.0	12.0	12.0	12.0	11.0	
Total Split (s)	45.0	45.0	40.0	85.0	19.0	
Total Split (%)	43.3%	43.3%	38.5%	81.7%	18.3%	
Maximum Green (s)	40.0	40.0	35.0	80.0	15.0	
Yellow Time (s)	4.0	4.0	4.0	4.0	3.0	
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	
Total Lost Time (s)	5.0	5.0	5.0	5.0	4.0	
Lead/Lag	Lag	Lag	Lead			
Lead-Lag Optimize?	Yes	Yes	Yes			
Vehicle Extension (s)	3.0	3.0	2.0	2.0	3.0	
Recall Mode	Min	Min	None	Min	None	
Act Effct Green (s)	40.0	40.0	80.0	80.0	15.0	55.0
Actuated g/C Ratio	0.38	0.38	0.77	0.77	0.14	0.53
v/c Ratio	1.35	0.17	1.39	0.31	0.25	0.58
Control Delay	196.9	9.4	212.2	4.3	42.5	18.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	196.9	9.4	212.2	4.3	42.5	18.6
LOS	F	A	F	A	D	B
Approach Delay	177.5			140.9	21.4	

TIP Before and After Evaluations - Franklin
 4: Upper Union St & King St

6/11/2014

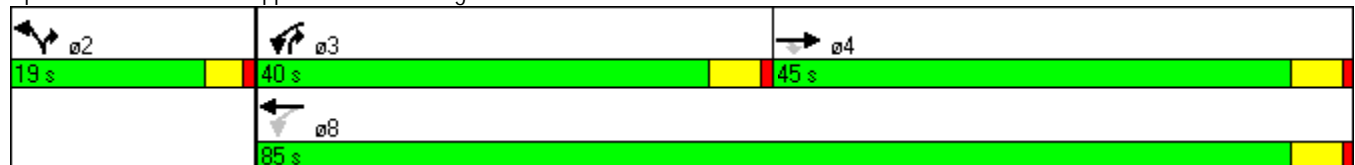


Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach LOS	F			F	C	
Stops (vph)	680	27	446	90	39	216
Fuel Used(gal)	50	1	35	2	1	3
CO Emissions (g/hr)	3491	99	2428	175	51	241
NOx Emissions (g/hr)	679	19	472	34	10	47
VOC Emissions (g/hr)	809	23	563	40	12	56
Dilemma Vehicles (#)	31	0	0	12	0	0
Queue Length 50th (ft)	~821	15	~713	73	36	185
Queue Length 95th (ft)	#1061	51	#729	83	63	211
Internal Link Dist (ft)	1332			499	253	
Turn Bay Length (ft)		250	325			
Base Capacity (vph)	693	619	609	1433	247	810
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	1.35	0.17	1.39	0.31	0.25	0.58

Intersection Summary

Area Type: Other
 Cycle Length: 104
 Actuated Cycle Length: 104
 Natural Cycle: 150
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 1.39
 Intersection Signal Delay: 132.1
 Intersection LOS: F
 Intersection Capacity Utilization 99.0%
 ICU Level of Service F
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 4: Upper Union St & King St



TIP Before and After Evaluations - Franklin
 4: Upper Union St & King St

6/11/2014



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↑	↑	↑	↑	↑
Volume (vph)	682	36	371	858	104	583
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	12	11	12	11	12
Storage Length (ft)		250	325		0	0
Storage Lanes		1	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.850				0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	1801	1495	1616	1863	1711	1495
Flt Permitted			0.089		0.950	
Satd. Flow (perm)	1801	1495	151	1863	1711	1495
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		33				52
Link Speed (mph)	40			40	30	
Link Distance (ft)	1412			579	333	
Travel Time (s)	24.1			9.9	7.6	
Peak Hour Factor	0.78	0.78	0.90	0.90	0.69	0.69
Heavy Vehicles (%)	2%	8%	8%	2%	2%	8%
Adj. Flow (vph)	874	46	412	953	151	845
Shared Lane Traffic (%)						
Lane Group Flow (vph)	874	46	412	953	151	845
Turn Type	NA	Perm	pm+pt	NA	NA	pt+ov
Protected Phases	4		3	8	2	2 3
Permitted Phases		4	8			
Detector Phase	4	4	3	8	2	2 3
Switch Phase						
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	
Minimum Split (s)	12.0	12.0	12.0	12.0	12.0	
Total Split (s)	45.0	45.0	40.0	85.0	19.0	
Total Split (%)	43.3%	43.3%	38.5%	81.7%	18.3%	
Maximum Green (s)	40.0	40.0	35.0	80.0	15.0	
Yellow Time (s)	4.0	4.0	4.0	4.0	3.0	
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	
Total Lost Time (s)	5.0	5.0	5.0	5.0	4.0	
Lead/Lag	Lag	Lag	Lead			
Lead-Lag Optimize?	Yes	Yes	Yes			
Vehicle Extension (s)	2.0	2.0	3.0	3.0	2.0	
Recall Mode	Min	Min	None	Min	None	
Act Effct Green (s)	40.0	40.0	80.0	80.0	15.0	55.0
Actuated g/C Ratio	0.38	0.38	0.77	0.77	0.14	0.53
v/c Ratio	1.26	0.08	0.68	0.67	0.61	1.04
Control Delay	159.0	9.9	26.8	8.5	53.3	65.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	159.0	9.9	26.8	8.5	53.3	65.8
LOS	F	A	C	A	D	E
Approach Delay	151.6			14.0	63.9	

TIP Before and After Evaluations - Franklin
 4: Upper Union St & King St

6/11/2014



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach LOS	F			B	E	
Stops (vph)	546	11	248	379	96	463
Fuel Used(gal)	34	1	6	9	2	12
CO Emissions (g/hr)	2375	37	414	599	135	831
NOx Emissions (g/hr)	462	7	80	117	26	162
VOC Emissions (g/hr)	550	9	96	139	31	193
Dilemma Vehicles (#)	25	0	0	31	0	0
Queue Length 50th (ft)	~733	5	179	245	96	~591
Queue Length 95th (ft)	#776	23	291	358	120	447
Internal Link Dist (ft)	1332			499	253	
Turn Bay Length (ft)		250	325			
Base Capacity (vph)	693	595	609	1433	247	815
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	1.26	0.08	0.68	0.67	0.61	1.04

Intersection Summary

Area Type: Other
 Cycle Length: 104
 Actuated Cycle Length: 104
 Natural Cycle: 130
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 1.26
 Intersection Signal Delay: 67.7
 Intersection LOS: E
 Intersection Capacity Utilization 79.5%
 ICU Level of Service D
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 4: Upper Union St & King St



TIP Before and After Evaluations - Franklin
4: Upper Union St & King St

6/11/2014



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↖↗	↑	↖	↗↗
Volume (vph)	982	198	1002	385	57	471
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	12	11	11	11	11
Storage Length (ft)		325	0		0	0
Storage Lanes		1	2		1	2
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	0.97	1.00	1.00	0.88
Frt	0.975					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3303	0	3134	1801	1711	2544
Flt Permitted			0.950		0.950	
Satd. Flow (perm)	3303	0	3134	1801	1711	2544
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	31					53
Link Speed (mph)	40			40	30	
Link Distance (ft)	1412			579	381	
Travel Time (s)	24.1			9.9	8.7	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	2%	8%	8%	2%	2%	8%
Adj. Flow (vph)	1034	208	1055	405	60	496
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1242	0	1055	405	60	496
Turn Type	NA		Prot	NA	NA	pt+ov
Protected Phases	2		1	6	8	8 1
Permitted Phases						
Detector Phase	2		1	6	8	8 1
Switch Phase						
Minimum Initial (s)	4.0		4.0	4.0	4.0	
Minimum Split (s)	10.0		10.0	10.0	10.0	
Total Split (s)	41.0		39.0	80.0	10.0	
Total Split (%)	45.6%		43.3%	88.9%	11.1%	
Maximum Green (s)	35.0		33.0	74.0	4.0	
Yellow Time (s)	4.0		4.0	4.0	4.0	
All-Red Time (s)	2.0		2.0	2.0	2.0	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	6.0		6.0	6.0	6.0	
Lead/Lag	Lag		Lead			
Lead-Lag Optimize?	Yes		Yes			
Vehicle Extension (s)	3.0		2.0	2.0	2.0	
Recall Mode	Min		C-Max	C-Max	None	
Act Effct Green (s)	35.0		33.0	74.0	4.0	43.0
Actuated g/C Ratio	0.39		0.37	0.82	0.04	0.48
v/c Ratio	0.95		0.92	0.27	0.79	0.40
Control Delay	43.1		36.9	2.2	92.5	10.4
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	43.1		36.9	2.2	92.5	10.4
LOS	D		D	A	F	B
Approach Delay	43.1			27.3	19.2	

TIP Before and After Evaluations - Franklin
 4: Upper Union St & King St

6/11/2014

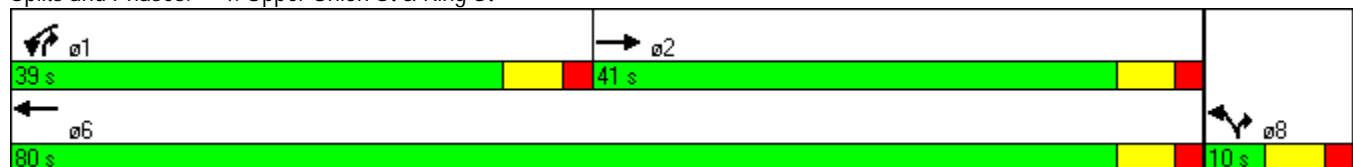


Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach LOS	D		C		B	
Stops (vph)	1009		909	87	44	355
Fuel Used(gal)	32		20	3	1	4
CO Emissions (g/hr)	2207		1426	177	104	305
NOx Emissions (g/hr)	429		277	35	20	59
VOC Emissions (g/hr)	511		330	41	24	71
Dilemma Vehicles (#)	62		0	11	0	0
Queue Length 50th (ft)	346		296	35	27	110
Queue Length 95th (ft)	#496		#422	m52	#99	148
Internal Link Dist (ft)	1332			499	301	
Turn Bay Length (ft)						
Base Capacity (vph)	1303		1149	1481	76	1243
Starvation Cap Reductn	0		0	0	0	0
Spillback Cap Reductn	0		0	0	0	0
Storage Cap Reductn	0		0	0	0	0
Reduced v/c Ratio	0.95		0.92	0.27	0.79	0.40

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 31 (34%), Referenced to phase 1:WBL and 6:WBT, Start of Green
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.95
 Intersection Signal Delay: 31.9
 Intersection LOS: C
 Intersection Capacity Utilization 80.4%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 4: Upper Union St & King St



TIP Before and After Evaluations - Franklin
4: Upper Union St & King St

6/11/2014



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↖↗	↑	↖	↗↖
Volume (vph)	764	45	474	942	183	940
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	12	11	11	11	11
Storage Length (ft)		325	0		0	0
Storage Lanes		1	2		1	2
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	0.97	1.00	1.00	0.88
Frt	0.992					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3383	0	3134	1801	1711	2544
Flt Permitted			0.950		0.950	
Satd. Flow (perm)	3383	0	3134	1801	1711	2544
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	7					102
Link Speed (mph)	40			40	30	
Link Distance (ft)	1412			579	381	
Travel Time (s)	24.1			9.9	8.7	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	2%	8%	8%	2%	2%	8%
Adj. Flow (vph)	804	47	499	992	193	989
Shared Lane Traffic (%)						
Lane Group Flow (vph)	851	0	499	992	193	989
Turn Type	NA		Prot	NA	NA	pt+ov
Protected Phases	2		1	6	8	8 1
Permitted Phases						
Detector Phase	2		1	6	8	8 1
Switch Phase						
Minimum Initial (s)	7.0		7.0	7.0	7.0	
Minimum Split (s)	13.0		13.0	13.0	15.5	
Total Split (s)	39.0		24.0	63.0	27.0	
Total Split (%)	43.3%		26.7%	70.0%	30.0%	
Maximum Green (s)	33.0		18.0	57.0	21.0	
Yellow Time (s)	4.0		4.0	4.0	4.0	
All-Red Time (s)	2.0		2.0	2.0	2.0	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	6.0		6.0	6.0	6.0	
Lead/Lag	Lag		Lead			
Lead-Lag Optimize?	Yes		Yes			
Vehicle Extension (s)	3.0		2.0	2.0	2.0	
Recall Mode	Min		None	Min	C-Max	
Act Effct Green (s)	30.0		17.3	53.3	24.7	48.0
Actuated g/C Ratio	0.33		0.19	0.59	0.27	0.53
v/c Ratio	0.75		0.83	0.93	0.41	0.70
Control Delay	30.8		43.3	22.2	24.9	17.2
Queue Delay	0.0		0.0	14.4	0.0	0.3
Total Delay	30.8		43.3	36.7	24.9	17.5
LOS	C		D	D	C	B
Approach Delay	30.8			38.9	18.7	

TIP Before and After Evaluations - Franklin
 4: Upper Union St & King St

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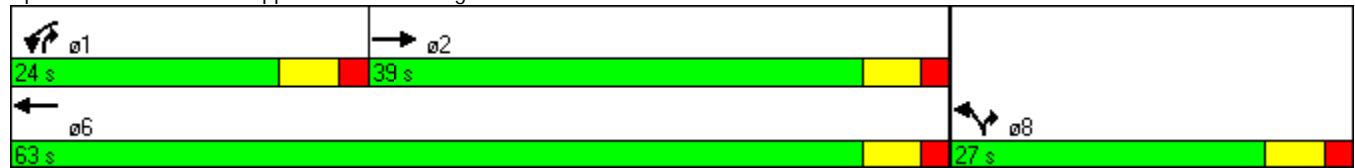


Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach LOS	C		D		B	
Stops (vph)	682		408	702	135	837
Fuel Used(gal)	20		10	15	2	11
CO Emissions (g/hr)	1364		703	1039	155	748
NOx Emissions (g/hr)	265		137	202	30	146
VOC Emissions (g/hr)	316		163	241	36	173
Dilemma Vehicles (#)	37		0	47	0	0
Queue Length 50th (ft)	210		134	365	85	283
Queue Length 95th (ft)	277		m152	m450	157	363
Internal Link Dist (ft)	1332			499	301	
Turn Bay Length (ft)						
Base Capacity (vph)	1245		627	1141	470	1424
Starvation Cap Reductn	0		0	156	0	96
Spillback Cap Reductn	0		0	0	0	0
Storage Cap Reductn	0		0	0	0	0
Reduced v/c Ratio	0.68		0.80	1.01	0.41	0.74

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 20 (22%), Referenced to phase 8:NBL, Start of Green
 Natural Cycle: 65
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.93
 Intersection Signal Delay: 30.2
 Intersection LOS: C
 Intersection Capacity Utilization 69.7%
 ICU Level of Service C
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 4: Upper Union St & King St



TIP Before and After Evaluations - Franklin
4: Constitution Blvd & King St

7/3/2014



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↖↗	↑	↖	↗↗
Volume (vph)	918	153	858	428	48	380
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	12	11	11	11	11
Storage Length (ft)		325	0		0	0
Storage Lanes		1	2		1	2
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	0.97	1.00	1.00	0.88
Frt	0.975					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3336	0	3224	1749	1531	2410
Flt Permitted			0.950		0.950	
Satd. Flow (perm)	3336	0	3224	1749	1531	2410
Right Turn on Red		Yes				No
Satd. Flow (RTOR)	30					
Link Speed (mph)	40			40	30	
Link Distance (ft)	1412			579	381	
Travel Time (s)	24.1			9.9	8.7	
Peak Hour Factor	0.85	0.71	0.74	0.85	0.63	0.88
Heavy Vehicles (%)	2%	2%	5%	5%	14%	14%
Adj. Flow (vph)	1080	215	1159	504	76	432
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1295	0	1159	504	76	432
Turn Type	NA		Prot	NA	NA	pt+ov
Protected Phases	2		1	6	8	8 1
Permitted Phases						
Detector Phase	2		1	6	8	8 1
Switch Phase						
Minimum Initial (s)	4.0		4.0	4.0	4.0	
Minimum Split (s)	10.0		10.0	10.0	10.0	
Total Split (s)	41.0		39.0	80.0	10.0	
Total Split (%)	45.6%		43.3%	88.9%	11.1%	
Maximum Green (s)	35.0		33.0	74.0	4.0	
Yellow Time (s)	4.0		4.0	4.0	4.0	
All-Red Time (s)	2.0		2.0	2.0	2.0	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	6.0		6.0	6.0	6.0	
Lead/Lag	Lag		Lead			
Lead-Lag Optimize?	Yes		Yes			
Vehicle Extension (s)	3.0		2.0	2.0	2.0	
Recall Mode	Min		C-Max	C-Max	None	
Act Effct Green (s)	35.0		33.0	74.0	4.0	43.0
Actuated g/C Ratio	0.39		0.37	0.82	0.04	0.48
v/c Ratio	0.98		0.98	0.35	1.12	0.38
Control Delay	49.1		46.3	1.9	188.2	16.2
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	49.1		46.3	1.9	188.2	16.2
LOS	D		D	A	F	B
Approach Delay	49.1			32.9	41.9	

TIP Before and After Evaluations - Franklin
 4: Constitution Blvd & King St

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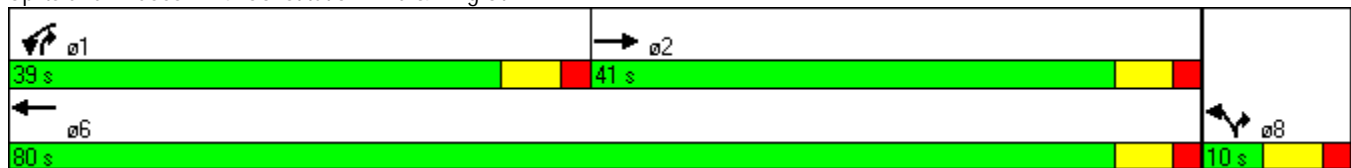


Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach LOS	D		C		D	
Stops (vph)	918		797	90	35	231
Fuel Used(gal)	30		19	3	2	4
CO Emissions (g/hr)	2095		1349	191	152	256
NOx Emissions (g/hr)	408		262	37	30	50
VOC Emissions (g/hr)	486		313	44	35	59
Dilemma Vehicles (#)	56		0	20	0	0
Queue Length 50th (ft)	368		367	40	~50	85
Queue Length 95th (ft)	#474		m329	m39	#85	121
Internal Link Dist (ft)	1332			499	301	
Turn Bay Length (ft)						
Base Capacity (vph)	1316		1182	1438	68	1151
Starvation Cap Reductn	0		0	0	0	0
Spillback Cap Reductn	0		0	0	0	0
Storage Cap Reductn	0		0	0	0	0
Reduced v/c Ratio	0.98		0.98	0.35	1.12	0.38

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 31 (34%), Referenced to phase 1:WBL and 6:WBT, Start of Green
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.12
 Intersection Signal Delay: 40.3
 Intersection LOS: D
 Intersection Capacity Utilization 73.1%
 ICU Level of Service D
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 4: Constitution Blvd & King St



TIP Before and After Evaluations - Franklin
4: Constitution Blvd & King St

7/3/2014



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↖↗	↑	↖	↗↗
Volume (vph)	421	36	327	970	168	873
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	12	11	11	11	11
Storage Length (ft)		325	0		0	0
Storage Lanes		1	2		1	2
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	0.97	1.00	1.00	0.88
Frt	0.986					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3341	0	3224	1749	1711	2694
Flt Permitted			0.950		0.950	
Satd. Flow (perm)	3341	0	3224	1749	1711	2694
Right Turn on Red		Yes				No
Satd. Flow (RTOR)	14					
Link Speed (mph)	40			40	30	
Link Distance (ft)	1412			579	381	
Travel Time (s)	24.1			9.9	8.7	
Peak Hour Factor	0.90	0.75	0.69	0.93	0.76	0.69
Heavy Vehicles (%)	3%	3%	5%	5%	2%	2%
Adj. Flow (vph)	468	48	474	1043	221	1265
Shared Lane Traffic (%)						
Lane Group Flow (vph)	516	0	474	1043	221	1265
Turn Type	NA		Prot	NA	NA	pt+ov
Protected Phases	2		1	6	8	8 1
Permitted Phases						
Detector Phase	2		1	6	8	8 1
Switch Phase						
Minimum Initial (s)	7.0		7.0	7.0	7.0	
Minimum Split (s)	13.0		13.0	13.0	15.5	
Total Split (s)	39.0		24.0	63.0	27.0	
Total Split (%)	43.3%		26.7%	70.0%	30.0%	
Maximum Green (s)	33.0		18.0	57.0	21.0	
Yellow Time (s)	4.0		4.0	4.0	4.0	
All-Red Time (s)	2.0		2.0	2.0	2.0	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	6.0		6.0	6.0	6.0	
Lead/Lag	Lag		Lead			
Lead-Lag Optimize?	Yes		Yes			
Vehicle Extension (s)	3.0		2.0	2.0	2.0	
Recall Mode	Min		None	Min	C-Max	
Act Effct Green (s)	32.4		18.0	56.4	21.6	45.6
Actuated g/C Ratio	0.36		0.20	0.63	0.24	0.51
v/c Ratio	0.43		0.73	0.95	0.54	0.93
Control Delay	22.3		34.0	27.6	35.9	34.3
Queue Delay	0.0		0.0	46.3	0.0	0.0
Total Delay	22.3		34.0	73.9	35.9	34.3
LOS	C		C	E	D	C
Approach Delay	22.3			61.4	34.5	

TIP Before and After Evaluations - Franklin
 4: Constitution Blvd & King St

7/3/2014

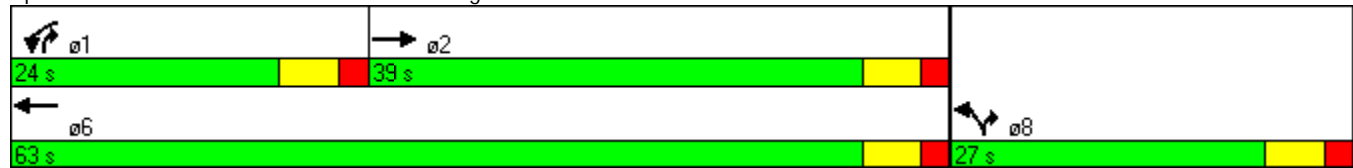


Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach LOS	C		E		C	
Stops (vph)	321		293	825	145	729
Fuel Used(gal)	10		6	17	3	13
CO Emissions (g/hr)	671		449	1214	177	889
NOx Emissions (g/hr)	131		87	236	34	173
VOC Emissions (g/hr)	156		104	281	41	206
Dilemma Vehicles (#)	19		0	46	0	0
Queue Length 50th (ft)	110		134	526	111	367
Queue Length 95th (ft)	154		m134	m572	150	299
Internal Link Dist (ft)	1332			499	301	
Turn Bay Length (ft)						
Base Capacity (vph)	1234		645	1108	410	1364
Starvation Cap Reductn	0		0	164	0	0
Spillback Cap Reductn	0		0	0	0	0
Storage Cap Reductn	0		0	0	0	0
Reduced v/c Ratio	0.42		0.73	1.10	0.54	0.93

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 20 (22%), Referenced to phase 8:NBL, Start of Green
 Natural Cycle: 80
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.95
 Intersection Signal Delay: 44.3
 Intersection LOS: D
 Intersection Capacity Utilization 70.4%
 ICU Level of Service C
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 4: Constitution Blvd & King St



TIP Before and After Evaluations - Franklin
 5: Upper Union St & Constitution Blvd

6/11/2014



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	232	10	7	167	101	643
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	252	11	8	182	110	699
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)					333	
pX, platoon unblocked						
vC, conflicting volume	656	459	809			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	656	459	809			
tC, single (s)	6.5	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.6	3.3	2.2			
p0 queue free %	39	98	99			
cM capacity (veh/h)	413	606	826			
Direction, Lane #						
	EB 1	NB 1	SB 1			
Volume Total	263	189	809			
Volume Left	252	8	0			
Volume Right	11	0	699			
cSH	418	826	1700			
Volume to Capacity	0.63	0.01	0.48			
Queue Length 95th (ft)	105	1	0			
Control Delay (s)	27.1	0.5	0.0			
Lane LOS	D	A				
Approach Delay (s)	27.1	0.5	0.0			
Approach LOS	D					
Intersection Summary						
Average Delay			5.7			
Intersection Capacity Utilization			65.1%	ICU Level of Service		C
Analysis Period (min)			15			

TIP Before and After Evaluations - Franklin
 5: Upper Union St & Constitution Blvd

6/11/2014



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	544	8	1	143	146	261
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	591	9	1	155	159	284
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (ft)					333	
pX, platoon unblocked						
vC, conflicting volume	458	301	442			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	458	301	442			
tC, single (s)	6.5	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.6	3.3	2.2			
p0 queue free %	0	99	100			
cM capacity (veh/h)	551	744	1128			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	600	157	442			
Volume Left	591	1	0			
Volume Right	9	0	284			
cSH	553	1128	1700			
Volume to Capacity	1.08	0.00	0.26			
Queue Length 95th (ft)	455	0	0			
Control Delay (s)	90.1	0.1	0.0			
Lane LOS	F	A				
Approach Delay (s)	90.1	0.1	0.0			
Approach LOS	F					
Intersection Summary						
Average Delay			45.1			
Intersection Capacity Utilization			61.0%		ICU Level of Service	B
Analysis Period (min)			15			

TIP Before and After Evaluations - Franklin
5: Upper Union St & Constitution Blvd

6/11/2014



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	270	10	9	258	458	742
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11
Lane Util. Factor	0.97	0.95	0.95	0.95	1.00	0.88
Frt	0.994					0.850
Flt Protected	0.954			0.998		
Satd. Flow (prot)	3055	0	0	3353	1837	2592
Flt Permitted	0.954			0.941		
Satd. Flow (perm)	3055	0	0	3161	1837	2592
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	5					713
Link Speed (mph)	30			30	30	
Link Distance (ft)	721			755	381	
Travel Time (s)	16.4			17.2	8.7	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	11%	0%	0%	4%	0%	6%
Adj. Flow (vph)	284	11	9	272	482	781
Shared Lane Traffic (%)						
Lane Group Flow (vph)	295	0	0	281	482	781
Turn Type	NA		Perm	NA	NA	Free
Protected Phases	4			2	6	
Permitted Phases			2			Free
Detector Phase	4		2	2	6	
Switch Phase						
Minimum Initial (s)	4.0		4.0	4.0	4.0	
Minimum Split (s)	10.0		10.0	10.0	10.0	
Total Split (s)	35.0		55.0	55.0	55.0	
Total Split (%)	38.9%		61.1%	61.1%	61.1%	
Maximum Green (s)	29.0		49.0	49.0	49.0	
Yellow Time (s)	4.0		4.0	4.0	4.0	
All-Red Time (s)	2.0		2.0	2.0	2.0	
Lost Time Adjust (s)	0.0			0.0	0.0	
Total Lost Time (s)	6.0			6.0	6.0	
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Recall Mode	None		Min	Min	C-Max	
Act Effect Green (s)	13.9			64.1	64.1	90.0
Actuated g/C Ratio	0.15			0.71	0.71	1.00
v/c Ratio	0.62			0.12	0.37	0.30
Control Delay	40.4			4.6	2.1	0.1
Queue Delay	0.0			0.0	0.6	0.0
Total Delay	40.4			4.6	2.7	0.1
LOS	D			A	A	A
Approach Delay	40.4			4.6	1.1	
Approach LOS	D			A	A	
Stops (vph)	248			79	49	0
Fuel Used(gal)	5			2	2	2

TIP Before and After Evaluations - Franklin
 5: Upper Union St & Constitution Blvd

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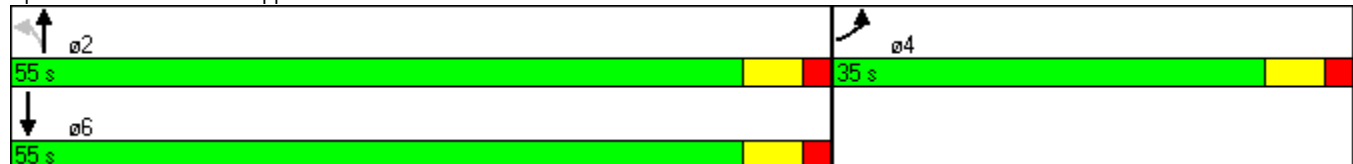


Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
CO Emissions (g/hr)	367			158	128	155
NOx Emissions (g/hr)	71			31	25	30
VOC Emissions (g/hr)	85			37	30	36
Dilemma Vehicles (#)	0			0	0	0
Queue Length 50th (ft)	80			22	33	0
Queue Length 95th (ft)	115			41	m37	m0
Internal Link Dist (ft)	641			675	301	
Turn Bay Length (ft)						
Base Capacity (vph)	988			2251	1308	2592
Starvation Cap Reductn	0			0	461	0
Spillback Cap Reductn	0			0	0	0
Storage Cap Reductn	0			0	0	0
Reduced v/c Ratio	0.30			0.12	0.57	0.30

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 40 (44%), Referenced to phase 6:SBT, Start of Green
 Natural Cycle: 40
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.62
 Intersection Signal Delay: 8.0
 Intersection LOS: A
 Intersection Capacity Utilization 42.1%
 ICU Level of Service A
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Upper Union St & Constitution Blvd



TIP Before and After Evaluations - Franklin
5: Upper Union St & Constitution Blvd

6/11/2014



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	630	12	3	493	225	294
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11
Lane Util. Factor	0.97	0.95	0.95	0.95	1.00	0.88
Frt	0.997					0.850
Flt Protected	0.953					
Satd. Flow (prot)	3168	0	0	3293	1717	2329
Flt Permitted	0.953			0.953		
Satd. Flow (perm)	3168	0	0	3138	1717	2329
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	3					309
Link Speed (mph)	30			30	30	
Link Distance (ft)	721			755	381	
Travel Time (s)	16.4			17.2	8.7	
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	7%	0%	0%	6%	7%	18%
Adj. Flow (vph)	663	13	3	519	237	309
Shared Lane Traffic (%)						
Lane Group Flow (vph)	676	0	0	522	237	309
Turn Type	NA		Perm	NA	NA	Free
Protected Phases	4			2	6	
Permitted Phases			2			Free
Detector Phase	4		2	2	6	
Switch Phase						
Minimum Initial (s)	4.0		4.0	4.0	4.0	
Minimum Split (s)	10.0		10.0	10.0	10.0	
Total Split (s)	47.0		43.0	43.0	43.0	
Total Split (%)	52.2%		47.8%	47.8%	47.8%	
Maximum Green (s)	41.0		37.0	37.0	37.0	
Yellow Time (s)	4.0		4.0	4.0	4.0	
All-Red Time (s)	2.0		2.0	2.0	2.0	
Lost Time Adjust (s)	0.0			0.0	0.0	
Total Lost Time (s)	6.0			6.0	6.0	
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Recall Mode	C-Max		Min	Min	Min	
Act Effct Green (s)	56.8			21.2	21.2	90.0
Actuated g/C Ratio	0.63			0.24	0.24	1.00
v/c Ratio	0.34			0.71	0.59	0.13
Control Delay	9.0			36.6	26.5	0.1
Queue Delay	0.0			0.0	0.0	0.0
Total Delay	9.0			36.6	26.5	0.1
LOS	A			D	C	A
Approach Delay	9.0			36.6	11.6	
Approach LOS	A			D	B	
Stops (vph)	289			433	218	0
Fuel Used(gal)	6			9	3	1

TIP Before and After Evaluations - Franklin
 5: Upper Union St & Constitution Blvd

6/11/2014

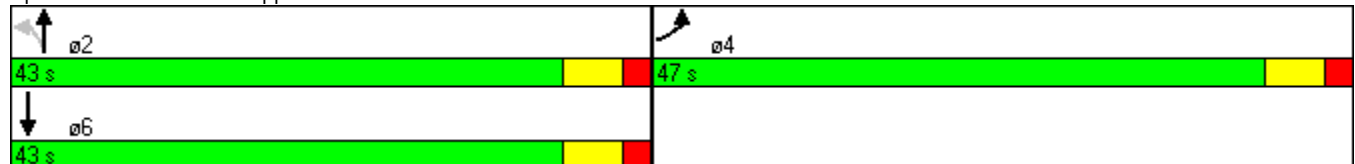


Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
CO Emissions (g/hr)	446			630	216	61
NOx Emissions (g/hr)	87			123	42	12
VOC Emissions (g/hr)	103			146	50	14
Dilemma Vehicles (#)	0			0	0	0
Queue Length 50th (ft)	84			143	141	0
Queue Length 95th (ft)	139			180	m179	m0
Internal Link Dist (ft)	641			675	301	
Turn Bay Length (ft)						
Base Capacity (vph)	2001			1290	706	2329
Starvation Cap Reductn	0			0	0	0
Spillback Cap Reductn	72			0	0	0
Storage Cap Reductn	0			0	0	0
Reduced v/c Ratio	0.35			0.40	0.34	0.13

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 34 (38%), Referenced to phase 4:EBL, Start of Green
 Natural Cycle: 40
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.71
 Intersection Signal Delay: 18.1
 Intersection LOS: B
 Intersection Capacity Utilization 44.1%
 ICU Level of Service A
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Upper Union St & Constitution Blvd



TIP Before and After Evaluations - Franklin
 5: Constitution Blvd & Upper Union St

7/3/2014



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	317	111	3	107	904
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.50	0.91	0.75	0.38	0.76	0.86
Hourly flow rate (vph)	0	348	148	8	141	1051
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						381
pX, platoon unblocked						
vC, conflicting volume	959	78			156	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	959	78			156	
tC, single (s)	6.8	6.9			4.2	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	64			90	
cM capacity (veh/h)	229	967			1414	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	348	99	57	141	526	526
Volume Left	0	0	0	141	0	0
Volume Right	348	0	8	0	0	0
cSH	967	1700	1700	1414	1700	1700
Volume to Capacity	0.36	0.06	0.03	0.10	0.31	0.31
Queue Length 95th (ft)	41	0	0	8	0	0
Control Delay (s)	10.8	0.0	0.0	7.8	0.0	0.0
Lane LOS	B			A		
Approach Delay (s)	10.8	0.0		0.9		
Approach LOS	B					

Intersection Summary						
Average Delay			2.9			
Intersection Capacity Utilization			29.6%	ICU Level of Service		A
Analysis Period (min)			15			

TIP Before and After Evaluations - Franklin
5: Constitution Blvd & Upper Union St

7/3/2014



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations		↗	↕↗		↖	↕↖
Volume (veh/h)	0	125	916	19	232	131
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.91	0.67	0.79	0.78	0.73
Hourly flow rate (vph)	0	137	1367	24	297	179
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						381
pX, platoon unblocked						
vC, conflicting volume	2064	696			1391	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2064	696			1391	
tC, single (s)	6.8	6.9			4.4	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.4	
p0 queue free %	100	64			30	
cM capacity (veh/h)	15	387			426	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	137	911	480	297	90	90
Volume Left	0	0	0	297	0	0
Volume Right	137	0	24	0	0	0
cSH	387	1700	1700	426	1700	1700
Volume to Capacity	0.36	0.54	0.28	0.70	0.05	0.05
Queue Length 95th (ft)	39	0	0	131	0	0
Control Delay (s)	19.4	0.0	0.0	30.8	0.0	0.0
Lane LOS	C			D		
Approach Delay (s)	19.4	0.0		19.2		
Approach LOS	C					

Intersection Summary						
Average Delay			5.9			
Intersection Capacity Utilization			45.4%	ICU Level of Service		A
Analysis Period (min)			15			

TIP Before and After Evaluations - Hanover
 1: Route 53 & Old Washington St

6/11/2014



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	258	105	61	795	442	77
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	8	8	12	12	12	10
Storage Length (ft)	50	0	0			100
Storage Lanes	1	1	0			1
Taper Length (ft)	25		25			
Lane Util. Factor	1.00	1.00	0.95	0.95	0.95	1.00
Frt		0.850				0.850
Flt Protected	0.950			0.996		
Satd. Flow (prot)	1564	1400	0	3562	3574	1507
Flt Permitted	0.950			0.881		
Satd. Flow (perm)	1564	1400	0	3151	3574	1507
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		114				82
Link Speed (mph)	35			40	40	
Link Distance (ft)	588			606	643	
Travel Time (s)	11.5			10.3	11.0	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.94	0.94
Heavy Vehicles (%)	0%	0%	0%	1%	1%	0%
Adj. Flow (vph)	280	114	66	864	470	82
Shared Lane Traffic (%)						
Lane Group Flow (vph)	280	114	0	930	470	82
Turn Type	NA	custom	Perm	NA	NA	Perm
Protected Phases				2	6	
Permitted Phases	4	4	2			6
Detector Phase	4	4	2	2	6	6
Switch Phase						
Minimum Initial (s)	8.0	8.0	35.0	35.0	35.0	35.0
Minimum Split (s)	14.0	14.0	41.0	41.0	41.0	41.0
Total Split (s)	31.0	31.0	41.0	41.0	41.0	41.0
Total Split (%)	43.1%	43.1%	56.9%	56.9%	56.9%	56.9%
Maximum Green (s)	25.0	25.0	35.0	35.0	35.0	35.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0		6.0	6.0	6.0
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	Max	Max	Max	Max
Act Effct Green (s)	16.3	16.3		35.2	35.2	35.2
Actuated g/C Ratio	0.26	0.26		0.55	0.55	0.55
v/c Ratio	0.70	0.26		0.53	0.24	0.09
Control Delay	30.9	5.6		11.4	8.6	2.8
Queue Delay	0.0	0.0		0.0	0.0	0.0
Total Delay	30.9	5.6		11.4	8.6	2.8
LOS	C	A		B	A	A
Approach Delay	23.6			11.4	7.7	

TIP Before and After Evaluations - Hanover
 1: Route 53 & Old Washington St

6/11/2014



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Approach LOS	C		B		A	
Stops (vph)	218	18		512	213	10
Fuel Used(gal)	4	1		11	5	0
CO Emissions (g/hr)	305	49		736	335	33
NOx Emissions (g/hr)	59	10		143	65	7
VOC Emissions (g/hr)	71	11		171	78	8
Dilemma Vehicles (#)	0	0		67	34	0
Queue Length 50th (ft)	97	0		107	43	0
Queue Length 95th (ft)	168	31		202	88	19
Internal Link Dist (ft)	508		526		563	
Turn Bay Length (ft)	50				100	
Base Capacity (vph)	618	622		1743	1977	870
Starvation Cap Reductn	0	0		0	0	0
Spillback Cap Reductn	0	0		0	0	0
Storage Cap Reductn	0	0		0	0	0
Reduced v/c Ratio	0.45	0.18		0.53	0.24	0.09

Intersection Summary

Area Type: Other
 Cycle Length: 72
 Actuated Cycle Length: 63.6
 Natural Cycle: 60
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 0.70
 Intersection Signal Delay: 12.9
 Intersection LOS: B
 Intersection Capacity Utilization 87.6%
 ICU Level of Service E
 Analysis Period (min) 15

Splits and Phases: 1: Route 53 & Old Washington St



TIP Before and After Evaluations - Hanover
 1: Route 53 & Old Washington St

6/11/2014



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	185	90	92	651	1042	250
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	8	8	12	12	12	10
Storage Length (ft)	50	0	0			100
Storage Lanes	1	1	0			1
Taper Length (ft)	25		25			
Lane Util. Factor	1.00	1.00	0.95	0.95	0.95	1.00
Frt		0.850				0.850
Flt Protected	0.950			0.994		
Satd. Flow (prot)	1564	1400	0	3557	3574	1507
Flt Permitted	0.950			0.682		
Satd. Flow (perm)	1564	1400	0	2441	3574	1507
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		51				222
Link Speed (mph)	35			40	40	
Link Distance (ft)	588			606	643	
Travel Time (s)	11.5			10.3	11.0	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.94	0.94
Heavy Vehicles (%)	0%	0%	0%	1%	1%	0%
Adj. Flow (vph)	201	98	100	708	1109	266
Shared Lane Traffic (%)						
Lane Group Flow (vph)	201	98	0	808	1109	266
Turn Type	NA	custom	Perm	NA	NA	Perm
Protected Phases				2	6	
Permitted Phases	4	4	2			6
Detector Phase	4	4	2	2	6	6
Switch Phase						
Minimum Initial (s)	8.0	8.0	35.0	35.0	35.0	35.0
Minimum Split (s)	14.0	14.0	41.0	41.0	41.0	41.0
Total Split (s)	31.0	31.0	41.0	41.0	41.0	41.0
Total Split (%)	43.1%	43.1%	56.9%	56.9%	56.9%	56.9%
Maximum Green (s)	25.0	25.0	35.0	35.0	35.0	35.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0		6.0	6.0	6.0
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	Max	Max	Max	Max
Act Effect Green (s)	12.8	12.8		35.1	35.1	35.1
Actuated g/C Ratio	0.21	0.21		0.58	0.58	0.58
v/c Ratio	0.60	0.29		0.57	0.53	0.27
Control Delay	29.0	13.1		10.4	9.3	2.7
Queue Delay	0.0	0.0		0.0	0.0	0.0
Total Delay	29.0	13.1		10.4	9.3	2.7
LOS	C	B		B	A	A
Approach Delay	23.8			10.4	8.0	

TIP Before and After Evaluations - Hanover
 1: Route 53 & Old Washington St

6/11/2014



Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Approach LOS	C		B		A	
Stops (vph)	156	39		435	580	31
Fuel Used(gal)	3	1		9	12	2
CO Emissions (g/hr)	213	64		623	854	107
NOx Emissions (g/hr)	42	12		121	166	21
VOC Emissions (g/hr)	49	15		144	198	25
Dilemma Vehicles (#)	0	0		61	86	0
Queue Length 50th (ft)	66	14		82	110	6
Queue Length 95th (ft)	123	47		163	199	39
Internal Link Dist (ft)	508			526	563	
Turn Bay Length (ft)	50					100
Base Capacity (vph)	654	615		1429	2093	974
Starvation Cap Reductn	0	0		0	0	0
Spillback Cap Reductn	0	0		0	0	0
Storage Cap Reductn	0	0		0	0	0
Reduced v/c Ratio	0.31	0.16		0.57	0.53	0.27

Intersection Summary

Area Type: Other
 Cycle Length: 72
 Actuated Cycle Length: 60
 Natural Cycle: 55
 Control Type: Semi Act-Uncoord
 Maximum v/c Ratio: 0.60
 Intersection Signal Delay: 10.7
 Intersection LOS: B
 Intersection Capacity Utilization 83.6%
 ICU Level of Service E
 Analysis Period (min) 15

Splits and Phases: 1: Route 53 & Old Washington St



TIP Before and After Evaluations - Hanover
 1: Route 53 & Old Washington St/Pond St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕		↗	↕↗		↗	↕↗	
Volume (vph)	271	5	110	5	5	5	64	836	5	5	465	81
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	8	12	8	12	12	12	12	12	12	12	12	10
Storage Length (ft)	0		100	0		0	310		0	0		100
Storage Lanes	0		1	0		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt			0.850		0.955			0.999			0.978	
Flt Protected		0.953			0.984		0.950			0.950		
Satd. Flow (prot)	0	1810	1400	0	1750	0	1805	3570	0	1770	3501	0
Flt Permitted		0.719			0.874		0.371			0.253		
Satd. Flow (perm)	0	1366	1400	0	1555	0	705	3570	0	471	3501	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			120		5			1				34
Link Speed (mph)		35			30			40				40
Link Distance (ft)		588			229			606				643
Travel Time (s)		11.5			5.2			10.3				11.0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.94
Heavy Vehicles (%)	0%	2%	0%	2%	2%	2%	0%	1%	2%	2%	1%	0%
Adj. Flow (vph)	295	5	120	5	5	5	70	909	5	5	495	86
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	300	120	0	15	0	70	914	0	5	581	0
Turn Type	Perm	NA	Perm	Perm	NA		pm+pt	NA		pm+pt	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8			2			6		
Detector Phase	4	4	4	8	8		5	2		1	6	
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0	6.0	6.0		6.0	10.0		6.0	10.0	
Minimum Split (s)	12.0	12.0	12.0	12.0	12.0		11.0	16.0		11.0	16.0	
Total Split (s)	24.0	24.0	24.0	24.0	24.0		11.0	25.0		11.0	25.0	
Total Split (%)	40.0%	40.0%	40.0%	40.0%	40.0%		18.3%	41.7%		18.3%	41.7%	
Maximum Green (s)	18.0	18.0	18.0	18.0	18.0		6.0	19.0		6.0	19.0	
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0		1.0	2.0		1.0	2.0	
Lost Time Adjust (s)		0.0	0.0		0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)		6.0	6.0		6.0		5.0	6.0		5.0	6.0	
Lead/Lag							Lead	Lag		Lead	Lag	
Lead-Lag Optimize?							Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None	None	None	None		None	Max		None	Max	
Act Effct Green (s)		15.2	15.2		15.2		25.6	23.5		23.8	19.6	
Actuated g/C Ratio		0.29	0.29		0.29		0.48	0.44		0.45	0.37	
v/c Ratio		0.77	0.25		0.03		0.15	0.58		0.01	0.44	
Control Delay		33.5	5.4		12.9		8.2	14.7		7.4	15.0	
Queue Delay		0.0	0.0		0.0		0.0	0.0		0.0	0.0	
Total Delay		33.5	5.4		12.9		8.2	14.7		7.4	15.0	
LOS		C	A		B		A	B		A	B	
Approach Delay		25.5			12.9			14.2			14.9	

TIP Before and After Evaluations - Hanover
 1: Route 53 & Old Washington St/Pond St

6/11/2014

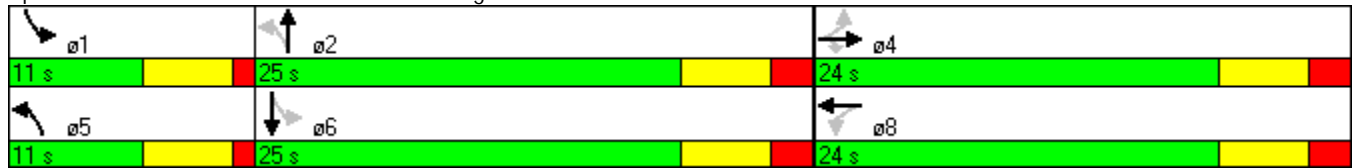


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		C			B			B			B	
Stops (vph)		223	20		9		32	564		4	367	
Fuel Used(gal)		5	1		0		1	12		0	8	
CO Emissions (g/hr)		331	52		8		48	805		5	535	
NOx Emissions (g/hr)		64	10		2		9	157		1	104	
VOC Emissions (g/hr)		77	12		2		11	187		1	124	
Dilemma Vehicles (#)		22	0		0		0	70		0	50	
Queue Length 50th (ft)		96	0		3		12	107		1	83	
Queue Length 95th (ft)		#206	31		14		28	#234		5	125	
Internal Link Dist (ft)		508			149			526			563	
Turn Bay Length (ft)			100				310					
Base Capacity (vph)		478	568		548		468	1582		363	1315	
Starvation Cap Reductn		0	0		0		0	0		0	0	
Spillback Cap Reductn		0	0		0		0	0		0	0	
Storage Cap Reductn		0	0		0		0	0		0	0	
Reduced v/c Ratio		0.63	0.21		0.03		0.15	0.58		0.01	0.44	

Intersection Summary

Area Type: Other
 Cycle Length: 60
 Actuated Cycle Length: 53
 Natural Cycle: 60
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.77
 Intersection Signal Delay: 16.8
 Intersection LOS: B
 Intersection Capacity Utilization 64.4%
 ICU Level of Service C
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Route 53 & Old Washington St/Pond St



TIP Before and After Evaluations - Hanover
 1: Route 53 & Old Washington St/Pond St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕		↖	↕↗		↖	↕↗	
Volume (vph)	194	5	95	5	5	5	97	684	5	5	1095	263
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	8	12	8	12	12	12	12	12	12	12	12	10
Storage Length (ft)	0		100	0		0	310		0	0		100
Storage Lanes	0		1	0		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt			0.850		0.955			0.999				0.971
Flt Protected		0.953			0.984		0.950			0.950		
Satd. Flow (prot)	0	1810	1400	0	1750	0	1805	3570	0	1770	3477	0
Flt Permitted		0.720			0.879		0.122			0.368		
Satd. Flow (perm)	0	1367	1400	0	1564	0	232	3570	0	685	3477	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			103		5			1				54
Link Speed (mph)		35			30			40				40
Link Distance (ft)		588			229			606				643
Travel Time (s)		11.5			5.2			10.3				11.0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.94
Heavy Vehicles (%)	0%	2%	0%	2%	2%	2%	0%	1%	2%	2%	1%	0%
Adj. Flow (vph)	211	5	103	5	5	5	105	743	5	5	1165	280
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	216	103	0	15	0	105	748	0	5	1445	0
Turn Type	Perm	NA	Perm	Perm	NA		pm+pt	NA		pm+pt	NA	
Protected Phases		4			8		5	2		1		6
Permitted Phases	4		4	8			2			6		
Detector Phase	4	4	4	8	8		5	2		1		6
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0	6.0	6.0		6.0	10.0		6.0		10.0
Minimum Split (s)	12.0	12.0	12.0	12.0	12.0		11.0	16.0		11.0		16.0
Total Split (s)	22.0	22.0	22.0	22.0	22.0		11.0	32.0		11.0		32.0
Total Split (%)	33.8%	33.8%	33.8%	33.8%	33.8%		16.9%	49.2%		16.9%		49.2%
Maximum Green (s)	16.0	16.0	16.0	16.0	16.0		6.0	26.0		6.0		26.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0		4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0		1.0	2.0		1.0		2.0
Lost Time Adjust (s)		0.0	0.0		0.0		0.0	0.0		0.0		0.0
Total Lost Time (s)		6.0	6.0		6.0		5.0	6.0		5.0		6.0
Lead/Lag							Lead	Lag		Lead		Lag
Lead-Lag Optimize?							Yes	Yes		Yes		Yes
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0		3.0
Recall Mode	None	None	None	None	None		None	Max		None		Max
Act Effct Green (s)		13.4	13.4		13.4		34.9	32.7		32.0		26.5
Actuated g/C Ratio		0.22	0.22		0.22		0.58	0.54		0.53		0.44
v/c Ratio		0.71	0.26		0.04		0.36	0.39		0.01		0.93
Control Delay		36.8	6.9		16.2		10.1	10.0		5.8		30.8
Queue Delay		0.0	0.0		0.0		0.0	0.0		0.0		0.0
Total Delay		36.8	6.9		16.2		10.1	10.0		5.8		30.8
LOS		D	A		B		B	A		A		C
Approach Delay		27.2			16.2			10.0				30.7

TIP Before and After Evaluations - Hanover
 1: Route 53 & Old Washington St/Pond St

6/11/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		C			B			A			C	
Stops (vph)		170	19		11		40	374		3	1027	
Fuel Used(gal)		4	1		0		1	8		0	25	
CO Emissions (g/hr)		253	48		9		69	552		4	1715	
NOx Emissions (g/hr)		49	9		2		13	107		1	334	
VOC Emissions (g/hr)		59	11		2		16	128		1	398	
Dilemma Vehicles (#)		14	0		0		0	48		0	103	
Queue Length 50th (ft)		77	0		3		16	73		1	~284	
Queue Length 95th (ft)		#159	33		16		36	162		4	#446	
Internal Link Dist (ft)		508			149			526			563	
Turn Bay Length (ft)			100				310					
Base Capacity (vph)		368	452		425		293	1935		473	1554	
Starvation Cap Reductn		0	0		0		0	0		0	0	
Spillback Cap Reductn		0	0		0		0	0		0	0	
Storage Cap Reductn		0	0		0		0	0		0	0	
Reduced v/c Ratio		0.59	0.23		0.04		0.36	0.39		0.01	0.93	

Intersection Summary

Area Type: Other
 Cycle Length: 65
 Actuated Cycle Length: 60.4
 Natural Cycle: 60
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.93
 Intersection Signal Delay: 23.5
 Intersection LOS: C
 Intersection Capacity Utilization 75.9%
 ICU Level of Service D
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Route 53 & Old Washington St/Pond St



TIP Before and After Evaluations - Hanover
 1: Route 53 & Old Washington St/Pond St

7/9/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕		↗	↕↗		↗	↕↗	
Volume (vph)	223	6	51	5	4	1	32	741	1	2	399	98
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	8	12	8	12	12	12	12	12	12	12	12	10
Storage Length (ft)	0		100	0		0	310		0	0		100
Storage Lanes	0		1	0		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt			0.850		0.977			0.999			0.965	
Flt Protected		0.954			0.976		0.950			0.950		
Satd. Flow (prot)	0	1795	1386	0	1647	0	1770	3536	0	1719	3318	0
Flt Permitted		0.717			0.821		0.297			0.246		
Satd. Flow (perm)	0	1349	1386	0	1385	0	553	3536	0	445	3318	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			96		4			1			71	
Link Speed (mph)		35			30			40			40	
Link Distance (ft)		588			229			606			643	
Travel Time (s)		11.5			5.2			10.3			11.0	
Peak Hour Factor	0.73	0.50	0.53	0.42	0.50	0.25	0.67	0.78	0.25	0.25	0.79	0.64
Heavy Vehicles (%)	1%	1%	1%	10%	10%	10%	2%	2%	2%	5%	5%	5%
Adj. Flow (vph)	305	12	96	12	8	4	48	950	4	8	505	153
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	317	96	0	24	0	48	954	0	8	658	0
Turn Type	Perm	NA	pm+ov	Perm	NA		pm+pt	NA		pm+pt	NA	
Protected Phases		4	5		8		5	2		1	6	
Permitted Phases	4		4	8			2			6		
Detector Phase	4	4	5	8	8		5	2		1	6	
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0	6.0	6.0		6.0	10.0		6.0	10.0	
Minimum Split (s)	12.0	12.0	11.0	12.0	12.0		11.0	16.0		11.0	16.0	
Total Split (s)	24.0	24.0	11.0	24.0	24.0		11.0	25.0		11.0	25.0	
Total Split (%)	40.0%	40.0%	18.3%	40.0%	40.0%		18.3%	41.7%		18.3%	41.7%	
Maximum Green (s)	19.0	19.0	6.0	19.0	19.0		6.0	20.0		6.0	20.0	
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)		0.0	0.0		0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)		5.0	5.0		5.0		5.0	5.0		5.0	5.0	
Lead/Lag			Lead				Lead	Lag		Lead	Lag	
Lead-Lag Optimize?			Yes				Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None	None	None	None		None	Max		None	Max	
Act Effct Green (s)		16.4	27.7		16.4		27.8	26.7		25.0	20.5	
Actuated g/C Ratio		0.30	0.50		0.30		0.50	0.48		0.45	0.37	
v/c Ratio		0.79	0.13		0.06		0.12	0.56		0.02	0.52	
Control Delay		35.5	2.6		13.2		8.0	13.7		7.5	15.3	
Queue Delay		0.0	0.0		0.0		0.0	0.0		0.0	0.0	
Total Delay		35.5	2.6		13.2		8.0	13.7		7.5	15.3	
LOS		D	A		B		A	B		A	B	
Approach Delay		27.9			13.2			13.5			15.2	

TIP Before and After Evaluations - Hanover
 1: Route 53 & Old Washington St/Pond St

7/9/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach LOS		C			B			B			B	
Stops (vph)		188	7		7		17	478		2	331	
Fuel Used(gal)		4	0		0		0	10		0	7	
CO Emissions (g/hr)		283	21		6		25	687		2	487	
NOx Emissions (g/hr)		55	4		1		5	134		0	95	
VOC Emissions (g/hr)		66	5		1		6	159		1	113	
Dilemma Vehicles (#)		18	0		0		0	56		0	44	
Queue Length 50th (ft)		101	0		5		8	110		1	88	
Queue Length 95th (ft)		83	4		10		15	185		2	113	
Internal Link Dist (ft)		508			149			526			563	
Turn Bay Length (ft)			100				310					
Base Capacity (vph)		474	741		489		413	1705		342	1273	
Starvation Cap Reductn		0	0		0		0	0		0	0	
Spillback Cap Reductn		0	0		0		0	0		0	0	
Storage Cap Reductn		0	0		0		0	0		0	0	
Reduced v/c Ratio		0.67	0.13		0.05		0.12	0.56		0.02	0.52	

Intersection Summary

Area Type:	Other
Cycle Length:	60
Actuated Cycle Length:	55.4
Natural Cycle:	60
Control Type:	Actuated-Uncoordinated
Maximum v/c Ratio:	0.79
Intersection Signal Delay:	16.9
Intersection LOS:	B
Intersection Capacity Utilization	54.3%
ICU Level of Service	A
Analysis Period (min)	15

Splits and Phases: 1: Route 53 & Old Washington St/Pond St



TIP Before and After Evaluations - Hanover
 1: Route 53 & Old Washington St/Pond St

7/9/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕		↗	↕↗		↗	↕↗	
Volume (vph)	236	0	85	1	0	0	65	608	1	0	1127	342
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	8	12	8	12	12	12	12	12	12	12	12	10
Storage Length (ft)	0		100	0		0	310		0	0		100
Storage Lanes	0		1	0		0	1		0	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	0.95
Frt			0.850					0.999			0.963	
Flt Protected		0.950			0.950		0.950					
Satd. Flow (prot)	0	1805	1400	0	1805	0	1787	3571	0	1881	3442	0
Flt Permitted		0.755			0.510		0.123					
Satd. Flow (perm)	0	1434	1400	0	969	0	231	3571	0	1881	3442	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			20					1				84
Link Speed (mph)		35			30			40				40
Link Distance (ft)		588			229			606				643
Travel Time (s)		11.5			5.2			10.3				11.0
Peak Hour Factor	0.98	0.92	0.82	0.25	0.92	0.92	0.74	0.84	0.25	0.92	0.92	0.85
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%
Adj. Flow (vph)	241	0	104	4	0	0	88	724	4	0	1225	402
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	241	104	0	4	0	88	728	0	0	1627	0
Turn Type	Perm	NA	pm+ov	Perm	NA		pm+pt	NA		pm+pt	NA	
Protected Phases		4	5		8		5	2		1	6	
Permitted Phases	4		4	8			2			6		
Detector Phase	4	4	5	8	8		5	2		1	6	
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0	6.0	6.0		6.0	10.0		6.0	10.0	
Minimum Split (s)	12.0	12.0	11.0	12.0	12.0		11.0	16.0		11.0	16.0	
Total Split (s)	22.0	22.0	11.0	22.0	22.0		11.0	32.0		11.0	32.0	
Total Split (%)	33.8%	33.8%	16.9%	33.8%	33.8%		16.9%	49.2%		16.9%	49.2%	
Maximum Green (s)	17.0	17.0	6.0	17.0	17.0		6.0	27.0		6.0	27.0	
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)		0.0	0.0		0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)		5.0	5.0		5.0		5.0	5.0		5.0	5.0	
Lead/Lag			Lead				Lead	Lag		Lead	Lag	
Lead-Lag Optimize?			Yes				Yes	Yes		Yes	Yes	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None	None	None	None		None	Max		None	Max	
Act Effect Green (s)		14.0	25.2		14.0		35.8	35.8			27.5	
Actuated g/C Ratio		0.23	0.42		0.23		0.60	0.60			0.46	
v/c Ratio		0.72	0.17		0.02		0.30	0.34			1.00	
Control Delay		35.3	10.5		18.0		8.4	7.0			43.3	
Queue Delay		0.0	0.0		0.0		0.0	0.0			0.0	
Total Delay		35.3	10.5		18.0		8.4	7.0			43.3	
LOS		D	B		B		A	A			D	
Approach Delay		27.8			18.0			7.1			43.3	

TIP Before and After Evaluations - Hanover
 1: Route 53 & Old Washington St/Pond St

7/9/2014



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Approach LOS		C				B				A			D
Stops (vph)		202	42			2		26	274			1063	
Fuel Used(gal)		4	1			0		1	6			30	
CO Emissions (g/hr)		295	60			1		44	424			2083	
NOx Emissions (g/hr)		57	12			0		9	82			405	
VOC Emissions (g/hr)		68	14			0		10	98			483	
Dilemma Vehicles (#)		16	0			0		0	40			109	
Queue Length 50th (ft)		84	19			1		13	65			~373	
Queue Length 95th (ft)		#170	41			8		24	90			#516	
Internal Link Dist (ft)		508				149			526			563	
Turn Bay Length (ft)			100					310					
Base Capacity (vph)		414	600			279		296	2131			1623	
Starvation Cap Reductn		0	0			0		0	0			0	
Spillback Cap Reductn		0	0			0		0	0			0	
Storage Cap Reductn		0	0			0		0	0			0	
Reduced v/c Ratio		0.58	0.17			0.01		0.30	0.34			1.00	

Intersection Summary

Area Type: Other
 Cycle Length: 65
 Actuated Cycle Length: 60
 Natural Cycle: 70
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 1.00
 Intersection Signal Delay: 30.8
 Intersection LOS: C
 Intersection Capacity Utilization 71.8%
 ICU Level of Service C
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 1: Route 53 & Old Washington St/Pond St

