BOSTON REGION METROPOLITAN PLANNING ORGANIZATION

Richard A. Davey, MassDOT Secretary and CEO and MPO Chairman
Karl H. Quackenbush, Executive Director, MPO Staff

MEMORANDUM

DATE **June 5, 2014**

TO **Boston Region Metropolitan Planning Organization**

FROM **Mark S. Abbott**
MPO Staff

RE **Safety and Operations Analyses at Selected Intersections, FFY 2013: Franklin Street (Route 37) at West Street and Granite Street in Braintree**

1 INTRODUCTION

This memorandum summarizes safety and operations analyses and proposes improvement strategies for the intersection of Route 37 (Franklin and Granite streets) at West Street in Braintree. The intersection and its location are shown in Figure 1.

The location was approved for study by the Boston Region MPO following a selection process[1] for four locations from a short list of 21 intersections based on five criteria, including a high EDPO (Equivalent Property Damage Only) crash rating, the number of pedestrian and bicycle crashes, transit significance, regional significance, and implementation potential.

The four locations approved for study are:

- North/South Franklin Street (Route 37) at Union Street/Plymouth Street (Route 139) in Holbrook
- Western Avenue (Route 107) at Washington Street (Route 129) in Lynn
- Lexington Street at Beaver Street in Waltham
- Route 37 (Franklin and Granite streets) at West Street in Braintree

The Route 37 at West Street location was the only intersection in Braintree that met all five criteria in the intersection selection criteria process. One other intersection in Braintree was considered; however, it met only three of the selection criteria.

The memo contains the following sections:

- Existing Conditions
- Issues and Concerns

[1] Mark Abbott and Chen-Yuan Wang, memorandum to Boston Region MPO, "Safety and Operations Analyses at Selected Intersections—FFY 2013, Task 1: Intersection Selection Procedure," November 1, 2012

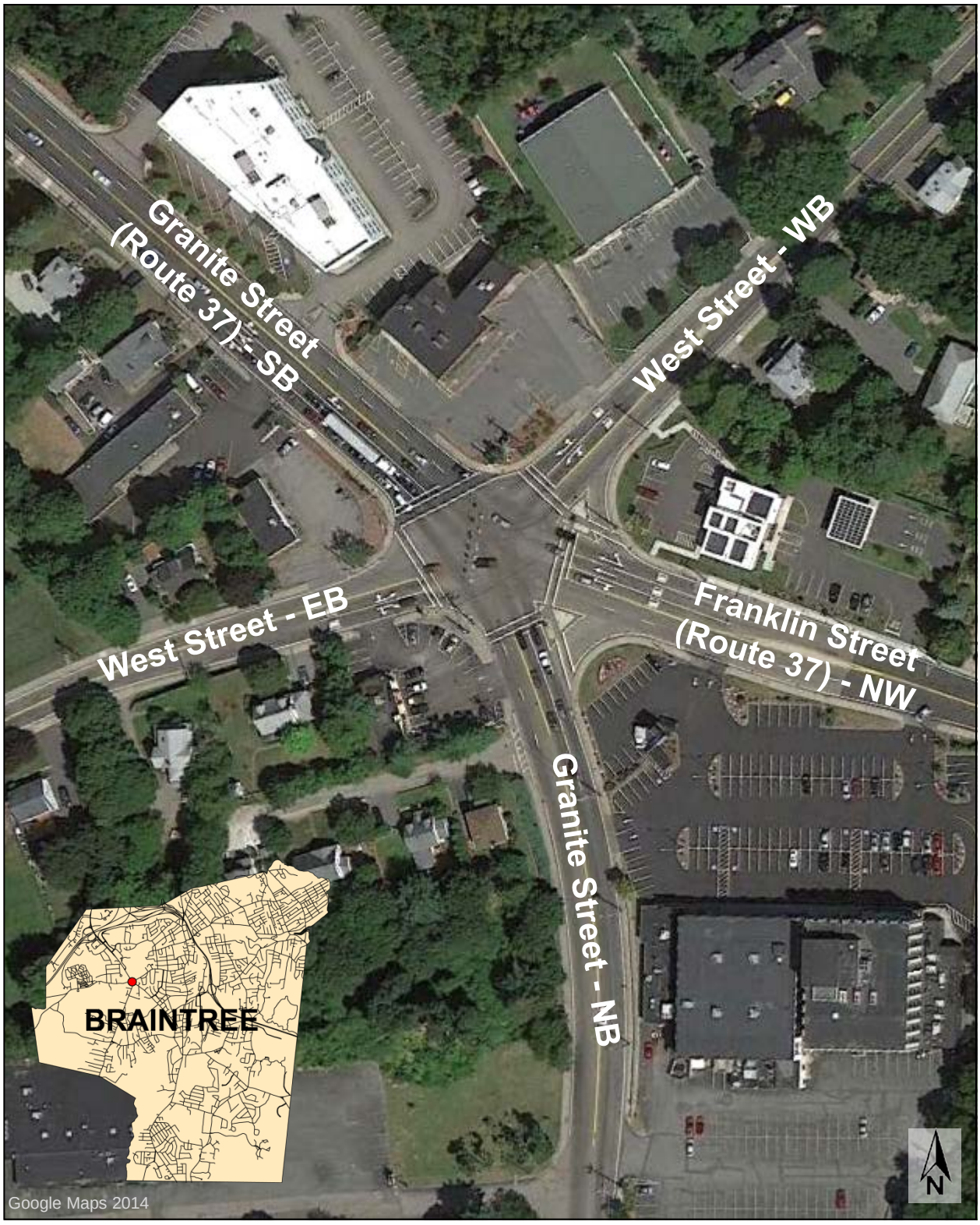

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FIGURE 1
Franklin Street (Route 37) at West Street, Braintree

Safety and Operations Analyses at Selected Intersections

- Crash Data Analysis
- Intersection Capacity Analysis
- Improvement Alternatives
- Recommendations and Discussion

It also includes technical appendices that contain methods and data applied in the study and detailed reports of the intersection capacity analyses.

2 EXISTING CONDITIONS

Route 37, running primarily in the north–south direction through the entire town of Braintree, is a principal arterial that is owned by MassDOT and is located within MassDOT's District 6 Highway Division region. It is named Granite Street north of the study intersection and has two lanes in each direction. South of the intersection it is named Franklin Street and has one lane in each direction. At the study intersection, Route 37 runs in a northwest–southeast direction.

Route 37 is intersected by West Street from the east and west; and Granite Street from the south. West Street, which has one lane in each direction, is a local town-owned roadway that runs primarily in an east–west direction through the study intersection. West of the intersection, West Street is classified as an urban principal arterial and east of the intersection the classification changes to urban minor arterial. Granite Street south of the intersection is also a town-owned roadway, which is classified as an urban principal arterial. It has one lane in each direction.

The intersection, Route 37 at West Street, is also known as the Five Corners. All the roadways approach the intersection at a skewed angle, as shown in Figure 2. The primary traffic flow through the intersection is along Route 37 and from Granite Street from the south.

The intersection is signalized, with multilane approaches on each approach leg. The Route 37 northwest approach widens to three lanes approximately 160 feet prior to the intersection. The left approach lane is marked for left turns to Granite and "through" movements to West Street westbound. The middle lane is marked for through movements to Route 37 northwest. The right lane is marked for through movements to Route 37 and right turns to West Street.

The Route 37 southbound approach also widens to three lanes before the intersection for approximately 215 feet. The left lane is marked for left turns to West Street and through movments to Route 37. The middle lane is marked as a shared through lane to both Route 37 (Franklin Street) southbound and Granite Street southbound. The right lane is marked as a shared lane for through movements to Granite Street and right turns to West Street.

The Granite Street northbound approach to the intersection widens to two lanes approximately 140 feet from the intersection. Both lanes are general purpose lanes and are unmarked. There is an unsignalized right-turn lane, seperated by a delta island; the roadway does not widen for this right-turn movement.

The West Street eastbound approach to the intersection widens to two lanes approximately 100 feet from the intersection. The left lane is marked as a left-turn lane to Route 37 northbound and through lane to West Street. The right lane is marked as a “through” lane to Franklin Street and a right-turn lane to Granite Street southbound.

The westbound West Street approach also widens to two lanes, approximatel 80 feet from the intersection. This approach is marked similiarly to the eastbound approach, with one lane providing access to Granite Street southbound and Franklin Street southbound; and the right lane providing access to West Street westbound and right turns to Route 37 northbound.

Pedestrian signals and crosswalks are provided on all intersection approaches. Two traffic islands for the exclusive right-turn lanes allow for shorter crosswalk lengths for pedestrians. Sidewalks (approximately six feet wide) are present along all five corners of the intersection and also along both sides of all of the approach streets. Wheelchair ramps are provided; however, several appear to not meet ADA requirements (see photo at the right). No provisions for bicycles have been provided.

Wheelchair ramp with no detectable warning pads

The signal heads, mounted on an overhead span wire (see photo below), include standard three-face signal heads, a five-face signal head, and a four-face signal head. No back plates are provided on any of the signal heads. The support poles for the span wire are located in the northeast and the southwest corners of the intersection. There are additional three-face signal heads mounted on the span wire poles and one lone post-mounted signal head located on the small delta island between Franklin Street and West Street in the southeast corner. The pedestrian heads are all pole-mounted or are also mounted on the span wire support poles. Pedestrian activation is provided.

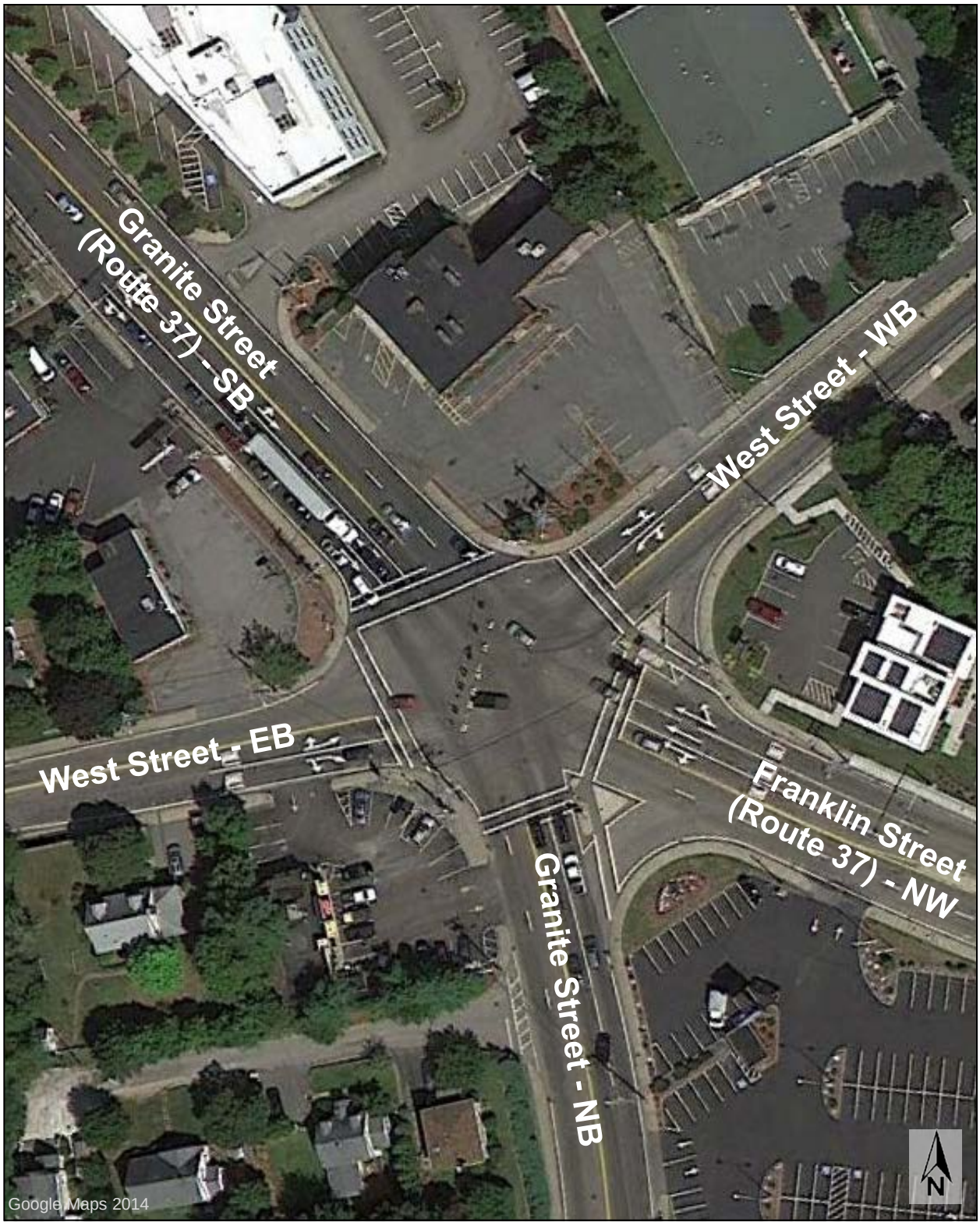

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FIGURE 2
Franklin Street (Route 37) at
West Street, Braintree

Safety and Operations
Analyses at
Selected Intersections

Existing span wire with signal heads

The land use at the five corners of the intersection is zoned either General Business or Highway Business. The southern corner, between Granite and Franklin streets, contains the 400 Franklin Street office building, which includes several businesses and shops. The parking lots for this building are between Franklin and Granite streets, and on the south side of the building. The southeast corner, between Franklin and West streets, has a TD Bank. The northeast corner has a Citizens Bank and the northwest corner has the Vitamin Shoppe and Firestone Complete Auto Care garage. A Dunkin Donuts is located on the southwest corner. Away from the intersection, along Franklin Street, Granite Street to the south, and West Street, the zoning changes to residential. Only along the eastern side of Route 37, north of the intersection, does the zoning remain business.

There are two Massachusetts Bay Transportation Authority (MBTA) bus routes that travel through the intersection— MBTA bus Routes 236 and 238. The Route 236 travels between the South Shore Plaza and Quincy Center. The Route 238 travels between the Holbrook/Randolph Commuter rail station and Quincy Center. Both bus routes travel along Route 37 north of the intersection and then split, with the 238 traveling along Granite Street south of the intersection and the 236 traveling along Franklin Street.

The bus stops for both routes, north of the intersection, are located approximately 250 feet from the intersection, on either side of Route 37. The Route 236 bus stops on both sides of Granite Street are located approximately 150 feet south of the intersection and the stops for Route 238 are located approximately 250 feet south of the intersection, along Franklin Street. The bus stops require the MBTA buses to stop in the curb-side travel lane to let

passengers on and off. During congested periods these stops could present a situation where side-swipe and rear-end accidents could occur.

3 ISSUES AND CONCERNS

Three major issues, which are related, were identified. First, the intersection has a high number of crashes; second, the intersection is highly congested during the AM and PM peak hours; and third, the intersection geometry is not ideal for a high-volume signalized intersection. In addition when there are traffic incidents or heavy delays on Route 93 and Route 3, Route 37 is used as a cut-through between those two highway facilities.

Based on the field observations and crash and traffic data analyses, the issues and concerns for the intersection can be summarized as:

- High number of crashes and high crash rate
- Failing traffic operations
- Traffic congestion
- No bicycle accommodations

4 CRASH DATA ANALYSIS

Table 1 summarizes the crash statistics at the intersection based on the MassDOT Registry of Motor Vehicles (RMV) 2006–2010 crash data. On average, approximately 17 crashes occurred at the intersection each year. About 35 percent of the total crashes resulted in personal injuries. Crash types consist of 52 percent angle collisions, 19 percent rear-end collisions, 8 percent sideswipe collisions, 7 percent head-on collisions, 7 percent unknown types of collisions, and 5 percent single-vehicle collisions.

In the five-year period, there were no reported pedestrian crashes or bicycle crashes.

About 48 percent of the total crashes occurred during peak periods, which indicates that many of the crashes are potentially related to stop-and-go traffic conditions at the intersection during congested periods.

Crash rate[2] is another effective tool for examining the relative safety of a location. Based on the crash data and the turning-movement counts collected recently by MPO staff, the crash rate for this intersection was calculated as 1.13 (see Appendix A). This is much higher than the average crash rate for

[2] Crash rates are estimated based on crash frequency (crashes per year) and vehicle exposure (traffic volumes or miles traveled). Per MassDOT guidance, crash rates are expressed as “crashes per million entering vehicles” for intersection locations and as “crashes per million miles traveled” for roadway segments.

signalized intersections in MassDOT Highway Division District 6, which is estimated to be 0.76.[3]

TABLE 1
Route 37 at West Street and Granite Street—Crash Summary

Crash Category	2006	2007	2008	2009	2010	Total	Average
Crash severity							
Property damage only	19	8	9	4	9	**49**	9.8
Personal injury	4	6	6	6	7	**29**	5.8
Fatality	0	0	0	0	0	**0**	0.0
Collision type							
Not reported	4	2	0	0	0	**6**	1.2
Angle	9	9	7	7	12	**44**	8.8
Rear-end	4	4	3	2	3	**16**	3.2
Side-swipe	2	2	3	0	0	**7**	1.4
Head-on	2	0	1	1	2	**6**	1.2
Single-vehicle	3	0	1	0	0	**4**	0.8
Roadway conditions							
Not reported	1	0	0	0	0	**1**	0.2
Wet or icy pavement	8	5	5	3	5	**26**	5.2
Weather conditions							
Dark/lighted	4	6	3	2	3	**18**	3.6
Clear	12	13	11	6	12	**54**	10.8
Cloudy	4	1	0	1	0	**6**	1.2
Rain	6	2	4	2	5	**19**	3.8
Snow	1	1	1	1	0	**4**	0.8
Crashes during weekday peak periods[1]	15	5	5	5	10	**40**	8.0
Crashes involving pedestrian(s)	0	0	0	0	0	**0**	0.0
Crashes involving bicyclist(s)	0	0	0	0	0	**0**	0.0
Total crashes	**24**	**17**	**16**	**10**	**17**	**84**	**16.8**

[1] Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM.

[3] The average crash rates estimated by the MassDOT Highway Division (as of January 23, 2013) are based on a database that contains intersection crash rates submitted to MassDOT as part of the review process for an Environmental Impact Report or Functional Design Report.

5 INTERSECTION CAPACITY ANALYSIS

Staff collected turning-movement counts at the intersection on Wednesday, December 5, 2012. The data were recorded in 15-minute intervals during peak traffic periods in the morning, from 7:00 to 9:00, and in the evening, from 4:00 to 6:00.

The peak-hour traffic volumes in each of the two peak periods was then identified, and data on the associated turning movements and pedestrian crossings were used for the intersection's capacity analysis.

Figure 3 shows the observed vehicular turning-movement counts in the AM and PM peak hours. The intersection carried about 3,310 vehicles in the AM peak , from 7:30 to 8:30, and about 3,650 vehicles in the PM peak hour, from 5:00 to 6:00 (see Appendix B for detailed 15-minute breakdowns for passenger vehicles, various heavy vehicles, pedestrians, and bicycles in the peak periods and the peak hours).

There were 14 and 8 pedestrians crossing the intersection during the AM and PM peak hours, respectively. The highest number of pedestrian crossings occurred on the southern section of the intersection, crossing Granite and Franklin streets. There were no bicyclist's observed during the peak periods during the traffic counts.

Heavy vehicles accounted for about 3.8 percent of the total entry traffic in the AM peak hour and about 1.0 percent in the PM peak hour. The through movements on the northbound and southbound Granite Street approaches carry the highest percentage of heavy vehicle traffic at the intersection. However, based on observations made by the Town of Braintree planners, there is significant truck traffic during the off-peak hours, predominately a high number of FedEx vehicles using Granite Street south of the intersection.

Based on the counts, signal permit data, and manual traffic signal timing, the intersection was modeled as a fully actuated isolated intersection. Table 2 summarizes the Synchro[4] analysis results for existing conditions in the AM and PM peak hours.

[4] Synchro Version 8 is developed and distributed by Trafficware Ltd. The software can perform capacity analysis and traffic simulation (when combined with SimTraffic) for an individual intersection or a series of intersections.

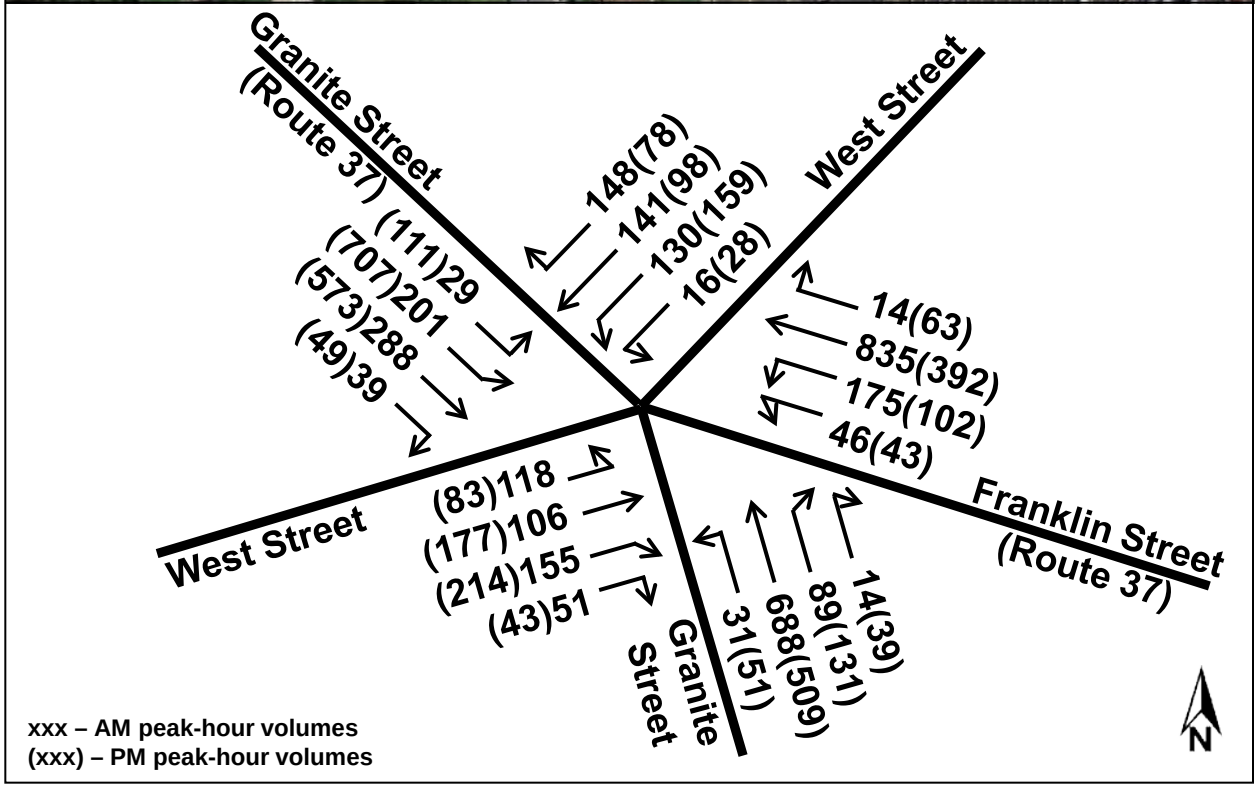

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FIGURE 3
Route 37 at West Street, Braintree – Traffic Volumes

Safety and Operations Analyses at Selected Intersections

TABLE 2
Intersection Capacity Analysis, Existing Conditions

Street Name	Approach/Movement	LOS[1]	Delay per Vehicle
Granite Street	NB – All	F (F)	94.8 (142.5)
Route 37 (Franklin)	NW – Left/through	F (F)	609.7 (335.5)
Route 37 (Franklin)	NW – Through/right	E (D)	66.8 (37.1)
Route 37 (Granite)	SB – Left/through	E (F)	66.0 (169.5)
Route 37 (Granite)	SB – Through/right	E (F)	55.3 (147.5)
West Street	EB – Left/through	F (F)	499.3 (400.4)
West Street	EB – Through/right	F (F)	161.3 (167.3)
West Street	WB – Left/through	F (F)	289.6 (465.6)
West Street	WB – Through/right	E (D)	55.7 (42.2)
Overall		**F (F)**	**162.8 (182.1)**

[1] LOS = level of service. The LOS for the AM peak hour is the first letter. The LOS for the PM peak hour is in parentheses.

The analysis indicates that the intersection operates at a level of service (LOS) F in the AM peak hour with an average delay of over two minutes per vehicle. In the PM peak hour, the intersection is estimated to operate at LOS F with an average delay of nearly three minutes per vehicle. Under the existing conditions at the intersection, the Route 37 approaches operate primarily at LOS E during the AM peak period. However conditions get worse in the PM peak hour, with the additional afternoon traffic. Detailed analysis parameters and results for the AM and PM peak hours are in Appendix C.

6 IMPROVEMENT ALTERNATIVES

The intersection's signal equipment has been updated fairly recently, and the very limited ability to widen any approaches or departures limits the options for improving the current operations at the intersection. MPO staff tested a number of alternatives with signal timing improvements, lane assignments, and additional approach lanes, specifically adding a lane on Route 37. However the impacts to adjacent businesses, including their parking, would be significant, and the resulting operational improvements would not result in significant benefits. Also it should be noted that any changes to existing lane assignments would necessitate widening of the departure lanes. Staff also examined the possibility of replacing the current signalized intersection with a modern roundabout.

To simplify the analysis, one alternative was examined with signal timing changes and one alternative was evaluated for the potential of constructing a modern roundabout. The two alternatives are:

- Alternative 1: Retime the traffic signal and signal phasing under the existing intersection geometry.
- Alternative 2: Replace the existing signalized intersection with a modern two-lane roundabout (two-lanes would be required, based on the existing traffic volumes). A two-lane roundabout (shown in Figure 4) was sketched out using a 150-foot inscribed circle diameter. A 150-foot diameter is the minimum diameter typically found with multilane roundabouts based on NCHRP Report 672 Roundabouts: An Informational Guide.[5] The two-lane roundabout is necessary because of the existing traffic volumes. This sketch shows the minimum impacts to neighboring properties that would be result from a two-lane roundabout.

Tables 3 and 4 summarize the capacity analyses for Alternative 1 (signal timing improvements) in both the AM and PM peak hours, and compares A with the existing conditions. Figure 5 shows the existing and proposed signal timings and phasing for the intersection and Table 5 provides a description of the movements and phases.

TABLE 3
Intersection Capacity Analysis of Level-of-Service for Existing Conditions and Alternatives

		Existing Conditions	Alternative 1
Street Name	**Approach**	**LOS[1]**	**LOS**
Granite Street	NB – All	F (F)	F (F)
Route 37 (Franklin)	NW – Left/through	F (F)	F (F)
Route 37 (Franklin)	NW – Through/right	E (D)	E (C)
Route 37 (Granite)	SB – Left/through	E (F)	F (D
Route 37 (Granite)	SB – Through/right	E (F)	E (D)
West Street	EB – Left/through	F (F)	F (F)
West Street	EB – Through/right	F (F)	F (F)
West Street	WB – Left/through	F (F)	F (F)
West Street	WB – Through/right	E (D)	C (C)
Overall		**F (F)**	**F (F)**

[1] LOS = level of service. The LOS for the AM peak hour is the first letter. The LOS for the PM peak hour is in parentheses.

[5] National Cooperative Highway Research Program, NCHRP Report 672: Roundabouts: An Informational Guide, Second Edition, Transportation Research Board, 2010.

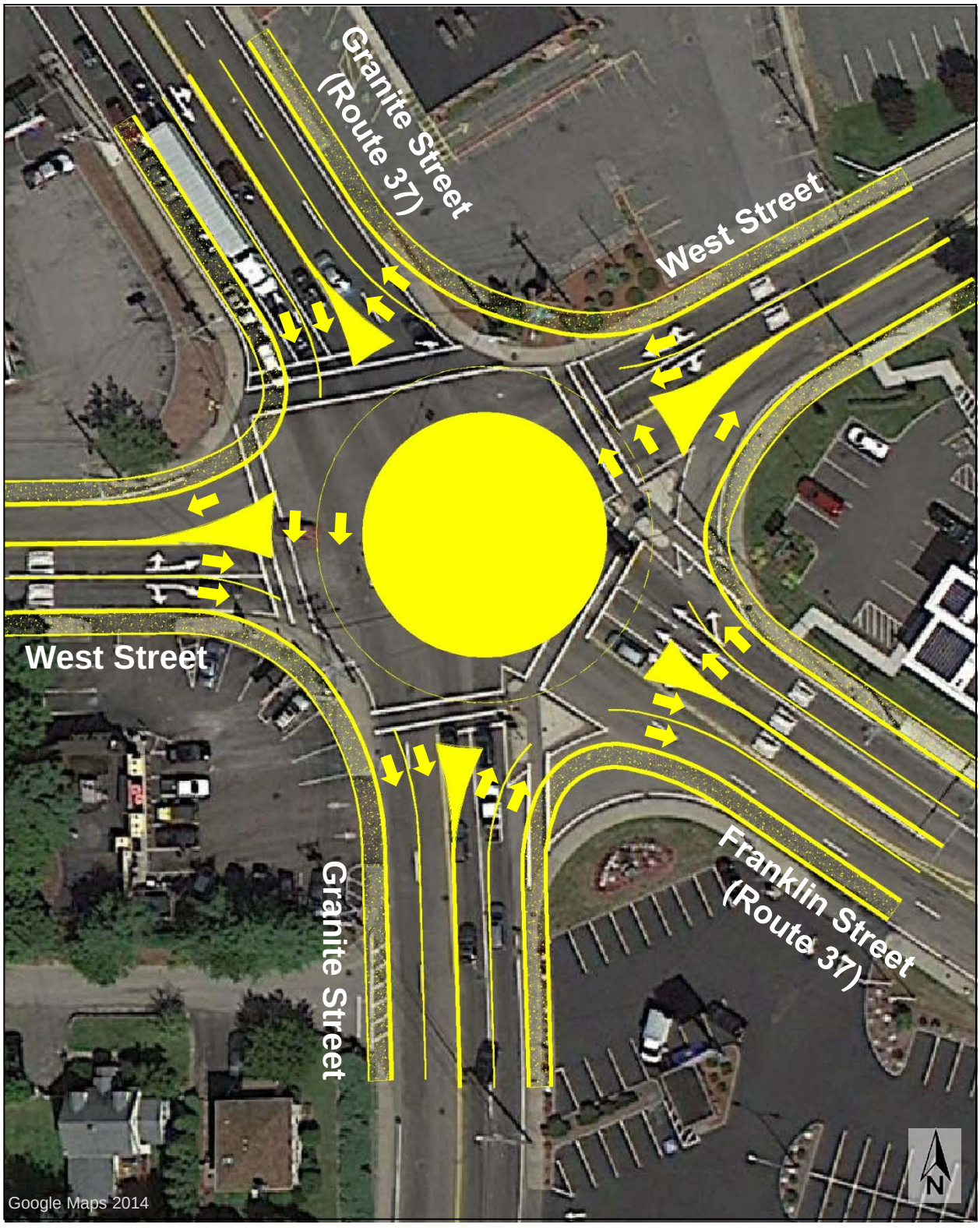

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FIGURE 4
Sketch of 150 Foot Diameter Roundabout

Safety and Operations Analyses at Selected Intersections

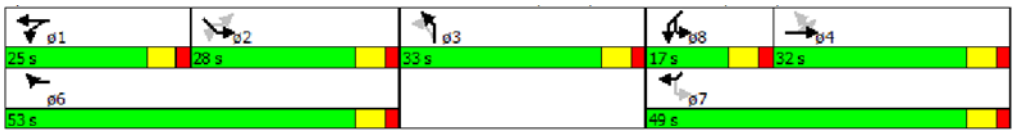
TABLE 4
Intersection Capacity Analysis of Delay for Existing Conditions and Alternatives

		Existing Conditions	Alternative 1
Street Name	**Approach**	**Delay[1]**	**Delay**
Granite Street	NB – All	94.8 (142.5)	128.3 (183.2)
Route 37 (Franklin)	NW – Left/through	609.7 (335.5)	189.9 (976.7)
Route 37 (Franklin)	NW – Through/right	66.8 (37.1)	57.2 (27.1)
Route 37 (Granite)	SB – Left/through	66.0 (169.5)	117.6 (49.0)
Route 37 (Granite)	SB – Through/right	55.3 (147.5)	62.3 (36.1)
West Street	EB – Left/through	499.3 (400.4)	259.7 (695.9)
West Street	EB – Through/right	161.3 (167.3)	108.8 (318.9)
West Street	WB – Left/through	289.6 (465.6)	257.5 (559.9)
West Street	WB – Through/right	55.7 (42.2)	27.7 (27.6)
Overall		**162.8 (182.1)**	**115.3 (217.6)**

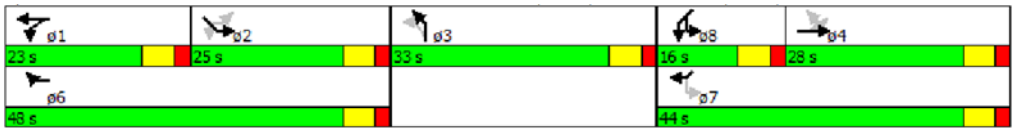
[1] The delay for the AM peak hour is the first number. The delay for the PM peak hour is in parentheses.

FIGURE 5
Intersection Signal Timings and Phasing for the Existing Conditions and Alternatives

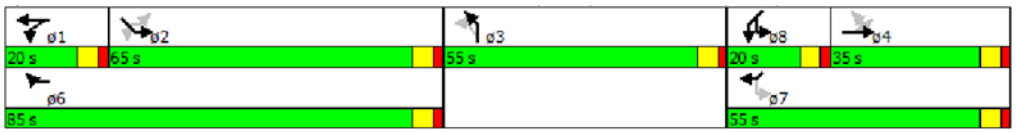
AM Peak Hour - Existing



AM Peak Hour – Alternative 1



PM Peak Hour - Existing



PM Peak Hour – Alternative 1

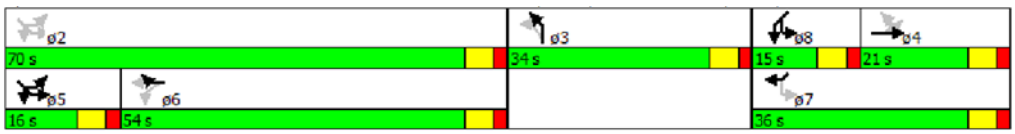


TABLE 5
Intersection Signal Phasing for
Existing Conditions and Alternatives

		Existing Conditions	Alternative 1
Street Name	**Approach**	**Phases**	**Phases**
Granite Street	NB – All	3	3
Route 37 (Franklin)	NW – Left	1	1
Route 37 (Franklin)	NW – Through/right	6	6
Route 37 (Granite)	SB – All	2	2
West Street	EB – All	4	4
West Street	WB – Left/through	8	8
West Street	WB – Through/right	7	7

Alternative 1, retiming the signal with the existing geometry, resulted in the same overall level of service, LOS F, during both the AM and PM peak hours. However the overall delay improved by 37 seconds in the AM peak hour. In the PM peak, while some individual movements improved, the overall delay increased slightly.

Alternative 2, replacing the existing signalized intersection with a modern roundabout, was evaluated with the Massachusetts Roundabout Installation Screening Form. The evaluation examines safety, operations, traffic calming, aesthetics and community enhancements, and access management factors. The evaluation determined that a roundabout is not recommended for this location because its high traffic volumes would require a multilane roundabout, and there is inadequate space at that location for a roundabout. The evaluation form is included in Appendix D.

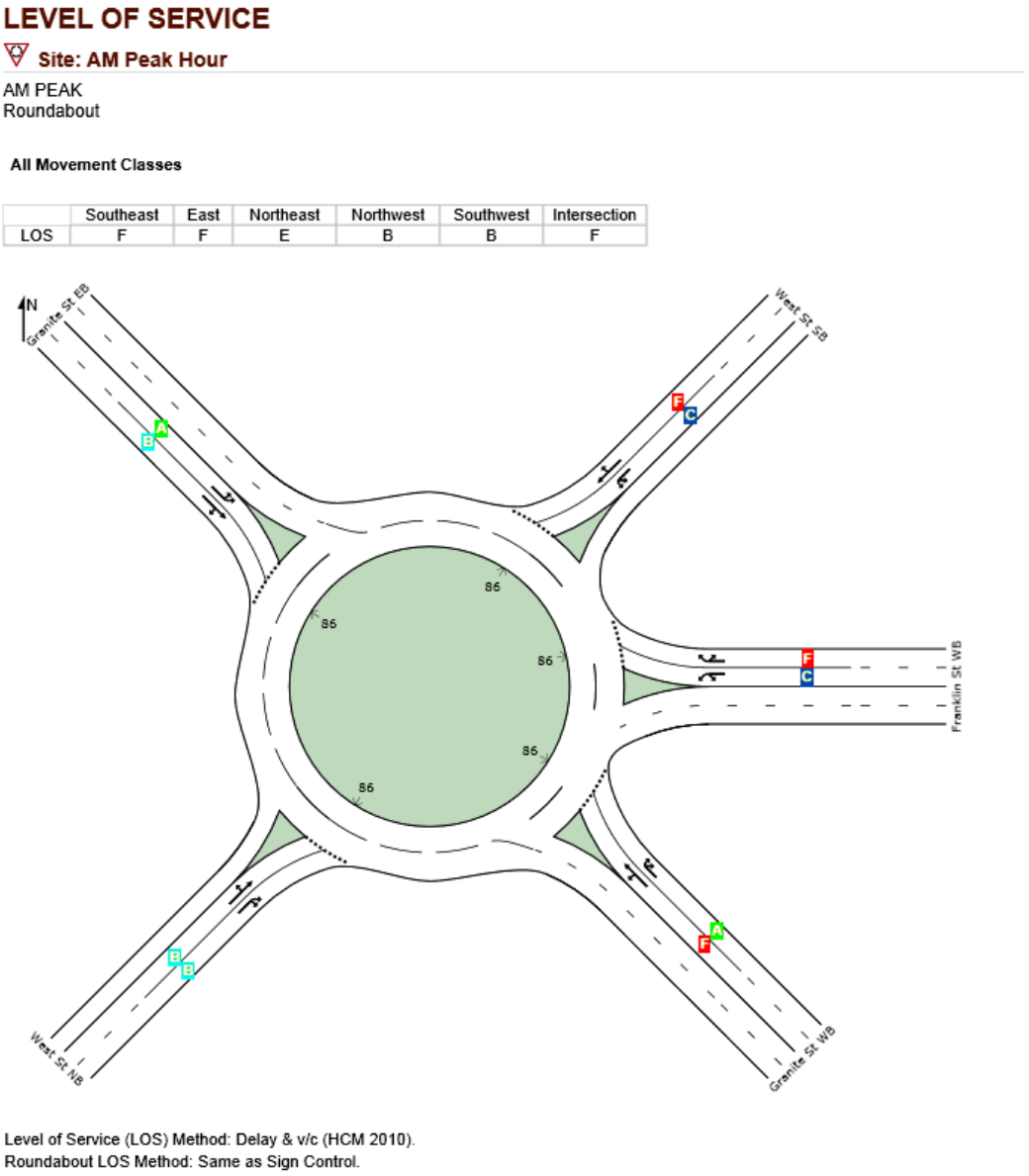
The alternative was also evaluated with SIDRA software[6] to determine the operations of a roundabout at that location with the existing traffic volumes. The figures below show the results of the analysis. As shown in the figures, the two-lane roundabout would operate overall at LOS F during both peak hours. Multiple legs of the roundabout would also have failing operations. Detailed analysis parameters and results for the AM and PM peak hour are included in Appendix E.

Between the results of the evaluation and the operations analysis, a two-lane roundabout is not recommended for this location. The sketch of the two-lane roundabout shows a minimum diameter of 150 feet. At this location, with the approach angles of the existing roadways, a larger-diameter roundabout would

[6] SIDRA Intersection 6.0.20.4660, © 2000-2014, Akcelik and Associates Pty. Ltd.

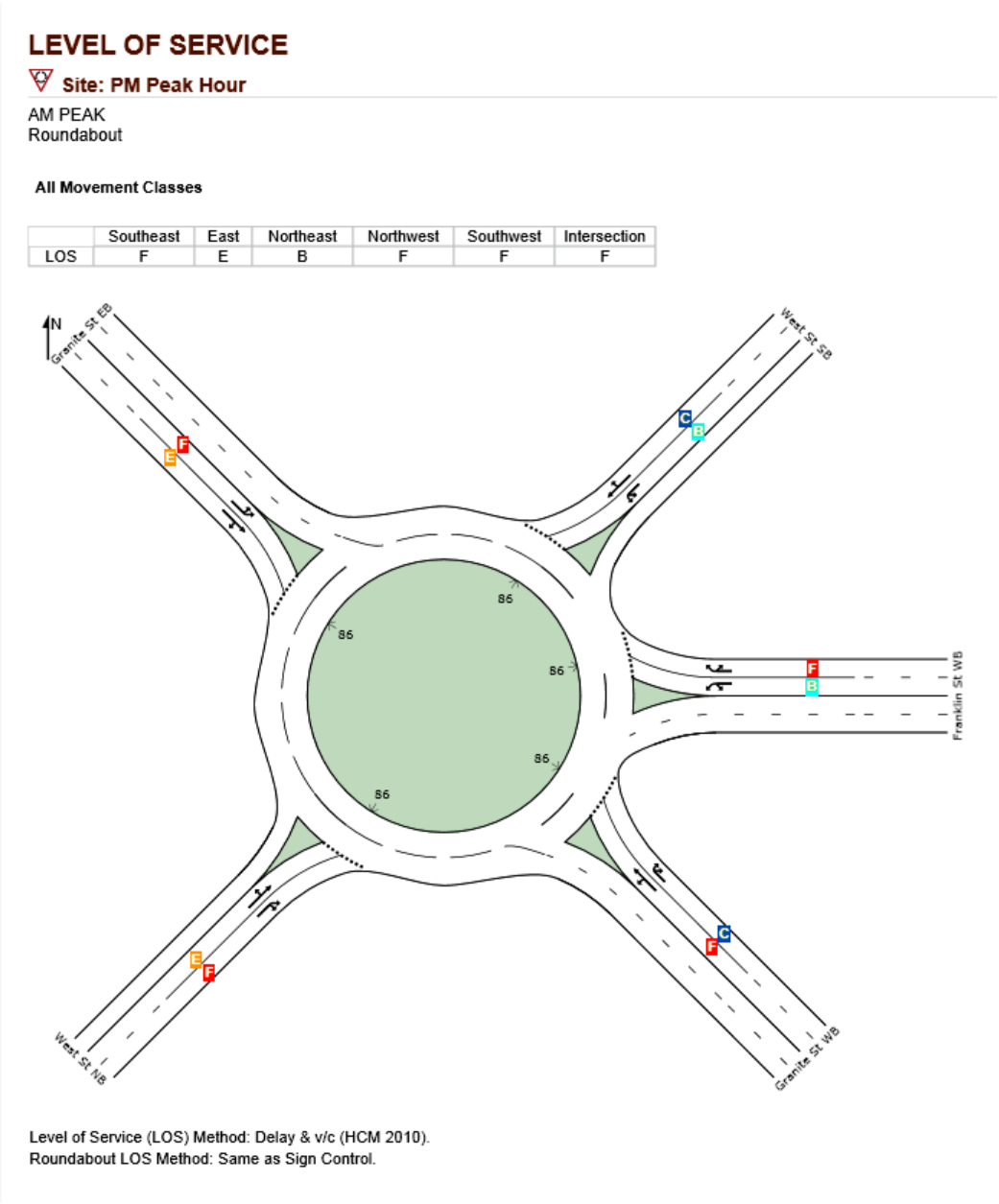
be necessary. This would cause a greater impact to neighboring property owners.

FIGURE 6
SIDRA Analysis Results for a Two-Lane Roundabout:
AM Peak Hour



Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.

FIGURE 7
SIDRA Analysis Results for a Two-Lane Roundabout:
PM Peak Hour



7 RECOMMENDATIONS AND DISCUSSIONS

The study intersection has a high number of crashes and is very congested during the peak hours. The above analyses indicate that many crashes are possibly related to the congested conditions at the intersection and the complicated turning movements caused by a five-legged skewed intersection.

Nevertheless, the congestion at the intersection is not easy to totally mitigate at any given approach without impacting one of the other approaches, and because of the very constrained right-of-way. Because of these limitations, staff recommends a comprehensive approach of minor improvements to the intersection to improve safety and operations.

The intersection improvements should include the following:

- Examine possible signal re-timings that would improve traffic flow for Route 37 and Granite Street at the minor expense of West Street. Conduct this examination with actual field trials of the new signal timings with observations made by Highway Division District 6 traffic engineers to determine the effectiveness of the changes.
- Provide pavement-marking extensions through the intersection for the heavy traffic movements of Route 37, as shown in Figure 8. This would provide a delineated path for vehicles to follow through the intersection, which should improve safety. It should also help to reduce possible side-swipe and angle crashes.
- Install “Do Not Block Driveway” sign at the Citizens Bank entrance/exit driveway on West Street, as shown in Figure 8.
- Examine possible driveway modifications. Provide right-turns-in/right turns-out-only, as shown in Figure 8.
- Modify driveways to 400 Franklin Street, as shown in Figure 8.
- Improve signal head visibility by installing black back plates on all signal housings.
- Maintain the use of concurrent pedestrian phases in the signal operations plan.
- Replace the current pedestrian signal heads to the newer countdown signal heads.
- Install the MUTCD-recommended “Turning Vehicles Yield to Pedestrians” sign (R10-15, see Figure 9) about 50 feet before the intersection on all approaches.

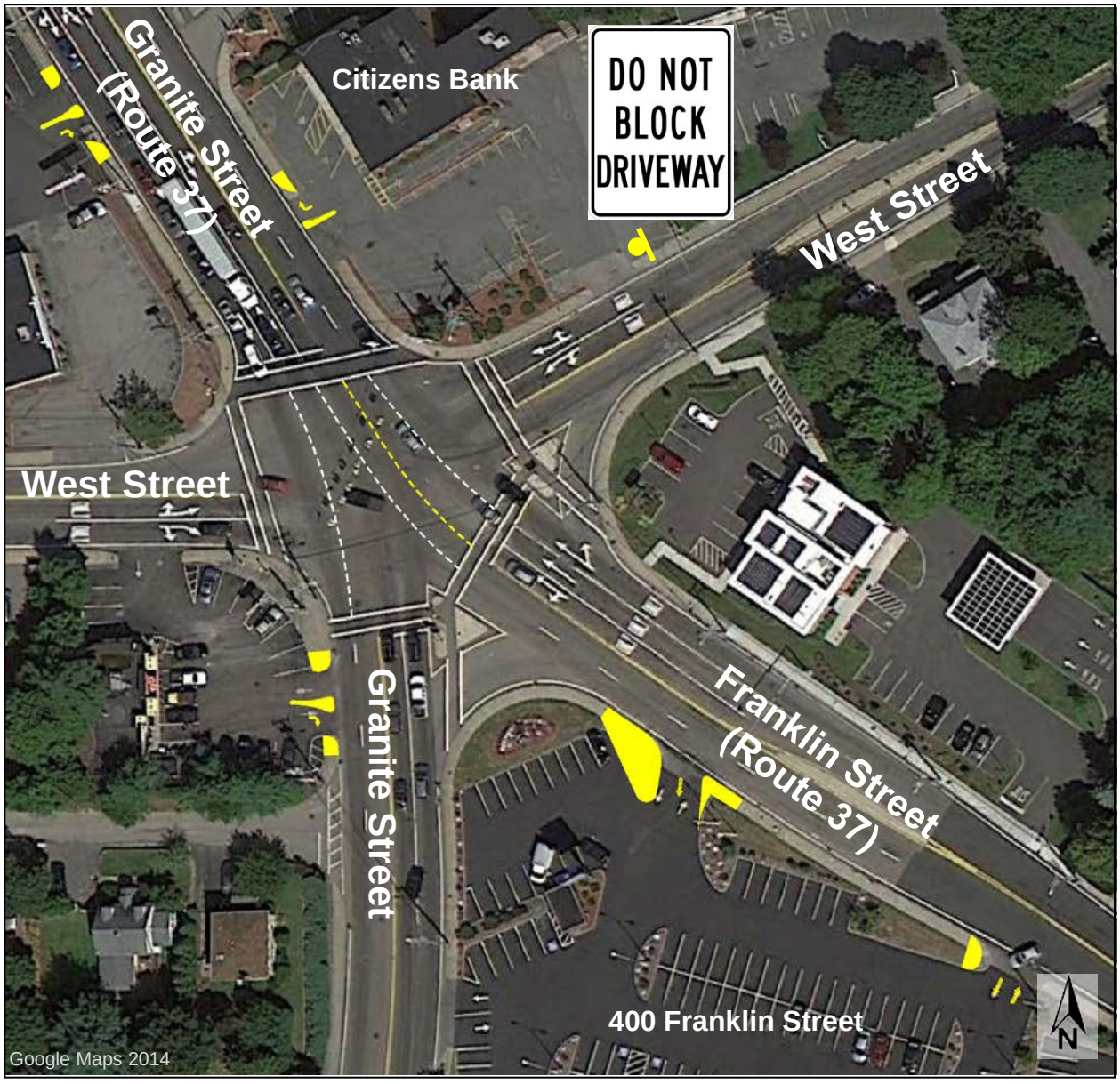


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FIGURE 8
Proposed Curb Cut Modifications and Signing

Safety and Operations Analyses at Selected Intersections

FIGURE 9
MUTCD Sign R10-15: Turning Vehicles Yield to Pedestrians

- Include bicycle accommodations, which would be limited because of the street widths, but which could include bicycle detection with appropriate signing.
- Longer-term bicycle improvements for the intersection could include widening the approaches to accommodate bicycle lanes through the intersection. However an overall examination of the Route 37 corridor and Granite Street should be completed to ensure that bicycle connections can be accommodated.
- A longer-term improvement for pedestrians would be to reconstruct the wheelchair ramps on each corner to meet current ADA (Americans with Disabilities Act) standards, with detectable warning pads on the ramps.

All of the improvements recommended above, except for the wheelchair ramp reconstruction, can be considered low-cost, short-term improvements. These improvements should improve operations and safety at the intersection not only for motor vehicles, but also for pedestrians and bicyclists.

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APPENDIX A

Crash Rate Worksheet

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Lynn COUNT DATE : 10/25/2012

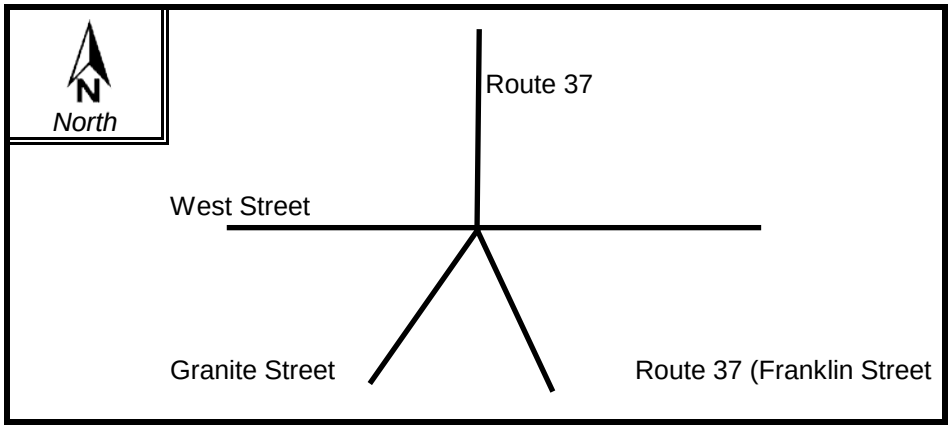
DISTRICT : 4 UNSIGNALIZED : SIGNALIZED : X

~ INTERSECTION DATA ~

MAJOR STREET : Route 37

MINOR STREET(S) : West Street and Granite Street

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	NW	NE	SB	EB	WB	
PEAK HOURLY VOLUMES (AM/**PM**) :	600	730	1,440	517	363	**3,650**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **40,556**

TOTAL # OF CRASHES : 84 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **16.80**

CRASH RATE CALCULATION : **1.13** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : District 6 Signalized Ave = 0.76 crashes per million entering vehilces

Project Title & Date: Safety and Operations Analyses at Selected Intersections - Braintree

APPENDIX B

Turning-Movement Count Data

Franklin Street (Rte. 37) at West Street, Braintree

Start Date: 12/5/2012
Start Time: 7:00:00 AM
Site Code: 12051221

AM Peak Hour
All Vehicles

	Franklin Street Northbound					Granite Street Northeastbound					Granite Street Southbound					West Street Eastbound					West Street Westbound					
Start Time	Hard Left to Granite	Left to West	Thru to Granite	Right to West	Peds	Left to West	Thru to Granite	Right to West	Hard Right to Franklin	Peds	Left to West	Thru to Franklin	Right to Granite	Hard Right to West	Peds	Left to Granite	Thru to West	Right to Franklin	Hard Right to Granite	Peds	Left to Franklin	Left to Granite	Thru to West	Right to Granite	Peds	Vehicle Total
07:30 AM	8	32	175	5	0	5	147	20	4	0	6	57	85	9	0	42	22	20	15	0	0	39	44	39	0	774
07:45 AM	9	41	234	5	0	5	204	20	2	0	10	59	76	13	0	22	28	68	16	1	10	34	31	43	0	930
08:00 AM	14	64	242	3	11	10	179	22	2	0	2	26	61	11	0	23	34	39	11	0	3	20	36	31	1	833
08:15 AM	15	38	184	1	0	11	158	27	6	0	11	59	66	6	0	31	22	28	9	1	3	37	30	35	0	777
Total:	46	175	835	14	11	31	688	89	14	0	29	201	288	39	0	118	106	155	51	2	16	130	141	148	1	3314
PHF:	0.77	0.68	0.86	0.70		0.78	0.84	0.82	0.58		0.66	0.85	0.85	0.75		0.70	0.78	0.57	0.80		0.40	0.83	0.80	0.86		
Truck%:	0.00%	1.14%	1.80%	14.29%		22.58%	5.52%	6.74%	7.14%		0.00%	1.99%	5.56%	20.51%		6.78%	9.43%	4.52%	0.00%		0.00%	0.00%	2.13%	0.00%		

AM Peak Period
All Vehicles

	Franklin Street Northbound					Granite Street Northeastbound					Granite Street Southbound					West Street Eastbound					West Street Westbound					
Start Time	Hard Left to Granite	Left to West	Thru to Granite	Right to West	Peds	Left to West	Thru to Granite	Right to West	Hard Right to Franklin	Peds	Left to West	Thru to Franklin	Right to Granite	Hard Right to West	Peds	Left to Granite	Thru to West	Right to Franklin	Hard Right to Granite	Peds	Left to Franklin	Left to Granite	Thru to West	Right to Granite	Peds	Vehicle Total
07:00 AM	19	33	59	5	1	6	42	20	2	0	2	56	55	8	0	7	12	109	20	0	2	49	19	22	0	547
07:15 AM	18	25	125	2	0	5	165	24	3	0	6	34	90	16	0	6	11	24	19	0	1	48	52	33	0	707
07:30 AM	8	32	175	5	0	5	147	20	4	0	6	57	85	9	0	42	22	20	15	0	0	39	44	39	0	774
07:45 AM	9	41	234	5	0	5	204	20	2	0	10	59	76	13	0	22	28	68	16	1	10	34	31	43	0	930
08:00 AM	14	64	242	3	11	10	179	22	2	0	2	26	61	11	0	23	34	39	11	0	3	20	36	31	1	833
08:15 AM	15	38	184	1	0	11	158	27	6	0	11	59	66	6	0	31	22	28	9	1	3	37	30	35	0	777
08:30 AM	6	22	156	7	0	7	182	14	2	0	1	20	44	3	0	26	31	20	18	0	2	14	12	13	0	600
08:45 AM	11	35	162	1	1	9	153	38	6	1	11	62	83	3	1	32	21	36	14	0	3	25	26	33	1	764
Total:	100	290	1337	29	13	58	1230	185	27	1	49	373	560	69	1	189	181	344	122	2	24	266	250	249	2	5932

Franklin Street (Rte. 37) at West Street, Braintree

Start Date: 12/5/2012
Start Time: 5:00 PM
Site Code: 12051212

PM Peak Hour
All Vehicles

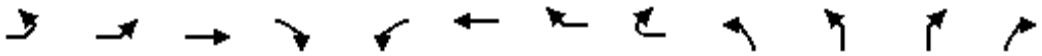
	Franklin Street Northbound					Granite Street Northeastbound					Granite Street Southbound					West Street Eastbound					West Street Westbound					
Start Time	Hard Left to Granite	Left to West	Thru to Granite	Right to West	Peds	Left to West	Thru to Granite	Right to West	Hard Right to Franklin	Peds	Left to West	Thru to Franklin	Right to Granite	Hard Right to West	Peds	Left to Granite	Thru to West	Right to Franklin	Hard Right to Granite	Peds	Left to Franklin	Left to Granite	Thru to West	Right to Granite	Peds	Vehicle Total
5:00 PM	11	24	101	33	2	27	124	39	10	0	18	188	141	19	0	32	48	55	6	0	10	35	29	15	0	**965**
5:15 PM	15	36	89	9	0	6	138	31	8	1	36	197	141	10	0	14	66	62	16	2	7	35	28	27	0	**971**
5:30 PM	6	23	105	12	0	9	136	33	8	0	27	168	141	13	2	18	30	41	13	0	7	39	22	25	0	**876**
5:45 PM	11	19	97	9	0	9	111	28	13	0	30	154	150	7	0	19	33	56	8	0	4	50	19	11	1	**838**
Total:	**43**	**102**	**392**	**63**	**2**	**51**	**509**	**131**	**39**	**1**	**111**	**707**	**573**	**49**	**2**	**83**	**177**	**214**	**43**	**2**	**28**	**159**	**98**	**78**	**1**	**3650**
PHF:	**0.72**	**0.71**	**0.93**	**0.48**		**0.47**	**0.92**	**0.84**	**0.75**		**0.77**	**0.90**	**0.96**	**0.64**		**0.65**	**0.67**	**0.86**	**0.67**		**0.70**	**0.80**	**0.84**	**0.72**		
Truck%:	**0.00%**	**0.00%**	**0.77%**	**0.00%**		**0.00%**	**1.77%**	**0.76%**	**0.00%**		**0.00%**	**0.28%**	**2.79%**	**2.04%**		**0.00%**	**0.56%**	**0.93%**	**0.00%**		**0.00%**	**0.63%**	**1.02%**	**1.28%**		

AM Peak Period
All Vehicles

	Franklin Street Northbound					Granite Street Northeastbound					Granite Street Southbound					West Street Eastbound					West Street Westbound					
Start Time	Hard Left to Granite	Left to West	Thru to Granite	Right to West	Peds	Left to West	Thru to Granite	Right to West	Hard Right to Franklin	Peds	Left to West	Thru to Franklin	Right to Granite	Hard Right to West	Peds	Left to Granite	Thru to West	Right to Franklin	Hard Right to Granite	Peds	Left to Franklin	Left to Granite	Thru to West	Right to Granite	Peds	Vehicle Total
4:00 PM	9	21	100	4	1	5	129	25	5	2	19	166	127	12	3	21	33	58	2	1	4	36	25	19	0	**820**
4:15 PM	9	14	98	6	1	4	99	25	5	0	32	157	136	17	0	9	29	38	7	0	9	58	31	19	1	**802**
4:30 PM	10	28	102	9	2	15	132	33	6	2	35	170	121	12	0	21	42	44	10	0	6	37	33	15	0	**881**
4:45 PM	8	20	92	5	0	5	123	50	9	2	32	152	102	10	1	22	36	47	6	0	6	29	28	15	0	**797**
5:00 PM	11	24	101	33	2	27	124	39	10	0	18	188	141	19	0	32	48	55	6	0	10	35	29	15	0	**965**
5:15 PM	15	36	89	9	0	6	138	31	8	1	36	197	141	10	0	14	66	62	16	2	7	35	28	27	0	**971**
5:30 PM	6	23	105	12	0	9	136	33	8	0	27	168	141	13	2	18	30	41	13	0	7	39	22	25	0	**876**
5:45 PM	11	19	97	9	0	9	111	28	13	0	30	154	150	7	0	19	33	56	8	0	4	50	19	11	1	**838**
Total:	**79**	**185**	**784**	**87**	**6**	**80**	**992**	**264**	**64**	**7**	**229**	**1352**	**1059**	**100**	**6**	**156**	**317**	**401**	**68**	**3**	**53**	**319**	**215**	**146**	**2**	**6950**

APPENDIX C

SYNCHRO Analysis



Lane Group	EBL2	EBL	EBT	EBR	WBL	WBT	WBR	WBR2	NBL2	NBL	NBR	NBR2
Lane Configurations												
Volume (vph)	118	106	155	51	46	175	835	14	31	688	89	14
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Satd. Flow (prot)	0	1770	1809	0	0	1846	2787	0	0	3396	0	0
Flt Permitted		0.519				0.991				0.910		
Satd. Flow (perm)	0	967	1809	0	0	1846	2787	0	0	3223	0	0
Right Turn on Red				Yes				Yes				Yes
Satd. Flow (RTOR)			5				84			117		
Link Speed (mph)			30			30				30		
Link Distance (ft)			489			473				515		
Travel Time (s)			11.1			10.8				11.7		
Peak Hour Factor	0.70	0.78	0.57	0.80	0.77	0.68	0.86	0.70	0.78	0.84	0.82	0.58
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	305	336	0	0	317	991	0	0	992	0	0
Turn Type	Perm	Perm	NA		Split	NA	custom		Perm	NA		
Protected Phases			4		1	1	6			3		
Permitted Phases	4	4					6		3			
Detector Phase	4	4	4		1	1	6		3	3		
Switch Phase												
Minimum Initial (s)	8.0	8.0	8.0		4.0	4.0	4.0		8.0	8.0		
Minimum Split (s)	14.0	14.0	14.0		20.0	20.0	21.0		33.0	33.0		
Total Split (s)	35.0	35.0	35.0		20.0	20.0	85.0		55.0	55.0		
Total Split (%)	17.9%	17.9%	17.9%		10.3%	10.3%	43.6%		28.2%	28.2%		
Yellow Time (s)	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		
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	Lag	Lag	Lag		Lead	Lead						
Lead-Lag Optimize?					Yes	Yes						
Recall Mode	None	None	None		None	None	Min		None	None		
Act Effct Green (s)		29.1	29.1			14.0	65.8			49.2		
Actuated g/C Ratio		0.16	0.16			0.08	0.36			0.27		
v/c Ratio		1.98	1.15			2.23	0.93			1.04		
Control Delay		499.3	161.3			609.7	66.8			94.8		
Queue Delay		0.0	0.0			0.0	0.0			0.0		
Total Delay		499.3	161.3			609.7	66.8			94.8		
LOS		F	F			F	E			F		
Approach Delay			322.1			198.4				94.8		
Approach LOS			F			F				F		
Stops (vph)		137	164			129	750			646		
Fuel Used(gal)		24	8			29	19			23		
CO Emissions (g/hr)		1704	591			2024	1316			1589		
NOx Emissions (g/hr)		332	115			394	256			309		
VOC Emissions (g/hr)		395	137			469	305			368		
Dilemma Vehicles (#)		0	0			0	0			0		
Queue Length 50th (ft)		~569	~471			~614	607			~609		
Queue Length 95th (ft)		#695	340			#623	663			#723		
Internal Link Dist (ft)			409			393				435		
Turn Bay Length (ft)												

Lane Group	SEL2	SEL	SER	SER2	SWL2	SWL	SWR	SWR2
Lane Configurations								
Volume (vph)	29	201	288	39	16	130	141	148
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900
Satd. Flow (prot)	0	3403	1441	0	0	1770	1583	0
Flt Permitted		0.560				0.950		
Satd. Flow (perm)	0	1991	1441	0	0	1770	1583	0
Right Turn on Red				Yes				Yes
Satd. Flow (RTOR)			117				84	
Link Speed (mph)		30				30		
Link Distance (ft)		577				518		
Travel Time (s)		13.1				11.8		
Peak Hour Factor	0.66	0.85	0.85	0.75	0.40	0.83	0.80	0.86
Shared Lane Traffic (%)			10%					
Lane Group Flow (vph)	0	314	357	0	0	197	348	0
Turn Type	Perm	NA	Perm		custom	NA	custom	
Protected Phases		2			8	8	7	
Permitted Phases	2		2		7		7	
Detector Phase	2	2	2		8	8	7	
Switch Phase								
Minimum Initial (s)	10.0	10.0	10.0		6.0	6.0	6.0	
Minimum Split (s)	16.0	16.0	16.0		12.0	12.0	12.0	
Total Split (s)	65.0	65.0	65.0		20.0	20.0	55.0	
Total Split (%)	33.3%	33.3%	33.3%		10.3%	10.3%	28.2%	
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	
Total Lost Time (s)		6.0	6.0			6.0	6.0	
Lead/Lag	Lag	Lag	Lag		Lead	Lead		
Lead-Lag Optimize?	Yes	Yes	Yes					
Recall Mode	Min	Min	Min		None	None	None	
Act Effct Green (s)		45.8	45.8			14.0	49.2	
Actuated g/C Ratio		0.25	0.25			0.08	0.27	
v/c Ratio		0.86dl	0.80			1.45	0.71	
Control Delay		66.0	55.3			289.6	55.7	
Queue Delay		0.0	0.0			0.0	0.0	
Total Delay		66.0	55.3			289.6	55.7	
LOS		E	E			F	E	
Approach Delay		60.3				140.2		
Approach LOS		E				F		
Stops (vph)		223	193			104	203	
Fuel Used(gal)		6	6			10	6	
CO Emissions (g/hr)		411	403			683	389	
NOx Emissions (g/hr)		80	78			133	76	
VOC Emissions (g/hr)		95	93			158	90	
Dilemma Vehicles (#)		0	0			0	0	
Queue Length 50th (ft)		173	309			~322	297	
Queue Length 95th (ft)		213	410			#484	381	
Internal Link Dist (ft)		497				438		
Turn Bay Length (ft)								

Lane Group	EBL2	EBL	EBT	EBR	WBL	WBT	WBR	WBR2	NBL2	NBL	NBR	NBR2
Base Capacity (vph)		154	293			142	1259			955		
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		1.98	1.15			2.23	0.79			1.04		

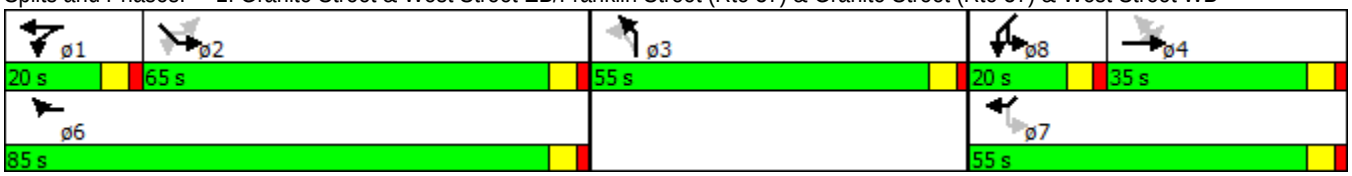
Intersection Summary			
Area Type:	Other		
Cycle Length: 195			
Actuated Cycle Length: 182.2			
Natural Cycle: 125			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 2.23			
Intersection Signal Delay: 162.8		Intersection LOS: F	
Intersection Capacity Utilization 91.0%		ICU Level of Service 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.

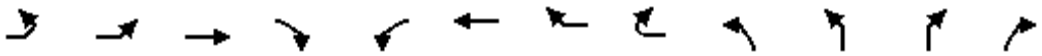
dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Splits and Phases: 1: Granite Street & West Street EB/Franklin Street (Rte 37) & Granite Street (Rte 37) & West Street WB



Lane Group	SEL2	SEL	SER	SER2	SWL2	SWL	SWR	SWR2
Base Capacity (vph)		646	547			136	488	
Starvation Cap Reductn		0	0			0	0	
Spillback Cap Reductn		0	0			0	0	
Storage Cap Reductn		0	0			0	0	
Reduced v/c Ratio		0.49	0.65			1.45	0.71	

Intersection Summary



Lane Group	EBL2	EBL	EBT	EBR	WBL	WBT	WBR	WBR2	NBL2	NBL	NBR	NBR2
Lane Configurations												
Volume (vph)	83	177	214	43	43	102	392	63	51	509	131	39
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Satd. Flow (prot)	0	1770	1805	0	0	1837	2787	0	0	3355	0	0
Flt Permitted		0.805				0.986				0.750		
Satd. Flow (perm)	0	1500	1805	0	0	1837	2787	0	0	2613	0	0
Right Turn on Red				Yes				Yes				Yes
Satd. Flow (RTOR)			6				84			117		
Link Speed (mph)			30			30				30		
Link Distance (ft)			489			473				515		
Travel Time (s)			11.1			10.8				11.7		
Peak Hour Factor	0.65	0.67	0.86	0.67	0.72	0.71	0.93	0.48	0.47	0.92	0.84	0.75
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	392	313	0	0	204	553	0	0	870	0	0
Turn Type	Perm	Perm	NA		Split	NA	custom		Perm	NA		
Protected Phases			4		1	1	6			3		
Permitted Phases	4	4					6		3			
Detector Phase	4	4	4		1	1	6		3	3		
Switch Phase												
Minimum Initial (s)	8.0	8.0	8.0		4.0	4.0	4.0		8.0	8.0		
Minimum Split (s)	14.0	14.0	14.0		20.0	20.0	21.0		33.0	33.0		
Total Split (s)	35.0	35.0	35.0		20.0	20.0	85.0		55.0	55.0		
Total Split (%)	17.9%	17.9%	17.9%		10.3%	10.3%	43.6%		28.2%	28.2%		
Yellow Time (s)	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		
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	Lag	Lag	Lag		Lead	Lead						
Lead-Lag Optimize?					Yes	Yes						
Recall Mode	None	None	None		None	None	Min		None	None		
Act Effct Green (s)		29.0	29.0			14.0	79.0			49.0		
Actuated g/C Ratio		0.15	0.15			0.07	0.41			0.25		
v/c Ratio		1.76	1.15			1.56	0.47			1.17		
Control Delay		400.4	167.3			335.5	37.1			142.5		
Queue Delay		0.0	0.0			0.0	0.0			0.0		
Total Delay		400.4	167.3			335.5	37.1			142.5		
LOS		F	F			F	D			F		
Approach Delay			296.9			117.5				142.5		
Approach LOS			F			F				F		
Stops (vph)		167	213			100	281			544		
Fuel Used(gal)		23	11			11	7			27		
CO Emissions (g/hr)		1615	763			768	466			1895		
NOx Emissions (g/hr)		314	148			149	91			369		
VOC Emissions (g/hr)		374	177			178	108			439		
Dilemma Vehicles (#)		0	0			0	0			0		
Queue Length 50th (ft)		~744	~462			~366	251			~621		
Queue Length 95th (ft)		#649	#633			#401	315			#759		
Internal Link Dist (ft)			409			393				435		
Turn Bay Length (ft)												

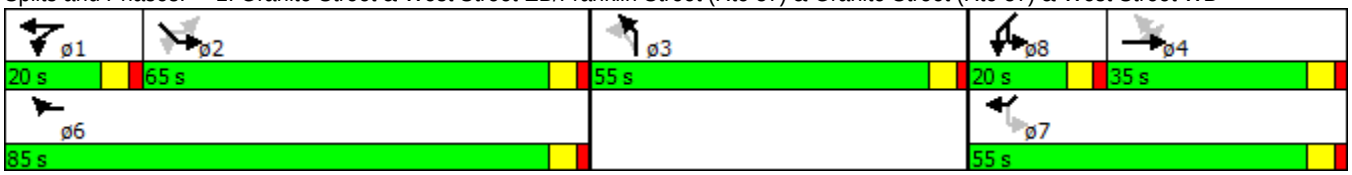
Lane Group	SEL2	SEL	SER	SER2	SWL2	SWL	SWR	SWR2
Lane Configurations								
Volume (vph)	111	707	573	49	28	159	98	78
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900
Satd. Flow (prot)	0	3420	1441	0	0	1770	1583	0
Flt Permitted		0.741				0.950		
Satd. Flow (perm)	0	2654	1441	0	0	1770	1583	0
Right Turn on Red				Yes				Yes
Satd. Flow (RTOR)			117				84	
Link Speed (mph)		30				30		
Link Distance (ft)		577				518		
Travel Time (s)		13.1				11.8		
Peak Hour Factor	0.77	0.90	0.96	0.64	0.70	0.80	0.84	0.72
Shared Lane Traffic (%)			10%					
Lane Group Flow (vph)	0	990	614	0	0	239	225	0
Turn Type	Perm	NA	Perm		custom	NA	custom	
Protected Phases		2			8	8	7	
Permitted Phases	2		2		7		7	
Detector Phase	2	2	2		8	8	7	
Switch Phase								
Minimum Initial (s)	10.0	10.0	10.0		6.0	6.0	6.0	
Minimum Split (s)	16.0	16.0	16.0		12.0	12.0	12.0	
Total Split (s)	65.0	65.0	65.0		20.0	20.0	55.0	
Total Split (%)	33.3%	33.3%	33.3%		10.3%	10.3%	28.2%	
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	
Total Lost Time (s)		6.0	6.0			6.0	6.0	
Lead/Lag	Lag	Lag	Lag		Lead	Lead		
Lead-Lag Optimize?	Yes	Yes	Yes					
Recall Mode	Min	Min	Min		None	None	None	
Act Effct Green (s)		59.0	59.0			14.0	49.0	
Actuated g/C Ratio		0.30	0.30			0.07	0.25	
v/c Ratio		1.23	1.19			1.88	0.49	
Control Delay		169.5	147.5			465.6	42.2	
Queue Delay		0.0	0.0			0.0	0.0	
Total Delay		169.5	147.5			465.6	42.2	
LOS		F	F			F	D	
Approach Delay		161.0				260.3		
Approach LOS		F				F		
Stops (vph)		718	394			116	95	
Fuel Used(gal)		38	22			19	3	
CO Emissions (g/hr)		2665	1515			1337	192	
NOx Emissions (g/hr)		519	295			260	37	
VOC Emissions (g/hr)		618	351			310	45	
Dilemma Vehicles (#)		0	0			0	0	
Queue Length 50th (ft)		~805	~917			~466	156	
Queue Length 95th (ft)		#943	#1200			#569	225	
Internal Link Dist (ft)		497				438		
Turn Bay Length (ft)								

Lane Group	EBL2	EBL	EBT	EBR	WBL	WBT	WBR	WBR2	NBL2	NBL	NBR	NBR2
Base Capacity (vph)		223	273			131	1179			744		
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		1.76	1.15			1.56	0.47			1.17		

Intersection Summary			
Area Type:	Other		
Cycle Length: 195			
Actuated Cycle Length: 195			
Natural Cycle: 145			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 1.88			
Intersection Signal Delay: 182.1		Intersection LOS: F	
Intersection Capacity Utilization 108.7%		ICU Level of Service G	
Analysis Period (min) 15			

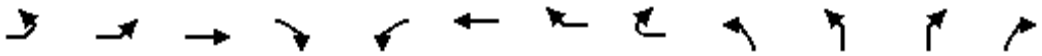
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Granite Street & West Street EB/Franklin Street (Rte 37) & Granite Street (Rte 37) & West Street WB



Lane Group	SEL2	SEL	SER	SER2	SWL2	SWL	SWR	SWR2
Base Capacity (vph)		803	517			127	460	
Starvation Cap Reductn		0	0			0	0	
Spillback Cap Reductn		0	0			0	0	
Storage Cap Reductn		0	0			0	0	
Reduced v/c Ratio		1.23	1.19			1.88	0.49	

Intersection Summary



Lane Group	EBL2	EBL	EBT	EBR	WBL	WBT	WBR	WBR2	NBL2	NBL	NBR	NBR2
Lane Configurations												
Volume (vph)	118	106	155	51	46	175	835	14	31	688	89	14
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Satd. Flow (prot)	0	1770	1809	0	0	1846	2787	0	0	3396	0	0
Flt Permitted		0.649				0.991				0.913		
Satd. Flow (perm)	0	1209	1809	0	0	1846	2787	0	0	3233	0	0
Right Turn on Red				Yes				Yes				Yes
Satd. Flow (RTOR)			8				131			183		
Link Speed (mph)			30			30				30		
Link Distance (ft)			489			473				515		
Travel Time (s)			11.1			10.8				11.7		
Peak Hour Factor	0.70	0.78	0.57	0.80	0.77	0.68	0.86	0.70	0.78	0.84	0.82	0.58
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	305	336	0	0	317	991	0	0	992	0	0
Turn Type	Perm	Perm	NA		Split	NA	custom		Perm	NA		
Protected Phases			4		1	1	6			3		
Permitted Phases	4	4					6		3			
Detector Phase	4	4	4		1	1	6		3	3		
Switch Phase												
Minimum Initial (s)	8.0	8.0	8.0		4.0	4.0	4.0		8.0	8.0		
Minimum Split (s)	14.0	14.0	14.0		20.0	20.0	21.0		33.0	33.0		
Total Split (s)	28.0	28.0	28.0		23.0	23.0	48.0		33.0	33.0		
Total Split (%)	22.4%	22.4%	22.4%		18.4%	18.4%	38.4%		26.4%	26.4%		
Yellow Time (s)	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		
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	Lag	Lag	Lag		Lead	Lead						
Lead-Lag Optimize?					Yes	Yes						
Recall Mode	None	None	None		None	None	Min		None	None		
Act Effct Green (s)		22.0	22.0			17.0	42.0			27.0		
Actuated g/C Ratio		0.18	0.18			0.14	0.34			0.22		
v/c Ratio		1.44	1.04			1.26	0.97			1.18		
Control Delay		259.7	108.8			189.9	57.2			128.3		
Queue Delay		0.0	0.0			0.0	0.0			0.0		
Total Delay		259.7	108.8			189.9	57.2			128.3		
LOS		F	F			F	E			F		
Approach Delay			180.6			89.4				128.3		
Approach LOS			F			F				F		
Stops (vph)		165	173			174	682			569		
Fuel Used(gal)		14	6			10	17			28		
CO Emissions (g/hr)		951	441			721	1174			1951		
NOx Emissions (g/hr)		185	86			140	228			380		
VOC Emissions (g/hr)		220	102			167	272			452		
Dilemma Vehicles (#)		0	0			0	0			0		
Queue Length 50th (ft)		~334	~286			~322	400			~432		
Queue Length 95th (ft)		#423	220			#330	#511			#498		
Internal Link Dist (ft)			409			393				435		
Turn Bay Length (ft)												

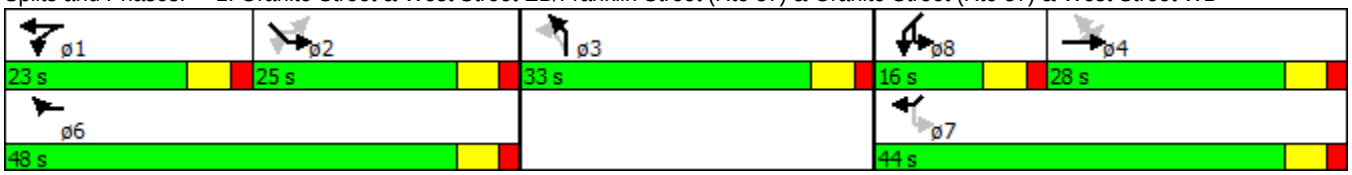
Lane Group	SEL2	SEL	SER	SER2	SWL2	SWL	SWR	SWR2
Lane Configurations								
Volume (vph)	29	201	288	39	16	130	141	148
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900
Satd. Flow (prot)	0	3403	1441	0	0	1770	1583	0
Flt Permitted		0.553				0.950		
Satd. Flow (perm)	0	1966	1441	0	0	1770	1583	0
Right Turn on Red				Yes				Yes
Satd. Flow (RTOR)			183				131	
Link Speed (mph)		30				30		
Link Distance (ft)		577				518		
Travel Time (s)		13.1				11.8		
Peak Hour Factor	0.66	0.85	0.85	0.75	0.40	0.83	0.80	0.86
Shared Lane Traffic (%)			10%					
Lane Group Flow (vph)	0	314	357	0	0	197	348	0
Turn Type	Perm	NA	Perm		custom	NA	custom	
Protected Phases		2			8	8	7	
Permitted Phases	2		2		7		7	
Detector Phase	2	2	2		8	8	7	
Switch Phase								
Minimum Initial (s)	10.0	10.0	10.0		6.0	6.0	6.0	
Minimum Split (s)	16.0	16.0	16.0		12.0	12.0	12.0	
Total Split (s)	25.0	25.0	25.0		16.0	16.0	44.0	
Total Split (%)	20.0%	20.0%	20.0%		12.8%	12.8%	35.2%	
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	
Total Lost Time (s)		6.0	6.0			6.0	6.0	
Lead/Lag	Lag	Lag	Lag		Lead	Lead		
Lead-Lag Optimize?	Yes	Yes	Yes					
Recall Mode	Min	Min	Min		None	None	None	
Act Effct Green (s)		19.0	19.0			10.0	38.0	
Actuated g/C Ratio		0.15	0.15			0.08	0.30	
v/c Ratio		1.05	0.95			1.40	0.61	
Control Delay		117.6	62.3			257.5	27.7	
Queue Delay		0.0	0.0			0.0	0.0	
Total Delay		117.6	62.3			257.5	27.7	
LOS		F	E			F	C	
Approach Delay		88.2				110.8		
Approach LOS		F				F		
Stops (vph)		220	131			107	159	
Fuel Used(gal)		9	6			9	4	
CO Emissions (g/hr)		600	409			618	257	
NOx Emissions (g/hr)		117	79			120	50	
VOC Emissions (g/hr)		139	95			143	60	
Dilemma Vehicles (#)		0	0			0	0	
Queue Length 50th (ft)		~142	165			~212	149	
Queue Length 95th (ft)		#217	#330			#328	204	
Internal Link Dist (ft)		497				438		
Turn Bay Length (ft)								

Lane Group	EBL2	EBL	EBT	EBR	WBL	WBT	WBR	WBR2	NBL2	NBL	NBR	NBR2
Base Capacity (vph)		212	324			251	1023			841		
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		1.44	1.04			1.26	0.97			1.18		

Intersection Summary			
Area Type:	Other		
Cycle Length: 125			
Actuated Cycle Length: 125			
Natural Cycle: 125			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 1.44			
Intersection Signal Delay: 115.3		Intersection LOS: F	
Intersection Capacity Utilization 91.0%		ICU Level of Service E	
Analysis Period (min) 15			

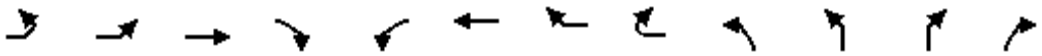
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Granite Street & West Street EB/Franklin Street (Rte 37) & Granite Street (Rte 37) & West Street WB



Lane Group	SEL2	SEL	SER	SER2	SWL2	SWL	SWR	SWR2
Base Capacity (vph)		298	374			141	572	
Starvation Cap Reductn		0	0			0	0	
Spillback Cap Reductn		0	0			0	0	
Storage Cap Reductn		0	0			0	0	
Reduced v/c Ratio		1.05	0.95			1.40	0.61	

Intersection Summary



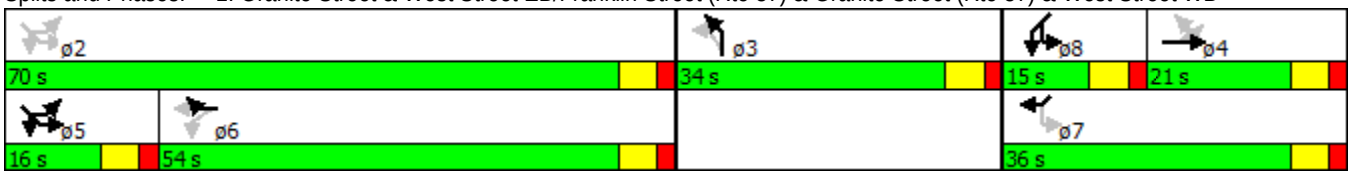
Lane Group	EBL2	EBL	EBT	EBR	WBL	WBT	WBR	WBR2	NBL2	NBL	NBR	NBR2
Lane Configurations												
Volume (vph)	83	177	214	43	43	102	392	63	51	509	131	39
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Satd. Flow (prot)	0	1770	1805	0	0	1837	2787	0	0	3355	0	0
Flt Permitted		0.805				0.106				0.769		
Satd. Flow (perm)	0	1500	1805	0	0	197	2787	0	0	2679	0	0
Right Turn on Red				Yes				Yes				Yes
Satd. Flow (RTOR)			7				164			164		
Link Speed (mph)			30			30				30		
Link Distance (ft)			489			473				515		
Travel Time (s)			11.1			10.8				11.7		
Peak Hour Factor	0.65	0.67	0.86	0.67	0.72	0.71	0.93	0.48	0.47	0.92	0.84	0.75
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	392	313	0	0	204	553	0	0	870	0	0
Turn Type	Perm	Perm	NA		custom	NA	custom		Perm	NA		
Protected Phases			4				6			3		
Permitted Phases	4	4			6	6	6		3			
Detector Phase	4	4	4		6	6	6		3	3		
Switch Phase												
Minimum Initial (s)	8.0	8.0	8.0		4.0	4.0	4.0		8.0	8.0		
Minimum Split (s)	14.0	14.0	14.0		21.0	21.0	21.0		33.0	33.0		
Total Split (s)	21.0	21.0	21.0		54.0	54.0	54.0		34.0	34.0		
Total Split (%)	15.0%	15.0%	15.0%		38.6%	38.6%	38.6%		24.3%	24.3%		
Yellow Time (s)	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		
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	Lag	Lag	Lag		Lag	Lag	Lag					
Lead-Lag Optimize?					Yes	Yes	Yes					
Recall Mode	None	None	None		Min	Min	Min		None	None		
Act Effct Green (s)		15.0	15.0			48.0	48.0			28.0		
Actuated g/C Ratio		0.11	0.11			0.34	0.34			0.20		
v/c Ratio		2.45	1.57			3.04	0.52			1.30		
Control Delay		695.9	318.9			976.7	27.1			183.2		
Queue Delay		0.0	0.0			0.0	0.0			0.0		
Total Delay		695.9	318.9			976.7	27.1			183.2		
LOS		F	F			F	C			F		
Approach Delay			528.5			283.0				183.2		
Approach LOS			F			F				F		
Stops (vph)		161	178			91	253			471		
Fuel Used(gal)		39	19			30	6			33		
CO Emissions (g/hr)		2706	1303			2088	391			2290		
NOx Emissions (g/hr)		527	254			406	76			446		
VOC Emissions (g/hr)		627	302			484	91			531		
Dilemma Vehicles (#)		0	0			0	0			0		
Queue Length 50th (ft)		~589	~400			~265	159			~459		
Queue Length 95th (ft)		#553	#559			#313	223			#592		
Internal Link Dist (ft)			409			393				435		
Turn Bay Length (ft)												

Lane Group	SEL2	SEL	SER	SER2	SWL2	SWL	SWR	SWR2	ø2
Lane Configurations									
Volume (vph)	111	707	573	49	28	159	98	78	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	
Satd. Flow (prot)	0	3410	1441	0	0	1770	1583	0	
Flt Permitted		0.621				0.950			
Satd. Flow (perm)	0	2215	1441	0	0	1770	1583	0	
Right Turn on Red				Yes				Yes	
Satd. Flow (RTOR)			117				117		
Link Speed (mph)		30				30			
Link Distance (ft)		577				518			
Travel Time (s)		13.1				11.8			
Peak Hour Factor	0.77	0.90	0.96	0.64	0.70	0.80	0.84	0.72	
Shared Lane Traffic (%)			15%						
Lane Group Flow (vph)	0	1020	584	0	0	239	225	0	
Turn Type	custom	NA	custom		custom	NA	custom		
Protected Phases	5	5	5		8	8	7		2
Permitted Phases	2	2	2		7		7		
Detector Phase	5	5	5		8	8	7		
Switch Phase									
Minimum Initial (s)	10.0	10.0	10.0		6.0	6.0	6.0		10.0
Minimum Split (s)	16.0	16.0	16.0		12.0	12.0	12.0		16.0
Total Split (s)	16.0	16.0	16.0		15.0	15.0	36.0		70.0
Total Split (%)	11.4%	11.4%	11.4%		10.7%	10.7%	25.7%		50%
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		
Total Lost Time (s)		6.0	6.0			6.0	6.0		
Lead/Lag	Lead	Lead	Lead		Lead	Lead			
Lead-Lag Optimize?	Yes	Yes	Yes						
Recall Mode	Min	Min	Min		None	None	None		Min
Act Effct Green (s)		64.0	64.0			9.0	30.0		
Actuated g/C Ratio		0.46	0.46			0.06	0.21		
v/c Ratio		0.93	0.81			2.12	0.52		
Control Delay		49.0	36.1			559.9	27.6		
Queue Delay		0.0	0.0			0.0	0.0		
Total Delay		49.0	36.1			559.9	27.6		
LOS		D	D			F	C		
Approach Delay		44.3				301.8			
Approach LOS		D				F			
Stops (vph)		657	385			118	77		
Fuel Used(gal)		17	8			23	2		
CO Emissions (g/hr)		1169	592			1588	149		
NOx Emissions (g/hr)		227	115			309	29		
VOC Emissions (g/hr)		271	137			368	34		
Dilemma Vehicles (#)		0	0			0	0		
Queue Length 50th (ft)		364	410			~344	85		
Queue Length 95th (ft)		#480	608			#448	151		
Internal Link Dist (ft)		497				438			
Turn Bay Length (ft)									

Lane Group	EBL2	EBL	EBT	EBR	WBL	WBT	WBR	WBR2	NBL2	NBL	NBR	NBR2
Base Capacity (vph)		160	199			67	1063			667		
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		2.45	1.57			3.04	0.52			1.30		

Intersection Summary			
Area Type:	Other		
Cycle Length: 140			
Actuated Cycle Length: 140			
Natural Cycle: 140			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 3.04			
Intersection Signal Delay: 217.6		Intersection LOS: F	
Intersection Capacity Utilization 108.7%		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: Granite Street & West Street EB/Franklin Street (Rte 37) & Granite Street (Rte 37) & West Street WB



Lane Group	SEL2	SEL	SER	SER2	SWL2	SWL	SWR	SWR2	ø2
Base Capacity (vph)		1097	722			113	431		
Starvation Cap Reductn		0	0			0	0		
Spillback Cap Reductn		0	0			0	0		
Storage Cap Reductn		0	0			0	0		
Reduced v/c Ratio		0.93	0.81			2.12	0.52		

Intersection Summary

APPENDIX D

Massachusetts Roundabout Installation Screening Form

MASSACHUSETTS ROUNDABOUT INSTALLATION SCREENING FORM

GENERAL INFORMATION	
Highway district: **MassDOT District 6**	Major street: **Route 37 (Granite and Franklin streets)**
MPO/RPA: Boston Region MPO	Minor street: **West and Granite streets**
City or Town: Braintree	Existing intersection control: **Signalized**
Prepared by: Seth Assante	Number of legs at the intersection: **Five**
Submitted by: Mark Abbott	ADT on major road: **Intersection ADT = 40,555**
Reviewed by:	ADT on minor road:
Phone:	Total number of crashes (5-year average): **16.8**
Email:	Speed limit (major road): **40 mph Route 37 north of int.**
Date:	Speed limit (minor road): **30 mph**

RESOURCES: DATA AND INFORMATION REQUIRED FOR ASSESSMENT	
1. Traffic counts (ADT and turning movements)	6. Aerial photographs of location
2. Vehicle classification (trucks and buses)	7. Crash data (3 years)
3. Pedestrian and bicyclist counts	8. Crash diagrams
4. Plan sheet or layout of existing intersection	9. Speed data
5. Geometric layout of roundabout	

STEP 1: BRIEF DESCRIPTION OF EXISTING PROBLEMS

Traffic congestion during peak periods and high number of crashes.

STEP 2: PROJECT OBJECTIVES (Check all that apply)

Question Number	Objectives	Primary		Secondary		Comment
		Yes	No	Yes	No	
2.1	Safety improvement	√				
2.2	Operational improvement	√				
2.3	Traffic-calming improvement		√			
2.4	Aesthetics/community enhancements		√			
2.5	Access management improvement		√			

STEP 3: TYPE OF ROUNDABOUT AND SPACE REQUIREMENTS (Check one)

Question Number	What type of roundabout is needed?	Yes	No	Other	Comment	Considerations/Supporting Information
3.1	**Mini-roundabout** (Use Exhibit 1 for planning estimate of a mini-roundabount.)					

MASSACHUSETTS ROUNDABOUT INSTALLATION SCREENING FORM						
	Single-lane roundabout (Use Exhibit 2 or 3 for planning estimate of a single-lane roundabout.)					Familiar to many motorists, pedestrians, and bicyclists. Has fewer conflict points than multi-lane roundabouts.
	Double-lane roundabout (Use Exhibit 2 or 3 for planning estimate of a double-lane roundabout.)	√			**Very high traffic volumes. Additional analysis required to ensure if multilane roundabout would operate adequately.**	Multi-lane roundabout is a big step from a single-lane roundabout and could pose challenges for pedestrians, bicyclists, and motorists. Consequently, a multi-lane roundabout could lead to project delays and may be a major factor in rejecting a roundabout design from further consideration in some cities and towns.
3.2	**Space requirement** Would there be sufficient right-of-way to build the roundabout? (Use Exhibit 4 for planning estimate of space requirements.)		√		**Existing intersection space may not be adequate for multlane roundabout.**	Right-of-way and geometric complications can be overcome in certain situations. In addition, consider cost and impact of land acquisition.
Assessment (3.1 to 3.2)	Based on your answers above, is the space requirement met?		√			
STEP 4: ROUNDABOUT SCREENING FACTORS (Check all that apply)						
SAFETY FACTORS						
Question Number	**Does the intersection where a roundabout is being considered have safety issues:**	**Yes**	**No**	**Other**	**Comment**	**Considerations/Supporting Information**
4.1	Resulting from multi-leg intersection or unusual geometry?	√				Too-tight skewed intersections can be problematic for large vehicles (design issues). In addition, too many legs could preclude using a roundabout design.
4.2	Resulting from high-speed crashes?		√			The purpose of considering a roundabout design could be to control speeds in conjunction with addressing other intersection control needs.
4.3	Causing crashes that are angle-type?	√				Roundabouts reduce the number of conflict points at which opposing vehicles intersect, hence they can provide possible solutions for angle crashes involving left-turn and crossing movements.
4.4	Associated with crashes resulting in personal injuries?			√		Collisions at roundabouts tend to be less severe because of low speeds on the entry approach and in the circulating roadway (20 - 25 mph).
Question Number	**Does the intersection where a roundabout is being considered have safety issues:**	**Yes**	**No**	**Other**	**Comment**	**Considerations/Supporting Information**
4.5	Associated with sight distance obstructions caused by alignment on existing stop-controlled approach?		√		**Signalized**	
4.6	Associated with a change-in-speed environment of the roadway?		√		**Signalized**	Generally, they occur at the fringes of an urban environment.

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4.7	Associated with visibility from all approaches?		√		**Signalized**	Some types of topography and construction complications can be overcome. The Highway Division successfully addressed vertical alignment issues and steep grades of a roundabout proposal on Cape Cod.
4.8	Associated with pedestrian and bicyclist volumes?		√		**No bike or pedestrian crashes reported.**	This would be an issue with a multi-lane roundabout and would need for further investigation, but it is less of a concern with a single-lane roundabout.
Assessment (4-1 to 4-8)	Based on your answers above, is the project safety improvement objective met—i.e., would a roundabout design address one or more of the project safety issues?			√	**Roundabout would reduce angle crashes but may introduce more rear-end crashes. Multilane roundabouts could also increase sideswipe-same-direction crashes.**	
OPERATIONAL FACTORS						
Question Number	**Does the intersection where a roundabout is being considered have issues:**	**Yes**	**No**	**Other**	**Comment**	**Considerations/Supporting Information**
4.9	Resulting from a high percentage of left turns experiencing high delay or a need for left-turn lanes or U-turns?			√	**Majority of traffic is on Granite and Franklin streets.**	Roundabouts may accommodate left-turning vehicles more efficiently with lower delays because they may not require storage lanes or separate turning phases.
4.10	Resulting in high delay but failing to meet traffic signal warrants?		√			
4.11	Resulting from a high proportion of left turns experiencing high delay and limited storage on an off-ramp?		√			A roundabout design can be particularly beneficial at interchanges if the roundabout alternative does not require bridge widening.
Question Number	**Is the intersection where a roundabout is being considered located:**	**Yes**	**No**	**Other**	**Comment**	**Considerations/Supporting Information**
4.12	Where traffic volumes on the minor roads are such that STOP or YIELD signs result in unacceptably high delays for the minor road?		√			
4.13	Where high traffic volumes during peak hours face excessive delays, but relatively low volumes and delays during non-peak hours?		√			
4.14	Away from a signalized intersection, where queues in general will not spill back into the roundabout?		√		**See adjacent signal on northern leg of Route 37**	Queue detection is an example of a possible remedy if queue spillback into the roundabout is occasional. Proper signal timing and coordination may remedy some queue spillbacks.
Question Number	**Is the intersection where a roundabout is being considered located:**	**Yes**	**No**	**Other**	**Comment**	**Considerations/Supporting Information**

MASSACHUSETTS ROUNDABOUT INSTALLATION SCREENING FORM						
4.15	Away from a school drop-off/pickup area, or transit stop, where queues in general will not spill back into the roundabout?	√				Bus bays or pullouts or locating transit stops further downstream of the splitter island may prevent queues from blocking the roundabout.
4.16	Outside of a coordinated arterial signal system or proposed roundabout where it will not impede progression through a corridor?	√				If the quality of progression is poor, a roundabout can replace a signalized intersection and improve coordination. Also, with correct signal timing and coordination, roundabouts and traffic signals can exist on the same corridor.
4.17	In an area where the percentage of major street traffic volume does not exceed 90% of the total entering traffic volume and the major street traffic volume is not opposed by relatively light traffic on the minor street?	√				Depends on how light the traffic is on the minor approach. In addition, if traffic calming is the main focus, then high or low traffic volume should not be the deciding factor.
4.18	Away from a railroad grade crossing, where queuing would not impact the roundabout or grade crossing?	√				Depends on the frequency of railroad trips.
4.19	Away from a direct emergency access roadway or driveway with preemption, where a roundabout would not impede emergency services?	√				Depends on the frequency of emergency trips.
Assessment (4.9 to 4.19)	Based on your answers above, is the project location favorable for roundabout installation—i.e., a roundabout design would function well and would not create additional operations problems?		√		**Space requirements and possible queue spilling into adjacent traffic signal on Route 37 to the north.**	
TRAFFIC CALMING FACTORS						
Question Number	**Does the intersection where a roundabout is being considered have issues:**	**Yes**	**No**	**Other**	**Comment**	**Considerations/Supporting Information**
4.20	That need to be addressed by traffic-calming measures for pedestrians, bicyclists, motorists, and transit users?		√			Generally, roundabout designs addressing traffic calming are located on local and residential roads.
4.21	Resulting from changes in land-use environments or transition to a new land-use environment?		√			Roundabout designs addressing environment or land-use transitions are located in areas where there may be a need to signify to drivers that the character of the road and surrounding land use is changing and, therefore, they need to change their driving behavior.
Assessment (4.20 to 4.21)	Based on your answers above, is the project traffic-calming improvement objective met—i.e., would a roundabout design address one or more of the project traffic calming issues?			√	**Not an objective of this project.**	
AESTHETICS AND COMMUNITY ENHANCEMENT FACTOR						

MASSACHUSETTS ROUNDABOUT INSTALLATION SCREENING FORM

Question Number	Is the proposed roundabout part of:	Yes	No	Other	Comment	Considerations/supporting information
4.22	A community enhancement or aesthetics (gateways) improvement project?		√			Roundabouts proposed for community enhancements and improved aesthetics should demonstrate that they would not introduce traffic problems that do not currently exist.
Assessment (4.22)	Based on your answer above, is the project aesthetics and community enhancement objective met—i.e., would the roundabout design address aesthetics and community enhancement issues?			√	**Not an objective of this project.**	

ACCESS MANAGEMENT FACTORS

Question Number	Does the corridor in which a roundabout is being considered have issues:	Yes	No	Other	Comment	Considerations/supporting information
4.23	Related to a controlled-access corridor, where U-turns/left turns are desirable at an intersection to access properties on the opposite side of the road?		√			Corridors that are hampered with numerous driveways, especially those to businesses, can benefit from roundabouts. Roundabouts in conjunction with raised medians facilitate the use of U-turns and left turns at intersections and allow right-in-right-out movements at driveways.
4.24	Related to many access/egress points where left turns experience unacceptable delay turning into and out of driveways and consolidating and controlling access points (installing a raised median) are desirable objectives?		√			
Assessment (4.23 to 4.24)	Based on your answers above, is the project access management objective met—i.e., does the roundabout address access management issues?		√		**Not an objective of this project.**	

STEP 5: SCREENING EVALUATION (Please circle one decision)

Decision	Criteria	Comments
Candidate	Advance a roundabout design for further analysis and design if it meets both of these criteria: 1. Space requirements 2. One or more of the project objectives	
Conditional	Advance a roundabout design for further analysis and design under these conditions (specify):	
Not recommended	A roundabout is not recommeded for further consideration if it fails to meet either of these criteria: 1. Space requirements 2. None of the project objectives	**High traffic volume multilane roundabout, inadequate space requirements make the location inappropriate for a roundabout.**

ATTACHMENTS

Please attach all of the data and information applied to this roundabout assessment tool to support your decision.

APPENDIX E

SIDRA Analysis

INPUT VOLUMES

Vehicles and pedestrians per 60 minutes

Site: PM Peak Hour

AM PEAK
Roundabout

Volume Display Method: Total and %

Volumes are shown for Movement Class(es): All Classes and Heavy Vehicles

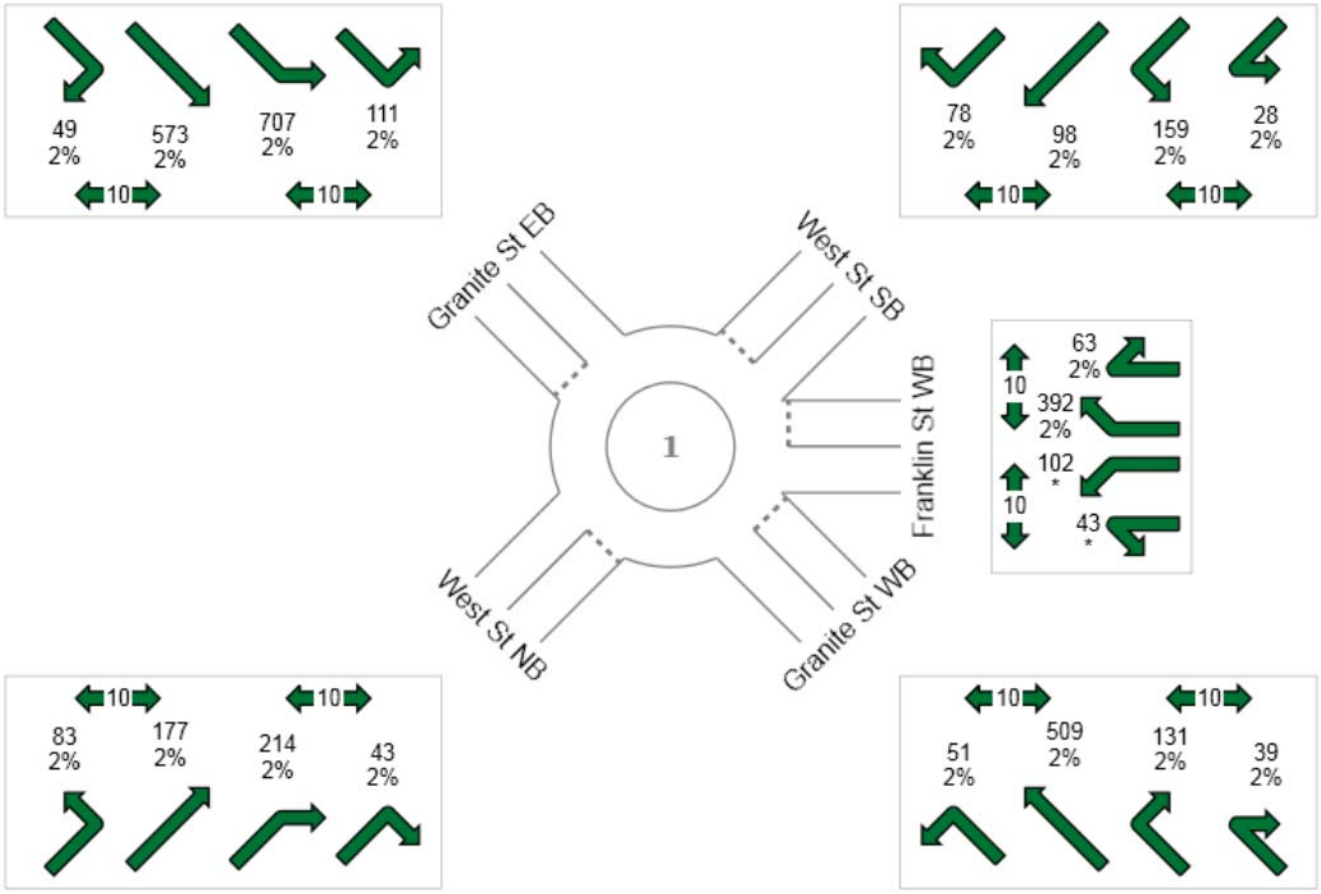
Total Intersection Volumes (veh)

All Movement Classes: 3650

Light Vehicles (LV): 3580

Heavy Vehicles (HV): 70

Pedestrians: 100



*** Class does not run in this movement.**

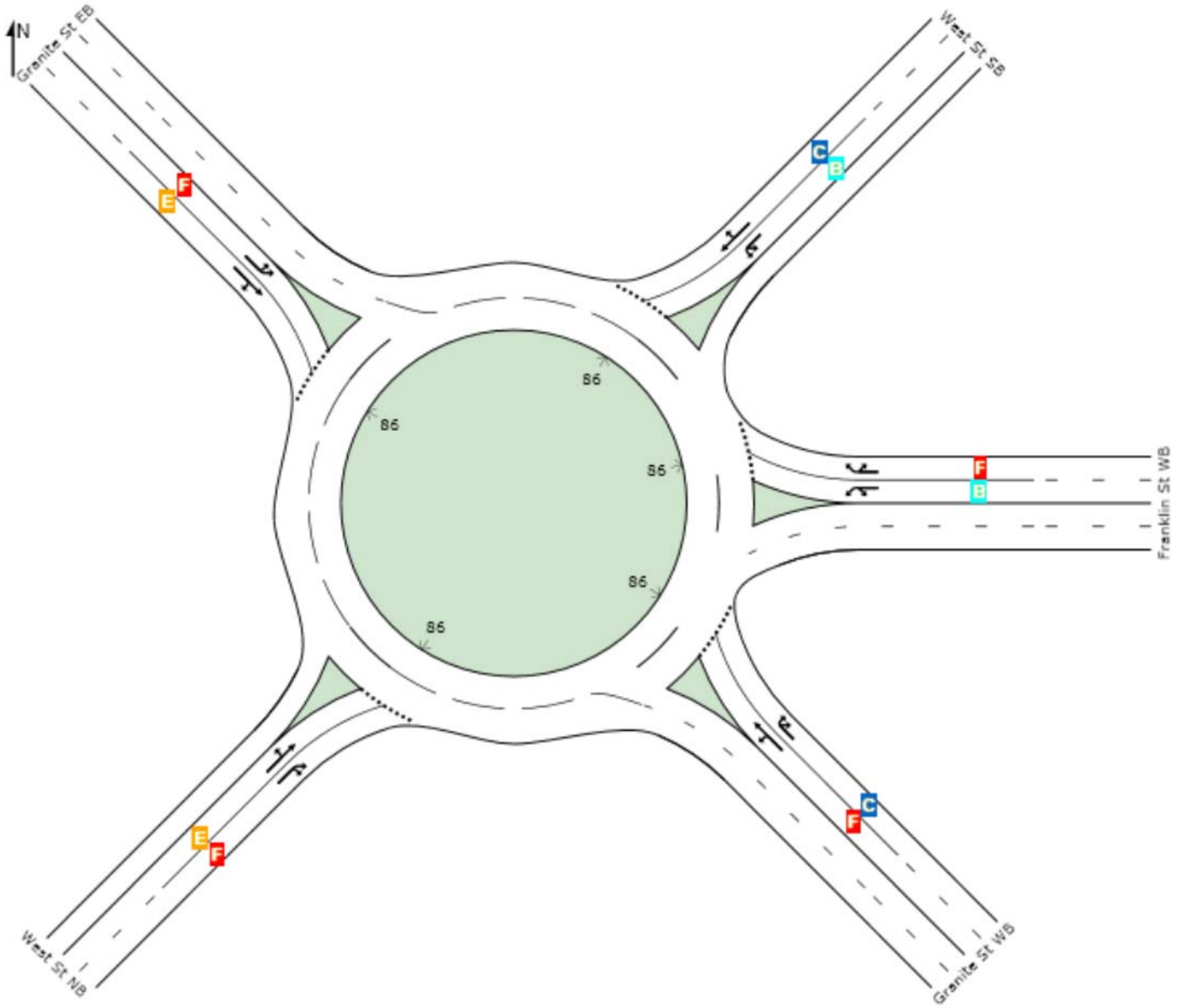
LEVEL OF SERVICE

Site: PM Peak Hour

AM PEAK
Roundabout

All Movement Classes

	Southeast	East	Northeast	Northwest	Southwest	Intersection
LOS	F	E	B	F	F	F



Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

DELAY (CONTROL)

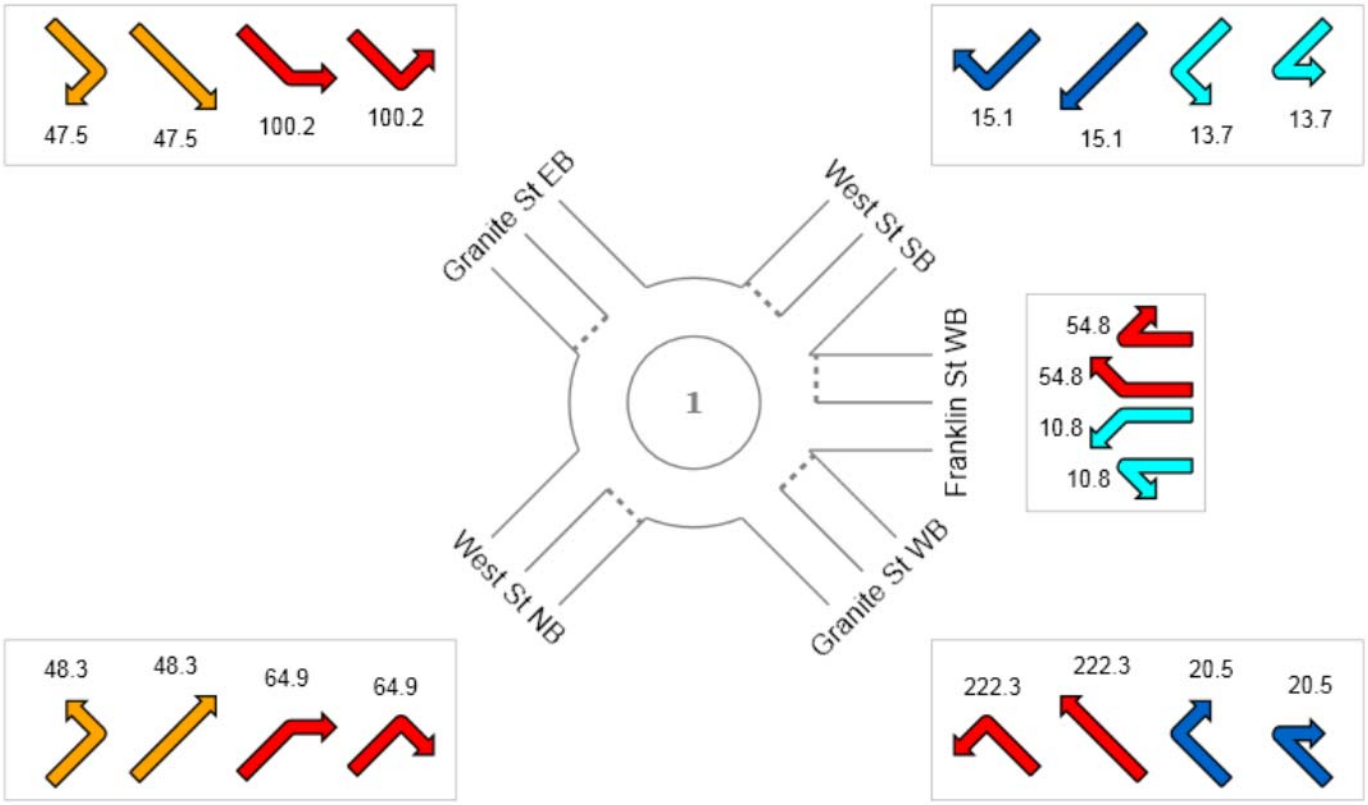
Average control delay per vehicle, or average pedestrian delay (seconds)

Site: PM Peak Hour

AM PEAK
Roundabout

All Movement Classes

	Southeast	East	Northeast	Northwest	Southwest	Intersection
Delay (Control)	175.3	44.2	14.4	77.4	56.6	82.3
LOS	F	E	B	F	F	F



Colour code based on Level of Service

LOS A | LOS B | LOS C | LOS D | LOS E | LOS F | Continuous

Level of Service Method: Delay & v/c (HCM 2010)
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Roundabout Level of Service Method: Same as Sign Control
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

INPUT VOLUMES

Vehicles and pedestrians per 60 minutes

Site: AM Peak Hour

AM PEAK
Roundabout

Volume Display Method: Total and %

Volumes are shown for Movement Class(es): All Classes and Heavy Vehicles

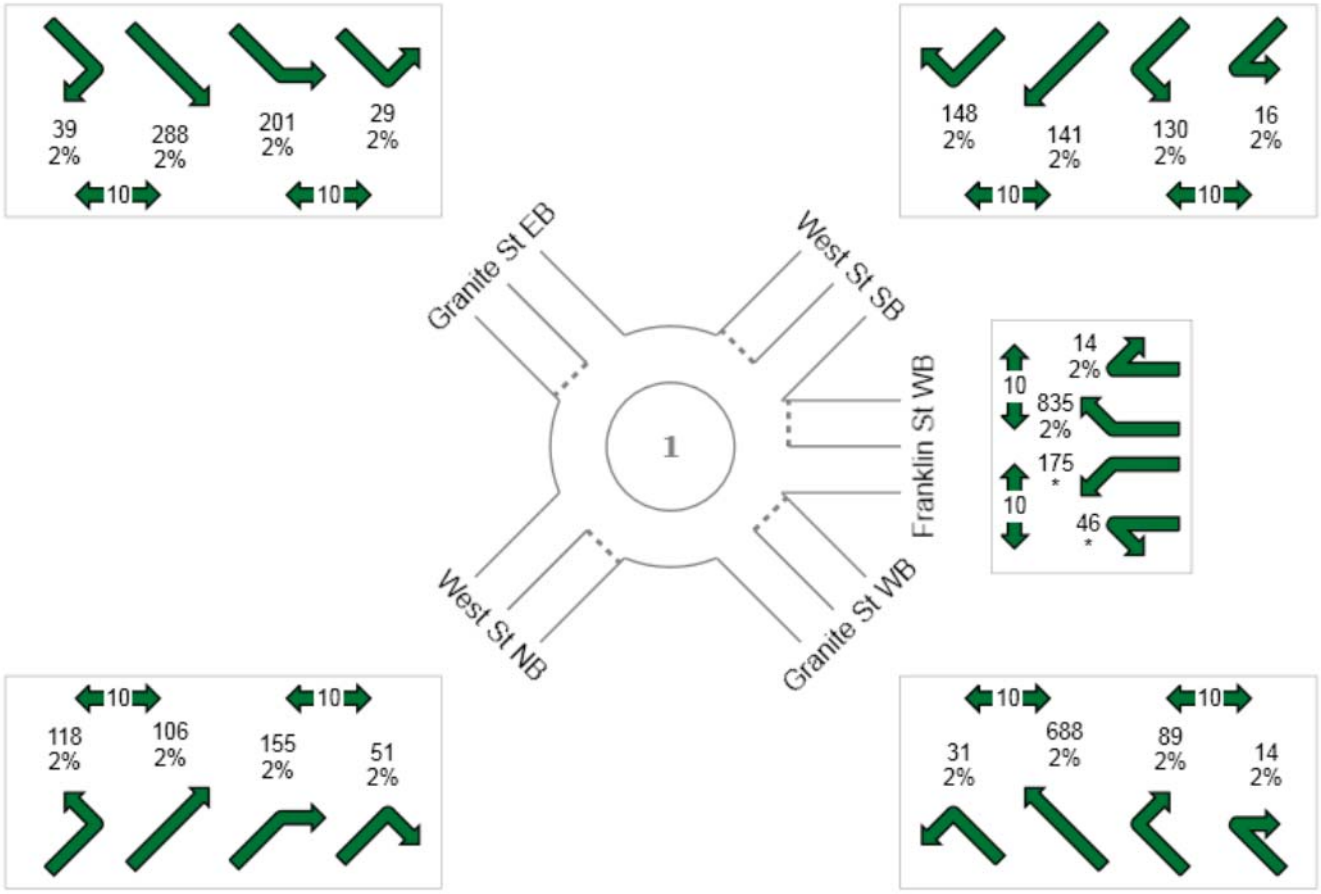
Total Intersection Volumes (veh)

All Movement Classes: 3314

Light Vehicles (LV): 3252

Heavy Vehicles (HV): 62

Pedestrians: 100



*** Class does not run in this movement.**

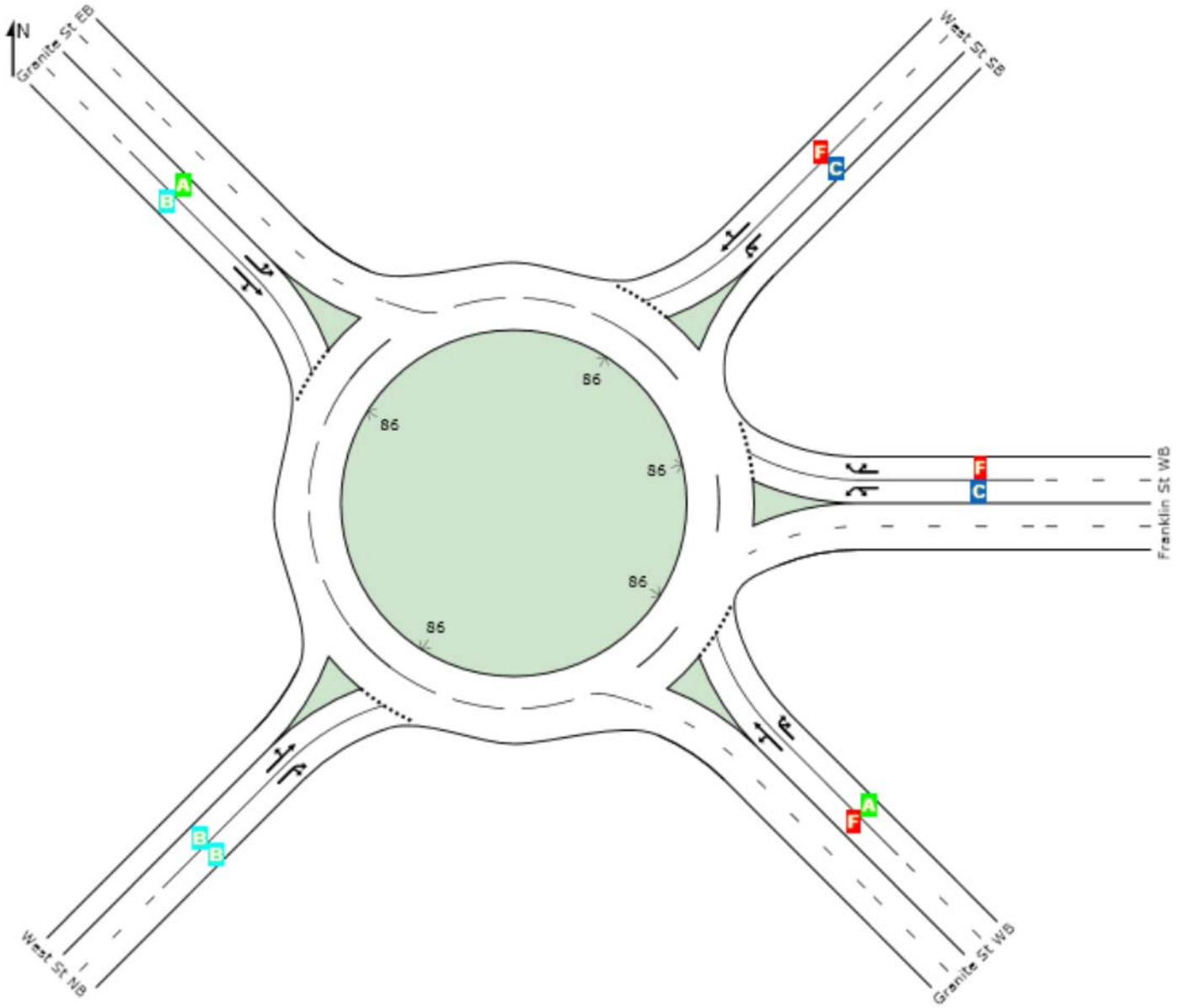
LEVEL OF SERVICE

Site: AM Peak Hour

AM PEAK
Roundabout

All Movement Classes

	Southeast	East	Northeast	Northwest	Southwest	Intersection
LOS	F	F	E	B	B	F



Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

DELAY (CONTROL)

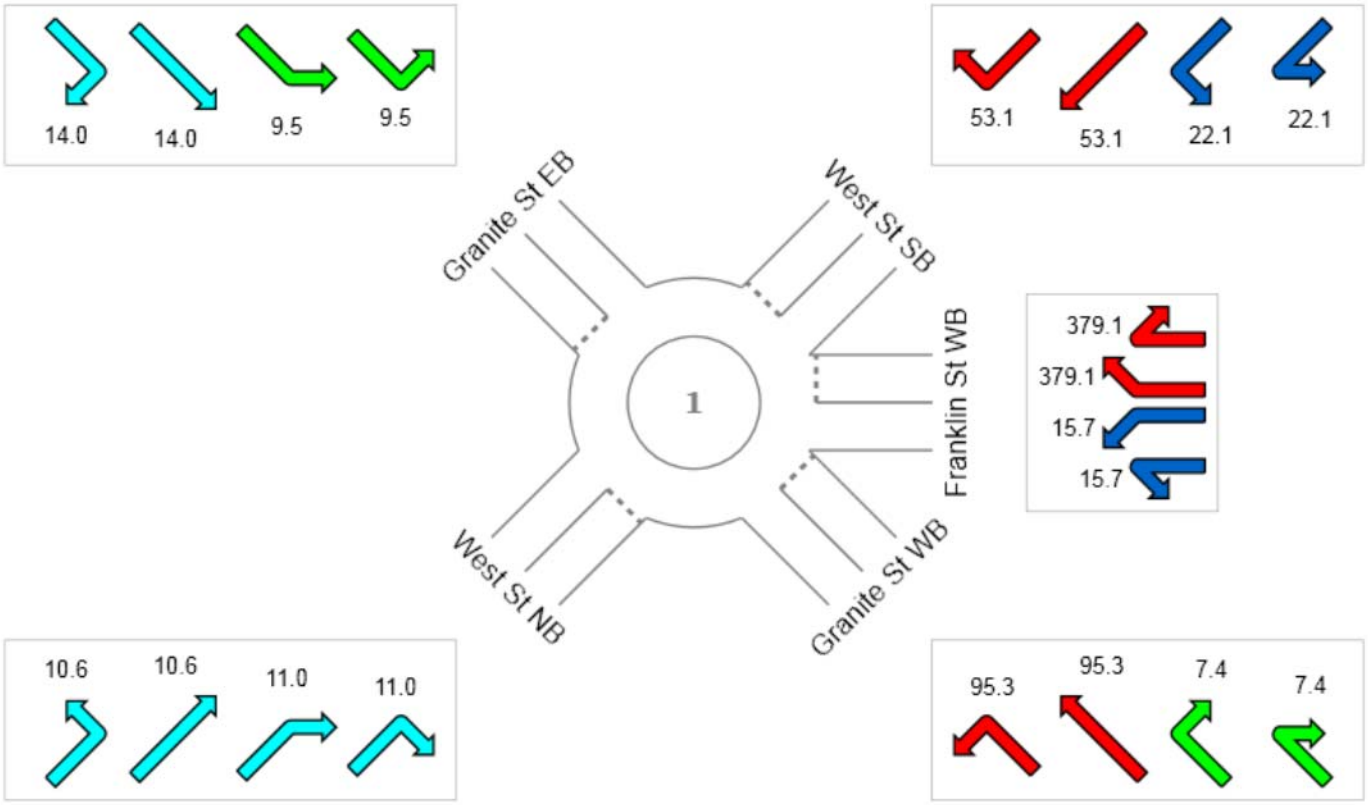
Average control delay per vehicle, or average pedestrian delay (seconds)

Site: AM Peak Hour

AM PEAK
Roundabout

All Movement Classes

	Southeast	East	Northeast	Northwest	Southwest	Intersection
Delay (Control)	84.2	304.1	42.7	12.1	10.8	128.1
LOS	F	F	E	B	B	F



Colour code based on Level of Service

LOS A | LOS B | LOS C | LOS D | LOS E | LOS F | Continuous

Level of Service Method: Delay & v/c (HCM 2010)
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Roundabout Level of Service Method: Same as Sign Control
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