Route 9 Corridor Study in Brookline

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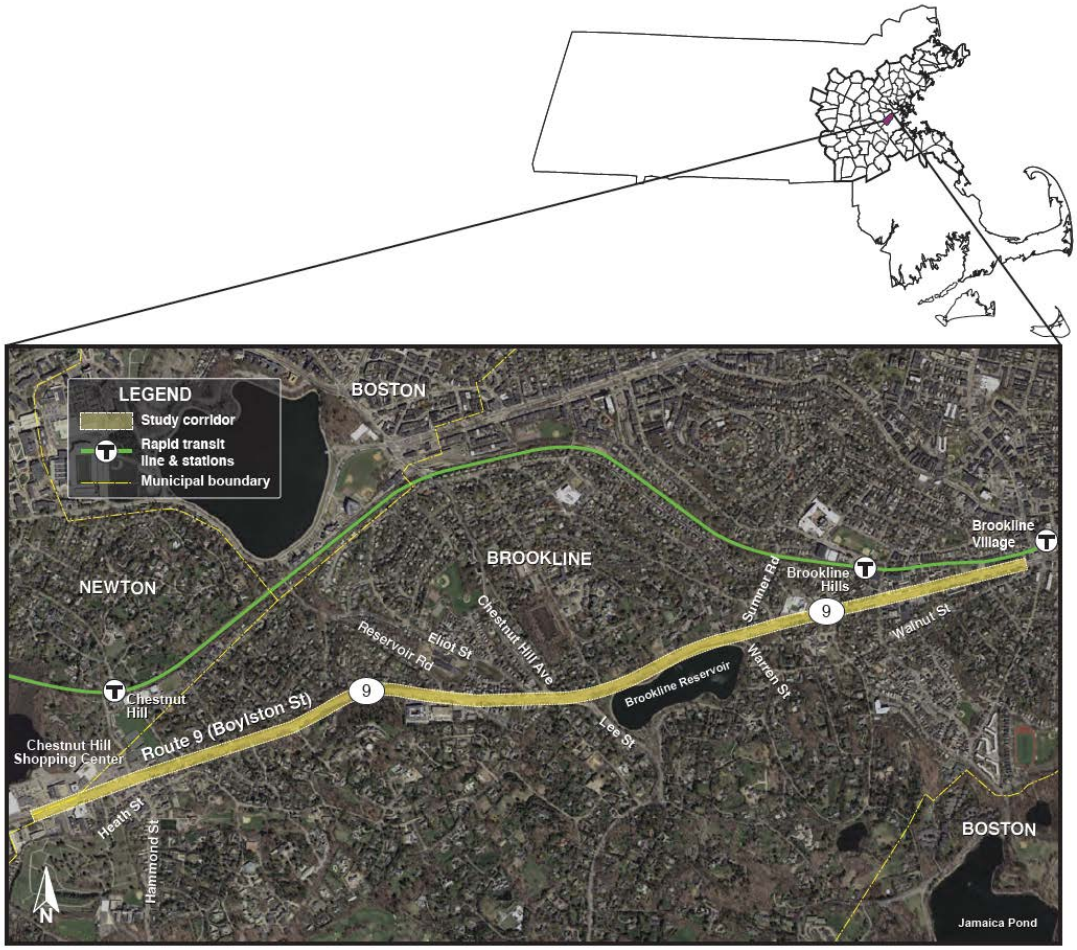

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Abstract

The *Route 9 Corridor Study in Brookline* is one in a series of studies supported by the Boston Region Metropolitan Planning Organization that address safety, mobility, and access on the Boston region's roadways. This report identifies specific transportation issues and concerns in the Route 9 corridor in Brookline, Massachusetts; presents an in-depth analysis of multiple transportation-related factors, such as bicycle accommodation and safety at pedestrian crossings; proposes short- and long-term improvements to address the problems; and provides a vision for the corridor's long-term development.

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Executive Summary

Each year, the Boston Region Metropolitan Planning Organization (MPO) conducts outreach to local agencies, municipalities, the public, and other stakeholders during the development of the Unified Planning Work Program, a program of studies and research projects that provide transportation planning and technical assistance to municipalities and agencies in the Boston region. The purpose of this outreach is to gather information about specific transportation problems in the region so that the issues may be studied and projects developed to address those issues and improve the operation of the transportation system as a whole.

The MPO's series of *Subregional Priority Roadways* studies grew out of this information-gathering process. These studies identify safety, mobility, access, and other transportation-related concerns on specific roadways identified by subregional planning groups as requiring improvements. The studies evaluate potential multimodal solutions to the problems and then make recommendations for agencies and municipalities to implement. Each year, the Boston Region MPO chooses an arterial or collector roadway for the MPO staff to analyze, which results in recommendations for short- and long-term improvements for that roadway area.

Selecting a study area in the Boston region is a thorough and exacting process, based upon many factors (described in the report). In any large metropolitan region, there are many roadways that need improvement, so it can be a challenge to single out just one. However, because the MPO's *Subregional Priority Roadways* program is ongoing, the MPO staff can address each problem area methodically according to priority and regional needs.

This report focuses on Route 9 in Brookline, Massachusetts. It contains review of existing conditions, various safety and operations analyses, safety and operational problems, and proposed short- and long-term improvements to address the problems in the study corridor.

Key issues and concerns identified for the corridor include the following:

- Significant number of pedestrian and bicycle crashes
- Lack of safe bicycle accommodation
- Pedestrian crossing and safety concerns
- Transit access issues
- Recurrent traffic congestion at major intersections
- Substandard on-street parking

The proposed short-term improvements, such as signage and pavement marking improvements at specific locations in the corridor, generally can be implemented within two years with a high benefit-to-cost ratio. The MPO staff recommends considering and implementing the improvements as soon as resources are available from highway maintenance or Chapter 90 funding.

Significantly improving the safety, mobility, and access for all users of the roadway would require a series of long-term improvements. Major long-term improvements proposed for the corridor and their expected benefits are summarized as follows:

- The proposed installation of separated bike lanes would provide bicyclists safe and comfortable accommodations in the corridor and significantly improve safety and mobility for bicyclists.
- Proposed improvements at major intersections, especially where Route 9 intersects with Sumner Road and Warren Street, Reservoir Road, and Hammond Street, would significantly improve safety and mobility for pedestrians, bicyclists, and motorists.
- Proposed improvements at major crossing locations, such as Route 9 at Clark Road and Kennard Road, and Dunster Road, would significantly improve safety and mobility for pedestrians and transit users.
- Proposed MBTA bus stop improvements at various locations in the corridor would improve safety and comfort for transit users and potentially increase the use of public transportation.
- The proposed sidewalk widening and enhancements would enrich pedestrians' walking experiences and promote healthy transportation.
- The overall proposed roadway reconfiguration—reducing travel lane width, maintaining medians, installing separated bicycle lanes, improving intersection and crosswalk operations, and enhancing sidewalk environment—would significantly reduce traffic speeds in the corridor and enhance safety for all users.

This report provides a detailed review and recommendations for improvements that address the transportation issues in the Route 9 corridor in Brookline. By addressing these problems systematically through the *Subregional Priority Roadways* program, the resulting improvements will help to enhance quality of life, support economic development, and improve air quality throughout the region.

Chapter 1—Introduction

1.1 STUDY BACKGROUND

During development of the Unified Planning Work Program (UPWP) and the Long-Range Transportation Plan (LRTP), the Boston Region Metropolitan Planning Organization (MPO) gathers feedback from the public, municipalities, the Metropolitan Area Planning Council's (MAPC) subregional groups, and the Massachusetts Department of Transportation (MassDOT) to identify transportation problems in the region. These problems generally involve bicycle and pedestrian accommodation, freight movement, traffic bottlenecks, safety of roadway users, and safe or convenient access for abutters along roadway corridors—problems that can adversely affect the region's quality of life, economic development, and air quality.

Each year, the MPO conducts a study—*Addressing Safety, Mobility, and Access on Subregional Priority Roadways*—to identify roadway segments in the Boston region that are of concern to stakeholders, but which have not been cited in the regional needs assessment conducted for the LRTP.[1] The *Subregional Priority Roadways* studies focus on arterial or collector roadways and result in recommendations for short- and long-term improvements. Funding for the *Route 9 Corridor Study in Brookline* was documented in the federal fiscal year (FFY) 2019 UPWP; and a work program outlining the study was approved by the MPO board on September 20, 2018.[2]

1.2 STUDY OBJECTIVES

The *Route 9 Corridor Study in Brookline* focused on safety, mobility, and access, as well as specific concerns related to bicycle and pedestrian transportation, multi-use trail feasibility, and other subjects raised by stakeholders. The objectives of the study were as follows:

- Identify safety, mobility, access, and other transportation-related problems in the study corridor.
- Develop and evaluate potential multimodal solutions to the problems, including those addressing the pedestrian, bicycle, truck, and transit modes.

[1] Roadways prioritized for improvement through this needs assessment are addressed through another annual work program, *Priority Corridors for LRTP Needs Assessment*.

[2] The FFY 2019 Unified Planning Work Program was endorsed by the Boston Region Metropolitan Planning Organization on June 21, 2018.

1.3 SELECTION PROCEDURE

The MPO selected Route 9 in Brookline by assessing 24 roadway corridors in the Boston region that were identified as strong potential candidates for study by various sources, including 1) suggestions heard during outreach for the FFY 2019 UPWP; 2) concerns documented in meeting records from the UPWP outreach process for the past five years; and 3) data from the MPO's Congestion Management Process (CMP). MPO staff assembled detailed data about these roadways and evaluated them according to the following selection criteria:

- ***Safety Conditions*:** The roadway has a high crash rate for its functional class, or there have been a significant number of collisions (two or more per mile) involving pedestrians or bicyclists.
- ***Multimodal Significance:*** The roadway supports transit, bicycle, or pedestrian activity, or accommodates large numbers of heavy vehicles (trucks and buses).
- ***Subregional Priority:*** The roadway carries a significant proportion of subregional vehicle, bicycle, or pedestrian traffic and is essential for the subregion's economic, cultural, or recreational development.
- ***Implementation Potential:*** Roadway improvements are proposed or endorsed by the agency or agencies that administer the roadway and other stakeholders voiced strong support for the improvements.
- ***Regional Equity*:** The roadway is situated in a subregion that has not been selected for the *Subregional Priority Roadways* study in the past two years.[3]

Route 9 in Brookline has a much higher pedestrian and bicycle crash rate than most other locations considered as study candidates. Route 9 carries regional and local traffic, pedestrians, bicycles, and Massachusetts Bay Transportation Authority (MBTA) bus Routes 51 and 60. In addition to residential areas, the corridor contains major commercial districts, such as Route 9 East and The Street at Chestnut Hill, and a popular town park, Brookline Reservoir Park.

The Town of Brookline is currently planning to enhance the vibrancy, design, and livability of the Route 9 corridor through land-use changes and capital improvements. This study supports the Town's goals by analyzing existing transportation conditions and identifying potential improvements to make the

[3] Details of the criteria and rating system may be found in the Central Transportation Planning Staff's technical memorandum "Selection of FFY 2019 Subregional Priority Roadway Study Location," dated October 18, 2018.

corridor safer and enhance mobility. The study was strongly endorsed by all stakeholders, including the Town of Brookline and MassDOT.

1.4 STUDY AREA AND DATA COLLECTION

The study corridor is approximately 2.8 miles long, beginning west of Washington Street in Brookline and extending to the Newton city line. The study area covers Route 9 (Boylston Street) and its adjacent areas and connected roadways. Major cross streets in the corridor include Cypress Street, Sumner Road, Warren Street, Lee Street, Chestnut Hill Avenue, Reservoir Road, and Hammond Street. Figure 1 shows the study corridor and major roadways and transit lines in the study area.

At the request of MPO staff, MassDOT collected traffic volume data and intersection turning-movement counts (including pedestrian and bicycle movements and the percentage of heavy vehicles) for this study. The data was collected in the fall of 2018, between November 28 and December 5, on both weekend and weekdays. MPO staff also collected information from the Town of Brookline and MassDOT, including recent transportation, city planning, land use, and economic studies, and the most recent police crash reports (for a five-year period).

1.5 STUDY ADVISORY COMMITTEE MEETINGS

During the course of the study, MPO staff worked closely with an advisory committee comprised of members who included representatives of the Town of Brookline and MassDOT. (See Appendix A for a complete list of advisory committee members.)

Three advisory committee meetings were held to guide and support the study. In the first meeting (November 6, 2018), MPO staff introduced the study, received input about the corridor's issues and concerns, and coordinated data collection. In the second meeting (February 14, 2019), staff presented the existing condition analyses and discussed ideas for potential improvements with the advisory committee members. In the final meeting (June 6, 2019), MPO staff reviewed the proposed short- and long-term improvements with advisory committee members. After the meetings, staff received comments and revised the proposed improvements accordingly.

Chapter 2—Existing Conditions and Issues

2.1 CORRIDOR OVERVIEW

Route 9 is one of the major east–west routes in Massachusetts, along with US Route 20, Route 2, and Interstate 90 (I-90). Route 9 starts at Copley Square in Boston, runs through Brookline and Newton, passes Route 128/Interstate 95 into the MetroWest suburbs, continues past Worcester to the Berkshire region, and ends near the city center of Pittsfield, a few miles from the New York state line.

In the Boston region, Route 9 is an alternate route to I-90, a toll road that is usually congested during peak commuting hours. Route 9 operates as a limited access highway in the MetroWest suburbs and provides entry to commercial developments adjacent to the roadway, whereas it serves mainly as a regional arterial in Newton, Brookline, and Boston where it connects to other major roadways through mostly at-grade intersections.

The section of Route 9 that is the focus of this study, from Washington Street to the Newton city line, is classified as an urban principal arterial. The entire section is under the jurisdiction of MassDOT Highway Division District 6. The corridor includes seven major signalized intersections, four signalized pedestrian crossings (three equipped with regular traffic signals and one with rectangular rapid-flashing beacons), and a number of unsignalized intersections and driveways.

Throughout the length of the corridor, there are two 12-foot travel lanes in the eastbound and westbound direction and traffic flow is separated by a median of variable width. The average daily traffic volumes range from nearly 30,000 vehicles per day (near Washington Street) to more than 42,000 vehicles per day (near the Newton city line), and most sections carry approximately 40,000 vehicles per day.

Adjacent to the corridor are residential homes, some commercial developments (Route 9 East and The Street at Chestnut Hill), local businesses and medical offices (near Reservoir Road), schools (the Lincoln School [public, kindergarten–8th grade] and Maimonides School [private, early childhood–12th grade]), a church (Saint Lawrence Church), and parks (Brookline Reservoir Park and Boylston Street Park).

2.2 TRANSIT SERVICE

Figure 2 shows transit services in the study area. The MBTA’s rapid transit Green Line D Branch runs parallel on the north side of Route 9. The D Branch

runs between Government Center Station in Boston and Riverside Station in Newton. There are five well-utilized stations in the study area: Brookline Village, Brookline Hills, Beaconsfield, Reservoir, and Chestnut Hill.

MBTA bus Route 60 (Kenmore Square—Mall at Chestnut Hill) runs on Route 9 from Cypress Street to the Newton city line and makes a number stops in the study corridor. MBTA bus Route 51 (Reservoir Station—Forest Hills Station) runs on a short section of the study corridor between Lee Street and Chestnut Hill Avenue and makes stops near Route 9. Both bus routes have headways of about 30 minutes during the morning and evening commuting periods.

In addition, Partners HealthCare's medical service shuttle, Route 3 (Brigham and Women's Hospital in Boston—Mall at Chestnut Hill in Newton), runs through the study corridor and has a major stop at Brigham and Women's Health Care Center (850 Boylston Street). It also has a stop at Clark Road (outbound) and Kennard Road (inbound) for patrons going to medical offices near the Brookline Hills stop on the Green Line.

2.3 PEDESTRIAN AND BICYCLE FACILITIES

Figure 2 also shows the location of pedestrian and bicycle facilities on Route 9 and in the surrounding study area. Sidewalks exist on both sides of Route 9, except on the south side from Lee Street to Warren Street adjacent to Brookline Reservoir Park. There is a multi-use trail surrounding the reservoir and its northern section runs parallel to Route 9. It is used as an alternative path to the missing sidewalk on the south side of Route 9.

There are no dedicated bike lanes in the entire corridor. Wide shoulders (approximately six feet or more in width) exist on both sides of the corridor between Sumner Road and Lee Street and between Reservoir Road and Dunster Road. These shoulders are next to travel lanes with high speed traffic and are not continuous along the corridor. Therefore, they are not suitable to be designated as bike lanes.

Brookline is a vibrant bicycling community. The Town has developed a bicycle network plan and designated a number of roadways adjacent to Route 9 as bike routes, including Cypress Street, Sumner Road/Warren Street, Heath Street, Lee Street/Chestnut Hill Avenue, and Hammond Street.[4] (See Figure 2.) Route 9 itself is not a designated bicycle route because it lacks suitable accommodation measures and there are safety concerns because of heavy volume and high-speed traffic conditions.

[4] Green Routes Network Plan, *A Bicycle Network Master Plan*, Brookline Bicycle Advisory Committee, November 10, 2008.

2.4 ISSUES AND CONCERNS

In the sections that follow, we categorize and summarize the numerous issues and concerns in the study area, which are based on discussions with the advisory committee members.

2.4.1 Pedestrian Accommodation and Safety

Advisory committee members from the Town of Brookline raised a number of pedestrian accommodation issues and safety concerns:

- Although sidewalks exist on most sections of the corridor, some are relatively narrow. There must be better connections to areas including Brookline Reservoir and The Street at Chestnut Hill shopping center.
- Crossing Route 9 safely and conveniently is a major concern of residents. A number of schools, including Brookline High School, Lincoln School, Maimonides School, Heath Elementary School, and Baldwin School, are adjacent to the study corridor. Some students who walk or bicycle from adjacent neighborhoods must cross Route 9, often during peak traffic conditions.
- The section of Route 9 near its intersection with Clark Road and Kennard Road is the area of most concern in terms of school crossings given the proximity to Lincoln School, Maimonides School, and Brookline High School. Students are often observed crossing Route 9 at mid-blocks, not using the signalized crosswalks at nearby intersections.[5]
- There is a signalized crosswalk on Route 9 at the site of the former Lincoln School. The school facility has been under renovation. The signal should be maintained for the future uses.[6]
- Some other common crossing locations include the intersections of Route 9 with Dunster Road and with Norfolk Road. The crosswalks are not signalized. Future improvements should focus on increasing drivers' awareness of these crosswalks.

[5] Advisory committee members representing MassDOT suggested that the presence of schools along the corridor may make potential projects eligible for Safe Routes to School funding. To qualify, nearby schools must be publicly funded kindergarten–8th grade schools that have a partnership with the MassDOT Safe Routes to School program. The Town should encourage any schools not currently partnered with the Safe Routes to School program to join the program if use of this funding source is desired.

[6] As this study was coming to a close in September 2019, staff of the Town of Brookline informed the MPO staff that the former Lincoln School now houses the 9th graders of Brookline High School. The signal is frequently used by students arriving or leaving school and traveling between this location and the main campus at 115 Greenough Street.

- Future corridor improvements should consider using shade trees or grass buffers to enhance the pedestrian experience and make the corridor more inviting. These trees and buffers could be installed within the state-owned right-of-way during future projects, or the owners of private properties adjacent to the corridor could be encouraged to plant trees.

2.4.2 Bicycle Accommodation and Safety

The following are bicycle accommodation issues and safety concerns raised by the advisory committee members representing the Town of Brookline.

- Currently dedicated bike lanes are planned for only a short section of Route 9 (between Brookline Avenue and Washington Street) as part of the Route 9 Gateway East reconstruction project. The bicycle community in Brookline would strongly support any expansion of these facilities further west on Route 9.
- Traffic on Route 9 is busy and vehicular travel speeds are generally fast (about 40 miles per hour [mph] or more). Separated bike facilities would be preferable under such conditions.
- Adjacent to the corridor, several side streets are designated as bicycle routes by the Town. Future improvements should consider accommodating bicycles at the Route 9 intersections and improving crossings on Route 9.

2.4.3 Transit Access and Safety

Advisory committee members raised the following concerns about transit access and safety:

- The Green Line D Branch runs parallel to Route 9 (on the north side) and has five stops within Brookline. Consideration should be given to making it safer and more convenient to walk and bicycle to the transit stops. Improving safety at crossing locations on Route 9 is especially important.
- Some of the bus stops along Route 9 may not meet MBTA guidelines for bus stop length or compliance with the Americans with Disabilities Act (ADA). Bus stops within the corridor should be examined for accessibility.
- Medical service shuttles that travel on Route 9 from Reservoir Road usually turn around at the driveway of the Chestnut Hill Benevolent Association. Other locations where the shuttles can make a U-turn should be identified.

2.4.4 Traffic Congestion and Safety

Advisory committee members raised the following concerns about safety and traffic congestion, which affects motorists as well as other users of the corridor:

- Traffic in the study corridor is very congested during the AM and PM peak periods. The peak traffic periods usually last at least three hours.
- Mid-day traffic volumes during the weekends can be as high as or higher than those during weekday peak periods, especially in the commercial areas.
- Motorists frequently use adjacent parallel and side streets to avoid the traffic congestion on Route 9. The use of routing apps may also increase cut-through traffic in the neighborhoods.
- On several side streets, motorists must wait in long queues to turn onto Route 9, which may further discourage them from using Route 9 and encourage them to travel on local streets instead.
- Some safety issues have been observed near the intersection with Reservoir Road. Left turns from Route 9 westbound onto Reservoir Road southbound are prohibited, but some vehicles still attempt this maneuver. Analyses of collision diagrams can further identify crash patterns at this and other locations.
- Traffic entering and exiting the driveways to two medical properties (Brigham and Women's at 850 Boylston Street and Longwood Orthopedic at 830 Boylston Street) near the intersection of Route 9 and Reservoir Road have caused some operational issues. The weekday evening count period could be extended to 7:00 PM to capture the evening shift at these offices.

2.4.5 On-Street Parking Issues

Advisory committee members raised the following concerns about parking:

- As on all state highways, on-street parking is generally prohibited on Route 9. However, there are a few locations in the corridor with existing on-street parking, such as eastbound between Tully Street and Hammond Street, and westbound between Washington Street and the newly developed Homewood Suites at 111 Boylston Street.
- The section of Route 9 between Washington Street and Sumner Road has a noticeable number of crashes related to on-street parked vehicles. The existing on-street parking lanes are narrow (six feet or less in width) and very close to the outside travel lane.

- Parking signage is inconsistent and unclear. For example, some locations have signs showing that overnight parking (1:00 AM–6:00 AM) is prohibited, while parking is generally prohibited 24 hours a day.

2.4.6 Emergency Response and Operations

Advisory committee members raised the following concerns about emergency response and operations:

- Three Brookline fire stations are located on or near Route 9: Station No.1 at Washington/High Street, Station No.4 at Reservoir Road, and Station No.6 at Hammond Street south of Route 9. Station No.4 serves most sections in the study corridor. Although the Reservoir Road intersection is equipped with an emergency preemption function, the signal equipment appears to be in need of an upgrade.
- All other signalized intersections in the study corridor are also equipped with a preemption function.

2.4.7 Potential Future Developments

The following are potential developments along the study corridor:

- The Route 9 East commercial area (from Washington Street to Cypress Street, including Cypress Street north of Route 9) has potential for a number of developments (commercial, multi-unit residential, and mixed use). Increased traffic, parking, pedestrian, and bicycle activities should be considered for this area.
- The Chestnut Hill Office Park near the Newton city line could be rezoned and developed into residential or mixed-use properties, which would likely increase pedestrian and bicycle traffic in this area.
- The Chestnut Hill Benevolent Association owns 25 acres along the south side of Route 9. While this organization has considered developing this wooded parcel in the past, no project is planned at the moment.

The above are issues and concerns raised by the advisory committee members about the corridor in general. Issues and concerns about specific locations in the corridor, where analyses identified safety and operational problems, and the proposed improvements are summarized by location in Chapter 5.

Chapter 3—Roadway Operations Analysis

3.1 DAILY TRAFFIC VOLUMES

Daily traffic volumes are the fundamental data for analyzing traffic intensity and patterns in a roadway corridor. MassDOT conducted automatic traffic recorder (ATR) counts at a number of locations in the Route 9 corridor and on adjacent streets during the period from November 28 (Wednesday) to December 5 (Wednesday), 2018.

Figure 3 shows daily traffic volumes at these locations. The numbers in the graphic represent average daily directional volumes collected during the period. The two tables in the graphic further summarize the data by count locations, directional split, combined volume of both directions, and adjusted annual average daily traffic (AADT).

In general, the corridor carries an average daily traffic volume of about 40,000 vehicles per day, ranging from nearly 30,000 (near Washington Street) to more than 42,000 (near the Newton city line). These counts show that traffic volumes gradually decrease along Route 9 in the eastbound direction toward Boston and gradually increase in the westbound direction away from Boston because of traffic diverging and converging around major cross streets such as Hammond Street, Chestnut Hill Avenue, Lee Street, Sumner Road, Warren Street, and Cypress Street.

Traffic volumes in late November and early December were slightly higher than the annual average. Adjusted for the seasonal factors, the corridor still carries about 40,000 vehicles per day at most locations.

3.2 INTERSECTION TRAFFIC, PEDESTRIAN, AND BICYCLE VOLUMES

In addition to daily traffic counts, MassDOT collected turning-movement counts at major intersections in the study corridor, including vehicle movements (by vehicle types), bicycle movements, and pedestrian crossings. These counts were collected during the morning peak period (7:00 AM–10:00 AM) and the extended evening peak period (2:00 PM–7:00 PM) on Thursday, November 29, 2018, and during the midday peak period (10:00 AM–2:00 PM) on Saturday, December 1, 2018.

Based on these data, MPO staff identified the peak hour in each of the peak periods for various traffic operational analyses and analyzed the pedestrian, bicycle, and heavy vehicle activities in the corridor.

3.2.1 Intersection Traffic and Pedestrian Volumes

Figure 4 shows the weekday AM peak hour (7:15 AM–8:15 AM) traffic and pedestrian volumes at major intersections in the corridor.[7] In general, major intersections on Route 9 carried about 3,000 to 4,300 vehicles during the AM peak hour. The intersections of Route 9 at Hammond Street, at Chestnut Hill Avenue, and at Lee Street were identified as the locations with the most traffic. All three intersections had high volumes of vehicles making left turns to and from Route 9. The intersection of Route 9 at Cypress Street carried nearly 3,000 vehicles per AM peak hour and a high volume of left-turning vehicles traveling from Route 9 eastbound to Cypress Street northbound.

Also shown in the figure are pedestrian crossing counts at the major intersections. Almost 200 pedestrians crossed the intersection of Route 9 and Cypress Street during the AM peak hour. And approximately 80 pedestrians crossed the intersection of Route 9 and Hammond Street during the AM peak hour.

Figure 5 shows the weekday PM peak hour (5:00 PM–6:00 PM) traffic and pedestrian volumes at major intersections in the corridor. In general, major intersections on Route 9 carried about 3,000 to 4,000 vehicles during the PM peak hour. The intersections of Route 9 at Hammond Street, at Chestnut Hill Avenue, and at Lee Street each carried nearly 4,000 vehicles per hour. The intersections of Route 9 at Cypress Street and at Reservoir Road each carried 3,000 vehicles per hour. Similar to the AM peak hour, the intersections of Route 9 at Hammond Street, at Chestnut Hill Avenue, at Lee Street, and at Cypress Street all had high volumes of vehicles making left turns to and from Route 9.

At the intersection of Route 9 and Cypress Street, there were almost 150 pedestrian crossings during the PM peak hour. The intersection of Route 9 and Hammond Street had approximately 80 pedestrians crossing in the PM peak hour.

Figure 6 shows the Saturday peak hour (12:15 PM–1:15 PM) traffic and pedestrian volumes at the major intersections. In general, traffic patterns during the Saturday peak hour were similar to those of the weekday PM peak hour, yet traffic volumes at major intersections were approximately 10 to 15 percent lower than during the PM peak hour. The busiest location was the intersection of Route 9 at Hammond Street, adjacent to The Street at Chestnut Hill shopping area.

[7] Staff selected 7:15 AM–8:15 AM, 5:00 PM–6:00 PM, 5:00 PM–6:00 PM as the weekday AM, weekday PM, and Saturday peak hours, respectively, because these were the periods when total volume observed through the corridor was highest.

3.2.2 Pedestrian Crossings on Route 9

The MPO staff used available turning-movement counts to estimate pedestrian crossings in the corridor. Figure 7 shows the numbers of pedestrian crossings at major intersections and crossing locations on Route 9 during the weekday AM, PM, and Saturday midday peak periods. Staff further generalized the peak period counts into hourly pedestrian crossings in four ranges: 0–5, 6–10, 11–50, and more than 50 crossings per hour.

In the highest range, the intersection of Route 9 at Cypress Street had approximately 100 or more pedestrian crossings per hour. In addition, there were a significant number of pedestrian crossings at the intersections of Route 9 at Hammond Street, at Sumner Road and Warren Street, and at Reservoir Road. At the crossing location of Route 9 at Clark Road and Kennard Road, where no crosswalks exist, there were about 6 to 10 pedestrians crossing Route 9 per peak hour. Note that these counts were taken in the late fall and pedestrian crossings in this area generally are higher in warmer months.

3.2.3 On-Road Bicycle Volumes

The turning-movement counts also provided a snapshot of bicycle activities in the corridor. Figure 8 summarizes the observed on-road bicycle volumes during the weekday AM, weekday PM, and Saturday peak periods. On the count days (November 29 and December 1, 2018), Route 9 generally carried insignificant numbers of bicycles between the Newton city line and Chestnut Hill Avenue, while there were noticeable numbers of bicycles traveling on Route 9 between Chestnut Hill Avenue and Washington Street. The estimate shows that besides Route 9, the primary routes of bicycle travel in the area are Cypress Street, Lee Street, Chestnut Hill Avenue, and Hammond Street. Cypress Street carried the highest number of bicycles during all three-peak periods.

3.2.4 Heavy Vehicle Volumes

It is essential to examine the amount of truck and bus traffic in a study corridor, as an unusually high percentage of these heavy vehicles may seriously affect roadway operations.[8] Figure 9 shows the percentages of heavy vehicle traffic at various locations in the corridor during the weekday AM, weekday PM, and Saturday peak periods.

[8] Heavy vehicles include single-unit trucks (Federal Highway Administration [FHWA] Vehicle Classes 5 to 7), articulated trucks (single- and multi-trailer trucks, FHWA Vehicle Classes 8 to 13), and buses (FHWA Vehicle Class 4). Vehicles on a single frame with two axles and six tires (dual rear wheels) (FHWA Vehicle Class 5) include trucks and recreational vehicles. Passenger cars of any type and all other two-axle four-tire vehicles (FHWA Vehicle Class 3), such as pickups, vans, mini-buses, ambulances, motor homes, and campers (even a passenger car pulling a trailer), are not considered heavy vehicles.

The percentage of heavy vehicles among the traffic in the AM peak period was higher than other peak periods and at most locations the percentage of heavy vehicles traveling in the off-peak direction was greater than those traveling in the peak direction. On average, heavy vehicles in the corridor accounted for approximately four to six percent of the traffic during the AM peak period, and approximately two to three percent in the PM and Saturday peak periods. These numbers are regarded as normal for an urban principal arterial.

The percentage of heavy vehicle traffic by direction of approach to the major intersections was calculated in the intersection capacity analyses and the traffic simulation models used for this study. The capacity analyses detailed in the following sections indicate that the existing volumes of heavy vehicles do not seriously affect traffic operations at the intersections studied.

3.3 INTERSECTION CAPACITY ANALYSES

Based on the turning-movement counts, MPO staff constructed peak hour traffic models for the entire corridor and conducted capacity analyses for major intersections using Synchro, a traffic analysis and simulation program.[9] The model set consisted of weekday AM, weekday PM, and Saturday midday peak hour models, and scenarios that assumed existing conditions and proposed improvement alternatives were tested.

Figure 10 shows the results of weekday AM peak hour capacity analyses for the existing conditions (as of 2019) at major intersections in the corridor and the level of service (LOS) each intersection provides. The LOS was determined based on criteria from the Highway Capacity Manual (HCM).[10] The HCM defines LOS—using a qualitative scale from A to F—for signalized and unsignalized intersections as a function of the average vehicle control delay.[11] For the intersections in a metropolitan urban area, LOS A, B, and C are considered desirable; LOS D and E are considered acceptable; and LOS F is considered undesirable.

Heavy traffic conditions in the AM peak hour caused the signalized intersections of Route 9 at Cypress Street, at Sumner Road/Warren Street, and at Hammond Street to operate at LOS F with an estimated average delay of one and a half

[9] Synchro Version 10.3 was used for the analyses. This software is developed and distributed by Trafficware Ltd. It can perform capacity analyses and traffic simulation (when combined with SimTraffic) for an individual intersection or a series of intersections in a roadway network.

[10] *Highway Capacity Manual 2010*, Transportation Research Board of the National Academies, Washington DC.

[11] Control delay quantifies the increase in travel time that a vehicle experiences due to a traffic signal or other type of control. It also provides a surrogate measure for driver discomfort and fuel consumption.

minutes to more than two minutes. The signalized intersections of Route 9 at Lee Street and Chestnut Hill Avenue operated at LOS E with an estimated average delay of about one minute.

Figure 11 shows the results of weekday PM peak hour capacity analyses and estimated LOS for the existing conditions at major intersections in the corridor. Because traffic volumes were slightly less as compared to the AM peak hour and there were fewer vehicles making left turns from Route 9, major intersections in the corridor generally operated at the same or better LOS in the PM peak hour. The signalized intersections of Route 9 at Sumner Road/Warren Street and at Hammond Street operated at LOS F with an estimated average delay of one and half to almost two minutes. The signalized intersections of Route 9 at Cypress Street and at Chestnut Hill Avenue operated at LOS E with an estimated average delay of about one minute.

Figure 12 shows Saturday peak hour capacity analyses and estimated LOS for the existing conditions at major intersections in the corridor. All the major intersections operated at an acceptable LOS or better, except the intersection of Route 9 at Hammond Street, which operated at LOS F with an estimated average delay of one and half minutes.

Details of Synchro capacity analysis reports for the major intersections in the AM, PM, and Saturday peak hour are included in Appendices B, C, and D.

3.4 ROADWAY TRAVEL SPEEDS

One of the concerns raised by the Town of Brookline is the generally high travel speeds in the corridor. In order to examine the prevailing travel speeds versus regulated speeds, MPO staff asked MassDOT to help collect spot-speed data during the period when automatic traffic counts were being conducted, from November 28 to December 5, 2018.

Figure 13 shows the existing speed regulations and estimated 85th percentile speed at selected locations in the corridor, based on spot-speed counts collected from automatic traffic recorders. The 85th percentile speed is the speed at or below which 85 percent of vehicles passing a given point are traveling, and it is the principal value used to establish speed controls by MassDOT.

Three speed regulations are in effect in the study corridor:

- Route 9 from Newton city line to Reservoir Road: 40 mph
- Route 9 from Reservoir Road to Sumner Road/Warren Street: 35 mph
- Route 9 from Sumner Road/Warren Street to Washington Street: 30 mph

These regulations apply to both directions of Route 9, except in the section adjacent to the Brookline Reservoir. In the section of Route 9 between Sumner Road/Warren Street and Lee Street, the speed limit for the westbound vehicles is 35 mph while the speed limit for the eastbound vehicles is 45 mph.

The spot-speed studies show that estimated 85th percentile speeds in the section adjacent to the Brookline Reservoir are approximately 40 mph in the westbound direction and nearly 50 mph in the eastbound direction. The other sections in the corridor generally have an estimated 85th percentile speed of less than five mph higher than the regulated speed limit, except the section between Reservoir Road and Norfolk Road, where the estimated 85th percentile speed is 10 mph or more higher than the regulated speed limit in both directions.

While the prevailing speeds in the corridor may appear high, the estimated speeds at the locations of the spot-speed study indicate that the speeds are all within the acceptable range, except on the wide section between Reservoir Road and Norfolk Road.[12] The proposed long-term improvements described in this report and the addition of separated bike lanes would significantly reduce travel speeds on this section of Route 9. The project design could plan for a 35 mph speed limit. In the near term, if any speed regulation is to be changed in the corridor, an engineering study, based on speed data collected from radar or laser guns, would have to be undertaken.[13]

3.5 ON-STREET PARKING INVENTORY AND ANALYSIS

Per request of the advisory committee, staff conducted an on-street parking inventory for the corridor based on site reconnaissance and a review of Google street views. The inventory data include all the curbside regulatory signage related to on-street parking and estimated parking spaces in the various sections of the corridor. Appendix E contains two figures that summarize the observed parking signage and estimated parking spaces in the corridor.

[12] Based on “Procedures for Speed Zoning on State and Municipal Roadways” (MassDOT Highway Division, May 2012), establishing speed regulations require that at speed observation locations, the established safe speed shall not be more than seven mph below the 85th percentile speed and not higher than the 95th percentile speed.

[13] To establish or modify speed controls, MassDOT requires the collection of speed data by radar gun or laser gun at critical locations at intervals not to exceed 0.25 miles, in addition to vehicle trial runs in the study area.

An estimated 186 parking spaces exist in the corridor. These include 125 spaces designated for daytime only parking with a two-hour limit, 59 spaces in unregulated areas where parking was observed, and two spaces for short-term parking with a 15-minute limit (valet parking for Homewood Suites).[14] The two-hour parking spaces are located in the commercial districts between Washington Street and Cypress Street, on the north side between Chestnut Hill Avenue and Reservoir Road, and on the south side between Hammond Street and the Newton city line. The parking spaces in unregulated areas are on the north side between Cypress Street and Sumner Road and on the south side between Hammond Street and Dunster Road.

These inventory data and on-site observations indicate that the parking signage in the corridor is inconsistent and sometimes confusing. For example, there are three types of parking prohibition signage: *State Highway Parking Prohibited, No Parking Anytime,* and *No Parking 1 AM–6 AM/Tow Zone*.[15] Meanwhile, as shown in Figures E-1 and E-2 in Appendix E, the placement of these no-parking signs is uneven and random. Further review of parking necessities and provision for consistent signage for the corridor should be a major component in the corridor's long-term improvement plan.

[14] The number of spaces was estimated because these spaces are not metered and have no space delineation. One space is estimated to be 22 feet long.

[15] Because there are no other parking regulatory signs, the *No Parking 1 AM–6 AM/Tow Zone* signs appear to indicate that people can park during times other than 1:00 AM–6:00 AM.

Chapter 4— Crash Data Analysis

4.1 CRASH LOCATIONS AND CRASH CLUSTERS

Crash data are an essential resource for identifying safety and operational problems in a study area. Analyzing data on the number of crashes and types of collisions that occur at particular locations, and the circumstances under which crashes occur, such as the time of day and roadway surface conditions, also helps to develop improvement strategies. For this study, MPO staff accessed two datasets:

- MassDOT Registry of Motor Vehicles (RMV) Division crash data for the years 2013 through 2015
- Crash reports from the Brookline Police Department for a five-year period, January 2013 to August 2018

MassDOT data were used to examine crash locations and identify high-crash locations. Police crash reports were used to construct collision diagrams and estimate crash rates for identifying safety and operational problems at the major intersections and in different sections of the corridor.

Figure 14 shows the crash locations and crash clusters in the corridor, based on the MassDOT data.[16] In general, crashes occurred at various locations in the corridor during the three-year period. The most significant cluster in the corridor was at the intersection Route 9 and Tully Street, where 18 crashes occurred in the three-year period. The value of the crash severity for this location, as estimated using the Equivalent Property Damage Only (EPDO) scale, is 46.[17]

A project addressing the intersection Route 9 and Tully Street would be eligible to receive funding through MassDOT's Highway Safety Improvement Program (HSIP) because the location is ranked in the top five percent of crash locations in the Boston Region MPO's planning area, based on 2012–14 MassDOT crash cluster data. However, further review of the individual crash information indicated that a number of crashes in the cluster actually occurred on the carriage road on the north side of Route 9 in The Street at Chestnut Hill shopping area.

[16] A crash cluster is identified by mapping a circle with a 25-meter (82-foot) radius from each crash location and observing where the spheres of two or more crashes overlap.

[17] MassDOT uses approximated EPDO values to rank high-crash locations. In the estimation, crashes that result in a fatality are weighted by 10, crashes that cause injury are weighted by five, and crashes that cause property damage only (or the severity of the crash is unknown) are not weighted.

The three-year MassDOT data show that four other crash clusters in the corridor had noticeable EPDO values greater than 20:

- Route 9 at Lee Street: EPDO value = 28
- Route 9 at Reservoir Road: EPDO value = 23
- Route 9 at Dunster Road: EPDO value = 26
- Route 9 at Hammond Street: EPDO value = 39

Figure 14 also shows that six pedestrian crashes and two bicycle crashes occurred in the study corridor from 2013 to 2015.[18]

4.2 CORRIDOR AND INTERSECTION CRASH RATES

MPO staff estimated that the entire 2.8-mile corridor has a crash rate of 1.31 crashes per million vehicle-miles traveled (MVMT), based on Brookline Police crash reports from 2013–18 and an average of the recently collected traffic counts. This crash rate is lower than the statewide average for principal urban arterials, which is 3.49 crashes per MVMT (updated January 2018, based on 2016 crash data).

Staff also calculated the crash rates at major intersections in the corridor, based on the Brookline Police crash data and the intersection traffic counts. The crash rates for the signalized intersections are as follows:

- Route 9 at Cypress Street: 0.36 crashes per million entering vehicles (MEV)
- Route 9 at Sumner Road/Warren Street: 0.25 crashes per MEV
- Route 9 at Lee Street: 0.20 crashes per MEV
- Route 9 at Chestnut Hill Avenue: 0.29 crashes per MEV
- Route 9 at Reservoir Road: 0.23 crashes per MEV
- Route 9 at Hammond Street: 0.24 crashes per MEV
- Route 9 at Tully Street: 0.24 crashes per MEV

The average crash rate for signalized intersections in MassDOT District 6 is 0.71 crashes per MEV (updated 2018, based on 2016 crash data). All the signalized intersections listed above have a crash rate lower than the district average.

[18] In this study, the term “pedestrian crashes” refers to crashes that involve at least one vehicle and one pedestrian; “bicycle crashes” refers to crashes that involve at least one vehicle and one bicycle. No crashes between at least one bicycle and one pedestrian were identified in the available data.

Among the unsignalized intersections, Route 9 at Dunster Road is estimated to have the highest crash rate of 0.38 crashes per MEV. This rate is lower than the average crash rate for unsignalized intersections in MassDOT District 6, which is 0.52 crashes per MEV.

Appendix F contains worksheets showing the crash rate calculations for the major intersections in the corridor.

4.3 COLLISION DIAGRAMS

To investigate safety and operational problems further, MPO staff constructed collision diagrams for the entire corridor—for major intersections and roadway segments between those intersections—based on Brookline Police crash reports for the five-year period. The crash reports, containing descriptions of how and where those crashes occurred, are useful when constructing collision diagrams.

Appendix G presents the collision diagrams for nine continuous sections in the corridor. It also contains nine tables that list all the crashes in each of the collision diagrams. The information about each crash includes crash date and time, number of involved vehicles, number of injured persons, severity (property damage only, non-fatal injury, fatality, incapacitating injury, or possible injury), manner of collision type (rear-end, angle, sideswipe, head-on, single vehicle, rear-to-rear, or unknown), road surface conditions, weather conditions, most harmful event, and driver contributing code.

The collision diagrams are useful for identifying safety and operational problems at major intersections or roadway segments in the corridor. The identified problems at intersections or specific roadway sections are discussed in the context of proposed improvements in Chapter 5.

4.4 PEDESTRIAN AND BICYCLE CRASHES

Based on the police data from 2013-18 and the collision diagrams, six pedestrian crashes were identified in the corridor. The locations, dates, times, and conditions of these crashes are summarized below:

- Route 9 at Lee Street: A crash occurred on Wednesday, September 30, 2015, at 12:33 PM, involving a car turning right from Lee Street and a pedestrian crossing Route 9 in the crosswalk. The crash resulted in a non-fatal injury to the pedestrian. The pedestrian did push the pedestrian signal button and the driver did not pay attention to the signal.
- Route 9 at Chestnut Hill Benevolent Association Driveway: A crash occurred on Friday, April 5, 2015, at 10:15 AM, involving a car traveling on Route 9 eastbound and a pedestrian crossing Route 9 in the crosswalk.

The crash resulted in a non-fatal injury to the pedestrian. The pedestrian, a jogger, did push the button and proceeded after the pedestrian signal indication illuminated. The driver did not stop her car in time and her car clipped the pedestrian. The pedestrian's injury was not serious.

- Route 9 at Dunster Road: Two crashes occurred at this intersection. The first crash occurred on Wednesday, August 28, 2013, at 4:37 PM, involving a pedestrian crossing Route 9 in the crosswalk toward the north side of Dunster Road and a car traveling on the outside lane of Route 9 westbound. Immediately before the crash, a car in the inside lane stopped for the pedestrian crossing but the car on the outside lane did not stop in time. The second crash occurred on Saturday, August 5, 2017, at 12:04 PM. The occurrence was similar to the first crash. In both cases, the pedestrian suffered a non-fatal injury.
- Route 9 at Hammond Street: Two crashes occurred at this intersection. The first crash occurred on Friday, October 14, 2016, at 8:45 PM, involving two pedestrians running across Route 9 in the crosswalk and a car traveling on Route 9 eastbound toward Hammond Street. It was dark and the car had the green light. Both pedestrians were injured. The second crash occurred on Thursday, December 15, 2016, at 12:10 PM, involving a pedestrian crossing Route 9 in the crosswalk and a car turning right from Hammond Street southbound. The pedestrian stated that she was already in the crosswalk, approximately ten feet from the curb, and the car clipped her without stopping afterward. Fortunately, she was not injured.

During the same five-year period, there were six bicycle crashes in the corridor. The locations, dates, times, and conditions of these crashes are summarized below:

- Route 9 near Washington Street: A crash occurred on Saturday, August 29, 2015, at 7:45 AM, involving a car exiting a parking space and a bicycle on Route 9 eastbound. The bicyclist was possibly injured.
- Route 9 at Cypress Street: A crash occurred on Saturday, November 30, 2013, at 10:44 AM, involving a car turning left from Cypress Street southbound and a bicycle going straight on Cypress Street northbound. The bicyclist suffered a non-fatal injury. The driver claimed to not see the bicyclist because of solar glare.
- Route 9 at Warren Street: A crash occurred on Wednesday, January 16, 2013, at 5:49 PM, involving a car turning right from Route 9 eastbound

and a bicycle going straight on Route 9 eastbound. The crash caused property damage, but there were no injuries.

- Route 9 at Reservoir Road: A crash occurred on Tuesday, May 21, 2013, at 3:57 PM, involving a car turning left from the medical center driveway and a bicycle turning left from Reservoir Road southbound. The car and bicycle collided at the middle of the intersection. The bicyclist suffered a non-fatal injury.
- Route 9 eastbound near Reservoir Road: A crash occurred on Wednesday, January 23, 2013, at 8:12 PM, involving a car traveling on Route 9 eastbound and a bicycle traveling in the same direction. It was dark and the bicycle was not equipped with flashers or lights. The bicyclist suffered a non-fatal injury.
- Route 9 at Randolph Road: A crash occurred on Thursday, September 28, 2017, at 11:00 AM, involving a car turning right from Randolph Road and a bicycle traveling in the wrong direction (westbound) on the shoulder of Route 9 eastbound. The driver looked to the left, saw that the traffic was clear, and proceeded to turn right. The bicyclist approaching from the right crashed into the car and suffered a non-fatal injury.

4.5 HIGHWAY SAFETY MANUAL METHODOLOGY: EXPECTED CRASHES

MPO staff used methods described in the 2010 edition of the *Highway Safety Manual* (HSM) to analyze safety in the corridor. These techniques combine information about roadway geometry, traffic volumes, crash history, and regional factors into a unified metric—*expected crashes*—that estimates the intrinsic safety conditions at a site by compensating for the random fluctuations typically associated with samples of collision data.

Expected crashes may be estimated in several ways, including by manner of collision and degree of injury, and those values may be converted into dollar values based on agreed-upon societal cost figures for different types of crashes. This information may be used to identify high-risk sites with potential for improvement and to compare the relative merits of different intervention strategies.[19]

The HSM methodology had previously been the subject of a research study by MassDOT in cooperation with faculty from the University of Massachusetts Lowell. That study refined the formulas and coefficients of the HSM methodology for intersections to match Massachusetts' traffic data better. MPO staff used

[19] *Highway Safety Manual 2010*, American Association of State Highway and Transportation Officials, Washington, DC, December 2010.

these regionalized versions of the HSM methods for its analysis of intersections.[20]

Figure H-1 in Appendix H summarizes the results of the safety analysis of the existing conditions. The HSM procedure analyzes segments and intersections within the corridor and distinct methods are applied for segments and intersections. Staff thus divided the corridor into eight intersections and seven segments. As shown in Figure H-1, for each intersection and each segment, the number of expected crashes during a five-year period is shown along with number of crashes that MassDOT recorded between 2011 and 2015. This comparison provides insight into the responsiveness of a particular location to safety interventions. If the predicted number of crashes (crashes per year under idealized circumstances) is significantly less than the expected number of crashes, it suggests that correctable factors are elevating the crash rate. The difference between predicted and actual crash numbers is referred to as the Potential for Safety Improvement (PSI).

Figure H-1 shows the PSI level for each location, while Table 1 shows the numerical values of the PSI for the different intersections and segments within the corridor. Table 1 also indicates whether the site is designated as *high risk*, based on a statistical comparison with other Massachusetts intersections developed as part of the research conducted by MassDOT and the University of Massachusetts. Five of 15 sites showed potential for improvement (having a PSI greater than zero), although none of the intersections qualified as high-risk.

[20] Yuanchang Xie and Chen (Julian) Chen, *Calibration of Safety Performance Functions for Massachusetts Urban and Suburban Intersections*, report prepared for Massachusetts Department of Transportation Office of Transportation Planning, March 2016.

Table 1
Potential for Safety Improvement

Analysis Location	Predicted Crashes	Expected Crashes	Potential for Safety Improvement	High-Risk Site
West of High Street to Sumner Road	1.96	3.90	1.94	
Intersection at Cypress Street	8.73	5.19	-3.54	N
Cypress Street to Sumner Road	1.86	2.21	0.35	
Intersection at Sumner Road and Warren Street	10.23	4.37	-5.86	N
Sumner Road to Lee Street	2.71	1.40	-1.31	
Intersection at Lee Street	5.38	3.55	-1.83	N
Intersection at Chestnut Hill Avenue	12.97	6.22	-6.74	N
Chestnut Hill Avenue to Reservoir Road	0.83	1.05	0.21	
Intersection at Reservoir Road	4.79	3.10	-1.69	N
Reservoir Road to Chestnut Hill Benevolent Association Driveway	1.83	0.81	-1.02	
Intersection at Chestnut Hill Benevolent Association Driveway	1.06	0.67	-0.40	N
Chestnut Hill Benevolent Association Driveway to Hammond Street	2.62	5.49	2.87	
Intersection at Hammond Street	9.14	4.75	-4.39	N
Hammond Street to Tully Street	1.67	3.19	1.52	
Intersection at Tully Street	4.82	2.77	-2.05	N
Entire Route 9 Corridor	**70.58**	**48.66**	**5 of 15**	**0 of 8**

Note: Green shading denotes intersections and white shading denotes segments within the corridor.
Source: Central Transportation Planning Staff.

Staff also used the HSM analysis results to assign a monetary value to the societal burden of traffic collisions. The Federal Highway Administration (FHWA) provides comprehensive cost values that take into account both economic costs (lost wages and property damage) and health and emotional costs (pain and suffering of those injured in crashes) that are monetized as quality-adjusted life years. These equivalencies are broken down by type and severity of accident. For the purposes of this study, MPO staff used two values: $15,600 per property

damage only crash and $260,800 per crash involving a non-incapacitating injury. Both values were adjusted to reflect the 2016 Massachusetts cost of living.[21]

Table 2 shows the total estimated comprehensive societal cost per year that resulted from collisions within the corridor. Estimated costs based on expected crashes and observed crashes are well above $4 million per year, which demonstrates that investing in safety improvements inside the corridor can yield large returns when taking the comprehensive societal cost into consideration.

Table 2
Comprehensive Costs of Crashes

Crash Severity	Crashes Per Year (Observed)	Estimated Cost (Observed)	Crashes Per Year (Expected)	Estimated Cost (Expected)
Property Damage Only	28.9	$500,000	33.1	$500,000
Fatal and Injury	18.5	$4,800,000	15.5	$4,100,000
Total	**47.4**	**$5,300,000**	**48.6**	**$4,600,000**

Source: Central Transportation Planning Staff.

Table H-1 in Appendix H presents further detail about the input data, computational steps, and HSM formula outputs.

[21] Massachusetts Department of Transportation, Technical Memorandum, *MassDOT Average Comprehensive Crash Costs*, January 1, 2018.

Chapter 5—Proposed Improvements

Based on the analyses in the previous chapters, MPO staff developed a series of short- and long-term improvements to address safety and operational problems in the corridor. The proposed short-term improvements generally can be implemented within two years at a relatively low cost. The long-term improvements are more complicated and cover larger areas, thus require intensive planning and design, and significant funding.

This chapter contains six sections. The first section analyzes roadway redesign options for accommodating bicyclists and improving or maintaining the accommodations of other users of the roadway. Based on the analysis, three alternatives for improving the corridor are explored and a preferred alternative is presented.

Each of the next five sections discuss the roadway characteristics and land uses around segments of the Route 9 corridor, review issues and concerns, and propose short- and long-term improvements at critical locations in the study area. The final section provides an overview of the proposed long-term improvements under the projected 2030 traffic conditions.

5.1 CORRIDOR ACCOMMODATION ANALYSIS AND PROPOSED IMPROVEMENT ALTERNATIVES

One of the key issues identified for the corridor is the lack of bicycle accommodations. Considering the generally high-speed and high-volume traffic conditions in the corridor, the advisory committee members concurred that bicycle accommodations separated from vehicular traffic should be considered for this location. Other key issues, such as pedestrian crossings, transit access, safety, and convenience should be considered in the future corridor improvements.

5.1.1 Corridor Accommodation Objectives and Design Strategies

Based on discussions with the advisory committee members, staff identified five main objectives for improving bicycle accommodations and safety:

- Provide safe and comfortable bike accommodations
- Use the opportunity to improve pedestrian accommodations
- Improve safety for pedestrians at crossings and make pedestrian crossings more convenient
- Improve access to transit services

- Minimize delays and increase safety at intersections while maintaining traffic flow on Route 9

To achieve the objectives, staff applied the following design strategies to the improvement alternatives:

- Provide separated bike lanes wherever applicable
- Expand sidewalks to at least six feet wide where applicable
- Enhance sidewalk buffer areas with trees or other landscaping elements where applicable
- Ensure effective access and sufficient roadway space for bus stops
- Maintain two travel lanes in each direction to process the high traffic volume without incurring serious traffic congestion
- Maintain traffic medians in the corridor to reduce crashes and increase safety for pedestrians and motorists

5.1.2 Separated Bike Lane Design Options

MassDOT's *Separated Bike Lane Planning and Design Guide* provides options for separated bike lane designs. Staff used the guide to analyze the feasibility of implementing separated bike lanes in the Route 9 corridor considering the width of the right-of-way in the corridor. The four options considered are as follows:

1) Sidewalk level separated bike lane
2) Intermediate level separated bike lane
3) Street level separated bike lane
4) Raised bike lane

Figure 15 illustrates typical layouts of the four types of separated bike lane design.

Option 1, the sidewalk level separated bike lane, is considered the most desirable among the four options because it offers bicyclists a high degree of separation from vehicular traffic. The design of sidewalk level bike lanes should provide a sidewalk buffer that discourages pedestrian encroachment into the bike lane and bicyclist encroachment onto the sidewalk.

Option 2, the intermediate level separated bike lane, generally requires a dimension similar to Option 1 but offers greater design flexibility for constrained areas. The key design element of the bike lane is a curb reveal of two to three

inches below sidewalk level that provides vertical separation from the adjacent sidewalk or sidewalk buffer.

Option 3, the street level separated bike lane, requires less space than Options 1 and 2 as sidewalk curbs provide separation between pedestrians and bicycles. The sidewalk buffer zone can be reduced or waived in constrained areas. However, the street buffer zone (generally four to six feet wide, and two feet wide at a minimum) is essential to separate vehicular traffic from the bike lane. Street level separated bike lanes are usually compatible with accessible on-street loading zones.

Option 4, the raised bike lane, is for areas with constrained right-of-way. Like intermediate level bike lanes, raised bike lanes may be built at any level between the sidewalk and the street. They are only appropriate in constrained locations where the combined bike lane and street buffer width is less than seven feet and sidewalks are narrow or the sidewalk buffer is eliminated. Because of their narrow street buffer, raised bike lanes are not recommended for two-way operation or adjacent to on-street parking.

The width of the right-of-way on Route 9 varies. For the purpose of analysis, the corridor was divided into five sections, each with similar right-of-way width and roadway characteristics. Table 3 summarizes the applicability of each of the four bike lane design options in the sections of the corridor.

Table 3
Feasibility Analysis of Separated Bike Lane Design Options

Route 9 Section	Option 1: Sidewalk Level Separated Bike Lane	Option 2: Intermediate Level Separated Bike Lane	Option 3: Street Level Separated Bike Lane	Option 4: Raised Bike Lane
1) Washington Street—Sumner Road	Not applicable. Insufficient space.	Not applicable. Insufficient space.	Applicable, with removal of on-street parking.	Applicable, with removal of on-street parking.
2) Sumner Road—Chestnut Hill Avenue	Applicable.	Applicable.	Applicable.	Applicable. Not desirable.
3) Chestnut Hill Avenue—Reservoir Road	Applicable, with removal of on-street parking.	Applicable, with removal of on-street parking.	Applicable, with removal of on-street parking.	Applicable. Not desirable.
4) Reservoir Road—Hammond Street	Applicable.	Applicable.	Applicable.	Applicable. Not desirable.
5) Hammond Street—Newton City Line	Applicable, with removal of on-street parking.	Applicable, with removal of on-street parking.	Applicable, with removal of on-street parking.	Applicable, with removal of on-street parking.

Source: Central Transportation Planning Staff.

Overall, all the separated bike lane options are applicable in most sections of the corridor, however, some would require the removal of the existing on-street parking. However, Options 1 and 2 are probably not applicable in the Washington Street to Sumner Road section because of insufficient right-of-way width and the fully built surroundings.

5.1.3 Corridor Improvement Alternatives

At this preliminary planning stage, staff explored three basic roadway reconfiguration alternatives based on the level of bicycle and traffic separation.

Alternative 1, focusing on the sidewalk level bike lane design, would provide a high level of separation between bicyclists and vehicular traffic and would require the removal of all on-street parking in the corridor. Alternative 2, focusing on the street level bike lane design, would provide a lower but acceptable level of separation from vehicular traffic and would require the removal of all on-street

parking. Alternative 3, intended for comparison purposes, would provide the same level of separation as Alternative 2 in most sections and allow limited on-street parking in essential sections. Table 4 summarizes the proposed components in the three corridor improvement alternatives.

Table 4
Proposed Components in Corridor Improvement Alternatives

Improvement Alternatives	Pedestrian Accommodation	Bicycle Accommodation	Traffic Accommodation
Alternative 1	6 foot or wider sidewalks	Sidewalk level separated bike lanes (approximately 75% of the corridor)	6 foot or wider traffic medians
	Sidewalk buffer zone amenities	Raised bike lanes (approximately 25% of the corridor)	Four 11-foot travel lanes
	Crosswalks at essential locations		No on-street parking in the corridor
	Traffic medians in the corridor		
Alternative 2	6 foot or wider sidewalks	Street level separated bike lanes (in the entire corridor)	6 foot or wider traffic medians
	Crosswalks at essential locations		Four 11-foot travel lanes
	Traffic medians in the corridor		No on-street parking in the corridor
Alternative 3	6 foot or wider sidewalks	Street level separated bike lanes (approximately 95% of the corridor)	6 foot or wider traffic medians
	Crosswalks at essential locations	Street level separated bike lanes adjacent to on-street parking (approximately 5% of the corridor)	Four 11-foot travel lanes
	Traffic medians in the corridor		On-street parking in limited sections

Source: Central Transportation Planning Staff.

Figures 16 to 22 show the existing roadway cross section and prospective reconfigured layouts of the three improvement alternatives in the different sections of the corridor.

In principal, parking on state highways is prohibited. The advisory committee members concurred that the existing on-street parking could be removed or relocated to provide safe and comfortable separated bike accommodation and the committee selected Alternative 1 as the preferred long-term improvement alternative for the corridor.

Essential on-street parking spaces, such as school, commercial, and school bus loading zones, and accessible parking spaces, cannot be fully addressed in this preliminary planning study because further engineering survey and collaboration with the neighborhoods and property owners is required. Most parking spaces would be limited to short-term parking and might be integrated with sidewalk or street level separated bike lanes. Additional shared parking lots may need to be constructed intermittently along the corridor to accommodate parking needs. These essential parking spaces should be further examined at the design stage.

In the Route 9 corridor, vehicles generally travel at a high speed and traffic volumes are usually heavy. This study does not recommend short-term bicycle accommodation improvements, such as restriping travel lanes, painting bike lanes (on shoulders), or adding buffer zones on the existing road surface, because these measures would not significantly slow down traffic or safely separate bicyclists from traffic. If these measures were considered, the designs would have to go through an engineering design and review process to demonstrate compliance with MassDOT's safety standards.

The proposed long-term improvements described in Alternative 1 would improve accommodation of bicyclists and pedestrians as well as enhance safety for all users of the corridor. The separated accommodations would reduce conflicts between travel modes. In addition, the reconfigured corridor would lower traffic speeds and could be designed as a consistent 35 mph regulated roadway. Crashes caused by vehicles and the severity of crashes would be considerably reduced.

5.2 ROUTE 9 FROM WASHINGTON STREET TO SUMNER ROAD

This section discusses the Route 9 corridor between Washington Street and Sumner Road. The large intersection of Route 9 at Washington Street, High Street, and Walnut Street at the eastern end of this section is not addressed in this study because the intersection and adjacent roadways in the Gateway East (Village Square) area have been completely redesigned and the improvements are scheduled for construction by MassDOT.[22]

[22] MassDOT project #605110 will make intersection and signal improvements on Route 9 in the Gateway East (Village Square) area of Brookline. The functional design for the project was completed in 2018 and the project is scheduled for construction in 2019. The project aims to

The roadway between Washington Street and Sumner Road contains two travel lanes in each direction. The land uses adjacent to the roadway are mainly commercial from Washington Street to Brighton Road and multi-family residential from Brighton Road to Sumner Road and Warren Street. In the commercial section, there are two major developments (the Homewood Suites hotel and an Audi car dealership), a neighborhood park (Boylston Street Playground), and a currently vacant primary school (the former Lincoln School location), and many local businesses and offices exist along Route 9. In the residential section, a private school (Maimonides School) occupies the north side of Route 9 from Clark Road to Buckminster Road.

5.2.1 Issues and Concerns

Three locations along this section of Route 9 are a major concern to the Town of Brookline. One is the intersection of Route 9 at Cypress Street, which is currently signalized. Cypress Street is a major route that connects the Green Line's Brookline Hills Station (located approximately 600 feet north of the intersection) and Washington Street, Brookline Village, and the areas further north and east. The intersection is very busy during the morning and afternoon peak hours with heavy vehicular traffic and continuous pedestrian crossings. In addition, Cypress Street is a town-designated bicycle route. A noticeable number of bicycles were observed crossing the intersection during the peak hours.

Another location of concern is the intersection of Route 9 at Clark Road and Kennard Road. The intersection is adjacent to Maimonides School. Stops for MBTA buses and Partners HealthCare shuttles are west of the intersection. A noticeable number of pedestrians were observed crossing Route 9 at this intersection. The residents from the south side of Route 9 usually cross via Clark Road to access the Brookline Hills rapid transit station. Passengers of the medical shuttles also use this intersection and Clark Road to reach the Brigham and Women's medical office near the station. The intersection is unsignalized and has no crosswalks across Route 9. Pedestrians and transit passengers usually have to cross Route 9 under the heavy and high-speed traffic conditions.

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improve the livability for residents and businesses in the area, improve regional connections for bicyclists and pedestrians, and improve the overall streetscape. Major elements of the project include 1) realignment of Walnut Street to Pearl Street to form a new four-way signalized intersection, 2) upgrades to the signals at Washington Street and at Brookline Avenue, 3) interconnection of the new signals at the three intersections, 4) demolition of the pedestrian bridge that is currently closed for safety concerns, and 5) provision of separated bicycle lanes.

The Town also raised concerns about pedestrian crossings in the area between Homewood Suites and the former Lincoln School. There is a signalized crosswalk on Route 9 at the former Lincoln School. The school building is currently closed and under renovation. Though the signal is now seldom used for school purposes, it is occasionally used by residents to access Boylston Street Park.

East of the signalized crosswalk, there are no crosswalks until Washington Street. The Town considers that there are needs for people to access businesses and other destinations on both sides of Route 9, especially to reach destinations such as the Brookline Village and Brookline Hills transit stations and the Washington Street business area from Walnut Path (on the south side of Route 9) and the pathway next to Homewood Suites (on the north side crossing the MBTA rail track).

In summary, these are the major issues and concerns regarding this section of roadway:

- The intersection of Route 9 at Cypress Street is very congested during the AM and PM peak periods, with heavy vehicular traffic and intensive pedestrian and bicycle crossings.
- There is a need to provide a safe crossing facility for pedestrians and transit users to cross Route 9 at the intersection with Clark Road and Kennard Road.
- There is a potential need for a pedestrian crossing at Walnut Path near the former Lincoln School.
- This section of Route 9 has a noticeable number of crashes related to on-street parked vehicles. The existing on-street parking lanes are narrow and very close to the outside travel lane.
- This section of Route 9 lacks separated bicycle accommodations.
- The adjacent areas are fully built-out and there is limited right-of-way available for expansion.

5.2.2 Proposed Short-Term Improvements

Proposed short-term improvements for this section of Route 9 between Washington Street and Sumner Road include the following:

- Restripe travel lanes from 12 to 11 feet and parking lanes from six to eight feet on both sides of Route 9.
- Move the stop line for the signalized crosswalk at the former Lincoln School 40 feet from the crosswalk on both sides of Route 9.

- Consider removing some on-street parking on Route 9 between Cypress Street and Sumner Road, except at essential locations.
- Add an additional right-turn indication to the traffic signal for the Cypress Street southbound approach.
- Relocate the mailbox at the northwest corner of the Cypress Street intersection, which blocks the wheelchair ramp at the crosswalk.
- Add retroreflective borders on traffic signal backplates at the Cypress Street intersection.
- Restripe faded pedestrian crosswalks at the Sumner Road/Warren Street intersection.

5.2.3 Proposed Long-Term Improvements

In the long term, this study proposes the following improvements for the section of Route 9 between Washington Street and Sumner Road in general and at specific locations. Figure 23 shows the conceptual plan of the proposed improvements in the central part of this section.

General Recommendations: Route 9 between Washington Street and Sumner Road

Proposed long-term improvements for the section include the following:

- Install raised bike lanes in both directions and remove all permanent on-street parking, except some essential short-term parking such as the existing 15-minute valet parking at Homewood Suites and commercial and school loading zones.
- Widen sidewalks to six feet where applicable.
- Enhance sidewalks with trees and landscape elements where applicable.

Route 9 at Cypress Street

This intersection is signalized and saturated with heavy traffic, pedestrian, and bicycle activity during peak hours. Proposed long-term improvements include the following:

- Extend the storage length of the eastbound left-turn lane from 150 to 350 feet.[23]
- Reduce the curb turning radii and increase curb extensions at all corners of the intersection.
- Install count-down pedestrian signals.

[23] The storage length of a turning lane refers to the space where vehicles queue to turn.

Route 9 at Clark Road/Kennard Road

This intersection is unsignalized and a noticeable number of pedestrians were observed crossing there. Proposed long-term improvements for pedestrians and transit riders include the following:

- Maintain the existing traffic median to prohibit traffic from crossing the center line or turning left off Route 9.
- Reduce the curb turning radii and increase curb extensions at all corners of the intersection.
- Install a crosswalk on the east side of the intersection and rectangular rapid-flashing beacons to help pedestrians cross Route 9. (See Figure 23.)
- Relocate the eastbound bus stop to the far side of the intersection, in conjunction with the proposed crosswalk.
- Extend both eastbound and westbound bus stop curbs to a sufficient length (80 feet at minimum).

Route 9 at Former Lincoln School and Walnut Path

The issue of pedestrian crossings in this area was raised during a later stage of this study, so pedestrian crossing data were not collected. As there are a number of undetermined factors about the future use of the former Lincoln School and potential developments in the adjacent commercial district, this study proposes the following improvement strategies:

- Maintain the existing signalized crosswalk at the former Lincoln School that now houses the 9th graders of Brookline High School.
- Conduct further studies to verify the need for crosswalks and identify potential locations for additional crosswalks in this area.
- In the future, the Town could request that developers fund studies and share the cost of implementing improvements.

5.3 ROUTE 9 FROM SUMNER ROAD TO CHESTNUT HILL AVENUE

This section discusses the Route 9 corridor between Sumner Road and Chestnut Hill Avenue, including the intersections of Route 9 at Sumner Road and Warren Street and at Chestnut Hill Avenue.

This section of Route 9 has two travel lanes in both the eastbound and westbound direction and its right-of-way is much wider than the section between Washington Street and Sumner Road, especially on the north side where wide

sidewalks with grass and trees exist. Both sides of the roadway have sufficient roadway shoulders.

The north side of Route 9, known as Fisher Hill, is sparsely settled with large single- and multi-family houses and has an abundance of greenery; the south side is entirely occupied by Brookline Reservoir Park from Lee Street to Warren Street. There are no sidewalks on the south side. People usually use the multi-use trail surrounding the reservoir, which has a path parallel to Route 9. There are no well-defined connections from Route 9 sidewalks to the multi-use trail around the reservoir, except for an opening on Lee Street just south of the intersection of Route 9 and Lee Street.

5.3.1 Issues and Concerns

This section of roadway is scenic and enjoyable to drive. However, motorists tend to drive fast in the spacious environment. The posted speed limits are different in the westbound (35 mph) and the eastbound (45 mph) directions. The spot-speed studies conducted in November and December 2018 showed that most motorists drove approximately 40 mph in the westbound direction and approximately 50 mph in the eastbound direction.

The signalized intersection of Route 9 at Sumner Road and Warren Street is congested during the peak hours, especially in the morning. Sumner Road is a popular route connecting to Brookline High School, the town center, and the areas in the north. Residents frequently use the intersection to access the park by Brookline Reservoir. The intersection has a fairly large layout and the distance for pedestrians to cross Route 9 is long. In addition, the arrangement of approaching lanes does not accommodate the prevailing traffic volumes, especially on the eastbound approach. The intersection should be reconfigured to accommodate traffic, pedestrians, and bicycles.

The three intersections of Route 9 at Lee Street, at Chestnut Hill Avenue, and at Lee Street at Lee Street Extension (connecting to Heath Street) together form a large complicated intersection. The intersections are all signalized and coordinated with the Chestnut Hill Avenue intersection as the master intersection. Pedestrian signal phases are concurrent with through and right-turning traffic and with no infringement by left-turning vehicles. Field observations and Synchro traffic simulations revealed that the three signals are well coordinated during heavy traffic conditions on all approaches. During peak hours, Lee Street (in the morning) and Chestnut Hill Avenue (in the evening) appear to be quite congested. However, the coordination setting has little room to adjust given the prevailing traffic patterns and the proximity of the three intersections.

In summary, major issues and concerns in this roadway section include the following:

- There are inconsistent speed regulations and vehicles travel at high speeds in the eastbound direction.
- There are no sidewalks on the south side of Route 9.
- Traffic congestion occurs at the intersection of Route 9 and Sumner Road/Warren Street.
- There is a long pedestrian crossing distance at the intersection of Route 9 and Sumner Road.
- Traffic congestion occurs on Chestnut Hill Avenue and on Lee Street during peak hours.

5.3.2 Proposed Short-Term Improvements

Proposed short-term improvements in this section include the following:

- Further study the potential of regulating travel speeds at 35 mph or 40 mph in both directions for this section of Route 9.
- Restripe wide longitudinal-line markings at all crosswalks in this section.
- Add retroreflective borders on traffic signal backplates at the intersections of Route 9 and Lee Street and Route 9 and Chestnut Hill Avenue.

5.3.3 Proposed Long-Term Improvements

In the long term, this study proposes the following improvements for the section in general and at specific locations. Figure 24 shows the conceptual plan of the proposed improvements.

General Recommendations: Route 9 between Sumner Road and Chestnut Hill Avenue

Proposed long-term improvements for the section include the following:

- Install sidewalk level separated bike lanes in both directions.
- Provide sidewalks on the south side of Route 9.

Route 9 at Sumner Road/Warren Street

The intersection is signalized and saturated with heavy traffic volumes during peak hours. The wide intersection layout can be modified to reduce pedestrian crossing distances and improve traffic and transit operations. Proposed long-term improvements include the following:

- Remove the low-volume eastbound right-turn lane.

- Extend storage length of the eastbound left-turn lane from 100 to 350 feet.
- Add a left-turn lane on the Warren Street approach.
- Shorten pedestrian crossing time by reducing the intersection footprint.
- Upgrade the traffic signal system.
- Relocate and provide standard MBTA bus stops in both directions on the far side of the intersection.

Route 9 at Lee Street/Chestnut Hill Avenue/Heath Street

The three signalized intersections of Route 9 at Lee Street and at Chestnut Hill Avenue, and Lee Street at Heath Street are well coordinated under the prevailing traffic patterns. Proposed improvements to enhance traffic operations and pedestrian movements include the following:

- Maintain the well-coordinated traffic signal settings for the three intersections.
- Add a right-turn exclusive lane on Lee Street and channelize it to eliminate conflicts between the right-turning traffic and pedestrians crossing Route 9 during the concurrent pedestrian phase.[24]
- Extend the storage length for the westbound left-turn lane from 175 to 350 feet at the Lee Street intersection.
- Extend the storage length for the eastbound left-turn lane from 250 to 400 feet at the Chestnut Hill Avenue intersection.
- Reduce curb radii to slow traffic at all corners of the three intersections, including those at Eliot Street.
- Improve pedestrian and bicycle accommodation and circulation through the entire area of the three intersections.

5.4 ROUTE 9 FROM CHESTNUT HILL AVENUE TO RESERVOIR ROAD

This section discusses the Route 9 corridor between Chestnut Hill Avenue and Reservoir Road, including the intersection of Route 9 at Reservoir Road. The right-of-way on this section of Route 9, which is between 90 and 95 feet wide, is narrower than the section between Sumner Road and Chestnut Hill Avenue. There are five- to six-foot sidewalks with grass and trees on both sides. On-street parking is generally allowed on the north side of the roadway. The south side has

[24] Currently the Lee Street approach contains two travel lanes, with the outside (right) lane shared by left- and right-turning vehicles. The crosswalk across Route 9 is located on the right-turn path and the pedestrian signal is operated concurrent to the Lee Street traffic signal phase. To expedite traffic movement, the additional lane on Lee Street should start approximately 350 feet south of the intersection of Route 9 and Lee Street. A conceptual sketch of the proposed improvements at this intersection from the 2030 Synchro traffic model is attached in Appendix I.

a shoulder approximately six to seven feet wide and parking is generally prohibited.

The developments on the north side are mainly multi-family residences and some retail and commercial establishments. On the south side are single- and multi-family residences and a large church, Saint Lawrence Church. Commercial and office developments are located near the intersection of Route 9 and Reservoir Road. Brookline Fire Station No. 4 also is located at the intersection and fire trucks exit the station directly to Route 9 when responding to emergencies. Brigham and Women's Health Care Center is located at the southwest quadrant of the intersection.

5.4.1 Issues and Concerns

The intersection of Route 9 at Reservoir Road is signalized and the signal is equipped with an emergency preemption function for the fire station. Reservoir Road intersects Route 9 in a sharp angle such that the northbound and southbound entry points to Route 9 are slightly offset. In addition to the Route 9 and Reservoir Road approaches, the intersection includes the driveway of Brigham and Women's Health Care Center. These factors and the necessity of keeping the frontage of the fire station clear create a fairly large and unusual layout. As a result, pedestrian crossing distances are long and the intersection can be confusing for drivers. To reduce traffic conflicts, the northbound approach to Reservoir Road is restricted to right turns only and left turns are prohibited from Route 9 westbound to the medical center and to Reservoir Road. The signal cycle includes an on-call exclusive pedestrian phase of nearly half a minute.

Another traffic signal in this section is located on Route 9 at Saint Lawrence Church. It is a pedestrian crossing signal for church activities and for residents to access MBTA bus stops on both sides of Route 9. The bus stop length is substandard on both sides of the roadway. On the north side (Route 9 westbound), buses pulling into the stop block access to Timon Avenue.

In summary, major issues and concerns in this roadway section include the following:

- The irregular and wide layout of the intersection of Route 9 and Reservoir Road creates long pedestrian crossing distances and can be confusing for drivers.
- There is limited right-of-way for layout modifications at the intersection of Route 9 and Reservoir Road, especially on the Reservoir Road approaches.

- Substandard bus stops are on both sides of Route 9 at the Saint Lawrence Church crosswalk.

5.4.2 Proposed Short-Term Improvements

Proposed short-term improvements in this section include the following:

- Restripe wide longitudinal-line markings at all crosswalks.
- Move the stop line for the signalized crosswalk at Saint Lawrence Church 40 feet from the crosswalk in both directions.
- Add retroreflective borders on the traffic signal backplates at the intersection of Route 9 and Reservoir Road.
- Relocate the bus stop on the westbound side of Route 9 in front of Saint Lawrence Church, so that buses will not block Timon Avenue, and expand the length of the stop.[25]

5.4.3 Proposed Long-Term Improvements

In the long term, this study proposes the improvements listed below for the section of Route 9 between Chestnut Hill Avenue and Reservoir Road in general and at specific locations. Figure 25 shows the conceptual plan for the proposed improvements.

General Recommendations: Route 9 between Chestnut Hill Avenue and Reservoir Road

Proposed long-term improvements for the section include the following:

- Install sidewalk level separated bike lanes in both directions.
- Extend all bus stops to the MBTA's standard length.

Route 9 at Reservoir Road

The wide intersection layout can be modified to reduce pedestrian crossing distances and improve traffic and transit operations. Proposed long-term improvements include the following:

- Realign the south leg of Reservoir Road to separate it from the driveway to the Brigham and Women's Health Care Center and reduce motorists' confusion at the intersection.
- Increase the sidewalk area and provide a more direct and visible crosswalk between the driveway to the Brigham and Women's Health Care Center and Reservoir Road.

[25] This improvement is currently being implemented by MassDOT.

- Slightly relocate crosswalks and stop lines on Route 9 while keeping the frontage to the fire station clear at the intersection.
- Shorten pedestrian crossing distances by reducing the footprint of the intersection.
- Extend the length of bus stops and expand passenger boarding areas on both sides of Route 9.
- Upgrade the traffic signal system.

5.5 ROUTE 9 FROM RESERVOIR ROAD TO HAMMOND STREET

This section discusses the Route 9 corridor between Reservoir Road and Hammond Street, not including the intersection of Route 9 at Hammond Street (which is discussed in the next section). In general, this section of Route 9 has a right-of-way of 100 to 110 feet, and the medians are sufficiently wide.[26] The posted speed is 40 mph for the entire section. Sidewalks with grass and trees exist on both sides. Some sidewalks on the north side, west of Reservoir Road, are narrow.

The development on this section of Route 9 is predominantly single-family homes, except on the south side of Route 9 between the signalized intersection at the driveway to the Chestnut Hill Benevolent Association (CHBA) and Reservoir Road. Most of the land on the south side is owned by CHBA and is currently undeveloped (and zoned for single-family residential housing). The other land on that side, between the CHBA and Reservoir Road, is occupied by Brigham and Women's Health Care Center.

5.5.1 Issues and Concerns

The signal at the intersection of Route 9 at the CHBA driveway is a pedestrian crossing signal for residents to access MBTA bus stops and the neighborhoods on either side of Route 9. The CHBA driveway carries a very low volume of traffic and the signal is not activated by vehicles. Partners HealthCare shuttles use the westbound left-turn lane at this intersection to make U-turns to the medical center, as left turns to the center are prohibited at the Reservoir Road intersection. During the morning peak hour, the continuous eastbound traffic can cause delays for the shuttles attempting to make U-turns. Approximately four shuttles access the medical center during the peak hour.

The roadway in this area is wide and motorists tend to drive much faster than the posted speed (40 mph). The spot-speed counts show that the prevailing (85th

[26] The roadway contains a median approximately eight-to-ten-feet wide between Reservoir Road and the driveway of Chestnut Hill Benevolent Association and a median approximately 18-to-20-feet wide between the driveway to Hammond Street.

percentile) travel speed is 50 mph in the westbound (uphill) direction and 52 mph in the eastbound (downhill) direction.

Further west, there are two unsignalized crosswalks on Route 9 at Norfolk Road and at Dunster Road. According to the turning-movement counts taken in the fall of 2018, the crosswalk at Norfolk Road, which is mainly for access to MBTA bus stops, was used by five pedestrians or fewer per peak hour. The crosswalk at Dunster Road, which is used mainly by residents to access Baldwin School (on the south side) and also to access other destinations on both sides of the roadway, was used by 10 to 15 pedestrians per peak hour.

During the evening peak hours, the traffic queues on Route 9 westbound frequently extend to Dunster Road and obstruct the views of pedestrians and motorists at the crosswalk. Based on the 2013–18 Brookline police reports, there were 14 crashes at the crosswalk, including two pedestrian-involved crashes that resulted in injuries and four crashes caused by vehicles that stopped suddenly for crossing pedestrians. There were seven crashes at the crosswalk at Norfolk Road; three were potentially caused by vehicles that stopped suddenly for pedestrians, though no pedestrians were injured.

In summary, major issues and concerns in this roadway section include the following:

- Vehicles travel at high speeds, especially in the hilly section near the CHBA driveway.
- Pedestrian crossings are unsafe at the unsignalized crosswalks, especially at the crosswalk at Route 9 and Dunster Road.
- There are no separated bike accommodations.

5.5.2 Proposed Short-Term Improvements

Proposed short-term improvements in this section include the following:

- Reinforce the 40 mph speed regulation.
- Stripe yield lines (shark teeth markings) about 40 feet before the crosswalks at Norfolk Road and at Dunster Road.[27]

[27] Federal Highway Administration's *Manual on Uniform Traffic Control Devices* (*MUTCD*) specifies that yield lines should be placed 20 to 50 feet in advance of the nearest crosswalk line (2009 *MUTCD* with Revision Numbers 1 and 2 incorporated, Chapter 3B).

Crosswalk on Route 9 at Dunster Road

The crosswalk at Dunster Road on Route 9 is currently unsignalized. There are a high number of pedestrian crossings during peak hours at this location and a relatively high number of crashes. The study advisory members concurred that rectangular rapid-flashing beacons should be considered for this location. The following improvements are proposed:

- Relocate the crosswalks on both Route 9 approaches, and create a two-stage crossing with a safe place in the median for pedestrians to reduce the crossing distance. (See Figure 26.)
- Install rectangular rapid-flashing beacons with accessible (audible) pedestrian signals.

Crosswalk on Route 9 at Norfolk Road

The crosswalk at Norfolk Road on Route 9 is currently unsignalized. Only a few pedestrians use the crosswalk per peak hour and there have been a relatively low number of crashes (none involving pedestrians). However, there are MBTA bus stops on both sides of Route 9 adjacent to the crosswalk. The Town of Brookline could work with MassDOT to further investigate and design for the installation of rectangular rapid-flashing beacons.

5.5.3 Proposed Long-Term Improvements

In the long term, this study proposes the following improvements for the section of Route 9 between Reservoir Road and Hammond Street in general and at specific locations.

General Recommendations: Route 9 between Reservoir Road and Hammond Street

Proposed long-term improvements for the section include the following:

- Install sidewalk level separated bike lanes on both sides of Route 9.
- Expand sidewalks to six feet in width where applicable.
- Enhance sidewalks with trees and landscape elements where applicable.
- Extend all bus stops to the MBTA's standard length.
- Continue monitoring crash conditions in this section of Route 9.

Route 9 at Chestnut Hill Benevolent Association Driveway

Proposed long-term improvements include the following:

- Upgrade the traffic signal to a fully functional signal that regulates a protected left-turn phase for vehicles making left turns into the CHBA

driveway and U-turns to the medical center when the CHBA property is developed.
- Install *Traffic Signal Ahead* warning signs approximately 500 feet before the intersection on both sides of the roadway.
- Relocate and provide standard length MBTA bus stops on both sides of Route 9 on the far sides of the intersection.

5.6 ROUTE 9 FROM HAMMOND STREET TO NEWTON CITY LINE

This section discusses the Route 9 corridor between Hammond Street and the Newton city line, including the intersections of Route 9 at Hammond Street and at Tully Street. It also includes the intersection of Hammond Street and Heath Street, as these three intersections are signalized and coordinated and should be analyzed together.

The development along this section of Route 9 is predominantly commercial. A few businesses are located east of the intersection of Route 9 and Hammond Street. West of the intersection on the north side of Route 9, there is The Street at Chestnut Hill (a village-type shopping mall), Star Market, CVS, and Cumberland Farms (a gas station and convenience store at the corner of Hammond Street). A carriage road serving these developments runs one-way parallel to Route 9 westbound. Surrounding the shopping mall and Star Market are several large lots for customer parking.

Along the south side of Route 9, there are retail stores, banking and financial services, and other offices. Two-hour on-street parking is allowed on this side of Route 9. In addition, most of the stores and offices have parking lots on their properties accessible from Sheafe Street and Holly Lane.

This section of Route 9 has two travel lanes on both the eastbound and westbound sides separated by a continuous traffic median. At the Hammond Street intersection, it expands to three lanes (adding an exclusive left-turn lane) in the eastbound direction and four lanes (adding left- and right-turn exclusive lanes) in the westbound direction. This section generally has a wide right-of-way of about 160 to 180 feet. The extra right-of-way available beyond the existing roadway is mainly on the north side along the carriage road. Sidewalks with trees exist on the south side and on the carriage road’s storefront side.

5.6.1 Issues and Concerns

The intersection of Route 9 at Hammond Street is the most congested location in this corridor. During the morning and evening peak periods, Hammond Street carries extensive commuter traffic to and from Route 9 and the MBTA Green

Line's Chestnut Hill Station. The signal regulates for leading, protected left turns from Hammond Street to Route 9, followed by through and right-turn movements on Route 9, and split phases (allowing traffic to advance from one approach at a time) for the Hammond Street approaches. Pedestrian phases are concurrent with Route 9 through and right-turning traffic and with the split phases on Hammond Street.

Both the intersection of Route 9 at Tully Street and the intersection of Hammond Street at Heath Street are not as congested as the intersection of Route 9 and Hammond Street. Capacity analyses show that they both operate at an acceptable level of service. Synchro traffic simulations show that the three intersections are well coordinated. Route 9 traffic moves smoothly and there are no queues spilling back from Heath Street to Route 9. However, the severe congested conditions on the Hammond Street northbound approach in the morning peak hour and on the southbound approach in the evening peak hour are difficult to mitigate under the existing signal and geometric conditions at the intersection of Route 9 and Hammond Street.

For an urbanized location, the intersection of Route 9 and Hammond Street has a crash rate that is not considered alarmingly high. There were two pedestrian-involved crashes in the five-year period from 2013 to 2018. One involved a southbound vehicle turning right that failed to stop for a crossing pedestrian. Another was initiated by a pedestrian who was crossing the road improperly.

The crash rate at the intersection of Route 9 and Tully Street is not high. The majority of the crashes were rear-end collisions that occurred on both approaches of Route 9. There were no pedestrian crashes in the same five-year period.

Pedestrian safety is a major concern in this section of Route 9. Currently a crosswalk equipped with a rectangular rapid-flashing beacon is located approximately 300 feet east of Tully Street. This crosswalk provides a path for customers and employees to reach the stores, services, and restaurants on both sides of Route 9. It is frequently used during business hours, especially midday during lunchtime. Seven crashes occurred at this location in the same five-year period. All were rear-end crashes caused by vehicles that stopped suddenly for crossing pedestrians. All seven crashes occurred in 2013 and 2014 prior to the installation of the rectangular rapid-flashing beacon. The beacon appears to be effective in warning and stopping the Route 9 traffic. However, it is not equipped with audible pedestrian signals or indicators that alert pedestrians when the beacon is flashing.

In summary, major issues and concerns in this roadway section include the following:

- This is a highly developed commercial area with heavy traffic and intensive pedestrian activities.
- Severe traffic congestion occurs at the intersection of Route 9 and Hammond Street in the AM and PM peak hours.
- There are no separated bike accommodations.

5.6.2 Proposed Short-Term Improvements

Proposed short-term improvements in the section of Route 9 between Hammond Street and the Newton city line include the following:

- Relocate the misplaced *Right Lane Must Turn Right* regulatory sign at the intersection of Route 9 and Hammond Street.[28]
- Relocate the *Turning Vehicles Yield to Pedestrians* regulatory signs from the corners to the right-turn lane curb at the intersection of Route 9 and Hammond Street.[29]
- Examine the feasibility of adding backplates with retroreflective borders on the signal heads at the intersection of Route 9 and Hammond Street.
- Add accessible pedestrian signals to the existing rectangular rapid-flashing beacons at the Route 9 midblock crosswalk.

5.6.3 Proposed Long-Term Improvements

In the long term, this study proposes the following improvements for the Route 9 corridor between Hammond Street and the Newton city line in general and at specific locations. Figure 26 shows the conceptual plan of the proposed improvements.

[28] The regulatory sign is intended for vehicles traveling westbound on Route 9 that are making right turns. It is currently located on the departure side curb (after the intersection) and should be moved to the approaching side curb (before the intersection) next to the westbound right-turn lane.

[29] The regulatory sign is intended for right-turning vehicles from all approaches. They are located at the far-side corners (after the intersection) and should be relocated to the near-side curb (before the intersection).

General Recommendations: Route 9 between Hammond Street and the Newton City Line

Proposed long-term improvements for this section of Route 9 include the following:

- Install sidewalk level separated bike lanes on the south side of Route 9 (with the removal of the existing on-street parking) and on the north side along the carriage road.
- Enhance sidewalks with trees and landscape elements on Route 9 and the carriage road where applicable.

Route 9 at Hammond Street

The intersection is very congested with heavy traffic, pedestrian, and bicycle volumes during peak hours. Proposed long-term improvements at this intersection include the following:

- Reconstruct and add an exclusive left-turn lane on the northbound approach.
- Change the Hammond Street signal operation from split phases to leading protected left turns followed by through movements (the same as the Route 9 operation).
- Operate the pedestrian signal concurrent with through movements on Hammond Street and increase the phase time from 30 to 35 seconds.
- Continue monitoring the crash conditions at this intersection and further examine the potential of adding leading pedestrian intervals in the signal setting at the design stage.[30]
- Upgrade the traffic signal system.
- Relocate the existing bus stops to the far side of the intersection in both the eastbound and westbound sides of Route 9.

[30] A Leading Pedestrian Interval (LPI) typically gives pedestrians a three to seven second head start when entering an intersection before vehicles traveling in the same direction get a green signal to proceed. Although the proposed improvements would significantly reduce delays and improve traffic and pedestrian operations at this intersection, most traffic phases would still be saturated with high traffic demands and operate at an undesirable level of service. Adding LPIs in the signal cycles would further increase delays and deteriorate the intersection's level of service. However, the use of LPIs should be further examined at the design stage as it is a proven pedestrian safety improvement measure. The *Manual on Uniform Traffic Control Devices* (*MUTCD*) specifies that an LPI should be at least three seconds in duration and timed to allow pedestrians to cross at least one lane of traffic. Also, consideration should be given to prohibiting vehicles from turning across the crosswalk for the duration of the LPI (2009 *MUTCD* with Revision Numbers 1 and 2 incorporated, Chapter 4E).

Route 9 at Tully Street and Hammond Street at Heath Street

Traffic signals at the intersection of Route 9 and Tully Street and the intersection of Hammond Street and Heath Street are well coordinated with the signals at the intersection of Route 9 and Hammond Street under the prevailing traffic patterns. Capacity analyses show that both intersections operate at an acceptable level of service. The results of crash data analyses show that the crash rates at these locations are not high. No long-term improvements are proposed for the two intersections at this time.

5.7 OVERVIEW OF PROPOSED LONG-TERM IMPROVEMENTS UNDER PROJECTED 2030 TRAFFIC CONDITIONS

To further examine the effect of the proposed long-term improvements at the various locations described above, staff constructed traffic models for projecting traffic conditions in the Route 9 corridor to the horizon year 2030. Staff projected the 2030 traffic volumes for the alternatives by using growth factors estimated from the Boston Region MPO's regional transportation planning model.[31]

Figures 27 and 28 summarize the weekday AM and PM peak hour intersection capacity analyses for major intersections in the corridor under the projected 2030 traffic conditions. With the proposed long-term improvements, all the intersections would operate at an acceptable level of service—LOS E or better—during the weekday AM and PM peak hours, except the intersection of Route 9 at Cypress Street in the AM peak hour. However, the Cypress Street intersection would maintain a similar level of service as in the existing conditions with no significant increase of delays.

Synchro capacity analysis reports of the study intersections are included in Appendices J and K. These reports present the results of the analysis of the future-year weekday AM and PM peak hour traffic conditions under the assumption that the proposed improvements are implemented.

[31] The traffic growth projection is based on the transportation planning model recently developed for the MPO's Long-Range Transportation Plan. With no major infrastructure (major new highway and transit) changes in the vicinity of Brookline, the model predicts that traffic in the study area would increase by three percent (0.25 percent annually) in the AM peak period and four percent (0.3 percent annually) in the PM peak period from 2019 to 2030.

Chapter 6— Summary and Recommendations

This report provides a vision for the long-term development of the Route 9 corridor in Brookline and presents a series of improvements that would allow the corridor to operate safely and efficiently for bicyclists, pedestrians, transit users, and motorists. The recommendations included are based on a series of safety and operations analyses that were performed to understand the safety and operational problems in the corridor and to identity solutions.

The recommended short-term improvements could enhance safety for all users, including pedestrians and bicyclists, and improve traffic operations in the study area. With a high benefit-to-cost ratio, these short-term improvements should be considered and implemented as soon as resources are available from highway maintenance or Chapter 90 funding.

Significantly improving the safety, mobility, and access for all users in the corridor would require a series of long-term improvements. The benefits expected to result from implementing the proposed long-term improvements from this study include the following:

- The proposed installation of separated bike lanes would provide bicyclists safe and comfortable accommodations in the corridor and significantly improve their safety and mobility.
- Proposed improvements at major intersections along Route 9, especially at Sumner Road and Warren Street, Reservoir Road, and Hammond Street, would significantly improve safety and mobility for pedestrians, bicyclists, and motorists.
- Proposed improvements at major crossing locations, such as Route 9 at Clark Road and Kennard Road and at Dunster Road, would significantly improve safety and mobility for pedestrians and transit users.
- Proposed MBTA bus stop improvements at various locations in the corridor would improve safety and comfort for transit users and potentially increase the use of public transportation.
- The proposed sidewalk widening and enhancements would enrich pedestrians' walking experiences and promote healthy transportation.
- The overall proposed roadway reconfiguration—reducing travel lane width, maintaining medians, installing separated bicycle lanes, improving intersection and crosswalk operations, and enhancing the sidewalk environment—would significantly reduce traffic speeds in the corridor and enhance safety for all users.

Implementing this vision for Route 9 via the recommended improvements would require significant effort and collaboration on the part of all stakeholders, including the Town of Brookline, residents, business owners, and MassDOT. All parties must concur about how the recommendations should be realized in a resourceful and fiscally responsible manner.

The next steps toward implementation are for the Town to identify priority sections of Route 9 and work with MassDOT District 6 to initiate a project. For municipalities to initiate roadway projects, MassDOT recently developed an online tool for submission. The Massachusetts Project Intake Tool (MaPIT) is a web-based application designed to help proponents map, create, and initiate projects with available in-house geographic information system (GIS) resources. The tool can be accessed from the GeoPass webpage of Massachusetts GIS for Transportation (GeoDOT) website, https://massdothpi.esriemcs.com/mapit.

To move a project from the initiation to the development stage, the Town must obtain favorable assessment from MassDOT's Project Review Committee, start the project design process, and identify potential funding sources by coordinating with MassDOT and the Boston Region MPO.

MPO staff will continue support this work by providing assistance with further project planning and the funding process. In addition, staff will continue to monitor the progress toward implementing this study's recommendations via the MPO's UPWP Study Recommendations Tracking Database.

Appendix L contains details about the various steps in MassDOT's project development process, including a schematic timetable. Information about the project development process also may be found on MassDOT's website, at https://www.mass.gov/service-details/project-development-process.

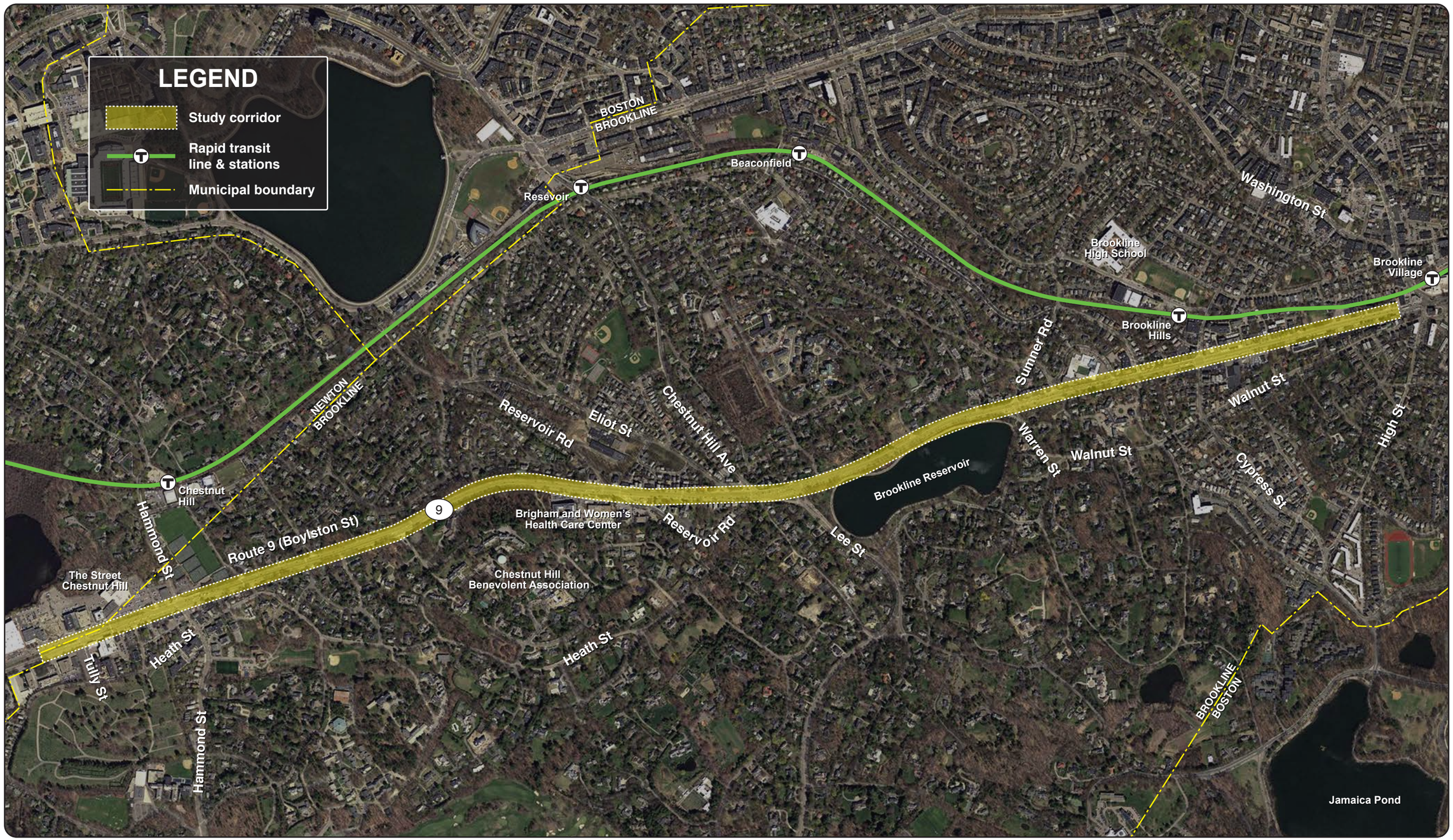

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Figure 1
Study Area Map
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

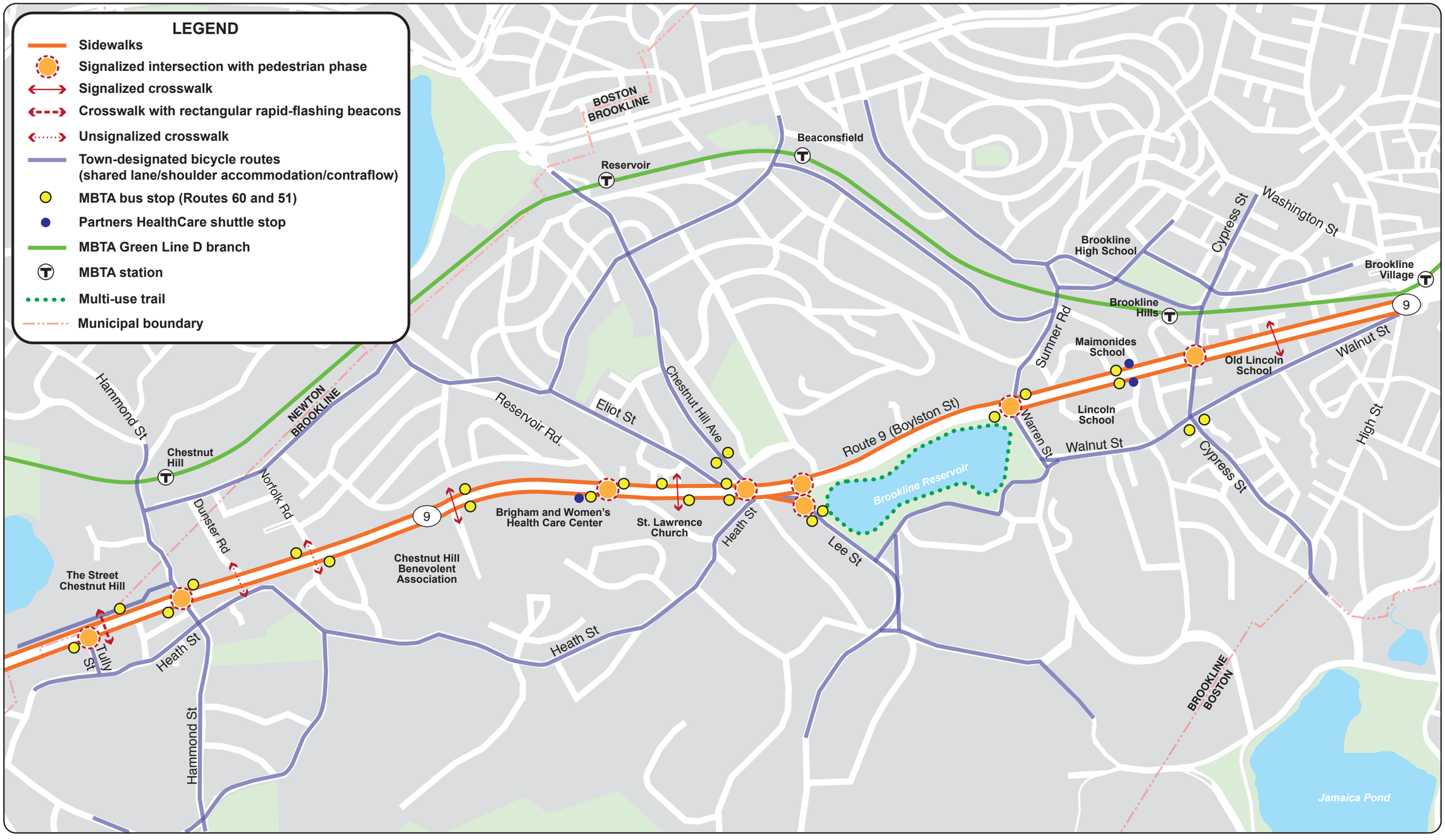

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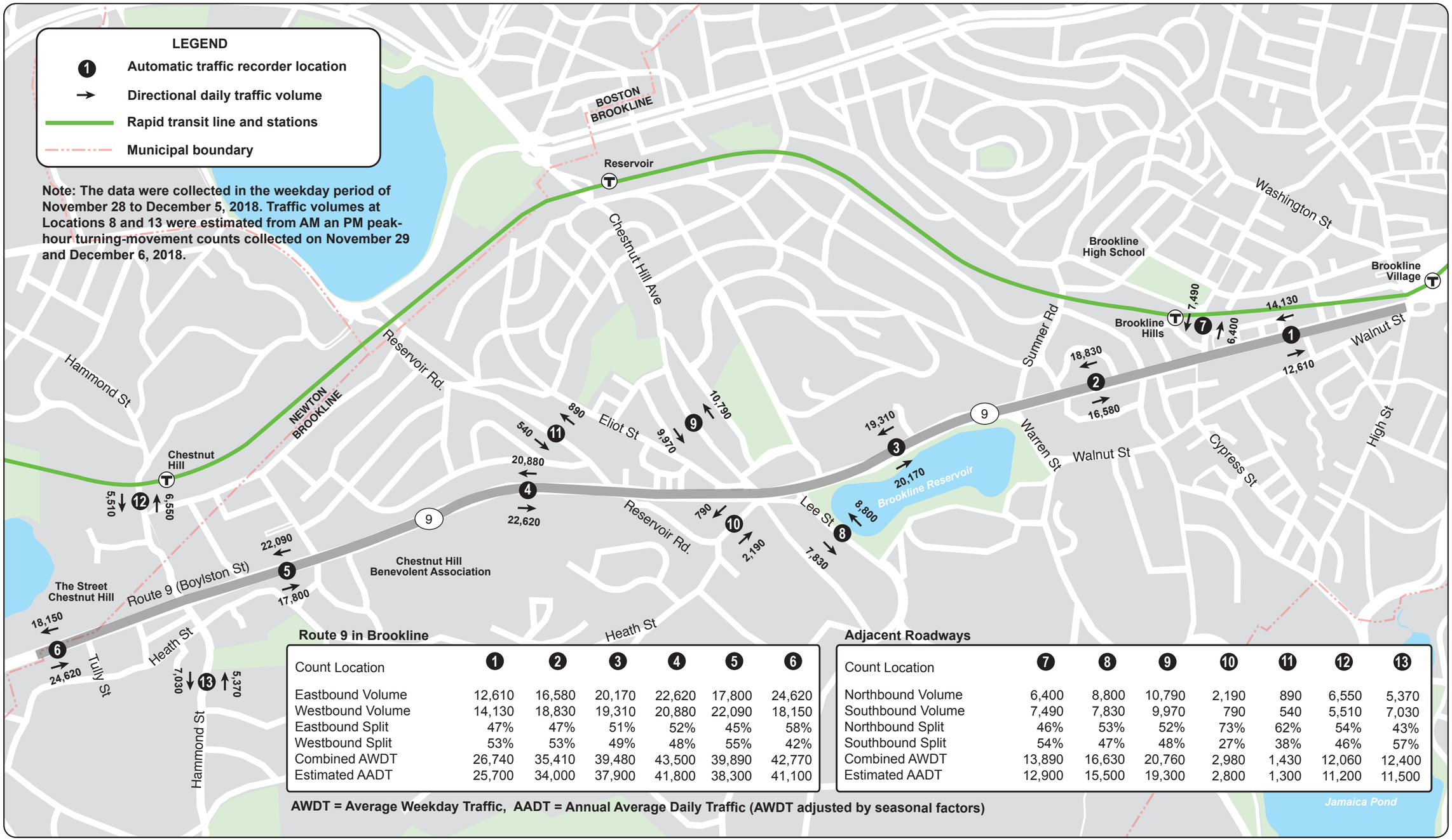
Figure 2
Transit Services and Pedestrian and Bicycle Facilities
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways



Route 9 in Brookline

Count Location	1	2	3	4	5	6
Eastbound Volume	12,610	16,580	20,170	22,620	17,800	24,620
Westbound Volume	14,130	18,830	19,310	20,880	22,090	18,150
Eastbound Split	47%	47%	51%	52%	45%	58%
Westbound Split	53%	53%	49%	48%	55%	42%
Combined AWDT	26,740	35,410	39,480	43,500	39,890	42,770
Estimated AADT	25,700	34,000	37,900	41,800	38,300	41,100

Adjacent Roadways

Count Location	7	8	9	10	11	12	13
Northbound Volume	6,400	8,800	10,790	2,190	890	6,550	5,370
Southbound Volume	7,490	7,830	9,970	790	540	5,510	7,030
Northbound Split	46%	53%	52%	73%	62%	54%	43%
Southbound Split	54%	47%	48%	27%	38%	46%	57%
Combined AWDT	13,890	16,630	20,760	2,980	1,430	12,060	12,400
Estimated AADT	12,900	15,500	19,300	2,800	1,300	11,200	11,500

AWDT = Average Weekday Traffic, AADT = Annual Average Daily Traffic (AWDT adjusted by seasonal factors)

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Figure 3
Daily Traffic Volumes
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

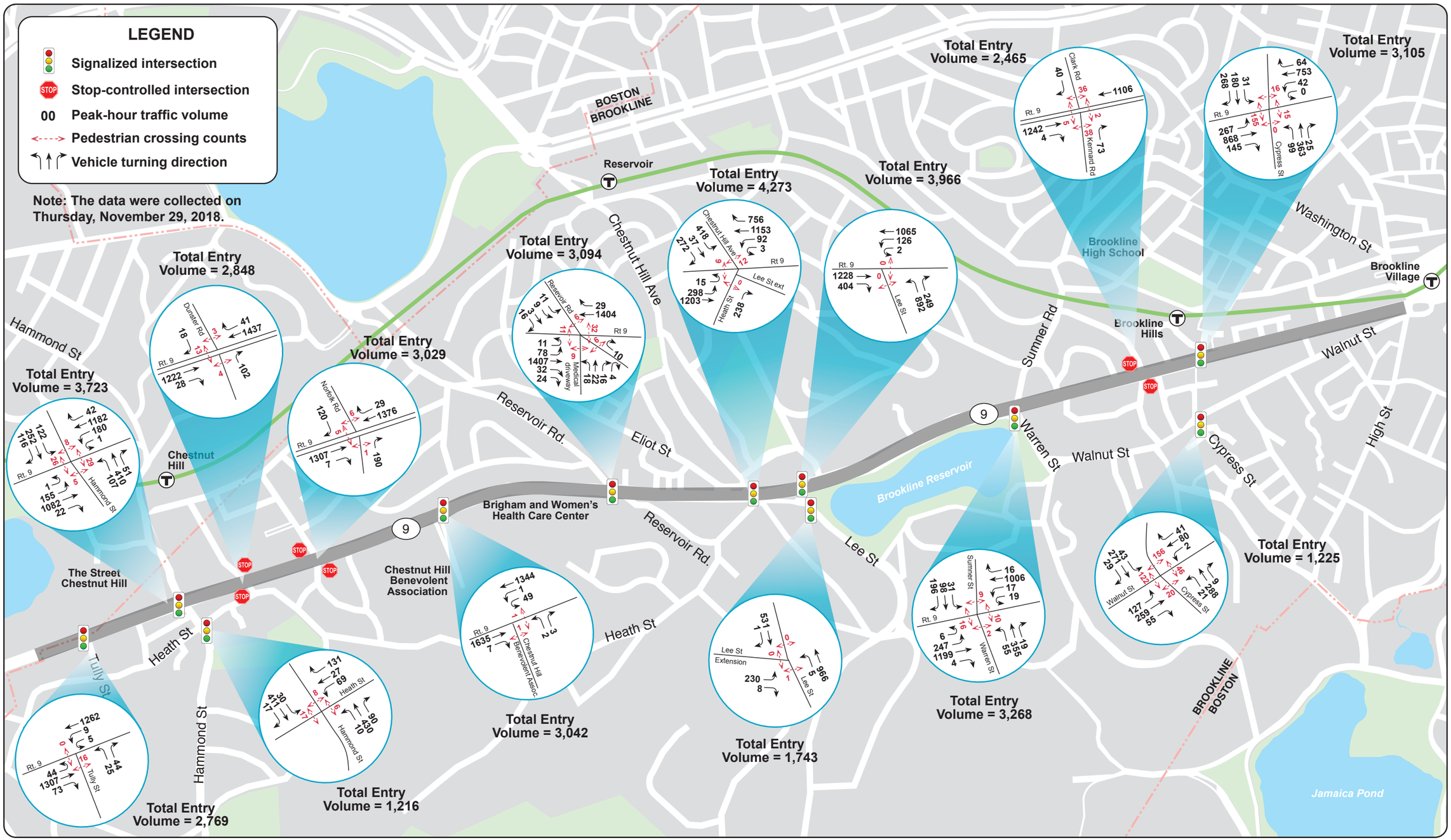

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Figure 4
Weekday AM Peak-Hour Traffic and Pedestrian Volumes at Major Intersections
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

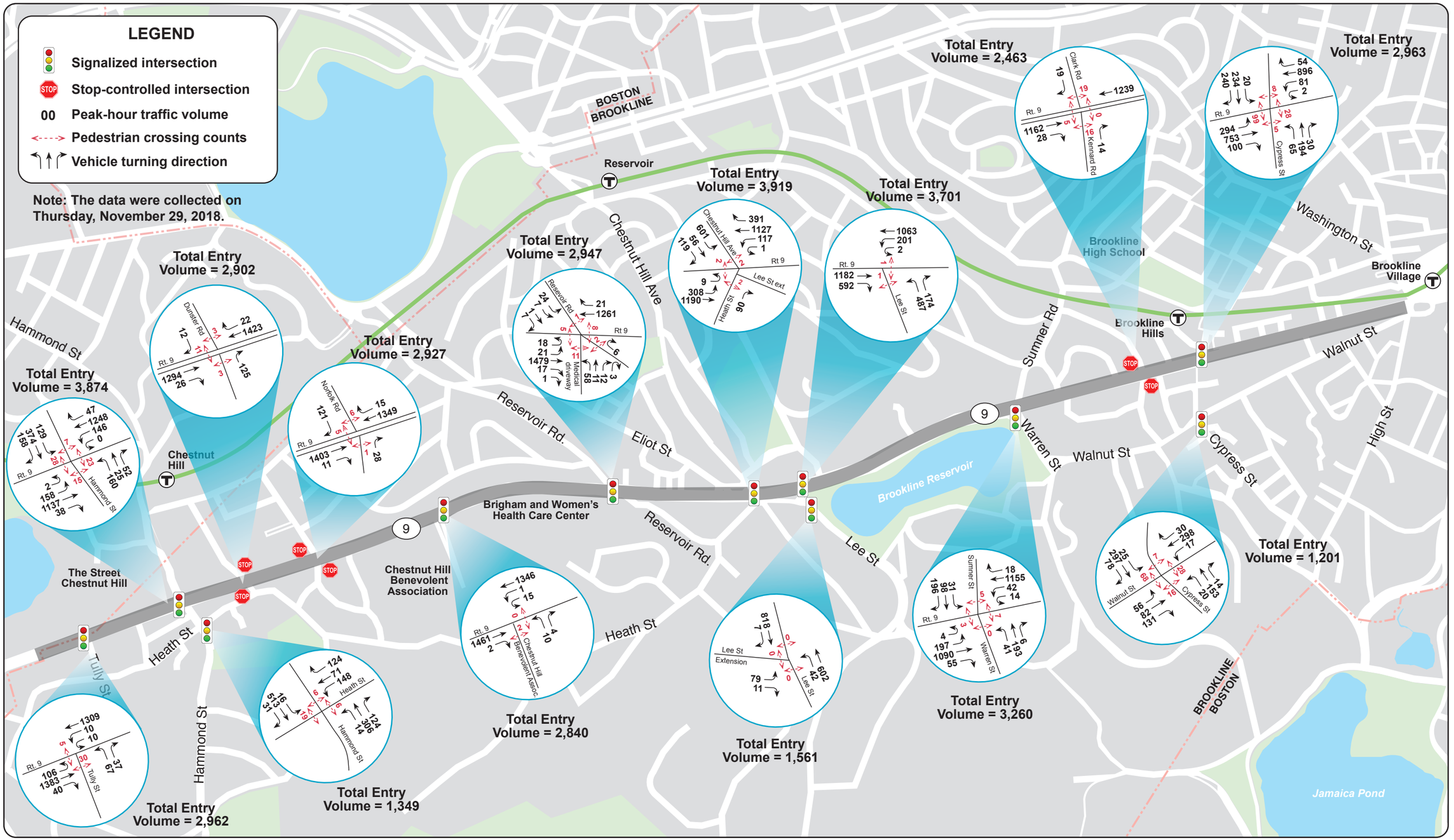

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Figure 5
Weekday PM Peak-Hour Traffic and Pedestrian Volumes at Major Intersections
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

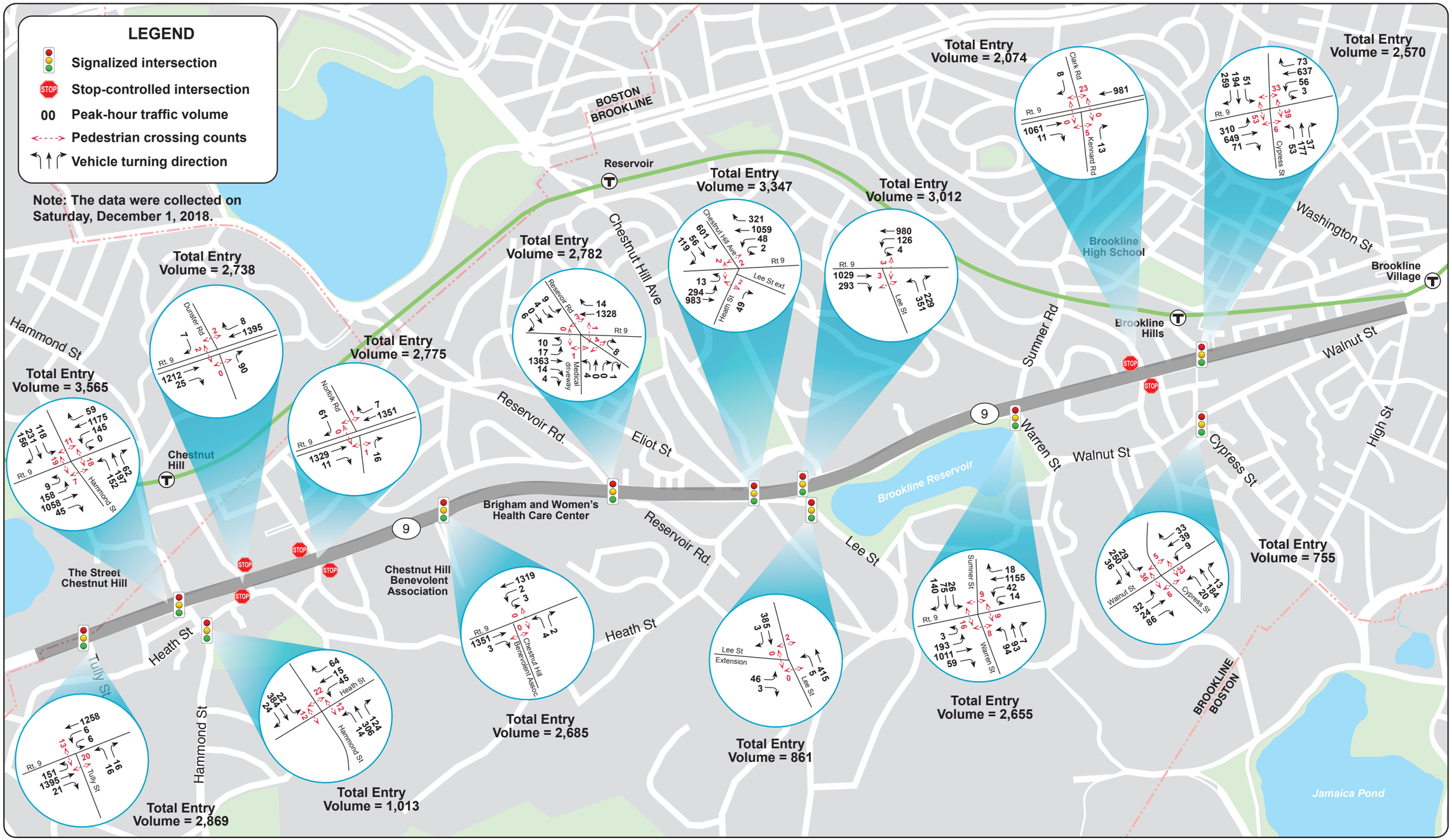

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Figure 6
Saturday Peak-Hour Traffic and Pedestrian Volumes at Major Intersections
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

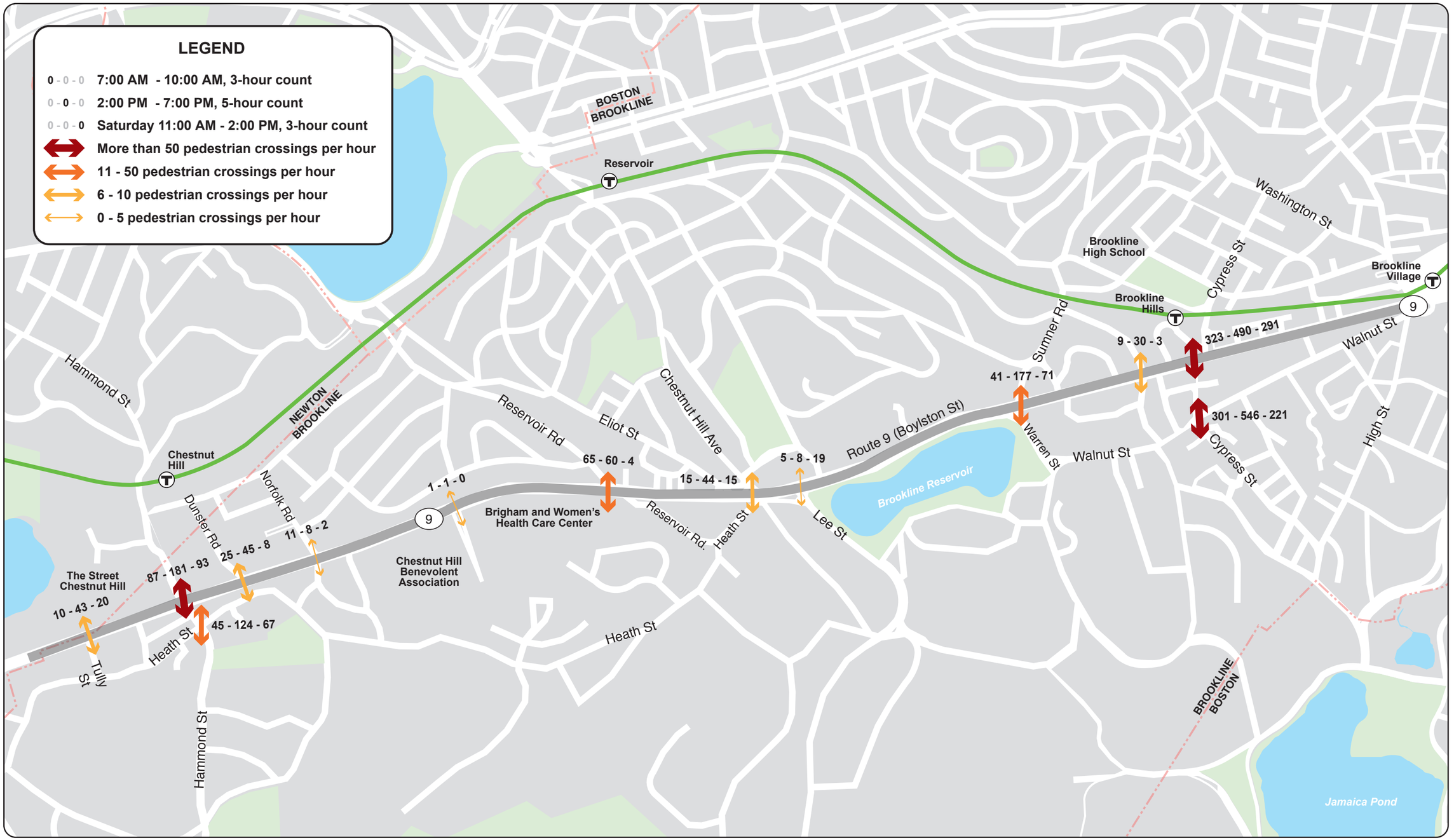

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Figure 7
Pedestrian Crossings during Peak Traffic Periods
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

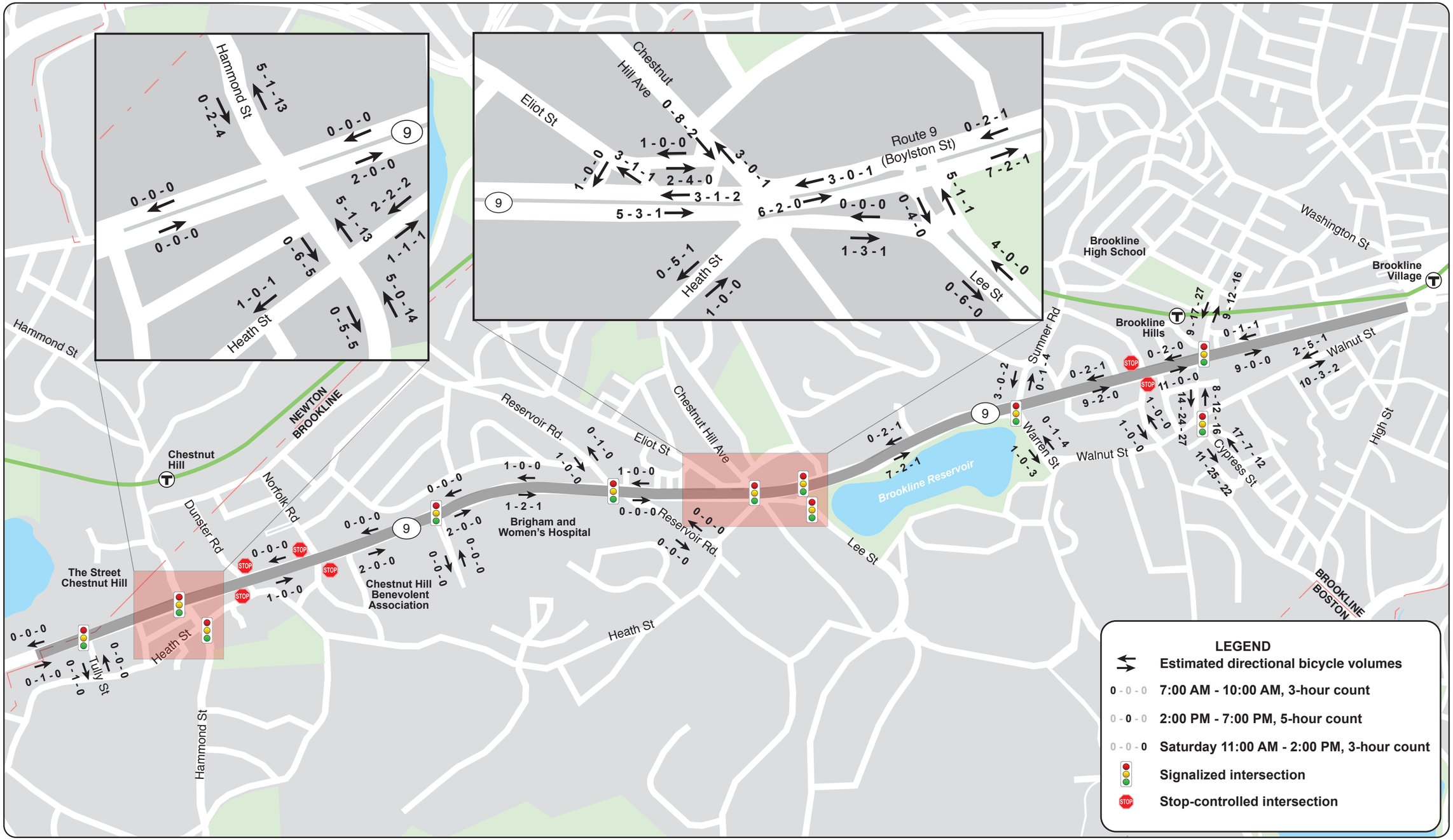

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Figure 8
On-Road Bicycle Volumes during Peak Traffic Periods
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

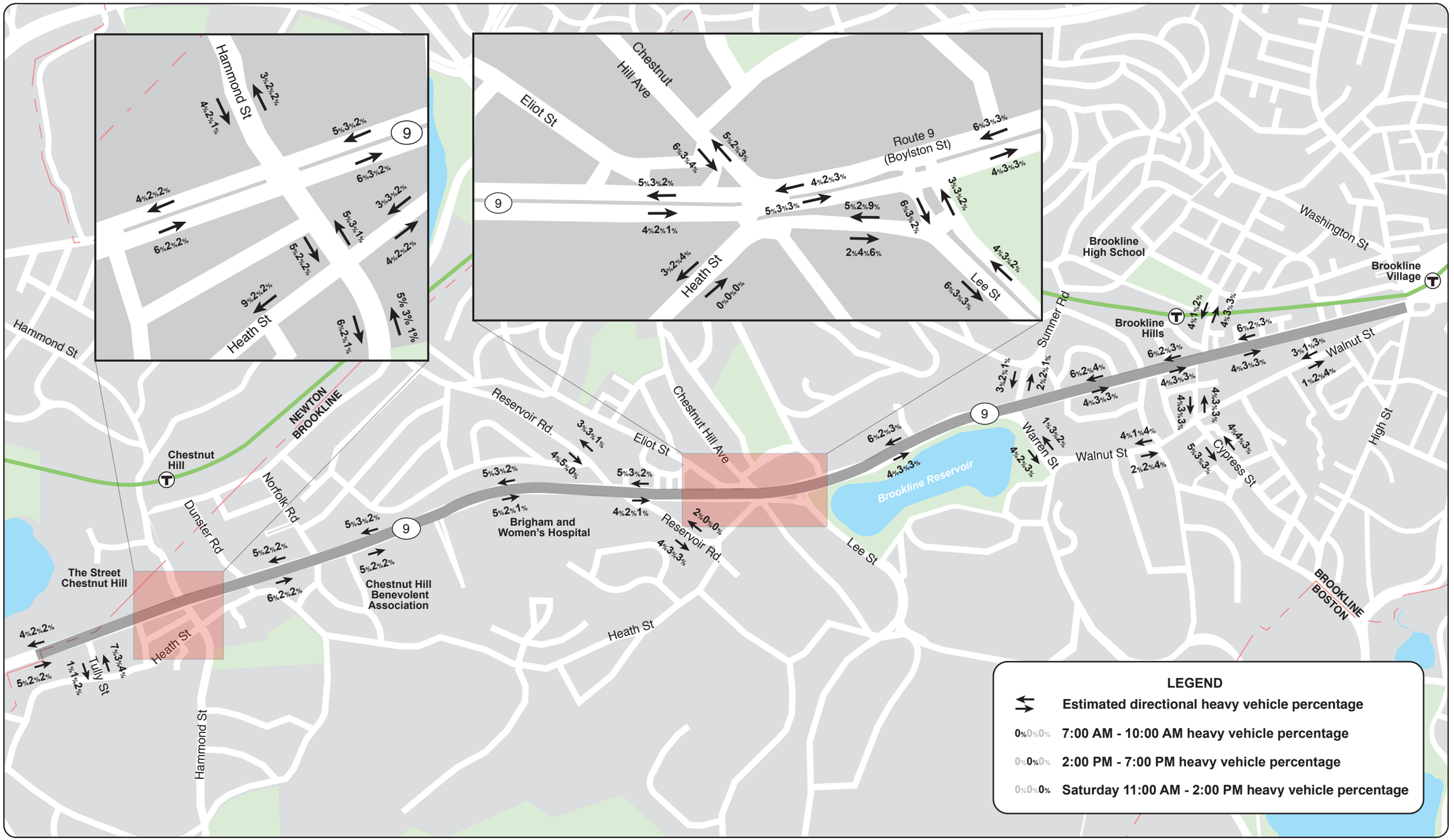

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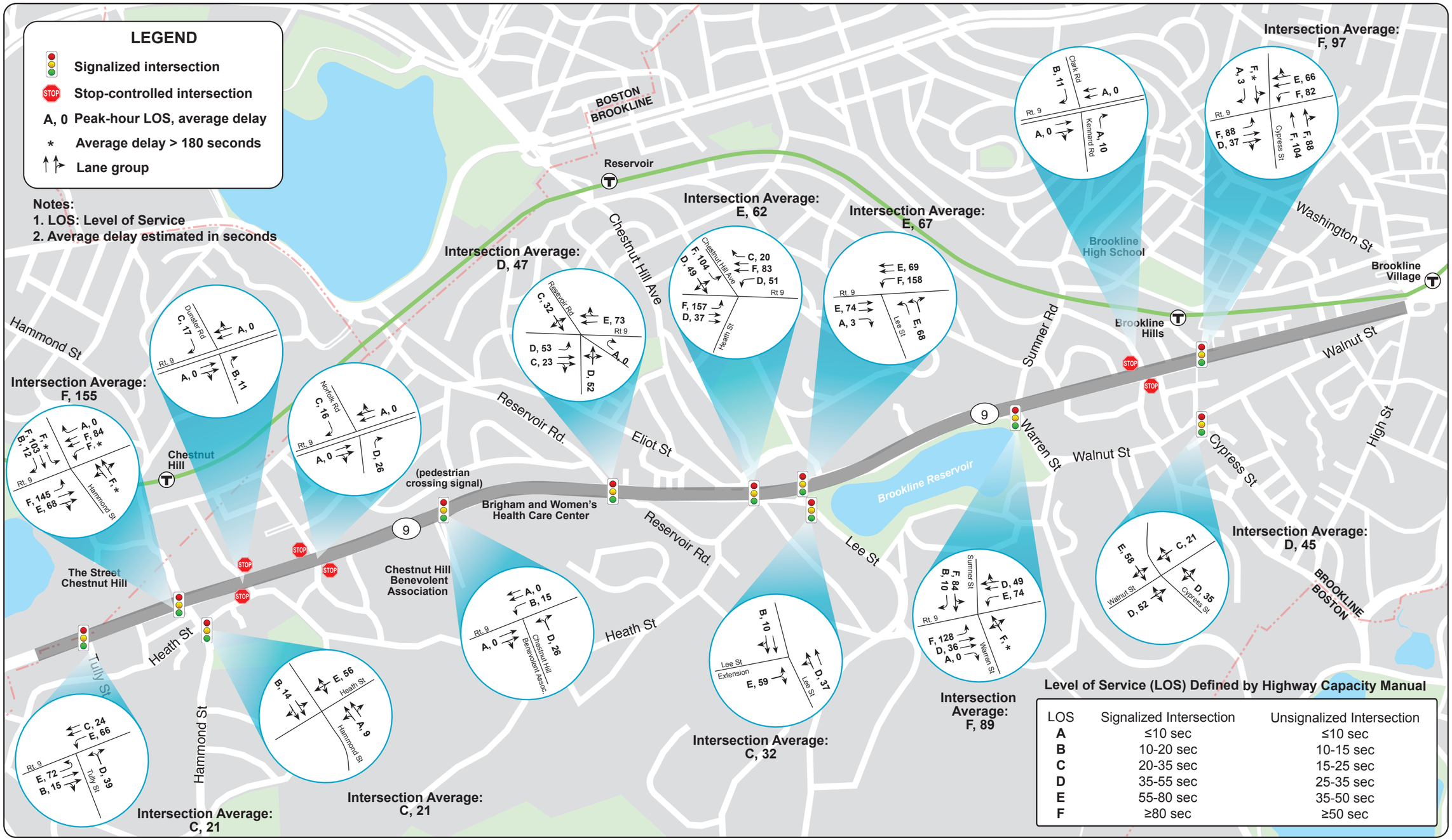
Figure 9
Heavy Vehicle Percentage during Peak Traffic Periods
Route 9 in Brookline

Addressing Safety,
Mobility, and Access on
Subregional Priority Roadways



LOS	Signalized Intersection	Unsignalized Intersection
A	≤10 sec	≤10 sec
B	10-20 sec	10-15 sec
C	20-35 sec	15-25 sec
D	35-55 sec	25-35 sec
E	55-80 sec	35-50 sec
F	≥80 sec	≥50 sec

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Figure 10
Weekday AM Peak Hour Intersection Capacity Analyses
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

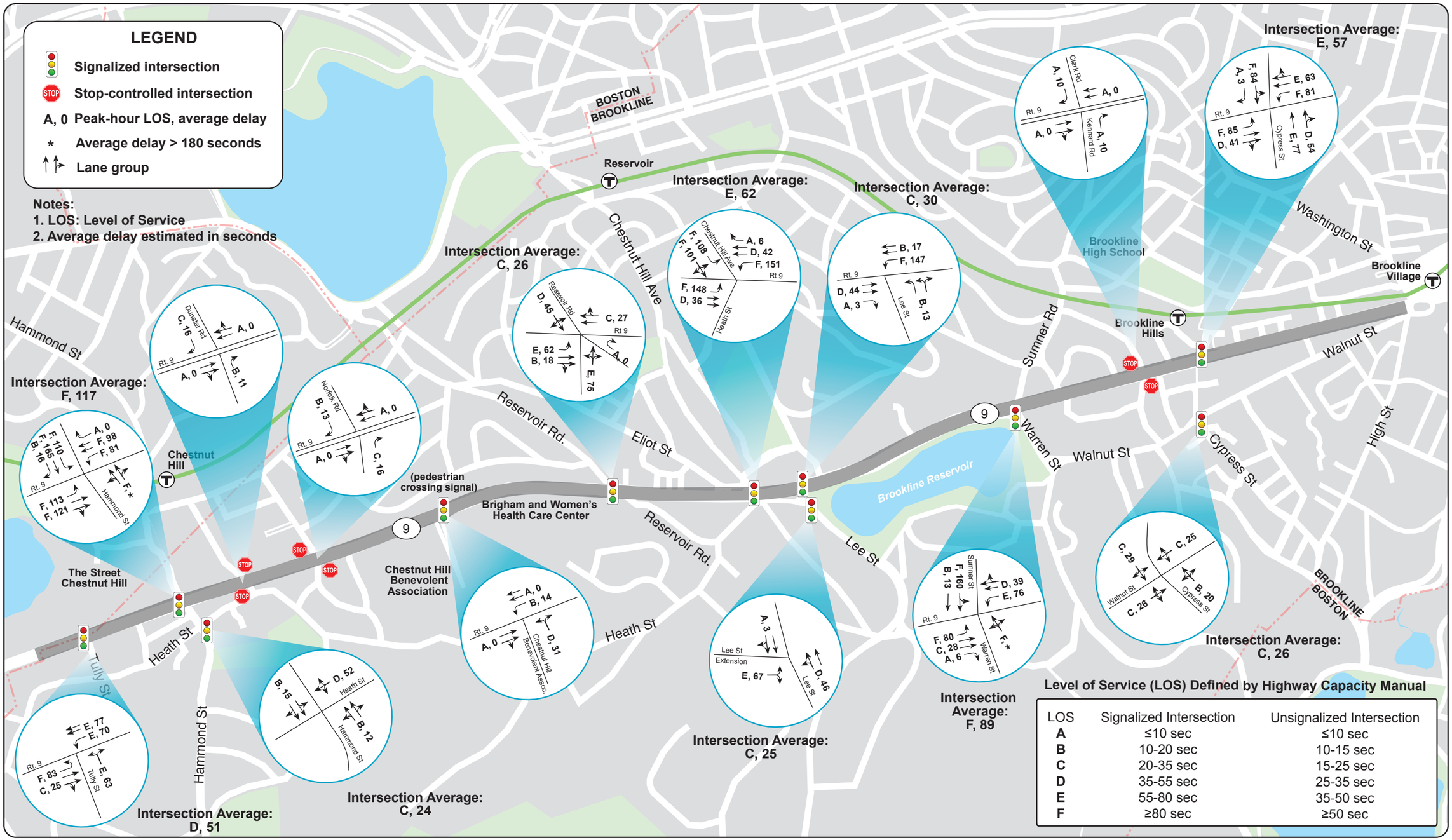

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Figure 11
Weekday PM Peak Hour Intersection Capacity Analyses
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

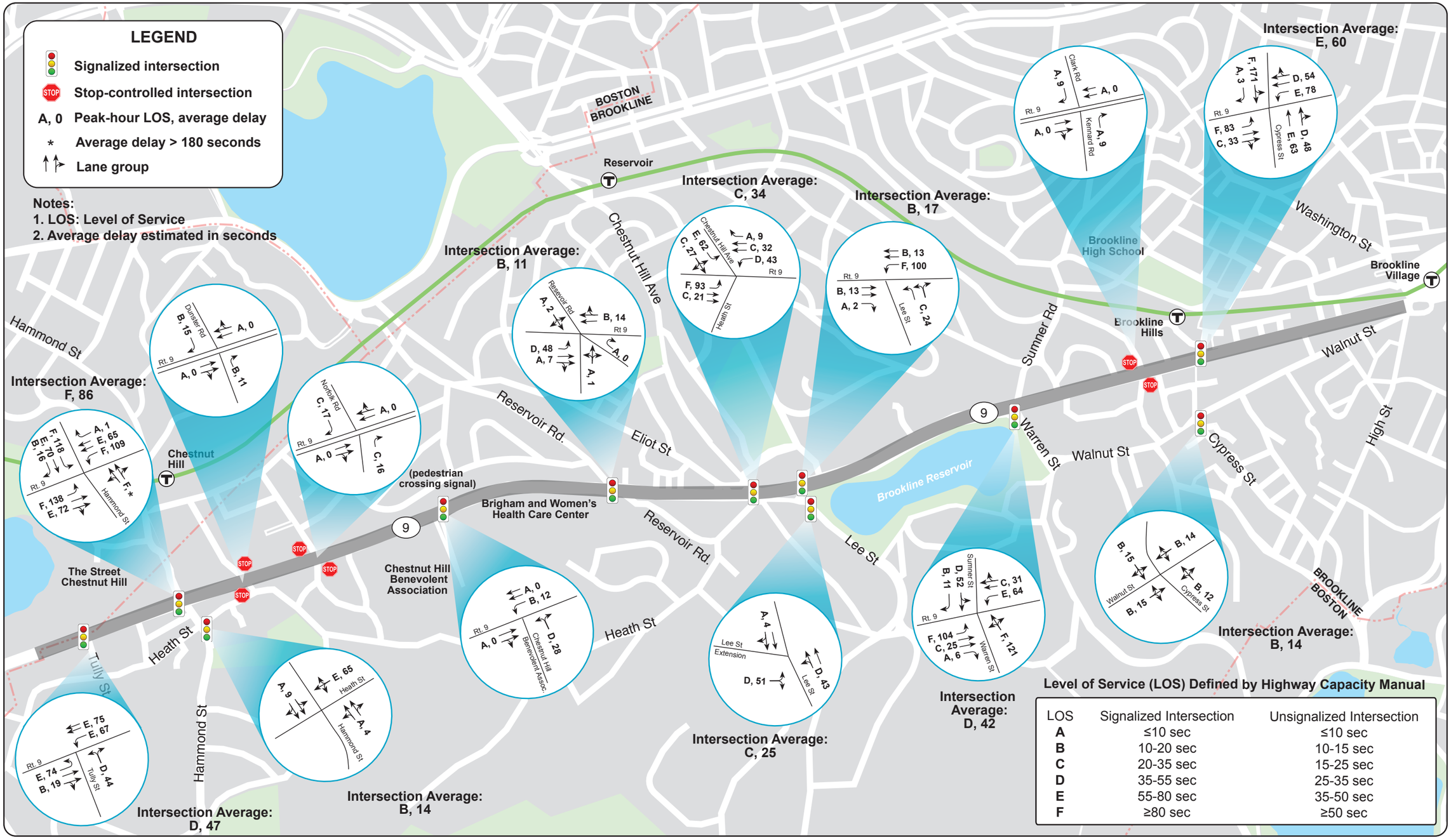

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Figure 12
Saturday Peak Hour Intersection Capacity Analyses
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

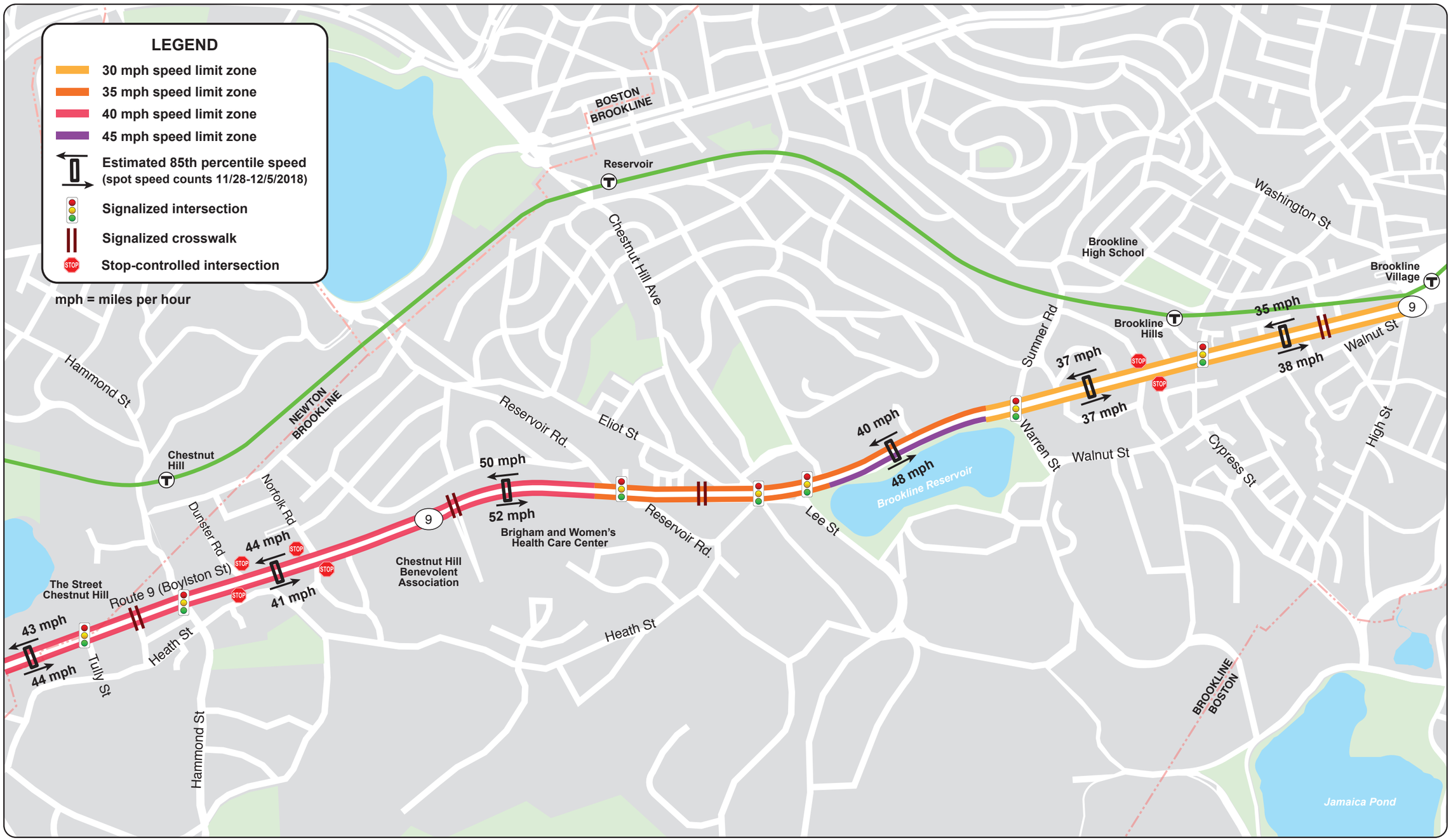

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Figure 13
Speed Regulations and Estimated 85th Percentile Speeds
Route 9 in Brookline

Addressing Safety,
Mobility, and Access on
Subregional Priority Roadways

LEGEND

- **Crashes involving a motor vehicle**
  (one dot may represent more than one crash)
- **Crashes involving a pedestrian or bicycle**
  (one dot may represent more than one crash)
- **Crash cluster (2013-15)**
- **HSIP* eligible crash cluster (2013-15)**
- **Principal arterial**
- **Other principal arterial**
- **Minor arterial**
- **Collector**
- **Local road**

*__HSIP__ = Highway Safety Improvement Program.

A crash cluster is identified by mapping a circle with a 25-meter (82-foot) radius from each crash location and observing where the spheres of two or more crashes overlap.

MassDOT uses approximated EPDO (Equivalent Property Damage Only) values to rank the statewide high-crash locations. In the estimation, crashes that result in a fatality are weighted by 10, crashes that cause injury are weighted by five, and crashes that cause property damage only (or the severity of the crash is unknown) are not weighted.

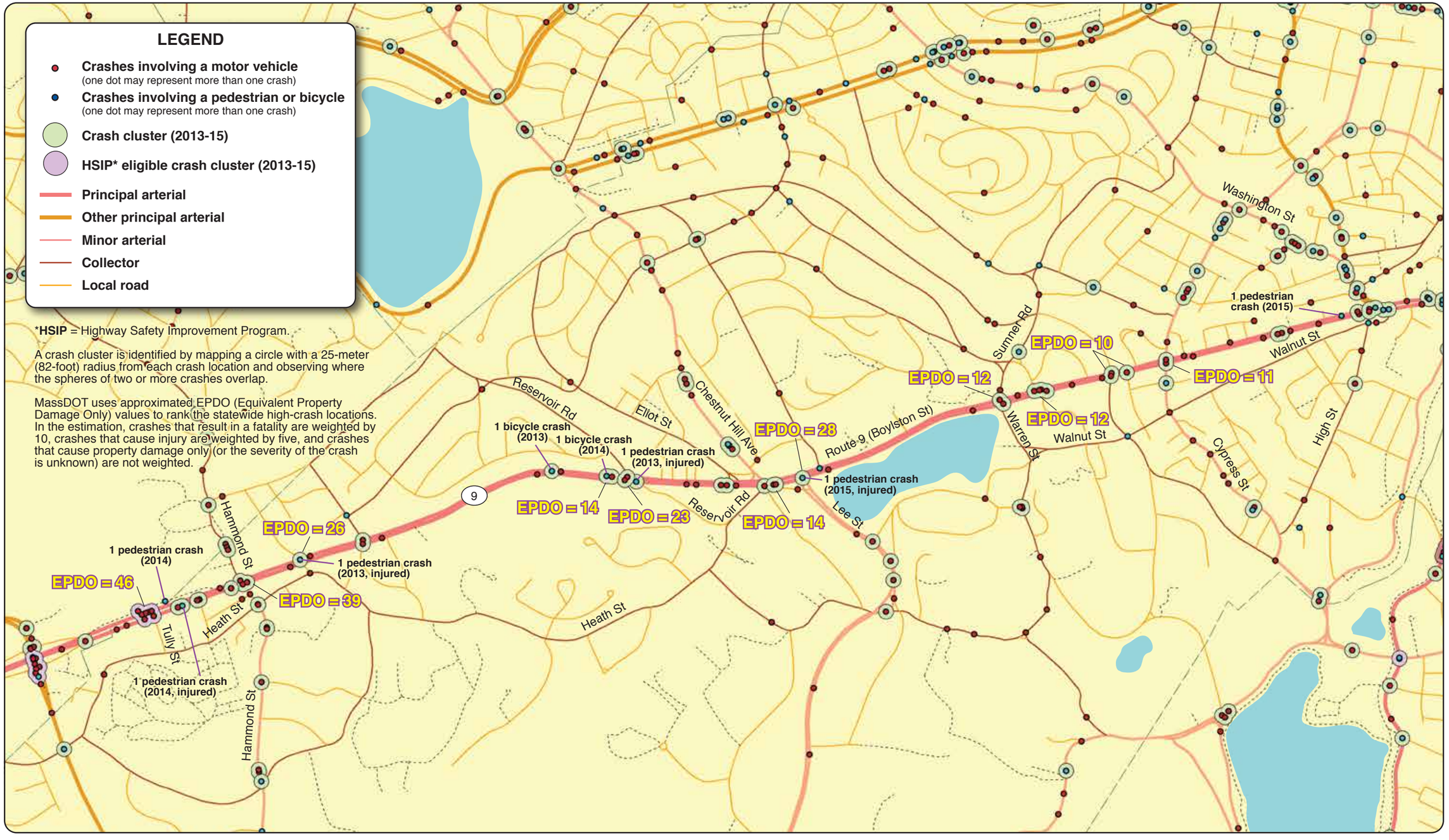

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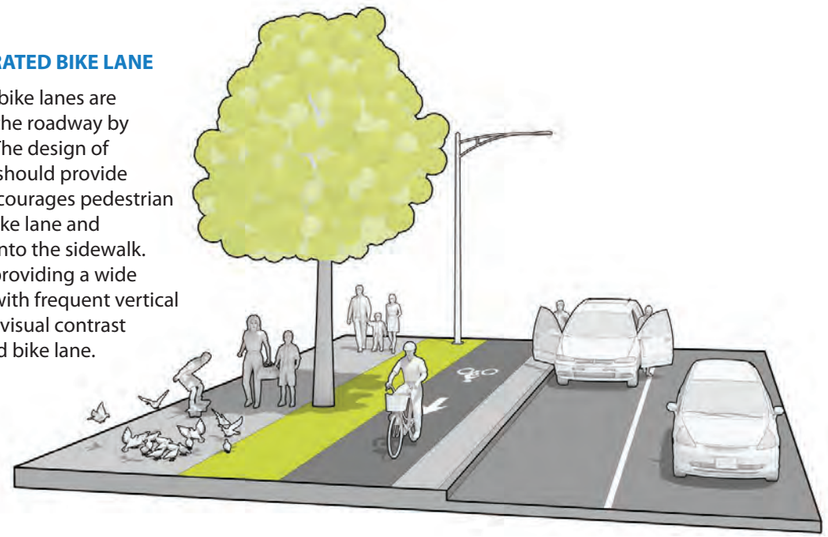
Figure 14
Crash Locations and Crash Clusters (MassDOT Crash Data 2013-15)
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

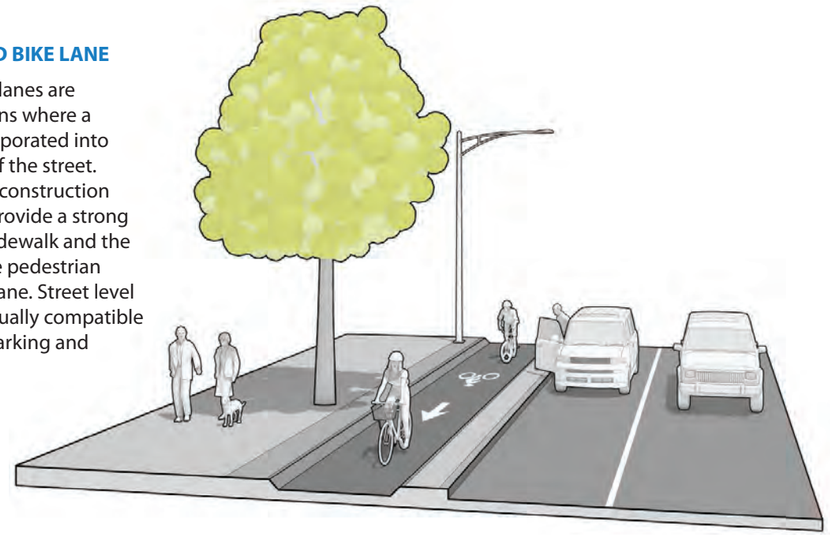
SIDEWALK LEVEL SEPARATED BIKE LANE

Sidewalk level separated bike lanes are typically separated from the roadway by a standard vertical curb. The design of sidewalk level bike lanes should provide a sidewalk buffer that discourages pedestrian encroachment into the bike lane and bicyclist encroachment onto the sidewalk. This can be achieved by providing a wide buffer, a sidewalk buffer with frequent vertical elements, or a significant visual contrast between the sidewalk and bike lane.



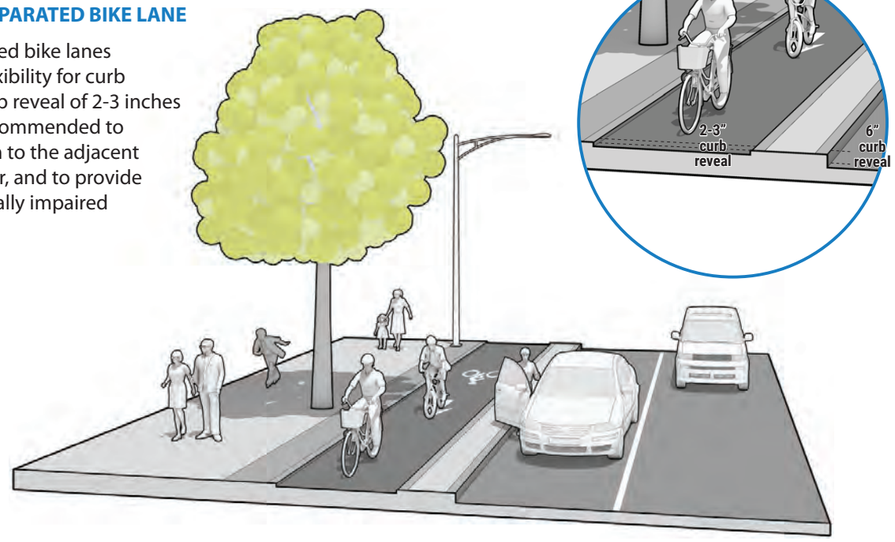
STREET LEVEL SEPARATED BIKE LANE

Street level separated bike lanes are common in retrofit situations where a separated bike lane is incorporated into the existing cross section of the street. They are also used for new construction where there is a desire to provide a strong delineation between the sidewalk and the bike lane in order to reduce pedestrian encroachment in the bike lane. Street level separated bike lanes are usually compatible with accessible on-street parking and loading zones.



INTERMEDIATE LEVEL SEPARATED BIKE LANE

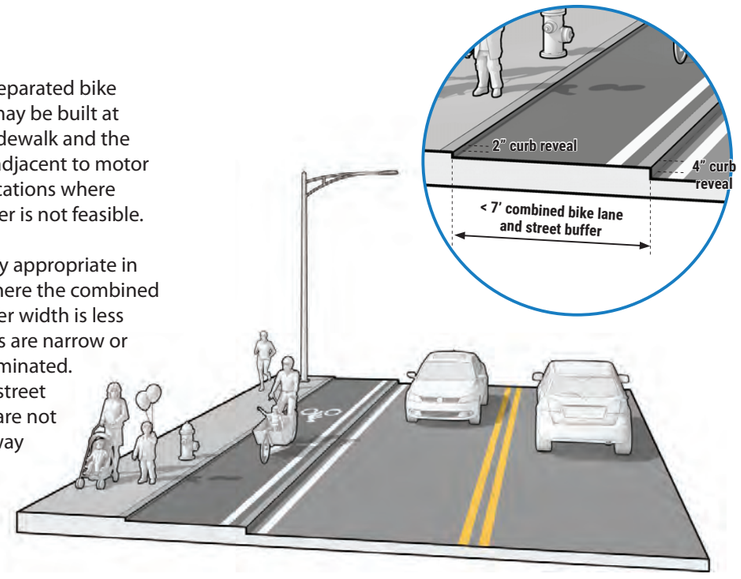
Intermediate level separated bike lanes provide greater design flexibility for curb reveal and drainage. A curb reveal of 2-3 inches below sidewalk level is recommended to provide vertical separation to the adjacent sidewalk or sidewalk buffer, and to provide a detectable edge for visually impaired pedestrians.



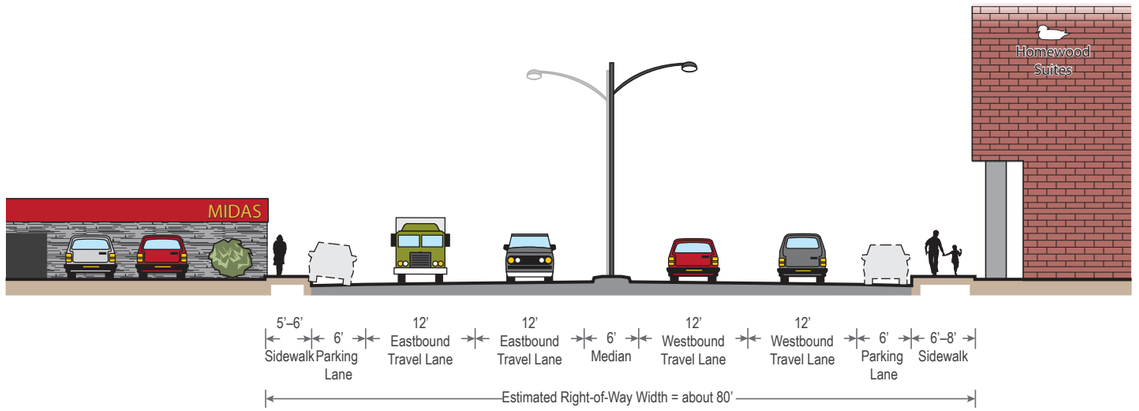
RAISED BIKE LANE

Like intermediate level separated bike lanes, raised bike lanes may be built at any level between the sidewalk and the street. They are directly adjacent to motor vehicle travel lanes at locations where provision of a street buffer is not feasible.

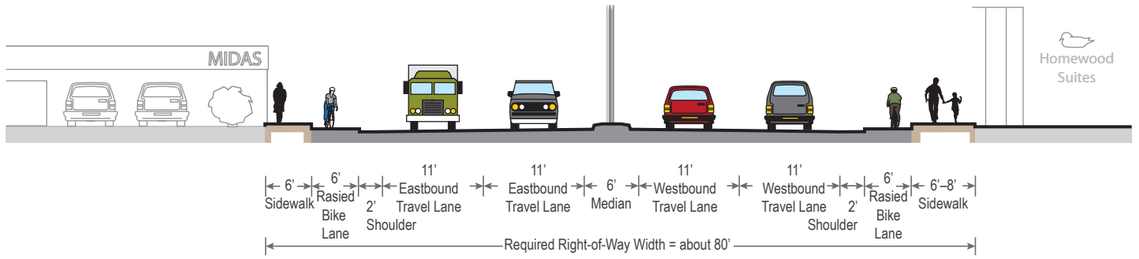
Raised bike lanes are only appropriate in constrained locations where the combined bike lane and street buffer width is less than 7 feet and sidewalks are narrow or the sidewalk buffer is eliminated. Because of their narrow street buffer, raised bike lanes are not recommended for two-way operation or adjacent to on-street parking.



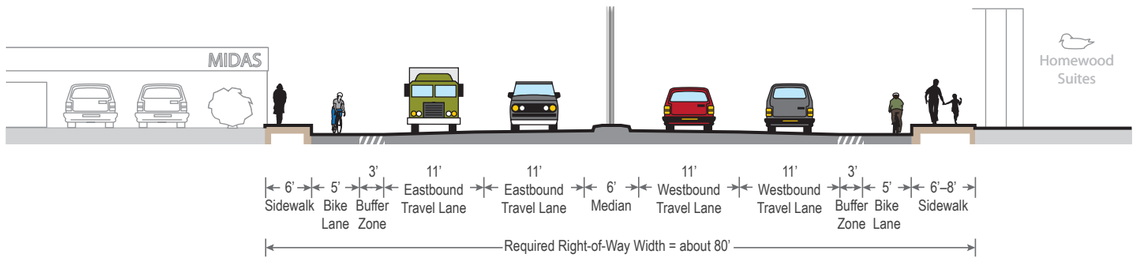
Source: ***MassDOT Separated Bike Lane Planning and Design Guide*****, 2015, pp. 25–28.**



Existing Roadway Cross Section



Potential Improvement Alternative 1



Potential Improvement Alternatives 2 and 3

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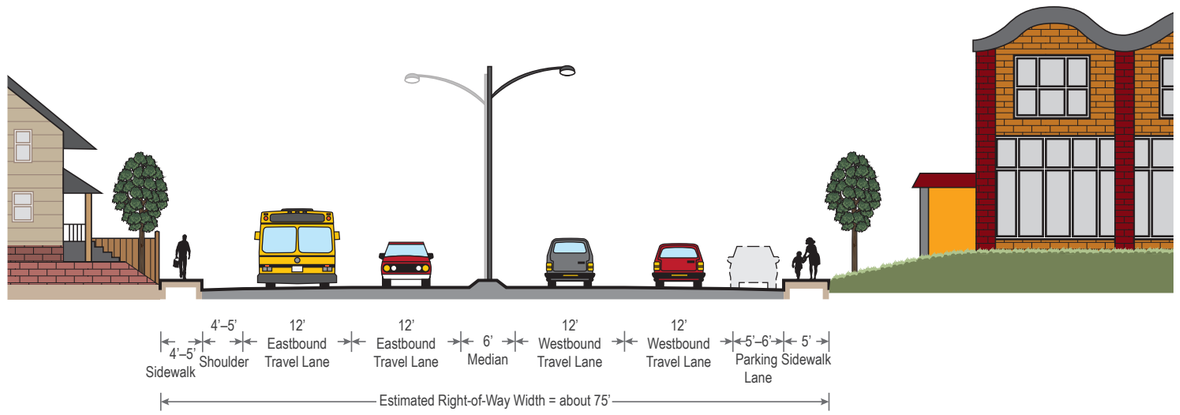
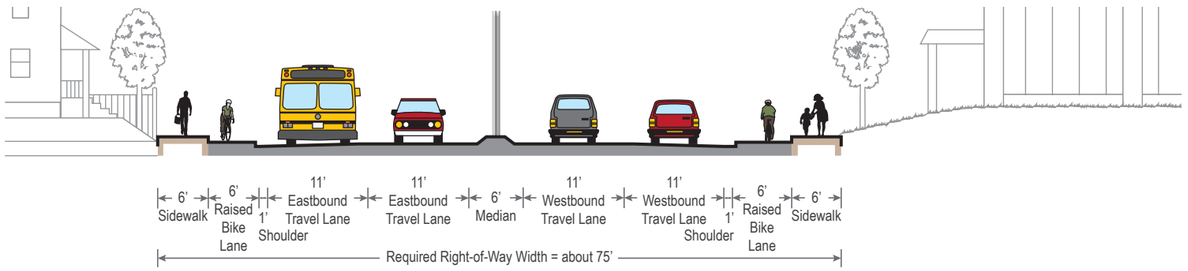
Figure 16
Roadway Accommodation Improvement Alternatives
Route 9 between Washington Street and Cypress Street

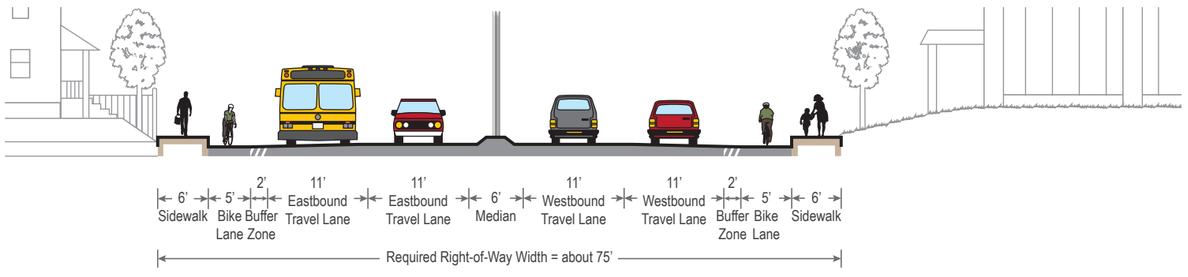
Addressing Safety, Mobility, and Access on Subregional Priority Roadways



Existing Roadway Cross Section



Potential Improvement Alternative 1



Potential Improvement Alternatives 2 and 3

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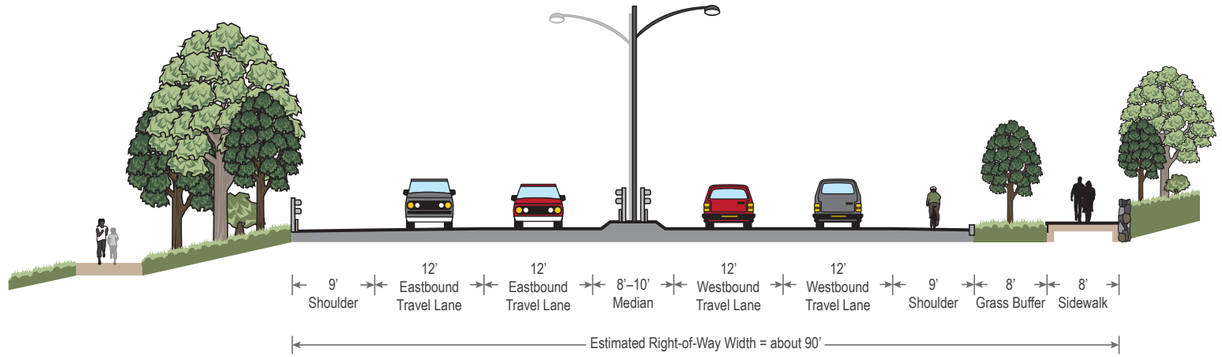
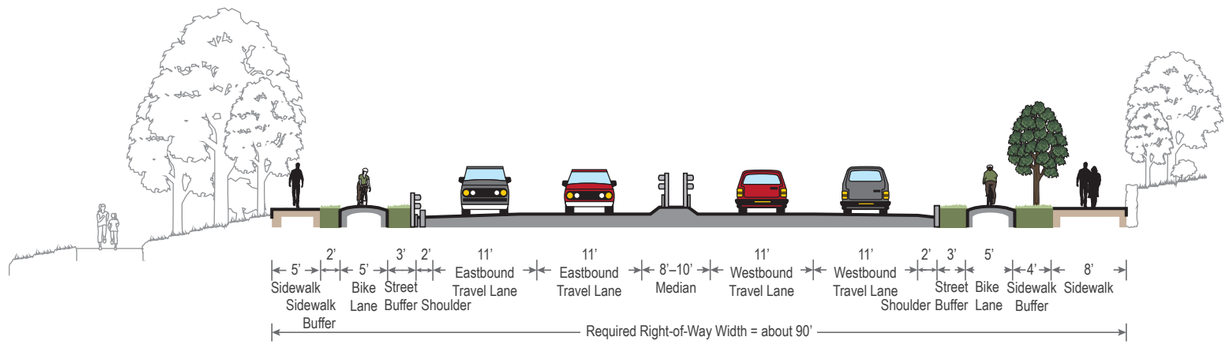
Figure 17
Roadway Accommodation Improvement Alternatives
Route 9 between Cypress Street and Sumner Road

Addressing Safety,
Mobility, and Access on
Subregional Priority Roadways



Existing Roadway Cross Section



Potential Improvement Alternative 1

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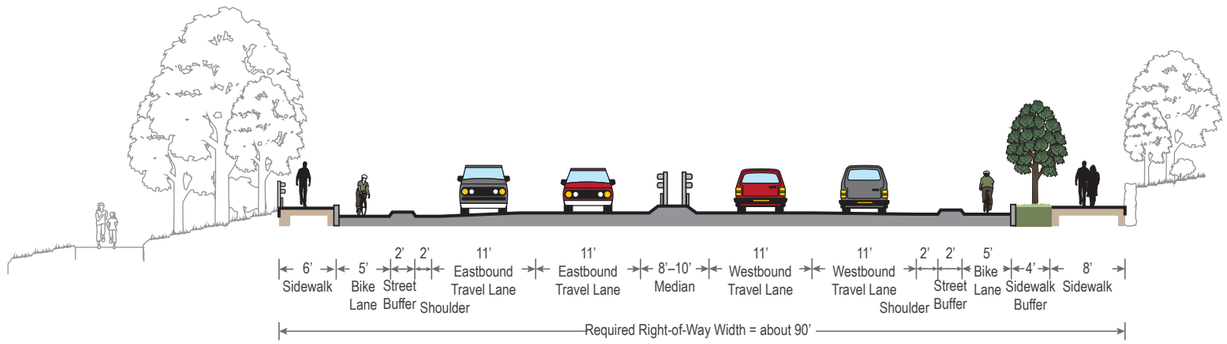
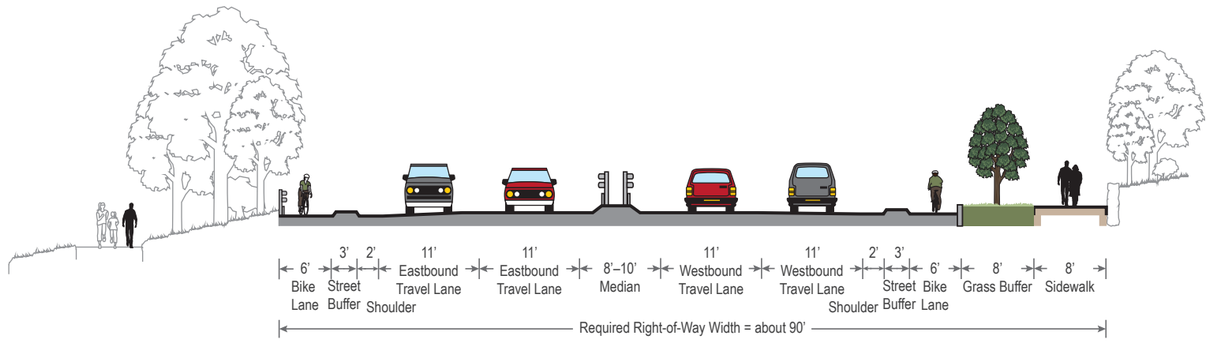
Figure 18-1
Roadway Accommodation Improvement Alternatives
Route 9 between Sumner Road and Lee Street

Addressing Safety,
Mobility, and Access on
Subregional Priority Roadways



Potential Improvement Alternative 2

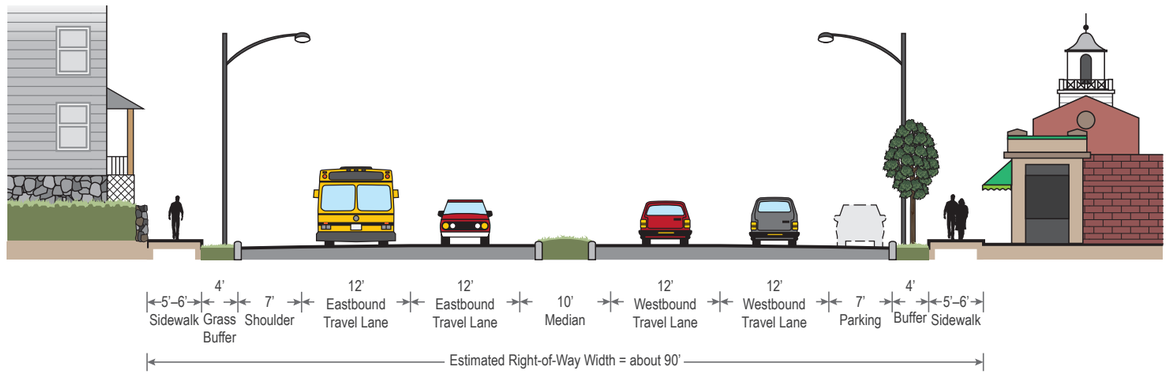


Potential Improvement Alternative 3

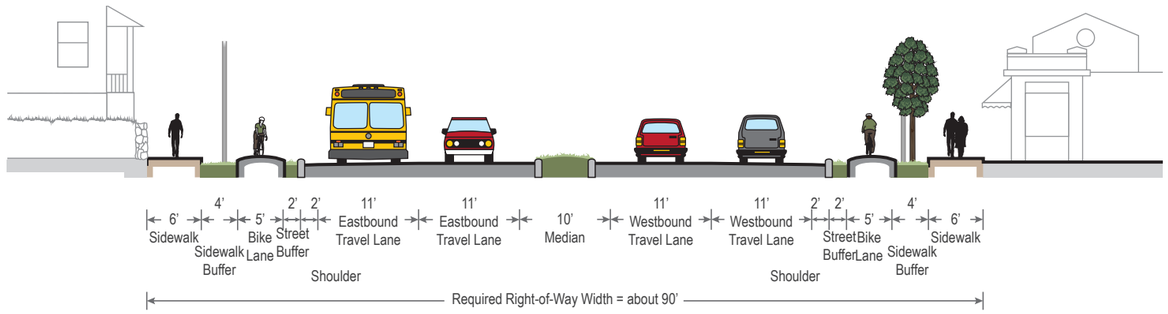
BOSTON REGION MPO

Figure 18-2
Roadway Accommodation Improvement Alternatives
Route 9 between Sumner Road and Lee Street

Addressing Safety, Mobility, and Access on Subregional Priority Roadways



Existing Roadway Cross Section



Potential Improvement Alternative 1

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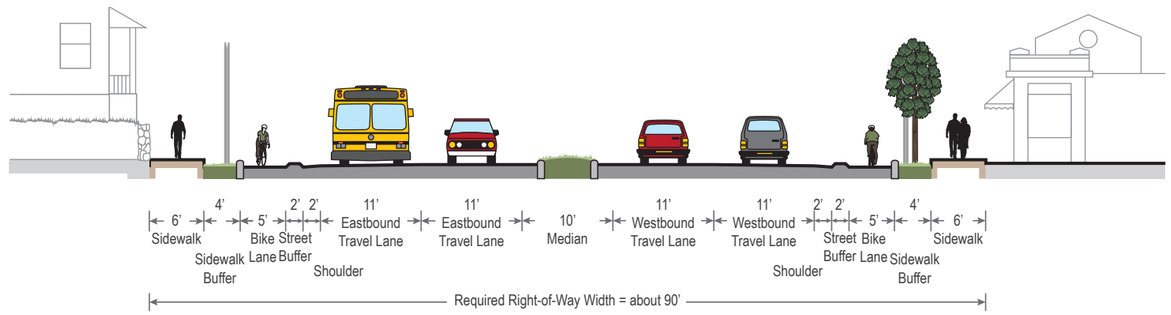
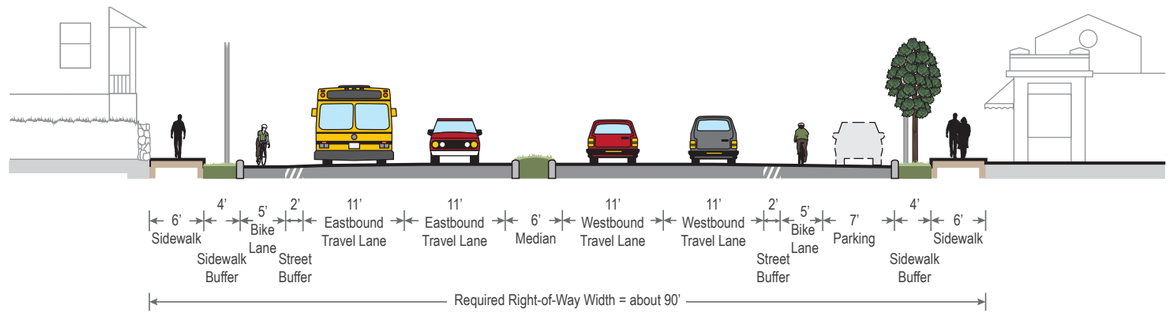
Figure 19-1
Roadway Accommodation Improvement Alternatives
Route 9 between Chestnut Hill Avenue and Reservoir Road

Addressing Safety,
Mobility, and Access on
Subregional Priority Roadways

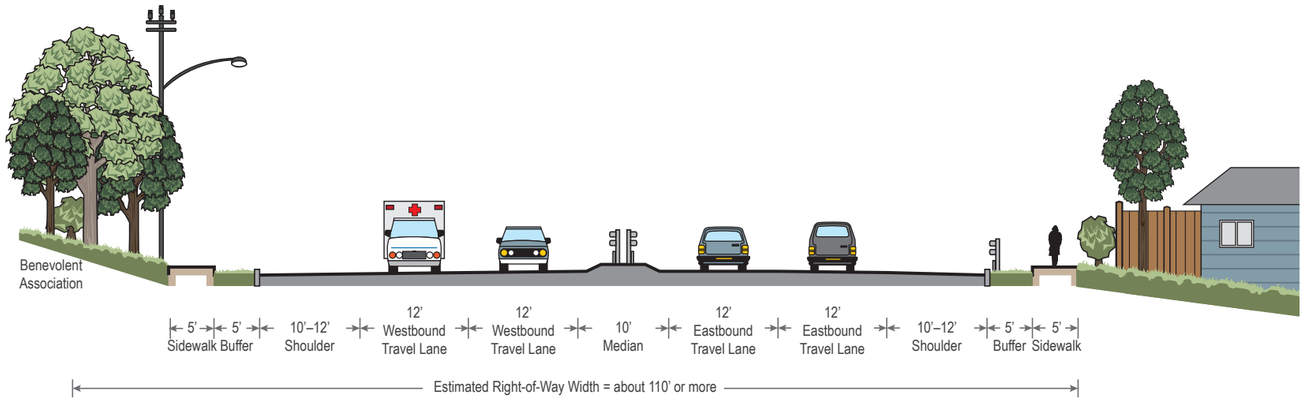


Potential Improvement Alternative 2

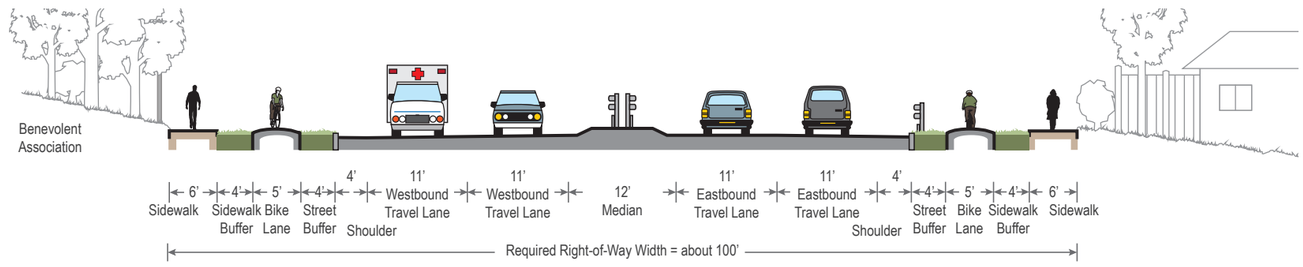


Potential Improvement Alternative 3 (On-Street Parking in Business District Only)

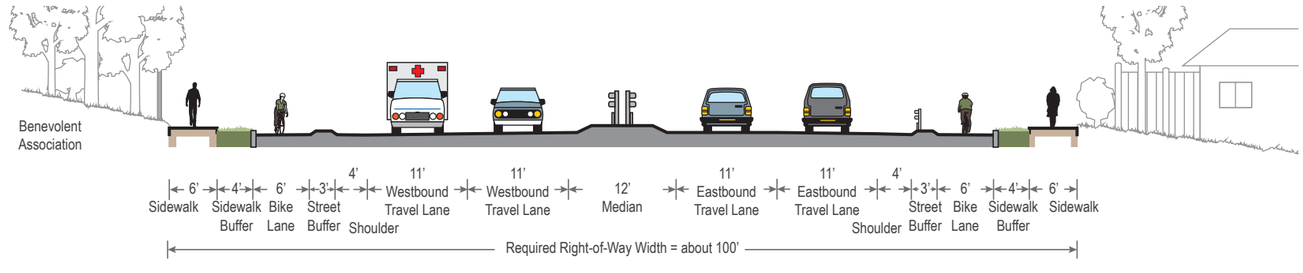
Figure 19-2
Roadway Accommodation Improvement Alternatives
Route 9 between Chestnut Hill Avenue and Reservoir Road



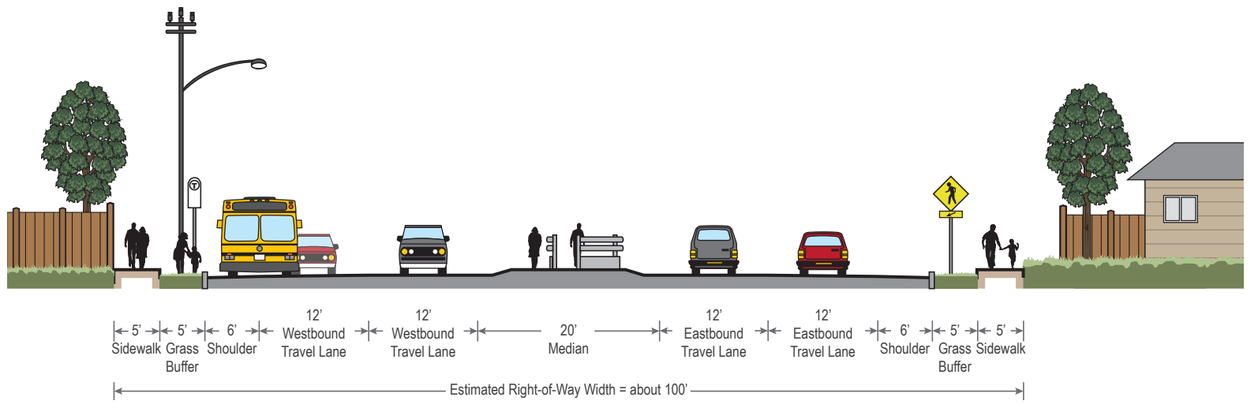
Existing Roadway Cross Section



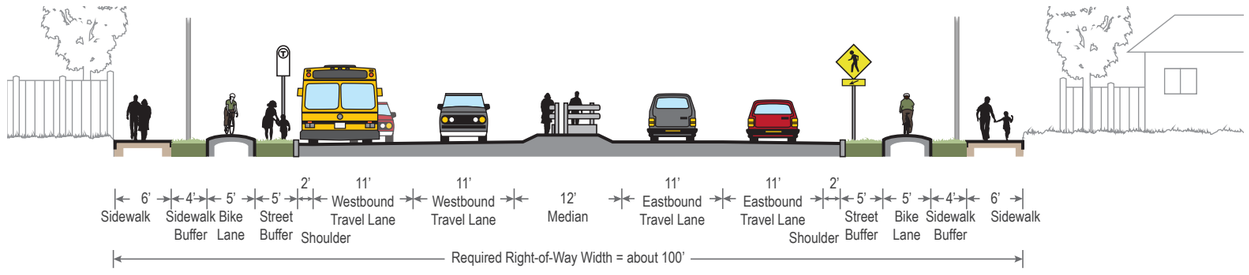
Potential Improvement Alternative 1



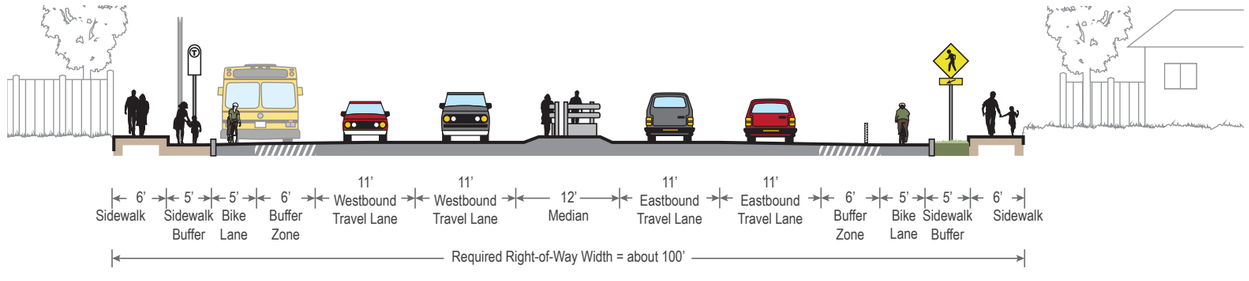
Potential Improvement Alternatives 2 and 3



Existing Roadway Cross Section



Potential Improvement Alternative 1

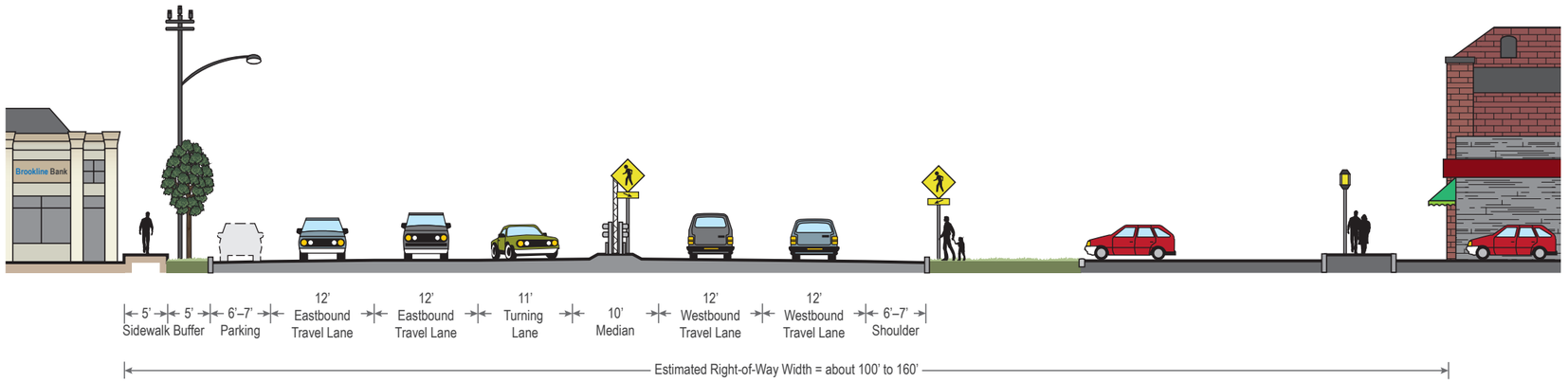


Potential Improvement Alternatives 2 and 3

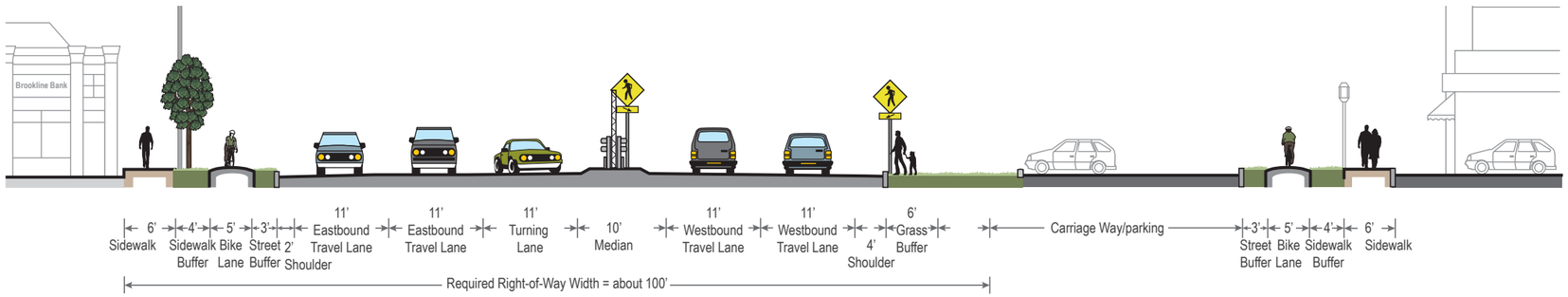
BOSTON REGION MPO

Figure 21
Roadway Accommodation Improvement Alternatives
Route 9 between Benevolent Association Driveway and Hammond Street

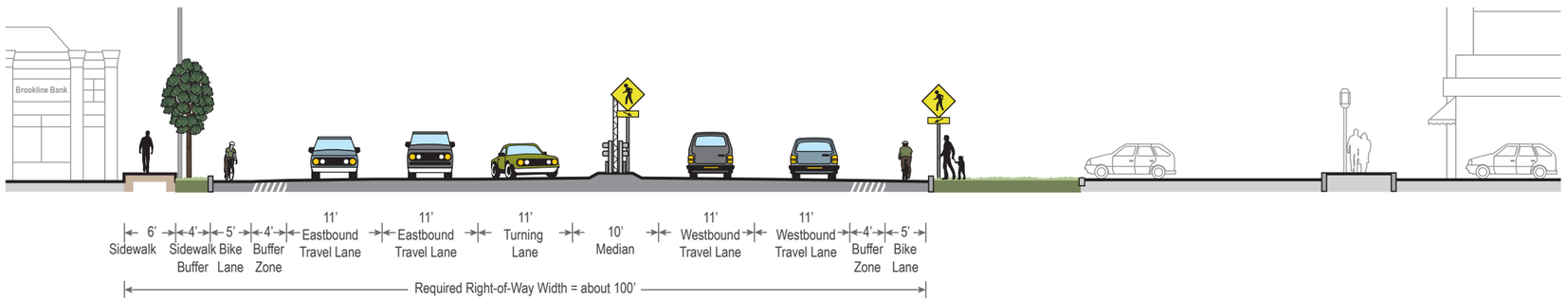
Addressing Safety, Mobility, and Access on Subregional Priority Roadways



Existing Roadway Cross Section



Potential Improvement Alternative 1



Potential Improvement Alternatives 2 and 3

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Figure 22
Roadway Accommodation Improvement Alternatives
Route 9 between Hammond Street and Newton City Line

Addressing Safety,
Mobility, and Access on
Subregional Priority Roadways

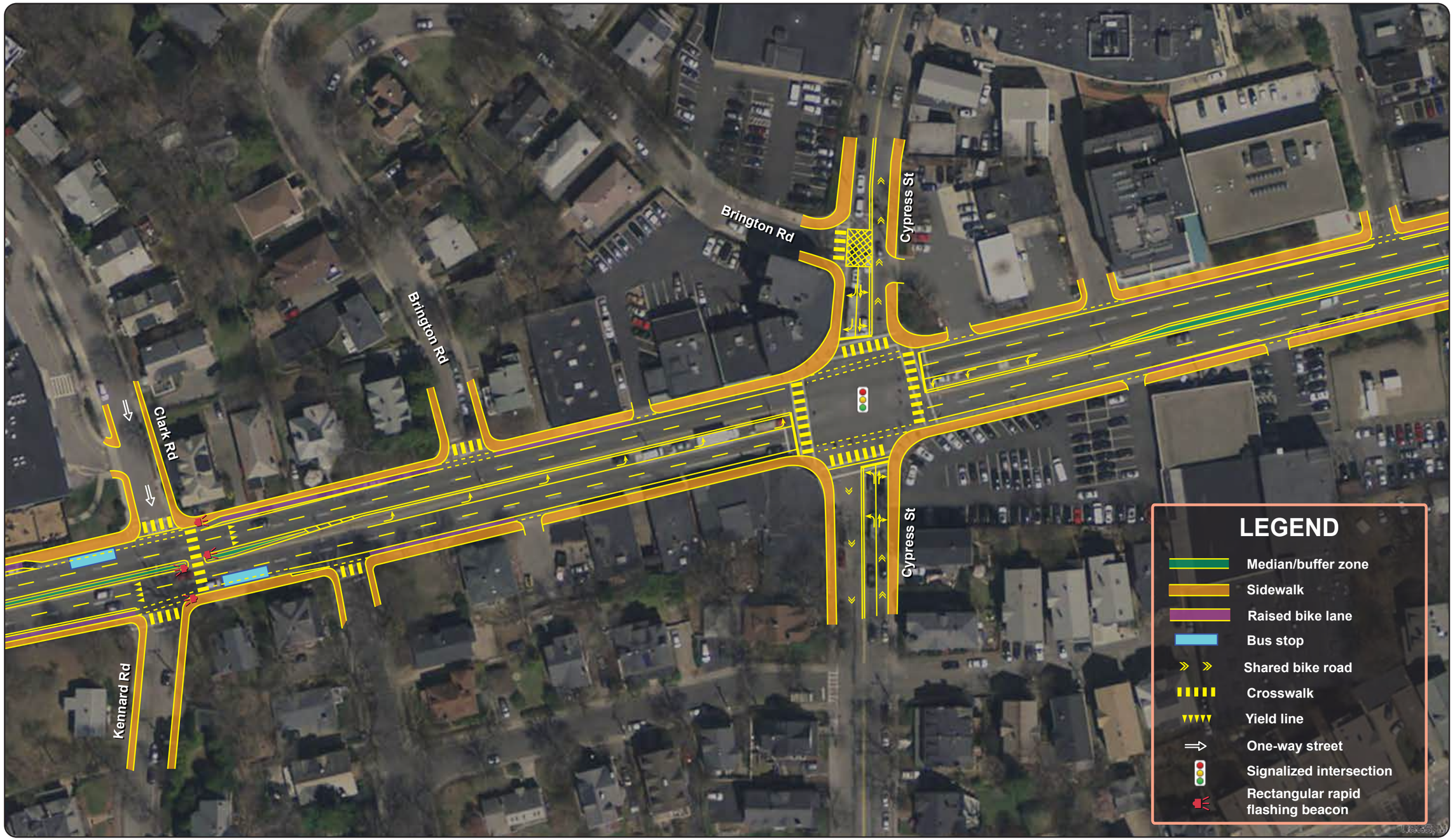

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Figure 23
Proposed Long-Term Improvements Conceptual Plan
Route 9 from Cypress Street to Clark Road

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

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Figure 24
Proposed Long-Term Improvements Conceptual Plan
Route 9 in the Vicinity of Sumner Road and Warren Street

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

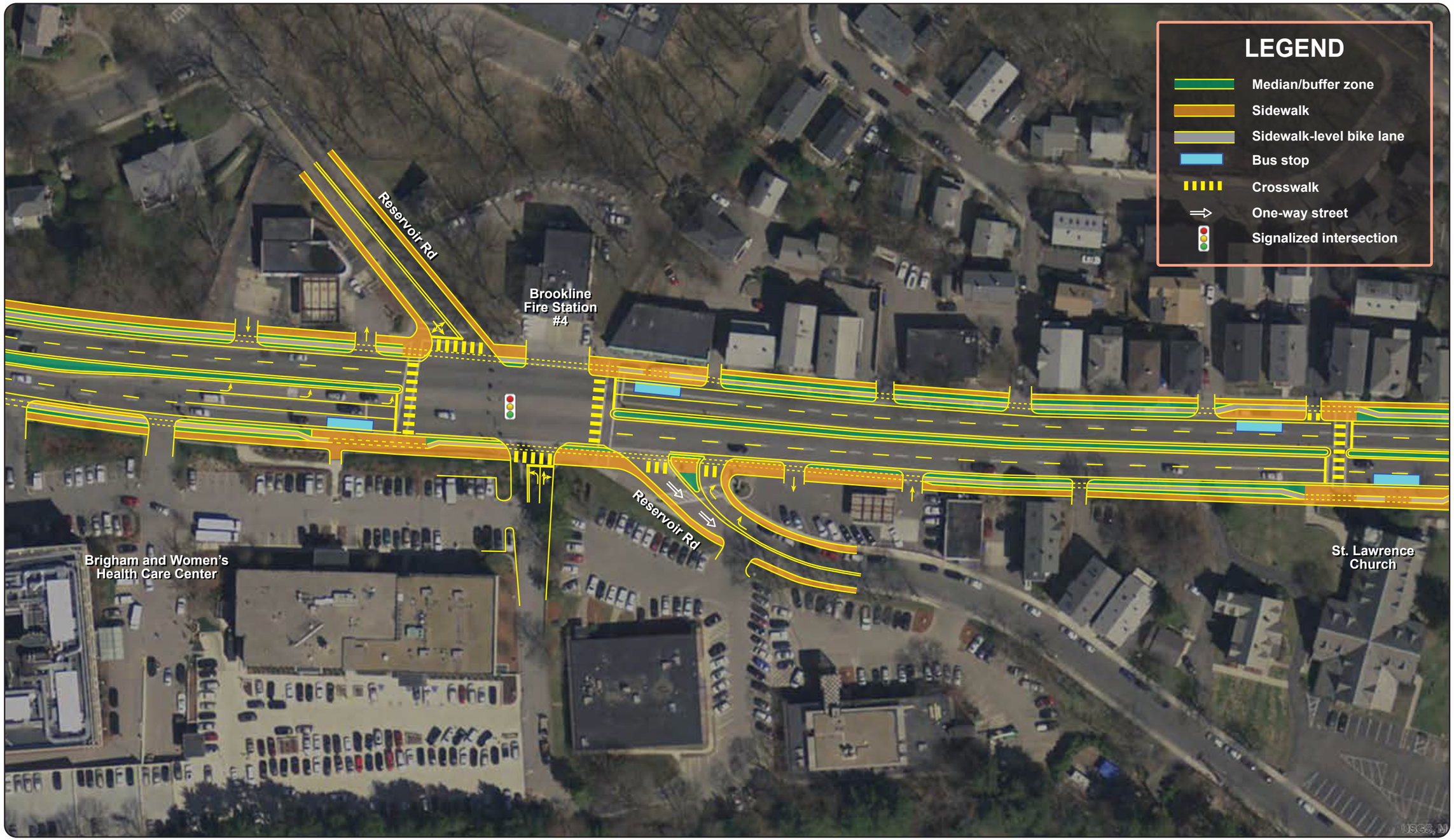

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Figure 25
Proposed Long-Term Improvements Conceptual Plan
Route 9 in the Vicinity of Reservoir Road

Addressing Safety,
Mobility, and Access on
Subregional Priority Roadways

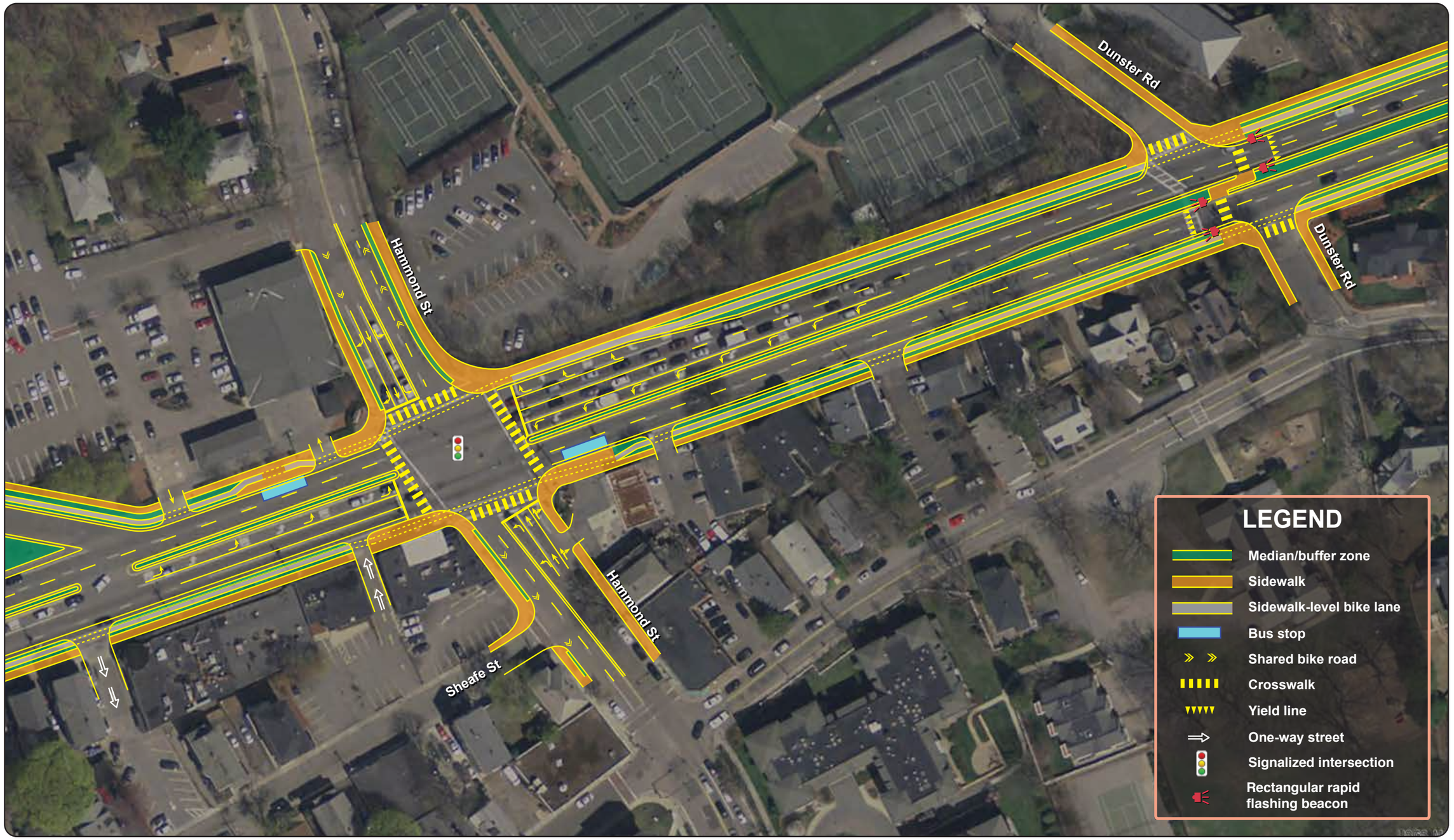

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Figure 26
Proposed Long-Term Improvements Conceptual Plan
Route 9 from Dunster Road to Hammond Street

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

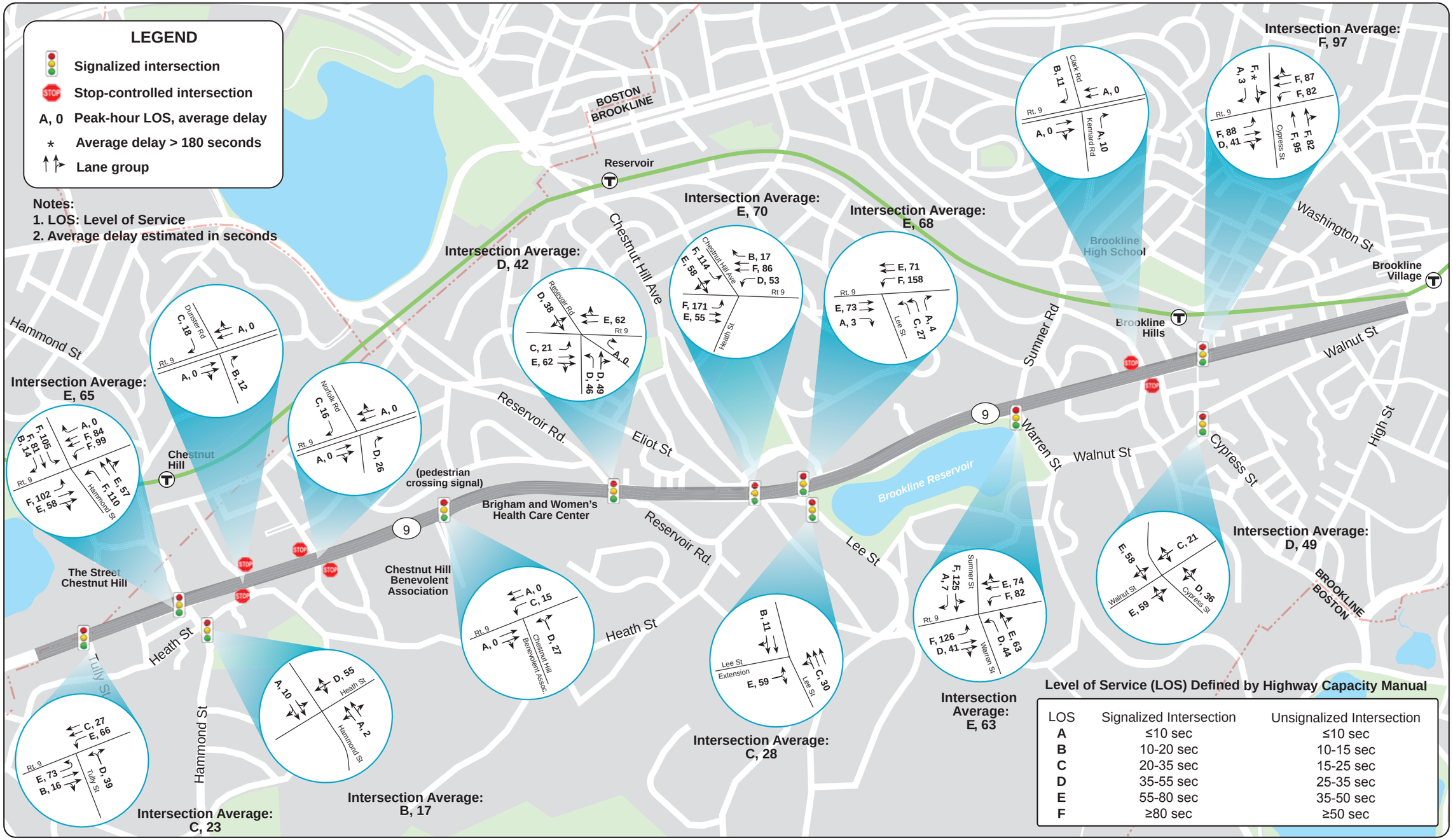

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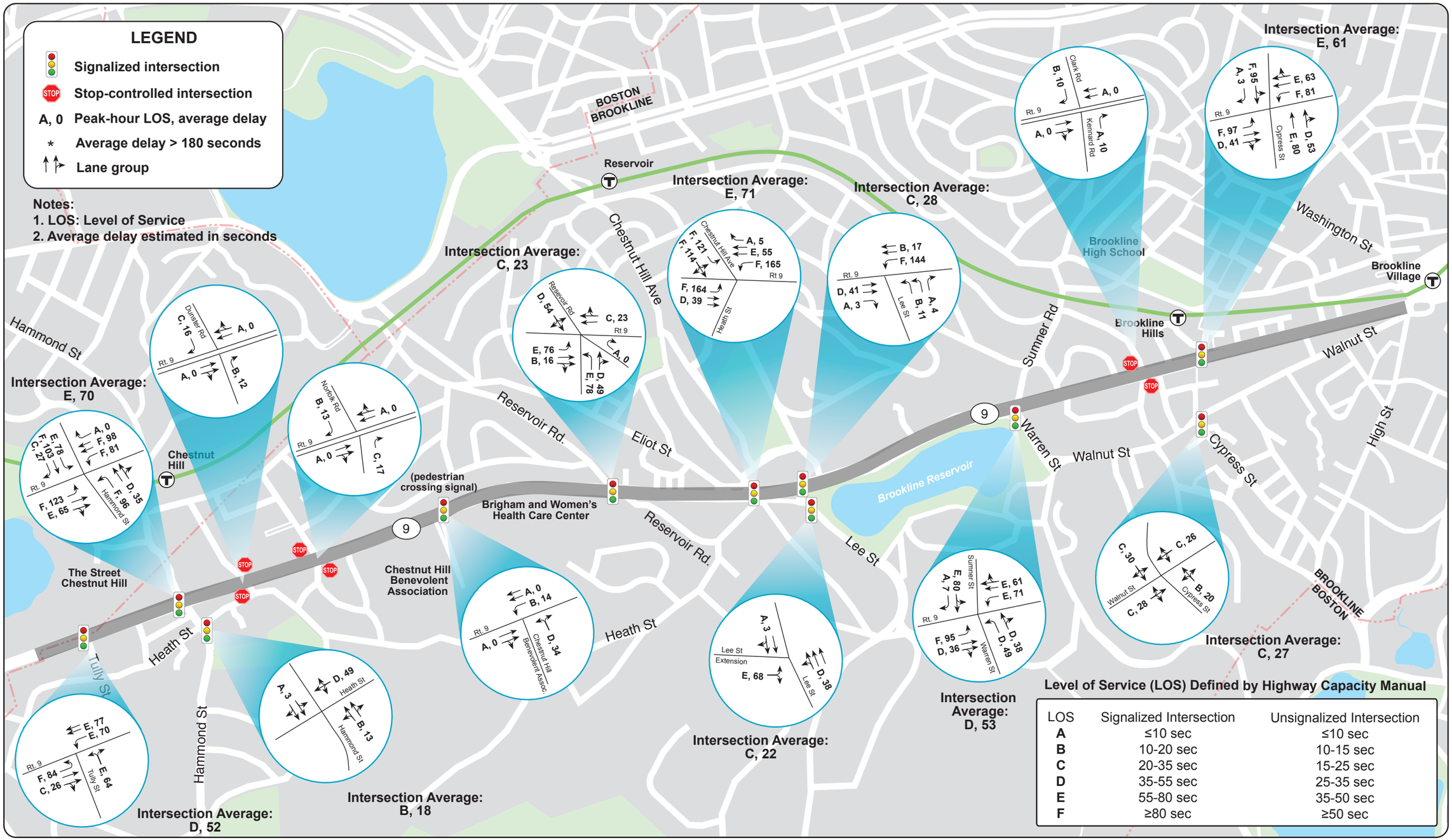
Figure 27
2030 Weekday AM Peak Hour Intersection Capacity Analyses with Proposed Long-Term Improvements
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways



LOS	Signalized Intersection	Unsignalized Intersection
A	≤10 sec	≤10 sec
B	10-20 sec	10-15 sec
C	20-35 sec	15-25 sec
D	35-55 sec	25-35 sec
E	55-80 sec	35-50 sec
F	≥80 sec	≥50 sec

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Figure 28
2030 Weekday PM Peak Hour Intersection Capacity Analyses with Proposed Long-Term Improvements
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

APPENDIX A

Study Advisory Members

Study Advisory Members

Subregional Priority Roadway Study: Route 9 in Brookline

Name	Affiliation	Email
Kara Brewton	Brookline Planning and Community Development, Economic Dev. Director	kbrewton@brooklinema.gov
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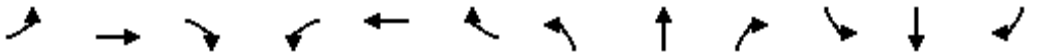
*Served from November 2018 to February 2019.

APPENDIX B

Intersection Capacity Analyses
Weekday AM Peak Hour
2019 Existing Conditions



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	267	868	145	42	753	64	99	363	25	31	180	268
Future Volume (vph)	267	868	145	42	753	64	99	363	25	31	180	268
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	12	11	11	12	11	11	11	11	11	10	11
Storage Length (ft)	200		0	150		0	0		0	0		0
Storage Lanes	1		0	1		0	1		0	0		1
Taper Length (ft)	100			100			0			0		
Satd. Flow (prot)	1678	3373	0	1745	3323	0	1662	1743	0	0	1677	1516
Flt Permitted	0.950			0.950			0.390				0.260	
Satd. Flow (perm)	1660	3373	0	1745	3323	0	605	1743	0	0	440	1516
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		16			8			4				323
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		614			1044			573			420	
Travel Time (s)		14.0			23.7			13.0			9.5	
Confl. Peds. (#/hr)	16					16	155		15	15		155
Peak Hour Factor	0.87	0.90	0.74	0.75	0.87	0.67	0.73	0.95	0.57	0.55	0.92	0.83
Heavy Vehicles (%)	4%	4%	6%	0%	7%	2%	5%	2%	16%	10%	3%	3%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	307	1160	0	56	962	0	136	426	0	0	252	323
Turn Type	Prot	NA		Prot	NA		Perm	NA		Perm	NA	pt+ov
Protected Phases	5	2		1	6			8			4	4 5
Permitted Phases							8			4		
Detector Phase	5	2		1	6		8	8		4	4	4 5
Switch Phase												
Minimum Initial (s)	5.0	10.0		6.0	10.0		6.0	6.0		6.0	6.0	
Minimum Split (s)	10.0	16.0		11.0	16.0		11.0	11.0		11.0	11.0	
Total Split (s)	35.0	51.0		35.0	51.0		40.0	40.0		40.0	40.0	
Total Split (%)	23.0%	33.6%		23.0%	33.6%		26.3%	26.3%		26.3%	26.3%	
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	2.0		1.0	2.0		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	6.0		5.0	6.0		5.0	5.0			5.0	
Lead/Lag	Lead	Lag		Lead	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Recall Mode	None	Min		None	Min		None	None		None	None	
Act Effct Green (s)	28.4	65.1		9.3	43.1		35.6	35.6			35.6	69.1
Actuated g/C Ratio	0.20	0.46		0.07	0.30		0.25	0.25			0.25	0.49
v/c Ratio	0.91	0.74		0.49	0.95		0.89	0.97			2.29	0.36
Control Delay	88.1	37.1		81.7	66.4		103.8	88.2			631.4	3.4
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0			0.0	0.0
Total Delay	88.1	37.1		81.7	66.4		103.8	88.2			631.4	3.4
LOS	F	D		F	E		F	F			F	A
Approach Delay		47.8			67.2			92.0			278.6	
Approach LOS		D			E			F			F	
Queue Length 50th (ft)	298	497		54	485		133	~446			~407	0
Queue Length 95th (ft)	#451	620		83	#587		#198	#666			#590	35
Internal Link Dist (ft)		534			964			493			340	

Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Lane Width (ft)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	20.0
Minimum Split (s)	26.0
Total Split (s)	26.0
Total Split (%)	17%
Yellow Time (s)	2.0
All-Red Time (s)	2.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
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	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	

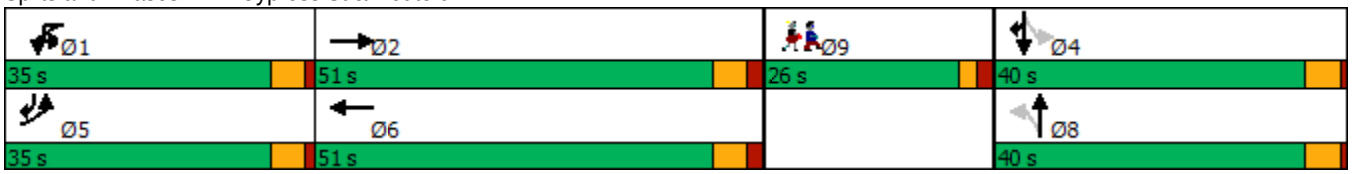
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Turn Bay Length (ft)	200			150								
Base Capacity (vph)	362	1559		377	1081		152	441			110	923
Starvation Cap Reductn	0	0		0	0		0	0			0	0
Spillback Cap Reductn	0	0		0	0		0	0			0	0
Storage Cap Reductn	0	0		0	0		0	0			0	0
Reduced v/c Ratio	0.85	0.74		0.15	0.89		0.89	0.97			2.29	0.35

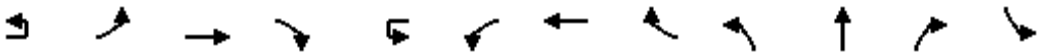
Intersection Summary			
Area Type:	Other		
Cycle Length: 152			
Actuated Cycle Length: 141.5			
Natural Cycle: 150			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 2.29			
Intersection Signal Delay: 96.8		Intersection LOS: F	
Intersection Capacity Utilization 87.2%		ICU Level of Service E	
Analysis Period (min) 15			
Description: 155 / 99 / 53			

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

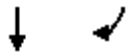
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 2: Cypress St & Route 9





Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	6	247	1199	4	19	17	1006	16	55	355	19	31
Future Volume (vph)	6	247	1199	4	19	17	1006	16	55	355	19	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11	12	11	11	11	11	11
Storage Length (ft)		150		150		150		0	0		0	0
Storage Lanes		1		1		1		0	0		0	0
Taper Length (ft)		100				100			0			0
Right Turn on Red				Yes				Yes			Yes	
Link Speed (mph)			30				30			30		
Link Distance (ft)			635				1295			738		
Travel Time (s)			14.4				29.4			16.8		
Confl. Peds. (#/hr)	16	9		2	10	2		9	16		10	10
Peak Hour Factor	0.38	0.91	0.89	0.50	0.53	0.61	0.87	0.57	0.76	0.85	0.68	0.70
Heavy Vehicles (%)	0%	4%	5%	25%	0%	0%	6%	6%	2%	0%	5%	13%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	287	1347	8	0	64	1184	0	0	518	0	0
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		Perm
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases				2					8			4
Detector Phase	5	5	2	2	1	1	6		8	8		4
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0	6.0	6.0	6.0	40.0		6.0	6.0		6.0
Minimum Split (s)	11.0	11.0	46.0	46.0	11.0	11.0	46.0		23.0	23.0		23.0
Total Split (s)	25.0	25.0	71.0	71.0	20.0	20.0	66.0		35.0	35.0		35.0
Total Split (%)	15.5%	15.5%	44.1%	44.1%	12.4%	12.4%	41.0%		21.7%	21.7%		21.7%
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)	1.0	1.0	2.0	2.0	1.0	1.0	2.0		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	6.0	6.0		5.0	6.0			5.0		
Lead/Lag	Lead	Lead	Lag	Lag	Lead	Lead	Lag					
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
Recall Mode	None	None	Min	Min	None	None	Min		None	None		None
Act Effct Green (s)		20.7	63.8	63.8		10.4	50.7			31.1		
Actuated g/C Ratio		0.16	0.49	0.49		0.08	0.39			0.24		
v/c Ratio		1.07	0.80	0.01		0.46	0.90			1.63		
Control Delay		128.1	36.2	0.0		73.6	48.8			330.9		
Queue Delay		0.0	0.0	0.0		0.0	0.0			0.0		
Total Delay		128.1	36.2	0.0		73.6	48.8			330.9		
LOS		F	D	A		E	D			F		
Approach Delay			52.1				50.1			330.9		
Approach LOS			D				D			F		
Queue Length 50th (ft)		213	404	0		45	398			~530		
Queue Length 95th (ft)		#595	#870	0		78	698			#1025		
Internal Link Dist (ft)			555				1215			658		
Turn Bay Length (ft)		150		150		150						
Base Capacity (vph)		267	1784	666		207	1617			317		
Starvation Cap Reductn		0	0	0		0	0			0		
Spillback Cap Reductn		0	0	0		0	0			0		



Lane Group	SBT	SBR	Ø9
Lane Configurations			
Traffic Volume (vph)	98	196	
Future Volume (vph)	98	196	
Ideal Flow (vphpl)	1900	1900	
Lane Width (ft)	11	11	
Storage Length (ft)		150	
Storage Lanes		1	
Taper Length (ft)			
Right Turn on Red		Yes	
Link Speed (mph)	30		
Link Distance (ft)	625		
Travel Time (s)	14.2		
Confl. Peds. (#/hr)		16	
Peak Hour Factor	0.64	0.91	
Heavy Vehicles (%)	4%	2%	
Shared Lane Traffic (%)			
Lane Group Flow (vph)	197	215	
Turn Type	NA	Perm	
Protected Phases	4		9
Permitted Phases		4	
Detector Phase	4	4	
Switch Phase			
Minimum Initial (s)	6.0	6.0	6.0
Minimum Split (s)	23.0	23.0	35.0
Total Split (s)	35.0	35.0	35.0
Total Split (%)	21.7%	21.7%	22%
Yellow Time (s)	4.0	4.0	2.0
All-Red Time (s)	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	
Total Lost Time (s)	5.0	5.0	
Lead/Lag			
Lead-Lag Optimize?			
Recall Mode	None	None	None
Act Effct Green (s)	31.1	31.1	
Actuated g/C Ratio	0.24	0.24	
v/c Ratio	0.86	0.42	
Control Delay	83.7	10.0	
Queue Delay	0.0	0.0	
Total Delay	83.7	10.0	
LOS	F	B	
Approach Delay	45.2		
Approach LOS	D		
Queue Length 50th (ft)	135	3	
Queue Length 95th (ft)	#233	82	
Internal Link Dist (ft)	545		
Turn Bay Length (ft)		150	
Base Capacity (vph)	228	511	
Starvation Cap Reductn	0	0	
Spillback Cap Reductn	0	0	

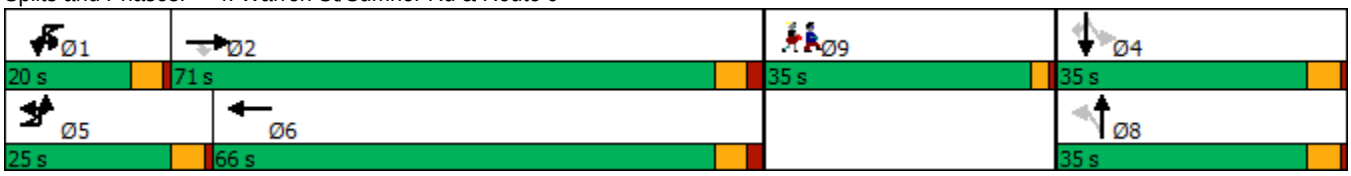
Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Storage Cap Reductn		0	0	0		0	0			0		
Reduced v/c Ratio		1.07	0.76	0.01		0.31	0.73			1.63		

Intersection Summary	
Area Type:	Other
Cycle Length: 161	
Actuated Cycle Length: 130.4	
Natural Cycle: 145	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 1.63	
Intersection Signal Delay: 88.5	Intersection LOS: F
Intersection Capacity Utilization 101.5%	ICU Level of Service G
Analysis Period (min) 15	
Description: 16 / 7 / 16	

~ 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: Warren St/Sumner Rd & Route 9

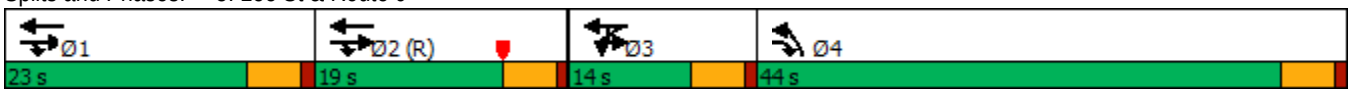


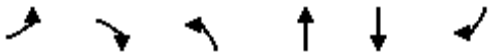
Lane Group	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø1	Ø2
Lane Configurations									
Traffic Volume (vph)	1228	404	2	126	1065	892	249		
Future Volume (vph)	1228	404	2	126	1065	892	249		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900		
Lane Width (ft)	12	11	11	11	12	11	11		
Storage Length (ft)		150		150		0	0		
Storage Lanes		1		1		2	0		
Taper Length (ft)				100		0			
Right Turn on Red		Yes					Yes		
Link Speed (mph)	30				30	30			
Link Distance (ft)	363				323	214			
Travel Time (s)	8.3				7.3	4.9			
Peak Hour Factor	0.94	0.90	0.50	0.81	0.94	0.84	0.90		
Heavy Vehicles (%)	5%	5%	50%	2%	5%	4%	3%		
Shared Lane Traffic (%)									
Lane Group Flow (vph)	1306	449	0	160	1133	1339	0		
Turn Type	NA	pt+ov	Prot	Prot	NA	Prot			
Protected Phases	1 2	1 2 4	3	3	1 2 3	4		1	2
Permitted Phases									
Detector Phase	1 2	1 2 4	3	3	1 2 3	4			
Switch Phase									
Minimum Initial (s)			5.0	5.0		6.0		5.0	10.0
Minimum Split (s)			10.0	10.0		29.0		10.0	19.0
Total Split (s)			14.0	14.0		44.0		23.0	19.0
Total Split (%)			14.0%	14.0%		44.0%		23%	19%
Yellow Time (s)			4.0	4.0		4.0		4.0	4.0
All-Red Time (s)			1.0	1.0		1.0		1.0	1.0
Lost Time Adjust (s)				0.0		0.0			
Total Lost Time (s)				5.0		5.0			
Lead/Lag			Lead	Lead		Lag		Lead	Lag
Lead-Lag Optimize?			Yes	Yes		Yes			
Recall Mode			None	None		None		None	C-Max
Act Effct Green (s)	37.0	81.0		9.0	51.0	39.0			
Actuated g/C Ratio	0.37	0.81		0.09	0.51	0.39			
v/c Ratio	1.03	0.37		1.05	0.65	1.05			
Control Delay	45.3	2.1		133.3	20.1	51.7			
Queue Delay	28.4	0.7		25.1	50.5	15.8			
Total Delay	73.7	2.7		158.4	70.6	67.5			
LOS	E	A		F	E	E			
Approach Delay	55.5				81.4	67.5			
Approach LOS	E				F	E			
Queue Length 50th (ft)	~360	17		~112	265	~114			
Queue Length 95th (ft)	m#547	m68		#207	336	#330			
Internal Link Dist (ft)	283				243	134			
Turn Bay Length (ft)		150		150					
Base Capacity (vph)	1272	1225		152	1753	1272			
Starvation Cap Reductn	120	439		0	0	46			
Spillback Cap Reductn	0	5		55	889	10			
Storage Cap Reductn	0	0		0	0	0			

Lane Group	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø1	Ø2
Reduced v/c Ratio	1.13	0.57		1.65	1.31	1.09			

Intersection Summary			
Area Type:	Other		
Cycle Length: 100			
Actuated Cycle Length: 100			
Offset: 93 (93%), Referenced to phase 2:EBWB, Start of Yellow			
Natural Cycle: 120			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 1.05			
Intersection Signal Delay: 66.8		Intersection LOS: E	
Intersection Capacity Utilization 86.8%		ICU Level of Service E	
Analysis Period (min) 15			
Description: ø2 (NB): 0 / 1 / 3			
ø4 (WB): 0 / 1 / 3			
~ 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: 5: Lee St & Route 9



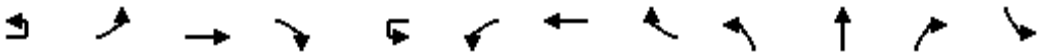


Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	Ø1
Lane Configurations							
Traffic Volume (vph)	230	8	5	966	531	1	
Future Volume (vph)	230	8	5	966	531	1	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	
Right Turn on Red		Yes				Yes	
Link Speed (mph)	30			30	30		
Link Distance (ft)	617			535	214		
Travel Time (s)	14.0			12.2	4.9		
Confl. Peds. (#/hr)		1					
Peak Hour Factor	0.83	0.67	0.62	0.89	0.89	0.25	
Heavy Vehicles (%)	3%	0%	0%	4%	5%	0%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	289	0	0	1093	601	0	
Turn Type	Prot		Perm	NA	NA		
Protected Phases	2			3	1 3		1
Permitted Phases			3				
Detector Phase	2		3	3	1 3		
Switch Phase							
Minimum Initial (s)	6.0		10.0	10.0			5.0
Minimum Split (s)	20.0		15.0	15.0			10.0
Total Split (s)	29.0		46.0	46.0			25.0
Total Split (%)	29.0%		46.0%	46.0%			25%
Yellow Time (s)	4.0		4.0	4.0			4.0
All-Red Time (s)	1.0		1.0	1.0			1.0
Lost Time Adjust (s)	0.0			0.0			
Total Lost Time (s)	5.0			5.0			
Lead/Lag	Lag						Lead
Lead-Lag Optimize?	Yes						Yes
Recall Mode	None		None	None			C-Max
Act Effct Green (s)	20.3			40.1	69.7		
Actuated g/C Ratio	0.20			0.40	0.70		
v/c Ratio	0.84			0.86	0.26		
Control Delay	58.8			35.1	9.6		
Queue Delay	0.0			2.1	0.8		
Total Delay	58.8			37.2	10.4		
LOS	E			D	B		
Approach Delay	58.8			37.2	10.4		
Approach LOS	E			D	B		
Queue Length 50th (ft)	174			306	98		
Queue Length 95th (ft)	236			405	m154		
Internal Link Dist (ft)	537			455	134		
Turn Bay Length (ft)							
Base Capacity (vph)	407			1324	2287		
Starvation Cap Reductn	0			0	1309		
Spillback Cap Reductn	0			118	0		
Storage Cap Reductn	0			0	0		
Reduced v/c Ratio	0.71			0.91	0.61		

Intersection Summary

Area Type:	Other	
Cycle Length: 100		
Actuated Cycle Length: 100		
Offset: 71 (71%), Referenced to phase 1:SBT, Start of Yellow		
Natural Cycle: 60		
Control Type: Actuated-Coordinated		
Maximum v/c Ratio: 0.86		
Intersection Signal Delay: 32.2	Intersection LOS: C	
Intersection Capacity Utilization 51.8%	ICU Level of Service A	
Analysis Period (min) 15		
Description: 1 / 0 / 2		
m Volume for 95th percentile queue is metered by upstream signal.		

Splits and Phases: 6: Lee St & Lee Street Extension



Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	15	298	1203	0	3	92	1153	756	0	0	0	418
Future Volume (vph)	15	298	1203	0	3	92	1153	756	0	0	0	418
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11	12	11	11	11	11	11
Storage Length (ft)		250		0		175		225	0		0	125
Storage Lanes		1		0		1		1	0		0	1
Taper Length (ft)		100				100			0			100
Right Turn on Red				Yes				Yes			Yes	
Link Speed (mph)			30				30			30		
Link Distance (ft)			495				363			179		
Travel Time (s)			11.3				8.3			4.1		
Confl. Peds. (#/hr)	9	12						12				
Peak Hour Factor	0.42	0.94	0.95	0.92	0.38	0.88	0.94	0.86	0.92	0.92	0.92	0.89
Heavy Vehicles (%)	0%	8%	5%	2%	0%	2%	4%	3%	2%	2%	2%	5%
Shared Lane Traffic (%)												10%
Lane Group Flow (vph)	0	353	1266	0	0	113	1227	879	0	0	0	423
Turn Type	Prot	Prot	NA		Prot	Prot	NA	custom				Split
Protected Phases	4	4	1 4 5		2	2	1 2 5	1 2 3				3
Permitted Phases												
Detector Phase	4	4	1 4 5		2	2	1 2 5	1 2 3				3
Switch Phase												
Minimum Initial (s)	5.0	5.0			5.0	5.0						5.0
Minimum Split (s)	10.0	10.0			10.0	10.0						23.0
Total Split (s)	23.0	23.0			18.0	18.0						30.0
Total Split (%)	23.0%	23.0%			18.0%	18.0%						30.0%
Yellow Time (s)	4.0	4.0			4.0	4.0						4.0
All-Red Time (s)	1.0	1.0			1.0	1.0						1.0
Lost Time Adjust (s)		0.0				0.0						0.0
Total Lost Time (s)		5.0				5.0						5.0
Lead/Lag	Lag	Lag			Lag	Lag						Lead
Lead-Lag Optimize?	Yes	Yes			Yes	Yes						Yes
Recall Mode	None	None			Max	Max						None
Act Effct Green (s)		18.0	47.0			13.0	42.0	53.0				25.0
Actuated g/C Ratio		0.18	0.47			0.13	0.42	0.53				0.25
v/c Ratio		1.20	0.78			0.51	0.84	0.82				1.07
Control Delay		157.1	26.6			50.7	35.0	12.8				103.7
Queue Delay		0.0	10.7			0.0	47.9	7.6				0.0
Total Delay		157.1	37.3			50.7	82.9	20.4				103.7
LOS		F	D			D	F	C				F
Approach Delay			63.4				56.5					
Approach LOS			E				E					
Queue Length 50th (ft)		~275	344			74	418	198				~316
Queue Length 95th (ft)		#450	433			m94	m448	m223				#505
Internal Link Dist (ft)			415				283			99		
Turn Bay Length (ft)		250				175		225				125
Base Capacity (vph)		293	1615			222	1457	1070				394
Starvation Cap Reductn		0	0			0	347	158				0
Spillback Cap Reductn		0	338			0	0	0				0

Lane Group	SBT	SBR	Ø1	Ø5
Lane Configurations				
Traffic Volume (vph)	37	272		
Future Volume (vph)	37	272		
Ideal Flow (vphpl)	1900	1900		
Lane Width (ft)	11	11		
Storage Length (ft)		100		
Storage Lanes		0		
Taper Length (ft)				
Right Turn on Red		Yes		
Link Speed (mph)	30			
Link Distance (ft)	916			
Travel Time (s)	20.8			
Confl. Peds. (#/hr)		9		
Peak Hour Factor	0.71	0.80		
Heavy Vehicles (%)	5%	3%		
Shared Lane Traffic (%)				
Lane Group Flow (vph)	439	0		
Turn Type	NA			
Protected Phases	3		1	5
Permitted Phases				
Detector Phase	3			
Switch Phase				
Minimum Initial (s)	5.0		1.0	5.0
Minimum Split (s)	23.0		6.0	19.0
Total Split (s)	30.0		10.0	19.0
Total Split (%)	30.0%		10%	19%
Yellow Time (s)	4.0		4.0	2.0
All-Red Time (s)	1.0		1.0	1.0
Lost Time Adjust (s)	0.0			
Total Lost Time (s)	5.0			
Lead/Lag	Lead		Lead	
Lead-Lag Optimize?	Yes		Yes	
Recall Mode	None		C-Max	None
Act Effct Green (s)	25.0			
Actuated g/C Ratio	0.25			
v/c Ratio	0.90			
Control Delay	46.2			
Queue Delay	2.7			
Total Delay	49.0			
LOS	D			
Approach Delay	75.8			
Approach LOS	E			
Queue Length 50th (ft)	187			
Queue Length 95th (ft)	206			
Internal Link Dist (ft)	836			
Turn Bay Length (ft)				
Base Capacity (vph)	487			
Starvation Cap Reductn	0			
Spillback Cap Reductn	15			

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Storage Cap Reductn		0	0			0	0	0				0
Reduced v/c Ratio		1.20	0.99			0.51	1.11	0.96				1.07

Intersection Summary	
Area Type:	Other
Cycle Length: 100	
Actuated Cycle Length: 100	
Offset: 0 (0%), Referenced to phase 1:EBWB, Start of Yellow, Master Intersection	
Natural Cycle: 120	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 1.20	
Intersection Signal Delay: 62.4	Intersection LOS: E
Intersection Capacity Utilization 82.9%	ICU Level of Service E
Analysis Period (min) 15	
Description: ø3 (EB+WB): 9 / 2 / 2	
ø5 (SB): 12 / 2 / 2	

~ 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: 7: Heath St/Chestnut Hill Ave & Route 9

Lane Group	EBU	EBL	EBT	EBR	EBR2	WBT	WBR	NBL	NBT	NBR	NBR2	SBL2
Lane Configurations												
Traffic Volume (vph)	11	78	1407	32	24	1404	29	18	22	16	4	11
Future Volume (vph)	11	78	1407	32	24	1404	29	18	22	16	4	11
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)		250		0			0	0		0		
Storage Lanes		1		0			0	0		0		
Taper Length (ft)		100						0				
Right Turn on Red					Yes		Yes				Yes	
Link Speed (mph)			30			30			30			
Link Distance (ft)			977			709			527			
Travel Time (s)			22.2			16.1			12.0			
Confl. Peds. (#/hr)	11	6		6	9		6	11		32	6	32
Peak Hour Factor	0.55	0.59	0.97	0.89	0.67	0.97	0.52	0.75	0.61	0.80	0.50	0.55
Heavy Vehicles (%)	0%	1%	5%	6%	0%	4%	0%	22%	0%	38%	0%	9%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	152	1523	0	0	1503	0	0	88	0	0	0
Turn Type	Prot	Prot	NA			NA		Perm	NA			Perm
Protected Phases	5	5	2			6			8			
Permitted Phases								8				4
Detector Phase	5	5	2			6		8	8			4
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0			6.0		6.0	6.0			6.0
Minimum Split (s)	12.0	12.0	12.0			12.0		11.0	11.0			11.0
Total Split (s)	20.0	20.0	46.0			26.0		25.0	25.0			25.0
Total Split (%)	20.0%	20.0%	46.0%			26.0%		25.0%	25.0%			25.0%
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		1.0	1.0			1.0
Lost Time Adjust (s)		0.0	0.0			0.0			0.0			
Total Lost Time (s)		6.0	6.0			6.0			5.0			
Lead/Lag	Lead	Lead				Lag						
Lead-Lag Optimize?	Yes	Yes				Yes						
Recall Mode	None	None	C-Min			C-Min		None	None			None
Act Effct Green (s)		13.6	63.5			42.7			11.6			
Actuated g/C Ratio		0.14	0.64			0.43			0.12			
v/c Ratio		0.65	0.73			1.05			0.56			
Control Delay		53.4	22.6			72.6			52.2			
Queue Delay		0.0	0.0			0.0			0.0			
Total Delay		53.4	22.6			72.6			52.2			
LOS		D	C			E			D			
Approach Delay			25.4			72.6			52.2			
Approach LOS			C			E			D			
Queue Length 50th (ft)		93	471			~728			51			
Queue Length 95th (ft)		95	#708			#970			62			
Internal Link Dist (ft)			897			629			447			
Turn Bay Length (ft)		250										
Base Capacity (vph)		261	2095			1426			271			
Starvation Cap Reductn		0	0			0			0			
Spillback Cap Reductn		0	0			0			0			
Storage Cap Reductn		0	0			0			0			

Lane Group	SBL	SBT	SBR	NWR2	Ø9
Lane Configurations					
Traffic Volume (vph)	9	3	16	10	
Future Volume (vph)	9	3	16	10	
Ideal Flow (vphpl)	1900	1900	1900	1900	
Storage Length (ft)	0		0		
Storage Lanes	0		0		
Taper Length (ft)	0				
Right Turn on Red			Yes	Yes	
Link Speed (mph)		30			
Link Distance (ft)		854			
Travel Time (s)		19.4			
Confl. Peds. (#/hr)	6		11	32	
Peak Hour Factor	0.75	0.38	0.57	0.50	
Heavy Vehicles (%)	0%	0%	0%	0%	
Shared Lane Traffic (%)					
Lane Group Flow (vph)	0	68	0	20	
Turn Type	Perm	NA		Perm	
Protected Phases		4			9
Permitted Phases	4			2 4	
Detector Phase	4	4		2 4	
Switch Phase					
Minimum Initial (s)	6.0	6.0			5.0
Minimum Split (s)	11.0	11.0			29.0
Total Split (s)	25.0	25.0			29.0
Total Split (%)	25.0%	25.0%			29%
Yellow Time (s)	4.0	4.0			2.0
All-Red Time (s)	1.0	1.0			0.0
Lost Time Adjust (s)		0.0			
Total Lost Time (s)		5.0			
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	None			None
Act Effct Green (s)		11.5		79.0	
Actuated g/C Ratio		0.12		0.79	
v/c Ratio		0.40		0.01	
Control Delay		32.3		0.0	
Queue Delay		0.0		0.0	
Total Delay		32.3		0.0	
LOS		C		A	
Approach Delay		32.3			
Approach LOS		C			
Queue Length 50th (ft)		24		0	
Queue Length 95th (ft)		16		0	
Internal Link Dist (ft)		774			
Turn Bay Length (ft)					
Base Capacity (vph)		277		1447	
Starvation Cap Reductn		0		0	
Spillback Cap Reductn		0		0	
Storage Cap Reductn		0		0	

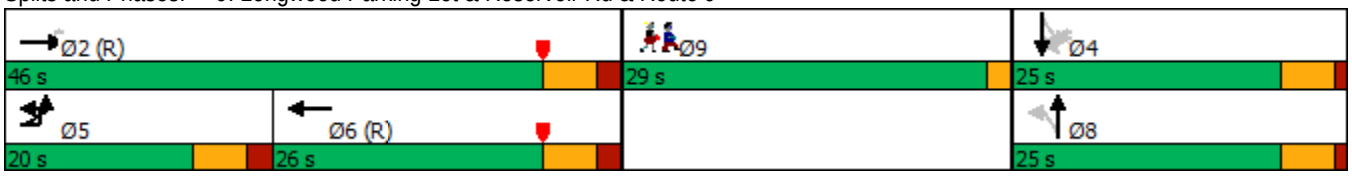
Lane Group	EBU	EBL	EBT	EBR	EBR2	WBT	WBR	NBL	NBT	NBR	NBR2	SBL2
Reduced v/c Ratio		0.58	0.73			1.05			0.32			

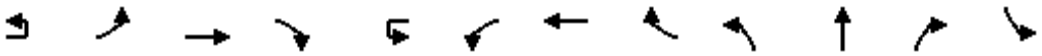
Intersection Summary			
Area Type:	Other		
Cycle Length: 100			
Actuated Cycle Length: 100			
Offset: 75 (75%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow			
Natural Cycle: 110			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 1.05			
Intersection Signal Delay: 47.3		Intersection LOS: D	
Intersection Capacity Utilization 77.1%		ICU Level of Service D	
Analysis Period (min) 15			
Description: 43 / 13 / 1			

~ 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: 9: Longwood Parking Lot & Reservoir Rd & Route 9





Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	1	155	1082	22	1	180	1182	42	107	410	51	122
Future Volume (vph)	1	155	1082	22	1	180	1182	42	107	410	51	122
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11	12	11	11	11	11	11
Storage Length (ft)		550		0		300		150	0		0	125
Storage Lanes		1		0		1		1	0		0	1
Taper Length (ft)		100				100			0			100
Right Turn on Red				Yes				Yes			Yes	
Link Speed (mph)			30				30			30		
Link Distance (ft)			726				711			307		
Travel Time (s)			16.5				16.2			7.0		
Confl. Peds. (#/hr)	26	8		5	19	5		8	26		19	19
Peak Hour Factor	0.25	0.90	0.96	0.79	0.25	0.90	0.92	0.75	0.64	0.91	0.75	0.78
Heavy Vehicles (%)	0%	6%	7%	18%	0%	6%	3%	7%	5%	2%	22%	6%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	176	1155	0	0	204	1285	56	0	686	0	156
Turn Type	Prot	Prot	NA		Prot	Prot	NA	Prot	Perm	NA		Perm
Protected Phases	1	1	6		5	5	2	2		4		
Permitted Phases									4			8
Detector Phase	1	1	6		5	5	2	2	4	4		8
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0		6.0	6.0	10.0	10.0	6.0	6.0		6.0
Minimum Split (s)	12.0	12.0	31.0		12.0	12.0	33.0	33.0	30.0	30.0		29.0
Total Split (s)	19.0	19.0	51.0		19.0	19.0	51.0	51.0	30.0	30.0		30.0
Total Split (%)	14.6%	14.6%	39.2%		14.6%	14.6%	39.2%	39.2%	23.1%	23.1%		23.1%
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0	3.0	3.0		3.0
All-Red Time (s)	2.0	2.0	2.0		2.0	2.0	2.0	2.0	3.0	3.0		3.0
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	6.0	6.0		6.0		6.0
Lead/Lag	Lead	Lead	Lag		Lead	Lead	Lag	Lag				
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes	Yes				
Recall Mode	None	None	C-Min		None	None	C-Min	C-Min	None	None		None
Act Effct Green (s)		13.0	45.0			13.0	45.0	45.0		24.0		24.0
Actuated g/C Ratio		0.10	0.35			0.10	0.35	0.35		0.18		0.18
v/c Ratio		1.07	1.00			1.24	1.06	0.10		2.78dl		1.27
Control Delay		145.4	67.8			197.7	84.1	0.3		478.6		212.8
Queue Delay		0.0	0.0			0.0	0.0	0.0		0.0		0.0
Total Delay		145.4	67.8			197.7	84.1	0.3		478.6		212.8
LOS		F	E			F	F	A		F		F
Approach Delay			78.0				96.1			478.6		
Approach LOS			E				F			F		
Queue Length 50th (ft)		~164	508			~213	~625	0		~477		~165
Queue Length 95th (ft)		#314	#667			#372	#764	0		#604		#253
Internal Link Dist (ft)			646				631			227		
Turn Bay Length (ft)		550				300		150				125
Base Capacity (vph)		164	1160			164	1213	587		346		123
Starvation Cap Reductn		0	0			0	0	0		0		0
Spillback Cap Reductn		0	0			0	0	0		0		0

Lane Group	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	252	116
Future Volume (vph)	252	116
Ideal Flow (vphpl)	1900	1900
Lane Width (ft)	11	11
Storage Length (ft)		125
Storage Lanes		1
Taper Length (ft)		
Right Turn on Red		Yes
Link Speed (mph)	30	
Link Distance (ft)	575	
Travel Time (s)	13.1	
Confl. Peds. (#/hr)		26
Peak Hour Factor	0.78	0.85
Heavy Vehicles (%)	5%	2%
Shared Lane Traffic (%)		
Lane Group Flow (vph)	323	136
Turn Type	NA	custom
Protected Phases	8	8
Permitted Phases		1
Detector Phase	8	8
Switch Phase		
Minimum Initial (s)	6.0	6.0
Minimum Split (s)	29.0	29.0
Total Split (s)	30.0	30.0
Total Split (%)	23.1%	23.1%
Yellow Time (s)	3.0	3.0
All-Red Time (s)	3.0	3.0
Lost Time Adjust (s)	0.0	0.0
Total Lost Time (s)	6.0	6.0
Lead/Lag		
Lead-Lag Optimize?		
Recall Mode	None	None
Act Effct Green (s)	24.0	37.0
Actuated g/C Ratio	0.18	0.28
v/c Ratio	1.00	0.27
Control Delay	103.7	11.9
Queue Delay	0.0	0.0
Total Delay	103.7	11.9
LOS	F	B
Approach Delay	111.1	
Approach LOS	F	
Queue Length 50th (ft)	~275	22
Queue Length 95th (ft)	#372	62
Internal Link Dist (ft)	495	
Turn Bay Length (ft)		125
Base Capacity (vph)	322	497
Starvation Cap Reductn	0	0
Spillback Cap Reductn	0	0

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Storage Cap Reductn		0	0			0	0	0		0		0
Reduced v/c Ratio		1.07	1.00			1.24	1.06	0.10		1.98		1.27

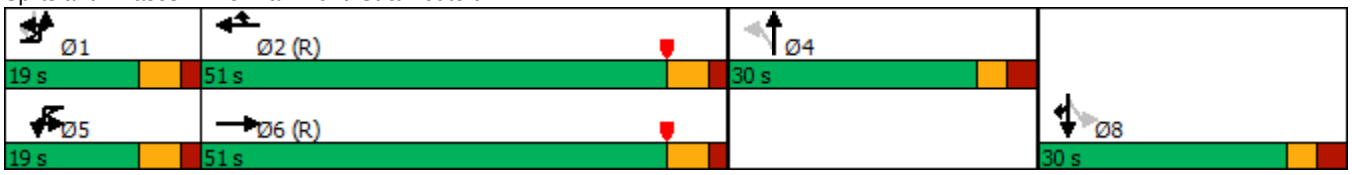
Intersection Summary			
Area Type:	Other		
Cycle Length: 130			
Actuated Cycle Length: 130			
Offset: 0 (0%), Referenced to phase 2:WBT and 6:EBT, Start of Yellow			
Natural Cycle: 145			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 1.98			
Intersection Signal Delay: 155.3		Intersection LOS: F	
Intersection Capacity Utilization 96.0%		ICU Level of Service F	
Analysis Period (min) 15			
Description: ø2 (SB): 8 / 7 / 11			
ø4 (WB): 19 / 23 / 18			
ø6 (NB): 5 / 15 / 7			
ø8 (EB): 26 / 28 / 19			

~ 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: 13: Hammond St & Route 9



Intersection Capacity Analysis
Hammond St & Heath St

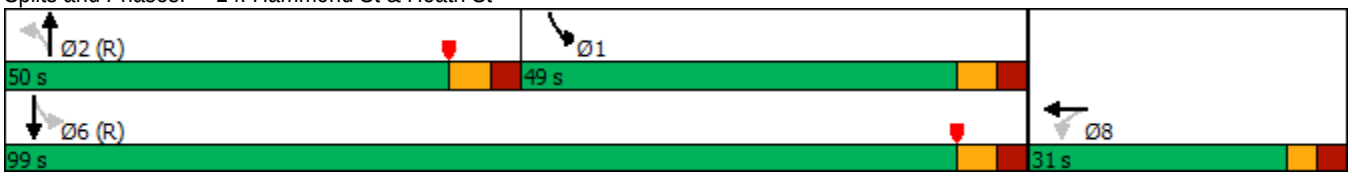
07/16/2019

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	69	27	131	10	430	90	30	411	17
Future Volume (vph)	0	0	0	69	27	131	10	430	90	30	411	17
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		436			675			648			307	
Travel Time (s)		9.9			15.3			14.7			7.0	
Confl. Peds. (#/hr)						8	17		6	6		17
Peak Hour Factor	0.92	0.92	0.92	0.75	0.52	0.73	0.50	0.93	0.64	0.62	0.84	0.61
Heavy Vehicles (%)	2%	2%	2%	1%	0%	2%	0%	4%	9%	10%	4%	24%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	323	0	0	623	0	0	565	0
Turn Type				Perm	NA		Perm	NA		pm+pt	NA	
Protected Phases					8			2		1	6	
Permitted Phases				8			2			6		
Detector Phase				8	8		2	2		1	6	
Switch Phase												
Minimum Initial (s)				6.0	6.0		6.0	6.0		6.0	6.0	
Minimum Split (s)				26.0	26.0		19.0	19.0		13.0	20.0	
Total Split (s)				31.0	31.0		50.0	50.0		49.0	99.0	
Total Split (%)				23.8%	23.8%		38.5%	38.5%		37.7%	76.2%	
Yellow Time (s)				3.0	3.0		4.0	4.0		4.0	4.0	
All-Red Time (s)				3.0	3.0		3.0	3.0		3.0	3.0	
Lost Time Adjust (s)					0.0			0.0			0.0	
Total Lost Time (s)					6.0			7.0			7.0	
Lead/Lag							Lead	Lead		Lag		
Lead-Lag Optimize?							Yes	Yes		Yes		
Recall Mode				None	None		C-Min	C-Min		None	C-Min	
Act Effct Green (s)					29.3			87.7			87.7	
Actuated g/C Ratio					0.23			0.67			0.67	
v/c Ratio					0.81			0.31			0.31	
Control Delay					56.7			9.3			13.1	
Queue Delay					0.0			0.0			0.6	
Total Delay					56.7			9.3			13.7	
LOS					E			A			B	
Approach Delay					56.7			9.3			13.7	
Approach LOS					E			A			B	
Queue Length 50th (ft)					225			101			105	
Queue Length 95th (ft)					147			150			m81	
Internal Link Dist (ft)		356			595			568			227	
Turn Bay Length (ft)												
Base Capacity (vph)					408			1985			1955	
Starvation Cap Reductn					0			0			962	
Spillback Cap Reductn					0			0			0	
Storage Cap Reductn					0			0			0	
Reduced v/c Ratio					0.79			0.31			0.57	

Intersection Summary

Area Type:	Other		
Cycle Length: 130			
Actuated Cycle Length: 130			
Offset: 92 (71%), Referenced to phase 2:NBTL and 6:SBTL, Start of Yellow			
Natural Cycle: 60			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.81			
Intersection Signal Delay: 21.1		Intersection LOS: C	
Intersection Capacity Utilization 59.1%		ICU Level of Service B	
Analysis Period (min) 15			
Description: ø2 (WB): 6 / 6 / 9			
ø6 (EB): 17 / 19 / 12			
ø8 (SB): 8 / 6 / 22			
m Volume for 95th percentile queue is metered by upstream signal.			

Splits and Phases: 14: Hammond St & Heath St



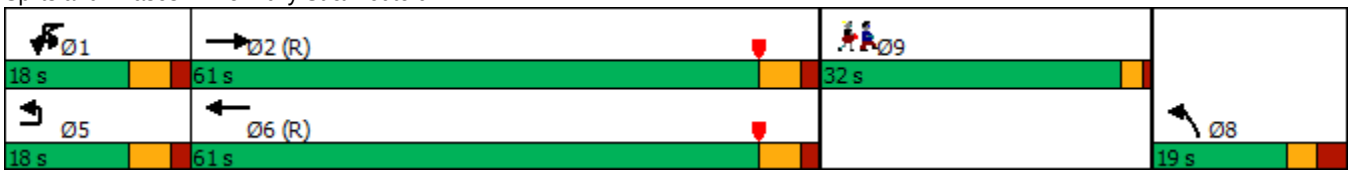
Lane Group	EBU	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø9
Lane Configurations									
Traffic Volume (vph)	44	1307	73	5	9	1262	25	44	
Future Volume (vph)	44	1307	73	5	9	1262	25	44	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	
Lane Width (ft)	11	12	11	11	11	12	11	11	
Storage Length (ft)	250		0		150		0	0	
Storage Lanes	1		0		1		1	0	
Taper Length (ft)	100				100		0		
Right Turn on Red			Yes					Yes	
Link Speed (mph)		30				30	30		
Link Distance (ft)		898				297	462		
Travel Time (s)		20.4				6.8	10.5		
Confl. Peds. (#/hr)			16		16				
Peak Hour Factor	0.73	0.87	0.55	0.42	0.75	0.93	0.89	0.79	
Heavy Vehicles (%)	0%	6%	1%	0%	0%	3%	12%	14%	
Shared Lane Traffic (%)									
Lane Group Flow (vph)	60	1635	0	0	24	1357	84	0	
Turn Type	Prot	NA		Prot	Prot	NA	Prot		
Protected Phases	5	2		1	1	6	8		9
Permitted Phases									
Detector Phase	5	2		1	1	6	8		
Switch Phase									
Minimum Initial (s)	6.0	10.0		6.0	6.0	10.0	1.0		5.0
Minimum Split (s)	12.0	23.0		12.0	12.0	23.0	7.0		32.0
Total Split (s)	18.0	61.0		18.0	18.0	61.0	19.0		32.0
Total Split (%)	13.8%	46.9%		13.8%	13.8%	46.9%	14.6%		25%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	3.0		2.0
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	3.0		1.0
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		Lead	Lead	Lag			
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes			
Recall Mode	None	C-Min		None	None	C-Min	None		None
Act Effct Green (s)	8.9	95.1			6.8	90.6	8.5		
Actuated g/C Ratio	0.07	0.73			0.05	0.70	0.07		
v/c Ratio	0.50	0.66			0.26	0.56	0.57		
Control Delay	72.3	15.3			66.0	15.2	38.8		
Queue Delay	0.0	0.0			0.0	8.7	0.0		
Total Delay	72.3	15.3			66.0	23.9	38.8		
LOS	E	B			E	C	D		
Approach Delay		17.3				24.6	38.8		
Approach LOS		B				C	D		
Queue Length 50th (ft)	50	302			20	233	23		
Queue Length 95th (ft)	76	#892			41	#706	74		
Internal Link Dist (ft)		818				217	382		
Turn Bay Length (ft)	250				150				
Base Capacity (vph)	161	2465			161	2442	195		
Starvation Cap Reductn	0	0			0	1054	0		
Spillback Cap Reductn	0	0			0	0	0		

Lane Group	EBU	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø9
Storage Cap Reductn	0	0			0	0	0		
Reduced v/c Ratio	0.37	0.66			0.15	0.98	0.43		

Intersection Summary			
Area Type:	Other		
Cycle Length: 130			
Actuated Cycle Length: 130			
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow			
Natural Cycle: 110			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.66			
Intersection Signal Delay: 21.1		Intersection LOS: C	
Intersection Capacity Utilization 52.6%		ICU Level of Service A	
Analysis Period (min) 15			
Description: 0 / 5 / 13			

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

Splits and Phases: 15: Tully St & Route 9



APPENDIX C

Intersection Capacity Analyses
Weekday PM Peak Hour
2019 Existing Conditions

Lane Group	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	294	753	100	2	81	896	54	65	194	30	20	234
Future Volume (vph)	294	753	100	2	81	896	54	65	194	30	20	234
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	12	11	11	11	12	11	11	11	11	11	10
Storage Length (ft)	200		0		150		0	0		0	0	
Storage Lanes	1		0		1		0	1		0	0	
Taper Length (ft)	100				100			0			0	
Right Turn on Red			Yes				Yes			Yes		
Link Speed (mph)		30				30			30			30
Link Distance (ft)		614				1044			573			420
Travel Time (s)		14.0				23.7			13.0			9.5
Confl. Peds. (#/hr)	8		5	28	5		8	99		28	28	
Peak Hour Factor	0.98	0.95	0.78	0.50	0.56	0.96	0.84	0.77	0.88	0.68	0.50	0.90
Heavy Vehicles (%)	1%	3%	2%	0%	0%	2%	2%	8%	0%	0%	5%	2%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	300	921	0	0	149	997	0	84	264	0	0	300
Turn Type	Prot	NA		Prot	Prot	NA		Perm	NA		Perm	NA
Protected Phases	5	2		1	1	6			8			4
Permitted Phases								8			4	
Detector Phase	5	2		1	1	6		8	8		4	4
Switch Phase												
Minimum Initial (s)	6.0	10.0		6.0	6.0	10.0		6.0	6.0		6.0	6.0
Minimum Split (s)	11.0	16.0		11.0	11.0	16.0		11.0	11.0		11.0	11.0
Total Split (s)	35.0	51.0		35.0	35.0	51.0		40.0	40.0		40.0	40.0
Total Split (%)	23.0%	33.6%		23.0%	23.0%	33.6%		26.3%	26.3%		26.3%	26.3%
Maximum Green (s)	30.0	45.0		30.0	30.0	45.0		35.0	35.0		35.0	35.0
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	2.0		1.0	1.0	2.0		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	6.0			5.0	6.0		5.0	5.0			5.0
Lead/Lag	Lead	Lag		Lead	Lead	Lag						
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes						
Vehicle Extension (s)	2.0	2.0		2.0	2.0	2.0		2.0	2.0		2.0	2.0
Recall Mode	None	Min		None	None	Min		None	None		None	None
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
Act Effct Green (s)	27.3	53.5			16.6	42.8		35.8	35.8			35.8
Actuated g/C Ratio	0.19	0.38			0.12	0.31		0.26	0.26			0.26
v/c Ratio	0.89	0.70			0.72	0.93		0.65	0.58			0.90
Control Delay	84.9	41.2			81.4	63.4		76.5	53.8			83.6
Queue Delay	0.0	0.0			0.0	0.0		0.0	0.0			0.0
Total Delay	84.9	41.2			81.4	63.4		76.5	53.8			83.6
LOS	F	D			F	E		E	D			F
Approach Delay		52.0				65.7			59.2			46.3
Approach LOS		D				E			E			D
Queue Length 50th (ft)	288	391			143	502		76	229			295
Queue Length 95th (ft)	#453	505			125	#639		#127	322			#495

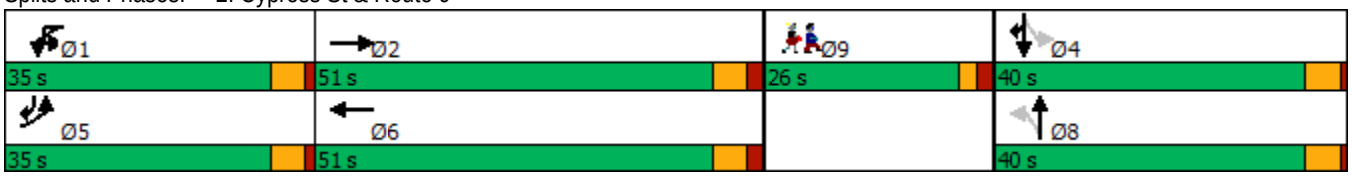
Lane Group	SBR	Ø9
Lane Configurations		
Traffic Volume (vph)	240	
Future Volume (vph)	240	
Ideal Flow (vphpl)	1900	
Lane Width (ft)	11	
Storage Length (ft)	0	
Storage Lanes	1	
Taper Length (ft)		
Right Turn on Red	Yes	
Link Speed (mph)		
Link Distance (ft)		
Travel Time (s)		
Confl. Peds. (#/hr)	99	
Peak Hour Factor	0.92	
Heavy Vehicles (%)	1%	
Shared Lane Traffic (%)		
Lane Group Flow (vph)	261	
Turn Type	pt+ov	
Protected Phases	4 5	9
Permitted Phases		
Detector Phase	4 5	
Switch Phase		
Minimum Initial (s)		20.0
Minimum Split (s)		26.0
Total Split (s)		26.0
Total Split (%)		17%
Maximum Green (s)		22.0
Yellow Time (s)		2.0
All-Red Time (s)		2.0
Lost Time Adjust (s)		
Total Lost Time (s)		
Lead/Lag		
Lead-Lag Optimize?		
Vehicle Extension (s)		2.0
Recall Mode		None
Walk Time (s)		7.0
Flash Dont Walk (s)		10.0
Pedestrian Calls (#/hr)		60
Act Effct Green (s)	68.2	
Actuated g/C Ratio	0.49	
v/c Ratio	0.29	
Control Delay	3.4	
Queue Delay	0.0	
Total Delay	3.4	
LOS	A	
Approach Delay		
Approach LOS		
Queue Length 50th (ft)	0	
Queue Length 95th (ft)	50	

Lane Group	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Internal Link Dist (ft)		534				964			493			340
Turn Bay Length (ft)	200				150							
Base Capacity (vph)	377	1327			382	1150		129	458			332
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	0.80	0.69			0.39	0.87		0.65	0.58			0.90

Intersection Summary			
Area Type:	Other		
Cycle Length: 152			
Actuated Cycle Length: 140.2			
Natural Cycle: 130			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 0.93			
Intersection Signal Delay: 56.6		Intersection LOS: E	
Intersection Capacity Utilization 86.1%		ICU Level of Service E	
Analysis Period (min) 15			
Description: 155 / 99 / 53			

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

Splits and Phases: 2: Cypress St & Route 9



Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	4	197	1090	55	14	42	1155	18	41	193	6	67
Future Volume (vph)	4	197	1090	55	14	42	1155	18	41	193	6	67
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11	12	11	11	11	11	11
Storage Length (ft)		150		150		150		0	0		0	0
Storage Lanes		1		1		1		0	0		0	0
Taper Length (ft)		100				100			0			0
Right Turn on Red				Yes				Yes			Yes	
Link Speed (mph)			30				30			30		
Link Distance (ft)			635				1295			738		
Travel Time (s)			14.4				29.4			16.8		
Confl. Peds. (#/hr)	3	5			7			5	3		7	7
Peak Hour Factor	0.50	0.91	0.94	0.76	0.58	0.66	0.89	0.90	0.60	0.93	0.50	0.80
Heavy Vehicles (%)	0%	1%	2%	0%	0%	5%	2%	6%	0%	2%	0%	0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	224	1160	72	0	88	1318	0	0	288	0	0
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		Perm
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases				2					8			4
Detector Phase	5	5	2	2	1	1	6		8	8		4
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0	6.0	6.0	6.0	40.0		6.0	6.0		6.0
Minimum Split (s)	11.0	11.0	46.0	46.0	11.0	11.0	46.0		23.0	23.0		23.0
Total Split (s)	25.0	25.0	71.0	71.0	20.0	20.0	66.0		35.0	35.0		35.0
Total Split (%)	15.5%	15.5%	44.1%	44.1%	12.4%	12.4%	41.0%		21.7%	21.7%		21.7%
Maximum Green (s)	20.0	20.0	65.0	65.0	15.0	15.0	60.0		30.0	30.0		30.0
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)	1.0	1.0	2.0	2.0	1.0	1.0	2.0		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	6.0	6.0		5.0	6.0			5.0		
Lead/Lag	Lead	Lead	Lag	Lag	Lead	Lead	Lag					
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
Vehicle Extension (s)	3.0	3.0	2.0	2.0	3.0	3.0	2.0		3.0	3.0		3.0
Recall Mode	None	None	Min	Min	None	None	Min		None	None		None
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
Act Effct Green (s)		20.2	66.7	66.7		11.6	58.1			30.4		
Actuated g/C Ratio		0.15	0.51	0.51		0.09	0.45			0.23		
v/c Ratio		0.84	0.64	0.09		0.59	0.84			2.10		
Control Delay		80.3	27.6	6.1		76.0	38.9			543.2		
Queue Delay		0.0	0.0	0.0		0.0	0.0			0.0		
Total Delay		80.3	27.6	6.1		76.0	38.9			543.2		
LOS		F	C	A		E	D			F		
Approach Delay			34.6				41.2			543.2		
Approach LOS			C				D			F		
Queue Length 50th (ft)		175	326	1		68	461			~363		
Queue Length 95th (ft)		#433	662	24		110	#880			#710		

Lane Group	SBT	SBR	Ø9
Lane Configurations			
Traffic Volume (vph)	250	128	
Future Volume (vph)	250	128	
Ideal Flow (vphpl)	1900	1900	
Lane Width (ft)	11	11	
Storage Length (ft)		0	
Storage Lanes		1	
Taper Length (ft)			
Right Turn on Red		Yes	
Link Speed (mph)	30		
Link Distance (ft)	625		
Travel Time (s)	14.2		
Confl. Peds. (#/hr)		3	
Peak Hour Factor	0.93	0.86	
Heavy Vehicles (%)	1%	2%	
Shared Lane Traffic (%)			
Lane Group Flow (vph)	353	149	
Turn Type	NA	Perm	
Protected Phases	4		9
Permitted Phases		4	
Detector Phase	4	4	
Switch Phase			
Minimum Initial (s)	6.0	6.0	6.0
Minimum Split (s)	23.0	23.0	35.0
Total Split (s)	35.0	35.0	35.0
Total Split (%)	21.7%	21.7%	22%
Maximum Green (s)	30.0	30.0	32.0
Yellow Time (s)	4.0	4.0	2.0
All-Red Time (s)	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	
Total Lost Time (s)	5.0	5.0	
Lead/Lag			
Lead-Lag Optimize?			
Vehicle Extension (s)	3.0	3.0	3.0
Recall Mode	None	None	None
Walk Time (s)			7.0
Flash Dont Walk (s)			25.0
Pedestrian Calls (#/hr)			7
Act Effct Green (s)	30.4	30.4	
Actuated g/C Ratio	0.23	0.23	
v/c Ratio	1.20	0.33	
Control Delay	159.6	13.3	
Queue Delay	0.0	0.0	
Total Delay	159.6	13.3	
LOS	F	B	
Approach Delay	116.2		
Approach LOS	F		
Queue Length 50th (ft)	~332	13	
Queue Length 95th (ft)	#721	76	

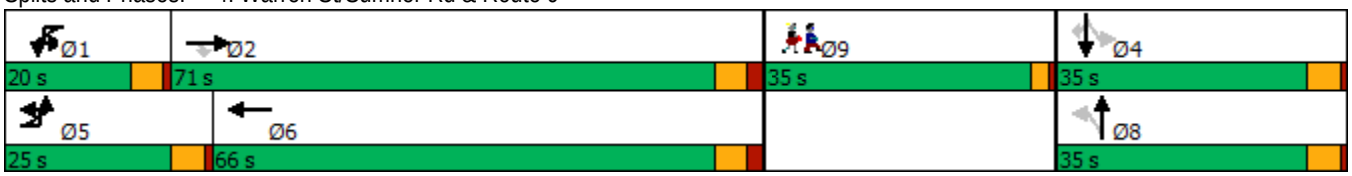
Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Internal Link Dist (ft)			555				1215			658		
Turn Bay Length (ft)		150		150		150						
Base Capacity (vph)		267	1809	831		195	1642			137		
Starvation Cap Reductn		0	0	0		0	0			0		
Spillback Cap Reductn		0	0	0		0	0			0		
Storage Cap Reductn		0	0	0		0	0			0		
Reduced v/c Ratio		0.84	0.64	0.09		0.45	0.80			2.10		

Intersection Summary			
Area Type:	Other		
Cycle Length: 161			
Actuated Cycle Length: 130.5			
Natural Cycle: 145			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 2.10			
Intersection Signal Delay: 88.5		Intersection LOS: F	
Intersection Capacity Utilization 91.6%		ICU Level of Service F	
Analysis Period (min) 15			
Description: 16 / 7 / 16			

~ 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: Warren St/Sumner Rd & Route 9

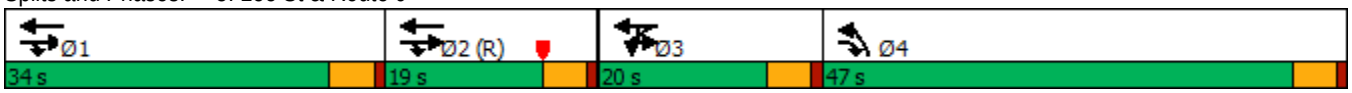


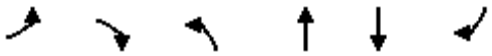
Lane Group	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø1	Ø2
Lane Configurations									
Traffic Volume (vph)	1182	592	2	201	1063	487	174		
Future Volume (vph)	1182	592	2	201	1063	487	174		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900		
Lane Width (ft)	12	11	11	11	12	11	11		
Storage Length (ft)		150		150		0	0		
Storage Lanes		1		1		2	0		
Taper Length (ft)				100		0			
Right Turn on Red		Yes					Yes		
Link Speed (mph)	30				30	30			
Link Distance (ft)	363				323	214			
Travel Time (s)	8.3				7.3	4.9			
Confl. Peds. (#/hr)		1	1	1			1		
Peak Hour Factor	0.91	0.99	0.50	0.93	0.93	0.94	0.93		
Heavy Vehicles (%)	2%	2%	0%	2%	2%	2%	2%		
Shared Lane Traffic (%)									
Lane Group Flow (vph)	1299	598	0	220	1143	705	0		
Turn Type	NA	pt+ov	Prot	Prot	NA	Prot			
Protected Phases	1 2	1 2 4	3	3	1 2 3	4		1	2
Permitted Phases									
Detector Phase	1 2	1 2 4	3	3	1 2 3	4			
Switch Phase									
Minimum Initial (s)			5.0	5.0		6.0		5.0	10.0
Minimum Split (s)			10.0	10.0		29.0		10.0	19.0
Total Split (s)			20.0	20.0		47.0		34.0	19.0
Total Split (%)			16.7%	16.7%		39.2%		28%	16%
Maximum Green (s)			15.0	15.0		42.0		29.0	14.0
Yellow Time (s)			4.0	4.0		4.0		4.0	4.0
All-Red Time (s)			1.0	1.0		1.0		1.0	1.0
Lost Time Adjust (s)				0.0		0.0			
Total Lost Time (s)				5.0		5.0			
Lead/Lag			Lead	Lead		Lag		Lead	Lag
Lead-Lag Optimize?			Yes	Yes		Yes			
Vehicle Extension (s)			3.0	3.0		3.0		3.0	3.0
Recall Mode			None	None		None		None	C-Max
Walk Time (s)						17.0			10.0
Flash Dont Walk (s)						7.0			4.0
Pedestrian Calls (#/hr)						1			1
Act Effct Green (s)	51.8	95.0		15.0	71.8	38.2			
Actuated g/C Ratio	0.43	0.79		0.12	0.60	0.32			
v/c Ratio	0.85	0.48		1.03	0.54	0.67			
Control Delay	25.8	1.7		121.9	16.2	8.8			
Queue Delay	17.8	0.8		24.4	1.1	4.0			
Total Delay	43.6	2.6		146.3	17.3	12.8			
LOS	D	A		F	B	B			
Approach Delay	30.7				38.1	12.8			
Approach LOS	C				D	B			
Queue Length 50th (ft)	525	19		~182	281	139			
Queue Length 95th (ft)	m552	m23		#342	347	77			

Lane Group	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø1	Ø2
Internal Link Dist (ft)	283				243	134			
Turn Bay Length (ft)		150		150					
Base Capacity (vph)	1527	1223		213	2117	1157			
Starvation Cap Reductn	256	339		0	0	360			
Spillback Cap Reductn	0	2		31	674	8			
Storage Cap Reductn	0	0		0	0	0			
Reduced v/c Ratio	1.02	0.68		1.21	0.79	0.88			

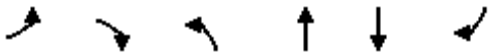
Intersection Summary			
Area Type:	Other		
Cycle Length: 120			
Actuated Cycle Length: 120			
Offset: 115 (96%), Referenced to phase 2:EBWB, Start of Yellow			
Natural Cycle: 80			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 1.03			
Intersection Signal Delay: 30.0		Intersection LOS: C	
Intersection Capacity Utilization 75.8%		ICU Level of Service D	
Analysis Period (min) 15			
Description: ø2 (NB): 0 / 1 / 3			
ø4 (WB): 0 / 1 / 3			
~ 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: 5: Lee St & Route 9





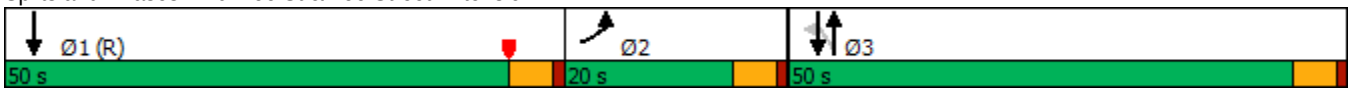
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	Ø1
Lane Configurations							
Traffic Volume (vph)	79	11	42	602	818	7	
Future Volume (vph)	79	11	42	602	818	7	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	
Right Turn on Red		Yes				Yes	
Link Speed (mph)	30			30	30		
Link Distance (ft)	617			535	214		
Travel Time (s)	14.0			12.2	4.9		
Peak Hour Factor	0.90	0.69	0.66	0.84	0.87	0.58	
Heavy Vehicles (%)	3%	0%	0%	2%	2%	0%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	104	0	0	781	952	0	
Turn Type	Prot		Perm	NA	NA		
Protected Phases	2			3	1 3		1
Permitted Phases			3				
Detector Phase	2		3	3	1 3		
Switch Phase							
Minimum Initial (s)	6.0		10.0	10.0			5.0
Minimum Split (s)	20.0		15.0	15.0			10.0
Total Split (s)	20.0		50.0	50.0			50.0
Total Split (%)	16.7%		41.7%	41.7%			42%
Maximum Green (s)	15.0		45.0	45.0			45.0
Yellow Time (s)	4.0		4.0	4.0			4.0
All-Red Time (s)	1.0		1.0	1.0			1.0
Lost Time Adjust (s)	0.0			0.0			
Total Lost Time (s)	5.0			5.0			
Lead/Lag	Lag						Lead
Lead-Lag Optimize?	Yes						Yes
Vehicle Extension (s)	2.0		2.0	2.0			2.0
Recall Mode	None		None	None			C-Max
Walk Time (s)	5.0						
Flash Dont Walk (s)	5.0						
Pedestrian Calls (#/hr)	0						
Act Effct Green (s)	11.1			43.1	98.9		
Actuated g/C Ratio	0.09			0.36	0.82		
v/c Ratio	0.65			0.83	0.34		
Control Delay	67.4			43.4	2.4		
Queue Delay	0.0			2.9	0.6		
Total Delay	67.4			46.4	3.0		
LOS	E			D	A		
Approach Delay	67.4			46.4	3.0		
Approach LOS	E			D	A		
Queue Length 50th (ft)	74			275	32		
Queue Length 95th (ft)	130			327	m117		
Internal Link Dist (ft)	537			455	134		
Turn Bay Length (ft)							
Base Capacity (vph)	215			995	2802		
Starvation Cap Reductn	0			0	1356		
Spillback Cap Reductn	0			124	0		

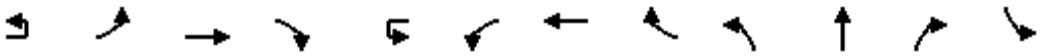


Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	Ø1
Storage Cap Reductn	0			0	0		
Reduced v/c Ratio	0.48			0.90	0.66		

Intersection Summary			
Area Type:	Other		
Cycle Length: 120			
Actuated Cycle Length: 120			
Offset: 105 (88%), Referenced to phase 1:SBT, Start of Yellow			
Natural Cycle: 55			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.83			
Intersection Signal Delay: 25.1		Intersection LOS: C	
Intersection Capacity Utilization 58.2%		ICU Level of Service B	
Analysis Period (min) 15			
Description: 1 / 0 / 2			
m Volume for 95th percentile queue is metered by upstream signal.			

Splits and Phases: 6: Lee St & Lee Street Extension





Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	9	308	1190	0	1	117	1127	391	0	0	0	601
Future Volume (vph)	9	308	1190	0	1	117	1127	391	0	0	0	601
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11	12	11	11	11	11	11
Storage Length (ft)		250		0		175		225	0		0	125
Storage Lanes		1		0		1		1	0		0	1
Taper Length (ft)		100				100			0			100
Right Turn on Red				Yes				Yes			Yes	
Link Speed (mph)			30				30			30		
Link Distance (ft)			495				363			179		
Travel Time (s)			11.3				8.3			4.1		
Confl. Peds. (#/hr)	2	2				2		2				
Peak Hour Factor	0.75	0.81	0.90	0.92	0.25	0.75	0.89	0.91	0.92	0.92	0.92	0.94
Heavy Vehicles (%)	0%	0%	2%	2%	0%	0%	2%	1%	2%	2%	2%	2%
Shared Lane Traffic (%)												32%
Lane Group Flow (vph)	0	392	1322	0	0	160	1266	430	0	0	0	435
Turn Type	Prot	Prot	NA		Prot	Prot	NA	custom				Split
Protected Phases	4	4	1 4 5		2	2	1 2 5	1 2 3				3
Permitted Phases												
Detector Phase	4	4	1 4 5		2	2	1 2 5	1 2 3				3
Switch Phase												
Minimum Initial (s)	5.0	5.0			5.0	5.0						5.0
Minimum Split (s)	10.0	10.0			10.0	10.0						23.0
Total Split (s)	28.0	28.0			15.0	15.0						35.0
Total Split (%)	23.3%	23.3%			12.5%	12.5%						29.2%
Maximum Green (s)	23.0	23.0			10.0	10.0						30.0
Yellow Time (s)	4.0	4.0			4.0	4.0						4.0
All-Red Time (s)	1.0	1.0			1.0	1.0						1.0
Lost Time Adjust (s)		0.0				0.0						0.0
Total Lost Time (s)		5.0				5.0						5.0
Lead/Lag	Lag	Lag			Lag	Lag						Lead
Lead-Lag Optimize?	Yes	Yes			Yes	Yes						Yes
Vehicle Extension (s)	3.0	3.0			3.0	3.0						3.0
Recall Mode	None	None			Max	Max						None
Walk Time (s)												13.0
Flash Dont Walk (s)												5.0
Pedestrian Calls (#/hr)												2
Act Effct Green (s)		23.0	65.0			10.0	52.0	68.0				30.0
Actuated g/C Ratio		0.19	0.54			0.08	0.43	0.57				0.25
v/c Ratio		1.17	0.69			1.10	0.83	0.40				1.07
Control Delay		148.1	22.5			150.6	34.5	4.9				108.2
Queue Delay		0.0	13.9			0.0	7.7	0.7				0.0
Total Delay		148.1	36.4			150.6	42.2	5.6				108.2
LOS		F	D			F	D	A				F
Approach Delay			61.9				43.1					
Approach LOS			E				D					
Queue Length 50th (ft)		~362	377			~142	486	77				~393
Queue Length 95th (ft)		#475	458			#219	565	137				#607

Lane Group	SBT	SBR	Ø1	Ø5
Lane Configurations				
Traffic Volume (vph)	56	119		
Future Volume (vph)	56	119		
Ideal Flow (vphpl)	1900	1900		
Lane Width (ft)	11	11		
Storage Length (ft)		100		
Storage Lanes		0		
Taper Length (ft)				
Right Turn on Red		Yes		
Link Speed (mph)	30			
Link Distance (ft)	916			
Travel Time (s)	20.8			
Confl. Peds. (#/hr)		2		
Peak Hour Factor	0.64	0.88		
Heavy Vehicles (%)	4%	2%		
Shared Lane Traffic (%)				
Lane Group Flow (vph)	427	0		
Turn Type	NA			
Protected Phases	3		1	5
Permitted Phases				
Detector Phase	3			
Switch Phase				
Minimum Initial (s)	5.0		5.0	5.0
Minimum Split (s)	23.0		15.0	19.0
Total Split (s)	35.0		23.0	19.0
Total Split (%)	29.2%		19%	16%
Maximum Green (s)	30.0		18.0	16.0
Yellow Time (s)	4.0		4.0	2.0
All-Red Time (s)	1.0		1.0	1.0
Lost Time Adjust (s)	0.0			
Total Lost Time (s)	5.0			
Lead/Lag	Lead		Lead	
Lead-Lag Optimize?	Yes		Yes	
Vehicle Extension (s)	3.0		3.0	3.0
Recall Mode	None		C-Max	None
Walk Time (s)	13.0			6.0
Flash Dont Walk (s)	5.0			10.0
Pedestrian Calls (#/hr)	2			2
Act Effct Green (s)	30.0			
Actuated g/C Ratio	0.25			
v/c Ratio	1.05			
Control Delay	99.4			
Queue Delay	1.7			
Total Delay	101.2			
LOS	F			
Approach Delay	104.7			
Approach LOS	F			
Queue Length 50th (ft)	~367			
Queue Length 95th (ft)	304			

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Internal Link Dist (ft)			415				283			99		
Turn Bay Length (ft)		250				175		225				125
Base Capacity (vph)		334	1916			145	1533	1062				406
Starvation Cap Reductn		0	0			0	237	330				0
Spillback Cap Reductn		0	599			0	0	0				0
Storage Cap Reductn		0	0			0	0	0				0
Reduced v/c Ratio		1.17	1.00			1.10	0.98	0.59				1.07

Intersection Summary			
Area Type:	Other		
Cycle Length: 120			
Actuated Cycle Length: 120			
Offset: 0 (0%), Referenced to phase 1:EBWB, Start of Yellow, Master Intersection			
Natural Cycle: 120			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 1.17			
Intersection Signal Delay: 62.3		Intersection LOS: E	
Intersection Capacity Utilization 83.0%		ICU Level of Service E	
Analysis Period (min) 15			
Description: ø3 (EB+WB): 9 / 2 / 2			
ø5 (SB): 12 / 2 / 2			
~ 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: 7: Heath St/Chestnut Hill Ave & Route 9

Lane Group	EBU	EBL	EBT	EBR	EBR2	WBT	WBR	NBL	NBT	NBR	NBR2	SBL2
Lane Configurations												
Traffic Volume (vph)	18	21	1479	17	1	1261	21	58	11	12	3	24
Future Volume (vph)	18	21	1479	17	1	1261	21	58	11	12	3	24
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)		250		0			0	0		0		
Storage Lanes		1		0			0	0		0		
Taper Length (ft)		100						0				
Right Turn on Red					Yes		Yes				Yes	
Link Speed (mph)			30			30			30			
Link Distance (ft)			977			709			527			
Travel Time (s)			22.2			16.1			12.0			
Confl. Peds. (#/hr)	5	1		2	11		1	5		8	2	8
Peak Hour Factor	0.75	0.58	0.94	0.61	0.25	0.96	0.66	0.63	0.69	0.60	0.75	0.75
Heavy Vehicles (%)	0%	0%	1%	0%	0%	1%	0%	7%	0%	33%	0%	0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	60	1605	0	0	1346	0	0	132	0	0	0
Turn Type	Prot	Prot	NA			NA		Perm	NA			Perm
Protected Phases	5	5	2			6			8			
Permitted Phases								8				4
Detector Phase	5	5	2			6		8	8			4
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0			6.0		6.0	6.0			6.0
Minimum Split (s)	12.0	12.0	12.0			12.0		11.0	11.0			11.0
Total Split (s)	25.0	25.0	66.0			41.0		25.0	25.0			25.0
Total Split (%)	20.8%	20.8%	55.0%			34.2%		20.8%	20.8%			20.8%
Maximum Green (s)	19.0	19.0	60.0			35.0		20.0	20.0			20.0
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		1.0	1.0			1.0
Lost Time Adjust (s)		0.0	0.0			0.0			0.0			
Total Lost Time (s)		6.0	6.0			6.0			5.0			
Lead/Lag	Lead	Lead				Lag						
Lead-Lag Optimize?	Yes	Yes				Yes						
Vehicle Extension (s)	3.0	3.0	2.0			2.0		3.0	3.0			3.0
Recall Mode	None	None	C-Min			C-Min		None	None			None
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
Act Effct Green (s)		9.5	80.8			67.7			16.6			
Actuated g/C Ratio		0.08	0.67			0.56			0.14			
v/c Ratio		0.43	0.69			0.69			0.76			
Control Delay		61.6	18.5			26.8			75.4			
Queue Delay		0.0	0.0			0.0			0.0			
Total Delay		61.6	18.5			26.8			75.4			
LOS		E	B			C			E			
Approach Delay			20.1			26.8			75.4			
Approach LOS			C			C			E			
Queue Length 50th (ft)		45	252			310			98			
Queue Length 95th (ft)		55	#770			#786			122			
Internal Link Dist (ft)			897			629			447			

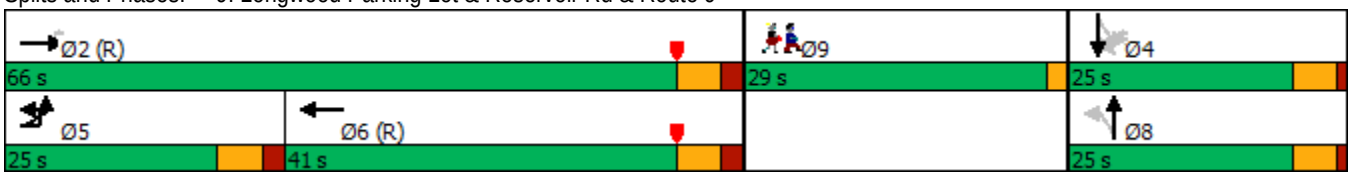
Lane Group	SBL	SBT	SBR	NWR2	Ø9
Lane Configurations					
Traffic Volume (vph)	7	1	7	6	
Future Volume (vph)	7	1	7	6	
Ideal Flow (vphpl)	1900	1900	1900	1900	
Storage Length (ft)	0		0		
Storage Lanes	0		0		
Taper Length (ft)	0				
Right Turn on Red			Yes	Yes	
Link Speed (mph)		30			
Link Distance (ft)		854			
Travel Time (s)		19.4			
Confl. Peds. (#/hr)	2		5	8	
Peak Hour Factor	0.44	0.25	0.58	0.38	
Heavy Vehicles (%)	0%	0%	0%	0%	
Shared Lane Traffic (%)					
Lane Group Flow (vph)	0	64	0	16	
Turn Type	Perm	NA		Perm	
Protected Phases		4			9
Permitted Phases	4			2 4	
Detector Phase	4	4		2 4	
Switch Phase					
Minimum Initial (s)	6.0	6.0			5.0
Minimum Split (s)	11.0	11.0			29.0
Total Split (s)	25.0	25.0			29.0
Total Split (%)	20.8%	20.8%			24%
Maximum Green (s)	20.0	20.0			27.0
Yellow Time (s)	4.0	4.0			2.0
All-Red Time (s)	1.0	1.0			0.0
Lost Time Adjust (s)		0.0			
Total Lost Time (s)		5.0			
Lead/Lag					
Lead-Lag Optimize?					
Vehicle Extension (s)	3.0	3.0			3.0
Recall Mode	None	None			None
Walk Time (s)					5.0
Flash Dont Walk (s)					22.0
Pedestrian Calls (#/hr)					13
Act Effct Green (s)		16.6		106.0	
Actuated g/C Ratio		0.14		0.88	
v/c Ratio		0.35		0.01	
Control Delay		44.9		0.0	
Queue Delay		0.0		0.0	
Total Delay		44.9		0.0	
LOS		D		A	
Approach Delay		44.9			
Approach LOS		D			
Queue Length 50th (ft)		39		0	
Queue Length 95th (ft)		17		0	
Internal Link Dist (ft)		774			

Lane Group	EBU	EBL	EBT	EBR	EBR2	WBT	WBR	NBL	NBT	NBR	NBR2	SBL2
Turn Bay Length (ft)		250										
Base Capacity (vph)		276	2318			1940			209			
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		0.22	0.69			0.69			0.63			

Intersection Summary			
Area Type:	Other		
Cycle Length: 120			
Actuated Cycle Length: 120			
Offset: 25 (21%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow			
Natural Cycle: 100			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.76			
Intersection Signal Delay: 25.5		Intersection LOS: C	
Intersection Capacity Utilization 65.7%		ICU Level of Service C	
Analysis Period (min) 15			
Description: 43 / 13 / 1			

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

Splits and Phases: 9: Longwood Parking Lot & Reservoir Rd & Route 9



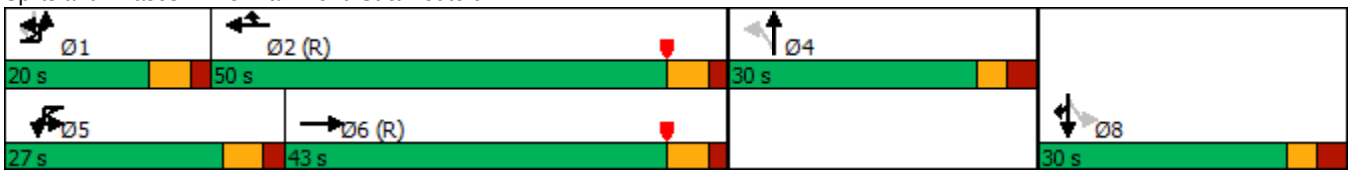
Lane Group	EBU	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	2	158	1137	38	146	1248	47	160	225	52	129	374
Future Volume (vph)	2	158	1137	38	146	1248	47	160	225	52	129	374
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	12	11	11	11	11	11	11
Storage Length (ft)		550		0	300		150	0		0	125	
Storage Lanes		1		0	1		1	0		0	1	
Taper Length (ft)		100			100			0			100	
Right Turn on Red				Yes			Yes			Yes		
Link Speed (mph)			30			30			30			30
Link Distance (ft)			726			711			307			892
Travel Time (s)			16.5			16.2			7.0			20.3
Confl. Peds. (#/hr)	28	7		15	15		7	28		23	23	
Peak Hour Factor	0.50	0.92	0.95	0.79	0.73	0.95	0.84	0.95	0.88	0.76	0.90	0.92
Heavy Vehicles (%)	0%	2%	2%	0%	1%	2%	2%	1%	2%	0%	2%	1%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	176	1245	0	200	1314	56	0	492	0	143	407
Turn Type	Prot	Prot	NA		Prot	NA	Prot	Perm	NA		Perm	NA
Protected Phases	1	1	6		5	2	2		4			8
Permitted Phases								4			8	
Detector Phase	1	1	6		5	2	2	4	4		8	8
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0		6.0	10.0	10.0	6.0	6.0		6.0	6.0
Minimum Split (s)	12.0	12.0	31.0		12.0	33.0	33.0	30.0	30.0		29.0	29.0
Total Split (s)	20.0	20.0	43.0		27.0	50.0	50.0	30.0	30.0		30.0	30.0
Total Split (%)	15.4%	15.4%	33.1%		20.8%	38.5%	38.5%	23.1%	23.1%		23.1%	23.1%
Maximum Green (s)	14.0	14.0	37.0		21.0	44.0	44.0	24.0	24.0		24.0	24.0
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0	4.0	3.0	3.0		3.0	3.0
All-Red Time (s)	2.0	2.0	2.0		2.0	2.0	2.0	3.0	3.0		3.0	3.0
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	Lag		Lead	Lag	Lag					
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes					
Vehicle Extension (s)	2.0	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0
Recall Mode	None	None	C-Min		None	C-Min	C-Min	None	None		None	None
Walk Time (s)			5.0			5.0	5.0	5.0	5.0		5.0	5.0
Flash Dont Walk (s)			20.0			22.0	22.0	19.0	19.0		18.0	18.0
Pedestrian Calls (#/hr)			15			7	7	23	23		28	28
Act Effct Green (s)		14.0	39.8		18.2	44.0	44.0		24.0		24.0	24.0
Actuated g/C Ratio		0.11	0.31		0.14	0.34	0.34		0.18		0.18	0.18
v/c Ratio		0.96	1.15		0.83	1.10	0.09		2.58dl		0.93	1.21
Control Delay		113.4	120.9		81.0	97.5	0.3		194.3		109.8	165.6
Queue Delay		0.0	0.0		0.0	0.0	0.0		0.0		0.0	0.0
Total Delay		113.4	120.9		81.0	97.5	0.3		194.3		109.8	165.6
LOS		F	F		F	F	A		F		F	F
Approach Delay			120.0			91.9			194.3			112.2
Approach LOS			F			F			F			F
Queue Length 50th (ft)		150	~669		164	~658	0		~280		120	~419
Queue Length 95th (ft)		#297	#827		195	#797	0		#383		#254	#624

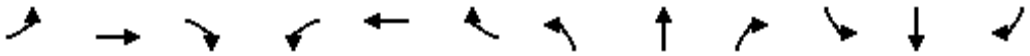
Lane Group	SBR
Lane Configurations	
Traffic Volume (vph)	158
Future Volume (vph)	158
Ideal Flow (vphpl)	1900
Lane Width (ft)	11
Storage Length (ft)	125
Storage Lanes	1
Taper Length (ft)	
Right Turn on Red	Yes
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Confl. Peds. (#/hr)	28
Peak Hour Factor	0.71
Heavy Vehicles (%)	1%
Shared Lane Traffic (%)	
Lane Group Flow (vph)	223
Turn Type	custom
Protected Phases	8
Permitted Phases	1
Detector Phase	8
Switch Phase	
Minimum Initial (s)	6.0
Minimum Split (s)	29.0
Total Split (s)	30.0
Total Split (%)	23.1%
Maximum Green (s)	24.0
Yellow Time (s)	3.0
All-Red Time (s)	3.0
Lost Time Adjust (s)	0.0
Total Lost Time (s)	6.0
Lead/Lag	
Lead-Lag Optimize?	
Vehicle Extension (s)	2.0
Recall Mode	None
Walk Time (s)	5.0
Flash Dont Walk (s)	18.0
Pedestrian Calls (#/hr)	28
Act Effct Green (s)	38.0
Actuated g/C Ratio	0.29
v/c Ratio	0.42
Control Delay	16.4
Queue Delay	0.0
Total Delay	16.4
LOS	B
Approach Delay	
Approach LOS	
Queue Length 50th (ft)	58
Queue Length 95th (ft)	76

Lane Group	EBU	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Internal Link Dist (ft)			646			631			227			812
Turn Bay Length (ft)		550			300		150				125	
Base Capacity (vph)		184	1078		279	1197	601		374		153	335
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		0.96	1.15		0.72	1.10	0.09		1.32		0.93	1.21

Intersection Summary	
Area Type:	Other
Cycle Length: 130	
Actuated Cycle Length: 130	
Offset: 0 (0%), Referenced to phase 2:WBT and 6:EBT, Start of Yellow, Master Intersection	
Natural Cycle: 145	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 1.32	
Intersection Signal Delay: 116.8	Intersection LOS: F
Intersection Capacity Utilization 99.7%	ICU Level of Service F
Analysis Period (min) 15	
Description: ø2 (SB): 8 / 7 / 11	
ø4 (WB): 19 / 23 / 18	
ø6 (NB): 5 / 15 / 7	
ø8 (EB): 26 / 28 / 19	
~ 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: 13: Hammond St & Route 9





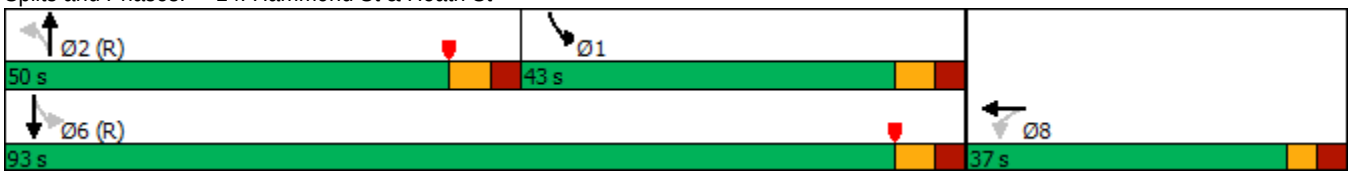
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	148	71	124	14	306	124	16	513	31
Future Volume (vph)	0	0	0	148	71	124	14	306	124	16	513	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		436			675			648			307	
Travel Time (s)		9.9			15.3			14.7			7.0	
Confl. Peds. (#/hr)						6	19		6	6		19
Peak Hour Factor	0.92	0.92	0.92	0.84	0.93	0.76	0.70	0.97	0.91	0.80	0.84	0.86
Heavy Vehicles (%)	2%	2%	2%	1%	1%	4%	0%	1%	0%	0%	1%	3%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	415	0	0	471	0	0	667	0
Turn Type				Perm	NA		Perm	NA		pm+pt	NA	
Protected Phases					8			2		1	6	
Permitted Phases				8			2			6		
Detector Phase				8	8		2	2		1	6	
Switch Phase												
Minimum Initial (s)				6.0	6.0		6.0	6.0		6.0	6.0	
Minimum Split (s)				26.0	26.0		19.0	19.0		13.0	20.0	
Total Split (s)				37.0	37.0		50.0	50.0		43.0	93.0	
Total Split (%)				28.5%	28.5%		38.5%	38.5%		33.1%	71.5%	
Maximum Green (s)				31.0	31.0		43.0	43.0		36.0	86.0	
Yellow Time (s)				3.0	3.0		4.0	4.0		4.0	4.0	
All-Red Time (s)				3.0	3.0		3.0	3.0		3.0	3.0	
Lost Time Adjust (s)					0.0			0.0			0.0	
Total Lost Time (s)					6.0			7.0			7.0	
Lead/Lag							Lead	Lead		Lag		
Lead-Lag Optimize?							Yes	Yes		Yes		
Vehicle Extension (s)				2.0	2.0		2.0	2.0		2.0	2.0	
Recall Mode				None	None		C-Min	C-Min		None	C-Min	
Walk Time (s)				7.0	7.0		7.0	7.0			7.0	
Flash Dont Walk (s)				13.0	13.0		5.0	5.0			6.0	
Pedestrian Calls (#/hr)				6	6		6	6			19	
Act Effct Green (s)					39.6			77.4			77.4	
Actuated g/C Ratio					0.30			0.60			0.60	
v/c Ratio					0.80			0.26			0.35	
Control Delay					51.6			11.8			14.7	
Queue Delay					0.0			0.0			0.7	
Total Delay					51.6			11.8			15.4	
LOS					D			B			B	
Approach Delay					51.6			11.8			15.4	
Approach LOS					D			B			B	
Queue Length 50th (ft)					305			84			111	
Queue Length 95th (ft)					423			121			m88	
Internal Link Dist (ft)		356			595			568			227	
Turn Bay Length (ft)												
Base Capacity (vph)					519			1784			2096	
Starvation Cap Reductn					0			0			1009	

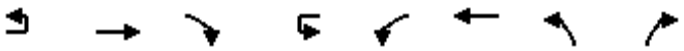
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Spillback Cap Reductn					0			0			0	
Storage Cap Reductn					0			0			0	
Reduced v/c Ratio					0.80			0.26			0.61	

Intersection Summary			
Area Type:	Other		
Cycle Length: 130			
Actuated Cycle Length: 130			
Offset: 90 (69%), Referenced to phase 2:NBTL and 6:SBTL, Start of Yellow			
Natural Cycle: 60			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.80			
Intersection Signal Delay: 24.0		Intersection LOS: C	
Intersection Capacity Utilization 57.5%		ICU Level of Service B	
Analysis Period (min) 15			
Description: ø2 (WB): 6 / 6 / 9			
ø6 (EB): 17 / 19 / 12			
ø8 (SB): 8 / 6 / 22			

m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 14: Hammond St & Heath St





Lane Group	EBU	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø9
Lane Configurations									
Traffic Volume (vph)	106	1383	40	10	10	1309	67	37	
Future Volume (vph)	106	1383	40	10	10	1309	67	37	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	
Lane Width (ft)	11	12	11	11	11	12	11	11	
Storage Length (ft)	250		0		150		0	0	
Storage Lanes	1		0		1		1	0	
Taper Length (ft)	100				100		0		
Right Turn on Red			Yes					Yes	
Link Speed (mph)		30				30	30		
Link Distance (ft)		898				297	462		
Travel Time (s)		20.4				6.8	10.5		
Confl. Peds. (#/hr)	5		30		30		5		
Peak Hour Factor	0.83	0.95	0.71	0.62	0.42	0.97	0.84	0.77	
Heavy Vehicles (%)	0%	2%	0%	10%	0%	2%	0%	3%	
Shared Lane Traffic (%)									
Lane Group Flow (vph)	128	1512	0	0	40	1349	128	0	
Turn Type	Prot	NA		Prot	Prot	NA	Prot		
Protected Phases	5	2		1	1	6	8		9
Permitted Phases									
Detector Phase	5	2		1	1	6	8		
Switch Phase									
Minimum Initial (s)	6.0	10.0		6.0	6.0	10.0	1.0		5.0
Minimum Split (s)	12.0	23.0		12.0	12.0	23.0	7.0		32.0
Total Split (s)	18.0	55.0		18.0	18.0	55.0	25.0		32.0
Total Split (%)	13.8%	42.3%		13.8%	13.8%	42.3%	19.2%		25%
Maximum Green (s)	12.0	49.0		12.0	12.0	49.0	19.0		29.0
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	3.0		2.0
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	3.0		1.0
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		Lead	Lead	Lag			
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes			
Vehicle Extension (s)	2.0	2.0		2.0	2.0	2.0	3.0		3.0
Recall Mode	None	C-Min		None	None	C-Min	None		None
Walk Time (s)									7.0
Flash Dont Walk (s)									22.0
Pedestrian Calls (#/hr)									15
Act Effct Green (s)	12.7	80.0			7.9	72.8	13.7		
Actuated g/C Ratio	0.10	0.62			0.06	0.56	0.11		
v/c Ratio	0.75	0.70			0.40	0.68	0.66		
Control Delay	83.2	24.8			69.5	27.1	63.3		
Queue Delay	0.0	0.0			0.0	49.4	0.0		
Total Delay	83.2	24.8			69.5	76.5	63.3		
LOS	F	C			E	E	E		
Approach Delay		29.3				76.3	63.3		
Approach LOS		C				E	E		
Queue Length 50th (ft)	105	323			33	324	89		
Queue Length 95th (ft)	#188	#911			32	#767	140		

Lane Group	EBU	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø9
Internal Link Dist (ft)		818				217	382		
Turn Bay Length (ft)	250				150				
Base Capacity (vph)	177	2163			154	1981	260		
Starvation Cap Reductn	0	0			0	915	0		
Spillback Cap Reductn	0	0			0	0	0		
Storage Cap Reductn	0	0			0	0	0		
Reduced v/c Ratio	0.72	0.70			0.26	1.27	0.49		

Intersection Summary			
Area Type:	Other		
Cycle Length: 130			
Actuated Cycle Length: 130			
Offset: 8 (6%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow			
Natural Cycle: 100			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.75			
Intersection Signal Delay: 51.4		Intersection LOS: D	
Intersection Capacity Utilization 65.6%		ICU Level of Service C	
Analysis Period (min) 15			
Description: 0 / 5 / 13			

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

Splits and Phases: 15: Tully St & Route 9

APPENDIX D

Intersection Capacity Analyses
Saturday Peak Hour
2019 Existing Conditions

Lane Group	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	310	649	71	3	56	637	73	53	177	37	51	194
Future Volume (vph)	310	649	71	3	56	637	73	53	177	37	51	194
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	12	11	11	11	12	11	11	11	11	11	10
Storage Length (ft)	200		0		150		0	0		0	0	
Storage Lanes	1		0		1		0	1		0	0	
Taper Length (ft)	100				100			0			0	
Right Turn on Red			Yes				Yes			Yes		
Link Speed (mph)		30				30			30			30
Link Distance (ft)		614				1044			573			420
Travel Time (s)		14.0				23.7			13.0			9.5
Confl. Peds. (#/hr)	33		6	39	6		33	53		39	39	
Peak Hour Factor	0.83	0.85	0.74	0.75	0.67	0.90	0.79	0.88	0.89	0.84	0.55	0.81
Heavy Vehicles (%)	1%	3%	6%	0%	0%	3%	3%	11%	2%	5%	8%	3%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	373	860	0	0	88	800	0	60	243	0	0	333
Turn Type	Prot	NA		Prot	Prot	NA		Perm	NA		Perm	NA
Protected Phases	5	2		1	1	6			8			4
Permitted Phases								8			4	
Detector Phase	5	2		1	1	6		8	8		4	4
Switch Phase												
Minimum Initial (s)	5.0	10.0		6.0	6.0	10.0		6.0	6.0		6.0	6.0
Minimum Split (s)	10.0	16.0		11.0	11.0	16.0		11.0	11.0		11.0	11.0
Total Split (s)	35.0	51.0		35.0	35.0	51.0		40.0	40.0		40.0	40.0
Total Split (%)	23.0%	33.6%		23.0%	23.0%	33.6%		26.3%	26.3%		26.3%	26.3%
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	2.0		1.0	1.0	2.0		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	6.0			5.0	6.0		5.0	5.0			5.0
Lead/Lag	Lead	Lag		Lead	Lead	Lag						
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes						
Recall Mode	None	Min		None	None	Min		None	None		None	None
Act Effct Green (s)	30.7	55.9			11.4	36.7		35.8	35.8			35.8
Actuated g/C Ratio	0.23	0.42			0.09	0.28		0.27	0.27			0.27
v/c Ratio	0.93	0.59			0.59	0.84		0.48	0.52			1.23
Control Delay	82.8	33.1			77.6	54.2		62.8	48.3			171.7
Queue Delay	0.0	0.0			0.0	0.0		0.0	0.0			0.0
Total Delay	82.8	33.1			77.6	54.2		62.8	48.3			171.7
LOS	F	C			E	D		E	D			F
Approach Delay		48.1				56.5			51.2			93.1
Approach LOS		D				E			D			F
Queue Length 50th (ft)	~375	334			81	373		49	196			~410
Queue Length 95th (ft)	#540	398			104	454		105	300			#551
Internal Link Dist (ft)		534				964			493			340
Turn Bay Length (ft)	200				150							
Base Capacity (vph)	400	1451			404	1192		125	470			271
Starvation Cap Reductn	0	0			0	0		0	0			0
Spillback Cap Reductn	0	0			0	0		0	0			0

Lane Group	SBR	Ø9
Lane Configurations		
Traffic Volume (vph)	259	
Future Volume (vph)	259	
Ideal Flow (vphpl)	1900	
Lane Width (ft)	11	
Storage Length (ft)	0	
Storage Lanes	1	
Taper Length (ft)		
Right Turn on Red	Yes	
Link Speed (mph)		
Link Distance (ft)		
Travel Time (s)		
Confl. Peds. (#/hr)	53	
Peak Hour Factor	0.89	
Heavy Vehicles (%)	2%	
Shared Lane Traffic (%)		
Lane Group Flow (vph)	291	
Turn Type	pt+ov	
Protected Phases	4 5	9
Permitted Phases		
Detector Phase	4 5	
Switch Phase		
Minimum Initial (s)		20.0
Minimum Split (s)		26.0
Total Split (s)		26.0
Total Split (%)		17%
Yellow Time (s)		2.0
All-Red Time (s)		2.0
Lost Time Adjust (s)		
Total Lost Time (s)		
Lead/Lag		
Lead-Lag Optimize?		
Recall Mode		None
Act Effct Green (s)	71.5	
Actuated g/C Ratio	0.54	
v/c Ratio	0.30	
Control Delay	3.2	
Queue Delay	0.0	
Total Delay	3.2	
LOS	A	
Approach Delay		
Approach LOS		
Queue Length 50th (ft)	0	
Queue Length 95th (ft)	49	
Internal Link Dist (ft)		
Turn Bay Length (ft)		
Base Capacity (vph)	960	
Starvation Cap Reductn	0	
Spillback Cap Reductn	0	

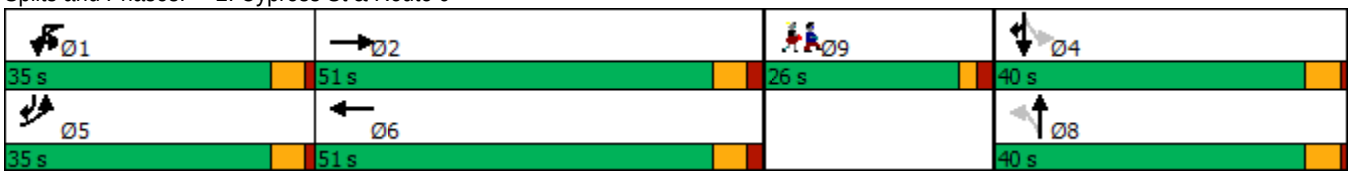
Lane Group	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Storage Cap Reductn	0	0			0	0		0	0			0
Reduced v/c Ratio	0.93	0.59			0.22	0.67		0.48	0.52			1.23

Intersection Summary			
Area Type:	Other		
Cycle Length: 152			
Actuated Cycle Length: 132.4			
Natural Cycle: 150			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 1.23			
Intersection Signal Delay: 60.1		Intersection LOS: E	
Intersection Capacity Utilization 80.1%		ICU Level of Service D	
Analysis Period (min) 15			
Description: 155 / 99 / 53			

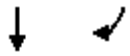
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

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

Splits and Phases: 2: Cypress St & Route 9



Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	3	193	1011	59	10	22	913	9	94	93	7	26
Future Volume (vph)	3	193	1011	59	10	22	913	9	94	93	7	26
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11	12	11	11	11	11	11
Storage Length (ft)		150		150		150		0	0		0	0
Storage Lanes		1		1		1		0	0		0	0
Taper Length (ft)		100				100			0			0
Right Turn on Red				Yes				Yes			Yes	
Link Speed (mph)			30				30			30		
Link Distance (ft)			635				1295			738		
Travel Time (s)			14.4				29.4			16.8		
Confl. Peds. (#/hr)	16	9		8	9	8		9	16		9	9
Peak Hour Factor	0.38	0.82	0.91	0.87	0.83	0.61	0.95	0.38	0.84	0.73	0.58	0.72
Heavy Vehicles (%)	0%	1%	2%	5%	0%	5%	3%	0%	2%	2%	0%	4%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	243	1111	68	0	48	985	0	0	251	0	0
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		Perm
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases				2					8			4
Detector Phase	5	5	2	2	1	1	6		8	8		4
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0	6.0	6.0	6.0	40.0		6.0	6.0		6.0
Minimum Split (s)	11.0	11.0	46.0	46.0	11.0	11.0	46.0		11.0	11.0		11.0
Total Split (s)	20.0	20.0	71.0	71.0	15.0	15.0	66.0		25.0	25.0		25.0
Total Split (%)	13.7%	13.7%	48.6%	48.6%	10.3%	10.3%	45.2%		17.1%	17.1%		17.1%
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)	1.0	1.0	2.0	2.0	1.0	1.0	2.0		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	6.0	6.0		5.0	6.0			5.0		
Lead/Lag	Lead	Lead	Lag	Lag	Lead	Lead	Lag					
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
Recall Mode	None	None	Min	Min	None	None	Min		None	None		None
Act Effct Green (s)		15.6	55.2	55.2		8.2	45.2			20.8		
Actuated g/C Ratio		0.14	0.50	0.50		0.07	0.41			0.19		
v/c Ratio		0.99	0.62	0.09		0.38	0.68			1.07		
Control Delay		103.6	25.6	4.9		63.6	31.3			121.2		
Queue Delay		0.0	0.0	0.0		0.0	0.0			0.0		
Total Delay		103.6	25.6	4.9		63.6	31.3			121.2		
LOS		F	C	A		E	C			F		
Approach Delay			37.9				32.8			121.2		
Approach LOS			D				C			F		
Queue Length 50th (ft)		138	225	0		26	225			142		
Queue Length 95th (ft)		#407	529	23		59	482			#369		
Internal Link Dist (ft)			555				1215			658		
Turn Bay Length (ft)		150		150		150						
Base Capacity (vph)		246	2187	921		159	1992			235		
Starvation Cap Reductn		0	0	0		0	0			0		
Spillback Cap Reductn		0	0	0		0	0			0		



Lane Group	SBT	SBR	Ø9
Lane Configurations			
Traffic Volume (vph)	75	140	
Future Volume (vph)	75	140	
Ideal Flow (vphpl)	1900	1900	
Lane Width (ft)	11	11	
Storage Length (ft)		150	
Storage Lanes		1	
Taper Length (ft)			
Right Turn on Red		Yes	
Link Speed (mph)	30		
Link Distance (ft)	625		
Travel Time (s)	14.2		
Confl. Peds. (#/hr)		16	
Peak Hour Factor	0.75	0.88	
Heavy Vehicles (%)	1%	1%	
Shared Lane Traffic (%)			
Lane Group Flow (vph)	136	159	
Turn Type	NA	Perm	
Protected Phases	4		9
Permitted Phases		4	
Detector Phase	4	4	
Switch Phase			
Minimum Initial (s)	6.0	6.0	6.0
Minimum Split (s)	11.0	11.0	35.0
Total Split (s)	25.0	25.0	35.0
Total Split (%)	17.1%	17.1%	24%
Yellow Time (s)	4.0	4.0	2.0
All-Red Time (s)	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	
Total Lost Time (s)	5.0	5.0	
Lead/Lag			
Lead-Lag Optimize?			
Recall Mode	None	None	None
Act Effct Green (s)	20.8	20.8	
Actuated g/C Ratio	0.19	0.19	
v/c Ratio	0.48	0.39	
Control Delay	51.9	10.9	
Queue Delay	0.0	0.0	
Total Delay	51.9	10.9	
LOS	D	B	
Approach Delay	29.8		
Approach LOS	C		
Queue Length 50th (ft)	68	0	
Queue Length 95th (ft)	159	62	
Internal Link Dist (ft)	545		
Turn Bay Length (ft)		150	
Base Capacity (vph)	281	409	
Starvation Cap Reductn	0	0	
Spillback Cap Reductn	0	0	

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Storage Cap Reductn		0	0	0		0	0			0		
Reduced v/c Ratio		0.99	0.51	0.07		0.30	0.49			1.07		

Intersection Summary	
Area Type:	Other
Cycle Length: 146	
Actuated Cycle Length: 109.5	
Natural Cycle: 135	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 1.07	
Intersection Signal Delay: 42.3	Intersection LOS: D
Intersection Capacity Utilization 82.5%	ICU Level of Service E
Analysis Period (min) 15	
Description: 16 / 7 / 16	

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

Splits and Phases: 4: Warren St/Sumner Rd & Route 9

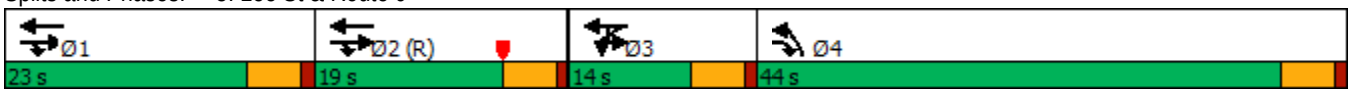
Lane Group	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø1	Ø2
Lane Configurations									
Traffic Volume (vph)	1029	293	4	126	980	351	229		
Future Volume (vph)	1029	293	4	126	980	351	229		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900		
Lane Width (ft)	12	11	11	11	12	11	11		
Storage Length (ft)		150		150		0	0		
Storage Lanes		1		1		2	0		
Taper Length (ft)				100		0			
Right Turn on Red		Yes					Yes		
Link Speed (mph)	30				30	30			
Link Distance (ft)	363				323	214			
Travel Time (s)	8.3				7.3	4.9			
Confl. Peds. (#/hr)		3	3	3			3		
Peak Hour Factor	0.89	0.85	0.50	0.95	0.94	0.88	0.88		
Heavy Vehicles (%)	2%	2%	0%	2%	3%	3%	2%		
Shared Lane Traffic (%)									
Lane Group Flow (vph)	1156	345	0	141	1043	659	0		
Turn Type	NA	pt+ov	Prot	Prot	NA	Prot			
Protected Phases	1 2	1 2 4	3	3	1 2 3	4		1	2
Permitted Phases									
Detector Phase	1 2	1 2 4	3	3	1 2 3	4			
Switch Phase									
Minimum Initial (s)			5.0	5.0		6.0		5.0	10.0
Minimum Split (s)			10.0	10.0		29.0		10.0	19.0
Total Split (s)			14.0	14.0		44.0		23.0	19.0
Total Split (%)			14.0%	14.0%		44.0%		23%	19%
Yellow Time (s)			4.0	4.0		4.0		4.0	4.0
All-Red Time (s)			1.0	1.0		1.0		1.0	1.0
Lost Time Adjust (s)				0.0		0.0			
Total Lost Time (s)				5.0		5.0			
Lead/Lag			Lead	Lead		Lag		Lead	Lag
Lead-Lag Optimize?			Yes	Yes		Yes			
Recall Mode			None	None		None		None	C-Max
Act Effct Green (s)	48.2	81.0		9.0	62.2	27.8			
Actuated g/C Ratio	0.48	0.81		0.09	0.62	0.28			
v/c Ratio	0.68	0.27		0.92	0.48	0.65			
Control Delay	12.3	1.0		100.0	12.4	19.2			
Queue Delay	0.4	0.4		0.0	0.5	4.6			
Total Delay	12.6	1.4		100.0	12.9	23.7			
LOS	B	A		F	B	C			
Approach Delay	10.0				23.3	23.7			
Approach LOS	B				C	C			
Queue Length 50th (ft)	150	8		91	173	179			
Queue Length 95th (ft)	#317	m14		#207	296	227			
Internal Link Dist (ft)	283				243	134			
Turn Bay Length (ft)		150		150					
Base Capacity (vph)	1704	1269		154	2178	1341			
Starvation Cap Reductn	159	493		0	0	594			
Spillback Cap Reductn	0	0		0	631	33			

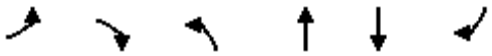
Lane Group	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø1	Ø2
Storage Cap Reductn	0	0		0	0	0			
Reduced v/c Ratio	0.75	0.44		0.92	0.67	0.88			

Intersection Summary			
Area Type:	Other		
Cycle Length: 100			
Actuated Cycle Length: 100			
Offset: 93 (93%), Referenced to phase 2:EBWB, Start of Yellow			
Natural Cycle: 70			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.92			
Intersection Signal Delay: 17.4		Intersection LOS: B	
Intersection Capacity Utilization 65.8%		ICU Level of Service C	
Analysis Period (min) 15			
Description: ø2 (NB): 0 / 1 / 3			
ø4 (WB): 0 / 1 / 3			

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: 5: Lee St & Route 9





Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	Ø1
Lane Configurations							
Traffic Volume (vph)	46	3	5	415	385	3	
Future Volume (vph)	46	3	5	415	385	3	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	
Right Turn on Red		Yes				Yes	
Link Speed (mph)	30			30	30		
Link Distance (ft)	617			535	214		
Travel Time (s)	14.0			12.2	4.9		
Confl. Peds. (#/hr)	2						
Peak Hour Factor	0.82	0.75	0.62	0.95	0.90	0.75	
Heavy Vehicles (%)	4%	0%	0%	3%	2%	0%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	60	0	0	445	432	0	
Turn Type	Prot		Perm	NA	NA		
Protected Phases	2			3	1 3		1
Permitted Phases			3				
Detector Phase	2		3	3	1 3		
Switch Phase							
Minimum Initial (s)	6.0		10.0	10.0			5.0
Minimum Split (s)	20.0		15.0	15.0			10.0
Total Split (s)	29.0		46.0	46.0			25.0
Total Split (%)	29.0%		46.0%	46.0%			25%
Yellow Time (s)	4.0		4.0	4.0			4.0
All-Red Time (s)	1.0		1.0	1.0			1.0
Lost Time Adjust (s)	0.0			0.0			
Total Lost Time (s)	5.0			5.0			
Lead/Lag	Lag						Lead
Lead-Lag Optimize?	Yes						Yes
Recall Mode	None		None	None			C-Max
Act Effct Green (s)	8.2			20.2	85.0		
Actuated g/C Ratio	0.08			0.20	0.85		
v/c Ratio	0.43			0.69	0.15		
Control Delay	50.9			42.1	3.4		
Queue Delay	0.0			0.8	0.3		
Total Delay	50.9			42.9	3.7		
LOS	D			D	A		
Approach Delay	50.9			42.9	3.7		
Approach LOS	D			D	A		
Queue Length 50th (ft)	35			139	42		
Queue Length 95th (ft)	67			176	m56		
Internal Link Dist (ft)	537			455	134		
Turn Bay Length (ft)							
Base Capacity (vph)	404			1312	2906		
Starvation Cap Reductn	0			0	1870		
Spillback Cap Reductn	10			554	0		
Storage Cap Reductn	0			0	0		
Reduced v/c Ratio	0.15			0.59	0.42		

Intersection Summary

Area Type:	Other	
Cycle Length: 100		
Actuated Cycle Length: 100		
Offset: 71 (71%), Referenced to phase 1:SBT, Start of Yellow		
Natural Cycle: 45		
Control Type: Actuated-Coordinated		
Maximum v/c Ratio: 0.69		
Intersection Signal Delay: 25.3		Intersection LOS: C
Intersection Capacity Utilization 28.3%		ICU Level of Service A
Analysis Period (min) 15		
Description: 1 / 0 / 2		
m Volume for 95th percentile queue is metered by upstream signal.		

Splits and Phases: 6: Lee St & Lee Street Extension

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	13	294	983	0	2	48	1059	321	0	0	0	315
Future Volume (vph)	13	294	983	0	2	48	1059	321	0	0	0	315
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11	12	11	11	11	11	11
Storage Length (ft)		250		0		175		225	0		0	125
Storage Lanes		1		0		1		1	0		0	1
Taper Length (ft)		100				100			0			100
Right Turn on Red				Yes				Yes			Yes	
Link Speed (mph)			30				30			30		
Link Distance (ft)			495				363			179		
Travel Time (s)			11.3				8.3			4.1		
Confl. Peds. (#/hr)	2	2				2		2				
Peak Hour Factor	0.46	0.94	0.91	0.92	0.50	0.75	0.95	0.94	0.92	0.92	0.92	0.88
Heavy Vehicles (%)	0%	1%	1%	2%	0%	0%	2%	5%	2%	2%	2%	5%
Shared Lane Traffic (%)												10%
Lane Group Flow (vph)	0	341	1080	0	0	68	1115	341	0	0	0	322
Turn Type	Prot	Prot	NA		Prot	Prot	NA	custom				Split
Protected Phases	4	4	1 4 5		2	2	1 2 5	1 2 3				3
Permitted Phases												
Detector Phase	4	4	1 4 5		2	2	1 2 5	1 2 3				3
Switch Phase												
Minimum Initial (s)	5.0	5.0			5.0	5.0						5.0
Minimum Split (s)	10.0	10.0			10.0	10.0						23.0
Total Split (s)	23.0	23.0			18.0	18.0						30.0
Total Split (%)	23.0%	23.0%			18.0%	18.0%						30.0%
Yellow Time (s)	4.0	4.0			4.0	4.0						4.0
All-Red Time (s)	1.0	1.0			1.0	1.0						1.0
Lost Time Adjust (s)		0.0				0.0						0.0
Total Lost Time (s)		5.0				5.0						5.0
Lead/Lag	Lag	Lag			Lag	Lag						Lead
Lead-Lag Optimize?	Yes	Yes			Yes	Yes						Yes
Recall Mode	None	None			Max	Max						None
Act Effct Green (s)		19.7	48.7			13.0	42.0	51.3				23.3
Actuated g/C Ratio		0.20	0.49			0.13	0.42	0.51				0.23
v/c Ratio		1.00	0.62			0.30	0.75	0.37				0.88
Control Delay		92.5	21.3			42.9	29.0	8.0				61.5
Queue Delay		0.0	0.1			0.0	2.4	0.5				0.0
Total Delay		92.5	21.4			42.9	31.5	8.6				61.5
LOS		F	C			D	C	A				E
Approach Delay			38.4				26.8					
Approach LOS			D				C					
Queue Length 50th (ft)		~247	265			43	344	51				204
Queue Length 95th (ft)		#421	336			71	427	135				#338
Internal Link Dist (ft)			415				283			99		
Turn Bay Length (ft)		250				175		225				125
Base Capacity (vph)		340	1738			226	1486	948				394
Starvation Cap Reductn		0	0			0	243	286				0
Spillback Cap Reductn		0	92			0	0	0				0

Lane Group	SBT	SBR	Ø1	Ø5
Lane Configurations				
Traffic Volume (vph)	27	285		
Future Volume (vph)	27	285		
Ideal Flow (vphpl)	1900	1900		
Lane Width (ft)	11	11		
Storage Length (ft)		100		
Storage Lanes		0		
Taper Length (ft)				
Right Turn on Red		Yes		
Link Speed (mph)	30			
Link Distance (ft)	916			
Travel Time (s)	20.8			
Confl. Peds. (#/hr)		2		
Peak Hour Factor	0.75	0.90		
Heavy Vehicles (%)	11%	1%		
Shared Lane Traffic (%)				
Lane Group Flow (vph)	389	0		
Turn Type	NA			
Protected Phases	3		1	5
Permitted Phases				
Detector Phase	3			
Switch Phase				
Minimum Initial (s)	5.0		1.0	5.0
Minimum Split (s)	23.0		6.0	19.0
Total Split (s)	30.0		10.0	19.0
Total Split (%)	30.0%		10%	19%
Yellow Time (s)	4.0		4.0	2.0
All-Red Time (s)	1.0		1.0	1.0
Lost Time Adjust (s)	0.0			
Total Lost Time (s)	5.0			
Lead/Lag	Lead		Lead	
Lead-Lag Optimize?	Yes		Yes	
Recall Mode	None		C-Max	None
Act Effct Green (s)	23.3			
Actuated g/C Ratio	0.23			
v/c Ratio	0.77			
Control Delay	27.0			
Queue Delay	0.1			
Total Delay	27.2			
LOS	C			
Approach Delay	42.7			
Approach LOS	D			
Queue Length 50th (ft)	109			
Queue Length 95th (ft)	149			
Internal Link Dist (ft)	836			
Turn Bay Length (ft)				
Base Capacity (vph)	526			
Starvation Cap Reductn	0			
Spillback Cap Reductn	5			

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Storage Cap Reductn		0	0			0	0	0				0
Reduced v/c Ratio		1.00	0.66			0.30	0.90	0.52				0.82

Intersection Summary			
Area Type:	Other		
Cycle Length: 100			
Actuated Cycle Length: 100			
Offset: 0 (0%), Referenced to phase 1:EBWB, Start of Yellow, Master Intersection			
Natural Cycle: 80			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 1.00			
Intersection Signal Delay: 34.4		Intersection LOS: C	
Intersection Capacity Utilization 77.0%		ICU Level of Service D	
Analysis Period (min) 15			
Description: ø3 (EB+WB): 9 / 2 / 2			
ø5 (SB): 12 / 2 / 2			

~ 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: 7: Heath St/Chestnut Hill Ave & Route 9

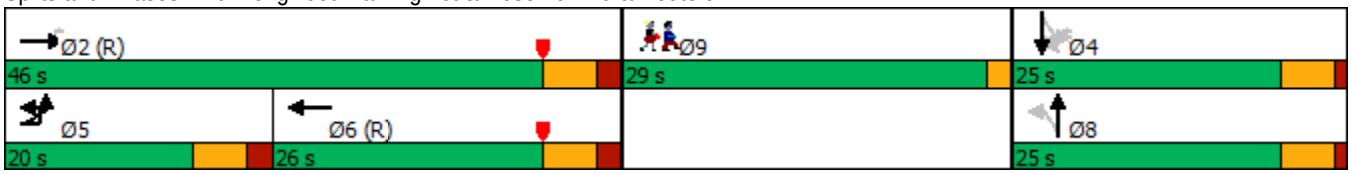
Lane Group	EBU	EBL	EBT	EBR	EBR2	WBT	WBR	NBL	NBT	NBR2	SBL2	SBL
Lane Configurations												
Traffic Volume (vph)	10	17	1363	14	4	1328	14	4	0	1	9	4
Future Volume (vph)	10	17	1363	14	4	1328	14	4	0	1	9	4
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)		250		0			0	0				0
Storage Lanes		1		0			0	0				0
Taper Length (ft)		100						0				0
Right Turn on Red					Yes		Yes			Yes		
Link Speed (mph)			30			30			30			
Link Distance (ft)			977			709			527			
Travel Time (s)			22.2			16.1			12.0			
Confl. Peds. (#/hr)		3		4	1		3			4	1	4
Peak Hour Factor	0.62	0.71	0.96	0.70	0.33	0.96	0.70	0.50	0.92	0.25	0.75	0.50
Heavy Vehicles (%)	0%	0%	1%	0%	0%	2%	0%	0%	0%	0%	0%	0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	40	1452	0	0	1403	0	0	12	0	0	0
Turn Type	Prot	Prot	NA			NA		Perm	NA		Perm	Perm
Protected Phases	5	5	2			6			8			
Permitted Phases								8			4	4
Detector Phase	5	5	2			6		8	8		4	4
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0			6.0		6.0	6.0		6.0	6.0
Minimum Split (s)	12.0	12.0	12.0			12.0		11.0	11.0		11.0	11.0
Total Split (s)	20.0	20.0	46.0			26.0		25.0	25.0		25.0	25.0
Total Split (%)	20.0%	20.0%	46.0%			26.0%		25.0%	25.0%		25.0%	25.0%
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		1.0	1.0		1.0	1.0
Lost Time Adjust (s)		0.0	0.0			0.0			0.0			
Total Lost Time (s)		6.0	6.0			6.0			5.0			
Lead/Lag	Lead	Lead				Lag						
Lead-Lag Optimize?	Yes	Yes				Yes						
Recall Mode	None	None	C-Min			C-Min		None	None		None	None
Act Effct Green (s)		7.9	84.0			75.0			6.0			
Actuated g/C Ratio		0.08	0.84			0.75			0.06			
v/c Ratio		0.29	0.50			0.55			0.06			
Control Delay		48.2	6.8			13.6			0.6			
Queue Delay		0.0	0.0			0.0			0.0			
Total Delay		48.2	6.8			13.6			0.6			
LOS		D	A			B			A			
Approach Delay			8.0			13.6			0.6			
Approach LOS			A			B			A			
Queue Length 50th (ft)		25	101			215			0			
Queue Length 95th (ft)		44	460			#674			0			
Internal Link Dist (ft)			897			629			447			
Turn Bay Length (ft)		250										
Base Capacity (vph)		244	2893			2561			417			
Starvation Cap Reductn		0	0			0			0			
Spillback Cap Reductn		0	0			0			0			
Storage Cap Reductn		0	0			0			0			

Lane Group	SBT	SBR	NWR2	Ø9
Lane Configurations				
Traffic Volume (vph)	0	6	8	
Future Volume (vph)	0	6	8	
Ideal Flow (vphpl)	1900	1900	1900	
Storage Length (ft)		0		
Storage Lanes		0		
Taper Length (ft)				
Right Turn on Red		Yes	Yes	
Link Speed (mph)	30			
Link Distance (ft)	854			
Travel Time (s)	19.4			
Confl. Peds. (#/hr)			1	
Peak Hour Factor	0.92	0.50	0.50	
Heavy Vehicles (%)	0%	0%	0%	
Shared Lane Traffic (%)				
Lane Group Flow (vph)	32	0	16	
Turn Type	NA		Perm	
Protected Phases	4			9
Permitted Phases			2 4	
Detector Phase	4		2 4	
Switch Phase				
Minimum Initial (s)	6.0			5.0
Minimum Split (s)	11.0			29.0
Total Split (s)	25.0			29.0
Total Split (%)	25.0%			29%
Yellow Time (s)	4.0			2.0
All-Red Time (s)	1.0			0.0
Lost Time Adjust (s)	0.0			
Total Lost Time (s)	5.0			
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	None			None
Act Effct Green (s)	6.0		93.0	
Actuated g/C Ratio	0.06		0.93	
v/c Ratio	0.16		0.01	
Control Delay	1.6		0.0	
Queue Delay	0.0		0.0	
Total Delay	1.6		0.0	
LOS	A		A	
Approach Delay	1.6			
Approach LOS	A			
Queue Length 50th (ft)	0		0	
Queue Length 95th (ft)	0		0	
Internal Link Dist (ft)	774			
Turn Bay Length (ft)				
Base Capacity (vph)	408		1535	
Starvation Cap Reductn	0		0	
Spillback Cap Reductn	0		0	
Storage Cap Reductn	0		0	

Lane Group	EBU	EBL	EBT	EBR	EBR2	WBT	WBR	NBL	NBT	NBR2	SBL2	SBL
Reduced v/c Ratio		0.16	0.50			0.55			0.03			

Intersection Summary			
Area Type:	Other		
Cycle Length: 100			
Actuated Cycle Length: 100			
Offset: 75 (75%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow			
Natural Cycle: 90			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.55			
Intersection Signal Delay: 10.5		Intersection LOS: B	
Intersection Capacity Utilization 62.4%		ICU Level of Service B	
Analysis Period (min) 15			
Description: 43 / 13 / 1			
# 95th percentile volume exceeds capacity, queue may be longer.			
Queue shown is maximum after two cycles.			

Splits and Phases: 9: Longwood Parking Lot & Reservoir Rd & Route 9



Lane Group	EBU	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	9	158	1058	45	145	1175	59	152	197	62	118	231
Future Volume (vph)	9	158	1058	45	145	1175	59	152	197	62	118	231
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	12	11	11	11	11	11	11
Storage Length (ft)		550		0	300		150	0		0	125	
Storage Lanes		1		0	1		1	0		0	1	
Taper Length (ft)		100			100			0			100	
Right Turn on Red				Yes			Yes			Yes		
Link Speed (mph)			30			30			30			30
Link Distance (ft)			726			711			307			575
Travel Time (s)			16.5			16.2			7.0			13.1
Confl. Peds. (#/hr)	19	11		7	7		11	19		18	18	
Peak Hour Factor	0.56	0.96	0.88	0.87	0.93	0.96	0.78	0.97	0.83	0.74	0.78	0.86
Heavy Vehicles (%)	0%	1%	1%	0%	3%	1%	3%	1%	3%	2%	3%	2%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	181	1254	0	156	1224	76	0	478	0	151	269
Turn Type	Prot	Prot	NA		Prot	NA	Prot	Perm	NA		Perm	NA
Protected Phases	1	1	6		5	2	2		4			8
Permitted Phases								4			8	
Detector Phase	1	1	6		5	2	2	4	4		8	8
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0		6.0	10.0	10.0	6.0	6.0		6.0	6.0
Minimum Split (s)	12.0	12.0	31.0		12.0	33.0	33.0	30.0	30.0		29.0	29.0
Total Split (s)	19.0	19.0	51.0		19.0	51.0	51.0	30.0	30.0		30.0	30.0
Total Split (%)	14.6%	14.6%	39.2%		14.6%	39.2%	39.2%	23.1%	23.1%		23.1%	23.1%
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0	4.0	3.0	3.0		3.0	3.0
All-Red Time (s)	2.0	2.0	2.0		2.0	2.0	2.0	3.0	3.0		3.0	3.0
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	Lag		Lead	Lag	Lag					
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes					
Recall Mode	None	None	C-Min		None	C-Min	C-Min	None	None		None	None
Act Effct Green (s)		13.0	45.0		13.0	45.0	45.0		24.0		24.0	24.0
Actuated g/C Ratio		0.10	0.35		0.10	0.35	0.35		0.18		0.18	0.18
v/c Ratio		1.05	1.02		0.92	0.99	0.13		2.28dl		0.97	0.81
Control Delay		138.5	72.3		109.4	65.5	1.1		187.5		118.7	70.3
Queue Delay		0.0	0.0		0.0	0.0	0.0		0.0		0.0	0.0
Total Delay		138.5	72.3		109.4	65.5	1.1		187.5		118.7	70.3
LOS		F	E		F	E	A		F		F	E
Approach Delay			80.6			66.8			187.5			65.1
Approach LOS			F			E			F			E
Queue Length 50th (ft)		~166	~586		132	537	0		~265		128	220
Queue Length 95th (ft)		#316	#699		#268	#696	0		#337		#214	#327
Internal Link Dist (ft)			646			631			227			495
Turn Bay Length (ft)		550			300		150				125	
Base Capacity (vph)		172	1231		169	1237	607		372		155	332
Starvation Cap Reductn		0	0		0	0	0		0		0	0
Spillback Cap Reductn		0	0		0	0	0		0		0	0

Lane Group	SBR
Lane Configurations	
Traffic Volume (vph)	156
Future Volume (vph)	156
Ideal Flow (vphpl)	1900
Lane Width (ft)	11
Storage Length (ft)	125
Storage Lanes	1
Taper Length (ft)	
Right Turn on Red	Yes
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Confl. Peds. (#/hr)	19
Peak Hour Factor	0.81
Heavy Vehicles (%)	1%
Shared Lane Traffic (%)	
Lane Group Flow (vph)	193
Turn Type	custom
Protected Phases	8
Permitted Phases	1
Detector Phase	8
Switch Phase	
Minimum Initial (s)	6.0
Minimum Split (s)	29.0
Total Split (s)	30.0
Total Split (%)	23.1%
Yellow Time (s)	3.0
All-Red Time (s)	3.0
Lost Time Adjust (s)	0.0
Total Lost Time (s)	6.0
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effct Green (s)	37.0
Actuated g/C Ratio	0.28
v/c Ratio	0.38
Control Delay	16.0
Queue Delay	0.0
Total Delay	16.0
LOS	B
Approach Delay	
Approach LOS	
Queue Length 50th (ft)	48
Queue Length 95th (ft)	90
Internal Link Dist (ft)	
Turn Bay Length (ft)	125
Base Capacity (vph)	513
Starvation Cap Reductn	0
Spillback Cap Reductn	0

Lane Group	EBU	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Storage Cap Reductn		0	0		0	0	0		0		0	0
Reduced v/c Ratio		1.05	1.02		0.92	0.99	0.13		1.28		0.97	0.81

Intersection Summary

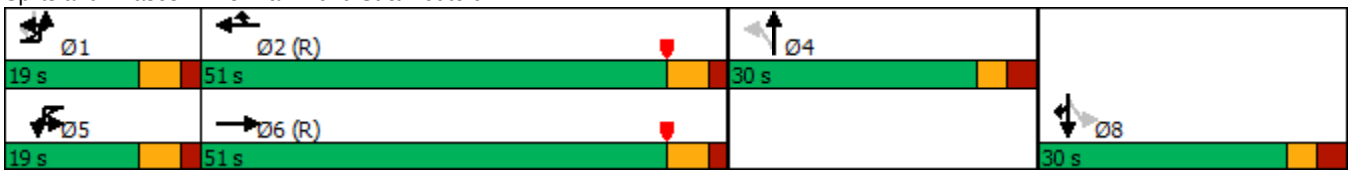
Area Type: Other
Cycle Length: 130
Actuated Cycle Length: 130
Offset: 0 (0%), Referenced to phase 2:WBT and 6:EBT, Start of Yellow
Natural Cycle: 135
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.28
Intersection Signal Delay: 86.0 Intersection LOS: F
Intersection Capacity Utilization 92.8% ICU Level of Service F
Analysis Period (min) 15
Description: ø2 (SB): 8 / 7 / 11
ø4 (WB): 19 / 23 / 18
ø6 (NB): 5 / 15 / 7
ø8 (EB): 26 / 28 / 19

~ 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: 13: Hammond St & Route 9



Intersection Capacity Analysis
Hammond St & Heath St

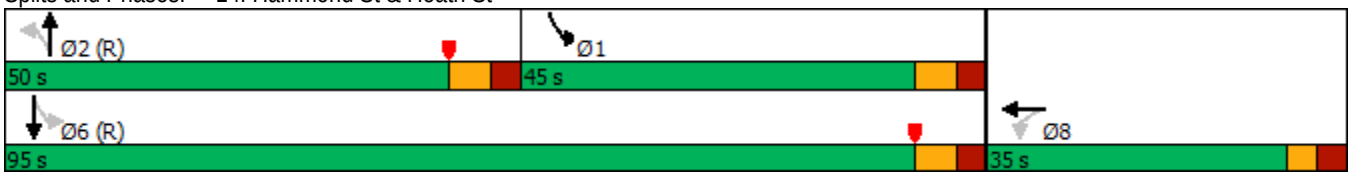
07/16/2019

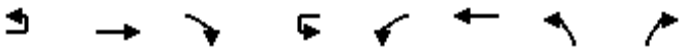
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	45	15	64	14	345	98	22	384	24
Future Volume (vph)	0	0	0	45	15	64	14	345	98	22	384	24
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		436			675			648			307	
Travel Time (s)		9.9			15.3			14.7			7.0	
Confl. Peds. (#/hr)						22	12		9	9		12
Peak Hour Factor	0.92	0.92	0.92	0.75	0.75	0.84	0.70	0.94	0.63	0.79	0.92	0.50
Heavy Vehicles (%)	2%	2%	2%	2%	0%	3%	0%	1%	1%	14%	2%	4%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	156	0	0	543	0	0	493	0
Turn Type				Perm	NA		Perm	NA		pm+pt	NA	
Protected Phases					8			2		1	6	
Permitted Phases				8			2			6		
Detector Phase				8	8		2	2		1	6	
Switch Phase												
Minimum Initial (s)				6.0	6.0		6.0	6.0		6.0	6.0	
Minimum Split (s)				16.0	16.0		17.0	17.0		13.0	17.0	
Total Split (s)				35.0	35.0		50.0	50.0		45.0	95.0	
Total Split (%)				26.9%	26.9%		38.5%	38.5%		34.6%	73.1%	
Yellow Time (s)				3.0	3.0		4.0	4.0		4.0	4.0	
All-Red Time (s)				3.0	3.0		3.0	3.0		3.0	3.0	
Lost Time Adjust (s)					0.0			0.0			0.0	
Total Lost Time (s)					6.0			7.0			7.0	
Lead/Lag							Lead	Lead		Lag		
Lead-Lag Optimize?							Yes	Yes		Yes		
Recall Mode				None	None		C-Min	C-Min		None	C-Min	
Act Effct Green (s)					14.7			102.3			102.3	
Actuated g/C Ratio					0.11			0.79			0.79	
v/c Ratio					0.75			0.23			0.21	
Control Delay					64.6			3.9			8.0	
Queue Delay					0.0			0.0			1.0	
Total Delay					64.6			3.9			8.9	
LOS					E			A			A	
Approach Delay					64.6			3.9			8.9	
Approach LOS					E			A			A	
Queue Length 50th (ft)					101			46			107	
Queue Length 95th (ft)					132			83			m118	
Internal Link Dist (ft)		356			595			568			227	
Turn Bay Length (ft)												
Base Capacity (vph)					376			2360			2341	
Starvation Cap Reductn					0			0			1527	
Spillback Cap Reductn					0			0			0	
Storage Cap Reductn					0			0			0	
Reduced v/c Ratio					0.41			0.23			0.61	

Intersection Summary

Area Type:	Other		
Cycle Length: 130			
Actuated Cycle Length: 130			
Offset: 90 (69%), Referenced to phase 2:NBTL and 6:SBTL, Start of Yellow			
Natural Cycle: 50			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.75			
Intersection Signal Delay: 13.9		Intersection LOS: B	
Intersection Capacity Utilization 47.1%		ICU Level of Service A	
Analysis Period (min) 15			
Description: ø2 (WB): 6 / 6 / 9			
ø6 (EB): 17 / 19 / 12			
ø8 (SB): 8 / 6 / 22			
m Volume for 95th percentile queue is metered by upstream signal.			

Splits and Phases: 14: Hammond St & Heath St





Lane Group	EBU	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø9
Lane Configurations									
Traffic Volume (vph)	151	1395	21	6	6	1258	16	16	
Future Volume (vph)	151	1395	21	6	6	1258	16	16	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	
Lane Width (ft)	11	12	11	11	11	12	11	11	
Storage Length (ft)	250		0		150		0	0	
Storage Lanes	1		0		1		1	0	
Taper Length (ft)	100				100		0		
Right Turn on Red			Yes					Yes	
Link Speed (mph)		30				30	30		
Link Distance (ft)		898				297	462		
Travel Time (s)		20.4				6.8	10.5		
Confl. Peds. (#/hr)	13		20		20		13		
Peak Hour Factor	0.94	0.92	0.66	0.50	0.38	0.89	0.67	0.67	
Heavy Vehicles (%)	1%	1%	0%	0%	0%	2%	0%	6%	
Shared Lane Traffic (%)									
Lane Group Flow (vph)	161	1548	0	0	28	1413	48	0	
Turn Type	Prot	NA		Prot	Prot	NA	Prot		
Protected Phases	5	2		1	1	6	8		9
Permitted Phases									
Detector Phase	5	2		1	1	6	8		
Switch Phase									
Minimum Initial (s)	6.0	10.0		6.0	6.0	10.0	1.0		5.0
Minimum Split (s)	12.0	23.0		12.0	12.0	23.0	7.0		32.0
Total Split (s)	19.0	59.0		19.0	19.0	59.0	20.0		32.0
Total Split (%)	14.6%	45.4%		14.6%	14.6%	45.4%	15.4%		25%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	3.0		2.0
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	3.0		1.0
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		Lead	Lead	Lag			
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes			
Recall Mode	None	C-Min		None	None	C-Min	Min		None
Act Effct Green (s)	16.6	89.2			7.1	74.8	7.7		
Actuated g/C Ratio	0.13	0.69			0.05	0.58	0.06		
v/c Ratio	0.73	0.63			0.30	0.69	0.40		
Control Delay	73.8	18.9			66.7	25.9	44.2		
Queue Delay	0.0	0.0			0.0	49.3	0.0		
Total Delay	73.8	18.9			66.7	75.2	44.2		
LOS	E	B			E	E	D		
Approach Delay		24.1				75.0	44.3		
Approach LOS		C				E	D		
Queue Length 50th (ft)	130	258			23	328	20		
Queue Length 95th (ft)	#242	#813			23	#760	39		
Internal Link Dist (ft)		818				217	382		
Turn Bay Length (ft)	250				150				
Base Capacity (vph)	221	2443			174	2036	196		
Starvation Cap Reductn	0	0			0	934	0		
Spillback Cap Reductn	0	0			0	0	0		

Lane Group	EBU	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø9
Storage Cap Reductn	0	0			0	0	0		
Reduced v/c Ratio	0.73	0.63			0.16	1.28	0.24		

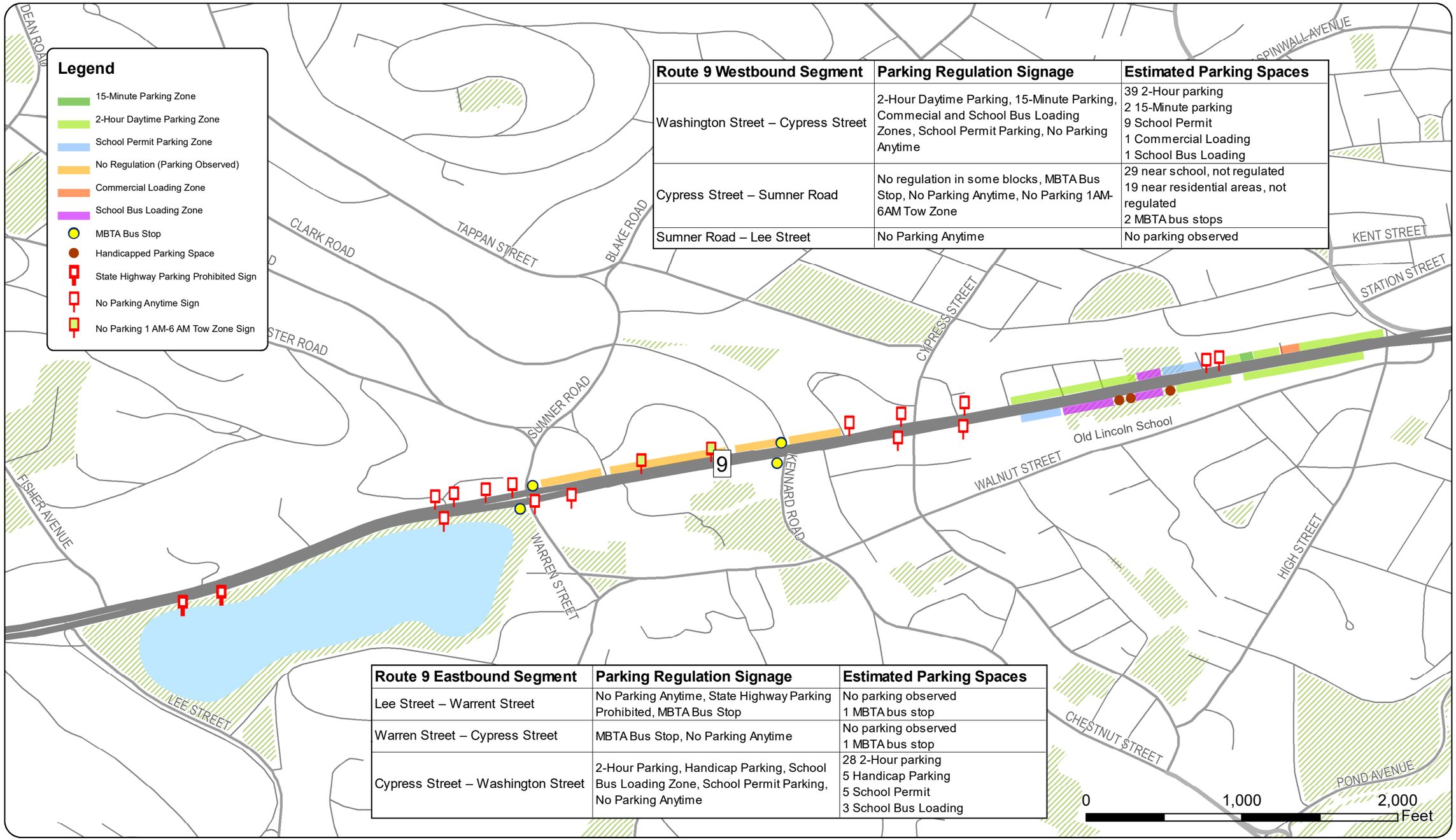
Intersection Summary			
Area Type:	Other		
Cycle Length: 130			
Actuated Cycle Length: 130			
Offset: 4 (3%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow			
Natural Cycle: 100			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.73			
Intersection Signal Delay: 47.3		Intersection LOS: D	
Intersection Capacity Utilization 62.6%		ICU Level of Service B	
Analysis Period (min) 15			
Description: 0 / 5 / 13			

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

Splits and Phases: 15: Tully St & Route 9

APPENDIX E

Route 9 On-Street Parking Signage and Estimated Spaces
March 2019



Route 9 Westbound Segment	Parking Regulation Signage	Estimated Parking Spaces
Washington Street – Cypress Street	2-Hour Daytime Parking, 15-Minute Parking, Commecial and School Bus Loading Zones, School Permit Parking, No Parking Anytime	39 2-Hour parking 2 15-Minute parking 9 School Permit 1 Commercial Loading 1 School Bus Loading
Cypress Street – Sumner Road	No regulation in some blocks, MBTA Bus Stop, No Parking Anytime, No Parking 1AM-6AM Tow Zone	29 near school, not regulated 19 near residential areas, not regulated 2 MBTA bus stops
Sumner Road – Lee Street	No Parking Anytime	No parking observed

Route 9 Eastbound Segment	Parking Regulation Signage	Estimated Parking Spaces
Lee Street – Warrent Street	No Parking Anytime, State Highway Parking Prohibited, MBTA Bus Stop	No parking observed 1 MBTA bus stop
Warren Street – Cypress Street	MBTA Bus Stop, No Parking Anytime	No parking observed 1 MBTA bus stop
Cypress Street – Washington Street	2-Hour Parking, Handicap Parking, School Bus Loading Zone, School Permit Parking, No Parking Anytime	28 2-Hour parking 5 Handicap Parking 5 School Permit 3 School Bus Loading

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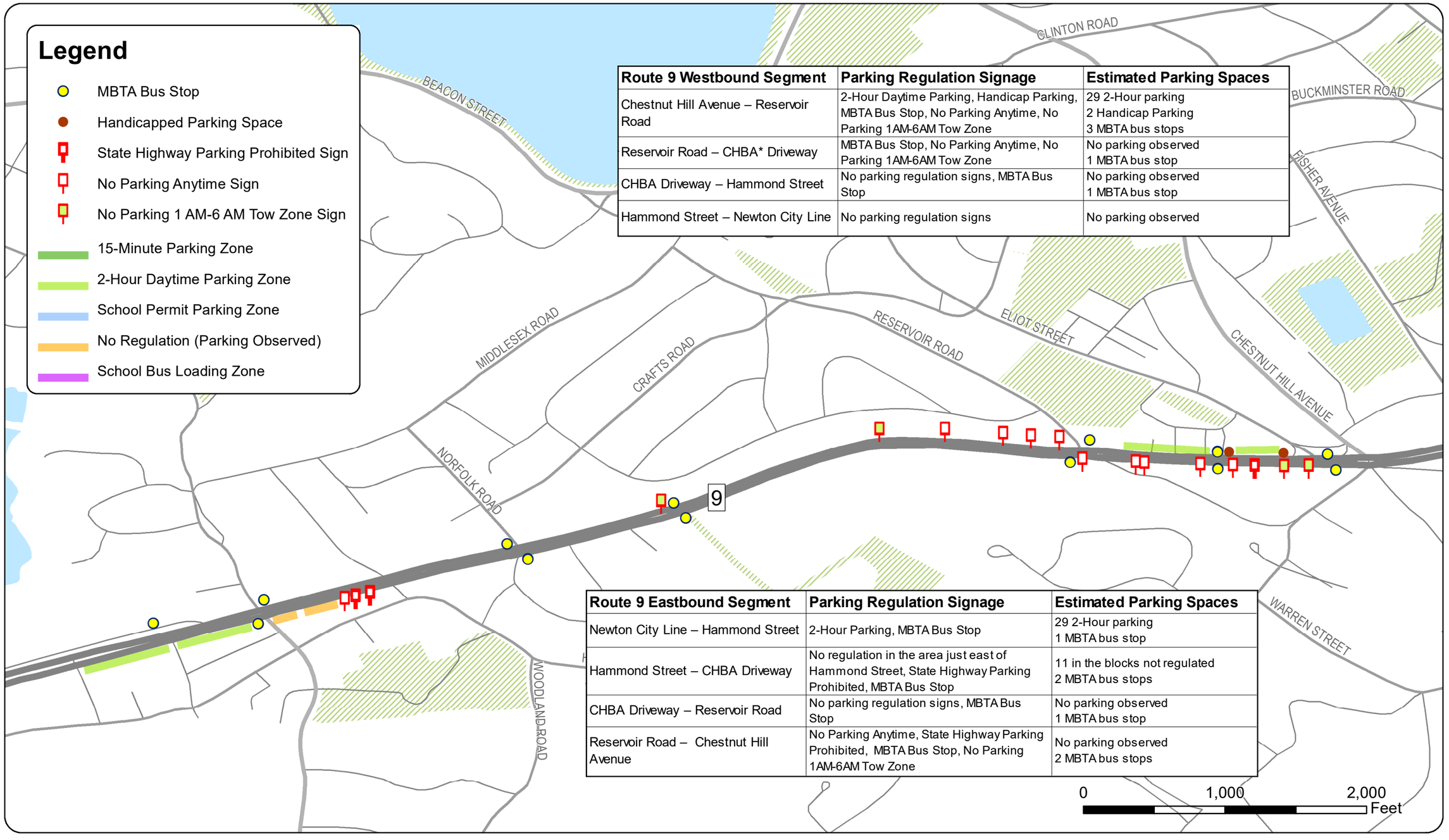
Figure E–1
Observed On-Street Parking Signage and Estimated parking Spaces (March, 2019)
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways



Route 9 Westbound Segment	Parking Regulation Signage	Estimated Parking Spaces
Chestnut Hill Avenue – Reservoir Road	2-Hour Daytime Parking, Handicap Parking, MBTA Bus Stop, No Parking Anytime, No Parking 1AM-6AM Tow Zone	29 2-Hour parking 2 Handicap Parking 3 MBTA bus stops
Reservoir Road – CHBA* Driveway	MBTA Bus Stop, No Parking Anytime, No Parking 1AM-6AM Tow Zone	No parking observed 1 MBTA bus stop
CHBA Driveway – Hammond Street	No parking regulation signs, MBTA Bus Stop	No parking observed 1 MBTA bus stop
Hammond Street – Newton City Line	No parking regulation signs	No parking observed

Route 9 Eastbound Segment	Parking Regulation Signage	Estimated Parking Spaces
Newton City Line – Hammond Street	2-Hour Parking, MBTA Bus Stop	29 2-Hour parking 1 MBTA bus stop
Hammond Street – CHBA Driveway	No regulation in the area just east of Hammond Street, State Highway Parking Prohibited, MBTA Bus Stop	11 in the blocks not regulated 2 MBTA bus stops
CHBA Driveway – Reservoir Road	No parking regulation signs, MBTA Bus Stop	No parking observed 1 MBTA bus stop
Reservoir Road – Chestnut Hill Avenue	No Parking Anytime, State Highway Parking Prohibited, MBTA Bus Stop, No Parking 1AM-6AM Tow Zone	No parking observed 2 MBTA bus stops

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Figure E–2
Observed Parking Signage and Estimated Parking Spaces (March, 2019)
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

APPENDIX F

Corridor and Intersection Crash Rate Worksheets

SEGMENT CRASH RATE WORKSHEET

CITY/TOWN : Brookline COUNT DATE : 11/29/2018

DISTRICT : 6

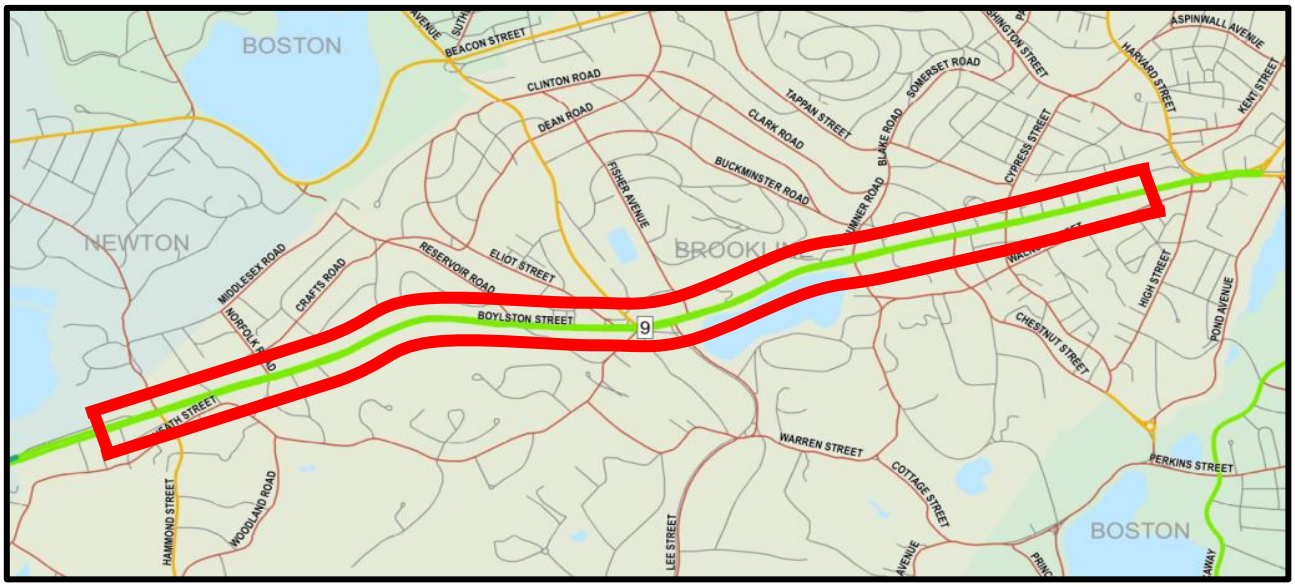
~ SEGMENT DATA ~

ROADWAY NAME: Boylston Street (Route 9)

START POINT: West of High Street

END POINT: Newton Town Line

FUNCTIONAL CLASSIFICATION OF ROADWAY: Principal Arterial - Other



SEGMENT LENGTH IN MILES (**L**):	**2.64**
AVERAGE DAILY TRAFFIC VOLUME (**V**):	37,700

TOTAL # OF CRASHES:	# OF YEARS :	AVERAGE # OF CRASHES PER YEAR (**A**) :
269	5.67	**47.47**

CRASH RATE CALCULATION : **1.31**

$$\text{RATE} = \frac{(A * 1{,}000{,}000)}{(L * V * 365)}$$

Comments : 2016 State Average for Urban Principal Arterial - Other = 3.49

Project Title & Date: Route 9 Priority Roadways Improvement Study

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Brookline | COUNT DATE : 11/29/2018

DISTRICT : 6 | UNSIGNALIZED : | SIGNALIZED : X

~ INTERSECTION DATA ~

MAJOR STREET : Route 9 (Boylston Street)

MINOR STREET(S) : Cypress Street

INTERSECTION DIAGRAM

PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	NB	SB		
PEAK HOURLY VOLUMES (AM/PM) :	1,214	946	388	487		**3,034**

" K " FACTOR : **0.090** | INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **33,711**

TOTAL # OF CRASHES : 25 | # OF YEARS : 5.67 | AVERAGE # OF CRASHES PER YEAR (**A**) : **4.41**

CRASH RATE CALCULATION : **0.36**

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

Comments : 2016 District 6 average for signalized intersections = 0.71

Project Title & Date: Route 9 Priority Roadways Improvement Study

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Brookline | COUNT DATE : 11/29/2018

DISTRICT : 6 | UNSIGNALIZED : | SIGNALIZED : X

~ INTERSECTION DATA ~

MAJOR STREET : Route 9 (Boylston Street)

MINOR STREET(S) : Warren Street

Sumner Road

INTERSECTION DIAGRAM

PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	NB	SB		
PEAK HOURLY VOLUMES (AM/PM) :	1,401	1,144	335	385		**3,264**

" K " FACTOR : **0.090** | INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **36,267**

TOTAL # OF CRASHES : 19 | # OF YEARS : 5.67 | AVERAGE # OF CRASHES PER YEAR (**A**) : **3.35**

CRASH RATE CALCULATION : **0.25**

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

Comments : 2016 District 6 average for signalized intersections = 0.71

Project Title & Date: Route 9 Priority Roadways Improvement Study

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Brookline | COUNT DATE : 11/29/2018

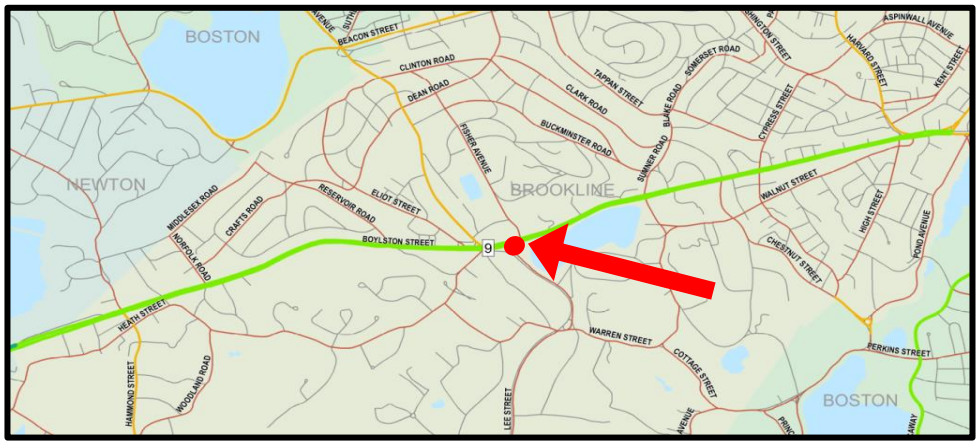
DISTRICT : 6 | UNSIGNALIZED : | SIGNALIZED : X

~ INTERSECTION DATA ~

MAJOR STREET : Route 9 (Boylston Street)

MINOR STREET(S) : Lee Street

INTERSECTION DIAGRAM



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	NB			
PEAK HOURLY VOLUMES (AM/PM) :	1,703	1,230	901			**3,834**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **42,594**

TOTAL # OF CRASHES : 18

OF YEARS : 5.67

AVERAGE # OF CRASHES PER YEAR (**A**) : **3.18**

CRASH RATE CALCULATION : **0.20**

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

Comments : 2016 District 6 average for signalized intersections = 0.71

Project Title & Date: Route 9 Priority Roadways Improvement Study

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Brookline | COUNT DATE : 11/29/2018

DISTRICT : 6 | UNSIGNALIZED : | SIGNALIZED : X

~ INTERSECTION DATA ~

MAJOR STREET : Route 9 (Boylston Street)

MINOR STREET(S) : Chestnut Hill Avenue

INTERSECTION DIAGRAM

PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	SB			
PEAK HOURLY VOLUMES (AM/PM) :	1,524	1,820	752			**4,096**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **45,506**

TOTAL # OF CRASHES : 27

OF YEARS : 5.67

AVERAGE # OF CRASHES PER YEAR (**A**) : **4.76**

CRASH RATE CALCULATION : **0.29**

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

Comments : 2016 District 6 average for signalized intersections = 0.71

Project Title & Date: Route 9 Priority Roadways Improvement Study

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Brookline | COUNT DATE : 11/29/2018

DISTRICT : 6 | UNSIGNALIZED : | SIGNALIZED : X

~ INTERSECTION DATA ~

MAJOR STREET : Route 9 (Boylston Street)

MINOR STREET(S) : Reservoir Road

Medical Center Driveway

INTERSECTION DIAGRAM

PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	NB	SB	NE	
PEAK HOURLY VOLUMES (AM/PM) :	1,544	1,358	8	39	72	**3,021**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **33,561**

TOTAL # OF CRASHES : 16

OF YEARS : 5.67

AVERAGE # OF CRASHES PER YEAR (**A**) : **2.82**

CRASH RATE CALCULATION : **0.23**

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

Comments : 2016 District 6 average for signalized intersections = 0.71

Project Title & Date: Route 9 Priority Roadways Improvement Study

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Brookline | COUNT DATE : 11/29/2018

DISTRICT : 6 | UNSIGNALIZED : X | SIGNALIZED :

~ INTERSECTION DATA ~

MAJOR STREET : Route 9 (Boylston Street)

MINOR STREET(S) : Chestnut Hill Benevolent Association Driveway

INTERSECTION DIAGRAM

PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	NB			
PEAK HOURLY VOLUMES (AM/PM) :	1,554	1,378	10			**2,941**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **32,678**

TOTAL # OF CRASHES : 8

OF YEARS : 5.67

AVERAGE # OF CRASHES PER YEAR (**A**) : **1.41**

CRASH RATE CALCULATION : **0.12**

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

Comments : 2016 District 6 average for unsignalized intersections = 0.52

Project Title & Date: Route 9 Priority Roadways Improvement Study

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Brookline | COUNT DATE : 11/29/2018

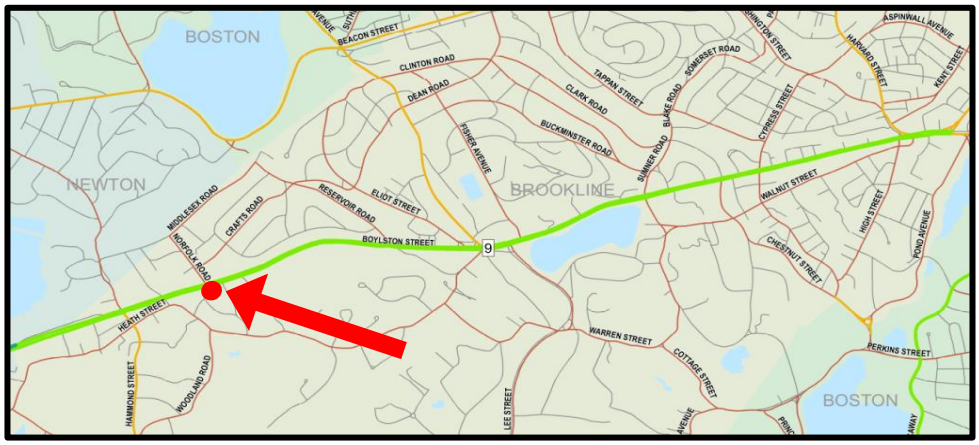
DISTRICT : 6 | UNSIGNALIZED : X | SIGNALIZED :

~ INTERSECTION DATA ~

MAJOR STREET : Route 9 Westbound (Boylston Street)

MINOR STREET(S) : Dunster Road

INTERSECTION DIAGRAM



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	WB	SB				
PEAK HOURLY VOLUMES (AM/PM) :	1,462	15				**1,477**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **16,406**

TOTAL # OF CRASHES : 13

OF YEARS : 5.67

AVERAGE # OF CRASHES PER YEAR (**A**) : **2.29**

CRASH RATE CALCULATION : **0.38**

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

Comments : 2016 District 6 average for unsignalized intersections = 0.52

Project Title & Date: Route 9 Priority Roadways Improvement Study

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Brookline | COUNT DATE : 11/29/2018

DISTRICT : 6 | UNSIGNALIZED : | SIGNALIZED : X

~ INTERSECTION DATA ~

MAJOR STREET : Route 9 (Boylston Street)

MINOR STREET(S) : Hammond Street

INTERSECTION DIAGRAM

PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	NB	SB		
PEAK HOURLY VOLUMES (AM/PM) :	1,298	1,423	503	576		**3,799**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **42,206**

TOTAL # OF CRASHES : 21 | # OF YEARS : 5.67 | AVERAGE # OF CRASHES PER YEAR (**A**) : **3.71**

CRASH RATE CALCULATION : **0.24**

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

Comments : 2016 District 6 average for signalized intersections = 0.71

Project Title & Date: Route 9 Priority Roadways Improvement Study

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Brookline | COUNT DATE : 11/29/2018

DISTRICT : 6 | UNSIGNALIZED : | SIGNALIZED : X

~ INTERSECTION DATA ~

MAJOR STREET : Route 9 (Boylston Street)

MINOR STREET(S) : Tully Street

INTERSECTION DIAGRAM

PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	NB			
PEAK HOURLY VOLUMES (AM/PM) :	1,477	1,303	87			**2,866**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **31,839**

TOTAL # OF CRASHES : 14

OF YEARS : 5.67

AVERAGE # OF CRASHES PER YEAR (**A**) : **2.47**

CRASH RATE CALCULATION : **0.21**

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

Comments : 2016 District 6 average for signalized intersections = 0.71

Project Title & Date: Route 9 Priority Roadways Improvement Study

APPENDIX G

Collision Diagrams and Crash Look-Up Tables
Nine Contiguous Segments in the Study Corridor

Symbols		Types of Crash		Severity
Moving Vehicle	Parked Vehicle	Head On	Sideswipe	Injury Accident
Backing Vehicle	Fixed Object	Angle	Out of Control	Fatal Accident
Pedestrian	Bicycle	Rear End		
Non-Involved Pedestrian	Animal			

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Figure G–1
Collision Diagram: Route 9 between Washington Street and Cypress Street
Brookline Police Department Crash Data: January 2013–August 2018

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

Symbols		Types of Crash		Severity
Moving Vehicle	Parked Vehicle	Head On	Sideswipe	Injury Accident
Backing Vehicle	Fixed Object	Angle	Out of Control	Fatal Accident
Pedestrian	Bicycle	Rear End		
Non-Involved Pedestrian	Animal			

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Figure G–2
Collision Diagram: Route 9 at Cypress Street and Clark Road/Kennard Road
Brookline Police Department Crash Data: January 2013–August 2018

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

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Figure G–3
Collision Diagram: Route 9 at Sumner Road/Warren Street and Adjacent Sections
Brookline Police Department Crash Data: January 2013–August 2018

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

Symbols		Types of Crash		Severity
Moving Vehicle	Parked Vehicle	Head On	Sideswipe	Injury Accident
Backing Vehicle	Fixed Object	Angle	Out of Control	Fatal Accident
Pedestrian	Bicycle	Rear End		
Non-Involved Pedestrian	Animal			

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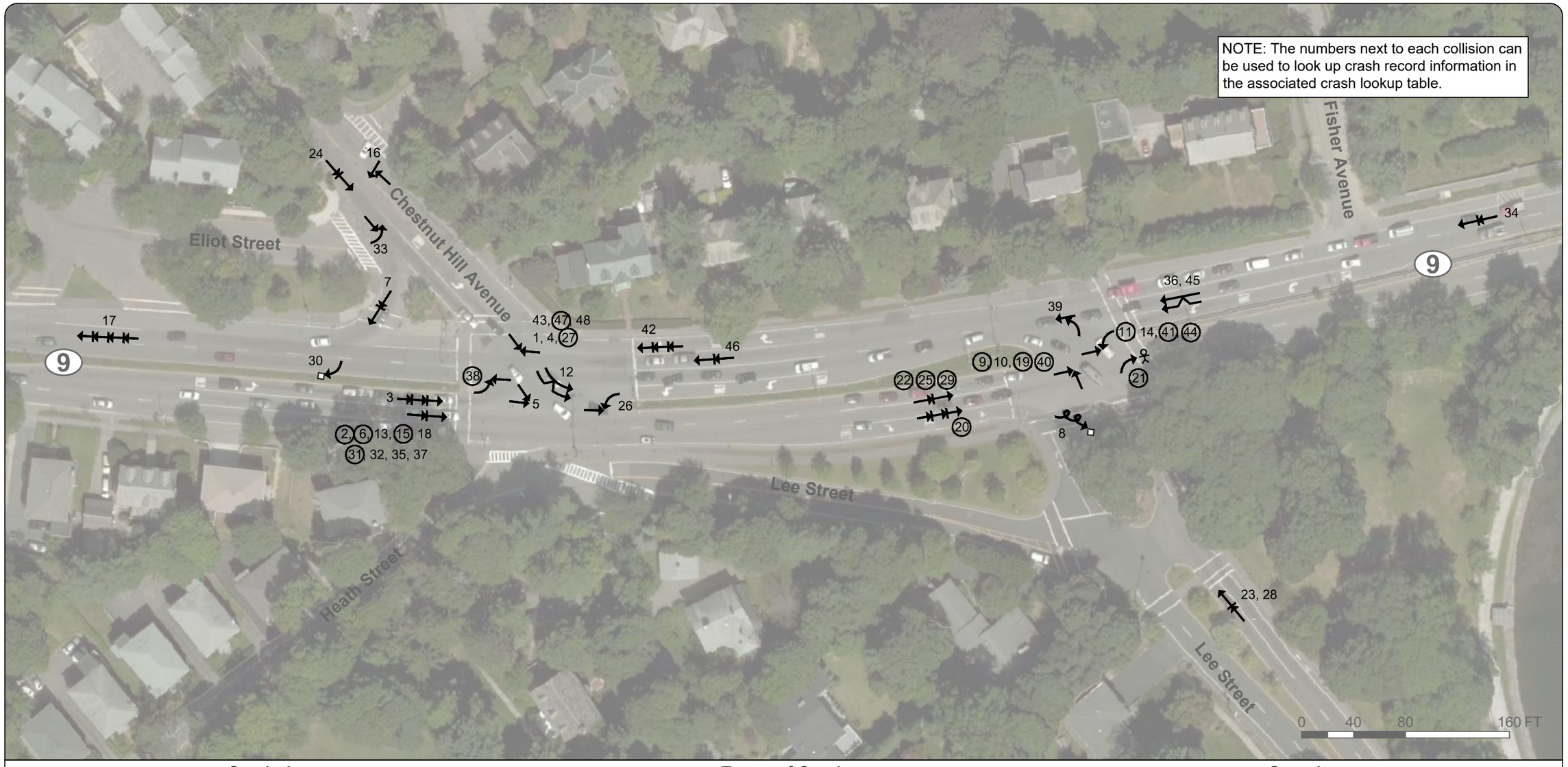
Figure G–4
Collision Diagram: Route 9 between Sumner Road/Warren Street and Lee Street
Brookline Police Department Crash Data: January 2013–August 2018

Addressing Safety, Mobility, and Access on Subregional Priority Roadways



Symbols

- Moving Vehicle
- Backing Vehicle
- Pedestrian
- Non-Involved Pedestrian
- Parked Vehicle
- Fixed Object
- Bicycle
- Animal

Types of Crash

- Head On
- Angle
- Rear End
- Sideswipe
- Out of Control

Severity

- Injury Accident
- Fatal Accident

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Figure G–5
Collision Diagram: Route 9 at Lee Street and Chestnut Hill Avenue
Brookline Police Department Crash Data: January 2013–August 2018

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

Symbols

- Moving Vehicle
- Backing Vehicle
- Pedestrian
- Non-Involved Pedestrian
- Parked Vehicle
- Fixed Object
- Bicycle
- Animal

Types of Crash

- Head On
- Angle
- Rear End
- Sideswipe
- Out of Control

Severity

- Injury Accident
- Fatal Accident

BOSTON REGION MPO

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Figure G–6
Collision Diagram: Route 9 at Reservoir Road and Adjacent Streets
Brookline Police Department Crash Data: January 2013–August 2018

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

Symbols		Types of Crash		Severity
Moving Vehicle	Parked Vehicle	Head On	Sideswipe	Injury Accident
Backing Vehicle	Fixed Object	Angle	Out of Control	Fatal Accident
Pedestrian	Bicycle	Rear End		
Non-Involved Pedestrian	Animal			

BOSTON REGION MPO

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Figure G–7
Collision Diagram: Route 9 between Reservoir Road and Dunster Road
Brookline Police Department Crash Data: January 2013–August 2018

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

Symbols

- Moving Vehicle
- Backing Vehicle
- Pedestrian
- Non-Involved Pedestrian
- Parked Vehicle
- Fixed Object
- Bicycle
- Animal

Types of Crash

- Head On
- Angle
- Rear End
- Sideswipe
- Out of Control

Severity

- Injury Accident
- Fatal Accident

BOSTON REGION MPO

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Figure G–8
Collision Diagram: Route 9 at Dunster Road and Hammond Street
Brookline Police Department Crash Data: January 2013–August 2018

Symbols		Types of Crash		Severity
Moving Vehicle	Parked Vehicle	Head On	Sideswipe	Injury Accident
Backing Vehicle	Fixed Object	Angle	Out of Control	Fatal Accident
Pedestrian	Bicycle	Rear End		
Non-Involved Pedestrian	Animal			

BOSTON REGION MPO

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Figure G–9
Collision Diagram: Route 9 between Newton City Line and Hammond Street
Brookline Police Department Crash Data: January 2013–August 2018

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

Table G-1

Crash Lookup Table: Route 9 between Washington Street and Cypress Street

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
1	2013-08-30	Fri	1:41 AM	Off-peak	2	0		Sideswipe, same direction	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Distracted / Swerving due to wind, slippery surface, or	
2	2013-10-24	Thu	8:15 AM	Peak	2	1	Possible	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	Other improper action	
3	2013-12-12	Thu	7:43 AM	Peak	4	2	Possible	Sideswipe, same direction	Dry	Daylight	Clear	Travelling straight ahead	Other fixed object (wall, building, tunnel)	Unknown	
4	2014-10-30	Thu	6:05 PM	Peak	3	0	Property damage only	Single vehicle crash	Dry	Dusk	Clear	Parked	Motor vehicle in traffic	No improper action	
5	2014-11-01	Sat	10:45 PM	Off-peak	3	0	Property damage only	Rear-end	Wet	Dark - lighted roadway	Rain	Travelling straight ahead	Parked motor vehicle	Unknown	
6	2015-03-08	Sun	6:15 PM	Peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Travelling straight ahead	Parked motor vehicle	Glare / Visibility obstructed	
7	2015-08-29	Sat	7:35 AM	Peak	1	0	Possible	Single vehicle crash	Dry	Daylight	Clear	Parked	Cyclist	Other improper action	Cyclist
8	2015-10-30	Fri	1:40 PM	Off-peak	5	0	Property damage only	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Failure to keep in proper lane	
9	2015-12-23	Wed	7:00 PM	Peak	4	2	Possible	Single vehicle crash	Wet	Dark - lighted roadway	Rain	Travelling straight ahead	Motor vehicle in traffic	Failure to keep in proper lane	
10	2015-12-25	Fri	12:46 AM	Off-peak	1	0	Property damage only	Single vehicle crash	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Light pole or other post/support	Distracted	
11	2016-02-05	Fri	11:25 AM	Off-peak	2	0	Possible	Rear-end	Snow	Daylight	Snow	Slowing or stopped	Motor vehicle in traffic	No improper action	Work zone
12	2016-02-12	Fri	9:06 PM	Off-peak	2	0	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
13	2016-04-12	Tue	2:10 PM	Off-peak	3	0	Property damage only	Single vehicle crash	Wet	Daylight	Rain	Travelling straight ahead	Parked motor vehicle	Failure to keep in proper lane	
14	2016-06-01	Wed	2:00 PM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Turning right	Motor vehicle in traffic	No improper action	
15	2016-06-04	Sat	2:15 PM	Off-peak	3	1	Non-fatal injury	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Failure to keep in proper lane	
16	2016-07-30	Sat	7:01 AM	Peak	1	1	Incapacitating	Single vehicle crash	Dry	Daylight	Clear	Changing lanes	Light pole or other post/support	Failure to keep in proper lane / Other improper action	
17	2016-09-21	Wed	2:45 PM	Off-peak	1	0	Property damage only	Single vehicle crash	Dry	Daylight	Clear	Leaving traffic lane	Light pole or other post/support	Disregarding traffic signs	School bus
18	2016-10-13	Thu	3:16 PM	Peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
19	2017-01-31	Tue	6:30 PM	Peak	2	0	Property damage only	Sideswipe, same direction	Wet	Dark - lighted roadway	Rain	Changing lanes	Motor vehicle in traffic	No improper action	
20	2017-04-27	Thu	10:06 PM	Off-peak	2	0		Single vehicle crash	Dry	Dark - unknown roadway lighting	Clear	Travelling straight ahead	Impact attenuator/crash	Exceeding speed limit	
21	2017-07-10	Mon	7:10 AM	Peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Parked	Parked motor vehicle	Unknown	

Table G-1
Crash Lookup Table: Route 9 between Washington Street and Cypress Street

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
22	2017-08-03	Thu	12:31 AM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Parked motor vehicle	Fatigued/Sleep	
23	2017-08-05	Sat	11:31 PM	Off-peak	2	0	Property damage only	Single vehicle crash	Dry	Dark - lighted roadway	Clear	Parked	Parked motor vehicle	No improper action	
24	2017-09-11	Mon	6:51 AM	Peak	2	1	Non-fatal injury	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Illness	
25	2018-01-05	Fri	6:18 PM	Peak	20	0	Property damage only	Rear-end	Wet	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
26	2018-01-22	Mon	6:47 AM	Peak	2	0	Property damage only	Sideswipe, same direction	Wet	Daylight	Rain	Changing lanes	Parked motor vehicle	No improper action	
27	2018-03-25	Sun	12:30 PM	Off-peak	2	1	Incapacitating	Sideswipe, same direction	Dry	Daylight	Clear	Entering traffic lane	Parked motor vehicle	Driving too fast for conditions	
28	2018-03-30	Fri	10:21 PM	Off-peak	3	2	Non-fatal injury	Sideswipe, same direction	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Parked motor vehicle	Failure to keep in proper lane	

Table G-2

Crash Lookup Table: Route 9 at Cypress Street and Clark Road/Kennard Road

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
1	2013-01-04	Fri	10:00 AM	Peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Travelling straight ahead	Parked motor vehicle	No improper action	
2	2013-02-07	Thu	1:32 PM	Off-peak	3	1	Possible	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
3	2013-05-22	Wed	5:15 PM	Peak	2	0	Property damage only	Angle	Dry	Daylight	Cloudy	Turning right	Motor vehicle in traffic	No improper action	
4	2013-06-13	Thu	4:00 PM	Peak	2	0	Property damage only	Angle	Wet	Daylight	Rain	Turning left	Motor vehicle in traffic	No improper action	
5	2013-10-08	Tue	7:48 AM	Peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
6	2013-10-16	Wed	11:00 PM	Off-peak	2	0		Rear-end	Dry	Dark - lighted roadway	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
7	2013-10-22	Tue	9:00 AM	Peak	3	2	Possible	Angle	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Erratic or reckless operation / Failure to keep	
8	2013-11-18	Mon	11:35 AM	Off-peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
9	2013-11-30	Sat	10:44 AM	Off-peak	2	1	Non-fatal injury	Angle	Dry	Daylight	Clear	Turning left	Cyclist	Glare	Cyclist
10	2013-12-04	Wed	11:05 AM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
11	2014-02-16	Sun	5:50 PM	Peak	3	2	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
12	2014-04-08	Tue	1:42 PM	Off-peak	2	0	Unknown	Sideswipe, same direction	Dry	Daylight	Cloudy	Travelling straight ahead	Parked motor vehicle	Unknown	
13	2014-05-07	Wed	8:20 AM	Peak	2	0	Possible	Angle	Dry	Daylight	Clear	Changing lanes	Motor vehicle in traffic	Follow too closely / Fail to yield right of way	
14	2014-09-04	Thu	6:20 PM	Peak	2	0	Possible	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
15	2014-09-22	Mon	12:15 PM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic		
16	2014-11-03	Mon	5:45 PM	Peak	3	1	Possible	Rear-end	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
17	2015-01-03	Sat	5:25 PM	Peak	2	1	Possible	Angle	Snow	Dark - lighted roadway	Snow	Travelling straight ahead	Motor vehicle in traffic	No improper action	
18	2015-02-28	Sat	4:11 PM	Peak	2	0	Property damage only	Sideswipe, same direction	Wet	Daylight	Clear	Changing lanes	Motor vehicle in traffic	Fail to yield right of way / Erratic or reckless	Work zone
19	2015-07-24	Fri	6:43 PM	Peak	2	0	Property damage only	Angle	Dry	Daylight	Clear	Travelling straight ahead	Immersion	No improper action	
20	2015-10-04	Sun	5:00 AM	Off-peak	1	0	Property damage only	Single vehicle crash	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Parked motor vehicle	Fatigued/Sleep	
21	2015-10-12	Mon	10:40 PM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	

Table G-2
Crash Lookup Table: Route 9 at Cypress Street and Clark Road/Kennard Road

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
22	2015-10-15	Thu	7:15 PM	Off-peak	3	1	Non-fatal injury	Rear-end	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Erratic or reckless operation	
23	2016-07-01	Fri	4:15 PM	Peak	1	1	Possible	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
24	2016-09-17	Sat	1:34 AM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Dry	Dark - lighted roadway	Clear	Turning left	Motor vehicle in traffic	Made improper turn	
25	2016-12-12	Mon	7:10 PM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Wet	Dark - lighted roadway	Cloudy	Travelling straight ahead	Motor vehicle in traffic	No improper action	
26	2017-01-16	Mon	7:35 AM	Peak	4	0		Single vehicle crash	Dry	Dark - lighted roadway	Clear	Turning right	Parked motor vehicle	Made improper turn / Driving too fast for	
27	2017-04-08	Sat	12:29 AM	Off-peak	2	0	Property damage only	Single vehicle crash	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Parked motor vehicle	Fatigued/Sleep	
28	2017-06-02	Fri	9:06 AM	Peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
29	2017-06-24	Sat	6:55 PM	Peak	1	0	Property damage only	Single vehicle crash	Dry	Daylight	Clear	Turning left	Light pole or other post/support	Glare	
30	2017-07-07	Fri	11:50 AM	Off-peak	2	0	Possible	Sideswipe, same direction	Wet	Daylight	Rain	Changing lanes	Motor vehicle in traffic	Failure to keep in proper lane	
31	2018-01-05	Fri	8:27 AM	Peak	2	0	Property damage only	Rear-end	Snow	Daylight	Cloudy	Slowing or stopped	Motor vehicle in traffic	No improper action	
32	2018-05-03	Thu	1:45 PM	Off-peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
33	2018-07-13	Fri	1:30 PM	Off-peak	2	1	Non-fatal injury	Sideswipe, same direction	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Inattention	
34	2018-08-13	Mon	6:50 AM	Peak	4	1	Non-fatal injury	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Parked motor vehicle	Failure to keep in proper lane / Inattention	

Table G-3
Crash Lookup Table: Route 9 at Sumner Road/Warren Street and Adjacent Sections

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
1	2013-01-16	Wed	5:49 PM	Peak	1	0	Property damage only	Single vehicle crash	Wet	Dark - lighted roadway	Cloudy	Travelling straight ahead	Cyclist	Fail to yield right of way	Cyclist
2	2013-01-19	Sat	3:05 AM	Off-peak	1	0	Property damage only	Single vehicle crash	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Light pole or other post/support	Failure to keep in proper lane / Fatigued/Sleep	
3	2013-03-07	Thu	7:25 PM	Off-peak	3	2	Non-fatal injury	Rear-end	Wet	Dark - lighted roadway	Rain	Travelling straight ahead	Motor vehicle in traffic	Failure to keep in proper lane / Other improper action	
4	2013-06-07	Fri	8:00 AM	Peak	2	0	Property damage only	Rear-end	Wet	Daylight	Rain	Slowing or stopped	Motor vehicle in traffic	No improper action	
5	2013-10-10	Thu	7:02 PM	Off-peak	3	1	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
6	2013-11-16	Sat	4:00 AM	Off-peak	1	0	Property damage only	Single vehicle crash	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Median barrier	Exceeding speed limit / Failure to keep in proper	
7	2013-12-09	Mon	6:30 AM	Peak	1	1	Property damage only	Single vehicle crash	Ice	Dawn	Rain	Travelling straight ahead	Curb	No improper action	
8	2014-01-04	Sat	11:20 AM	Off-peak	2	0	Property damage only	Angle	Snow	Daylight	Clear	Changing lanes	Motor vehicle in traffic	Made improper turn	
9	2014-02-02	Sun	11:55 AM	Off-peak	1	1	Possible	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Cross median/centerline		
10	2014-03-23	Sun	2:30 AM	Off-peak	2	1	Non-fatal injury	Angle	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
11	2014-06-18	Wed	2:39 PM	Off-peak	2	1	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
12	2014-09-19	Fri	8:30 AM	Peak	4	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
13	2014-09-22	Mon	2:00 PM	Off-peak	2	1	Possible	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Erratic or reckless operation / Inattention	Work zone
14	2014-12-24	Wed	9:40 PM	Off-peak	3	0	Property damage only	Single vehicle crash	Wet	Dark - lighted roadway	Rain	Travelling straight ahead	Parked motor vehicle	Swerving due to wind, slippery surface, or object	
15	2015-06-11	Thu	3:15 PM	Peak	3	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
16	2015-09-21	Mon	7:20 PM	Off-peak	3	1	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
17	2015-10-30	Fri	5:28 PM	Peak	3	1	Possible	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
18	2015-12-01	Tue	5:25 PM	Peak	2	0	Property damage only	Rear-end	Wet	Dark - lighted roadway	Cloudy	Slowing or stopped	Motor vehicle in traffic	No improper action	
19	2016-02-11	Thu	4:41 PM	Peak	3	0	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
20	2016-04-01	Fri	9:35 PM	Off-peak	2	0	Possible	Angle	Wet	Dark - lighted roadway	Rain	Travelling straight ahead	Motor vehicle in traffic	Disregarding traffic signs / Fail to yield right of way	
21	2017-02-03	Fri	1:30 PM	Off-peak	2	0	Property damage only	Head on	Dry	Daylight	Clear	Turning left	Motor vehicle in traffic	Failure to keep in proper lane	

Table G-3
Crash Lookup Table: Route 9 at Sumner Road/Warren Street and Adjacent Sections

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
22	2017-02-17	Fri	7:38 AM	Peak	2	0	Property damage only	Angle	Dry	Daylight	Clear	Turning left	Motor vehicle in traffic	No improper action	
23	2017-03-22	Wed	8:08 PM	Off-peak	2	2	Possible	Angle	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
24	2017-09-16	Sat	2:16 AM	Off-peak	1	0	Property damage only	Single vehicle crash	Wet	Dark - lighted roadway	Rain	Travelling straight ahead	Guardrail	Fatigued/Sleep / Failure to keep in proper lane	
25	2017-10-27	Fri	6:45 PM	Peak	2	0	Property damage only	Sideswipe, same direction	Dry	Dusk	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
26	2017-12-08	Fri	2:28 PM	Off-peak	3	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
27	2017-12-30	Sat	2:45 PM	Off-peak	2	1	Non-fatal injury	Rear-end	Dry	Daylight	Cloudy	Slowing or stopped	Motor vehicle in traffic	No improper action	
28	2018-03-14	Wed	4:00 PM	Peak	2	0	Non-fatal injury	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
29	2018-05-17	Thu	8:30 AM	Peak	2	0	Property damage only	Head on	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic		
30	2018-06-18	Mon	10:25 AM	Off-peak	1	0	Property damage only	Single vehicle crash	Dry	Daylight	Clear	Turning right		No improper action	Tractor trailer
31	2018-07-23	Mon	3:00 AM	Off-peak	1	0	Unknown	Angle	Wet	Dark - lighted roadway	Rain	Travelling straight ahead	Light pole or other post/support	Unknown	

Table G-4

Crash Lookup Table: Route 9 between Sumner Road/Warren Street and Lee Street

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
1	2014-03-15	Sat	4:45 PM	Peak	1	0	Property damage only	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Curb	No improper action	
2	2014-06-20	Fri	4:05 PM	Peak	2	1	Non-fatal injury	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
3	2015-02-26	Thu	7:00 PM	Peak	2	1	Property damage only	Angle	Dry	Dark - lighted roadway	Clear	Turning right	Motor vehicle in traffic	Fail to yield right of way	
4	2017-04-01	Sat	4:09 AM	Off-peak	1	0	Property damage only	Single vehicle crash	Wet	Dark - lighted roadway	Rain	Travelling straight ahead	Ran off road left		
5	2018-01-03	Wed	4:23 PM	Peak	2	0	Property damage only	Sideswipe, same direction	Dry	Dusk	Cloudy	Travelling straight ahead	Motor vehicle in traffic		
6	2018-01-09	Tue	6:55 PM	Peak	2	0	Property damage only	Rear-end	Dry	Dark - lighted roadway	Cloudy	Travelling straight ahead	Motor vehicle in traffic		

Table G-5
Crash Lookup Table: Route 9 at Lee Street and Chestnut Hill Avenue

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
1	2013-01-27	Sun	12:01 AM	Off-peak	2	0	Property damage only	Sideswipe, opposite direction	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Unknown	
2	2013-03-08	Fri	11:20 AM	Off-peak	2	1	Possible	Rear-end	Snow	Daylight	Snow	Slowing or stopped	Motor vehicle in traffic	No improper action	
3	2013-04-05	Fri	5:55 PM	Peak	3	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
4	2013-05-25	Sat	2:00 AM	Off-peak	2	0	Property damage only	Angle	Wet	Dark - lighted roadway	Rain	Travelling straight ahead	Motor vehicle in traffic	Unknown	
5	2013-06-18	Tue	3:12 PM	Peak	2	0	Property damage only	Angle	Wet	Daylight	Rain	Travelling straight ahead	Motor vehicle in traffic	Unknown	
6	2013-11-22	Fri	6:30 AM	Peak	2	0	Possible	Rear-end	Wet	Dawn	Rain	Slowing or stopped	Motor vehicle in traffic	Unknown	
7	2013-12-28	Sat	12:40 PM	Off-peak	3	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
8	2014-01-03	Fri	8:30 AM	Peak	1	0	Property damage only	Single vehicle crash	Ice	Dawn	Snow	Turning right	Ran off road left	Driving too fast for conditions	
9	2014-02-10	Mon	12:40 PM	Off-peak	2	1	Non-fatal injury	Angle	Dry	Daylight	Clear	Turning left	Motor vehicle in traffic	Disregarding traffic signs	
10	2014-04-29	Tue	8:10 PM	Off-peak	2	0	Property damage only	Angle	Dry	Dark - lighted roadway	Cloudy	Turning left	Motor vehicle in traffic	Unknown	
11	2014-07-28	Mon	4:39 PM	Peak	2	1	Non-fatal injury	Angle	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Disregarding traffic signs	
12	2014-11-12	Wed	4:10 PM	Peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Turning left	Motor vehicle in traffic	No improper action	
13	2014-11-14	Fri	6:26 AM	Peak	2	0	Property damage only	Rear-end	Snow	Daylight	Snow	Slowing or stopped	Motor vehicle in traffic	No improper action	
14	2014-12-04	Thu	12:00 AM	Off-peak	2	0	Property damage only	Angle	Dry	Daylight	Cloudy	Turning left	Motor vehicle in traffic	No improper action	
15	2015-01-06	Tue	1:00 PM	Off-peak	2	1	Non-fatal injury	Rear-end	Snow	Daylight	Snow	Slowing or stopped	Motor vehicle in traffic	Driving too fast for conditions	
16	2015-03-14	Sat	8:30 PM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Dry	Dark - lighted roadway	Clear	Entering traffic lane	Motor vehicle in traffic	Wrong side or wrong way	
17	2015-05-09	Sat	3:20 PM	Peak	4	2	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
18	2015-05-09	Sat	10:20 PM	Off-peak	2	0	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Slowing or stopped		No improper action	
19	2015-06-09	Tue	5:40 AM	Off-peak	2	1	Non-fatal injury	Angle	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
20	2015-09-17	Thu	2:45 PM	Off-peak	3	2	Non-fatal injury	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
21	2015-09-30	Wed	12:33 PM	Off-peak	1	1	Non-fatal injury	Single vehicle crash	Wet	Daylight	Cloudy	Turning right	Pedestrian	Fail to yield right of way	Pedestrian

Table G-5
Crash Lookup Table: Route 9 at Lee Street and Chestnut Hill Avenue

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
22	2015-11-01	Sun	10:24 PM	Off-peak	2	1	Non-fatal injury	Rear-end	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Other improper action	
23	2015-11-02	Mon	9:30 AM	Peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
24	2015-11-29	Sun	12:30 AM	Off-peak	2	0	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Unknown	
25	2016-01-27	Wed	12:14 PM	Off-peak	2	1	Non-fatal injury	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Unknown	
26	2016-03-24	Thu	11:50 PM	Off-peak	2	0	Property damage only	Angle	Wet	Dark - lighted roadway	Rain	Turning left	Motor vehicle in traffic	Unknown	
27	2016-03-28	Mon	9:20 AM	Peak	2	2	Non-fatal injury	Angle	Wet	Daylight	Rain	Travelling straight ahead	Motor vehicle in traffic	Disregarding traffic signs	
28	2016-06-03	Fri	8:09 AM	Peak	2	0	Property damage only	Rear-end	Dry	Daylight	Cloudy	Slowing or stopped	Motor vehicle in traffic	No improper action	
29	2016-06-29	Wed	5:30 AM	Off-peak	2	1	Non-fatal injury	Rear-end	Wet	Dawn	Cloudy	Slowing or stopped	Motor vehicle in traffic	No improper action	
30	2016-07-28	Thu	7:00 PM	Peak	1	1	Property damage only	Single vehicle crash	Dry	Daylight	Clear	Turning right	Motor vehicle in traffic	Failure to keep in proper lane / Made improper turn	
31	2016-09-11	Sun	3:15 PM	Peak	2	1	Possible	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
32	2016-10-26	Wed	8:12 PM	Off-peak	2	0	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
33	2016-11-14	Mon	9:35 AM	Peak	2	0	Property damage only	Angle	Dry	Daylight	Clear	Turning left	Motor vehicle in traffic	Unknown	Transit bus
34	2016-11-26	Sat	7:09 PM	Off-peak	2	0	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
35	2017-01-03	Tue	6:59 PM	Peak	2	0	Property damage only	Rear-end	Wet	Dark - lighted roadway	Rain	Slowing or stopped	Separation of units	No improper action	
36	2017-01-04	Wed	10:22 AM	Off-peak	3	0	Property damage only	Sideswipe, same direction	Wet	Daylight	Cloudy	Changing lanes	Motor vehicle in traffic	Fail to yield right of way	
37	2017-01-10	Tue	12:15 PM	Off-peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
38	2017-03-19	Sun	8:50 PM	Off-peak	2	1	Possible	Angle	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Disregarding traffic signs	
39	2017-05-19	Fri	1:43 PM	Off-peak	2	0	Property damage only	Angle	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Unknown	
40	2017-05-23	Tue	5:50 AM	Off-peak	2	1	Possible	Angle	Wet	Daylight	Cloudy	Travelling straight ahead	Motor vehicle in traffic	No improper action	
41	2017-09-07	Thu	5:20 PM	Peak	2	1	Non-fatal injury	Head on	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Disregarding traffic signs	
42	2017-10-02	Mon	8:52 AM	Peak	3	1	Property damage only	Rear-end	Dry	Daylight	Clear	Changing lanes	Motor vehicle in traffic		

Table G-5
Crash Lookup Table: Route 9 at Lee Street and Chestnut Hill Avenue

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
43	2017-10-04	Wed	10:14 AM	Off-peak	3	0	Property damage only	Angle	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Disregarding traffic signs	
44	2017-10-26	Thu	2:59 PM	Off-peak	2	0	Non-fatal injury	Angle	Dry	Daylight	Cloudy	Travelling straight ahead	Motor vehicle in traffic	No improper action	
45	2018-01-09	Tue	3:30 PM	Peak	3	1	Property damage only	Angle	Dry	Daylight	Cloudy	Changing lanes	Motor vehicle in traffic		
46	2018-02-07	Wed	1:15 PM	Off-peak	2	0	Property damage only	Rear-end	Snow	Daylight	Snow	Slowing or stopped	Motor vehicle in traffic	No improper action	
47	2018-04-17	Tue	6:47 AM	Peak	2	1	Non-fatal injury	Angle	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Unknown	
48	2018-07-25	Wed	2:24 PM	Off-peak	2	0	Property damage only	Angle	Dry	Daylight	Cloudy	Travelling straight ahead	Motor vehicle in traffic	Disregarding traffic signs	

Table G-6
Crash Lookup Table: Route 9 at Reservoir Road and Adjacent Streets

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
1	2013-04-15	Mon	9:53 AM	Peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
2	2013-05-21	Tue	3:57 PM	Peak	1	1	Non-fatal injury	Head on	Dry	Daylight	Clear				
3	2013-06-06	Thu	11:39 AM	Off-peak	2	1	Non-fatal injury	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
4	2013-08-07	Wed	2:00 PM	Off-peak	2	2	Possible	Single vehicle crash	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
5	2013-08-08	Thu	2:10 PM	Off-peak	11	1	Possible	Single vehicle crash	Dry	Daylight	Clear	Backing	Parked motor vehicle	Erratic or reckless operation / Illness	
6	2013-11-19	Tue	2:49 PM	Off-peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
7	2014-04-24	Thu	9:00 AM	Peak	2	1	Possible	Angle	Dry	Daylight	Clear	Turning left	Motor vehicle in traffic	Inattention	
8	2014-08-26	Tue	9:30 AM	Peak	3	1	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
9	2014-09-04	Thu	10:30 AM	Off-peak	1	1	Possible	Single vehicle crash	Dry	Daylight	Clear	Backing	Tree	Inattention / Other improper action	
10	2014-10-03	Fri	9:10 AM	Peak	1	0	Property damage only	Single vehicle crash	Dry	Daylight	Cloudy	Turning right	Other	Failure to keep in proper lane	
11	2014-10-09	Thu	8:40 AM	Peak	1	0	Possible	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Other fixed object (wall, building, tunnel)	Operating defective equipment	
12	2014-10-23	Thu	12:04 AM	Off-peak	1	0	Property damage only	Single vehicle crash	Wet	Dark - lighted roadway	Rain	Travelling straight ahead	Guardrail	No improper action	
13	2014-10-23	Thu	6:09 PM	Peak	2	0	Possible	Rear-end	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
14	2014-11-11	Tue	9:50 AM	Peak	3	0	Property damage only	Single vehicle crash	Dry	Daylight	Clear	Turning right	Parked motor vehicle	Inattention	
15	2014-12-11	Thu	7:04 PM	Off-peak	2	0	Property damage only	Angle	Wet	Dark - lighted roadway	Cloudy	Travelling straight ahead	Motor vehicle in traffic	Unknown	
16	2015-01-29	Thu	6:09 PM	Peak	1	0	Property damage only	Angle	Wet	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Disregarding traffic signs	
17	2015-03-12	Thu	9:00 PM	Off-peak	4	0	Property damage only	Single vehicle crash	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Swerving due to wind, slippery surface, or object	
18	2015-05-14	Thu	12:30 PM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Failure to keep in proper lane	
19	2015-06-02	Tue	3:01 PM	Peak	2	0	Property damage only	Rear-end	Dry	Daylight	Cloudy	Travelling straight ahead	Parked motor vehicle	Erratic or reckless operation	
20	2015-12-03	Thu	7:45 AM	Peak	2	0	Property damage only	Rear-end	Dry	Daylight	Cloudy	Slowing or stopped	Motor vehicle in traffic	No improper action	
21	2016-09-04	Sun	4:15 PM	Peak	4	0	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely / Failure to keep in proper lane	

Table G-6
Crash Lookup Table: Route 9 at Reservoir Road and Adjacent Streets

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
22	2017-03-08	Wed	3:17 PM	Peak	3	0	Property damage only	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Parked motor vehicle	Unknown	
23	2017-05-25	Thu	12:17 PM	Off-peak	3	0	Property damage only	Rear-end	Wet	Daylight	Rain	Slowing or stopped	Impact attenuator/crash	No improper action	
24	2017-08-06	Sun	5:36 AM	Off-peak	1	0	Property damage only	Single vehicle crash	Dry	Dawn	Clear	Travelling straight ahead	Other	Failure to keep in proper lane / Fatigued/Sleep	
25	2018-04-18	Wed	6:25 PM	Peak	2	1	Possible	Angle	Dry	Daylight	Cloudy	Changing lanes	Motor vehicle in traffic	Fail to yield right of way	
26	2018-06-06	Wed	7:39 AM	Peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Cloudy	Travelling straight ahead	Motor vehicle in traffic	Unknown	

Table G-7

Crash Lookup Table: Route 9 between Reservoir Road and Dunster Road

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
1	2013-01-23	Wed	8:12 PM	Off-peak	1	1	Property damage only	Single vehicle crash	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Cyclist	No improper action	Cyclist
2	2013-03-11	Mon	8:40 AM	Peak	1	0	Property damage only	Single vehicle crash	Ice	Daylight	Cloudy	Travelling straight ahead	Utility pole	No improper action	
3	2013-05-31	Fri	3:00 AM	Off-peak	2	1	Non-fatal injury	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
4	2014-03-01	Sat	3:15 PM	Peak	3	0	Non-fatal injury	Rear-end	Dry	Daylight	Cloudy	Slowing or stopped	Motor vehicle in traffic	No improper action	
5	2014-05-08	Thu	10:00 PM	Off-peak	1	0	Possible	Single vehicle crash	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Guardrail	No improper action	
6	2014-08-14	Thu	5:45 PM	Peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely / Inattention	
7	2014-10-17	Fri	2:04 AM	Off-peak	1	1	Possible	Single vehicle crash	Wet	Dark - lighted roadway	Cloudy	Travelling straight ahead	Utility pole	Exceeding speed limit	
8	2015-01-18	Sun	7:00 AM	Peak	1	0	Property damage only	Single vehicle crash	Wet	Dawn	Cloudy	Travelling straight ahead	Guardrail	Over-correcting/over-steering	
9	2015-01-20	Tue	12:20 PM	Off-peak	1	1	Incapacitating	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Utility pole	Unknown	Work zone
10	2015-01-21	Wed	5:00 PM	Peak	2	0	Property damage only	Rear-end	Dry	Dusk	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
11	2015-02-06	Fri	10:15 AM	Off-peak	2	1	Possible	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
12	2015-04-05	Sun	6:56 PM	Peak	1	0	Non-fatal injury	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Pedestrian	Fail to yield right of way	Pedestrian
13	2015-04-23	Thu	4:30 PM	Peak	3	0	Possible	Rear-end	Unknown	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
14	2016-05-18	Wed	3:05 PM	Peak	3	1	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
15	2016-06-19	Sun	2:30 PM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Failure to keep in proper lane / Inattention	
16	2016-08-08	Mon	7:42 AM	Peak	1	1	Possible	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Guardrail	Inattention	
17	2016-11-26	Sat	1:52 AM	Off-peak	1	1	Possible	Single vehicle crash	Wet	Dark - lighted roadway	Cloudy	Travelling straight ahead	Motor vehicle in traffic	Unknown	
18	2016-11-26	Sat	8:35 AM	Peak	1	0	Property damage only	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Guardrail	Failure to keep in proper lane / Erratic or reckless	
19	2016-12-11	Sun	2:20 AM	Off-peak	1	1	Non-fatal injury	Head on	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Utility pole	Fatigued/Sleep	
20	2017-05-05	Fri	9:45 AM	Peak	2	0	Property damage only	Rear-end	Dry	Daylight	Cloudy	Slowing or stopped	Motor vehicle in traffic	No improper action	
21	2017-05-26	Fri	5:35 PM	Peak	3	0	Property damage only	Rear-end	Wet	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	

Table G-7
Crash Lookup Table: Route 9 between Reservoir Road and Dunster Road

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
22	2017-06-08	Thu	12:49 PM	Off-peak	2	1	Non-fatal injury	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Utility pole	Fatigued/Sleep / Failure to keep in proper lane	
23	2017-06-14	Wed	9:00 AM	Peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
24	2017-09-22	Fri	11:20 PM	Off-peak	1	0	Property damage only	Single vehicle crash	Wet	Dark - lighted roadway	Rain	Travelling straight ahead		Driving too fast for conditions	
25	2017-09-28	Thu	11:00 AM	Off-peak	1	1	Non-fatal injury	Angle	Dry	Daylight	Clear	Turning right	Cyclist	No improper action	Cyclist
26	2017-12-15	Fri	10:29 AM	Off-peak	2	2	Non-fatal injury	Angle	Dry	Daylight	Clear	Making U-turn	Motor vehicle in traffic	Fail to yield right of way	
27	2018-03-23	Fri	4:36 PM	Peak	4	0	Property damage only	Head on	Dry	Daylight	Cloudy	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
28	2018-05-23	Wed	12:25 AM	Off-peak	1	0	Property damage only	Single vehicle crash	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Guardrail	Other improper action	
29	2018-06-29	Fri	10:30 AM	Off-peak	4	0	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
30	2018-07-12	Thu	9:55 AM	Peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	

Table G-8
Crash Lookup Table: Route 9 at Dunster Road and Hammond Street

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
1	2013-03-22	Fri	8:13 PM	Off-peak	3	1	Non-fatal injury	Angle	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Disregarding traffic signs	
2	2013-04-04	Thu	2:50 PM	Off-peak	1	0	Property damage only	Single vehicle crash	Dry	Daylight	Clear	Turning right	Light pole or other post/support	Inattention	
3	2013-08-14	Wed	9:53 PM	Off-peak	2	2	Non-fatal injury	Angle	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
4	2013-08-28	Wed	4:37 PM	Peak	1	1	Non-fatal injury	Single vehicle crash	Dry	Daylight	Clear	Travelling straight ahead	Pedestrian	Disregarding traffic signs	Pedestrian
5	2013-09-24	Tue	4:25 PM	Peak	3	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
6	2013-12-30	Mon	12:45 PM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Turning left	Motor vehicle in traffic	Unknown	
7	2014-01-14	Tue	5:48 PM	Peak	2	0	Property damage only	Angle	Wet	Dark - lighted roadway	Unknown	Turning right	Motor vehicle in traffic	Disregarding traffic signs	
8	2014-04-03	Thu	11:05 AM	Off-peak	5	3	Possible	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Driving too fast for conditions / Follow too	
9	2014-04-11	Fri	9:05 PM	Off-peak	2	0	Property damage only	Angle	Dry	Dark - lighted roadway	Cloudy	Turning right	Motor vehicle in traffic	No improper action	
10	2014-04-17	Thu	12:20 PM	Off-peak	3	2	Incapacitating	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
11	2014-06-24	Tue	12:00 PM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
12	2014-08-19	Tue	6:10 PM	Peak	6	1	Non-fatal injury	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
13	2014-09-24	Wed	7:18 PM	Off-peak	2	0	Possible	Rear-end	Dry	Dark - lighted roadway	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
14	2014-11-06	Thu	1:04 PM	Off-peak	3	3	Non-fatal injury	Rear-end	Wet	Daylight	Rain	Travelling straight ahead	Motor vehicle in traffic	Follow too closely / Failure to keep in proper lane	
15	2014-12-18	Thu	4:18 PM	Peak	2	1	Possible	Rear-end	Dry	Dusk	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
16	2015-04-13	Mon	1:45 PM	Off-peak	2	1	Possible	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
17	2015-05-26	Tue	11:00 PM	Off-peak	3	0	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
18	2015-05-28	Thu	9:00 PM	Off-peak	3	1	Possible	Rear-end	Dry	Dark - roadway not lighted	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
19	2015-07-01	Wed	6:55 AM	Peak	2	1	Possible	Rear-end	Wet	Daylight	Rain	Slowing or stopped	Motor vehicle in traffic	No improper action	
20	2015-08-09	Sun	1:46 PM	Off-peak	2	0	Property damage only	Angle	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
21	2015-08-20	Thu	7:30 PM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Dry	Dusk	Clear	Turning left	Motor vehicle in traffic	No improper action	

Table G-8
Crash Lookup Table: Route 9 at Dunster Road and Hammond Street

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
22	2015-11-11	Wed	6:48 PM	Peak	3	0	Property damage only	Rear-end	Wet	Dark - lighted roadway	Cloudy	Slowing or stopped	Separation of units	No improper action	
23	2015-12-21	Mon	11:30 PM	Off-peak	2	0	Property damage only	Angle	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
24	2016-01-26	Tue	3:01 PM	Peak	2	1	Non-fatal injury	Rear-end	Wet	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Unknown	
25	2016-02-05	Fri	11:36 AM	Off-peak	2	0	Property damage only	Rear-end	Snow	Daylight	Snow	Travelling straight ahead		No improper action	
26	2016-05-19	Thu	6:40 PM	Peak	2	1	Possible	Rear-end	Dry	Daylight	Clear	Slowing or stopped		No improper action	
27	2016-05-22	Sun	4:00 PM	Peak	2	1	Possible	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	Erratic or reckless operation	
28	2016-06-23	Thu	7:00 PM	Peak	1	0	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
29	2016-06-30	Thu	4:57 PM	Peak	3	1	Non-fatal injury	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely / Heart Condition/Epilepsy/Fainting	
30	2016-07-11	Mon	6:27 PM	Peak	3	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Separation of units	No improper action	
31	2016-10-02	Sun	11:30 AM	Off-peak	3	0	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Inattention	
32	2016-10-07	Fri	11:10 AM	Off-peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
33	2016-10-14	Fri	8:45 PM	Off-peak	1	2	Non-fatal injury	Single vehicle crash	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Pedestrian	No improper action	Pedestrian
34	2016-11-04	Fri	10:05 AM	Off-peak	2	0	Possible	Sideswipe, same direction	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
35	2016-11-28	Mon	5:00 PM	Peak	4	0	Possible	Rear-end	Dry	Dark - lighted roadway	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
36	2016-12-15	Thu	12:10 PM	Off-peak	1	0		Single vehicle crash	Dry	Daylight	Clear	Turning right	Pedestrian		Pedestrian
37	2016-12-23	Fri	4:15 PM	Peak	2	0	Property damage only	Rear-end	Dry	Dusk	Clear	Travelling straight ahead	Fence	Fatigued/Sleep	
38	2017-08-05	Sat	12:04 PM	Off-peak	1	1	Incapacitating	Single vehicle crash	Wet	Daylight	Rain	Travelling straight ahead	Pedestrian	Fail to yield right of way	Pedestrian
39	2017-10-19	Thu	4:10 PM	Peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Changing lanes	Motor vehicle in traffic	Fail to yield right of way	School bus
40	2017-10-23	Mon	7:35 AM	Peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
41	2017-12-08	Fri	12:25 PM	Off-peak	1	0	Property damage only	Single vehicle crash	Dry	Daylight	Clear	Changing lanes	Fence	Unknown	
42	2018-01-20	Sat	3:17 PM	Peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Turning left	Motor vehicle in traffic	Made improper turn	

Table G-8
Crash Lookup Table: Route 9 at Dunster Road and Hammond Street

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
43	2018-03-09	Fri	10:10 AM	Off-peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
44	2018-05-15	Tue	8:00 AM	Peak	3	1	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	

Table G-9
Crash Lookup Table: Route 9 between Newton City Line and Hammond Street

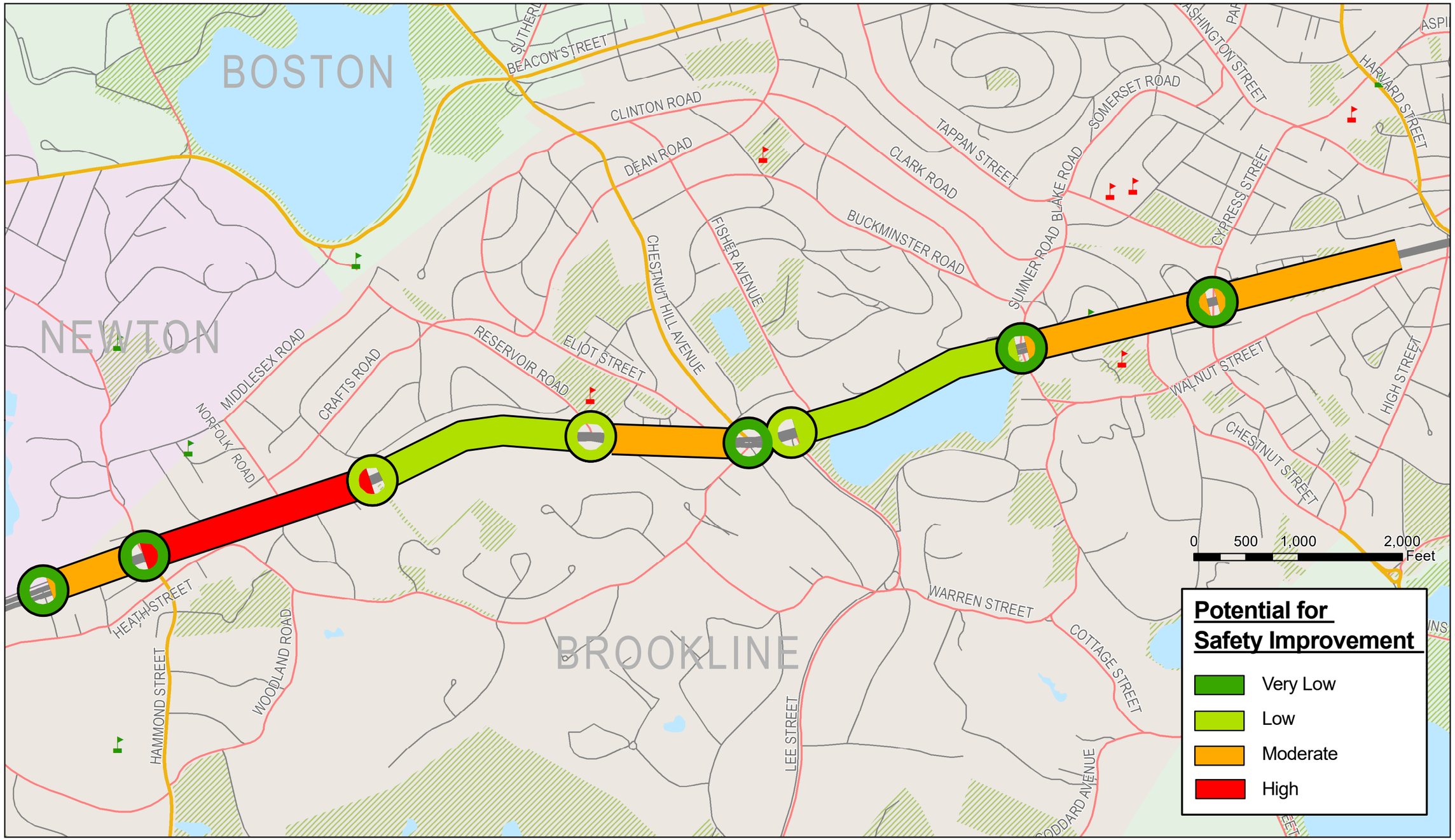
Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
1	2013-01-04	Fri	7:55 AM	Peak	3	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Other	No improper action	
2	2013-05-25	Sat	1:05 AM	Off-peak	2	1	Non-fatal injury	Rear-end	Wet	Dark - lighted roadway	Rain	Travelling straight ahead	Parked motor vehicle	Driving too fast for conditions / Other improper	
3	2013-07-26	Fri	12:35 PM	Off-peak	3	1	Property damage only	Rear-end	Wet	Daylight	Rain	Slowing or stopped	Motor vehicle in traffic	No improper action	
4	2013-08-16	Fri	6:00 PM	Peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
5	2013-12-10	Tue	3:40 PM	Peak	2	2	Possible	Rear-end	Wet	Daylight	Snow	Slowing or stopped	Motor vehicle in traffic	No improper action	
6	2014-02-12	Wed	5:29 PM	Peak	2	0	Possible	Rear-end	Dry	Dusk	Clear	Slowing or stopped	Motor vehicle in traffic	Follow too closely	
7	2014-02-18	Tue	2:31 PM	Off-peak	4	0	Property damage only	Rear-end	Snow	Daylight	Snow	Slowing or stopped	Motor vehicle in traffic	No improper action	
8	2014-03-04	Tue	9:38 PM	Off-peak	2	0	Property damage only	Angle	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
9	2014-04-28	Mon	8:15 PM	Off-peak	2	0	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
10	2014-05-14	Wed	2:20 PM	Off-peak	2	1	Property damage only	Rear-end	Dry	Daylight	Cloudy	Travelling straight ahead	Pedestrian	Follow too closely	Pedestrian
11	2014-09-22	Mon	1:30 PM	Off-peak	3	1	Possible	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
12	2014-12-02	Tue	10:15 AM	Off-peak	2	1	Non-fatal injury	Sideswipe, same direction	Wet	Dark - lighted roadway	Rain	Changing lanes	Motor vehicle in traffic	Failure to keep in proper lane	
13	2014-12-13	Sat	12:40 PM	Off-peak	2	0	Property damage only	Rear-end	Dry	Daylight	Cloudy	Slowing or stopped	Motor vehicle in traffic	No improper action	
14	2015-04-30	Thu	11:15 PM	Off-peak	2	0	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Changing lanes	Motor vehicle in traffic	Made improper turn	
15	2015-05-20	Wed	12:19 PM	Off-peak	2	1	Non-fatal injury	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
16	2015-12-05	Sat	1:40 AM	Off-peak	1	0	Property damage only	Single vehicle crash	Dry	Dark - lighted roadway	Clear	Turning left		No improper action	
17	2015-12-17	Thu	11:20 AM	Off-peak	3	0	Possible	Rear-end	Dry	Daylight	Cloudy	Slowing or stopped	Motor vehicle in traffic	No improper action	
18	2016-01-26	Tue	12:00 PM	Off-peak	2	2	Possible	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Unknown	
19	2016-03-02	Wed	1:26 PM	Off-peak	3	0	Property damage only	Rear-end	Dry	Daylight	Cloudy	Slowing or stopped	Motor vehicle in traffic	No improper action	
20	2016-03-09	Wed	11:50 AM	Off-peak	2	1	Possible	Head on	Dry	Dark - lighted roadway	Clear	Travelling straight ahead	Other	Other improper action / Wrong side or wrong way	
21	2016-04-19	Tue	8:10 AM	Peak	4	2	Possible	Rear-end	Dry	Daylight	Cloudy	Slowing or stopped	Motor vehicle in traffic	No improper action	

Table G-9
Crash Lookup Table: Route 9 between Newton City Line and Hammond Street

Index	Crash Date	Day	Time	Peak Hour	# Veh	# Injured	Crash Severity	Manner of Collision	Road Surface Conditions	Ambient Light Conditions	Weather Conditions	Vehicle Action	Most Harmful Event	Driver Contributing Code	Notes
22	2016-08-11	Thu	1:25 PM	Off-peak	2	0	Property damage only	Sideswipe, same direction	Dry	Daylight	Clear	Travelling straight ahead	Parked motor vehicle	Failure to keep in proper lane	Work zone
23	2016-09-07	Wed	8:18 AM	Peak	2	0	Possible	Rear-end	Wet	Daylight	Rain	Travelling straight ahead	Motor vehicle in traffic	No improper action	
24	2016-09-07	Wed	12:30 PM	Off-peak	0	0	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	No improper action	
25	2016-09-22	Thu	10:00 AM	Peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
26	2016-12-05	Mon	7:30 PM	Off-peak	3	0	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
27	2017-03-27	Mon	1:45 PM	Off-peak	3	0	Property damage only	Rear-end	Wet	Daylight	Rain	Slowing or stopped	Motor vehicle in traffic	No improper action	
28	2017-04-25	Tue	6:20 PM	Peak	2	0	Property damage only	Rear-end	Wet	Daylight	Rain	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
29	2017-04-26	Wed	9:18 AM	Peak	4	0	Possible	Rear-end	Wet	Daylight	Rain	Slowing or stopped	Motor vehicle in traffic	No improper action	
30	2017-06-14	Wed	5:15 PM	Peak	2	0	Property damage only	Rear-end	Dry	Daylight	Clear	Travelling straight ahead	Motor vehicle in traffic	Follow too closely	
31	2017-09-22	Fri	6:57 AM	Peak	2	0	Property damage only	Rear-end	Wet	Dawn	Rain	Slowing or stopped	Motor vehicle in traffic	No improper action / No improper action	
32	2017-12-10	Sun	5:53 PM	Peak	2	1	Possible	Rear-end	Wet	Dark - lighted roadway	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	
33	2018-01-10	Wed	7:30 PM	Off-peak	3	0	Property damage only	Rear-end	Dry	Dark - lighted roadway	Clear	Slowing or stopped	Motor vehicle in traffic	No improper action	

APPENDIX H

Highway Safety Manual Crash Analysis



BOSTON REGION MPO

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Figure H–1
Corridor Observed Crashes and Potential for Safety Improvement (PSI)
Route 9 in Brookline

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

Table H-1
Summary of Expected Crashes Analysis for Existing Conditions
Route 9 in Brookline

Location	Analysis Type	Total observed crashes	Average observed crashes	Average predicted crashes	Total expected crashes	Average expected crashes	Potential for Safety Improvement (PSI)	High-Risk Site	Observed crashes > Expected Crashes	FI Crash Rate	PDO Crash Rate	FI Cost	PDO Cost	Total Cost
West of High Street to Sumner Road	Segment	***31***	5.5	*1.96*	22.1	*3.90*	***1.94***	-	***Y***	1.24	2.66	$323,751	$41,537	$365,300
Route 9 at Cypress Street	Intersection	***25***	4.4	*8.73*	29.4	*5.19*	-3.54	*N*	*N*	1.70	3.49	$444,055	$54,402	$498,500
Cypress Street to Sumner Road	Segment	***15***	2.6	*1.85*	12.5	*2.21*	***0.35***	-	***Y***	0.62	1.59	$160,903	$24,805	$185,700
Route 9 at Sumner Street and Warren Street	Intersection	***19***	3.4	*10.23*	24.8	*4.37*	-5.86	*N*	*N*	1.64	2.73	$427,583	$42,576	$470,200
Sumner Road to Lee Street	Segment	***9***	1.6	*2.71*	7.9	*1.40*	-1.31	-	***Y***	0.39	1.01	$100,687	$15,739	$116,400
Route 9 at Lee Street	Intersection	***18***	3.2	*5.38*	20.1	*3.55*	-1.83	*N*	*N*	1.29	2.26	$335,762	$35,299	$371,100
Route 9 at Chestnut Hill Avenue	Intersection	***27***	4.8	*12.97*	35.3	*6.22*	-6.74	*N*	*N*	2.04	4.18	$532,504	$65,238	$597,700
Chestnut Hill Avenue to Reservoir Road	Segment	***6***	1.1	*0.83*	5.9	*1.05*	***0.21***	-	***Y***	0.29	0.75	$76,443	$11,761	$88,200
Route 9 at Reservoir Road	Intersection	***16***	2.8	*4.79*	17.6	*3.10*	-1.69	*N*	*N*	1.02	2.08	$265,083	$32,476	$297,600
Reservoir Road to Benevolent Association Driveway	Segment	***8***	1.4	*1.83*	4.6	*0.81*	-1.02	-	***Y***	0.23	0.59	$58,720	$9,155	$67,900
Route 9 at Benevolent Association Driveway	Intersection	***8***	1.4	*1.06*	3.8	*0.67*	-0.40	*N*	***Y***	0.21	0.45	$55,159	$7,093	$62,300
Benevolent Association Driveway to Hammond Stre	Segment	***33***	5.8	*2.62*	31.1	*5.49*	***2.87***	-	***Y***	1.53	3.96	$398,836	$61,725	$460,600
Route 9 at Hammond Street	Intersection	***21***	3.7	*9.14*	26.9	*4.75*	-4.39	*N*	*N*	1.56	3.19	$406,683	$49,823	$456,500
Hammond Street to Tully Street	Segment	***19***	3.4	*1.67*	18.1	*3.19*	***1.52***	-	***Y***	0.89	2.29	$232,786	$35,793	$268,600
Route 9 at Tully Street	Intersection	***14***	2.5	*4.82*	15.7	*2.77*	-2.05	*N*	*N*	0.89	1.88	$231,807	$29,347	$261,200
Entire Route 9 Corridor		**269**	**47.5**	**70.58**	**275.7**	**48.66**	**5 of 15**	**0 of 8**	**8 of 15**	**15.5**	**33.1**	**$4,050,762**	**$516,767**	**$4,567,800**

Notes:

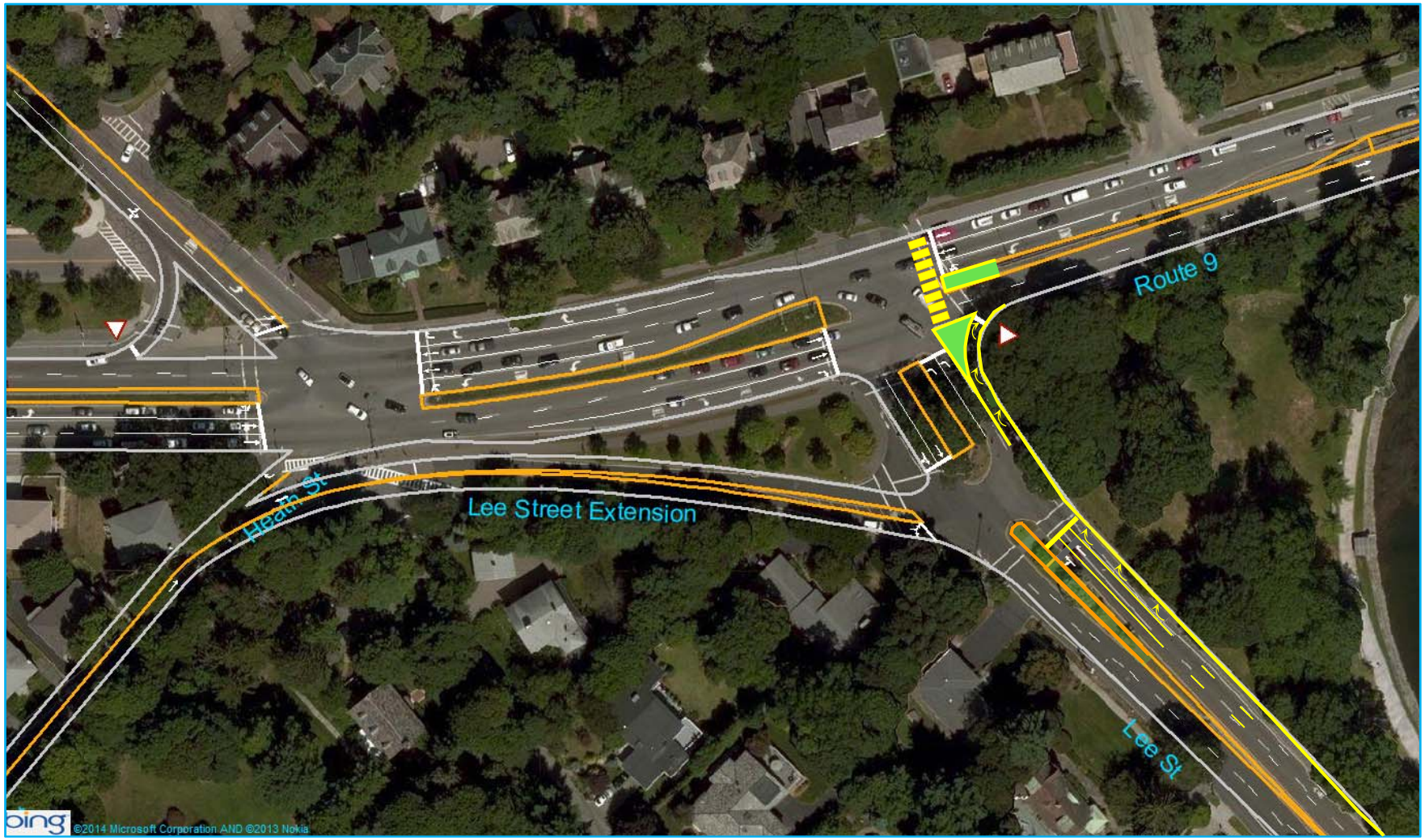
Analysis Type = Highway Safety Manual (HSM) method of analysis. Intersection analyses use MassDOT corrected formulas.
Total observed crashes = total number of crashes reported to Brookline Police between January 2013 and August 2018
Average observed crashes = observed crashes / (5.67 years)
Average predicted crashes = number of crashes per year predicted for an average facility with similar geometric and traffic characteristics
Total expected crashes = predicted crashes corrected using Empirical Bayes correlation and observed crashes
Average expected crashes = expected crashes / (5.67 years)
Potential for Safety Improvement (PSI) = (average expected crashes) - (average predicted crashes). Represents the number of crashes per year occuring in excess of the predicted number

High-Risk Site = MassDOT designation for intersections with high safety risk
Observed crashes > Expected Crashes = shows if recent crash history is above average
Fatal or Injury (FI) Crash Rate = number of expected crashes per year that result in a fatality or injury
Property Damage Only (PDO) Crash Rate = number of expected crashes per year that only result in property damage in excess of $1,000
FI Cost = annual cost of expected FI crashes. Uses MassDOT comprehensive crash cost of $260,800 per FI crash
PDO Cost = annual cost of expected PDO crashes. Uses MassDOT comprehensive crash cost of $15,600 per PDO crash
Total Cost = FI Cost + PDO Cost

APPENDIX I

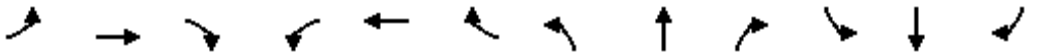
Conceptual Sketch
Proposed Modification at Route 9/Lee Street Intersection

Conceptual Sketch of Proposed Modification at Route 9/Lee Street Intersection
Synchro 2030 Traffic Model



APPENDIX J

Intersection Capacity Analyses
Weekday AM Peak Hour
Proposed Long-Term Improvements under 2030 Traffic Conditions



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	267	868	145	42	753	64	99	363	25	31	180	268
Future Volume (vph)	267	868	145	42	753	64	99	363	25	31	180	268
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	12	11	11	12	11	11	11	11	11	10	11
Storage Length (ft)	350		0	150		0	0		0	0		0
Storage Lanes	1		0	1		0	1		0	0		1
Taper Length (ft)	100			100			0			0		
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		614			1044			573			420	
Travel Time (s)		14.0			23.7			13.0			9.5	
Confl. Peds. (#/hr)	16					16	155		15	15		155
Peak Hour Factor	0.87	0.90	0.74	0.75	0.87	0.67	0.73	0.95	0.57	0.55	0.92	0.83
Growth Factor	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%
Heavy Vehicles (%)	4%	4%	6%	0%	7%	2%	5%	2%	16%	10%	3%	3%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	316	1195	0	58	989	0	140	439	0	0	260	333
Turn Type	Prot	NA		Prot	NA		Perm	NA		Perm	NA	pt+ov
Protected Phases	5	2		1	6			8			4	4 5
Permitted Phases							8			4		
Detector Phase	5	2		1	6		8	8		4	4	4 5
Switch Phase												
Minimum Initial (s)	5.0	10.0		5.0	10.0		6.0	6.0		6.0	6.0	
Minimum Split (s)	10.0	16.0		10.0	16.0		11.0	11.0		11.0	11.0	
Total Split (s)	36.0	62.0		20.0	46.0		42.0	42.0		42.0	42.0	
Total Split (%)	24.0%	41.3%		13.3%	30.7%		28.0%	28.0%		28.0%	28.0%	
Maximum Green (s)	31.0	56.0		15.0	40.0		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	2.0		1.0	2.0		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	6.0		5.0	6.0		5.0	5.0			5.0	
Lead/Lag	Lead	Lag		Lead	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Recall Mode	None	Min		None	Min		None	None		None	None	
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
Act Effct Green (s)	28.9	62.7		9.1	40.4		37.4	37.4			37.4	71.3
Actuated g/C Ratio	0.20	0.44		0.06	0.29		0.26	0.26			0.26	0.50
v/c Ratio	0.92	0.79		0.52	1.03		0.86	0.94			2.11	0.36
Control Delay	88.1	40.5		82.3	87.3		94.7	81.8			555.6	3.1
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0			0.0	0.0
Total Delay	88.1	40.5		82.3	87.3		94.7	81.8			555.6	3.1
LOS	F	D		F	F		F	F			F	A
Approach Delay		50.5			87.0			84.9			245.3	
Approach LOS		D			F			F			F	
Queue Length 50th (ft)	300	534		55	~563		132	424			~404	0

Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Lane Width (ft)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Right Turn on Red	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	20.0
Minimum Split (s)	26.0
Total Split (s)	26.0
Total Split (%)	17%
Maximum Green (s)	22.0
Yellow Time (s)	2.0
All-Red Time (s)	2.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Vehicle Extension (s)	2.0
Recall Mode	None
Walk Time (s)	7.0
Flash Dont Walk (s)	10.0
Pedestrian Calls (#/hr)	70
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	
Queue Length 50th (ft)	

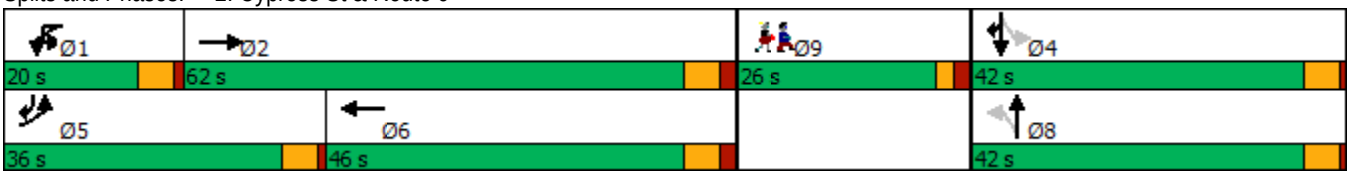
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Length 95th (ft)	#449	#667		85	#663		#191	#657			#588	33
Internal Link Dist (ft)		534			964			493			340	
Turn Bay Length (ft)	350			150								
Base Capacity (vph)	372	1507		187	956		162	465			123	951
Starvation Cap Reductn	0	0		0	0		0	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	0.85	0.79		0.31	1.03		0.86	0.94			2.11	0.35

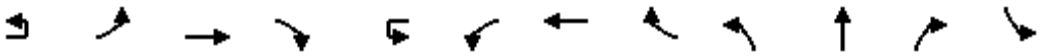
Intersection Summary			
Area Type:	Other		
Cycle Length: 150			
Actuated Cycle Length: 141.2			
Natural Cycle: 150			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 2.11			
Intersection Signal Delay: 97.1		Intersection LOS: F	
Intersection Capacity Utilization 89.3%		ICU Level of Service E	
Analysis Period (min) 15			
Description: 155 / 99 / 53			

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

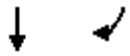
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 2: Cypress St & Route 9





Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	6	247	1199	4	19	17	1006	16	55	355	19	31
Future Volume (vph)	6	247	1199	4	19	17	1006	16	55	355	19	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11	12	11	11	11	11	11
Storage Length (ft)		350		150		150		0	0		0	0
Storage Lanes		1		0		1		0	1		0	0
Taper Length (ft)		100				100			0			0
Right Turn on Red				Yes				Yes			Yes	
Link Speed (mph)			30				30			30		
Link Distance (ft)			635				1295			738		
Travel Time (s)			14.4				29.4			16.8		
Confl. Peds. (#/hr)	16	9		2	10	2		9	16		10	10
Peak Hour Factor	0.38	0.91	0.89	0.50	0.53	0.61	0.87	0.57	0.76	0.85	0.68	0.70
Growth Factor	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%
Heavy Vehicles (%)	0%	4%	5%	25%	0%	0%	6%	6%	2%	0%	5%	13%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	296	1396	0	0	66	1220	0	75	459	0	0
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA		Perm
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases									8			4
Detector Phase	5	5	2		1	1	6		8	8		4
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0		6.0	6.0	40.0		6.0	6.0		6.0
Minimum Split (s)	11.0	11.0	46.0		11.0	11.0	46.0		23.0	23.0		23.0
Total Split (s)	27.0	27.0	65.0		15.0	15.0	53.0		44.0	44.0		44.0
Total Split (%)	18.0%	18.0%	43.3%		10.0%	10.0%	35.3%		29.3%	29.3%		29.3%
Maximum Green (s)	22.0	22.0	59.0		10.0	10.0	47.0		39.0	39.0		39.0
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	2.0		1.0	1.0	2.0		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	6.0			5.0	6.0		5.0	5.0		
Lead/Lag	Lead	Lead	Lag		Lead	Lead	Lag					
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes					
Vehicle Extension (s)	3.0	3.0	2.0		3.0	3.0	2.0		3.0	3.0		3.0
Recall Mode	None	None	Min		None	None	Min		None	None		None
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
Act Effct Green (s)		22.2	63.1			9.0	47.4		39.3	39.3		
Actuated g/C Ratio		0.17	0.47			0.07	0.35		0.29	0.29		
v/c Ratio		1.07	0.87			0.56	1.02		0.28	0.86		
Control Delay		125.7	41.0			82.3	73.9		43.6	63.2		
Queue Delay		0.0	0.0			0.0	0.0		0.0	0.0		
Total Delay		125.7	41.0			82.3	73.9		43.6	63.2		
LOS		F	D			F	E		D	E		
Approach Delay			55.8				74.3			60.4		
Approach LOS			E				E			E		
Queue Length 50th (ft)		239	507			51	493		45	336		



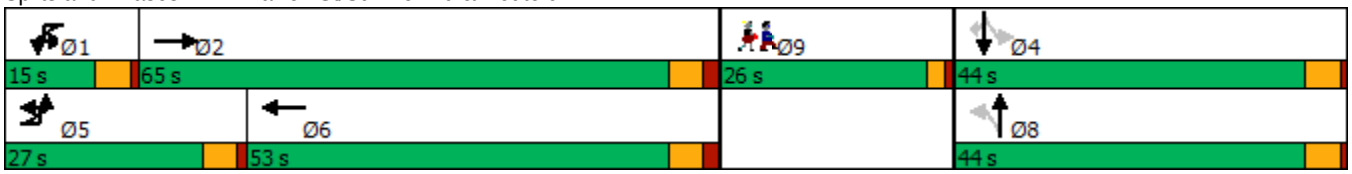
Lane Group	SBT	SBR	Ø9
Lane Configurations			
Traffic Volume (vph)	98	196	
Future Volume (vph)	98	196	
Ideal Flow (vphpl)	1900	1900	
Lane Width (ft)	11	11	
Storage Length (ft)		0	
Storage Lanes		1	
Taper Length (ft)			
Right Turn on Red		Yes	
Link Speed (mph)	30		
Link Distance (ft)	625		
Travel Time (s)	14.2		
Confl. Peds. (#/hr)		16	
Peak Hour Factor	0.64	0.91	
Growth Factor	103%	103%	
Heavy Vehicles (%)	4%	2%	
Shared Lane Traffic (%)			
Lane Group Flow (vph)	204	222	
Turn Type	NA	Perm	
Protected Phases	4		9
Permitted Phases		4	
Detector Phase	4	4	
Switch Phase			
Minimum Initial (s)	6.0	6.0	6.0
Minimum Split (s)	23.0	23.0	26.0
Total Split (s)	44.0	44.0	26.0
Total Split (%)	29.3%	29.3%	17%
Maximum Green (s)	39.0	39.0	23.0
Yellow Time (s)	4.0	4.0	2.0
All-Red Time (s)	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	
Total Lost Time (s)	5.0	5.0	
Lead/Lag			
Lead-Lag Optimize?			
Vehicle Extension (s)	3.0	3.0	3.0
Recall Mode	None	None	None
Walk Time (s)			7.0
Flash Dont Walk (s)			16.0
Pedestrian Calls (#/hr)			16
Act Effct Green (s)	39.3	39.3	
Actuated g/C Ratio	0.29	0.29	
v/c Ratio	1.05	0.38	
Control Delay	125.8	7.1	
Queue Delay	0.0	0.0	
Total Delay	125.8	7.1	
LOS	F	A	
Approach Delay	63.9		
Approach LOS	E		
Queue Length 50th (ft)	162	0	

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Queue Length 95th (ft)		#545	#892			78	#829		91	#610		
Internal Link Dist (ft)			555				1215			658		
Turn Bay Length (ft)		350				150						
Base Capacity (vph)		277	1609			130	1196		264	531		
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	0.87			0.51	1.02		0.28	0.86		

Intersection Summary			
Area Type:	Other		
Cycle Length: 150			
Actuated Cycle Length: 134.4			
Natural Cycle: 150			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 1.07			
Intersection Signal Delay: 63.4		Intersection LOS: E	
Intersection Capacity Utilization 99.8%		ICU Level of Service F	
Analysis Period (min) 15			
Description: 16 / 7 / 16			

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

Splits and Phases: 4: Warren St/Sumner Rd & Route 9

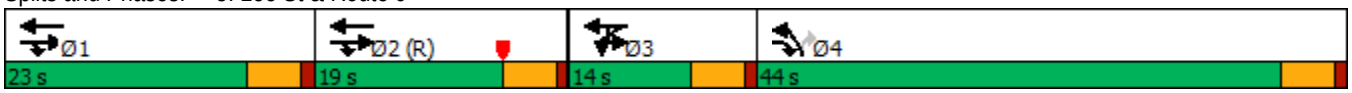


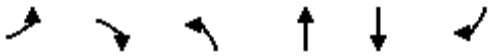
Lane Group	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø1	Ø2
Lane Configurations									
Traffic Volume (vph)	1228	404	2	126	1065	892	249		
Future Volume (vph)	1228	404	2	126	1065	892	249		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900		
Lane Width (ft)	12	11	11	11	12	11	11		
Storage Length (ft)		225		350		0	0		
Storage Lanes		1		1		2	1		
Taper Length (ft)				100		0			
Right Turn on Red		Yes					Yes		
Link Speed (mph)	30				30	30			
Link Distance (ft)	363				323	214			
Travel Time (s)	8.3				7.3	4.9			
Peak Hour Factor	0.94	0.90	0.50	0.81	0.94	0.84	0.90		
Growth Factor	103%	103%	103%	103%	103%	103%	103%		
Heavy Vehicles (%)	5%	5%	50%	2%	5%	4%	3%		
Shared Lane Traffic (%)									
Lane Group Flow (vph)	1346	462	0	164	1167	1094	285		
Turn Type	NA	pt+ov	Prot	Prot	NA	Prot	Perm		
Protected Phases	1 2	1 2 4	3	3	1 2 3	4		1	2
Permitted Phases							4		
Detector Phase	1 2	1 2 4	3	3	1 2 3	4	4		
Switch Phase									
Minimum Initial (s)			5.0	5.0		6.0	6.0	5.0	10.0
Minimum Split (s)			10.0	10.0		29.0	29.0	10.0	19.0
Total Split (s)			14.0	14.0		44.0	44.0	23.0	19.0
Total Split (%)			14.0%	14.0%		44.0%	44.0%	23%	19%
Maximum Green (s)			9.0	9.0		39.0	39.0	18.0	14.0
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	1.0	1.0	1.0
Lost Time Adjust (s)				0.0		0.0	0.0		
Total Lost Time (s)				5.0		5.0	5.0		
Lead/Lag			Lead	Lead		Lag	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
Recall Mode			None	None		None	None	None	C-Max
Walk Time (s)						7.0	7.0		10.0
Flash Dont Walk (s)						17.0	17.0		4.0
Pedestrian Calls (#/hr)						0	0		0
Act Effct Green (s)	37.0	81.0		9.0	51.0	39.0	39.0		
Actuated g/C Ratio	0.37	0.81		0.09	0.51	0.39	0.39		
v/c Ratio	1.06	0.38		1.08	0.67	0.86	0.39		
Control Delay	55.8	2.2		140.4	20.5	21.4	2.8		
Queue Delay	17.3	0.7		18.0	50.8	5.8	1.4		
Total Delay	73.0	3.0		158.3	71.3	27.2	4.1		
LOS	E	A		F	E	C	A		
Approach Delay	55.1				82.0	22.4			
Approach LOS	E				F	C			
Queue Length 50th (ft)	~482	21		~117	277	369	8		
Queue Length 95th (ft)	m#567	m73		#212	351	387	m15		

Lane Group	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø1	Ø2
Internal Link Dist (ft)	283				243	134			
Turn Bay Length (ft)		225		350					
Base Capacity (vph)	1272	1224		152	1753	1269	732		
Starvation Cap Reductn	119	440		0	0	134	267		
Spillback Cap Reductn	0	5		60	940	4	0		
Storage Cap Reductn	0	0		0	0	0	0		
Reduced v/c Ratio	1.17	0.59		1.78	1.44	0.96	0.61		

Intersection Summary			
Area Type:	Other		
Cycle Length: 100			
Actuated Cycle Length: 100			
Offset: 93 (93%), Referenced to phase 2:EBWB, Start of Yellow			
Natural Cycle: 90			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 1.08			
Intersection Signal Delay: 53.1		Intersection LOS: D	
Intersection Capacity Utilization 81.0%		ICU Level of Service D	
Analysis Period (min) 15			
Description: ø2 (NB): 0 / 1 / 3			
ø4 (WB): 0 / 1 / 3			
~ 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: 5: Lee St & Route 9



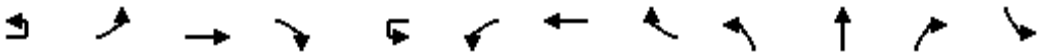


Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	Ø1
Lane Configurations							
Traffic Volume (vph)	230	8	5	966	531	1	
Future Volume (vph)	230	8	5	966	531	1	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	
Right Turn on Red		Yes				Yes	
Link Speed (mph)	30			30	30		
Link Distance (ft)	617			340	214		
Travel Time (s)	14.0			7.7	4.9		
Confl. Peds. (#/hr)		1					
Peak Hour Factor	0.83	0.67	0.62	0.89	0.89	0.25	
Growth Factor	103%	103%	103%	103%	103%	103%	
Heavy Vehicles (%)	3%	0%	0%	4%	5%	0%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	297	0	0	1126	619	0	
Turn Type	Prot		Perm	NA	NA		
Protected Phases	2			3	1 3		1
Permitted Phases			3				
Detector Phase	2		3	3	1 3		
Switch Phase							
Minimum Initial (s)	6.0		10.0	10.0			5.0
Minimum Split (s)	20.0		15.0	15.0			10.0
Total Split (s)	29.0		46.0	46.0			25.0
Total Split (%)	29.0%		46.0%	46.0%			25%
Maximum Green (s)	24.0		41.0	41.0			20.0
Yellow Time (s)	4.0		4.0	4.0			4.0
All-Red Time (s)	1.0		1.0	1.0			1.0
Lost Time Adjust (s)	0.0			0.0			
Total Lost Time (s)	5.0			5.0			
Lead/Lag	Lag						Lead
Lead-Lag Optimize?	Yes						Yes
Vehicle Extension (s)	2.0		2.0	2.0			2.0
Recall Mode	None		None	None			C-Max
Walk Time (s)	5.0						
Flash Dont Walk (s)	5.0						
Pedestrian Calls (#/hr)	1						
Act Effct Green (s)	20.6			36.1	69.4		
Actuated g/C Ratio	0.21			0.36	0.69		
v/c Ratio	0.85			0.69	0.27		
Control Delay	59.4			29.3	9.7		
Queue Delay	0.0			0.6	0.8		
Total Delay	59.4			29.9	10.5		
LOS	E			C	B		
Approach Delay	59.4			29.9	10.5		
Approach LOS	E			C	B		
Queue Length 50th (ft)	179			217	113		
Queue Length 95th (ft)	243			245	m156		
Internal Link Dist (ft)	537			260	134		
Turn Bay Length (ft)							
Base Capacity (vph)	408			1848	2266		

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	Ø1
Starvation Cap Reductn	0			0	1277		
Spillback Cap Reductn	0			331	0		
Storage Cap Reductn	0			0	0		
Reduced v/c Ratio	0.73			0.74	0.63		

Intersection Summary			
Area Type:	Other		
Cycle Length: 100			
Actuated Cycle Length: 100			
Offset: 71 (71%), Referenced to phase 1:SBT, Start of Yellow			
Natural Cycle: 55			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.85			
Intersection Signal Delay: 28.3		Intersection LOS: C	
Intersection Capacity Utilization 44.7%		ICU Level of Service A	
Analysis Period (min) 15			
Description: 1 / 0 / 2			
m Volume for 95th percentile queue is metered by upstream signal.			

Splits and Phases: 6: Lee St & Lee Street Extension



Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	15	298	1203	0	3	92	1153	756	0	0	0	418
Future Volume (vph)	15	298	1203	0	3	92	1153	756	0	0	0	418
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11	12	11	11	11	11	11
Storage Length (ft)		375		0		175		225	0		0	250
Storage Lanes		1		0		1		1	0		0	1
Taper Length (ft)		100				100			0			100
Right Turn on Red				Yes				Yes			Yes	
Link Speed (mph)			30				30			30		
Link Distance (ft)			571				363			179		
Travel Time (s)			13.0				8.3			4.1		
Confl. Peds. (#/hr)	9	12						12				
Peak Hour Factor	0.42	0.94	0.95	0.92	0.38	0.88	0.94	0.86	0.92	0.92	0.92	0.89
Growth Factor	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%
Heavy Vehicles (%)	0%	8%	5%	2%	0%	2%	4%	3%	2%	2%	2%	5%
Shared Lane Traffic (%)												10%
Lane Group Flow (vph)	0	364	1304	0	0	116	1263	905	0	0	0	436
Turn Type	Prot	Prot	NA		Prot	Prot	NA	custom				Split
Protected Phases	4	4	1 4 5		2	2	1 2 5	1 2 3				3
Permitted Phases												
Detector Phase	4	4	1 4 5		2	2	1 2 5	1 2 3				3
Switch Phase												
Minimum Initial (s)	5.0	5.0			5.0	5.0						5.0
Minimum Split (s)	10.0	10.0			10.0	10.0						23.0
Total Split (s)	23.0	23.0			18.0	18.0						30.0
Total Split (%)	23.0%	23.0%			18.0%	18.0%						30.0%
Maximum Green (s)	18.0	18.0			13.0	13.0						25.0
Yellow Time (s)	4.0	4.0			4.0	4.0						4.0
All-Red Time (s)	1.0	1.0			1.0	1.0						1.0
Lost Time Adjust (s)		0.0				0.0						0.0
Total Lost Time (s)		5.0				5.0						5.0
Lead/Lag	Lag	Lag			Lag	Lag						Lead
Lead-Lag Optimize?	Yes	Yes			Yes	Yes						Yes
Vehicle Extension (s)	3.0	3.0			3.0	3.0						3.0
Recall Mode	None	None			Max	Max						None
Walk Time (s)												13.0
Flash Dont Walk (s)												5.0
Pedestrian Calls (#/hr)												9
Act Effct Green (s)		18.0	47.0			13.0	42.0	53.0				25.0
Actuated g/C Ratio		0.18	0.47			0.13	0.42	0.53				0.25
v/c Ratio		1.24	0.81			0.52	0.87	0.85				1.11
Control Delay		171.0	27.5			53.0	38.2	13.9				114.0
Queue Delay		0.0	27.7			0.0	47.5	2.7				0.1
Total Delay		171.0	55.3			53.0	85.7	16.6				114.1
LOS		F	E			D	F	B				F
Approach Delay			80.5				56.7					
Approach LOS			F				E					
Queue Length 50th (ft)		~290	361			76	435	176				~334

Lane Group	SBT	SBR	Ø1	Ø5
Lane Configurations				
Traffic Volume (vph)	37	272		
Future Volume (vph)	37	272		
Ideal Flow (vphpl)	1900	1900		
Lane Width (ft)	11	11		
Storage Length (ft)		100		
Storage Lanes		0		
Taper Length (ft)				
Right Turn on Red		Yes		
Link Speed (mph)	30			
Link Distance (ft)	916			
Travel Time (s)	20.8			
Confl. Peds. (#/hr)		9		
Peak Hour Factor	0.71	0.80		
Growth Factor	103%	103%		
Heavy Vehicles (%)	5%	3%		
Shared Lane Traffic (%)				
Lane Group Flow (vph)	452	0		
Turn Type	NA			
Protected Phases	3		1	5
Permitted Phases				
Detector Phase	3			
Switch Phase				
Minimum Initial (s)	5.0		1.0	5.0
Minimum Split (s)	23.0		6.0	19.0
Total Split (s)	30.0		10.0	19.0
Total Split (%)	30.0%		10%	19%
Maximum Green (s)	25.0		5.0	16.0
Yellow Time (s)	4.0		4.0	2.0
All-Red Time (s)	1.0		1.0	1.0
Lost Time Adjust (s)	0.0			
Total Lost Time (s)	5.0			
Lead/Lag	Lead		Lead	
Lead-Lag Optimize?	Yes		Yes	
Vehicle Extension (s)	3.0		3.0	3.0
Recall Mode	None		C-Max	None
Walk Time (s)	13.0			6.0
Flash Dont Walk (s)	5.0			10.0
Pedestrian Calls (#/hr)	9			12
Act Effct Green (s)	25.0			
Actuated g/C Ratio	0.25			
v/c Ratio	0.93			
Control Delay	50.9			
Queue Delay	7.2			
Total Delay	58.0			
LOS	E			
Approach Delay	85.6			
Approach LOS	F			
Queue Length 50th (ft)	200			

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Queue Length 95th (ft)		#468	454			m104	518	286				#524
Internal Link Dist (ft)			491				283			99		
Turn Bay Length (ft)		375				175		225				250
Base Capacity (vph)		293	1615			222	1457	1069				394
Starvation Cap Reductn		0	0			0	350	83				0
Spillback Cap Reductn		0	372			0	0	0				4
Storage Cap Reductn		0	0			0	0	0				0
Reduced v/c Ratio		1.24	1.05			0.52	1.14	0.92				1.12

Intersection Summary	
Area Type:	Other
Cycle Length: 100	
Actuated Cycle Length: 100	
Offset: 0 (0%), Referenced to phase 1:EBWB, Start of Yellow, Master Intersection	
Natural Cycle: 120	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 1.24	
Intersection Signal Delay: 70.2	Intersection LOS: E
Intersection Capacity Utilization 85.0%	ICU Level of Service E
Analysis Period (min) 15	
Description: ø3 (EB+WB): 9 / 2 / 2	
ø5 (SB): 12 / 2 / 2	

~ 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: 7: Heath St/Chestnut Hill Ave & Route 9

Lane Group	EBU	EBL	EBT	EBR	EBR2	WBT	WBR	NBL	NBT	NBR	NBR2	SBL2
Lane Configurations												
Traffic Volume (vph)	11	78	1407	32	24	1404	29	18	22	16	4	11
Future Volume (vph)	11	78	1407	32	24	1404	29	18	22	16	4	11
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)		250		0			0	0		0		
Storage Lanes		1		0			0	1		0		
Taper Length (ft)		100						0				
Right Turn on Red					Yes		Yes				Yes	
Link Speed (mph)			30			30			30			
Link Distance (ft)			977			709			527			
Travel Time (s)			22.2			16.1			12.0			
Confl. Peds. (#/hr)	11	6		6	9		6	11		32	6	32
Peak Hour Factor	0.55	0.59	0.97	0.89	0.67	0.97	0.52	0.75	0.61	0.80	0.50	0.55
Growth Factor	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%
Heavy Vehicles (%)	0%	1%	5%	6%	0%	4%	0%	22%	0%	38%	0%	9%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	157	1568	0	0	1548	0	25	66	0	0	0
Turn Type	Prot	Prot	NA			NA		Perm	NA			Perm
Protected Phases	5	5	2			6			8			
Permitted Phases								8				4
Detector Phase	5	5	2			6		8	8			4
Switch Phase												
Minimum Initial (s)	6.0	6.0	1.0			6.0		6.0	6.0			6.0
Minimum Split (s)	12.0	12.0	12.0			12.0		11.0	11.0			11.0
Total Split (s)	14.0	14.0	53.0			39.0		18.0	18.0			18.0
Total Split (%)	14.0%	14.0%	53.0%			39.0%		18.0%	18.0%			18.0%
Maximum Green (s)	8.0	8.0	47.0			33.0		13.0	13.0			13.0
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		1.0	1.0			1.0
Lost Time Adjust (s)		0.0	0.0			0.0		0.0	0.0			
Total Lost Time (s)		6.0	6.0			6.0		5.0	5.0			
Lead/Lag	Lead	Lead				Lag						
Lead-Lag Optimize?	Yes	Yes				Yes						
Vehicle Extension (s)	3.0	3.0	2.0			2.0		3.0	3.0			3.0
Recall Mode	None	None	C-Min			C-Min		None	None			None
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
Act Effct Green (s)		13.1	65.4			45.2		9.6	9.6			
Actuated g/C Ratio		0.13	0.65			0.45		0.10	0.10			
v/c Ratio		0.69	0.73			1.03		0.24	0.47			
Control Delay		61.7	21.0			61.3		45.9	49.3			
Queue Delay		0.0	0.0			0.0		0.0	0.0			
Total Delay		61.7	21.0			61.3		45.9	49.3			
LOS		E	C			E		D	D			
Approach Delay			24.7			61.3			48.4			
Approach LOS			C			E			D			
Queue Length 50th (ft)		99	475			~704		15	37			
Queue Length 95th (ft)		#129	#695			#843		33	50			

Lane Group	SBL	SBT	SBR	NWR2	Ø9
Lane Configurations					
Traffic Volume (vph)	9	3	16	10	
Future Volume (vph)	9	3	16	10	
Ideal Flow (vphpl)	1900	1900	1900	1900	
Storage Length (ft)	0		0		
Storage Lanes	0		0		
Taper Length (ft)	0				
Right Turn on Red			Yes	Yes	
Link Speed (mph)		30			
Link Distance (ft)		854			
Travel Time (s)		19.4			
Confl. Peds. (#/hr)	6		11	32	
Peak Hour Factor	0.75	0.38	0.57	0.50	
Growth Factor	103%	103%	103%	103%	
Heavy Vehicles (%)	0%	0%	0%	0%	
Shared Lane Traffic (%)					
Lane Group Flow (vph)	0	70	0	21	
Turn Type	Perm	NA		Perm	
Protected Phases		4			9
Permitted Phases	4			2 4	
Detector Phase	4	4		2 4	
Switch Phase					
Minimum Initial (s)	6.0	6.0			5.0
Minimum Split (s)	11.0	11.0			29.0
Total Split (s)	18.0	18.0			29.0
Total Split (%)	18.0%	18.0%			29%
Maximum Green (s)	13.0	13.0			26.0
Yellow Time (s)	4.0	4.0			2.0
All-Red Time (s)	1.0	1.0			1.0
Lost Time Adjust (s)		0.0			
Total Lost Time (s)		5.0			
Lead/Lag					
Lead-Lag Optimize?					
Vehicle Extension (s)	3.0	3.0			3.0
Recall Mode	None	None			None
Walk Time (s)					5.0
Flash Dont Walk (s)					21.0
Pedestrian Calls (#/hr)					35
Act Effct Green (s)		9.6		79.0	
Actuated g/C Ratio		0.10		0.79	
v/c Ratio		0.48		0.01	
Control Delay		37.7		0.0	
Queue Delay		0.0		0.0	
Total Delay		37.7		0.0	
LOS		D		A	
Approach Delay		37.7			
Approach LOS		D			
Queue Length 50th (ft)		25		0	
Queue Length 95th (ft)		17		0	

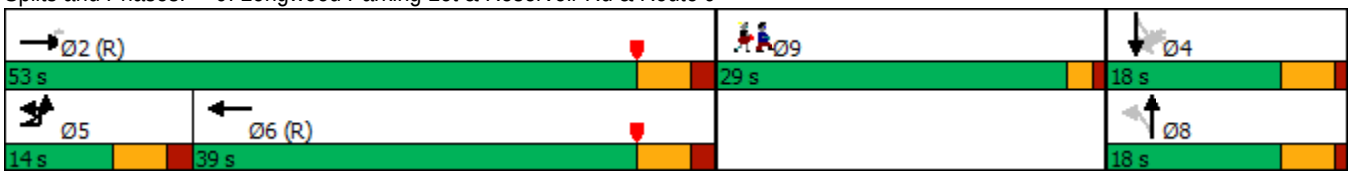
Lane Group	EBU	EBL	EBT	EBR	EBR2	WBT	WBR	NBL	NBT	NBR	NBR2	SBL2
Internal Link Dist (ft)			897			629			447			
Turn Bay Length (ft)		250										
Base Capacity (vph)		226	2159			1508		144	189			
Starvation Cap Reductn		0	0			0		0	0			
Spillback Cap Reductn		0	0			0		0	0			
Storage Cap Reductn		0	0			0		0	0			
Reduced v/c Ratio		0.69	0.73			1.03		0.17	0.35			

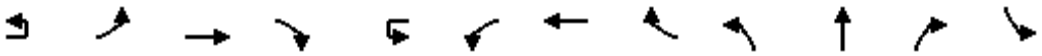
Intersection Summary			
Area Type:	Other		
Cycle Length: 100			
Actuated Cycle Length: 100			
Offset: 47 (47%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow			
Natural Cycle: 110			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 1.03			
Intersection Signal Delay: 41.9		Intersection LOS: D	
Intersection Capacity Utilization 82.9%		ICU Level of Service E	
Analysis Period (min) 15			
Description: 43 / 13 / 1			

~ 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: 9: Longwood Parking Lot & Reservoir Rd & Route 9





Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	1	155	1082	22	1	180	1182	42	107	410	51	122
Future Volume (vph)	1	155	1082	22	1	180	1182	42	107	410	51	122
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11	12	11	11	11	11	11
Storage Length (ft)		550		0		300		150	0		0	125
Storage Lanes		1		0		1		1	1		0	1
Taper Length (ft)		100				100			20			100
Right Turn on Red				Yes				Yes			Yes	
Link Speed (mph)			30				30			30		
Link Distance (ft)			726				711			307		
Travel Time (s)			16.5				16.2			7.0		
Confl. Peds. (#/hr)	26	8		5	19	5		8	26		19	19
Peak Hour Factor	0.25	0.90	0.96	0.79	0.25	0.90	0.92	0.75	0.64	0.91	0.75	0.78
Growth Factor	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%
Heavy Vehicles (%)	0%	6%	7%	18%	0%	6%	3%	7%	5%	2%	22%	6%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	181	1190	0	0	210	1323	58	172	534	0	161
Turn Type	Prot	Prot	NA		Prot	Prot	NA	Prot	Prot	NA		Prot
Protected Phases	1	1	6		5	5	2	2	3	8		7
Permitted Phases												
Detector Phase	1	1	6		5	5	2	2	3	8		7
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0		6.0	6.0	10.0	10.0	5.0	6.0		5.0
Minimum Split (s)	12.0	12.0	33.0		12.0	12.0	33.0	33.0	10.0	33.0		10.0
Total Split (s)	21.0	21.0	53.0		23.0	23.0	55.0	55.0	19.0	35.0		19.0
Total Split (%)	16.2%	16.2%	40.8%		17.7%	17.7%	42.3%	42.3%	14.6%	26.9%		14.6%
Maximum Green (s)	15.0	15.0	47.0		17.0	17.0	49.0	49.0	14.0	29.0		14.0
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0	4.0	4.0	3.0	3.0		3.0
All-Red Time (s)	2.0	2.0	2.0		2.0	2.0	2.0	2.0	2.0	3.0		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	5.0	6.0		5.0
Lead/Lag	Lead	Lead	Lag		Lead	Lead	Lag	Lag	Lead	Lag		Lead
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes		Yes
Vehicle Extension (s)	2.0	2.0	2.0		2.0	2.0	2.0	2.0	3.0	2.0		3.0
Recall Mode	None	None	C-Min		None	None	C-Min	C-Min	None	None		None
Walk Time (s)			7.0				7.0	7.0		7.0		
Flash Dont Walk (s)			20.0				20.0	20.0		20.0		
Pedestrian Calls (#/hr)			5				8	8		26		
Act Effct Green (s)		15.6	48.1			17.9	50.4	50.4	14.0	27.0		14.0
Actuated g/C Ratio		0.12	0.37			0.14	0.39	0.39	0.11	0.21		0.11
v/c Ratio		0.91	0.96			0.93	0.97	0.09	0.97	0.78		0.91
Control Delay		101.6	58.0			99.0	58.6	0.3	109.6	50.9		104.7
Queue Delay		0.0	0.0			0.0	0.0	0.0	0.0	5.6		0.0
Total Delay		101.6	58.0			99.0	58.6	0.3	109.6	56.5		104.7
LOS		F	E			F	E	A	F	E		F
Approach Delay			63.8				61.8			69.4		
Approach LOS			E				E			E		
Queue Length 50th (ft)		154	518			179	~584	0	145	225		136

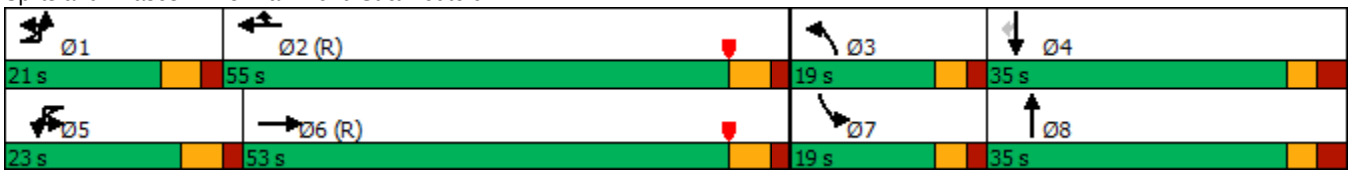
Lane Group	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	252	116
Future Volume (vph)	252	116
Ideal Flow (vphpl)	1900	1900
Lane Width (ft)	11	11
Storage Length (ft)		125
Storage Lanes		1
Taper Length (ft)		
Right Turn on Red		Yes
Link Speed (mph)	30	
Link Distance (ft)	575	
Travel Time (s)	13.1	
Confl. Peds. (#/hr)		26
Peak Hour Factor	0.78	0.85
Growth Factor	103%	103%
Heavy Vehicles (%)	5%	2%
Shared Lane Traffic (%)		
Lane Group Flow (vph)	333	141
Turn Type	NA	Perm
Protected Phases	4	
Permitted Phases		4
Detector Phase	4	4
Switch Phase		
Minimum Initial (s)	6.0	6.0
Minimum Split (s)	33.0	33.0
Total Split (s)	35.0	35.0
Total Split (%)	26.9%	26.9%
Maximum Green (s)	29.0	29.0
Yellow Time (s)	3.0	3.0
All-Red Time (s)	3.0	3.0
Lost Time Adjust (s)	0.0	0.0
Total Lost Time (s)	6.0	6.0
Lead/Lag	Lag	Lag
Lead-Lag Optimize?	Yes	Yes
Vehicle Extension (s)	2.0	2.0
Recall Mode	None	None
Walk Time (s)	7.0	7.0
Flash Dont Walk (s)	20.0	20.0
Pedestrian Calls (#/hr)	26	26
Act Effct Green (s)	27.0	27.0
Actuated g/C Ratio	0.21	0.21
v/c Ratio	0.92	0.36
Control Delay	80.5	13.5
Queue Delay	0.0	0.0
Total Delay	80.5	13.5
LOS	F	B
Approach Delay	71.7	
Approach LOS	E	
Queue Length 50th (ft)	271	16

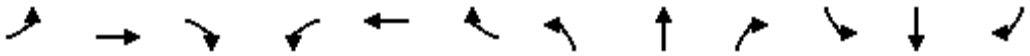
Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Queue Length 95th (ft)		#301	#677			#340	#749	0	#159	290		#214
Internal Link Dist (ft)			646				631			227		
Turn Bay Length (ft)		550				300		150				125
Base Capacity (vph)		198	1239			227	1358	636	178	734		177
Starvation Cap Reductn		0	0			0	0	0	0	145		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		0.91	0.96			0.93	0.97	0.09	0.97	0.91		0.91

Intersection Summary

Area Type: Other
Cycle Length: 130
Actuated Cycle Length: 130
Offset: 0 (0%), Referenced to phase 2:WBT and 6:EBT, Start of Yellow, Master Intersection
Natural Cycle: 110
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.97
Intersection Signal Delay: 65.2 Intersection LOS: E
Intersection Capacity Utilization 86.6% ICU Level of Service E
Analysis Period (min) 15
Description: ø2 (SB): 8 / 7 / 11
ø4 (WB): 19 / 23 / 18
ø6 (NB): 5 / 15 / 7
ø8 (EB): 26 / 28 / 19
~ 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: 13: Hammond St & Route 9





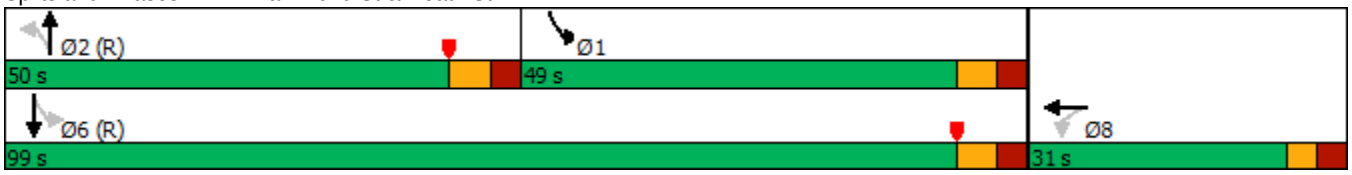
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	69	27	131	10	430	90	30	411	17
Future Volume (vph)	0	0	0	69	27	131	10	430	90	30	411	17
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		0	50		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	0			0			0			20		
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		436			675			648			307	
Travel Time (s)		9.9			15.3			14.7			7.0	
Confl. Peds. (#/hr)						8	17		6	6		17
Peak Hour Factor	0.92	0.92	0.92	0.75	0.52	0.73	0.50	0.93	0.64	0.62	0.84	0.61
Growth Factor	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%	103%
Heavy Vehicles (%)	2%	2%	2%	1%	0%	2%	0%	4%	9%	10%	4%	24%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	333	0	0	642	0	0	583	0
Turn Type				Perm	NA		Perm	NA		pm+pt	NA	
Protected Phases					8			2		1	6	
Permitted Phases				8			2			6		
Detector Phase				8	8		2	2		1	6	
Switch Phase												
Minimum Initial (s)				6.0	6.0		6.0	6.0		6.0	6.0	
Minimum Split (s)				26.0	26.0		19.0	19.0		13.0	20.0	
Total Split (s)				31.0	31.0		50.0	50.0		49.0	99.0	
Total Split (%)				23.8%	23.8%		38.5%	38.5%		37.7%	76.2%	
Maximum Green (s)				25.0	25.0		43.0	43.0		42.0	92.0	
Yellow Time (s)				3.0	3.0		4.0	4.0		4.0	4.0	
All-Red Time (s)				3.0	3.0		3.0	3.0		3.0	3.0	
Lost Time Adjust (s)					0.0			0.0			0.0	
Total Lost Time (s)					6.0			7.0			7.0	
Lead/Lag							Lead	Lead		Lag		
Lead-Lag Optimize?							Yes	Yes		Yes		
Vehicle Extension (s)				2.0	2.0		2.0	2.0		2.0	2.0	
Recall Mode				None	None		C-Min	C-Min		None	C-Min	
Walk Time (s)				7.0	7.0		7.0	7.0			7.0	
Flash Dont Walk (s)				13.0	13.0		5.0	5.0			6.0	
Pedestrian Calls (#/hr)				8	8		6	6			17	
Act Effct Green (s)					30.8			86.2			86.2	
Actuated g/C Ratio					0.24			0.66			0.66	
v/c Ratio					0.80			0.33			0.32	
Control Delay					54.8			9.9			2.0	
Queue Delay					0.1			0.0			0.3	
Total Delay					54.9			10.0			2.3	
LOS					D			A			A	
Approach Delay					54.9			10.0			2.3	
Approach LOS					D			A			A	
Queue Length 50th (ft)					232			109			27	
Queue Length 95th (ft)					151			158			m15	

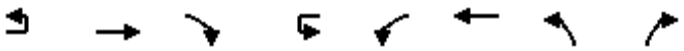
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Internal Link Dist (ft)		356			595			568			227	
Turn Bay Length (ft)												
Base Capacity (vph)					421			1948			1932	
Starvation Cap Reductn					0			0			698	
Spillback Cap Reductn					1			90			0	
Storage Cap Reductn					0			0			0	
Reduced v/c Ratio					0.79			0.35			0.47	

Intersection Summary			
Area Type:	Other		
Cycle Length: 130			
Actuated Cycle Length: 130			
Offset: 105 (81%), Referenced to phase 2:NBTL and 6:SBTL, Start of Yellow			
Natural Cycle: 60			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.80			
Intersection Signal Delay: 16.7		Intersection LOS: B	
Intersection Capacity Utilization 60.2%		ICU Level of Service B	
Analysis Period (min) 15			
Description: ø2 (WB): 6 / 6 / 9			
ø6 (EB): 17 / 19 / 12			
ø8 (SB): 8 / 6 / 22			

m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 14: Hammond St & Heath St





Lane Group	EBU	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø9
Lane Configurations									
Traffic Volume (vph)	44	1307	73	5	9	1262	25	44	
Future Volume (vph)	44	1307	73	5	9	1262	25	44	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	
Lane Width (ft)	11	12	11	11	11	12	11	11	
Storage Length (ft)	250		0		150		0	0	
Storage Lanes	1		0		1		1	0	
Taper Length (ft)	100				100		0		
Right Turn on Red			Yes					Yes	
Link Speed (mph)		30				30	30		
Link Distance (ft)		898				297	462		
Travel Time (s)		20.4				6.8	10.5		
Confl. Peds. (#/hr)			16		16				
Peak Hour Factor	0.73	0.87	0.55	0.42	0.75	0.93	0.89	0.79	
Growth Factor	103%	103%	103%	103%	103%	103%	103%	103%	
Heavy Vehicles (%)	0%	6%	1%	0%	0%	3%	12%	14%	
Shared Lane Traffic (%)									
Lane Group Flow (vph)	62	1684	0	0	24	1398	86	0	
Turn Type	Prot	NA		Prot	Prot	NA	Prot		
Protected Phases	5	2		1	1	6	8		9
Permitted Phases									
Detector Phase	5	2		1	1	6	8		
Switch Phase									
Minimum Initial (s)	6.0	10.0		6.0	6.0	10.0	1.0		5.0
Minimum Split (s)	12.0	23.0		12.0	12.0	23.0	7.0		32.0
Total Split (s)	18.0	61.0		18.0	18.0	61.0	19.0		32.0
Total Split (%)	13.8%	46.9%		13.8%	13.8%	46.9%	14.6%		25%
Maximum Green (s)	12.0	55.0		12.0	12.0	55.0	13.0		29.0
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	3.0		2.0
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	3.0		1.0
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		Lead	Lead	Lag			
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes			
Vehicle Extension (s)	2.0	2.0		2.0	2.0	2.0	3.0		3.0
Recall Mode	None	C-Min		None	None	C-Min	None		None
Walk Time (s)									7.0
Flash Dont Walk (s)									22.0
Pedestrian Calls (#/hr)									8
Act Effct Green (s)	9.0	95.0			6.8	90.4	8.6		
Actuated g/C Ratio	0.07	0.73			0.05	0.70	0.07		
v/c Ratio	0.52	0.68			0.26	0.57	0.58		
Control Delay	72.8	15.7			66.0	15.5	39.2		
Queue Delay	0.0	0.0			0.0	11.4	0.0		
Total Delay	72.8	15.7			66.0	27.0	39.2		
LOS	E	B			E	C	D		
Approach Delay		17.7				27.6	39.2		
Approach LOS		B				C	D		
Queue Length 50th (ft)	51	322			20	247	24		

Lane Group	EBU	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø9
Queue Length 95th (ft)	78	#936			41	#745	75		
Internal Link Dist (ft)		818				217	382		
Turn Bay Length (ft)	250				150				
Base Capacity (vph)	161	2463			161	2438	196		
Starvation Cap Reductn	0	0			0	1031	0		
Spillback Cap Reductn	0	0			0	0	0		
Storage Cap Reductn	0	0			0	0	0		
Reduced v/c Ratio	0.39	0.68			0.15	0.99	0.44		

Intersection Summary	
Area Type:	Other
Cycle Length: 130	
Actuated Cycle Length: 130	
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow	
Natural Cycle: 110	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.68	
Intersection Signal Delay: 22.6	Intersection LOS: C
Intersection Capacity Utilization 53.9%	ICU Level of Service A
Analysis Period (min) 15	
Description: 0 / 5 / 13	

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

Splits and Phases: 15: Tully St & Route 9

APPENDIX K

Intersection Capacity Analyses
Weekday PM Peak Hour
Proposed Long-Term Improvements under 2030 Traffic Conditions

Lane Group	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	294	753	100	2	81	896	54	65	194	30	20	234
Future Volume (vph)	294	753	100	2	81	896	54	65	194	30	20	234
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	12	11	11	11	12	11	11	11	11	11	10
Storage Length (ft)	350		0		150		0	0		0	0	
Storage Lanes	1		0		1		0	1		0	0	
Taper Length (ft)	100				100			0			0	
Right Turn on Red			Yes				Yes			Yes		
Link Speed (mph)		30				30			30			30
Link Distance (ft)		614				1044			573			420
Travel Time (s)		14.0				23.7			13.0			9.5
Confl. Peds. (#/hr)	8		5	28	5		8	99		28	28	
Peak Hour Factor	0.98	0.95	0.78	0.50	0.56	0.96	0.84	0.77	0.88	0.68	0.50	0.90
Growth Factor	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%
Heavy Vehicles (%)	1%	3%	2%	0%	0%	2%	2%	8%	0%	0%	5%	2%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	312	957	0	0	154	1038	0	88	275	0	0	312
Turn Type	Prot	NA		Prot	Prot	NA		Perm	NA		Perm	NA
Protected Phases	5	2		1	1	6			8			4
Permitted Phases								8			4	
Detector Phase	5	2		1	1	6		8	8		4	4
Switch Phase												
Minimum Initial (s)	6.0	10.0		6.0	6.0	10.0		6.0	6.0		6.0	6.0
Minimum Split (s)	11.0	16.0		11.0	11.0	16.0		11.0	11.0		11.0	11.0
Total Split (s)	32.0	60.0		22.0	22.0	50.0		42.0	42.0		42.0	42.0
Total Split (%)	21.3%	40.0%		14.7%	14.7%	33.3%		28.0%	28.0%		28.0%	28.0%
Maximum Green (s)	27.0	54.0		17.0	17.0	44.0		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	4.0
All-Red Time (s)	1.0	2.0		1.0	1.0	2.0		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	6.0			5.0	6.0		5.0	5.0			5.0
Lead/Lag	Lead	Lag		Lead	Lead	Lag						
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes						
Vehicle Extension (s)	2.0	2.0		2.0	2.0	2.0		2.0	2.0		2.0	2.0
Recall Mode	None	Min		None	None	Min		None	None		None	None
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
Act Effct Green (s)	27.1	56.1			15.3	44.2		37.2	37.2			37.2
Actuated g/C Ratio	0.19	0.39			0.11	0.31		0.26	0.26			0.26
v/c Ratio	0.95	0.71			0.83	0.96		0.70	0.59			0.96
Control Delay	97.1	41.4			96.5	68.1		79.7	52.8			94.5
Queue Delay	0.0	0.0			0.0	0.0		0.0	0.0			0.0
Total Delay	97.1	41.4			96.5	68.1		79.7	52.8			94.5
LOS	F	D			F	E		E	D			F
Approach Delay		55.1				71.7			59.3			52.2
Approach LOS		E				E			E			D
Queue Length 50th (ft)	304	421			147	526		78	232			303

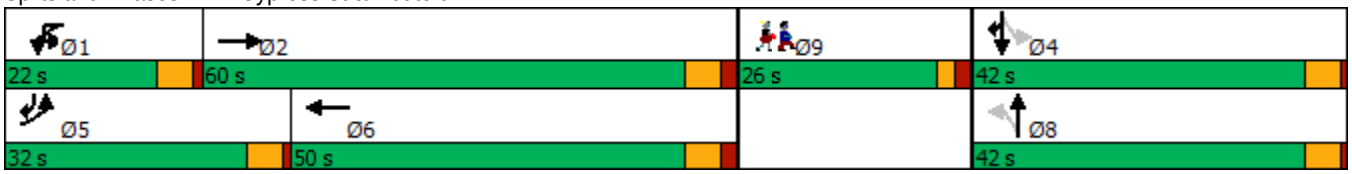
Lane Group	SBR	Ø9
Lane Configurations		
Traffic Volume (vph)	240	
Future Volume (vph)	240	
Ideal Flow (vphpl)	1900	
Lane Width (ft)	11	
Storage Length (ft)	0	
Storage Lanes	1	
Taper Length (ft)		
Right Turn on Red	Yes	
Link Speed (mph)		
Link Distance (ft)		
Travel Time (s)		
Confl. Peds. (#/hr)	99	
Peak Hour Factor	0.92	
Growth Factor	104%	
Heavy Vehicles (%)	1%	
Shared Lane Traffic (%)		
Lane Group Flow (vph)	271	
Turn Type	pt+ov	
Protected Phases	4 5	9
Permitted Phases		
Detector Phase	4 5	
Switch Phase		
Minimum Initial (s)		20.0
Minimum Split (s)		26.0
Total Split (s)		26.0
Total Split (%)		17%
Maximum Green (s)		22.0
Yellow Time (s)		2.0
All-Red Time (s)		2.0
Lost Time Adjust (s)		
Total Lost Time (s)		
Lead/Lag		
Lead-Lag Optimize?		
Vehicle Extension (s)		2.0
Recall Mode		None
Walk Time (s)		7.0
Flash Dont Walk (s)		10.0
Pedestrian Calls (#/hr)		60
Act Effct Green (s)	69.3	
Actuated g/C Ratio	0.48	
v/c Ratio	0.31	
Control Delay	3.4	
Queue Delay	0.0	
Total Delay	3.4	
LOS	A	
Approach Delay		
Approach LOS		
Queue Length 50th (ft)	0	

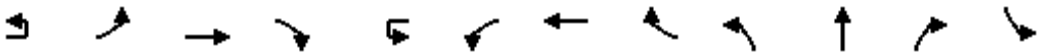
Lane Group	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Queue Length 95th (ft)	#505	505			135	#681		#130	325			#508
Internal Link Dist (ft)		534				964			493			340
Turn Bay Length (ft)	350				150							
Base Capacity (vph)	327	1348			208	1082		126	465			324
Starvation Cap Reductn	0	0			0	0		0	0			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	0.95	0.71			0.74	0.96		0.70	0.59			0.96

Intersection Summary	
Area Type:	Other
Cycle Length: 150	
Actuated Cycle Length: 143.2	
Natural Cycle: 150	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.96	
Intersection Signal Delay: 60.9	Intersection LOS: E
Intersection Capacity Utilization 88.8%	ICU Level of Service E
Analysis Period (min) 15	
Description: 155 / 99 / 53	

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

Splits and Phases: 2: Cypress St & Route 9





Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	4	197	1090	55	14	42	1155	18	41	193	6	67
Future Volume (vph)	4	197	1090	55	14	42	1155	18	41	193	6	67
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11	12	11	11	11	11	11
Storage Length (ft)		350		150		150		0	100		0	0
Storage Lanes		1		0		1		0	1		0	0
Taper Length (ft)		100				100			50			0
Right Turn on Red				Yes				Yes			Yes	
Link Speed (mph)			30				30			30		
Link Distance (ft)			635				1295			738		
Travel Time (s)			14.4				29.4			16.8		
Confl. Peds. (#/hr)	3	5			7			5	3		7	7
Peak Hour Factor	0.50	0.91	0.94	0.76	0.58	0.66	0.89	0.90	0.60	0.93	0.50	0.80
Growth Factor	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%
Heavy Vehicles (%)	0%	1%	2%	0%	0%	5%	2%	6%	0%	2%	0%	0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	233	1281	0	0	91	1371	0	71	228	0	0
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA		Perm
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases									8			4
Detector Phase	5	5	2		1	1	6		8	8		4
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0		6.0	6.0	40.0		6.0	6.0		6.0
Minimum Split (s)	11.0	11.0	46.0		11.0	11.0	46.0		23.0	23.0		23.0
Total Split (s)	22.0	22.0	57.0		17.0	17.0	52.0		40.0	40.0		40.0
Total Split (%)	15.7%	15.7%	40.7%		12.1%	12.1%	37.1%		28.6%	28.6%		28.6%
Maximum Green (s)	17.0	17.0	51.0		12.0	12.0	46.0		35.0	35.0		35.0
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	2.0		1.0	1.0	2.0		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	6.0			5.0	6.0		5.0	5.0		
Lead/Lag	Lead	Lead	Lag		Lead	Lead	Lag					
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes					
Vehicle Extension (s)	3.0	3.0	2.0		3.0	3.0	2.0		3.0	3.0		3.0
Recall Mode	None	None	Min		None	None	Min		None	None		None
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
Act Effct Green (s)		17.1	52.8			10.6	46.3		35.2	35.2		
Actuated g/C Ratio		0.14	0.44			0.09	0.39		0.30	0.30		
v/c Ratio		0.94	0.82			0.61	1.00		0.47	0.43		
Control Delay		95.3	35.6			71.1	61.0		49.4	38.3		
Queue Delay		0.0	0.0			0.0	0.0		0.0	0.0		
Total Delay		95.3	35.6			71.1	61.0		49.4	38.3		
LOS		F	D			E	E		D	D		
Approach Delay			44.8				61.6			40.9		
Approach LOS			D				E			D		
Queue Length 50th (ft)		170	415			64	507		42	131		

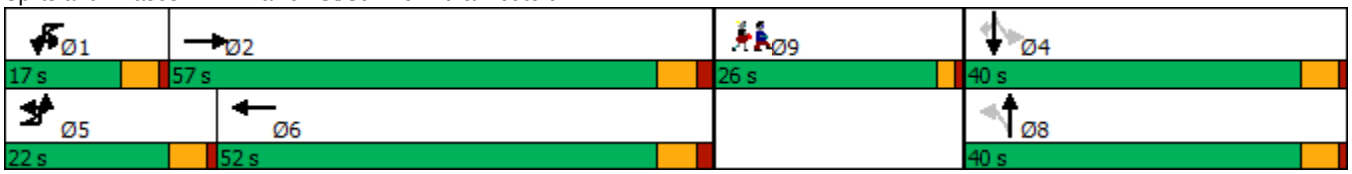
Lane Group	SBT	SBR	Ø9
Lane Configurations			
Traffic Volume (vph)	250	128	
Future Volume (vph)	250	128	
Ideal Flow (vphpl)	1900	1900	
Lane Width (ft)	11	11	
Storage Length (ft)		0	
Storage Lanes		1	
Taper Length (ft)			
Right Turn on Red		Yes	
Link Speed (mph)	30		
Link Distance (ft)	625		
Travel Time (s)	14.2		
Confl. Peds. (#/hr)		3	
Peak Hour Factor	0.93	0.86	
Growth Factor	104%	104%	
Heavy Vehicles (%)	1%	2%	
Shared Lane Traffic (%)			
Lane Group Flow (vph)	367	155	
Turn Type	NA	Perm	
Protected Phases	4		9
Permitted Phases		4	
Detector Phase	4	4	
Switch Phase			
Minimum Initial (s)	6.0	6.0	6.0
Minimum Split (s)	23.0	23.0	26.0
Total Split (s)	40.0	40.0	26.0
Total Split (%)	28.6%	28.6%	19%
Maximum Green (s)	35.0	35.0	23.0
Yellow Time (s)	4.0	4.0	2.0
All-Red Time (s)	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	
Total Lost Time (s)	5.0	5.0	
Lead/Lag			
Lead-Lag Optimize?			
Vehicle Extension (s)	3.0	3.0	3.0
Recall Mode	None	None	None
Walk Time (s)			5.0
Flash Dont Walk (s)			18.0
Pedestrian Calls (#/hr)			7
Act Effct Green (s)	35.2	35.2	
Actuated g/C Ratio	0.30	0.30	
v/c Ratio	0.96	0.28	
Control Delay	79.9	7.0	
Queue Delay	0.0	0.0	
Total Delay	79.9	7.0	
LOS	E	A	
Approach Delay	58.2		
Approach LOS	E		
Queue Length 50th (ft)	260	0	

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Queue Length 95th (ft)		#414	#776			103	#914		70	265		
Internal Link Dist (ft)			555				1215			658		
Turn Bay Length (ft)		350				150			100			
Base Capacity (vph)		247	1558			170	1371		151	529		
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	0.82			0.54	1.00		0.47	0.43		

Intersection Summary			
Area Type:	Other		
Cycle Length: 140			
Actuated Cycle Length: 119.2			
Natural Cycle: 150			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 1.00			
Intersection Signal Delay: 52.8		Intersection LOS: D	
Intersection Capacity Utilization 91.4%		ICU Level of Service F	
Analysis Period (min) 15			
Description: 16 / 7 / 16			

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

Splits and Phases: 4: Warren St/Sumner Rd & Route 9



Lane Group	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø1	Ø2
Lane Configurations									
Traffic Volume (vph)	1182	592	2	201	1063	487	174		
Future Volume (vph)	1182	592	2	201	1063	487	174		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900		
Lane Width (ft)	12	11	11	11	12	11	11		
Storage Length (ft)		225		350		0	0		
Storage Lanes		1		1		2	1		
Taper Length (ft)				100		0			
Right Turn on Red		Yes					Yes		
Link Speed (mph)	30				30	30			
Link Distance (ft)	363				323	214			
Travel Time (s)	8.3				7.3	4.9			
Confl. Peds. (#/hr)		1	1	1			1		
Peak Hour Factor	0.91	0.99	0.50	0.93	0.93	0.94	0.93		
Growth Factor	104%	104%	104%	104%	104%	104%	104%		
Heavy Vehicles (%)	2%	2%	0%	2%	2%	2%	2%		
Shared Lane Traffic (%)									
Lane Group Flow (vph)	1351	622	0	229	1189	539	195		
Turn Type	NA	pt+ov	Prot	Prot	NA	Prot	Perm		
Protected Phases	1 2	1 2 4	3	3	1 2 3	4		1	2
Permitted Phases							4		
Detector Phase	1 2	1 2 4	3	3	1 2 3	4	4		
Switch Phase									
Minimum Initial (s)			5.0	5.0		6.0	6.0	5.0	10.0
Minimum Split (s)			10.0	10.0		29.0	29.0	10.0	19.0
Total Split (s)			20.0	20.0		47.0	47.0	34.0	19.0
Total Split (%)			16.7%	16.7%		39.2%	39.2%	28%	16%
Maximum Green (s)			15.0	15.0		42.0	42.0	29.0	14.0
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	1.0	1.0	1.0
Lost Time Adjust (s)				0.0		0.0	0.0		
Total Lost Time (s)				5.0		5.0	5.0		
Lead/Lag			Lead	Lead		Lag	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
Recall Mode			None	None		None	None	None	C-Max
Walk Time (s)						17.0	17.0		10.0
Flash Dont Walk (s)						7.0	7.0		4.0
Pedestrian Calls (#/hr)						1	1		1
Act Effct Green (s)	54.4	95.0		15.0	74.4	35.6	35.6		
Actuated g/C Ratio	0.45	0.79		0.12	0.62	0.30	0.30		
v/c Ratio	0.84	0.50		1.08	0.54	0.55	0.33		
Control Delay	23.8	1.8		132.6	15.2	9.6	3.1		
Queue Delay	17.3	0.9		11.6	1.6	1.0	1.3		
Total Delay	41.1	2.7		144.2	16.9	10.5	4.4		
LOS	D	A		F	B	B	A		
Approach Delay	29.0				37.4	8.9			
Approach LOS	C				D	A			
Queue Length 50th (ft)	537	21		~197	274	137	18		

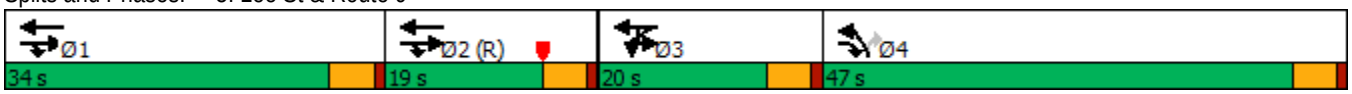
Lane Group	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø1	Ø2
Queue Length 95th (ft)	m#562	m25		#358	366	73	5		
Internal Link Dist (ft)	283				243	134			
Turn Bay Length (ft)		225		350					
Base Capacity (vph)	1603	1230		213	2193	1161	655		
Starvation Cap Reductn	279	339		0	0	357	284		
Spillback Cap Reductn	0	2		36	774	0	0		
Storage Cap Reductn	0	0		0	0	0	0		
Reduced v/c Ratio	1.02	0.70		1.29	0.84	0.67	0.53		

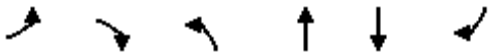
Intersection Summary

Area Type: Other
Cycle Length: 120
Actuated Cycle Length: 120
Offset: 115 (96%), Referenced to phase 2:EBWB, Start of Yellow
Natural Cycle: 90
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.08
Intersection Signal Delay: 28.3 Intersection LOS: C
Intersection Capacity Utilization 72.8% ICU Level of Service C
Analysis Period (min) 15
Description: ø2 (NB): 0 / 1 / 3
ø4 (WB): 0 / 1 / 3

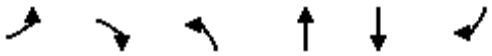
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Lee St & Route 9





Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	Ø1
Lane Configurations							
Traffic Volume (vph)	79	11	42	602	818	7	
Future Volume (vph)	79	11	42	602	818	7	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	
Right Turn on Red		Yes				Yes	
Link Speed (mph)	30			30	30		
Link Distance (ft)	617			340	214		
Travel Time (s)	14.0			7.7	4.9		
Peak Hour Factor	0.90	0.69	0.66	0.84	0.87	0.58	
Growth Factor	104%	104%	104%	104%	104%	104%	
Heavy Vehicles (%)	3%	0%	0%	2%	2%	0%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	108	0	0	811	991	0	
Turn Type	Prot		Perm	NA	NA		
Protected Phases	2			3	1 3		1
Permitted Phases			3				
Detector Phase	2		3	3	1 3		
Switch Phase							
Minimum Initial (s)	6.0		10.0	10.0			5.0
Minimum Split (s)	20.0		15.0	15.0			10.0
Total Split (s)	20.0		50.0	50.0			50.0
Total Split (%)	16.7%		41.7%	41.7%			42%
Maximum Green (s)	15.0		45.0	45.0			45.0
Yellow Time (s)	4.0		4.0	4.0			4.0
All-Red Time (s)	1.0		1.0	1.0			1.0
Lost Time Adjust (s)	0.0			0.0			
Total Lost Time (s)	5.0			5.0			
Lead/Lag	Lag						Lead
Lead-Lag Optimize?	Yes						Yes
Vehicle Extension (s)	2.0		2.0	2.0			2.0
Recall Mode	None		None	None			C-Max
Walk Time (s)	5.0						
Flash Dont Walk (s)	5.0						
Pedestrian Calls (#/hr)	0						
Act Effct Green (s)	11.3			38.2	98.7		
Actuated g/C Ratio	0.09			0.32	0.82		
v/c Ratio	0.66			0.68	0.35		
Control Delay	68.3			38.2	2.7		
Queue Delay	0.0			0.2	0.6		
Total Delay	68.3			38.4	3.3		
LOS	E			D	A		
Approach Delay	68.3			38.4	3.3		
Approach LOS	E			D	A		
Queue Length 50th (ft)	77			197	33		
Queue Length 95th (ft)	136			206	m138		
Internal Link Dist (ft)	537			260	134		
Turn Bay Length (ft)							
Base Capacity (vph)	215			1407	2791		
Starvation Cap Reductn	0			0	1320		

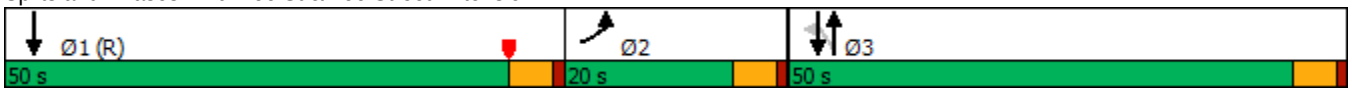


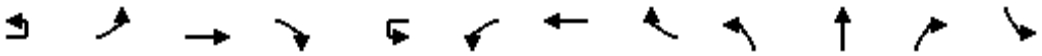
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	Ø1
Spillback Cap Reductn	0			116	0		
Storage Cap Reductn	0			0	0		
Reduced v/c Ratio	0.50			0.63	0.67		

Intersection Summary			
Area Type:	Other		
Cycle Length: 120			
Actuated Cycle Length: 120			
Offset: 105 (88%), Referenced to phase 1:SBT, Start of Yellow			
Natural Cycle: 50			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.68			
Intersection Signal Delay: 21.9		Intersection LOS: C	
Intersection Capacity Utilization 54.5%		ICU Level of Service A	
Analysis Period (min) 15			
Description: 1 / 0 / 2			

m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 6: Lee St & Lee Street Extension





Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	9	308	1190	0	1	117	1127	391	0	0	0	601
Future Volume (vph)	9	308	1190	0	1	117	1127	391	0	0	0	601
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	11	12	11	11	11	11	11
Storage Length (ft)		400		0		175		225	0		0	250
Storage Lanes		1		0		1		1	0		0	1
Taper Length (ft)		100				100			0			100
Right Turn on Red				Yes				Yes			Yes	
Link Speed (mph)			30				30			30		
Link Distance (ft)			584				363			179		
Travel Time (s)			13.3				8.3			4.1		
Confl. Peds. (#/hr)	2	2				2		2				
Peak Hour Factor	0.75	0.81	0.90	0.92	0.25	0.75	0.89	0.91	0.92	0.92	0.92	0.94
Growth Factor	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%
Heavy Vehicles (%)	0%	0%	2%	2%	0%	0%	2%	1%	2%	2%	2%	2%
Shared Lane Traffic (%)												32%
Lane Group Flow (vph)	0	407	1375	0	0	166	1317	447	0	0	0	452
Turn Type	Prot	Prot	NA		Prot	Prot	NA	custom				Split
Protected Phases	4	4	1 4 5		2	2	1 2 5	1 2 3				3
Permitted Phases												
Detector Phase	4	4	1 4 5		2	2	1 2 5	1 2 3				3
Switch Phase												
Minimum Initial (s)	5.0	5.0			5.0	5.0						5.0
Minimum Split (s)	10.0	10.0			10.0	10.0						23.0
Total Split (s)	28.0	28.0			15.0	15.0						35.0
Total Split (%)	23.3%	23.3%			12.5%	12.5%						29.2%
Maximum Green (s)	23.0	23.0			10.0	10.0						30.0
Yellow Time (s)	4.0	4.0			4.0	4.0						4.0
All-Red Time (s)	1.0	1.0			1.0	1.0						1.0
Lost Time Adjust (s)		0.0				0.0						0.0
Total Lost Time (s)		5.0				5.0						5.0
Lead/Lag	Lag	Lag			Lag	Lag						Lead
Lead-Lag Optimize?	Yes	Yes			Yes	Yes						Yes
Vehicle Extension (s)	3.0	3.0			3.0	3.0						3.0
Recall Mode	None	None			Max	Max						None
Walk Time (s)												13.0
Flash Dont Walk (s)												5.0
Pedestrian Calls (#/hr)												2
Act Effct Green (s)		23.0	65.0			10.0	52.0	68.0				30.0
Actuated g/C Ratio		0.19	0.54			0.08	0.43	0.57				0.25
v/c Ratio		1.22	0.72			1.14	0.86	0.42				1.11
Control Delay		164.0	23.3			164.9	38.3	4.8				121.0
Queue Delay		0.0	16.1			0.0	17.0	0.6				0.0
Total Delay		164.0	39.4			164.9	55.3	5.4				121.0
LOS		F	D			F	E	A				F
Approach Delay			67.8				53.2					
Approach LOS			E				D					
Queue Length 50th (ft)		~386	402			~151	514	73				~422

Lane Group	SBT	SBR	Ø1	Ø5
Lane Configurations				
Traffic Volume (vph)	56	119		
Future Volume (vph)	56	119		
Ideal Flow (vphpl)	1900	1900		
Lane Width (ft)	11	11		
Storage Length (ft)		100		
Storage Lanes		0		
Taper Length (ft)				
Right Turn on Red		Yes		
Link Speed (mph)	30			
Link Distance (ft)	916			
Travel Time (s)	20.8			
Confl. Peds. (#/hr)		2		
Peak Hour Factor	0.64	0.88		
Growth Factor	104%	104%		
Heavy Vehicles (%)	4%	2%		
Shared Lane Traffic (%)				
Lane Group Flow (vph)	445	0		
Turn Type	NA			
Protected Phases	3		1	5
Permitted Phases				
Detector Phase	3			
Switch Phase				
Minimum Initial (s)	5.0		5.0	5.0
Minimum Split (s)	23.0		15.0	19.0
Total Split (s)	35.0		23.0	19.0
Total Split (%)	29.2%		19%	16%
Maximum Green (s)	30.0		18.0	16.0
Yellow Time (s)	4.0		4.0	2.0
All-Red Time (s)	1.0		1.0	1.0
Lost Time Adjust (s)	0.0			
Total Lost Time (s)	5.0			
Lead/Lag	Lead		Lead	
Lead-Lag Optimize?	Yes		Yes	
Vehicle Extension (s)	3.0		3.0	3.0
Recall Mode	None		C-Max	None
Walk Time (s)	13.0			6.0
Flash Dont Walk (s)	5.0			10.0
Pedestrian Calls (#/hr)	2			2
Act Effct Green (s)	30.0			
Actuated g/C Ratio	0.25			
v/c Ratio	1.09			
Control Delay	112.1			
Queue Delay	2.1			
Total Delay	114.2			
LOS	F			
Approach Delay	117.6			
Approach LOS	F			
Queue Length 50th (ft)	~396			

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Queue Length 95th (ft)		#499	487			#228	596	130				#640
Internal Link Dist (ft)			504				283			99		
Turn Bay Length (ft)		400				175		225				250
Base Capacity (vph)		334	1916			145	1533	1069				406
Starvation Cap Reductn		0	138			0	242	296				0
Spillback Cap Reductn		0	559			0	0	0				0
Storage Cap Reductn		0	0			0	0	0				0
Reduced v/c Ratio		1.22	1.01			1.14	1.02	0.58				1.11

Intersection Summary	
Area Type:	Other
Cycle Length: 120	
Actuated Cycle Length: 120	
Offset: 0 (0%), Referenced to phase 1:EBWB, Start of Yellow, Master Intersection	
Natural Cycle: 130	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 1.22	
Intersection Signal Delay: 71.4	Intersection LOS: E
Intersection Capacity Utilization 85.8%	ICU Level of Service E
Analysis Period (min) 15	
Description: ø3 (EB+WB): 9 / 2 / 2	
ø5 (SB): 12 / 2 / 2	

~ 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: 7: Heath St/Chestnut Hill Ave & Route 9

Lane Group	EBU	EBL	EBT	EBR	EBR2	WBT	WBR	NBL	NBT	NBR	NBR2	SBL2
Lane Configurations												
Traffic Volume (vph)	18	21	1479	17	1	1261	21	58	11	12	3	24
Future Volume (vph)	18	21	1479	17	1	1261	21	58	11	12	3	24
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)		250		0			0	0		0		
Storage Lanes		1		0			0	1		0		
Taper Length (ft)		100						0				
Right Turn on Red					Yes		Yes				Yes	
Link Speed (mph)			30			30			30			
Link Distance (ft)			977			709			527			
Travel Time (s)			22.2			16.1			12.0			
Confl. Peds. (#/hr)	5	1		2	11		1	5		8	2	8
Peak Hour Factor	0.75	0.58	0.94	0.61	0.25	0.96	0.66	0.63	0.69	0.60	0.75	0.75
Growth Factor	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%
Heavy Vehicles (%)	0%	0%	1%	0%	0%	1%	0%	7%	0%	33%	0%	0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	63	1669	0	0	1399	0	96	42	0	0	0
Turn Type	Prot	Prot	NA			NA		Perm	NA			Perm
Protected Phases	5	5	2			6			8			
Permitted Phases								8				4
Detector Phase	5	5	2			6		8	8			4
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0			6.0		6.0	6.0			6.0
Minimum Split (s)	12.0	12.0	12.0			12.0		11.0	11.0			11.0
Total Split (s)	12.0	12.0	71.0			59.0		20.0	20.0			20.0
Total Split (%)	10.0%	10.0%	59.2%			49.2%		16.7%	16.7%			16.7%
Maximum Green (s)	6.0	6.0	65.0			53.0		15.0	15.0			15.0
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		1.0	1.0			1.0
Lost Time Adjust (s)		0.0	0.0			0.0		0.0	0.0			
Total Lost Time (s)		6.0	6.0			6.0		5.0	5.0			
Lead/Lag	Lead	Lead				Lag						
Lead-Lag Optimize?	Yes	Yes				Yes						
Vehicle Extension (s)	3.0	3.0	2.0			2.0		3.0	3.0			3.0
Recall Mode	None	None	C-Min			C-Min		None	None			None
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
Act Effct Green (s)		7.6	84.5			73.4		12.9	12.9			
Actuated g/C Ratio		0.06	0.70			0.61		0.11	0.11			
v/c Ratio		0.58	0.69			0.66		0.71	0.27			
Control Delay		75.9	16.2			21.9		77.9	49.2			
Queue Delay		0.0	0.0			0.5		0.0	0.0			
Total Delay		75.9	16.2			22.4		77.9	49.2			
LOS		E	B			C		E	D			
Approach Delay			18.4			22.4			69.2			
Approach LOS			B			C			E			
Queue Length 50th (ft)		47	232			309		72	27			
Queue Length 95th (ft)		61	703			#680		88	47			

Lane Group	SBL	SBT	SBR	NWR2	Ø9
Lane Configurations					
Traffic Volume (vph)	7	1	7	6	
Future Volume (vph)	7	1	7	6	
Ideal Flow (vphpl)	1900	1900	1900	1900	
Storage Length (ft)	0		0		
Storage Lanes	0		0		
Taper Length (ft)	0				
Right Turn on Red			Yes	Yes	
Link Speed (mph)		30			
Link Distance (ft)		854			
Travel Time (s)		19.4			
Confl. Peds. (#/hr)	2		5	8	
Peak Hour Factor	0.44	0.25	0.58	0.38	
Growth Factor	104%	104%	104%	104%	
Heavy Vehicles (%)	0%	0%	0%	0%	
Shared Lane Traffic (%)					
Lane Group Flow (vph)	0	67	0	16	
Turn Type	Perm	NA		Perm	
Protected Phases		4			9
Permitted Phases	4			2 4	
Detector Phase	4	4		2 4	
Switch Phase					
Minimum Initial (s)	6.0	6.0			5.0
Minimum Split (s)	11.0	11.0			29.0
Total Split (s)	20.0	20.0			29.0
Total Split (%)	16.7%	16.7%			24%
Maximum Green (s)	15.0	15.0			26.0
Yellow Time (s)	4.0	4.0			2.0
All-Red Time (s)	1.0	1.0			1.0
Lost Time Adjust (s)		0.0			
Total Lost Time (s)		5.0			
Lead/Lag					
Lead-Lag Optimize?					
Vehicle Extension (s)	3.0	3.0			3.0
Recall Mode	None	None			None
Walk Time (s)					5.0
Flash Dont Walk (s)					21.0
Pedestrian Calls (#/hr)					13
Act Effct Green (s)		12.9		106.0	
Actuated g/C Ratio		0.11		0.88	
v/c Ratio		0.46		0.01	
Control Delay		53.5		0.0	
Queue Delay		0.0		0.0	
Total Delay		53.5		0.0	
LOS		D		A	
Approach Delay		53.5			
Approach LOS		D			
Queue Length 50th (ft)		43		0	
Queue Length 95th (ft)		19		0	

Lane Group	EBU	EBL	EBT	EBR	EBR2	WBT	WBR	NBL	NBT	NBR	NBR2	SBL2
Internal Link Dist (ft)			897			629			447			
Turn Bay Length (ft)		250										
Base Capacity (vph)		109	2423			2106		158	176			
Starvation Cap Reductn		0	0			294		0	0			
Spillback Cap Reductn		0	0			0		0	0			
Storage Cap Reductn		0	0			0		0	0			
Reduced v/c Ratio		0.58	0.69			0.77		0.61	0.24			

Intersection Summary			
Area Type:	Other		
Cycle Length: 120			
Actuated Cycle Length: 120			
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow			
Natural Cycle: 90			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.71			
Intersection Signal Delay: 22.8		Intersection LOS: C	
Intersection Capacity Utilization 71.3%		ICU Level of Service C	
Analysis Period (min) 15			
Description: 43 / 13 / 1			

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

Splits and Phases: 9: Longwood Parking Lot & Reservoir Rd & Route 9

Lane Group	EBU	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	2	158	1137	38	146	1248	47	160	225	52	129	374
Future Volume (vph)	2	158	1137	38	146	1248	47	160	225	52	129	374
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	12	11	11	12	11	11	11	11	11	11
Storage Length (ft)		550		0	300		150	0		0	125	
Storage Lanes		1		0	1		1	1		0	1	
Taper Length (ft)		100			100			0			100	
Right Turn on Red				Yes			Yes			Yes		
Link Speed (mph)			30			30			30			30
Link Distance (ft)			726			711			307			892
Travel Time (s)			16.5			16.2			7.0			20.3
Confl. Peds. (#/hr)	28	7		15	15		7	28		23	23	
Peak Hour Factor	0.50	0.92	0.95	0.79	0.73	0.95	0.84	0.95	0.88	0.76	0.90	0.92
Growth Factor	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%
Heavy Vehicles (%)	0%	2%	2%	0%	1%	2%	2%	1%	2%	0%	2%	1%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	183	1295	0	208	1366	58	175	337	0	149	423
Turn Type	Prot	Prot	NA		Prot	NA	Prot	Prot	NA		Prot	NA
Protected Phases	1	1	6		5	2	2	3	8		7	4
Permitted Phases												
Detector Phase	1	1	6		5	2	2	3	8		7	4
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0		6.0	10.0	10.0	5.0	6.0		5.0	6.0
Minimum Split (s)	12.0	12.0	31.0		12.0	33.0	33.0	10.0	29.0		10.0	29.0
Total Split (s)	20.0	20.0	54.0		22.0	56.0	56.0	19.0	33.0		21.0	35.0
Total Split (%)	15.4%	15.4%	41.5%		16.9%	43.1%	43.1%	14.6%	25.4%		16.2%	26.9%
Maximum Green (s)	14.0	14.0	48.0		16.0	50.0	50.0	15.0	27.0		17.0	29.0
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0	4.0	3.0	3.0		3.0	3.0
All-Red Time (s)	2.0	2.0	2.0		2.0	2.0	2.0	1.0	3.0		1.0	3.0
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)		6.0	6.0		6.0	6.0	6.0	4.0	6.0		4.0	6.0
Lead/Lag	Lead	Lead	Lag		Lead	Lag	Lag	Lead	Lag		Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes		Yes	Yes
Vehicle Extension (s)	2.0	2.0	2.0		2.0	2.0	2.0	3.0	2.0		3.0	2.0
Recall Mode	None	None	C-Min		None	C-Min	C-Min	None	None		None	None
Walk Time (s)			5.0			5.0	5.0		5.0			5.0
Flash Dont Walk (s)			20.0			22.0	22.0		18.0			18.0
Pedestrian Calls (#/hr)			15			7	7		28			28
Act Effct Green (s)		14.0	48.0		16.0	50.0	50.0	14.8	28.9		15.1	29.2
Actuated g/C Ratio		0.11	0.37		0.12	0.38	0.38	0.11	0.22		0.12	0.22
v/c Ratio		0.99	1.00		0.98	1.00	0.09	0.89	0.45		0.75	1.04
Control Delay		122.6	64.9		113.8	65.2	0.3	96.2	35.0		78.4	103.0
Queue Delay		0.0	0.0		0.0	0.0	0.0	0.0	0.5		0.0	0.0
Total Delay		122.6	64.9		113.8	65.2	0.3	96.2	35.5		78.4	103.0
LOS		F	E		F	E	A	F	D		E	F
Approach Delay			72.0			69.1			56.3			76.6
Approach LOS			E			E			E			E
Queue Length 50th (ft)		157	568		177	~605	0	134	132		122	~386

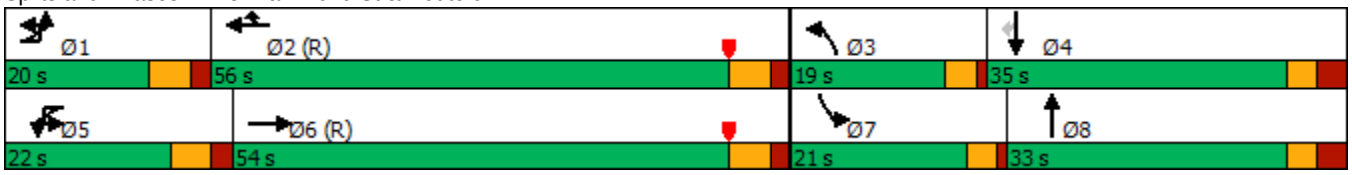
Lane Group	SBR
Lane Configurations	
Traffic Volume (vph)	158
Future Volume (vph)	158
Ideal Flow (vphpl)	1900
Lane Width (ft)	11
Storage Length (ft)	125
Storage Lanes	1
Taper Length (ft)	
Right Turn on Red	Yes
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Confl. Peds. (#/hr)	28
Peak Hour Factor	0.71
Growth Factor	104%
Heavy Vehicles (%)	1%
Shared Lane Traffic (%)	
Lane Group Flow (vph)	231
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Detector Phase	4
Switch Phase	
Minimum Initial (s)	6.0
Minimum Split (s)	29.0
Total Split (s)	35.0
Total Split (%)	26.9%
Maximum Green (s)	29.0
Yellow Time (s)	3.0
All-Red Time (s)	3.0
Lost Time Adjust (s)	0.0
Total Lost Time (s)	6.0
Lead/Lag	Lag
Lead-Lag Optimize?	Yes
Vehicle Extension (s)	2.0
Recall Mode	None
Walk Time (s)	5.0
Flash Dont Walk (s)	18.0
Pedestrian Calls (#/hr)	28
Act Effct Green (s)	29.2
Actuated g/C Ratio	0.22
v/c Ratio	0.55
Control Delay	27.2
Queue Delay	0.0
Total Delay	27.2
LOS	C
Approach Delay	
Approach LOS	
Queue Length 50th (ft)	84

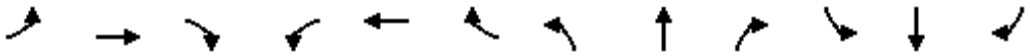
Lane Group	EBU	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Queue Length 95th (ft)		#311	#734		#239	#770	0	m#264	m137		#207	#592
Internal Link Dist (ft)			646			631			227			812
Turn Bay Length (ft)		550			300		150				125	
Base Capacity (vph)		184	1300		212	1361	655	199	749		223	408
Starvation Cap Reductn		0	0		0	0	0	0	145		0	0
Spillback Cap Reductn		0	0		0	0	0	0	0		0	0
Storage Cap Reductn		0	0		0	0	0	0	0		0	0
Reduced v/c Ratio		0.99	1.00		0.98	1.00	0.09	0.88	0.56		0.67	1.04

Intersection Summary

Area Type: Other
Cycle Length: 130
Actuated Cycle Length: 130
Offset: 0 (0%), Referenced to phase 2:WBT and 6:EBT, Start of Yellow, Master Intersection
Natural Cycle: 125
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.04
Intersection Signal Delay: 70.0 Intersection LOS: E
Intersection Capacity Utilization 93.1% ICU Level of Service F
Analysis Period (min) 15
Description: ø2 (SB): 8 / 7 / 11
ø4 (WB): 19 / 23 / 18
ø6 (NB): 5 / 15 / 7
ø8 (EB): 26 / 28 / 19
~ 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: 13: Hammond St & Route 9



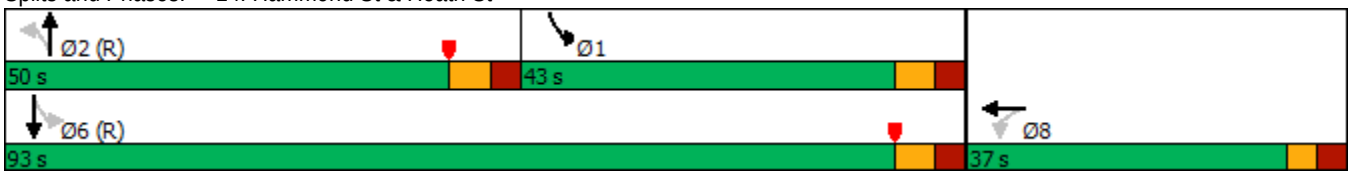


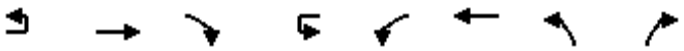
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	148	71	124	14	306	124	16	513	31
Future Volume (vph)	0	0	0	148	71	124	14	306	124	16	513	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		436			675			648			307	
Travel Time (s)		9.9			15.3			14.7			7.0	
Confl. Peds. (#/hr)						6	19		6	6		19
Peak Hour Factor	0.92	0.92	0.92	0.84	0.93	0.76	0.70	0.97	0.91	0.80	0.84	0.86
Growth Factor	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%	104%
Heavy Vehicles (%)	2%	2%	2%	1%	1%	4%	0%	1%	0%	0%	1%	3%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	432	0	0	491	0	0	693	0
Turn Type				Perm	NA		Perm	NA		pm+pt	NA	
Protected Phases					8			2		1	6	
Permitted Phases				8			2			6		
Detector Phase				8	8		2	2		1	6	
Switch Phase												
Minimum Initial (s)				6.0	6.0		6.0	6.0		6.0	6.0	
Minimum Split (s)				26.0	26.0		19.0	19.0		13.0	20.0	
Total Split (s)				37.0	37.0		50.0	50.0		43.0	93.0	
Total Split (%)				28.5%	28.5%		38.5%	38.5%		33.1%	71.5%	
Maximum Green (s)				31.0	31.0		43.0	43.0		36.0	86.0	
Yellow Time (s)				3.0	3.0		4.0	4.0		4.0	4.0	
All-Red Time (s)				3.0	3.0		3.0	3.0		3.0	3.0	
Lost Time Adjust (s)					0.0			0.0			0.0	
Total Lost Time (s)					6.0			7.0			7.0	
Lead/Lag							Lead	Lead		Lag		
Lead-Lag Optimize?							Yes	Yes		Yes		
Vehicle Extension (s)				2.0	2.0		2.0	2.0		2.0	2.0	
Recall Mode				None	None		C-Min	C-Min		None	C-Min	
Walk Time (s)				7.0	7.0		7.0	7.0			7.0	
Flash Dont Walk (s)				13.0	13.0		5.0	5.0			6.0	
Pedestrian Calls (#/hr)				6	6		6	6			19	
Act Effct Green (s)					42.3			74.7			74.7	
Actuated g/C Ratio					0.33			0.57			0.57	
v/c Ratio					0.78			0.29			0.38	
Control Delay					48.6			13.0			2.4	
Queue Delay					0.0			0.0			0.3	
Total Delay					48.6			13.0			2.7	
LOS					D			B			A	
Approach Delay					48.6			13.0			2.7	
Approach LOS					D			B			A	
Queue Length 50th (ft)					315			92			23	
Queue Length 95th (ft)					442			129			m21	
Internal Link Dist (ft)		356			595			568			227	
Turn Bay Length (ft)												
Base Capacity (vph)					553			1716			2092	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Starvation Cap Reductn					0			0			753	
Spillback Cap Reductn					0			0			0	
Storage Cap Reductn					0			0			0	
Reduced v/c Ratio					0.78			0.29			0.52	

Intersection Summary			
Area Type:	Other		
Cycle Length: 130			
Actuated Cycle Length: 130			
Offset: 105 (81%), Referenced to phase 2:NBTL and 6:SBTL, Start of Yellow			
Natural Cycle: 60			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.78			
Intersection Signal Delay: 18.1		Intersection LOS: B	
Intersection Capacity Utilization 59.3%		ICU Level of Service B	
Analysis Period (min) 15			
Description: ø2 (WB): 6 / 6 / 9			
ø6 (EB): 17 / 19 / 12			
ø8 (SB): 8 / 6 / 22			
m Volume for 95th percentile queue is metered by upstream signal.			

Splits and Phases: 14: Hammond St & Heath St





Lane Group	EBU	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø9
Lane Configurations									
Traffic Volume (vph)	106	1383	40	10	10	1309	67	37	
Future Volume (vph)	106	1383	40	10	10	1309	67	37	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	
Lane Width (ft)	11	12	11	11	11	12	11	11	
Storage Length (ft)	250		0		150		0	0	
Storage Lanes	1		0		1		1	0	
Taper Length (ft)	100				100		0		
Right Turn on Red			Yes					Yes	
Link Speed (mph)		30				30	30		
Link Distance (ft)		898				297	462		
Travel Time (s)		20.4				6.8	10.5		
Confl. Peds. (#/hr)	5		30		30		5		
Peak Hour Factor	0.83	0.95	0.71	0.62	0.42	0.97	0.84	0.77	
Growth Factor	104%	104%	104%	104%	104%	104%	104%	104%	
Heavy Vehicles (%)	0%	2%	0%	10%	0%	2%	0%	3%	
Shared Lane Traffic (%)									
Lane Group Flow (vph)	133	1573	0	0	42	1403	133	0	
Turn Type	Prot	NA		Prot	Prot	NA	Prot		
Protected Phases	5	2		1	1	6	8		9
Permitted Phases									
Detector Phase	5	2		1	1	6	8		
Switch Phase									
Minimum Initial (s)	6.0	10.0		6.0	6.0	10.0	1.0		5.0
Minimum Split (s)	12.0	23.0		12.0	12.0	23.0	7.0		32.0
Total Split (s)	18.0	55.0		18.0	18.0	55.0	25.0		32.0
Total Split (%)	13.8%	42.3%		13.8%	13.8%	42.3%	19.2%		25%
Maximum Green (s)	12.0	49.0		12.0	12.0	49.0	19.0		29.0
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	3.0		2.0
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	3.0		1.0
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		Lead	Lead	Lag			
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes			
Vehicle Extension (s)	2.0	2.0		2.0	2.0	2.0	3.0		3.0
Recall Mode	None	C-Min		None	None	C-Min	None		None
Walk Time (s)									7.0
Flash Dont Walk (s)									22.0
Pedestrian Calls (#/hr)									15
Act Effct Green (s)	13.0	79.7			8.0	72.3	13.9		
Actuated g/C Ratio	0.10	0.61			0.06	0.56	0.11		
v/c Ratio	0.76	0.73			0.41	0.71	0.68		
Control Delay	83.8	25.7			69.8	28.0	63.8		
Queue Delay	0.0	0.0			0.0	49.2	0.0		
Total Delay	83.8	25.7			69.8	77.3	63.8		
LOS	F	C			E	E	E		
Approach Delay		30.2				77.1	63.8		
Approach LOS		C				E	E		
Queue Length 50th (ft)	109	352			35	354	93		

Lane Group	EBU	EBT	EBR	WBU	WBL	WBT	NBL	NBR	Ø9
Queue Length 95th (ft)	#197	#969			33	#817	144		
Internal Link Dist (ft)		818				217	382		
Turn Bay Length (ft)	250				150				
Base Capacity (vph)	180	2154			154	1968	261		
Starvation Cap Reductn	0	0			0	880	0		
Spillback Cap Reductn	0	0			0	0	0		
Storage Cap Reductn	0	0			0	0	0		
Reduced v/c Ratio	0.74	0.73			0.27	1.29	0.51		

Intersection Summary	
Area Type:	Other
Cycle Length: 130	
Actuated Cycle Length: 130	
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow	
Natural Cycle: 110	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.76	
Intersection Signal Delay: 52.2	Intersection LOS: D
Intersection Capacity Utilization 67.4%	ICU Level of Service C
Analysis Period (min) 15	
Description: 0 / 5 / 13	

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

Splits and Phases: 15: Tully St & Route 9

APPENDIX L

MassDOT Project Development Process

Overview of the Project Development Process

Transportation decision-making is complex and can be influenced by legislative mandates, environmental regulations, financial limitations, agency programmatic commitments, and partnering opportunities. Decision-makers and reviewing agencies, when consulted early and often throughout the project development process, can ensure that all participants understand the potential impact these factors can have on project implementation. Project development is the process that takes a transportation improvement from concept through construction.

The MassDOT Highway Division has developed a comprehensive project development process which is contained in Chapter 2 of the *MassDOT Highway Division's Project Development and Design Guide*. The eight-step process covers a range of activities extending from identification of a project need, through completion of a set of finished contract plans, to construction of the project. The sequence of decisions made through the project development process progressively narrows the project focus and, ultimately, leads to a project that addresses the identified needs. The descriptions provided below are focused on the process for a highway project, but the same basic process will need to be followed for non-highway projects as well.

1. Needs Identification

For each of the locations at which an improvement is to be implemented, MassDOT leads an effort to define the problem, establishes project goals and objectives, and defines the scope of the planning needed for implementation. To that end, it has to complete a Project Need Form (PNF), which states in general terms the deficiencies or needs related to the transportation facility or location. The PNF documents the problems and explains why corrective action is needed. For this study, the information defining the need for the project will be drawn primarily, perhaps exclusively, from the present report. Also, at this point in the process, MassDOT meets with potential participants, such as the Metropolitan Planning Organization (MPO) and community members, to allow for an informal review of the project.

The PNF is reviewed by the MassDOT Highway Division district office whose jurisdiction includes the location of the proposed project. MassDOT also sends the PNF to the MPO, for informational purposes. The outcome of this step determines whether the project requires further planning, whether it is already well supported by prior planning studies, and, therefore, whether it is ready to move forward into the design phase, or whether it should be dismissed from further consideration.

2. Planning

This phase will likely not be required for the implementation of the improvements proposed in this planning study, as this planning report should constitute the outcome of this step. However, in general, the purpose of this implementation step is for the project proponent to identify issues, impacts, and approvals that may need to be obtained, so that the subsequent design and permitting processes are understood.

The level of planning needed will vary widely, based on the complexity of the project. Typical tasks include: define the existing context, confirm project need, establish goals and objectives, initiate public outreach, define the project, collect data, develop and analyze alternatives, make

recommendations, and provide documentation. Likely outcomes include consensus on the project definition to enable it to move forward into environmental documentation (if needed) and design, or a recommendation to delay the project or dismiss it from further consideration.

3. Project Initiation

At this point in the process, the proponent, MassDOT Highway Division, fills out a Project Initiation Form (PIF) for each improvement, which is reviewed by its Project Review Committee (PRC) and the MPO. The PRC is composed of the Chief Engineer, each District Highway Director, and representatives of the Project Management, Environmental, Planning, Right-of-Way, Traffic, and Bridge departments, and the MassDOT Federal Aid Program Office (FAPO). The PIF documents the project type and description, summarizes the project planning process, identifies likely funding and project management responsibility, and defines a plan for interagency and public participation. First the PRC reviews and evaluates the proposed project based on the MassDOT's statewide priorities and criteria. If the result is positive, MassDOT Highway Division moves the project forward to the design phase, and to programming review by the MPO. The PRC may provide a Project Management Plan to define roles and responsibilities for subsequent steps. The MPO review includes project evaluation based on the MPO's regional priorities and criteria. The MPO may assign project evaluation criteria score, a Transportation Improvement Program (TIP) year, a tentative project category, and a tentative funding category.

4. Environmental Permitting, Design, and Right-of-Way Process

This step has four distinct but closely integrated elements: public outreach, environmental documentation and permitting (if required), design, and right-of-way acquisition (if required). The outcome of this step is a fully designed and permitted project ready for construction. However, a project does not have to be fully designed in order for the MPO to program it in the TIP. The sections below provide more detailed information on the four elements of this step of the project development process.

Public Outreach

Continued public outreach in the design and environmental process is essential to maintain public support for the project and to seek meaningful input on the design elements. The public outreach is often in the form of required public hearings, but can also include less formal dialogues with those interested in and affected by a proposed project.

Environmental Documentation and Permitting

The project proponent, in coordination with the Environmental Services section of the MassDOT Highway Division, will be responsible for identifying and complying with all applicable federal, state, and local environmental laws and requirements. This includes determining the appropriate project category for both the Massachusetts Environmental Protection Act (MEPA) and the National Environmental Protection Act (NEPA). Environmental documentation and permitting is often completed in conjunction with the **Preliminary Design** phase described below.

Design
There are three major phases of design. The first is **Preliminary Design**, which is also referred to as the 25-percent submission. The major components of this phase include full survey of the project area, preparation of base plans, development of basic geometric layout, development of preliminary cost estimates, and submission of a functional design report. Preliminary Design, although not required to, is often completed in conjunction with the Environmental Documentation and Permitting. The next phase is **Final Design**, which is also referred to as the 75-percent and 100-percent submission. The major components of this phase include preparation of a subsurface exploratory plan (if required), coordination of utility relocations, development of traffic management plans through construction zones, development of final cost estimates, and refinement and finalization of the construction plans. Once Final Design is complete, a full set of **Plans, Specifications, and Estimates (PS&E)** is developed for the project.

Right-of-Way Acquisition
A separate set of Right-of-Way plans are required for any project that requires land acquisition or easements. The plans must identify the existing and proposed layout lines, easements, property lines, names of property owners, and the dimensions and areas of estimated takings and easements.

5. Programming (Identification of Funding)
Programming, which typically begins during the design phase, can actually occur at any time during the process, from planning to design. In this step, which is distinct from project initiation, the proponent requests that the MPO place the project in the region's Transportation Improvement Program (TIP). The proponent requesting the project's listing on the TIP can be the community or it can be one of the MPO member agencies (the Regional Planning Agency, MassDOT, and the Regional Transit Authority). The MPO then considers the project in terms of state and regional needs, evaluation criteria, and compliance with the regional Transportation Plan and decides whether to place it in the draft TIP for public review and then in the final TIP.

6. Procurement
Following project design and programming of a highway project, the MassDOT Highway Division publishes a request for proposals. It then reviews the bids and awards the contract to the qualified bidder with the lowest bid.

7. Construction
After a construction contract is awarded, MassDOT Highway Division and the contractor develop a public participation plan and a management plan for the construction process.

8. Project Assessment
The purpose of this step is to receive constituents' comments on the project development process and the project's design elements. MassDOT Highway Division can apply what is learned in this process to future projects.

Project Development Schematic Timetable

Description	Schedule Influence	Typical Duration
Step I: Problem/Need/Opportunity Identification The proponent completes a Project Need Form (PNF). This form is then reviewed by the MassDOT Highway District office which provides guidance to the proponent on the subsequent steps of the process.	The Project Need Form has been developed so that it can be prepared quickly by the proponent, including any supporting data that is readily available. The District office shall return comments to the proponent within one month of PNF submission.	1 to 3 months
Step II: Planning Project planning can range from agreement that the problem should be addressed through a clear solution to a detailed analysis of alternatives and their impacts.	For some projects, no planning beyond preparation of the Project Need Form is required. Some projects require a planning study centered on specific project issues associated with the proposed solution or a narrow family of alternatives. More complex projects will likely require a detailed alternatives analysis.	Project Planning Report: 3 to 24+ months
Step III: Project Initiation The proponent prepares and submits a Project Initiation Form (PIF) and a Transportation Evaluation Criteria (TEC) form in this step. The PIF and TEC are informally reviewed by the Metropolitan Planning Organization (MPO) and MassDOT Highway District office, and formally reviewed by the PRC.	The PIF includes refinement of the preliminary information contained in the PNF. Additional information summarizing the results of the planning process, such as the Project Planning Report, are included with the PIF and TEC. The schedule is determined by PRC staff review (dependent on project complexity) and meeting schedule.	1 to 4 months
Step IV: Design, Environmental, and Right of Way The proponent completes the project design. Concurrently, the proponent completes necessary environmental permitting analyses and files applications for permits. Any right of way needed for the project is identified and the acquisition process begins.	The schedule for this step is dependent upon the size of the project and the complexity of the design, permitting, and right-of-way issues. Design review by the MassDOT Highway district and appropriate sections is completed in this step.	3 to 48+ months
Step V: Programming The MPO considers the project in terms of its regional priorities and determines whether or not to include the project in the draft Regional Transportation Improvement Program (TIP) which is then made available for public comment. The TIP includes a project description and funding source.	The schedule for this step is subject to each MPO's programming cycle and meeting schedule. It is also possible that the MPO will not include a project in its Draft TIP based on its review and approval procedures.	3 to 12+ months
Step VI: Procurement The project is advertised for construction and a contract awarded.	Administration of competing projects can influence the advertising schedule.	1 to 12 months
Step VII: Construction The construction process is initiated including public notification and any anticipated public involvement. Construction continues to project completion.	The duration for this step is entirely dependent upon project complexity and phasing.	3 to 60+ months
Step VIII: Project Assessment The construction period is complete and project elements and processes are evaluated on a voluntary basis.	The duration for this step is dependent upon the proponent's approach to this step and any follow-up required.	1 month

Source: MassDOT Highway Division Project Development and Design Guide