BOSTON REGION METROPOLITAN PLANNING ORGANIZATION



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DRAFT TECHNICAL MEMORANDUM

- DATE: February 18, 2016
- TO: Boston Region MPO
- FROM: Chen-Yuan Wang, MPO Staff
- RE: Summer Street/George Washington Boulevard Subregional Priority Roadway Study in Hingham and Hull

The roadway corridor of Summer Street, Rockland Street, and George Washington Boulevard in Hingham and Hull was selected for analysis in a Boston Region Metropolitan Planning Organization (MPO) funded project for federal fiscal year (FFY) 2015: "Addressing Safety, Mobility, and Access on Subregional Priority Roadways." The work program for this corridor was approved on October 16, 2014, and the selection was approved on April 2, 2015.

1 INTRODUCTION

This memorandum summarizes the existing conditions and issues, roadway operations and safety analyses, and proposed short- and long-term improvements for the entire study corridor and for specific locations. It contains the following sections:

- 1. Introduction
- 2. Existing Conditions and Issues
- 3. Roadway Operations Analysis
- 4. Crash Data Analysis
- 5. Proposed Improvements
- 6. Summary and Recommendations

This memorandum also includes technical appendices that contain the data and methods used in the study.

1.1 Study Background

During the MPO's outreach for developing the Unified Planning Work Program (UPWP) and the Long-Range Transportation Plan (LRTP), Metropolitan Area Planning Council (MAPC) subregional groups and other entities submit comments and identify transportation problems and issues that concern them. These issues are related to bicycle, pedestrian, and freight accommodation, bottlenecks, safety, or lack of safe or convenient access for abutters along

roadway corridors. They can affect not only mobility and safety along a roadway and its side streets, but also quality of life, including economic development and air quality.

The purpose of this study was to identify roadway corridors in the MPO region that are of concern to Boston Region MPO subregional groups, but which have not been identified in the LRTP regional needs assessment. In addition to identifying the problems, this study also recommends improvements to address them. In addition to mobility, safety, and access, the study considered transit feasibility, truck issues, bicycle and pedestrian transportation, preservation, and other topics.

1.2 Selection Procedure

This corridor was selected through a comprehensive process. First, MPO staff identified potential study locations using various sources: soliciting suggestions during the outreach process for the FFY 2015 UPWP; reviewing meeting records from the UPWP outreach process for the past five years; and appraising potential locations from the monitored roadways in the MPO's Congestion Management Process (CMP) program.

MPO staff identified 30 roadway corridors in the MPO region as potential study locations. The staff assembled detailed data on the identified roadways and evaluated them according to four selection criteria¹:

- Safety Conditions: The location has a high crash rate for its functional class, or contains areas with a large number of crashes or with a significant number of pedestrian-bicycle collisions.
- *Multimodal Significance*: The location supports transit, bicycle, or pedestrian activity, or accommodates large amounts of heavy vehicles (trucks/busses).
- Subregional Priority: The location 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*: The location was proposed or endorsed by the roadway administrative agency/agencies and has strong support from its stakeholders.

The Summer Street/George Washington Boulevard corridor contains several high-crash and congested locations, such as the Route 3A and North Street

¹ Details of the criteria and rating system may be found in the CTPS technical memorandum "Selection of Study Location: FFY 2015 Addressing Safety, Mobility, and Access on Subregional Priority Roadways," April 2, 2015.

intersection, which need to be improved for the safety and mobility of users of all modes. Major portions of the corridor have strong potential for design and implementation toward a Complete Street² roadway. More importantly, the study site has strong support from all stakeholders, including officers and representatives from Hingham and Hull and the Massachusetts Department of Transportation (MassDOT).

1.3 Study Objectives

The objectives of this study were to:

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

1.4 Study Area and Data Collection

This study focuses on an almost three-mile corridor that consists of Summer Street (from North Street to Rockland Street), Rockland Street (from Summer Street to George Washington Boulevard), and the entire section George Washington Boulevard in Hingham and Hull. All segments of the corridors are under the jurisdiction of MassDOT Highway Division District 5.

Based on MPO staff requests, MassDOT collected extensive traffic volumes, spot speed data, and intersection turning-movement counts (including pedestrian and bicycle movements and the percentages of heavy vehicles) for this study. The data were collected during two periods: late spring (June 1-4, 2015), and high summer (July 9-12, 2015). Staff also collected various data from the towns, including recent transportation and land-use studies, information about adjacent developments, and multiple-year police crash reports.

1.5 Study Advisory Meetings

During the course of the study, MPO staff worked closely with the towns and MassDOT District 5. Two advisory meetings were held to guide and support the study. The advisory members included representatives from Hingham and Hull, State Senator Hedlund's and Representative Bradley's offices, MassDOT, and the Massachusetts Department of Conservation and Recreation (see Appendix A for a list of meeting participants).

² According to Smart Growth America, a "complete street" is a street for everyone. Complete streets are designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities. They make it easy to cross the street, walk to shops, and bicycle to work.

In the first meeting (May 13, 2015), MPO staff introduced the study, received input about the corridor's issues and concerns, and coordinated data collection. In the second meeting (November 3, 2015), MPO staff reviewed the findings and proposed improvement alternatives. After the meetings, staff continued to receive comments from the advisory members and revised the proposals accordingly.

2 EXISTING CONDITIONS AND ISSUES

This section examines the corridor's location, associated major transportation facilities, transit services, existing roadway configurations, and adjacent land uses. It also summarizes the concerns raised in the first advisory meeting.

2.1 Corridor Location and Adjacent Transportation Facilities

As seen in Figure 1, the study corridor is located in the coastal areas of Hingham and Hull, approximately 15 miles from Boston Downtown. It runs along the south side of Hingham Bay from Hingham Harbor, across Weir River, to Nantasket Beach.

The corridor is the major roadway used by residents of Hull and North Hingham to access Boston proper and adjacent communities. It consists of three segments: Summer Street (from North Street to Rockland Street), Rockland Street (from Summer Street to George Washington Boulevard), and George Washington Boulevard (the entire section in Hingham and Hull).

The section of Summer Street from North Street to the Route 3A Rotary is part of State Route 3A. It is classified as an urban principal arterial and is the busiest section of the corridor. The other sections of the corridor all are classified as urban minor arterials and carry less traffic than the Route 3A section.

Major cross streets of the corridor include North Street, Water Street, Chief Justice Cushing Highway, Summer Street, and Rockland Street in Hingham; and Rockland Circle, Wharf Avenue, and Nantasket Avenue in Hull. Most of these cross streets are urban minor arterials, except Summer Street and Rockland Circle (both classified as collector roads).

Essentially, the corridor is a four-lane roadway, with two travel lanes in each direction. The adjacent land uses are mainly residential and public open space, with some businesses in the Hingham Harbor area. Sidewalks exist mainly on the north side of the corridor, except in the Harbor area, where sidewalks also exist on the south side. There are no dedicated or separated bicycle lanes in the corridor. A multi-use trail exists on the north side of the corridor from

Martins Lane to the Hull border. The trial is about six- to-eight-feet wide and operates in both directions.

In addition to the roadway network, the Massachusetts Bay Transportation Authority (MBTA) Greenbush commuter rail line runs south of the corridor parallel to Summer Street and Rockland Street. This and other transit services are described further in the next section.

2.2 Transit Services in the Area

The MBTA provides a number of transit services in the study area, including the Greenbush commuter rail line, Bus Routes 220 and 714, and Hingham and Hull Ferries (See Figure 2.)

Greenbush Commuter Rail Line

The Greenbush line runs between South Station in Boston and Greenbush Station in Situate—through Quincy, East Braintree, Weymouth, Hingham, and Cohasset—and makes two stops in Hingham: West Hingham and Nantasket Junction. Nantasket Junction station is located on Summer Street near Route 3A (Chief Justice Cushing Highway) approximately 1,000 feet south of the study corridor. The station has 495 parking spaces, which are about 20-to-30 percent occupied during weekdays, with a lower occupancy rate on weekends.

MBTA Bus Route 220

Route 220 runs between Quincy Center Station (MBTA rapid transit Red Line) and Hingham Depot, with a relative high frequency of more than 40 weekday trips each way.³ On Saturdays, it maintains approximately 30 trips each way, and on Sundays about 15 trips each way. It connects to Route 714 at Hingham Depot for various destinations in Hull, including Nantasket Beach and Hull Medical Center (on George Washington Boulevard).

MBTA Bus Route 714

Route 714 runs between Hingham Depot and Pemberton Point Ferry Station in Hull. It travels mainly on Nantasket Avenue and partly through the study corridor, with diversions to Nantasket Junction by request only. It provides 14 trips each way on weekdays and 9 trips each way on weekends. This service operates under contract, and uses smaller vehicles than the regular MBTA buses.

³ The estimation based on MBTA 2015 bus summer schedules from June 27 to September 4.

MBTA Commuter Ferry

The MBTA ferry service consists of two major routes: Hingham-Boston and Hingham-Hull-Boston, via Logan Airport. The service is operated by Boston Harbor Cruises, and utilizes various vessels each with the capacity for about 350-to-400 passengers.

The Hingham-Boston route provides 18 round trips daily from Hingham (Hewitt's Cove/Hingham Shipyard Terminal) to Boston (Rowe's Wharf). The Hingham-Hull-Boston route provides 18-to-20 round trips daily from Hingham or Hull (Pemberton Point Terminal) to Boston (Long Wharf), with various arrangements of stops at Pemberton Point, Logan Airport, Grape Island, and George's Island. These trips include eight inbound stopovers/origins from Hull and 12 outbound stopovers/destinations to Hull.⁴

During weekends, the service provides 16 Saturday and 14 Sunday round trips from Hingham to Boston, with six inbound and four outbound trips stopping over at Pemberton Point in Hull and Logan Airport; the other trips stop over at Grape, George's and other Boston Harbor Islands. The weekend ferries, along with stopovers at the Boston Harbor Islands, usually end on Columbus Day weekend.

2.3 Roadway Conditions and Adjacent Land Uses

The study corridor has a consistent four-lane layout, but with quite different adjacent land uses and roadside conditions, as analyzed below.

2.3.1 Summer Street—Harbor Area

Summer Street from North Street to Route 3A Rotary is the busiest section of the corridor. In addition to local traffic, it carries regional traffic from Chief Justice Cushing Highway and North Street.

The top graphic in Figure 3-1 shows Summer Street's existing roadway conditions and adjacent land uses. The cross-section is based on the street view of an eastbound driver. The roadway surface consists of four 11-foot travel lanes. With almost no shoulders on both sides, the travel lanes contain catch basins, and bicycles need to travel with the traffic.

Summer Street has five-foot-wide sidewalks on both sides, which frequently are blocked by utility poles. Pedestrian access from the downtown side to the harbor side is limited and difficult. Crosswalks exist only at the North Street intersection; and the east-side crosswalk is hard to access because of fast and heavy rightturning traffic. There are no crosswalks at the rotary; its wide layout, with fast,

⁴ The estimation based on MBTA commuter ferry schedules effective May 25, 2015.

heavy traffic, makes it difficult for pedestrians and cyclists to access the harbor side.

Hingham Harbor occupies the roadway's north side with mainly public open spaces (Whitney Park and Veterans Memorial Park), and a few private developments, including a private wharf (Hingham Harbor Marina), a coffee shop, and a small office building near the rotary. A number of business developments, including restaurants, a bank, a supermarket, gas stations, and a car wash occupy the south side. This area is regarded as an extension of Downtown Hingham (also known as Hingham Square), which consists of businesses, shops, and restaurants that are thickly settled along North Street.

2.3.2 Summer Street—Residential Area

The bottom graphic of Figure 3-1 shows the existing roadway conditions and adjacent land uses on Summer Street in the resident area of Hingham. The similar four-lane roadway layout extends from the harbor area to the residential section, with five-foot sidewalks on only the north side, which frequently are blocked by utility poles. The adjacent land use is predominantly single-family houses on relatively large tracts.

2.3.3 Rockland Street and George Washington Boulevard–Hingham

The top graphic of Figure 3-2 shows the existing roadway conditions and adjacent land uses on Rockland Street and George Washington Boulevard. Rockland Street has the same four-lane layout as Summer Street: 11-foot lanes with narrow shoulders. The roadway gradually widens to include four 11.5-foot lanes on George Washington Boulevard, and the adjacent land areas gradually become more open.

In this section of the study area, the north-side sidewalks are replaced by a multiuse six- to-eight-foot-wide trail, which runs from Martins Lane to the bridge over the Weir River. A grassy, five-foot-wide buffer generally exists between the trail and the roadway. Though its size is considered substandard, this trail provides a much safer accommodation for pedestrians and cyclists than do other sections of the corridor.⁵

The land use on the north side generally consists of open spaces, including a large section of parkland owned by the town, and some private vacant land parcels. On the south side, the land use is mostly single-family residential, except for a major section of George Washington Boulevard occupied by Hingham District Court.

⁵ The trial was built about 20 years ago. Based on today's standards, a two-way multi-use trail should be at least ten-feet wide.

2.3.4 George Washington Boulevard in Hull

The bottom graphic of Figure 3-2 shows the existing roadway conditions and adjacent land uses on George Washington Boulevard in Hull. The layout is the same as that of George Washington Boulevard in Hingham: four 11.5-foot travel lanes with narrow shoulders. The north-side multi-use trails are replaced by six-foot sidewalks with no traffic buffers. They are suitable for pedestrians, but and not for bicyclists. Bicycles going to Nantasket Beach need to travel with the traffic.

The adjacent land on the north side is mainly coastal areas, including a singlefamily home neighborhood, community health care center, and the Steamboat Wharf commercial development. On the south side, south of Rockland Circle is the Weir River estuary with a commercial development, a multi-family home building, and a few single-family homes; north of Rockland Circle are the remote parking lots of Nantasket Beach with a few commercial developments near the roadway's intersection with Nantasket Avenue.

The northern part of this corridor section is adjacent to Nantasket Beach, a popular destination for beachgoers, walkers, joggers, and others coming to enjoy the ocean view. The beach, owned by the Department of Conservation and Recreation, is 1.3 miles long with nearly 1,500 parking spaces. During the summer, pedestrian and bicycle activities abound near the beach, especially on weekends. Hull is concerned with the high volume of traffic around Nantasket Beach, which causes congestion, as well as the lack of convenient transit service and safe bicycle accommodations to the beach.

2.4 Issues and Concerns

In the first study advisory meeting, representatives from the towns and MassDOT shared their views about the corridor, which general concerns are summarized below:

- Large number of crashes at Route 3A Rotary and North Street
- High travel speeds in most sections of the corridor
- Limited pedestrian access to Hingham Harbor
- Insufficient and substandard sidewalks
- Lack of bicycle accommodations
- Insufficient roadway shoulders
- Congestion during increased summer traffic
- Limited transit services to Nantasket Beach

The advisory members also discussed concerns about specific locations in the corridor, where analyses identified safety and operational problems, which along with the proposed improvements, are summarized by location in Section 5 of this memo.

3 ROADWAY OPERATIONS ANALYSIS

This section examines the corridor's traffic volumes and patterns, pedestrian and bicycle volumes, traffic operations at major intersections, and travel speeds at various locations. To support these analyses, MassDOT collected various transportation data, including daily traffic volumes, spot speed data, and intersection traffic, pedestrian, and bicycle counts during two periods: June 1-4, 2015 and July 9-12, 2015, one representing average daily traffic conditions and one representing high-summer Saturday traffic conditions.

3.1 Traffic Volumes

The most fundamental data for analyzing traffic intensity and patterns in a roadway corridor are daily traffic volumes. MassDOT collected traffic volumes at 12 locations: seven in the corridor and five on adjacent streets.

3.1.1 Daily Traffic Volumes

Figure 4 shows daily traffic volumes at the twelve locations based on Automatic Traffic Recorder (ATR) counts collected in the weekday period of June 1 to 4. The numbers in the graphic represent average daily directional volumes. 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 June counts show that traffic in the corridor is split evenly, by approximately 50 percent in each direction. Total traffic volumes vary significantly among different locations in the corridor, ranging from approximately 13,000 vehicles per day (near Nantasket Avenue) to nearly 30,000 vehicles per day (west of Route 3A Rotary).

In June, traffic in this area is somewhat higher than the annual average volume. Adjusted by the seasonal factors, AADT data indicate that the corridor carries traffic volumes of different magnitude, from 11,500 vehicles near Nantasket Avenue to 26,500 vehicles west of Route 3A Rotary on an average day. Overall, traffic volumes gradually become less going from the western to the eastern segments of the corridor.

• Summer Street west of Hingham Harbor (Location 1) carries about 20,500 vehicles per day.

- Summer Street between North Street and Route 3A Rotary (Location 2) carries the highest volume in the corridor—approximately 26,500 vehicles per day. The increase mostly is a result of traffic at North Street (Location 8, carrying approximately 7,500 vehicles per day), and Chief justice Cushing Highway (Location 9, carrying approximately 12,000 vehicles per day).
- Summer Street and Rockland Street in the Hingham residential area (Locations 3 and 4) carry approximately 15,000 and 16,000 vehicles per day, respectively.
- George Washington Boulevard carries approximately 11,500 to 12,500 vehicles per day.

3.1.2 Summer Saturday Traffic Volumes

Figure 5 shows the average daily traffic volumes at the same 12 locations based on ATR counts collected during the weekend of July 9 to 12. The numbers in the graphic represent the highest level of daily directional volumes in that period— Saturday, July 11, 2015. The two tables in the graphic further summarize the data by location, directional split, and combined volume of both directions.

Similar to the weekday counts, the Saturday counts show that the corridor carries evenly split traffic on summer weekend days. Total traffic volumes vary among different locations, ranging from almost 22,000 vehicles per day on George Washington Boulevard near Nantasket Beach to 38,000 vehicles on Summer Street in the Hingham Harbor area. This accounts for an approximate 45-to-85 percent increase from the normal weekday traffic, mainly because of the traffic in and around Nantasket Beach in Hull.

Saturday, July 11, 2015, was dry, with a temperature of more than 85 degrees. These traffic counts represent almost the highest potential traffic volumes in the corridor under the conditions cited above, which presumably would occur approximately four-to-six weekends every year. The Saturday traffic volumes at the various locations are summarized below:

- Summer Street west of Hingham Harbor (Location 1) carries nearly 28,000 vehicles per day.
- Summer Street between North Street and Route 3A Rotary (Location 2) carries approximately 38,000 vehicles per day. Traffic on North Street (Location 8) increases from 7,500 to 11,500 vehicles in an average day. Traffic from Chief Justice Cushing Highway (Location 9) maintains a similar level of traffic on an average day (12,000 vehicles).

- Summer Street and Rockland Street in the Hingham residential area (Locations 3 and 4) carry approximately 27,000-to-27,500 vehicles per day.
- George Washington Boulevard carries approximately 21,500-to-24,500 vehicles per day.

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. They were collected during the morning peak period (7:00–9:00 AM) and the evening peak period (4:00–6:00 PM) on Thursday June 4, 2015, and during the midday peak period (10:00 AM– 2:00 PM) on Saturday July 11, 2015. Staff then identified the peak hour in each of the peak periods for various traffic operational analyses.

3.2.1 Weekday Peak-Hour Traffic and Pedestrian Volumes

Figure 6 shows the weekday peak-hour traffic and pedestrian volumes at major intersections in the corridor. Entry volumes at these intersections vary from 1,000 vehicles per hour at the intersection of George Washington Boulevard at Wharf Avenue to 2,600 vehicles per hour at Route 3A Rotary, and generally are somewhat higher in the evening than in the morning.

The three intersections in the Hingham Harbor area had higher traffic entry volumes than did the other intersections, each carrying approximately 2,500-to-2,600 vehicles per peak hour. The two intersections in the Hingham residential area carried approximately 1,400-to-1,600 vehicles per peak hour each. The intersections on George Washington Boulevard carried approximately 1,000-to-1,300 vehicles per peak hour each.

Four pedestrians in the AM peak hour and ten pedestrians in the PM peak hour crossed the intersection of Summer Street at North Street. Thirty-three (33) pedestrians in the AM peak hour and 23 pedestrians in the PM peak hour crossed the intersection of George Washington Boulevard at Nantasket Avenue. The other intersections generally experienced five or fewer pedestrian crossings per peak hour.

3.2.2 Summer Saturday Peak-Hour Traffic and Pedestrian Volumes

Figure 7 shows the summer Saturday peak-hour traffic and pedestrian volumes at major intersections in the corridor. These intersections generally carried a total entry volume that was approximately 20 percent to 75 percent greater than during the June weekday peak hour. The three intersections in Hingham Harbor carried between 3,000-to-3,200 vehicles per peak hour each. The two intersections in the Hingham residential area carried approximately 2,300-to-2,400 vehicles per peak hour each. The two intersections on George Washington Boulevard leading to Nantasket Beach carried approximately 2,000-to-2,100 vehicles per peak hour each.

Noticeably, the Saturday count showed that pedestrian activities were significant on the roadways in the Hingham Harbor and Nantasket Beach areas. The intersection of Summer Street at North Street had 74 pedestrian crossings during the midday per peak hour from 12:00 to 1:00. The intersection of George Washington Boulevard at Nantasket Avenue had 102 pedestrian crossings during the midday peak hour. The intersection of George Washington Boulevard at Bay Street/Nantasket Avenue had 51 pedestrian crossings during the midday peak hour.

3.2.3 Summer Saturday On-Road Bicycle Volumes

The turning movement counts at major intersections indicate that three or fewer bicycles traveled the corridor on a spring weekday (June 4, 2015). However, the cycling activity increased significantly during summer weekends.

The Saturday (July 11, 2015) counts show that there were between 20 and 30 bicycles traveling in the corridor during the four-hour period from 10:00 AM to 2:00 PM, and among them approximately 10-to-12 bicycles traveling in the peak hour from 10:00 to 11:00 AM. Figure 8 shows the estimated bicycle volumes by direction at various locations in the corridor, excluding bicycles that traveled on the multi-use path.

The adjacent areas of the corridor contain scenic coasts, wetlands, and woodlands. Presumably, bicycle volumes would be much higher if the corridor contained dedicated bicycle lanes.

3.2.4 Heavy Vehicle Percentage

It is essential to examine the amount of heavy-vehicle traffic in a study corridor, as an unusually high percentage of heavy vehicles (trucks and buses) may seriously affect roadway operations. The weekday turning movement counts by vehicle type indicate that, on average, most intersections in the study corridor carried about two percent of heavy vehicles during peak-hour traffic; and a few carried about three percent in the morning peak hour, and one percent in the evening peak hour. These percentages are considered normal, or even slightly less than average, and would not seriously affect roadway operations.

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 by using the Synchro traffic analysis and simulation program.⁶ The model set consists of two weekday AM and PM, and one Saturday midday peak-hour models, with scenarios under existing conditions or various proposed improvement alternatives.

3.3.1 Weekday Peak-Hour Analyses

Figure 9 shows weekday AM and PM peak-hour capacity analyses for major intersections in the corridor, under existing conditions. The graphic includes a table of intersection level-of-service (LOS) criteria based on average intersection control delay defined by the Highway Capacity Manual (HCM).⁷ LOS is a qualitative measure used to relate the quality of traffic service. 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. For the intersections in a metropolitan urban area, LOS C or better is considered desirable; LOS E or better is considered acceptable; and LOS F is considered undesirable.

Overall, staff estimate that all the major intersections generally operate at a desirable LOS C or better in both peak AM and PM hours, except the intersection of Summer Street at North Street and the Route 3A Rotary.

Staff estimate that the North Street intersection operates at LOS D in the AM peak hour with an average delay of about half a minute per vehicle. The westbound approach is critical to the intersection, where more than 250 left-turning vehicles need to share the inside lane with through traffic. Staff estimate that the approach operates at LOS D, with an average delay of about 50 seconds.

Staff estimate that the Route 3A rotary operates at LOS E in the AM peak hour, with an average delay of 45 seconds per vehicle.⁸ The northbound approach is critical to the intersection, where one single lane carries heavy, primarily left-turning, commuter traffic. Staff estimate that this approach operates at LOS F, with an average delay of about one-and-a-half minutes.

⁶ Synchro Version 8.0 was used for the analyses. This software is developed and distributed by Trafficware Ltd. It can perform capacity analysis and traffic simulation (when combined with SimTraffic) for an individual intersection or a series of intersections in a roadway network.

⁷ HCM 2010, Transportation Research Board of the National Academies, Washington D. C.

⁸ The rotary is considered an unsignalized intersection.

The two intersections' existing weekday operations are considered acceptable for their urban settings. Signal timings and lane assignments at all the signalized intersections appear to be appropriate under existing roadway layouts. Appendices B and C contain Synchro capacity analysis reports of the major intersections, including input volumes, signal timings, estimated delays and queue lengths, and LOS for AM and PM peak-hour existing conditions.

3.3.2 Summer Saturday Peak-Hour Analyses

Figure 10 shows the Saturday midday peak-hour capacity analyses for major intersections in the corridor, under existing conditions. The analyses include an additional location per Hingham's request: Route 3A (Otis Street) at Bathing Beach Driveway. This intersection is the main access to the beach's parking lot, where the popular Hingham Farmers Market is held every Saturday from 10:00 AM to 2:00 PM.

Although Saturday traffic volumes increase significantly from normal weekdays, the intersections' operations maintain about the same or slightly worse LOS compared to the weekdays. The analyses indicate that most intersections operate at desirable LOS C or better, including the intersection of Route 3A at Bathing Beach Driveway. Appendix D contains Synchro capacity analysis reports of the major intersections for the Saturday midday existing conditions.

Staff estimate that the North Street intersection operates at LOS D in the midday peak hour with an average delay of about 40 seconds per vehicle; and that the critical westbound approach deteriorates to LOS F, with an average delay of nearly one-and-a-half minutes. The Route 3A rotary operates at LOS E, with an average delay of nearly 45 seconds per vehicle, and maintains the same LOS as the weekday AM peak hour. However, staff estimate that the average delay on the northbound approach increases to nearly two minutes; this is because, under existing rotary traffic operations, the heavy eastbound traffic (toward Nantasket Beach) consistently blocks the approach.

3.4 Roadway Travel Speeds

The area's residents are very concerned about the high travel speeds in the corridor. In order to understand these fast driving patterns, MPO staff requested MassDOT to help collect spot speeds during the period when automatic traffic counts were being conducted in June and July 2015.

Figure 10 shows the existing speed regulations and estimated 85th percentile at selected locations in the corridor based on speed data collected on weekdays in

the early June.⁹ The "85th percentile" is the speed at or below which 85 percent of vehicles passing a given point are traveling, and is the principal value used to establish speed controls.

Currently, regulated travel speeds in the corridor are: 40 miles per hour (MPH) in the Bathing Beach area; 25 MPH in Hingham Harbor and the Route 3A rotary; 35 MPH on Summer Street and Rockland Street in the Hingham residential area; 45 MPH on George Washington Boulevard north of Rockland Street until south of Rockland Circle; and 35 MPH on George Washington Boulevard in the Nantasket Beach area from Rockland Circle to Nantasket Avenue.

In the Hingham residential area's 35-MPH zone, the estimated 85th percentile speeds are generally 8-to-10 MPH higher than the regulated speed, which confirms Hingham residents' concern. In the 35-MPH zone near Nantasket Beach, the 85th percentile speed also is between 8-to-10 MPH higher than the regulated speed. The prevailing traffic speed of 43-to-45 MPH presents unsafe conditions for pedestrians to cross the street and for cyclists to ride with traffic.

During the study (after the speed data had been collected), Hull raised the concern of high vehicle speeds on George Washington Boulevard in the Rockaway neighborhood, which is located in the middle of a 45-MPH zone. Judging from the magnitude of speed increases, and according to the Hull Police Department's observations, vehicles probably travel much more than 50 MPH in this 45-MPH zone.

4 CRASH DATA ANALYSIS

Crash data are an essential source for identifying safety and operational problems in a study area. Analyzing crash locations, collision types, time-of-day, roadway conditions, and other factors also help to develop improvement strategies. For this study, staff collected two datasets:

- 2008–12 MassDOT Registry of Motor Vehicles (RMV) Division Crash Data
- Recent five-year (March 2010 through April 2015) crash reports from the Hingham and Hull police departments

Staff used the five-year MassDOT data to examine crash locations and crash rates. It used the police crash reports to construct collision diagrams to analyze safety and operational problems at the major intersections and in different segments of the corridor.

⁹ Because of limited resources, the July speed data were collected for fewer locations. Although the traffic volumes are higher in the summer weekend, the observed 85th percentile speeds are about the same or slightly lower than the weekday average.

4.1 Crash Locations and Crash Rates

Figure 12 shows the crash locations and quantities for the five-year period 2008– 12. The corridor is divided into three sections, each with similar land use characteristics:

- 1. Hingham Harbor Section: Summer Street from North Street to Route 3A Rotary
- 2. Hingham Residential Section: Summer Street/Rockland Street from Route 3A Rotary to George Washington Boulevard
- 3. Low-Density Development Section: George Washington Boulevard in Hingham and Hull

Among the total 205 crashes, more than half (105 crashes) occurred in Section 1, which carried heavy traffic with frequent turning movements to and from adjacent developments; 56 crashes occurred in Section 2; and 44 crashes occurred in Section 3. Based on recent traffic counts, staff estimated the crash rates for the three sections:

- Section 1: 8.51 crashes per million vehicle miles traveled (MVMT)
- Section 2: 2.59 crashes per MVMT
- Section 3: 1.16 crashes per MVMT

The crash rate for Section 1 is much higher than the Massachusetts average for urban principal arterials (3.35 crashes per MVMT). The crash rates for Sections 2 and 3 are lower than the state average for urban minor arterials (3.74 crashes per MVMT). See Appendix E for worksheets.

Staff estimated the crash rates at major intersections of the corridor, as summarized below:

- Intersection of Summer Street at North Street: 0.78 crashes per million entering vehicles (MEV)—about the same as the MassDOT District 5 average for signalized intersections (0.77 crashes per MEV).
- Route 3A Rotary: 1.33 crashes per MEV—much higher than the MassDOT District 5 average for unsignalized intersections (0.58 crashes per MEV).
- All other major intersections: Crash rates lower than the MassDOT District 5 average for signalized/unsignalized intersections.

Appendix F contains worksheets for these crash rates. Appendix G summarizes the 2008–12 MassDOT crash data at each of the major intersections according to crash severity (property damage only, non-fatal injury, fatality, unknown), collision type (single-vehicle, rear-end, angle, sideswipe, head-on, rear-to-rear,

unknown), pedestrian or bicycle involvement, time of day, pavement conditions, and light conditions.

4.2 Pedestrian and Bicycle Crashes

Figure 12 shows the pedestrian and bicycle crash locations in the corridor that were identified from both datasets—in total, four pedestrian crashes and five bicycle crashes: ¹⁰

- Summer Street/North Street Intersection: three pedestrian crashes (two in 2009, one in 2011)
- Route 3A Rotary: one pedestrian crash (2011), three bicycle crashes (2008, 2009, 2010)
- George Washington Boulevard/Wharf Avenue Intersection: one bicycle crash (2013)
- George Washington Boulevard/Nantasket Avenue Intersection: one bicycle crash (2008)

Significantly, these crashes all occurred on roadways adjacent to the pedestrian and cyclist areas of Hingham Harbor and Nantasket Beach.

4.3 Collision Diagrams

To investigate safety and operational problems further, MPO staff constructed collision diagrams for the entire corridor by major intersections and in-between roadway segments, based on recent five-year crash reports provided by the towns' police departments. The crash reports contain detailed information about how and where those crashes occurred. Appendix H presents the collision diagrams for different locations in the corridor.

Below we summarize major findings from the collision diagrams and other factors affecting safety and operations:

Summer Street at North Street and at Water Street (Figure H-1)

- Thirty (30) crashes at the two adjacent intersections
- Sixteen (16) crashes (more than half of the total crashes) related to westbound traffic on Summer Street
- Eight crashes potentially related to a westbound left-turning vehicle

¹⁰ In this study, the term "pedestrian crashes" refers to those 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.

- High westbound left-turn volumes during peak hours
- Short distance from Route 3A Rotary to the intersections with intensive lane-changing activities on westbound Summer Street
- One pedestrian crash in 2011 at west-side crosswalk on Summer Street

Summer Street at Route 3A Rotary (Figure H-2)

- Fifty-nine (59) crashes at the intersection
- Large number of side-swipe crashes inside rotary
- Large number of rear-end crashes on all major approaches, especially on Chief Justice Cushing Highway
- Lack of pavement markings inside rotary to indicate entry/exit paths
- Lack of pavement markings on Summer Street approaches to indicate lane assignments
- High travel speeds approaching and inside rotary
- One pedestrian crash, and one bicycle crash

Summer Street between Route 3A Rotary and Rockland Street (Figure H-3)

- Sixteen (16) crashes
- Large number of out-of-control single-vehicle crashes (about half of total crashes)
- Large proportion of crashes causing personal injuries (more than 60 percent of total crashes)
- Horizontal curves and vertical curves in the section
- High travel speeds (8-to-10 MPH higher than the posted 35-MPH speed limit) in the section

Summer Street at Rockland Street/Martins Lane (Figure H-4)

- Nine crashes
- Mostly rear-end crashes, an usual type of collision at signalized intersections
- Large number of crashes on westbound approach, where drivers approach intersection uphill, and face glaring afternoon sun
- No other noticeable crash patterns

Summer Street at Rockland Street/Martins Lane (Figure H-5)

- Ten (10) crashes
- Three out-of-control single-vehicle crashes near the intersection
- No other noticeable crash patterns

George Washington Boulevard in the vicinity of Hingham District Court (Figure H-6)

- Six crashes
- Crashes mainly because of relatively high-speed multi-lane traffic on George Washington Boulevard, with occasional turbulence from vehicles turning into or away from the district court
- No other noticeable crash patterns

George Washington Boulevard between Weir River and Rockland Circle (Figure H-7)

- Five crashes at Logan Avenue/Barnstable Road intersection
- Four crashes at/near Weir River Estuary
- Difficult pedestrian crossing on George Washington Boulevard because of high travel speeds (more than 50 MPH)
- No noticeable crash patterns

George Washington Boulevard at Rockland Circle (Figure H-8)

- Less than two crashes per year
- Mostly westbound rear-end crashes
- No other noticeable crash patterns

George Washington Boulevard at Wharf Avenue (Figure H-9)

- Only one identifiable crash per year
- No noticeable crash patterns
- One bicycle crash

George Washington Boulevard at Nantasket Avenue (Figure H-9)

- Less than two crashes per year
- Two crashes, possibly caused by pedestrian crossings at northeast corner near Nantasket Avenue
- One bicycle crash on Nantasket Avenue near the intersection
- Heavy pedestrian crossing during peak summer hours
- Poor visibility of pedestrians at northeast corner for drivers coming from Nantasket Avenue

Route 3A (Otis Street) between Hingham Bathing Beach and North Street (Figure H-10)

- Only the recent two-year (March 2013–April 2015) data available
- No noticeable crash patterns

5 PROPOSED IMPROVEMENTS

Based on the above analyses, MPO staff developed a series of short- and longterm improvements to address safety and operational problems. It is possible to implement the short-term improvements within two years at relatively low cost. Long-term improvements generally are more complicated and cover larger areas, which would require intensive planning, design, and funding.

As the corridor covers an extensive length of roadways with different land use characteristics, we describe the proposed improvements in four sections below.

5.1 Summer Street in the Harbor Area

Table 1-1 summarizes the proposed short- and long-term improvements for the section of Summer Street in the Hingham Harbor area, along with the area's issues and concerns; these are arranged according to general roadway section, and by specific location, from west to east.

Figure 13 shows locations and layouts of the proposed short-term improvements in this section, including:

- Restripe (retrofit) Route 3A Rotary similar to a double-lane modern roundabout by installing pavement markings in the inscribe circle and approaching lanes of the rotary.¹¹
- Install MUTCD¹² Circular Intersection Ahead (W2-6) and 25-MPH speed limit plaque (W13-1P) assembly on approaches of Route 3A Rotary.
- Install MUTCD Advanced Intersection Lane Control (R3-8) on the two Summer Street approaches toward Route 3A Rotary.
- Consider prohibiting left turns from Summer Street onto Water Street.¹³
- Enhance signal visibility, crosswalk markings, and yield signage at North Street intersection.

¹¹ The retrofit would be accomplished through pavement markings under the existing rotary layout in order to save the high cost of reconstruction. The width of the traffic island on the Chief Justice Cushing Highway approach would need to be reduced slightly in order to allow two circulating lanes.

¹² Manual on Uniform Traffic Control Devices, 2009 Edition with Revisions 1 and 2, Federal Highway Administration, US Department of Transportation, May 2012.

¹³ Most of the left turns presumably are cut-through traffic heading to Hingham Square or further southeast. If access to the nearby supermarket is a concern, at least the turns should be prohibited during the AM peak period from 7:00 to 9:00. Meanwhile, the prohibition would require readjusting the signal timing at North Street and continuing to monitor traffic conditions at the Summer Street/North Street intersection (and the North Street/Mill Street intersection).

Figure 14-1 shows locations and layouts of the proposed long-term improvements in this section. Staff did not create the conceptual plan to scale, but in approximate proportion, in order to show how the proposed improvements would relate to their surroundings. The upper graphic of Figure 15 shows the proposed roadway cross-section. Major long-term improvements proposed for this section include:

- Convert the Route 3A rotary into a signalized intersection.
- Reconstruct the North street intersection.
- Reconstruct the north-side sidewalks to 10-to-12-foot multi-use trails with a five-foot traffic buffer.
- Add a pedestrian bridge across Hingham Harbor.
- Maintain existing travel lanes to serve high traffic volumes.
- Add two-foot shoulders on both sides to improve drainage.

MPO staff proposed to convert the rotary mainly based on safety concerns. It has a high crash rate and its wide layout is difficult and unsafe for pedestrians and cyclists to traverse. Although the rotary currently operates at LOS E or better during peak hours, drivers on the Chief Justice Highway approach endure excessive delays on weekday morning and summer Saturday midday peak hours.

Staff evaluated both the traffic signal and modern roundabout options. The traffic signal option was studied in two variations: one with a driveway to access Lincoln Maritime Center, and one without the driveway. The roundabout option was examined in single- and double-lane layouts. The single-lane layout was not feasible as its operation would fail during all the peak hours on weekdays and summer weekend days. Staff consider the signal option somewhat more favorable than the roundabout option because it has a smaller layout and would be safer for pedestrians and cyclists.

As shown in Figure 14-1, the proposed traffic signal option would incorporate the driveway to Lincoln Maritime Center. The intersection would operate at desirable LOS C or better during peak hours, with exclusive pedestrian signal phases. Staff also suggest that, at the functional design stage for the rotary conversion, the other signal option (without the driveway connection) and the two-lane roundabout option should be included for further examination.

Figure 14-1A shows conceptual plans for the two additional options. The signal option without the driveway would have a smaller layout with shorter pedestrian crossing distances than the one with the driveway. The Lincoln Maritime Center

driveway needs to remain at its existing location so would disturb traffic operations at the intersection.

The two-lane roundabout option would require an inscribed circle (150-foot diameter minimum, 160-foot as shown) with two entry lanes from all approaches. Traffic operation on the Chief Justice Cushing Highway approach would improve to LOS E. With this option, the estimated average delay per vehicle would be slightly higher (about five seconds) than the proposed signalization. In the meantime, pedestrians need to cross two lanes of constantly moving traffic during peak hours.

At the intersection of Summer Street at North Street, crosswalks exist across Summer Street from both sides of North Street. However, the east-side crosswalk is used less often because of inconvenient and unsafe pedestrian accommodations on the east side of North Street.¹⁴ Staff propose to reconstruct the intersection by removing the right-turn channelization and reconfiguring the northbound approach with separate turning lanes, in order to slow down traffic and provide better and safer pedestrian accommodations. The reconstruction also includes upgrading the signal system with new mast arms and better traffic signal indications, relocating the signal control cabinet, increasing pedestrian staging areas and crosswalk widths (15-feet wide is desirable), and providing count-down and accessible pedestrian signals.

One essential long-term improvement proposed for this section is to reconstruct the harbor-side sidewalks as multi-use trails between the two major intersections. The Town of Hingham has improved many attractions in the harbor area, including Bathing Beach, Bandstand, Iron Horse Park, and Whitney Wharf Park. The proposed multi-use trail would serve as a foundation to connect all of these attractions. If the right-of-way (ROW) is available, it should extend from Bathing Beach (or even from the Crow Point neighborhood) to Steamboat Wharf.¹⁵Pedestrian access to Hingham Harbor would improve significantly by reconstructing these two major intersections.

5.2 Summer Street in the Residential Area

Table 1-2 summarizes the proposed short- and long-term improvements for the section of Summer Street in the Hingham residential area, with issues and

¹⁴ The east side of North Street also is more convenient for pedestrians from Hingham Depot and the Hingham downtown area.

¹⁵ Based on town' assessor's maps, the proposed multi-use trials in the Harbor area would extend slightly beyond the MassDOT Route 3A right-of-way and may require some land takings. Most of the adjacent lands are owned by the town, except Kimball's Wharf (Hingham Harbor Marina) and the nearby small office building.

concerns listed for reference. The key proposed short-term improvements include:

- Install solar-powered Your Speed warning signs in conjunction with the 35-MPH speed regulation at suitable locations approaching the horizontal curves (the segment between Steamboat Lane and Barnes Road).
- Update pedestrian signal timing and replace missing signal backplates at the intersection of Summer Street at Rockland Street/martins Lane.
- Trim overgrown vegetation in both directions.
- Patch/repave/seal rutting and cracking pavements.

Figure 14-2 shows the conceptual plan of proposed long-term improvements in this section. The lower graphic of Figure 15-1 shows the proposed roadway cross-section accordingly. Major long-term improvements proposed for this section include:

- Convert roadway from four- to two-lane traffic operation (one lane each direction) with center median/left-turn lane and five-and-a half-foot bicycle lanes on both sides.¹⁶
- Reconstruct existing north-side sidewalks to be eight-foot wide with a minimum five-foot clearance.
- Install five-foot sidewalks on the south side.
- Reconstruct intersection of Summer Street at Rockland Street/Martins Lane to include the following items:
 - Modify intersection according to proposed corridor configuration.
 - Maintain flare area and provide two approaching lanes northbound and southbound approaches.
 - Reduce curb turning radii and add crosswalks on westbound and northbound approaches.
 - Upgrade signal system with count-down/accessible pedestrian signals.

5.3 Rockland Street and George Washington Street in Hingham

Table 1-3 summarizes the proposed short- and long-term improvements for the section of Rockland Street and George Washington Street in Hingham. The key proposed short-term improvements include:

- Install solar-powered Your Speed warning signs on Rockland Street (in conjunction with existing 35-MPH regulation signs) in both directions.
- Trim overgrown vegetation in both directions.
- Patch/repave/seal rutting and cracking pavements.

¹⁶ The bicycle lanes also can be used as roadway shoulders for emergency stopping.

Figure 14-3 shows the conceptual plan of proposed long-term improvements in this section. The upper graphic of Figure 15-2 shows the proposed roadway cross-section. Major long-term improvements proposed for this section include:

- Convert to two-lane traffic operation (one lane each direction) with center median/left-turn lane and five- to six-and-a half-foot bicycle lanes on both sides.
- Upgrade multi-use trail from 10- to 12-feet wide.
- Install five-foot sidewalks on south side.
- Consider changing George Washington Boulevard's speed limit from 45 to 40 MPH after the roadway reconfiguration
- Modify the intersection of Rockland Street at George Washington Boulevard according to proposed roadway reconfiguration.
 - Utilize the existing intersection layout by maintaining two westbound lanes (one for through movements and one for left turns) and adding traffic median on eastbound approach.
 - o Add crosswalks on eastbound and northbound approaches.
 - Upgrade signal system with count-down/accessible pedestrian signals.

5.4 George Washington Street in Hull

Table 1-4 summarizes the proposed short- and long-term improvements for the section of George Washington Street in Hull. The key proposed short-term improvements include:

- Install solar-powered Your Speed warning signs in conjunction with 45-MPH regulation signs at suitable locations approaching Barnstable Road/Logan Avenue intersection.
- Continue monitoring crash and traffic conditions at Barnstable Road/Logan Avenue intersection.
- Update exclusive pedestrian signal timing from 17 to 21 seconds at intersection of George Washington Boulevard at Wharf Avenue.
- Patch/repave/seal the rutting and cracking pavements.

Figure 14-4 shows the conceptual plan of proposed long-term improvements in this section. The lower graphic of Figure 15-2 shows the proposed roadway cross-section. Major long-term improvements proposed for this section include:

- Convert to two-lane traffic operation (one lane each direction) with a center median/left-turn lane and six-and-a half-foot bicycle lanes on both sides.
- Install five-foot sidewalks on east side.
- Consider extending existing 35-MPH zone to vicinity of Barnstable Road/Logan Avenue after the roadway reconfiguration.

- Consider changing existing 45-MPH zone to 40 MPH after the roadway reconfiguration.
- Modify the intersection of George Washington Boulevard at Rockland Circle according to the proposed roadway reconfiguration.
 - Provide northbound right-turn lane of about 150 feet long.
 - $\circ~$ Add crosswalks on northbound and westbound approaches.
 - Upgrade entire signal system, including count-down/accessible pedestrian signals, new mast arms, and detectors.
- Modify intersection of George Washington Boulevard at Wharf Avenue according to proposed roadway reconfiguration and upgrade signal system including count-down/accessible pedestrian signals and new mast arms.
- Redesign intersection of George Washington Boulevard at Nantasket Avenue with curb extension (pedestrian bulb-out) at northwest corner and realignments of two adjacent crosswalks. The design plan for this intersection depends on a future traffic circulation scheme that the Town of Hull is studying for the Nantasket Beach Revitalization Plan.

5.5 Multi-Use Trails: Long-Term Improvement Alternative

One long-term improvement alternative worthy of consideration is to extend the proposed multi-use trails from the Hingham Harbor area to cover the entire corridor until the Nantasket Beach area. The continuous multi-use path would be about three miles long and mostly on the scenic coastal side.

Figures 16-1 and 16-2 show the proposed roadway cross-sections for the four different sections of the corridor. The curb-to-curb roadway configurations would remain the same as those proposed in the above four sections. The proposed multi-use trails would mostly be 12-foot wide, except some ROW limited areas (10-foot wide minimum).

A quick review of the highway layouts shows that most of the proposed multi-use trails would be within the MassDOT's right-of-way. The proposed reconstruction might require some land takings but most would be on public lands. As proposed previously, Hingham should at least consider the multi-use trails for the harbor section. If the right-of-way is unobtainable for some sections, a combination of trials, bicycle lanes, and sidewalks with carefully designed connections (such as crosswalks at intersections) could be considered.

5.6 Transit Services and Cycling to Nantasket Beach

Hull is concerned with traffic congestion in the Nantasket Beach area during the summer; the proposed bicycle accommodations in the corridor potentially would mitigate some of the congestion.

The MBTA Greenbush commuter line allows bicycles on most trains on weekdays and on all trains on Saturdays and Sundays. People can take their bicycles from the Nantasket Junction station and connect with the proposed bicycle lanes or multi-use trails all the way to Nantasket Beach. The parking at Nantasket Junction is underused, especially on weekends. Once the dedicated bicycle accommodation is available, a reduced fee or even free parking could be considered in order to promote cycling, instead of driving, to Nantasket Beach.

The MBTA will receive funding from Federal Transit Administration MAP-21 (Moving Ahead for Progress in the 21st Century Act) Passenger Ferry Grant Program to replace a twin engine and control equipment for the Quincy-Hull-Boston "Lightening" high-speed ferry (about \$900K), and to upgrade the Pemberton Pier ferry terminal in Hull (about \$200K). This funding would improve the Hull ferry service and would help to encourage use of the ferry to Nantasket Beach (via connection with MBTA Bus 714).

Further steps to mitigate congestion in the beach area and to increase transit usage include:

- Improve Nantasket Beach remote parking lots with sidewalks and, most importantly, a pedestrian path that connects to Nantasket Avenue and the beach directly.¹⁷
- Provide clear, sufficient information on parking locations, direction, and connection to the beach with a detailed map on the Department of Conservation and Recreation (DCR) Nantasket Beach Reservation website.
- Explore possibility of utilizing MBTA Bus 714 to provide shuttle services from remote parking lots to the beach. Currently, the route loops around the corner of Rockland Circle, about 200 feet from George Washington Boulevard.
- Promote MBTA Bus 714 weekend services through various media including the Town of Hull and Chamber of Commerce websites. If the ridership increases, the Town can request adding service trips.¹⁸

¹⁷ Field observations in July 2015 indicated that the two remote parking lots were underutilized, even during high summer.

¹⁸ Currently, Bus 714 provides nine trips each direction on summer Saturdays and Sundays. It can be increased to 15 trips in conjunction with the existing Bus 220 schedule. No summer

- Provide MBTA Bus 714 service information on the DCR website.
- Continue to study the feasibility and explore the funding resources for the Steamboat Wharf Ferry service.¹⁹

5.7 Proposed Long-Term Improvements under Projected Future-Year (2040) Traffic Conditions

The most significant long-term improvement recommendation in the roadway corridor, except in the Hingham Harbor section, is the reconfiguration from four to two lanes plus a center lane as traffic median, or for left turns, and bicycle lanes on both sides. Such four- to three-lane road-diet applications have been applied in a number of US cities with positive results in improving safety for all modes of travel. The analyses in this section indicate that the proposed long-term improvements, including the road-diet section, would operate adequately under the future-year traffic conditions.

Similar to the base-year models, staff constructed future-year 2040 traffic models for the entire corridor based on the roadway layouts with the proposed long-term improvements. Staff also conducted future-year traffic analyses based on traffic growth projections from the transportation planning model recently developed for the MPO's Long-Range Transportation Plan.²⁰

Recent counts indicate that all sections of the corridor (except the Harbor section) experience average daily traffic of fewer than 20,000 vehicles. These sections are suitable for the road-diet application. Although in a few sections, such as Summer Street and Rockland Street in the residential area, traffic surges to more than 25,000 vehicles per day on some summer Saturdays and Sundays, these represent about 10-to-15 days per year and usually are not considered for roadway design.

Traffic simulations from the 2040 Saturday traffic model show that traffic would move constantly in the corridor without spillbacks from one intersection to

Saturday or Sunday ridership data are available. The data collected in the winter of 2013 show a relatively low ridership of about 50-to-60 riders on all trips on an average Saturday.

¹⁹ The Town of Hull conducted a study with a service plan of the summer ferry from Boston to Steamboat Wharf in 2009 and received support from the Boston Region MPO's Subregional Mobility Program. The further study can be based on the previous study.

²⁰ The model predicts future traffic growths base on demographic changes from 2015 to 2040. As population and employment are predicted to increase slightly in Hingham, and practically not at all in Hull, traffic growth at various locations in the corridor is projected to increase by 5 percent or less. Therefore, staff therefore used 5 percent traffic growth for all 2040 weekday and Saturday peak-hour models.

another. The proposed three-lane configuration would remove left-turning vehicles from the main travel lane, and would widen appropriately at major intersections to include left- and right-turn lanes (and in some cases an additional through lane). Consequently, traffic would be able to continue moving on the main lane and pass through the intersections with no extensive delays.

Figures 17 and 18 show the intersection capacity of major intersections in the corridor under the projected 2040 traffic conditions for the weekday peak hours and summer Saturday midday peak hour. With the proposed long-term improvements, all intersections would operate at desirable LOS C or better during the weekday peak hours and at acceptable LOS D or better during the summer Saturday peak. Synchro capacity analysis reports of the major intersections for the future-year weekday AM, weekday PM, and summer Saturday peak hour conditions are included in Appendices I, J, and K.

6 SUMMARY AND RECOMMENDATIONS

This study performed a series of safety and operations analyses, identified safety and operational problems, and proposed a number of short- and long-term improvements to address identified problems in the study corridor.

The recommended key short-term improvements include:

- Restripe (retrofit) Route 3A Rotary similar to a double-lane modern roundabout with pavement markings and signage.
- Install solar-power Your Speed warning signs in conjunction with the existing speed regulation signs at suitable locations.
- Increase pedestrian signal timing at applicable intersections.
- Install traffic signal backplates with reflective borders at applicable intersections.
- Repaint faded crosswalk and pavement markings at applicable intersections.
- Trim overgrown vegetation at applicable locations.
- Patch/repave/seal rutting and cracking pavements.

These improvements could enhance safety for all users and improve traffic operations moderately. The recommended improvements at the rotary are more involved and more costly, but potentially could reduce crashes in the rotary and vicinity. With a high benefit/cost ratio, these short-term improvements should be implemented as soon as the resources are available from highway maintenance or local Chapter 90 funding.

Together, the conceptual plans and suggested long-term improvements create a vision that would accommodate all users and would improve their safety, mobility, and access in the corridor significantly. Some expected benefits from proposed long-term improvements include:

- The road-diet modification—conversion to two-lane traffic with center median/left-turn lane and dedicated bicycle lanes on both sides—would slow traffic, provide separate bicycle accommodations, and reduce pedestrian crossing distances and risks.
- The road-diet modification would reinforce the existing 35-MPH speed regulation, and support a potential speed limit reduction from 45 to 40 MPH. thus enhancing the safety of all users, including residents.
- The sidewalk and shoulder expansions would enhance pedestrian and cyclist accommodations and safety, and improve drainage and traffic operations.
- The proposed improvements at intersections, especially at North Street and the Route 3A rotary, would significantly improve safety and mobility for all users.
- The proposed multi-use trails in the Harbor area, in addition to the improvements at North Street, would improve safety, mobility, and access for pedestrians and cyclists, enhancing quality of life for the area's residents and visitors.
- The proposed bicycle accommodations in the entire corridor would enhance quality of life for residents and visitors, and potentially could mitigate traffic congestion in the Nantasket Beach area.

In addition, the corridor would benefit by promoting transit usage in the summer time and gaining a comprehensive parking and access management program at Nantasket Beach.

Implementing the proposed long-term improvements would require sufficient resources. MPO staff recommend the improvements be implemented in the following stages:

- Summer Street in the Harbor area, including reconstruction of the two major intersections, expansion of harbor-side sidewalks, and pedestrian access improvements (the entire area should be considered as one project)
- 2) Summer Street and Rockland Street in the Hingham residential area, including the road-diet reconfiguration with pedestrian/bicycle accommodations and the proposed intersection improvements

 George Washington Boulevard in Hingham and Hull, including the roaddiet reconfiguration with pedestrian/bicycle accommodations and the proposed intersection improvements

At this preliminary planning stage, staff estimate reconstruction of the entire corridor would cost approximately \$12,500,000 to \$15,000,000.²¹ The approximate costs of the three implementation stages are:

- 1) Summer Street in the Harbor area: \$5,500,000 to \$6,500,000²²
- 2) Summer Street and Rockland Street in the Hingham residential area: \$2,500,000 to \$3,000,000
- 3) George Washington Boulevard in Hingham and Hull: \$4,500,000 to \$5,500,000

This study provides a vision for the corridor's long-term development, and confirms that the corridor has great potential to operate safely and efficiently for all users and various transportation modes. It will require significant effort and collaboration on the part of all stakeholders, including the Towns of Hingham and Hull, residents and owners of adjacent developments, MassDOT, MBTA and DCR to achieve the vision.

The implementation process must ensure that all parties concur about how the recommendations can be realized in a resourceful and fiscally responsible manner. The Towns need to work with MassDOT's Highway Division District 5 to initiate the project, obtain favorable review from MassDOT's Project Review Committee, and identify potential funding resources through MassDOT and the Boston Region MPO.

Appendix L details the actions that are required in the various steps of MassDOT's project development process, including a schematic timetable. Information regarding the project development process also may be found on MassDOT's website, at www.massdot.state.ma.us/planning/Main/PlanningProcess/ProjectDevelopmentP rocess.aspx and at

www.massdot.state.ma.us/Portals/8/docs/designGuide/CH_2_a.pdf.

CW/cw

²¹ This cost was estimated using the general expenses of similar projects. The estimate is only for design and construction and does not include right-of-way, utility relocation, or other contingency costs.

²² This estimate does not include relocating major gas lines at the middle of the Route 3A Rotary.

TABLE 1-1 Proposed Improvements: Summer Street in the Harbor Area

Location	Issues/Concerns	Short-Term Improvements	Long-Te
The section in general	 Insufficient pedestrian access to Hingham Harbor Narrow sidewalks with frequent utility pole blockages No separate bicycle accommodations Multiple-lane (four-lane) traffic operation with extensive lane-change maneuvers High crash rate Pavement rutting and cracking 	 Install pavement markings and signage at the Route 3A rotary to improve traffic operations. Consider prohibiting left turns onto Water Street. Patch/repave/seal the rutting and cracking pavements. 	 Conver interse Recons multi-u Add a Mainta volume Add 2- Reloca
Intersections: Summer Street at North Street and at Water Street	 Somewhat large number of crashes (30 in the past five years) More than half of total crashes related to Summer Street westbound traffic and most of them involving a left-turning vehicle or a lane-change maneuver No storage lane for left turns to Water Street or to North Street Inconvenient and unsafe pedestrian accommodations on the east side of North Street Poor visibility of signal indications, especially for the eastbound drivers 	 Consider prohibiting left turns from Summer Street to Water Street. Readjust signal timing and continue monitoring traffic conditions (including the North street/Mill Street). Double up Yield (MUTCD R1-2) signs and add "Yield pavement marking on the right-turn approach to Summer Street. Restripe faded crosswalks at the North Street intersection. Install signal backplates with reflective borders (requiring further examination of the existing mast arms' capacities). Trim overgrown trees that obstruct signal visibility 	 Reconst the righ northbo to slow accomi Increast North \$ Upgrad better t access Reloca pedest
Route 3A Traffic Rotary: Summer Street at Chief Justice Cushing Highway/Green Street	 Large number of crashes (59 in the past five years) High approaching and circulating speeds at the rotary Lack of pavement marking to indicate entry/exit paths and lane assignments Faded Yield pavement markings High travel speeds approaching and inside the rotary Drivers' sight to the rotary obstructed by overgrown vegetation from Chief Justice Cushing Highway 	 Install pavement markings on circulation lanes and on all the approaches to guide drivers through the rotary. Install MUTCD Advanced Intersection Lane Control (R3- 8) signs on the Summer Street approaches. Install MUTCD Circular Intersection Ahead (W2-6) and 25-MPH speed limit plaque (W13-1P) assembly on all three approaches. Trim overgrown vegetation on the approach of Chief Justice Cushing Highway. 	 Conversion interse signals Consid design Consid Reconsid Install sign
Route 3A (Otis Street) at Bathing Beach Driveway	 Traffic Signal Ahead warning sign on Route 3A eastbound blocked by overgrown vegetation Route 3A eastbound left turns blocking through traffic during Saturday Farmers Market hours Outdated traffic signal system 	Clear the overgrown vegetation for drivers' visibility of the warning sign.	Upgrad phases provide
Route 3A (Otis Street) at Ship Street	Faded crosswalk	 Restripe the crosswalks with white longitudinal lines to emphasize the pedestrian crossing area. Install MUTCD Pedestrian Crossing warning signs (W11- 2) with a location indication plaque (W16-7P) at both ends of the crosswalk to alert approaching drivers and to guide pedestrians to cross at this crosswalk. 	• N/A

MPH: Miles per hour. MUTCD: Manual on Uniform Traffic Devices, Federal Highway Administration, 2009 Edition with Numbers 1 and 2 Revisions, May 2012. N/A: Not available or applicable.

Term Improvements

- vert the Route 3A rotary into a signalized section.
- onstruct the North Street intersection.
- onstruct the north-side sidewalks as 10- to 12-foot i-use trails with a 5-foot traffic buffer.
- a pedestrian bridge across Hingham Harbor.
- tain existing travel lanes because of high traffic mes.
- 2-foot shoulders on both sides to improve drainage. cate utility poles if applicable.
- onstruct the North Street intersection by removing ight-turn channelization and reconfiguring the bound approach with separate turning lanes, so as ow down traffic and provide better and safer
- mmodation for pedestrians.
- ease pedestrian staging areas at all corners of the h Street intersection.
- rade the entire signal system with new mast arms, er traffic signal indications, and count-down and essible pedestrian signals.
- cate the signal control cabinet and provide wider estrian crosswalks.
- vert the rotary into a fully functional signalized section with count-down and accessible pedestrian als.
- sider modern roundabout option in the functional gn stage.
- sider providing access to Lincoln Marina.
- onstruct the rotary adjacent areas.
- all a stop control on Green Street.

rade the signal system to provide left-turn signal ses (requiring installation of detector loops) and to ide count-down/accessible pedestrian signals.

 TABLE 1-2

 Proposed Improvements: Summer Street in the Residential Area

Location	Issues/Concerns	Short-Term Improvements	Long-Te	
The section in general	 High travel speeds under multiple-lane traffic operation Large proportion of injury crashes (more than 60%). Narrow sidewalks with frequent utility pole blockages. No separate bicycle accommodations. Narrow 1-foot or less shoulders insufficient for bicycle accommodations or school bus/emergency vehicle standing. Unsafe turning maneuvers to adjacent residences (crossing two lanes of fast and sometime busy traffic). Horizontal curve with overgrown vegetation. Pavement rutting and cracking. 	 Install solar-powered Your Speed warning signs in conjunction with the 35-MPH speed regulation at suitable locations approaching the horizontal curves (the area between Steamboat Lane and Barnes Road). Trim overgrown vegetation in both directions. Patch/repave/seal the rutting and cracking pavements. 	 Conver directio bicycle stoppin Recons wide wi Install \$ Recons intersed 	
Signalized Intersection: Summer Street at Rockland Street/Martins Lane	 Long crossing distance (about 70 feet) for pedestrians. Lack of crosswalks across the westbound and northbound approaches. Sun glare obstructs signal indications. Missing overhead signal backplates. 	 Update the exclusive pedestrian signal phase from 23 to 25 seconds. Replace the missing signal backplates. Install reflective borders on all signal backplates. 	 Modify corrido Mainta lanes c Reduct westbc Upgrac pedest 	

MPH: Miles per hour. MUTCD: Manual on Uniform Traffic Devices, Federal Highway Administration, 2009 Edition with Numbers 1 and 2 Revisions, May 2012.

TABLE 1-3

Proposed Improvements: Rockland Street/George Washington Boulevard in Hingham

Location	Issues/Concerns	Short-Term Improvements	Long-Te
The section in general	 High travel speeds under multiple-lane traffic operation. Substandard multi-use trail (6- to 8-foot wide) on the north side. Insufficient bicycle accommodations. Narrow 1-foot or less shoulders. Unsafe turning maneuvers to adjacent developments (crossing two lanes of fast traffic). Pavement rutting and cracking. 	 Install solar-powered Your Speed warning signs on Rockland Street (in conjunction with the existing 35-MPH regulation signs) in both directions. Trim overgrown vegetation in both directions. Patch/repave/seal the rutting and cracking pavements. 	 Conve direction 6.5-foct Upgrade Install Consider speed reconfi
Signalized Intersection: Rockland Street at George Washington Boulevard	No crosswalks at the intersection.	Add reflective borders on the existing signal backplates (if applicable).	 Restrip corrido Utilize westbo mediai Add cr approa Upgrad pedest

Term Improvements

vert to two-lane traffic operation (one lane each ction) with a center median/left-turn lane and 5.5-foot cle lanes (also as roadway shoulders for emergency ping) on both sides.

onstruct the existing north-side sidewalks to 8-foot with a minimal 5-foot clearance.

Ill 5-sidewalks on the south side.

onstruct the Rockland Street/Martins Lane section.

ify the intersection according to the proposed dor configuration.

tain the flare area and provide two approaching s on the northbound and southbound approaches. uce curb turning radii and add crosswalks on the bound and the northbound approaches.

rade the signal system with count-down/accessible

Term Improvements

vert to two-lane traffic operation (one lane each ction) with a center median/left-turn lane and 5- to foot bicycle lanes on both sides.

rade the multi-use trail from 10- to 12-foot wide. all 5-foot sidewalks on the south side.

sider changing George Washington Boulevard's ed limit from 45 to 40 MPH after the roadway nfiguration.

ripe the intersection according to the proposed dor configuration.

te the existing intersection layout by maintaining two bound approach lanes and adding eastbound traffic ian.

crosswalks on the eastbound and the northbound roaches.

rade the signal system with count-down/accessible estrian signals.

 TABLE 1-4

 Proposed Improvements: George Washington Boulevard in Hull

Location	Issues/Concerns	Short-Term Improvements	Long-Te
The section in general	 High travel speeds under multiple-lane traffic operation. Unsafe turning maneuvers to adjacent developments (crossing two lanes of fast traffic). Substandard multi-use trail (6-foot wide) on the north/west side. Insufficient bicycle accommodations. Narrow 1-foot or less shoulders. Pavement rutting and cracking. 	 Install solar-powered Your Speed warning signs in conjunction with 45-MPH regulation signs at suitable locations approaching the Barnstable Road/Logan Avenue intersection. Continue monitoring crash and traffic conditions at the Barnstable Road/Logan Avenue intersection. Patch/repave/seal the rutting and cracking pavements. 	 Conver direction bicycle Install & Consid vicinity roadwa Consid after the
Unsignalized Intersection: George Washington Boulevard at Barnstable Road/Logan Avenue	 High travel speeds on George Washington Boulevard. Unsafe for pedestrians to cross multi-lane traffic on George Washington Boulevard. No left-turn lanes on George Washington Boulevard for vehicles to access the adjacent business and residential developments. 	 Install solar-powered Your Speed warning signs in conjunction with 45-MPH regulation signs at suitable locations on George Washington Boulevard. Continue monitoring crash and traffic conditions. 	 Consid speed I Rockla Conver lane wi directio Consid flashing deterio
Signalized Intersection: George Washington Boulevard at Rockland Circle	 No crosswalks at the intersection. Outdated signal system. 	• N/A	 Restrip corrido Provide long. Add cro approa Upgrac down/a detector
Signalized Intersection: George Washington Boulevard at Wharf Avenue	 Heavy pedestrian crossing during peak summer hours. Short time period (17 seconds) for pedestrians to cross George Washington Boulevard. Outdated signal system. 	Update the exclusive pedestrian signal phase from 17 to 21 seconds.	 Restrip corrido Upgrac down/a detecto The fin traffic o the National States
Unsignalized Intersection: George Washington Boulevard at Nantasket Avenue/Bay Street	 Heavy pedestrian crossings during peak summer hours. Poor visibility of pedestrians and the existing crosswalk at the northwest corner (near the Superwash store) for drivers from Nantasket Avenue. 	• The Town recently installed pedestrian crossing warning signs and improved pavement markings on Nantasket Avenue.	 Redesi (pedes realign) The de area's Town.

MPH: Miles per hour. MUTCD: Manual on Uniform Traffic Devices, Federal Highway Administration, 2009 Edition with Numbers 1 and 2 Revisions, May 2012. N/A: Not available or applicable.

Term Improvements

vert to two-lane traffic operation (one lane each tion) with a center median/left-turn lane and 6.5-foot cle lanes on both side.

Il 5-foot sidewalks on the east side.

sider extending the existing 35-MPH zone to the ity of Barnstable Road/Logan Avenue after the way reconfiguration.

sider changing the existing 45-MPH zone to 40 MPH the roadway reconfiguration.

sider changing George Washington Boulevard's ed limit from 45 MPH to 35 MPH (extended from kland Circle), with further engineering study. vert to a through and right-turn lane and a left-turn with a median for pedestrian refuge in each stion of George Washington Boulevard.

sider installing a crosswalk with pedestrian hybrid ing beacons if the future traffic and crash conditions riorate and meet the warrants for such installations.

ripe the intersection according to the proposed dor configuration.

ide a northbound right-turn lane of about 150 feet

crosswalks on the northbound and the westbound oaches.

ade the entire signal system, including countn/accessible pedestrian signals, new mast arms, and ctors.

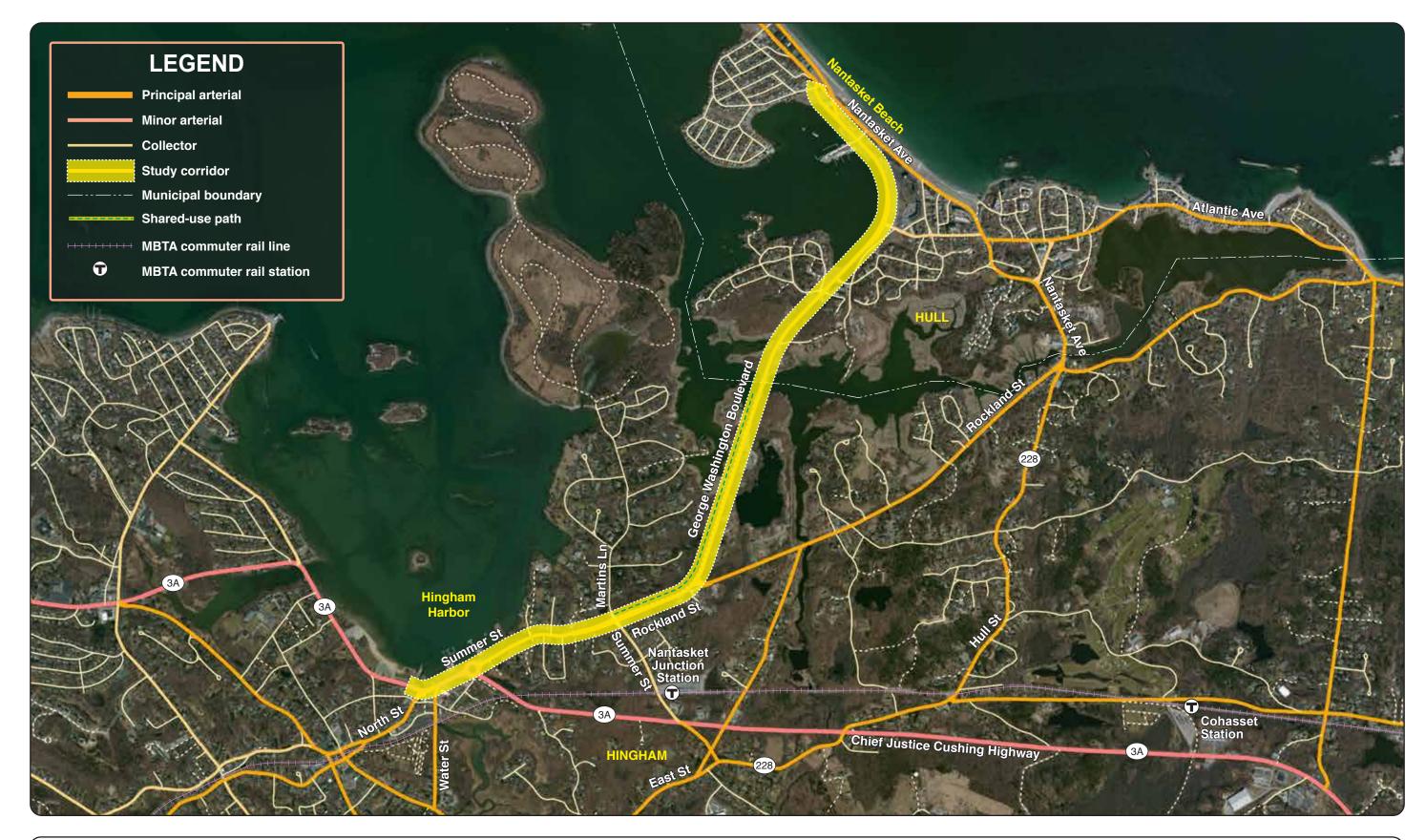
ripe the intersection according to the proposed dor configuration.

ade the entire signal system, including countn/accessible pedestrian signals, new mast arms, and ctors.

final plan for this intersection depends on the future c circulation scheme that the Town is studying for Nantasket Beach Revitalization Plan.

esign the intersection with a curb extension estrian bulb-out) at the northwest corner and gnments of the two adjacent crosswalks.

design plan for this intersection depends on the 's traffic circulation scheme currently studied by the n.



BOSTON REGION MPO	\mathbf{A}	FIGURE 1 Corridor Location and Adjacent Transportation Facilities Summer Street/George Washington Boulevard in Hingham and Hull
-		Summer Street/George Washington Doulevaru in ringham and run

Addressing Safety, Mobility, and Access on Subregional Priority Roadways



BOSTON REGION MPO		FIGURE 2 MBTA Transit Services in the Study Area
MPO	^r N'	Summer Street/George Washington Boulevard in Hingham and Hull

Addressing Safety, Mobility, and Access on Subregional Priority Roadways

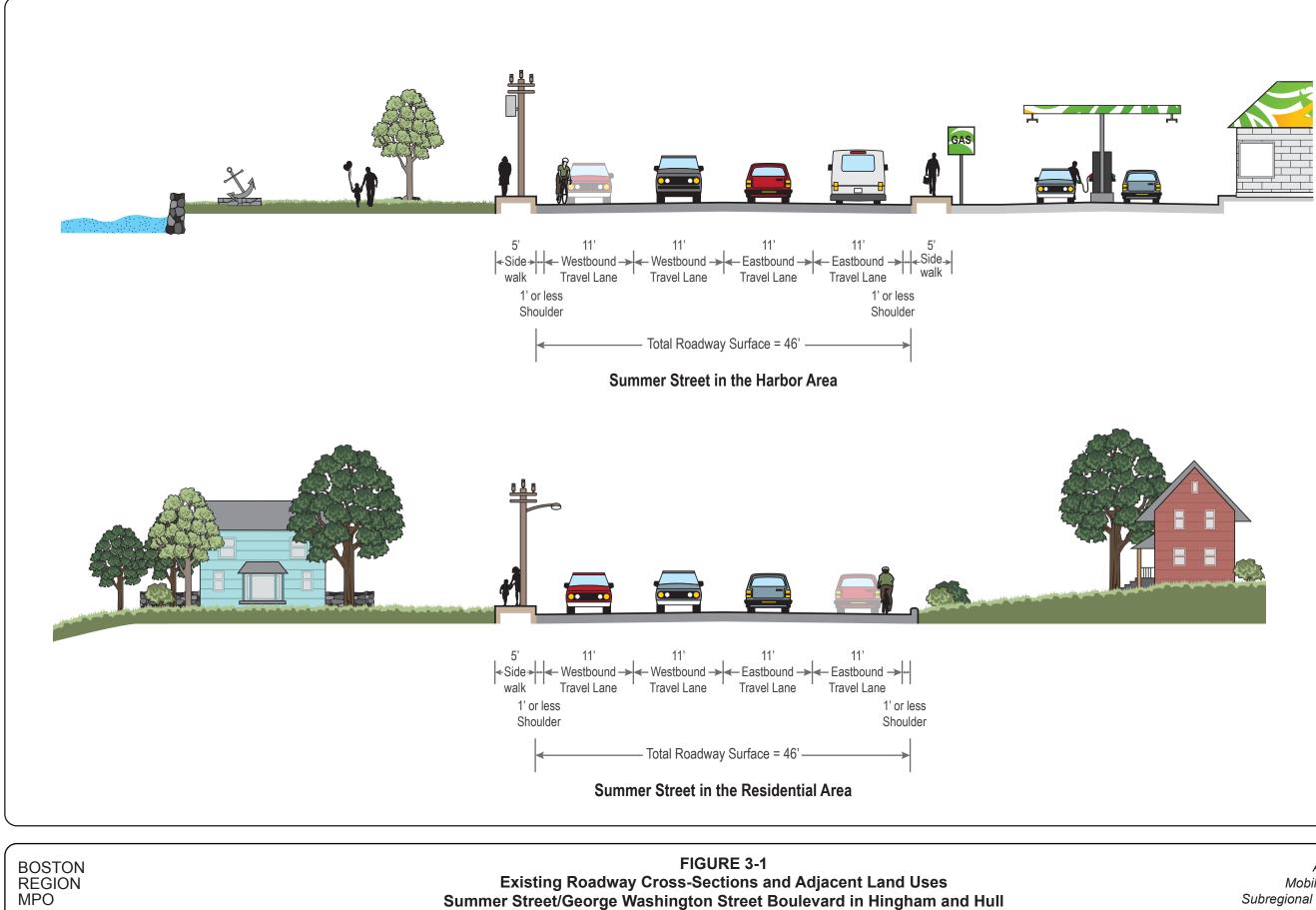
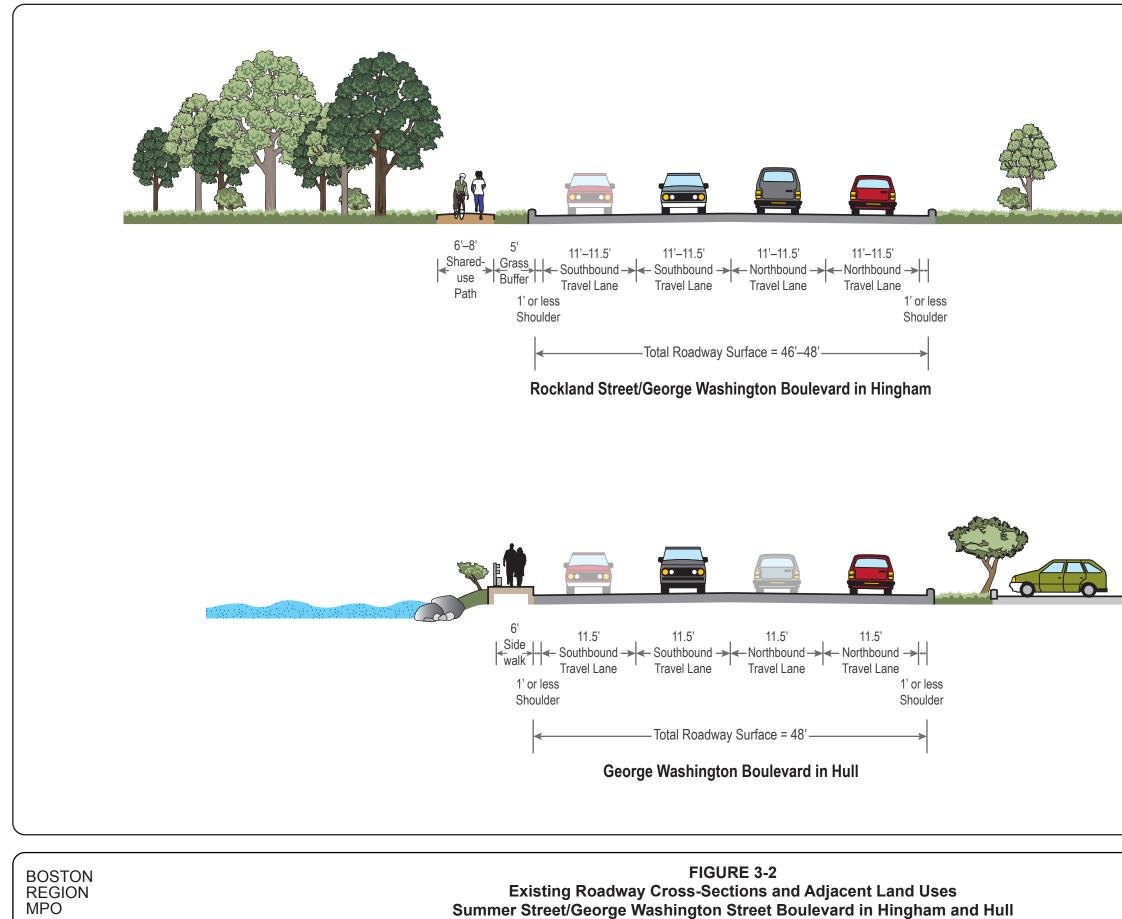


FIGURE 3-1	
Existing Roadway Cross-Sections and Adjacent Land Uses	
Summer Street/George Washington Street Boulevard in Hingham and Hull	I

Addressing Safety, Mobility, and Access on Subregional Priority Roadways



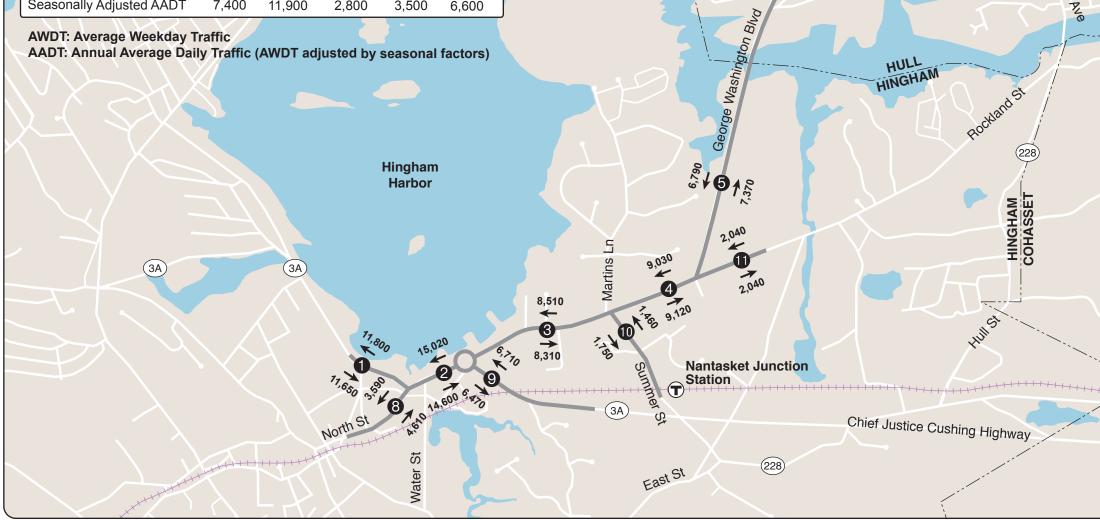




								13.
Corridor Daily Traffic Sum Count Location	0	2	3	4	6	6	7	Naniaskei Bea
Inbound Volume	11,800	15,020	8,510	9,030	6,790	6,380	6,280	× ** 12
Outbound Volume	11,650	14,600	8,310	9,120	7,370	7,010	6,620	
Inbound Split	50%	51%	51%	50%	48%	48%	49%	
Outbound Split	50%	49%	49%	50%	52%	52%	51%	Sea Contraction of the second s
Combined AWDT	22,690	29,620	16,820	18,150	14,160	13,390	12,900	
Seasonally Adjusted AADT	20,400	26,700	14,600	15,800	12,300	11,600	11,200	
Deily Troffie on Adiacont	Deedureur							
Daily Traffic on Adjacent	-					-		
Count Location	8	9	10	D	12			
Inbound Volume	4,610	6,710	1,460	2,040	3,660			
Outbound Volume	3,590	6,470	1,750	2,040	3,970			
Inbound Split	56%	51%	45%	50%	48%			

				-	
Seasonally Adjusted AADT	7,400	11,900	2,800	3,500	6,600
Combined AWDT	8,200	13,180	3,210	4,080	7,630
Outbound Split	44%	49%	55%	50%	52%
Inbound Split	56%	51%	45%	50%	48%

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

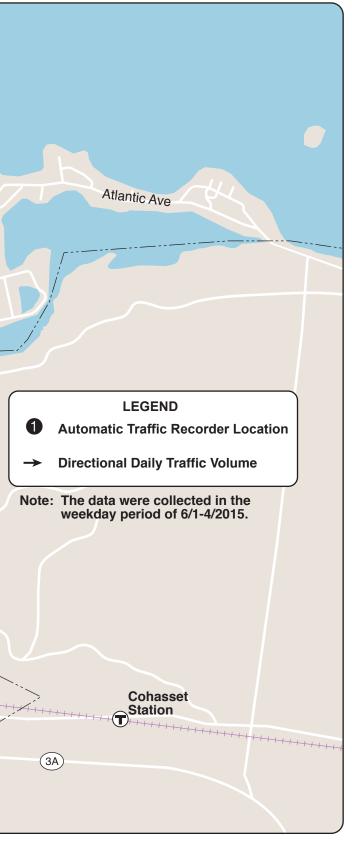


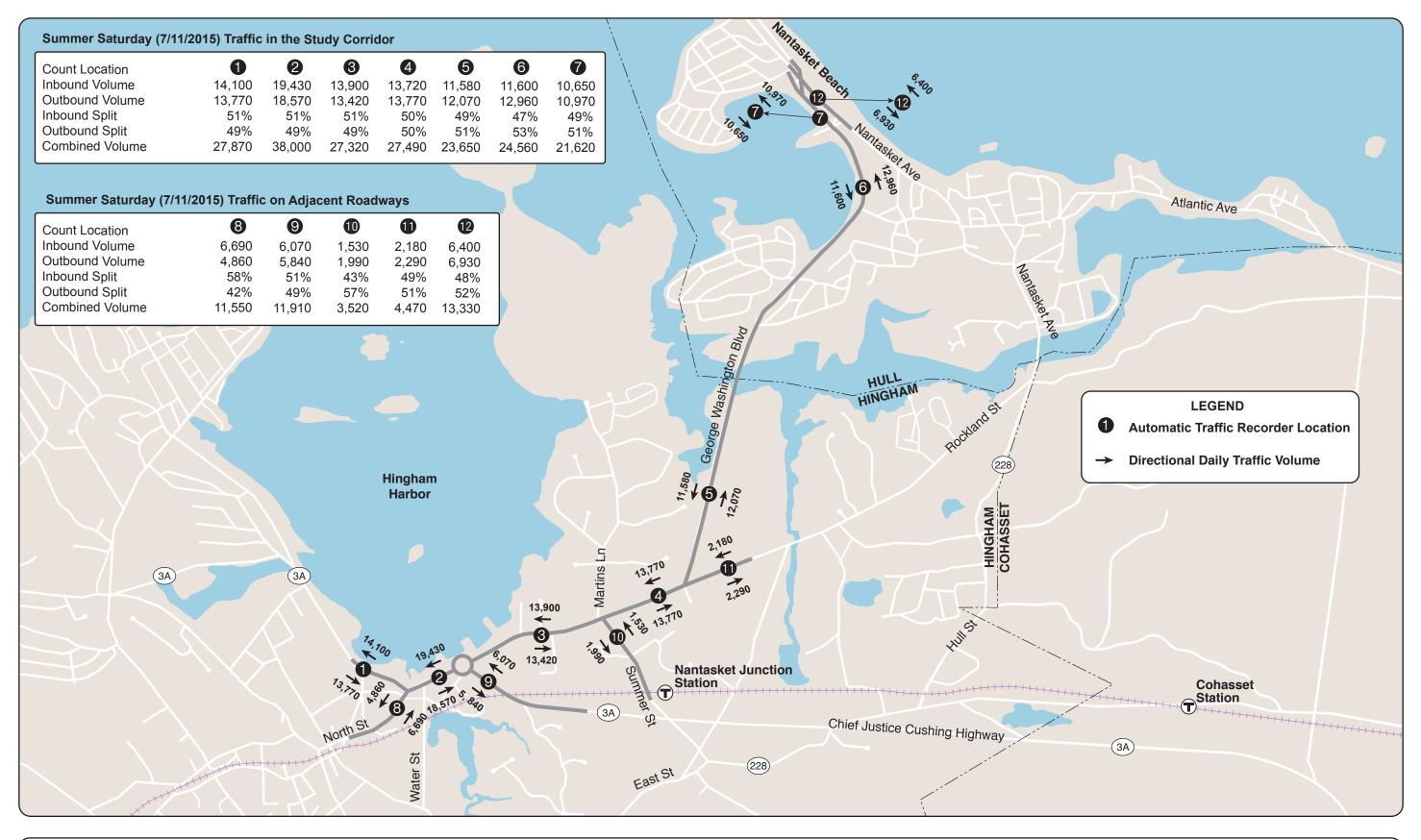
Nantasket Ave

Nantasket Ave

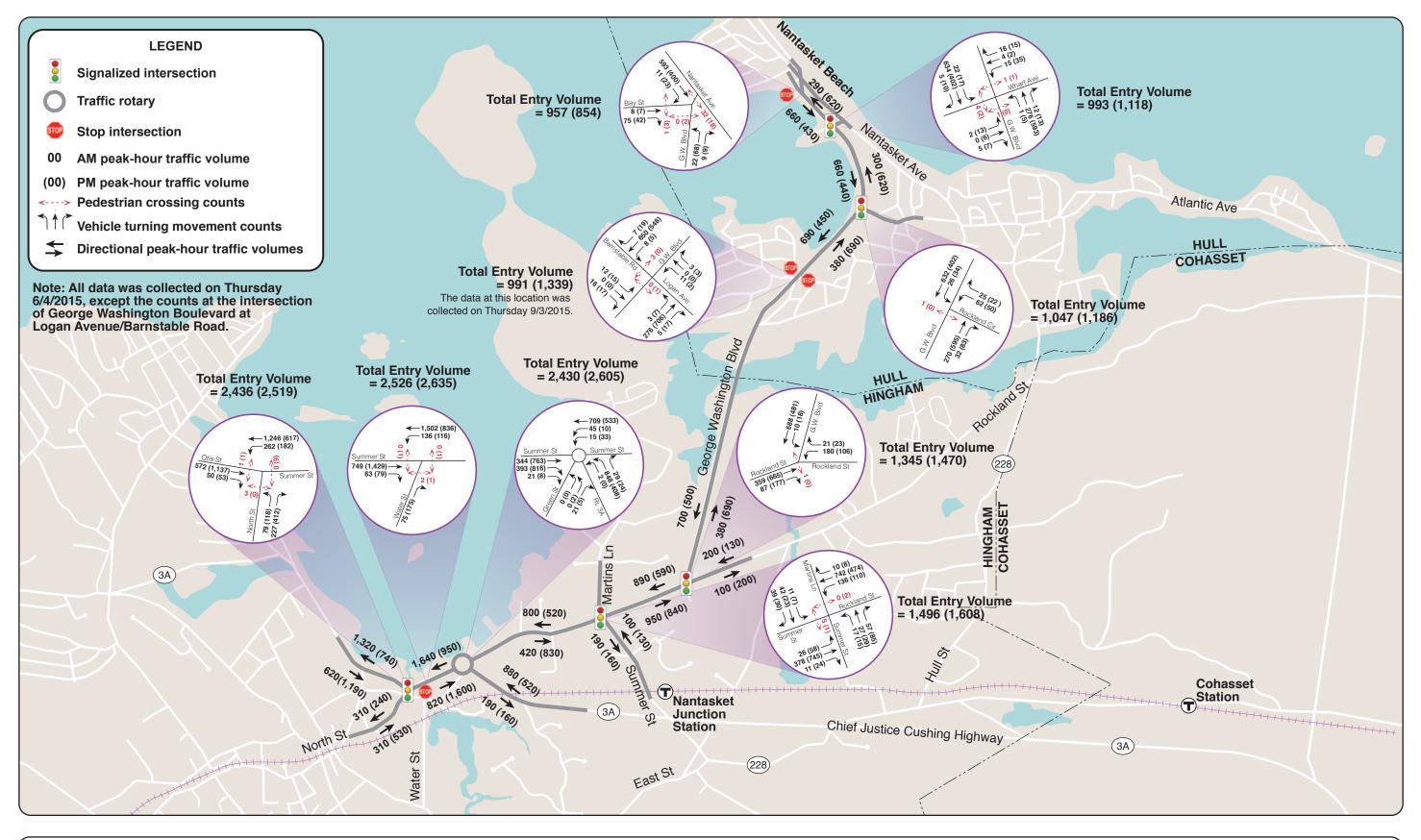
7.010 1.01

BOSTON REGION MPO		FIGURE 4 Daily Traffic Volumes Summer Street/George Washington Boulevard in Hingham and Hull
MPO	Ϋ́Ν`	Summer Street/George Washington Boulevard in Hingham and Hull

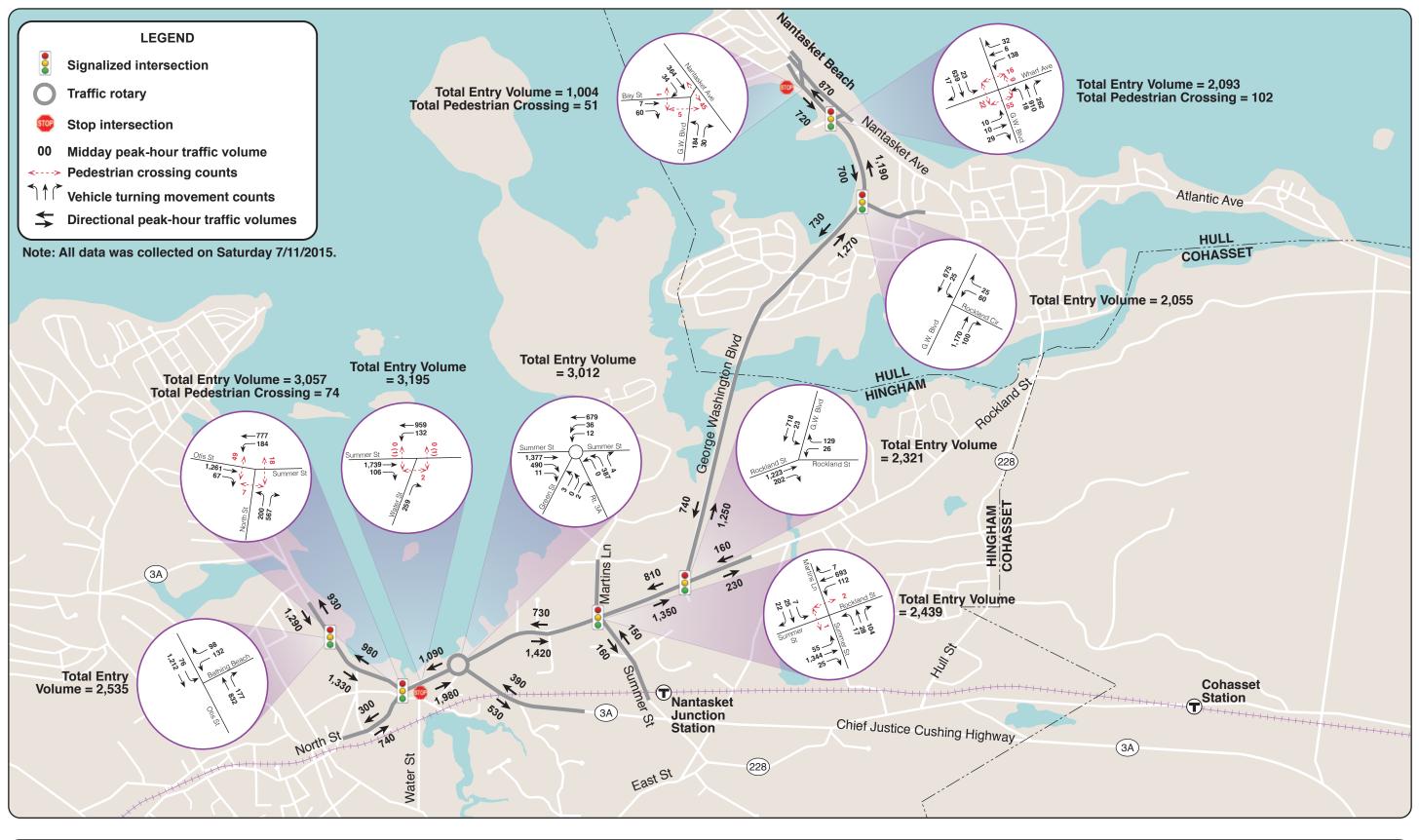




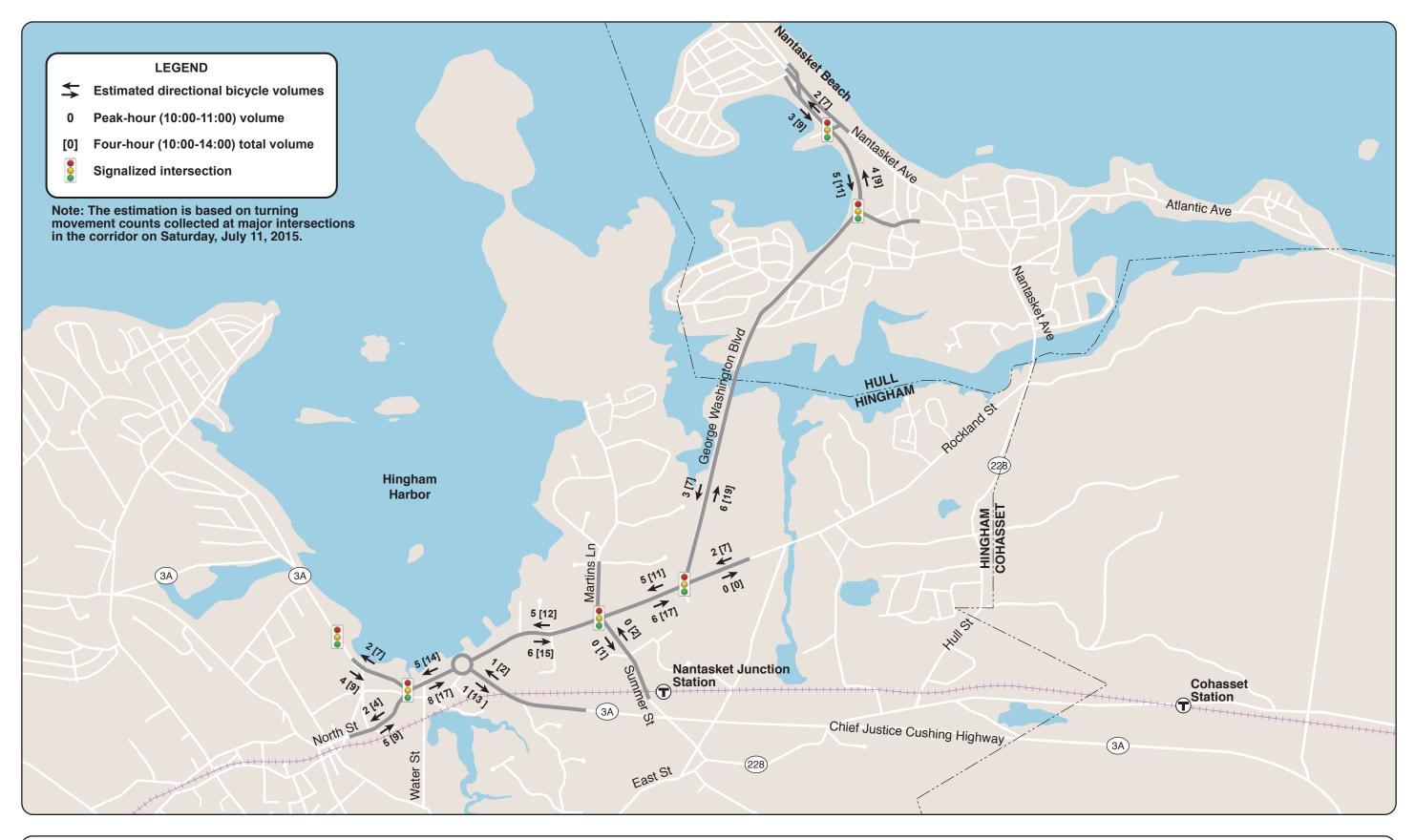
(B	BOSTON	Λ	FIGURE 5
	REGION		Summer Saturday Traffic Volumes
	/IPO	N	Summer Street/George Washington Boulevard in Hingham and Hull



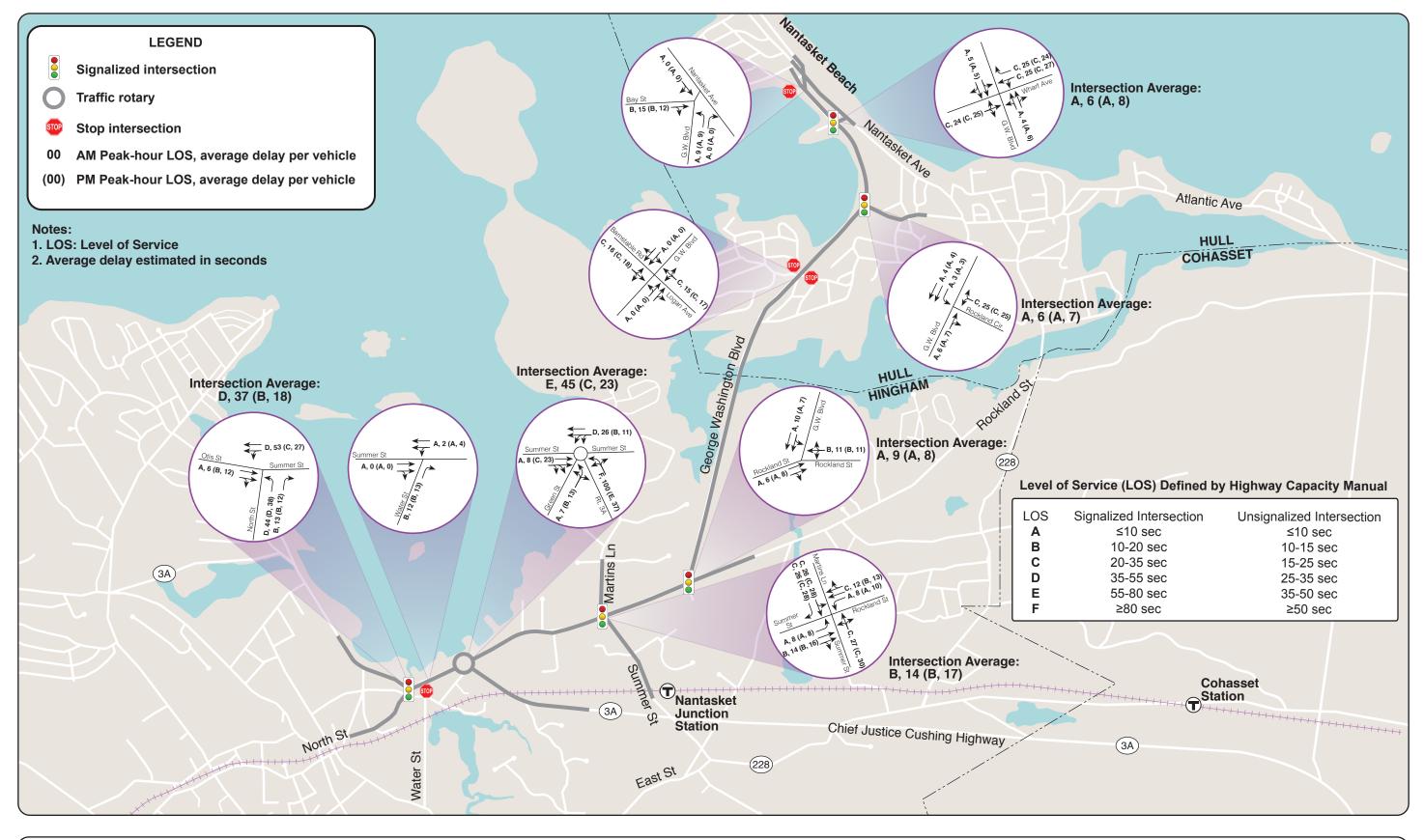
BOSTON REGION	Λ	FIGURE 6
MPO		Weekday Peak-Hour Traffic and Pedestrian Volumes Summer Street/George Washington Boulevard in Hingham and Hull



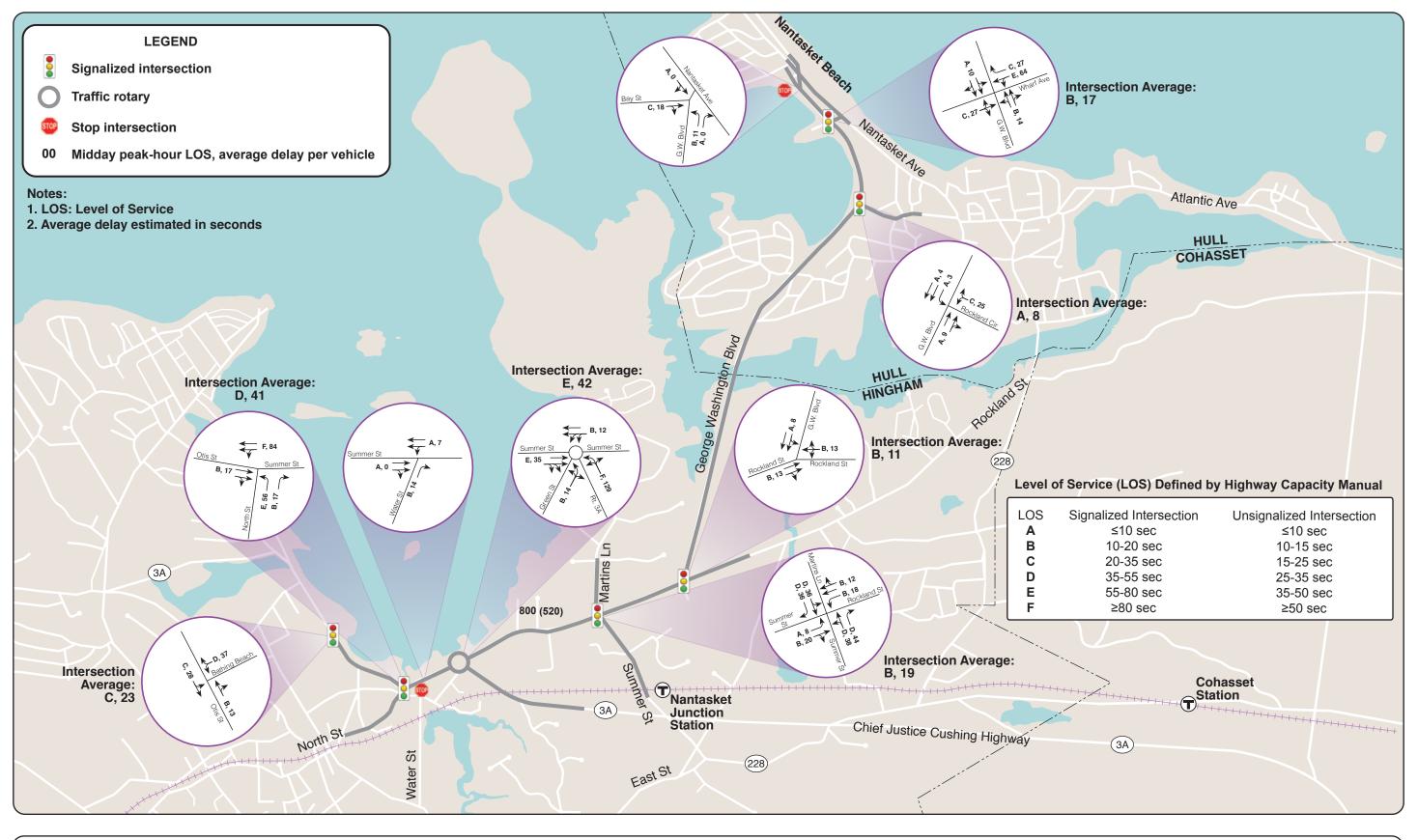
REGION Summer Saturday Peak-Hour Traffic and Pedestrian Volumes MPO N Summer Street/George Washington Boulevard in Hingham and Hull			•	
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BOSTON	Λ	FIGURE 8
REGION		Summer Saturday On-Road Bicycle Volumes
MPO	Ň	Summer Street/George Washington Boulevard in Hingham and Hull



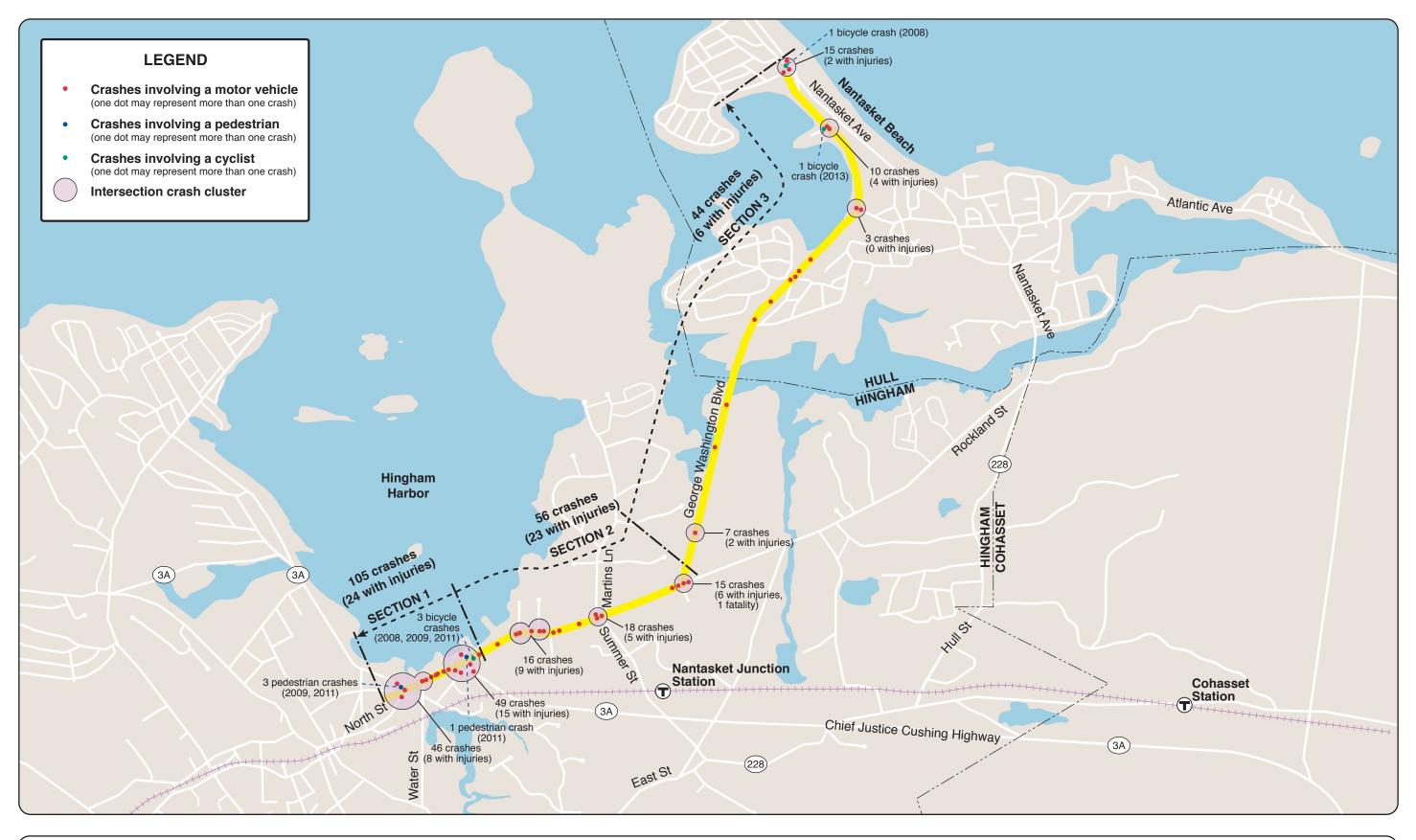
BOSTON	Λ	FIGURE 9
REGION		Weekday Peak-Hour Intersection Capacity Analyses
MPO	Ň	Summer Street/George Washington Boulevard in Hingham and Hull



BOSTON	FIGURE 10	
REGION	Summer Saturday Peak-Hour Intersection Capacity	Analyses
MPO	Summer Street/George Washington Boulevard in Hing	ham and Hull



BOSTON REGION		FIGURE 11 Speed Regulations and Estimated 85th Percentile Speeds
MPO	N	Summer Street/George Washington Boulevard in Hingham and Hull



BOSTON REGION MPO		FIGURE 12 Summary of MassDOT Crash Data 2008-12 Summer Street/George Washington Boulevard in Hingham and Hull
MPO	N	Summer Street/George Washington Boulevard in Hingham and Hull

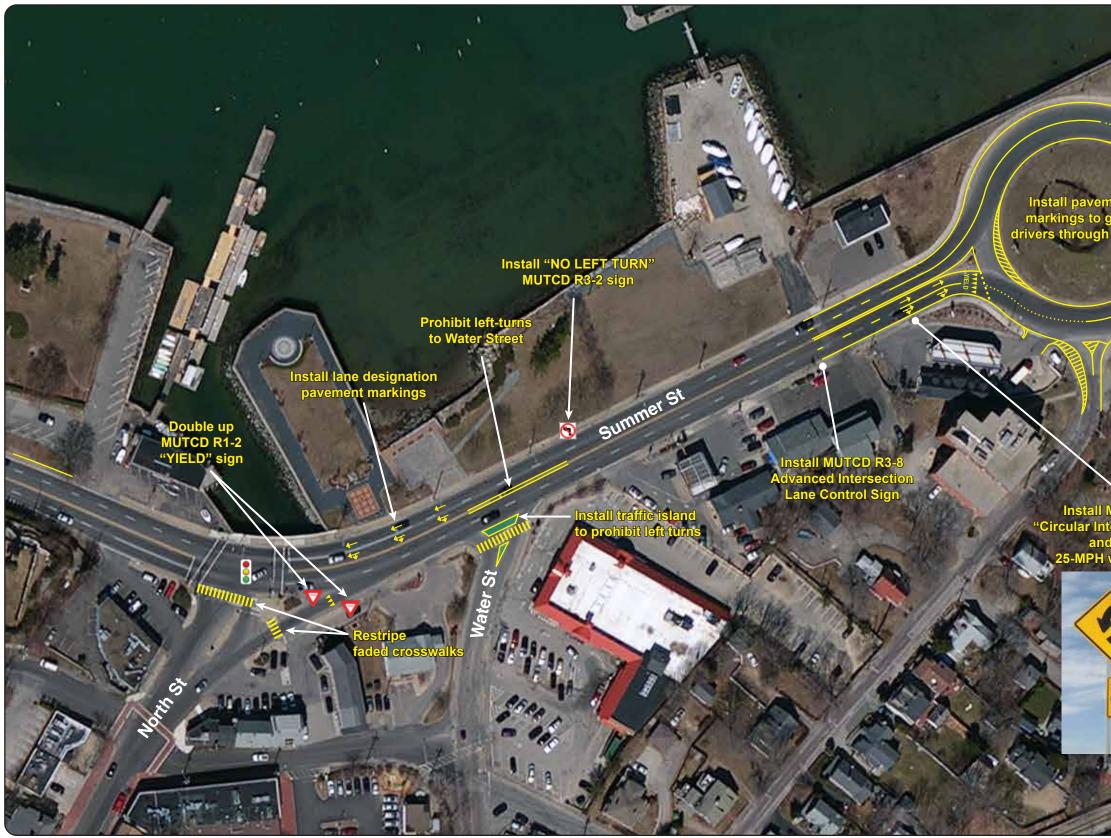


FIGURE 13 Proposed Key Short-Term Improvement Conceptual Plan: Summer Street in the Harbor Area Summer Street/George Washington Boulevard in Hingham and Hull



ed Intersection Chief Justice Cushing Highwe ITCD and W13-1p PH warning sign

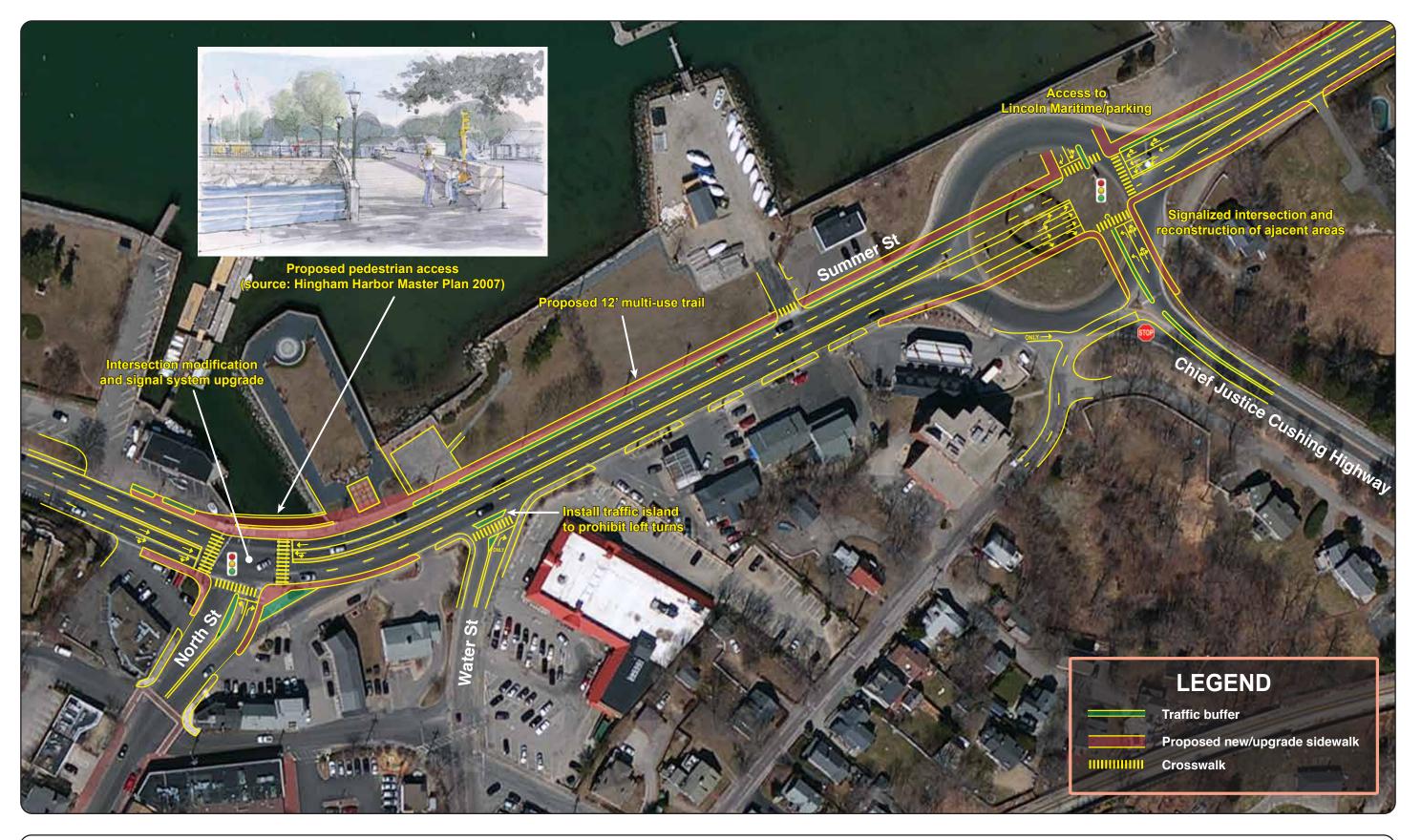


FIGURE 14-1 Proposed Long-Term Improvement Conceptual Plan: Summer Street in the Harbor Area Summer Street/George Washington Boulevard in Hingham and Hull



Alternative Signalized Intersection Design



Two-Lane Modern Roundabout

FIGURE 14-1A Route 3A Rotary Long-Term Improvement Alternatives Summer Street/George Washington Boulevard in Hingham and Hull

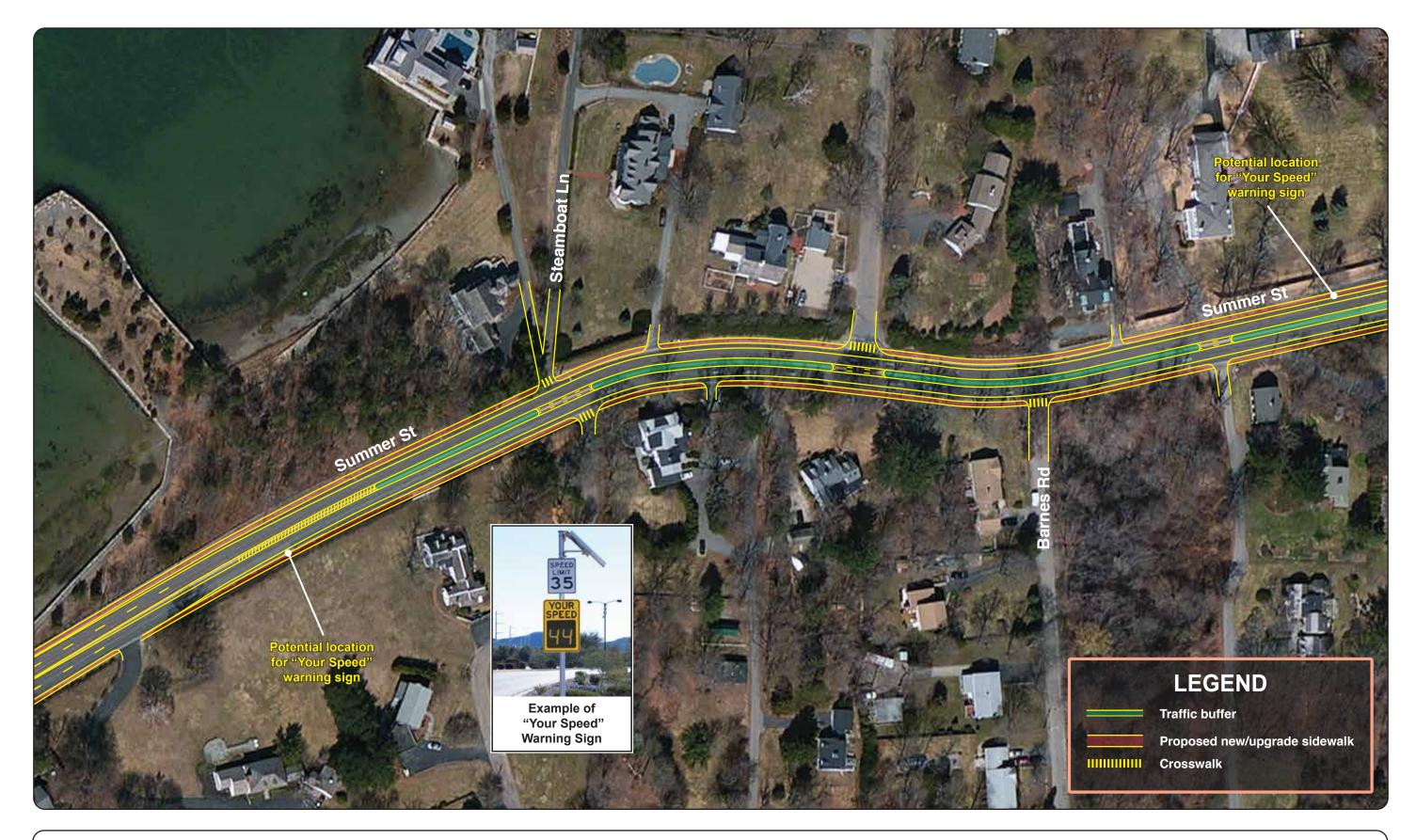


FIGURE 14-2 Proposed Long-Term Improvement Conceptual Plan: Summer Street in the Residential Area Summer Street/George Washington Boulevard in Hingham and Hull

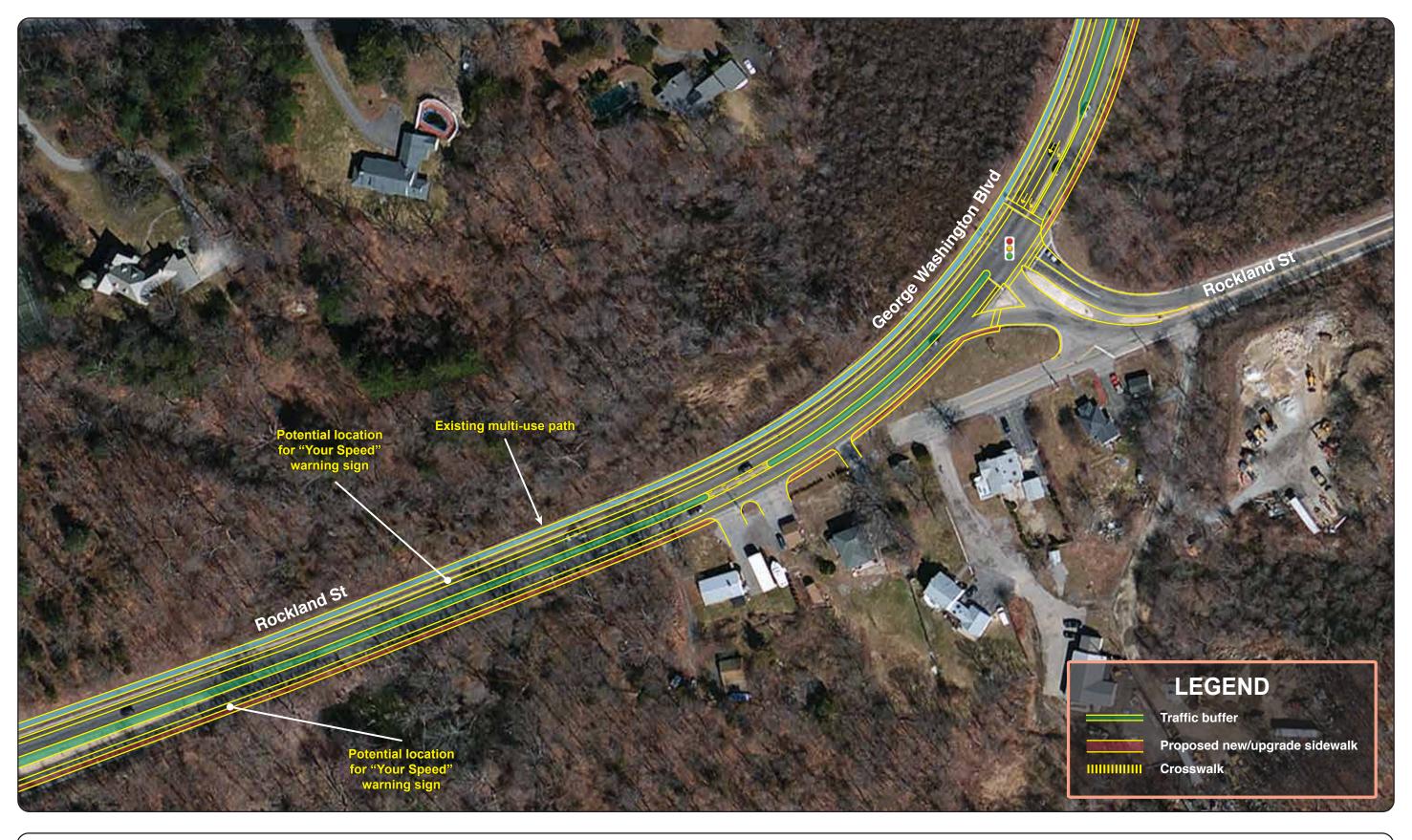


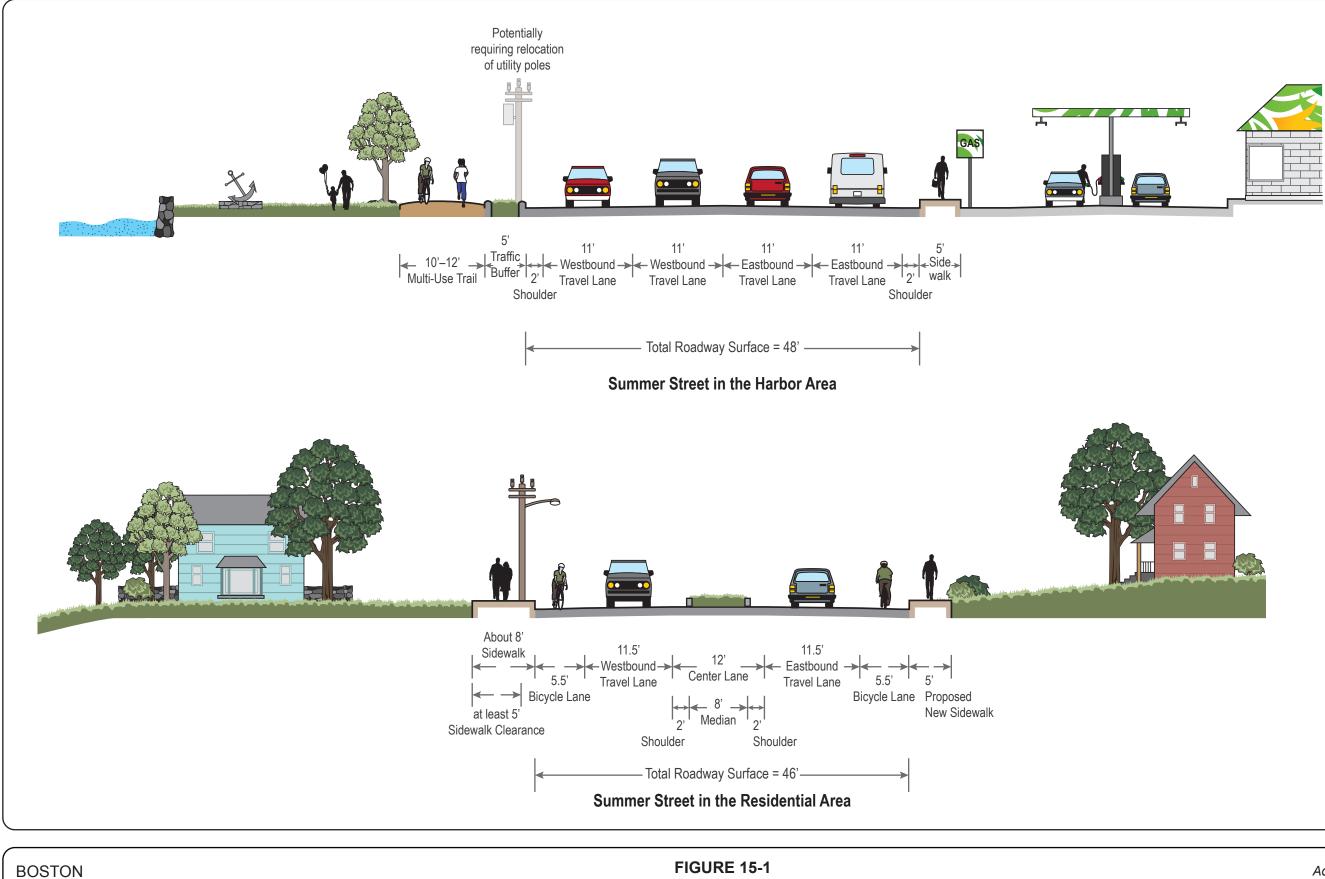
FIGURE 14-3 Proposed Long-Term Improvement Conceptual Plan: Rockland Street/George Washington Boulevard in Hingham Summer Street/George Washington Boulevard in Hingham and Hull

BOSTON REGION MPO

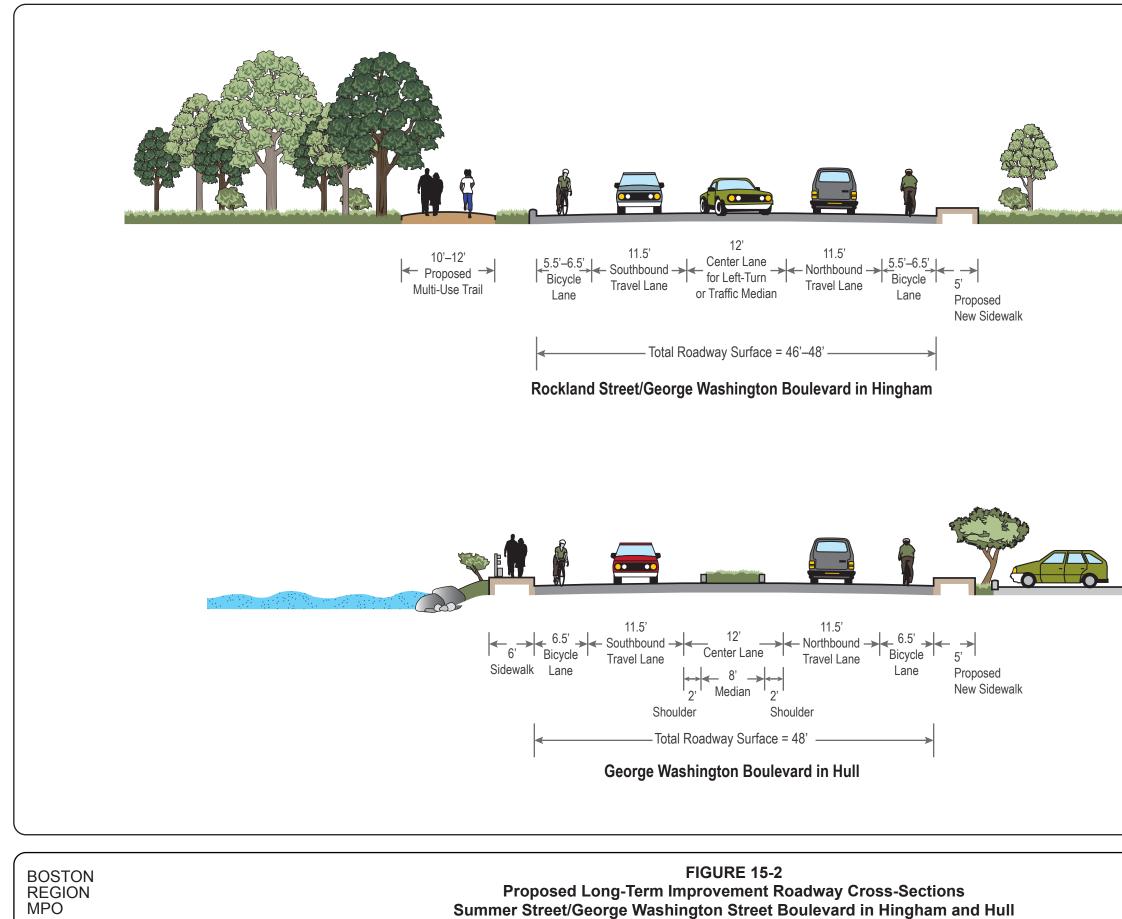




FIGURE 14-4 Proposed Long-Term Improvement Conceptual Plan: George Washington Boulevard in Hull Summer Street/George Washington Boulevard in Hingham and Hull



Proposed Long-Term Improvement Roadway Cross-Sections Summer Street/George Washington Street Boulevard in Hingham and Hull







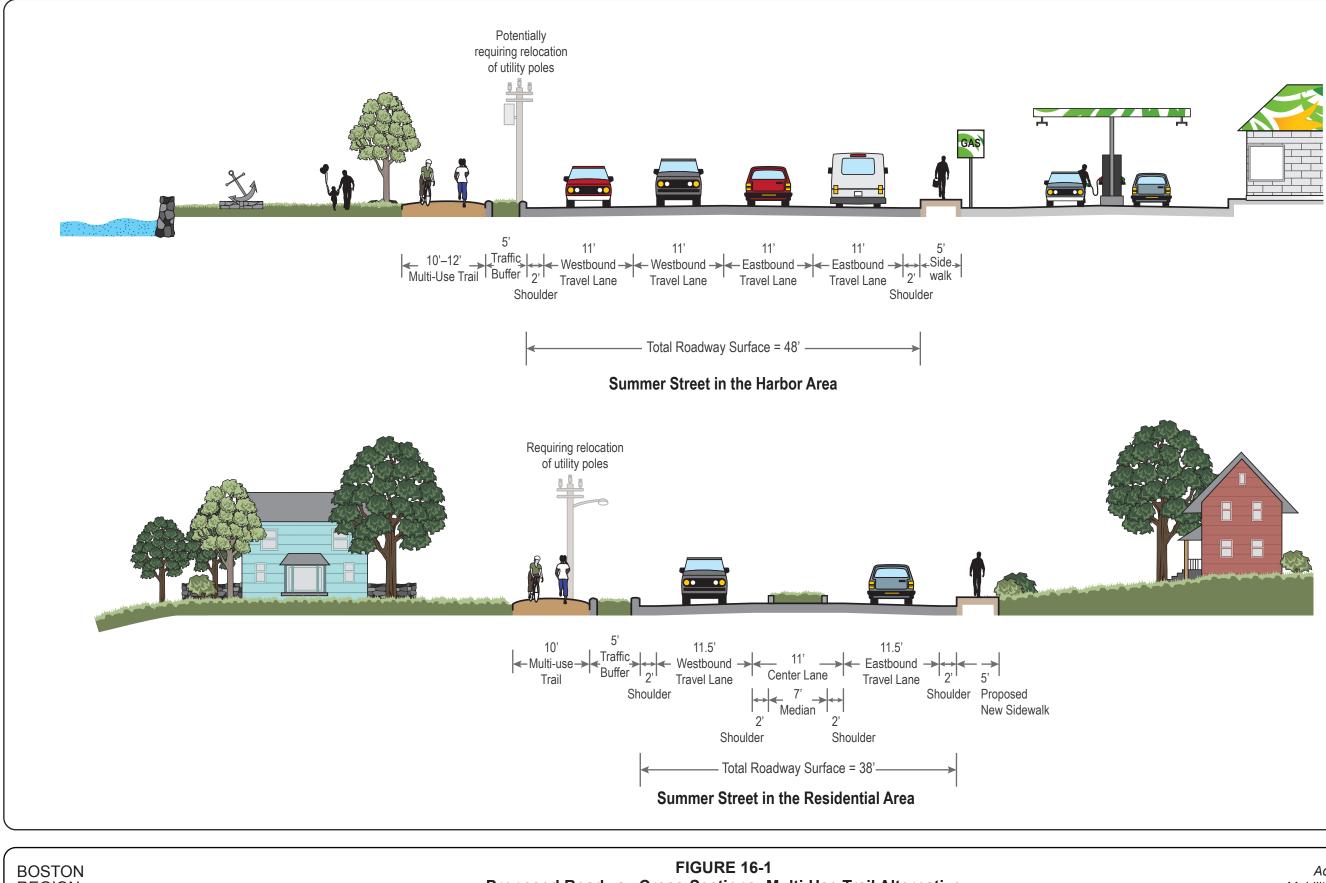
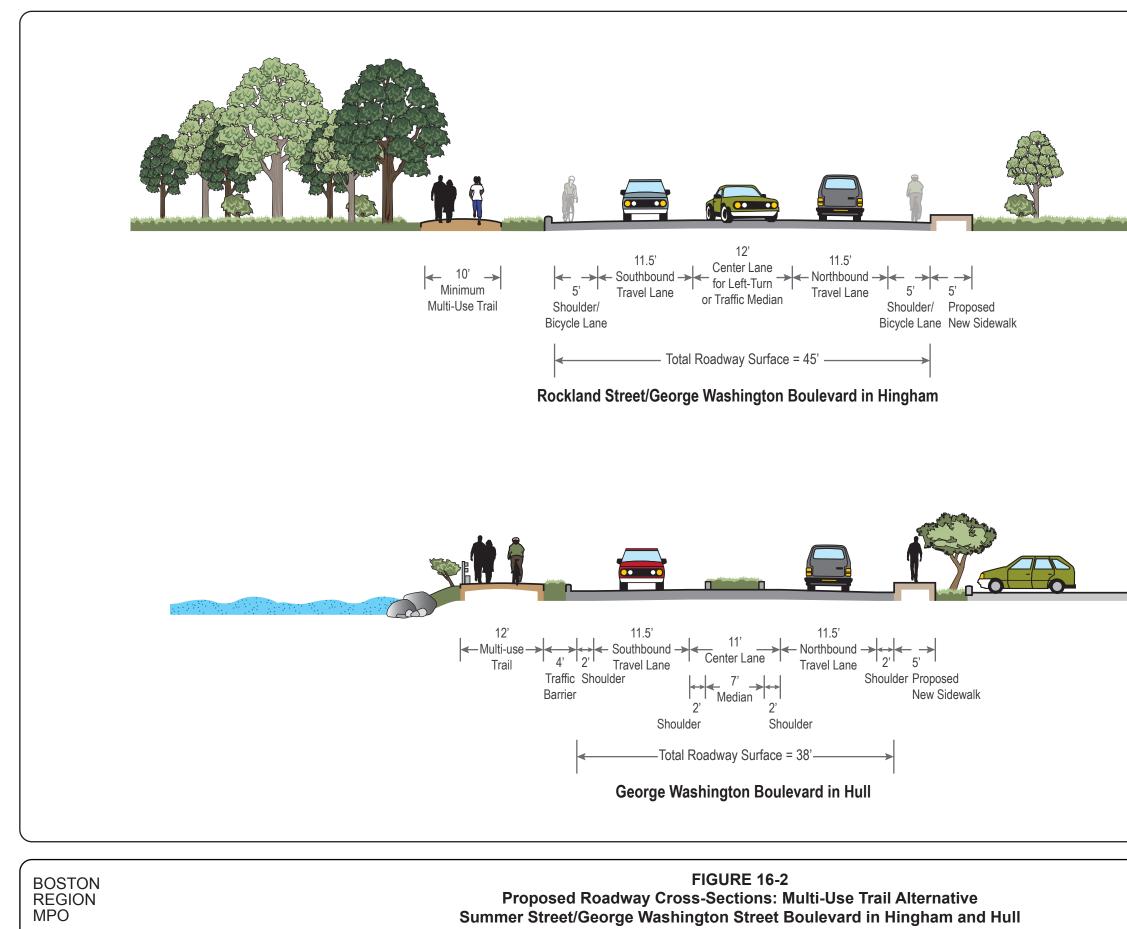
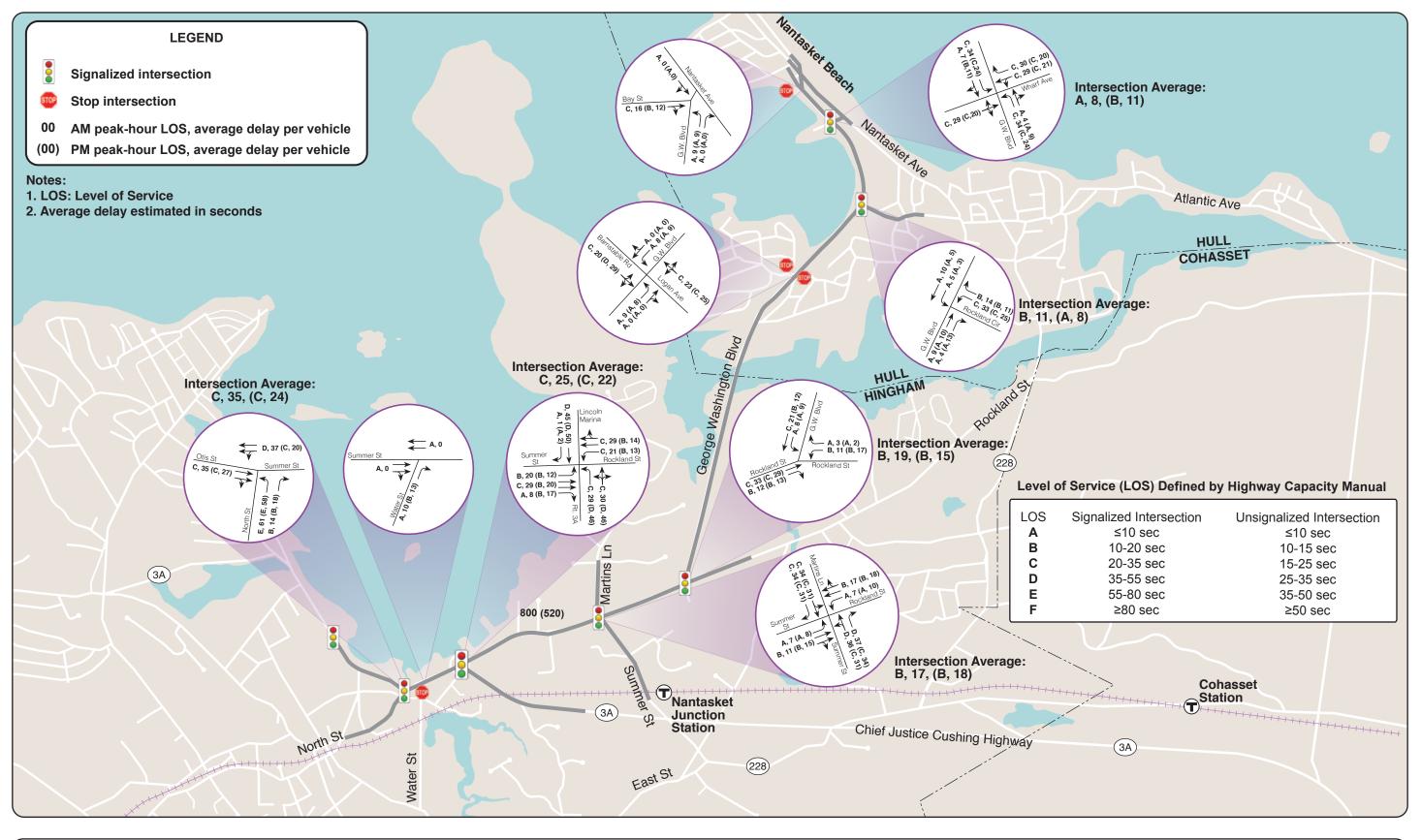


FIGURE 16-1 Proposed Roadway Cross-Sections: Multi-Use Trail Alternative Summer Street/George Washington Street Boulevard in Hingham and Hull

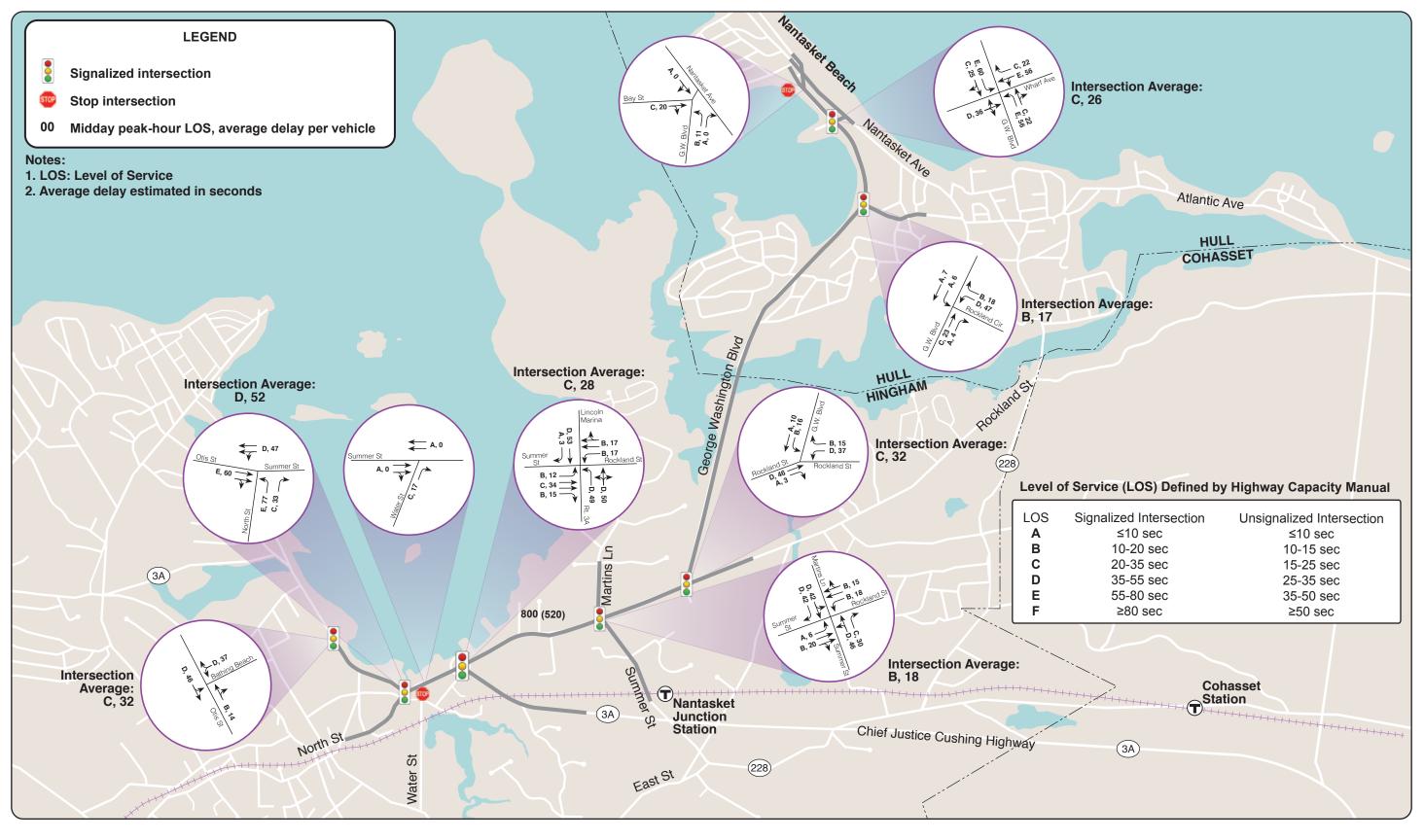








BOSTON REGION MPO		FIGURE 17 Projected 2040 Weekday Peak-Hour Intersection Capacity Analyses Summer Street/George Washington Boulevard in Hingham and Hull
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BOSTON REGION MPO	Â	FIGURE 18 Projected 2040 Summer Saturday Peak-Hour Intersection Capacity Analyses Summer Street/George Washington Boulevard in Hingham and Hull
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APPENDIX A

Participants of Study Advisory Meetings May 13 and November 3, 2015

Participants of Study Advisory Meetings

Summer Street/George Washington Boulevard Corridor in Hingham and Hull May 13 and November 3, 2015

Name	Affiliation	Email
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Katrina Crocker	СТРЅ	kcrocker@ctps.org

APPENDIX B

Intersection Capacity Analyses Weekday AM Peak Hour 2015 Existing Conditions

Intersection Capacity Analysis 1. Summer St @ North St

	-	\mathbf{i}	<	-	•	1	
Lano Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3
Lane Group Lane Configurations	 ≜ ⊅	LDK	VVDL	1000			00
Volume (vph)	T ₽ 572	50	262	H T 1246	79	227	
Satd. Flow (prot)	3036	0	202	3082	1577	1411	
Flt Permitted	2020	0	0	0.696	0.950	1411	
Satd. Flow (perm)	3036	0	0	2164	1577	1411	
Satd. Flow (RTOR)	9	0	0	2104	1377	261	
Confl. Peds. (#/hr)	9	3	3			201	
Peak Hour Factor	0.95	0.95	0.93	0.93	0.87	0.87	
Heavy Vehicles (%)	2%	2%	0.93	0.93	3%	3%	
3	Ζ 70	Z 70	I 70	I 70	370	370	
Shared Lane Traffic (%)	455	0	0	1/00	01	0/1	
Lane Group Flow (vph)	655 NA	0	0 D.P+P	1622	91 Drot	261	
Turn Type	NA			NA	Prot	Perm	2
Protected Phases	2		1	6	4		3
Permitted Phases	0		2	,		4	
Detector Phase	2		1	6	4	4	
Switch Phase				0.6	0.0	0.0	
Minimum Initial (s)	8.0		4.0	8.0	9.0	9.0	4.0
Minimum Split (s)	13.0		9.0	13.0	14.0	14.0	21.0
Total Split (s)	40.0		25.0	65.0	25.0	25.0	21.0
Total Split (%)	36.0%		22.5%	58.6%	22.5%	22.5%	19%
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0		1.0	1.0	1.0	1.0	0.0
Lost Time Adjust (s)	0.0			0.0	0.0	0.0	
Total Lost Time (s)	5.0			5.0	5.0	5.0	
Lead/Lag	Lead		Lag		Lag	Lag	Lead
Lead-Lag Optimize?	Yes		Yes		Yes	Yes	Yes
Recall Mode	Min		None	Min	None	None	None
Act Effct Green (s)	61.2			61.2	11.0	11.0	
Actuated g/C Ratio	0.71			0.71	0.13	0.13	
v/c Ratio	0.30			1.05	0.45	0.64	
Control Delay	6.3			52.7	43.5	12.9	
Queue Delay	0.0			0.0	0.0	0.0	
Total Delay	6.3			52.7	43.5	12.9	
LOS	A			D	D	В	
Approach Delay	6.3			52.7	20.8		
Approach LOS	A			D	C		
Queue Length 50th (ft)	41			331	43	0	
Queue Length 95th (ft)	163			#904	104	65	
Internal Link Dist (ft)	764			218	85	00	
Turn Bay Length (ft)	704			210	05		
Base Capacity (vph)	2171			1546	373	533	
Starvation Cap Reductn	2171			1540	0	035	
	0			0	0		
Spillback Cap Reductn Storage Cap Reductn						0 0	
	0 20			0	0 24		
Reduced v/c Ratio	0.30			1.05	0.24	0.49	
Intersection Summary							

Cycle Length: 111 Actuated Cycle Length: 85.6

Baseline

Natural Cycle: 150		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 1.05		
Intersection Signal Delay: 36.9	Intersection LOS: D	
Intersection Capacity Utilization 86.1%	ICU Level of Service E	
Analysis Period (min) 15		
# 95th percentile volume exceeds capacity, queue may b	e longer.	
Queue shown is maximum after two cycles.		

Splits and Phases: 1: North St & Otis St/Summer St

	√ ø1	∦ ¶ø3	↑ ø4
40 s	25 s	21 s	25 s
← ø6			
65 s			

Intersection								
Intersection Delay, s/veh	45.2							
Intersection LOS	E							
Approach		EB		WB		NB		NW
Entry Lanes		2		2		1		1
Conflicting Circle Lanes		2		2		2		2
Adj Approach Flow, veh/h		892		836		42		915
Demand Flow Rate, veh/h		927		844		44		934
Vehicles Circulating, veh/h		67		947		917		465
Vehicles Exiting, veh/h		1724		452		77		496
Follow-Up Headway, s		3.186		3.186		3.186		3.186
Ped Vol Crossing Leg, #/h		0		0		0		0
Ped Cap Adj		1.000		1.000	1	1.000		1.000
Approach Delay, s/veh		8.3		26.4		7.2		100.2
Approach LOS		А		D		А		F
Lane	Left	Right	Left	Right	Left		Left	
Designated Moves	LT	TR	LT	TR	LR		LR	
Assumed Moves	LT	R	LT	TR	LR		LR	
RT Channelized								
Lane Util	0.454	0.546	0.470	0.530	1.000		1.000	
Critical Headway, s	4.293	4.113	4.293	4.113	4.113		4.113	
Entry Flow, veh/h	421	506	397	447	44		934	
Cap Entry Lane, veh/h	1075	1078	555	582	595		816	
Entry HV Adj Factor	0.962	0.962	0.990	0.991	0.955		0.980	
Flow Entry, veh/h	405	487	393	443	42		915	
Cap Entry, veh/h	1033	1038	550	577	568		799	
V/C Ratio	0.392	0.469	0.715	0.768	0.074		1.145	
Control Delay, s/veh	7.7	8.8	24.8	27.7	7.2		100.2	
LOS	А	А	С	D	А		F	
95th %tile Queue, veh	2	3	6	7	0		27	

Intersection Capacity Analysis 3. Summer St @ Rockland St

	٨	-	\mathbf{r}	4	+	•	•	Ť	1	1	ţ	-
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	٦	¢β		ሻ	A			र्स	1		स	1
Volume (vph)	26	378	11	136	742	10	17	27	57	11	42	39
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	11	11	11	12	12	12	16	16	16
Storage Length (ft)	150		0	150		0	0	12	50	0	10	75
Storage Lanes	130		0	130		0	0		1	0		1
Taper Length (ft)	25		U	25		U	25		•	25		
Satd. Flow (prot)	1694	3374	0	1728	3448	0	0	1775	1538	0	2090	1794
Flt Permitted	0.338	5574	0	0.437	3440	0	0	0.852	1550	U	0.923	1774
Satd. Flow (perm)	603	3374	0	795	3448	0	0	1542	1538	0	1949	1794
Right Turn on Red	003	3374	No	195	3440	No	0	1042	No	0	1747	No
			NU			NU			INU			INU
Satd. Flow (RTOR)		35			35			35			35	
Link Speed (mph)												
Link Distance (ft)		458			438			329			717	
Travel Time (s)	0.00	8.9	0.00	0.00	8.5	0.00	0.04	6.4	0.04	0.00	14.0	0.00
Peak Hour Factor	0.93	0.93	0.93	0.90	0.90	0.90	0.84	0.84	0.84	0.92	0.92	0.92
Heavy Vehicles (%) Shared Lane Traffic (%)	3%	3%	3%	1%	1%	1%	5%	5%	5%	2%	2%	2%
Lane Group Flow (vph)	28	418	0	151	835	0	0	52	68	0	58	42
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	Perm
Protected Phases	5	2		1	6			3			3	
Permitted Phases	2			6			3		3	3		3
Detector Phase	5	2		1	6		3	3	3	3	3	3
Switch Phase												
Minimum Initial (s)	4.0	15.0		4.0	15.0		8.0	8.0	8.0	8.0	8.0	8.0
Minimum Split (s)	8.0	20.0		8.0	20.0		13.0	13.0	13.0	13.0	13.0	13.0
Total Split (s)	14.0	55.0		14.0	55.0		25.0	25.0	25.0	25.0	25.0	25.0
Total Split (%)	12.0%	47.0%		12.0%	47.0%		21.4%	21.4%	21.4%	21.4%	21.4%	21.4%
Yellow Time (s)	3.0	4.0		3.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Lost Time (s)	4.0	5.0		4.0	5.0			5.0	5.0		5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag			0.0	0.0		0.0	0.0
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Recall Mode	None	Min		Min	Min		None	None	None	None	None	None
Act Effct Green (s)	28.7	21.5		34.0	32.2		NONE	10.9	10.9	None	10.9	10.9
Actuated g/C Ratio	0.53	0.40		0.63	0.60			0.20	0.20		0.20	0.20
v/c Ratio	0.06	0.40		0.03	0.00			0.20	0.20		0.20	0.20
	7.9	14.4		8.1	12.0			26.7	27.1		25.9	26.1
Control Delay												
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Delay	7.9	14.4		8.1	12.0			26.7	27.1		25.9	26.1
LOS	А	В		А	В			С	С		С	С
Approach Delay		14.0			11.4			27.0			26.0	
Approach LOS	-	В			В			С			C	
Queue Length 50th (ft)	2	41		14	52			11	15		12	9
Queue Length 95th (ft)	22	137		82	280			60	74		70	54
Internal Link Dist (ft)		378			358			249			637	
Turn Bay Length (ft)	150			150					50			75
Base Capacity (vph)	619	2991		714	3057			676	674		854	786

Baseline

Lane Group	ø9	
LaneConfigurations		
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)		
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)	4.0	
Minimum Split (s)	23.0	
Total Split (s)	23.0	
Total Split (%)	20%	
Yellow Time (s)	2078	
All-Red Time (s)	0.0	
Lost Time Adjust (s)	0.0	
Total Lost Time (s)		
Lead/Lag		
Lead-Lag Optimize?		
Recall Mode	None	
Act Effct Green (s)	NUTE	
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)		
Turn Bay Length (ft)		
Base Capacity (vph)		

Baseline

11/21/2015

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Intersection Capacity Analysis 3. Summer St @ Rockland St

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
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	0.05	0.14		0.21	0.27			0.08	0.10		0.07	0.05
Intersection Summary												
Area Type:	Other											
Cycle Length: 117												
Actuated Cycle Length: 53	3.7											
Natural Cycle: 65												
Control Type: Actuated-Ur	ncoordinated											
Maximum v/c Ratio: 0.40												
Intersection Signal Delay:	14.1			In	tersection	ו LOS: B						
Intersection Capacity Utiliz	zation 46.7%			IC	U Level	of Service	A					
Analysis Period (min) 15												

Splits and Phases: 4: Summer St & Rockland St & Martins Ln

√ ø1		₩ _{ø3}	∦ ≹ _{ø9}
14 s	55 s	25 s	23 s
▶ ø5	€ Ø6		
14 s	55 s		

11/21/2015

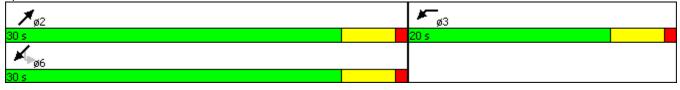
Intersection Capacity Analysis 4. Rockland St @ G. W. Blvd

	*	۲	*	/	6	¥
Lane Group	WBL	WBR	NET	NER	SWL	SWT
Lane Configurations	<u>۲</u> ۲		≜ †}			
Volume (vph)	180	21	T ₽ 359	87	10	₩ T 688
Ideal Flow (vphpl)	1900	21 1900	359 1900	1900	1900	1900
	3290	1900	3322	1900	1900	3418
Satd. Flow (prot)		U	33ZZ	U	0	
Flt Permitted	0.957	0	0000	0	0	0.946
Satd. Flow (perm)	3285	0	3322	0	0	3236
Right Turn on Red		Yes		Yes		
Satd. Flow (RTOR)	26		85			
Link Speed (mph)	35		35			35
Link Distance (ft)	180		737			669
Travel Time (s)	3.5		14.4			13.0
Confl. Peds. (#/hr)	1					
Peak Hour Factor	0.77	0.77	0.91	0.91	0.90	0.90
Shared Lane Traffic (%)						
Lane Group Flow (vph)	261	0	491	0	0	775
Turn Type	Prot	,	NA	Ű	Perm	NA
Protected Phases	3		2		1 0111	6
Permitted Phases	5		۷		6	U
Detector Phase	3		2		6	6
Switch Phase	3		Z		U	U
	7.0		7.0		7.0	7.0
Minimum Initial (s)	7.0		7.0		7.0	7.0
Minimum Split (s)	12.0		12.0		12.0	12.0
Total Split (s)	20.0		30.0		30.0	30.0
Total Split (%)	40.0%		60.0%		60.0%	60.0%
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			0.0
Total Lost Time (s)	5.0		5.0			5.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	Min		None		None	None
Act Effct Green (s)	10.0		14.7		TIONO	14.7
Actuated g/C Ratio	0.29		0.42			0.42
v/c Ratio	0.29		0.42			0.42
Control Delay	10.6		6.2			9.5
Queue Delay	0.0		0.0			0.0
Total Delay	10.6		6.2			9.5
LOS	В		А			А
Approach Delay	10.6		6.2			9.5
Approach LOS	В		А			А
Queue Length 50th (ft)	17		23			51
Queue Length 95th (ft)	37		48			96
Internal Link Dist (ft)	100		657			589
Turn Bay Length (ft)			-			
Base Capacity (vph)	1468		2468			2382
Starvation Cap Reductn	0		0			0
Spillback Cap Reductn	0		0			0
						0
Storage Cap Reductn	0		0			
Reduced v/c Ratio	0.18		0.20			0.33

Baseline

Intersection Summa	ary				
Area Type:	Other				
Cycle Length: 50					
Actuated Cycle Len	igth: 35				
Natural Cycle: 40					
Control Type: Actua	ated-Uncoordinated				
Maximum v/c Ratio	: 0.57				
Intersection Signal	Intersection LOS: A				
Intersection Capacity Utilization 40.3% ICU Level of Service A					
Analysis Period (mi	n) 15				

Splits and Phases: 13:



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Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	¢₽		1	^	Y	
Volume (vph)	270	32	26	632	62	25
Satd. Flow (prot)	3270	0	1728	3455	1972	0
Flt Permitted	5270	Ŭ	0.507	0100	0.966	Ű
Satd. Flow (perm)	3270	0	922	3455	1972	0
Satd. Flow (RTOR)	17	0	, 22	0100	20	U
Confl. Peds. (#/hr)	17				20	1
Peak Hour Factor	0.92	0.92	0.93	0.93	0.87	0.87
Heavy Vehicles (%)	5%	5%	1%	1%	1%	1%
Shared Lane Traffic (%)	570	570	170	170	170	170
Lane Group Flow (vph)	328	0	28	680	100	0
Turn Type	NA	U	pm+pt	NA	Prot	U
Protected Phases	NA 2		• •	NA 6	P101 3	
	Z		1	0	3	
Permitted Phases	n		6	/	2	
Detector Phase	2		1	6	3	
Switch Phase	40.0		0.0	40.0	0.0	
Minimum Initial (s)	40.0		8.0	40.0	8.0	
Minimum Split (s)	46.0		12.0	46.0	13.0	
Total Split (s)	46.0		24.0	70.0	25.0	
Total Split (%)	48.4%		25.3%	73.7%	26.3%	
Yellow Time (s)	4.0		3.0	4.0	3.0	
All-Red Time (s)	2.0		1.0	2.0	2.0	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	6.0		4.0	6.0	5.0	
Lead/Lag	Lag		Lead			
Lead-Lag Optimize?	Yes		Yes			
Recall Mode	Min		None	None	None	
Act Effct Green (s)	45.0		50.0	49.2	9.4	
Actuated g/C Ratio	0.68		0.76	0.75	0.14	
v/c Ratio	0.15		0.04	0.26	0.33	
Control Delay	6.1		3.0	3.9	25.4	
Queue Delay	0.0		0.0	0.0	0.0	
Total Delay	6.1		3.0	3.9	25.4	
LOS	А		А	А	С	
Approach Delay	6.1			3.9	25.4	
Approach LOS	А			А	С	
Queue Length 50th (ft)	17		2	42	26	
Queue Length 95th (ft)	57		9	74	72	
Internal Link Dist (ft)	1154			331	60	
Turn Bay Length (ft)			200	50.		
Base Capacity (vph)	2244		949	3263	621	
Starvation Cap Reductn	0		0	0	021	
Spillback Cap Reductn	0		0	0	0	
Storage Cap Reductn	0		0	0	0	
Reduced v/c Ratio	0.15		0.03	0.21	0.16	
	0.15		0.05	0.21	0.10	
Intersection Summary						
Cycle Length: 95						
Actuated Cycle Length: 65	.7					

Actuated Cycle Length: 65.7

Baseline_AM

Intersection Capacity Analysis 5. G. W. Blvd @ Rockland Circle

Natural Cycle: 75	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.33	
Intersection Signal Delay: 6.4	Intersection LOS: A
Intersection Capacity Utilization 49.2%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 3: Rockland Cir & G W Blvd

√ ø1	→ ø2	↑ ø3
24 s	46 s	25 s
★ ø6		
70 s		

Intersection Capacity Analysis 6. G. W. Blvd @ Whalf Ave

	٦	-	\mathbf{F}	4	-	•	1	1	1	1	ŧ	~
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		4			ર્સ	1		4 î -			đ þ	
Volume (vph)	2	0	5	15	4	16	1	276	12	22	634	5
Satd. Flow (prot)	0	1720	0	0	1621	1432	0	3447	0	0	3564	0
Flt Permitted		0.907						0.954			0.939	
Satd. Flow (perm)	0	1579	0	0	1682	1412	0	3288	0	0	3353	0
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)	1		1	1		1			4	4		
Peak Hour Factor	0.88	0.88	0.88	0.80	0.80	0.80	0.88	0.88	0.88	0.92	0.92	0.92
Heavy Vehicles (%)	10%	10%	10%	9%	9%	9%	4%	4%	4%	1%	1%	1%
Shared Lane Traffic (%)	1070	1070	1070	,,,,	,,,,	,,,,	170	170	170	170	170	170
Lane Group Flow (vph)	0	8	0	0	24	20	0	329	0	0	718	0
Turn Type	Perm	NĂ	0	Perm	NA	Perm	Perm	NA	Ū	Perm	NA	Ū
Protected Phases	- Chil	4		1 GHH	8	1 GIIII	1 GHH	2		1 GHH	6	
Permitted Phases	4	т		8	0	8	2	2		6	U	
Detector Phase	4	4		8	8	8	2	2		6	6	
Switch Phase	т	т		0	0	0	2	2		0	U	
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	33.0	33.0		33.0	33.0	
Minimum Split (s)	9.0	9.0		9.0	9.0	9.0	38.0	38.0		38.0	38.0	
Total Split (s)	9.0 15.0	9.0 15.0		9.0 15.0	9.0 15.0	9.0 15.0	38.0	38.0		38.0	38.0	
Total Split (%)	21.4%	21.4%		21.4%	21.4%	21.4%	54.3%	54.3%		54.3%	54.3%	
Yellow Time (s)	21.4%	21.4 <i>7</i> 0 3.0		21.4%	21.4%	21.470	3.0 ³	3.0 ³		3.0 ³	34.3 <i>%</i>	
.,	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0	
All-Red Time (s)	2.0	0.0		2.0	2.0	2.0	2.0	0.0		2.0	0.0	
Lost Time Adjust (s)		5.0			5.0	5.0		5.0			5.0	
Total Lost Time (s)		5.0			0.C	5.0		5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?	Nono	None		Nono	Nono	Nono	Min	Min		Min	Min	
Recall Mode	None	None		None	None	None	Min	Min		Min		_
Act Effct Green (s)		6.5			6.7	6.7		45.9			45.9	
Actuated g/C Ratio		0.12			0.12	0.12		0.83			0.83	_
v/c Ratio		0.04			0.12	0.12		0.12			0.26	
Control Delay		23.7			24.5	24.8		4.3			4.7	_
Queue Delay		0.0			0.0	0.0		0.0			0.0	
Total Delay		23.7			24.5	24.8		4.3			4.7	
LOS		C			С	С		A			A	
Approach Delay		23.7			24.6			4.3			4.7	
Approach LOS		С			С			А			А	
Queue Length 50th (ft)		2			7	6		0			0	_
Queue Length 95th (ft)		14			26	23		61			141	
Internal Link Dist (ft)		20			82			386			422	
Turn Bay Length (ft)												
Base Capacity (vph)		288			307	258		2723			2777	
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		0.03			0.08	0.08		0.12			0.26	
Intersection Summary												
Cycle Length: 70												

Cycle Length: 70 Actuated Cycle Length: 55.4

Baseline_AM

Synchro 8 Report Page 1

Lane Configurations Volume (oph) Satk - Flow (prot) Fli Permitted Satk - Flow (prot) Fli Permitted Satk - Flow (prot) Satk - Flow (perm) Peak + Our Factor Heasy Vehicles (%) Shared Lane Trafic (%) Lane Group Flow (oph) Turn Type Protected Phases 9 Permitted Phases 9 Permitted Phases 9 Permitted Phases Switch Phase Minimum Spit (%) 17.0 Total Spit (%) 17.0 Total Spit (%) 10 Lost Time Adjust (%) 1.0 Lost Time Adjust (%) Actuated giC Ratio We Ratio Control Delay Oueue Delay Actuated giC Ratio Verm Sin Control Delay Dueue Losh Sth (ft) Uurn Sin Control Delay Dueue Losh Sth (ft) Uurn Bay Length (fth) Tarna Type Protected Phase Sin Control Delay Coueu Length Sth (ft) Turn Bay Length (fth) Starvation Cap Reductin Sirvage Cap Redu	Lane Group	ø9	
Satd. Flow (perm) Satd. Flow (perm) Satd. Flow (perm) Satd. Flow (RTOR) Confl. Peds. (#hr) Peak Hour Factor Heary Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Petrnitted Phases Detector Phase Switch Phase Minimum Spiil (\$) 17.0 Total Spiil (\$)			
FI Permited Sald. Flow (PRTOR) Confl. Peds. (#Int) Peak Hour Factor Heary Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (uph) Turn Type Protected Phases Permitted Phases Defector Phase Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 17.0 Total Split (s) 17.0 Total Split (s) 17.0 Total Split (s) 2.0 All-Red Time (s) 2.0 Liked Time (s) 1.0 Lost Time Adjust (s) 1.0 Lost Time (s) 2.0 Lead/Lag Lead/Lag Lead/Lag Lead/Lag Lead/Lag Lead/Lag Control Delay Outmize? Recall Mode None Act Effect Green (s) Actuated g/C Ratio Control Delay Outmut of the set of the s	Volume (vph)		
Sald. Flow (PTOR) Confl. Peds. (#hr) Peak Hour Factor Peak Hour Factor Peak Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (wh) Tum Type Protected Phases Switch Phase Minimun Inital (\$) 4.0 Minimun Inital (\$) 17.0 Total Split (\$) 17.0 Total Split (\$) 2.0 All-Red Time (\$) 2.0 All-Red Time (\$) 2.0 All-Red Time (\$) 1.0 Lost Time Adjust (\$) 1.0 Lost Time (\$) 2.0 All-Red Time (\$) 1.0 Lost Time (\$) 2.0 All-Red Time (\$) 1.0 Lost Time Adjust (\$) Total Lost Time (\$) Lead/Lag Optimize? Recall Mode Recall Mode None Act Effet Green (\$) Act Effet Green (\$) Act Effet Green (\$) Act Effet Green (\$) Approach Delay Approach Delay Approach Delay Approach Delay Approach Delay Approach Delay Queue Len	Satd. Flow (prot)		
Sald. Flow (RTOR) Confl. Peds. (#hn) Peak Hour Factor Heavy Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (vph) Tum Type Protected Phases 9 Permitted Phases 9 Detector Phase Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 17.0 Total Split (%) 24% Yellow Time (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) Total Lost Time (s) Lead.lag 1.0 Lost Time (s) 2.0 Lead.lag Optimize? Recall Mode Recall Mode None Act Ladg Optimize? Recall Mode Recall Mode None Act Lift Green (s) Actuated g/C Ratio Control Delay Oueue Delay LOS Total Lost Time Shift (f) LOS Approach LOS Oueue Delay Control Delay LOS Approach LOS Oueue Delay Fisht (ff) Total Deli Fisht (fi) Itermal Lin	Flt Permitted		
Confl. Peds. (v/in) Peak Hour Factor Heavy Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (vph) Tum Type Protected Phases 9 Permitted Phases 9 Permitted Phases 5 Wich Phase 5 Wich Phase 5 10 10 10 10 10 10 10 10 10 10	Satd. Flow (perm)		
Peak Hour Factor Heavy Vehicles (%) Shared Lame Traffic (%) Lane Group Flow (vph) Turn Type Princeted Phases 9 Permitted Phases 9 Detector Phase 9 Minimum Initial (%) 4.0 Minimum Initial (%) 4.0 Minimum Spift (%) 17.0 Total Spift (%) 24% Yellow Time (\$) 2.0 All-Red Time (\$) 1.0 Lost Time Adjust (\$) Total Lost Time (\$) Lead-Lag Optimize? Recall Mode Recall Mode None Act Left Green (\$) Actuated g/C Ratio Vic Ratio Uos Control Delay Uose LOS Approach LOS Queue Delay Ead-Lag Network (\$) LOS Approach LOS Queue Length Spift (1) Internal Link Dist (1) Turn Bay Length (10) Base Capacity (\$) Saration Cap Reductn Spilback Cap Reductn Spilback Cap Reductn Spilback Cap Reductn Spilback Cap Reductn Spilback Cap Reductn	Satd. Flow (RTOR)		
Heavy Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (xph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 17.0 Total Split (%) 24% Yellow Time (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) 1.0 Lost Time Adjust (s) 1.0 Lost Time Adjust (s) 4.0 Act Left Green (s) Actuated g/C Ratio Vic Ratio Vic Ratio Control Delay Queue Delay Total Delay LOS Approach LoS Approach Delay Queue Length 95th (ft) Heaster Adjust (s) Slareactift (r%) Slareactift (r%) Los Slareactift (r%) Approach LoS Slareactift (r%) Gueue Length 95th (ft) Slareactift (r%) Slareactift (r%) Slareactift (r%) LOS Slareactift (r%) Approach LoS Slareactift (r%) Queue Length 9	Confl. Peds. (#/hr)		
Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Switch Phase Switch Phase Switch Phase Minimum Initial (s) 4.0 Minimum Spitl (s) 17.0 Total Spitl (s) 17.0 Total Spitl (s) 24% Yellow Time (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) 1.0 Lost Time (s) 1.0 Lead/Lag Lead/Lag Lead/Lag None Act Effet Green (s) Act Effet Green (s) Actuated g/C Ratio Vic Ratio Control Delay Oueue Delay Oueue Delay Oueue Length 50th (ft) Internat Link Dist (ft) Itme Hume Hume Hume Hume Hume Hume Hume Hu	Peak Hour Factor		
Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases 9 Detector Phase 9 Switch Phase 9 Minimum Initial (s) 4.0 Minimum Spitt (s) 17.0 Total Spitt (s) 17.0 Total Spitt (s) 2.0 All-Red Time (s) 2.0 All-Red Time (s) 1.0 Lost Time (s) 2.0 All-Red Time (s) 1.0 Lead/Lag 1.0 Lead/Lag Vellow Time (s) Lead/Lag Vellow Time (s) Actuated g/C Ratio None Actuated g/C Ratio Vic Ratio Control Delay Oueue Delay Total Delay Oueue Length Stoth (ft) Oueue Length Stoth (ft) Oueue Length Stoth (ft) Oueue Length Stoth (ft) Starvation Cap Reductn Spillback Cap Reductn Spillback Cap Reductn Spillback Cap Reductn Spillback Cap Reductn	Heavy Vehicles (%)		
Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Detector Phase Switch Phase Minimum Split (\$) 4.0 Minimum Split (\$) 17.0 Total Split (\$) 17.0 Total Split (\$) 17.0 Total Split (\$) 24% Yellow Time (\$) 2.0 All-Red Time (\$) 1.0 Lost Time Adjust (\$) Total Split (\$) Total Split (\$) Total Split (\$) Total Split (\$) 1.0 Lost Time (\$) 1.0 Lost Time Adjust (\$) Total Split (\$) Total Split (\$) Total Split (\$) Total Lost Time (\$) 1.0 Lead/Lag Lead/Lag Lead/Lag Lead/Lag Control Detay Control Detay Control Detay Control Detay Control Delay Control Delay Control Delay Control Delay Cource Leigh 50th (t) Control Delay Cource Leigh 50th (t) Cource Leigh 50th	Shared Lane Traffic (%)		
Protected Phases 9 Permitted Phases	Lane Group Flow (vph)		
Permitted Phases Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 17.0 Total Split (s) 17.0 Total Split (s) 24% Yellow Time (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) 5 Total Lost Time (s) 1.0 Lead-Lag Optimize? Recall Mode Recall Mode None Act Effci Green (s) Actuated g/C Ratio Vic Ratio Vic Ratio Vic Ratio Ucueu Delay Ontrol Delay Oucueu Delay Lost Control Delay Queue Length Stoth (ft) Oucueu Length Stoth (ft) Oucueu Length Stoth (ft) Oucueu Length Stoth (ft) Oucueu Length Stoth (ft) Internal Link Dist (ft) Tim Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Spillback Cap Reductn Starvation Cap Reductn Spillback Cap Reductn Starvation Cap Reductn	Turn Type		
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Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio			
Storage Cap Reductn Reduced v/c Ratio			
Reduced v/c Ratio			

Intersection Capacity Analysis 6. G. W. Blvd @ Whalf Ave

Natural Cycle: 65		
Control Type: Semi Act-Uncoord		
Maximum v/c Ratio: 0.26		
Intersection Signal Delay: 5.5	Intersection LOS: A	
Intersection Capacity Utilization 46.7%	ICU Level of Service A	
Analysis Period (min) 15		

Splits and Phases: 7: G W Blvd & Wharf Ave

1 ø2	↓ _{ø4}	∦\$ ø9
38 s	15 s	17 s
↓ ø6	∲ ø8	
38 s	15 s	

APPENDIX C

Intersection Capacity Analyses Weekday PM Peak Hour 2015 Existing Conditions

Intersection Capacity Analysis 1. Summer St @ North St

	→	\mathbf{i}	4	+	1	1	
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3
Lane Configurations	 ∱ ⊅	LDIX	VVDL	•001 •↑₽			03
Volume (vph)	1137	53	182	H T 617	118	412	
Satd. Flow (prot)	3085	0	0	3045	1608	1439	
Flt Permitted	2000	0	0	0.521	0.950	1439	
Satd. Flow (perm)	3085	0	0	1604	1584	1439	
Satd. Flow (RTOR)	3083 4	0	0	1004	1004	509	
Confl. Peds. (#/hr)	4	1	1		9	009	
Peak Hour Factor	0.95	0.95	0.87	0.87	0.81	0.81	
			2%		1%	1%	
Heavy Vehicles (%)	1%	1%	Ζ%	2%	170	170	
Shared Lane Traffic (%)	1050	0	0	010	14/	EOO	
Lane Group Flow (vph)	1253	0	0 D.P+P	918 NA	146 Drot	509 Dorm	
Turn Type Drotoctod Dhasas	NA			NA	Prot	Perm	n
Protected Phases	2		1	6	4	٨	3
Permitted Phases	2		2	,	4	4	
Detector Phase	2		1	6	4	4	
Switch Phase	0.0		1.0	0.0	0.0	0.0	1.0
Minimum Initial (s)	8.0		4.0	8.0	9.0	9.0	4.0
Minimum Split (s)	13.0		9.0	13.0	14.0	14.0	21.0
Total Split (s)	40.0		25.0	65.0	25.0	25.0	21.0
Total Split (%)	36.0%		22.5%	58.6%	22.5%	22.5%	19%
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0		1.0	1.0	1.0	1.0	0.0
Lost Time Adjust (s)	0.0			0.0	0.0	0.0	
Total Lost Time (s)	5.0			5.0	5.0	5.0	
Lead/Lag	Lead		Lag		Lag	Lag	Lead
Lead-Lag Optimize?	Yes		Yes		Yes	Yes	Yes
Recall Mode	Min		None	Min	None	None	None
Act Effct Green (s)	47.6			47.6	13.6	13.6	
Actuated g/C Ratio	0.64			0.64	0.18	0.18	
v/c Ratio	0.64			1.20dl	0.50	0.75	
Control Delay	11.8			27.4	38.3	11.5	
Queue Delay	0.0			0.0	0.0	0.0	
Total Delay	11.8			27.4	38.3	11.5	
LOS	В			С	D	В	
Approach Delay	11.8			27.4	17.5		
Approach LOS	В			С	В		
Queue Length 50th (ft)	128			131	55	0	
Queue Length 95th (ft)	435			#479	143	46	
Internal Link Dist (ft)	764			218	85		
Turn Bay Length (ft)				2.5			
Base Capacity (vph)	1963			1324	462	776	
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	0.64			0.69	0.32	0.66	
	0.04			0.07	0.52	0.00	
Intersection Summary							

Cycle Length: 111 Actuated Cycle Length: 74.8

Baseline

Natural Cycle: 90	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.90	
Intersection Signal Delay: 18.2	Intersection LOS: B
Intersection Capacity Utilization 81.6%	ICU Level of Service D
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be	onger.
Queue shown is maximum after two cycles.	
dl Defacto Left Lane. Recode with 1 though lane as a left la	ane.
, i i i i i i i i i i i i i i i i i i i	

Splits and Phases: 1: North St & Otis St/Summer St

≁ ø2	√ ø1		1 ø4
40 s	25 s	21 s	25 s
← ø6			
65 s			

Intersection								
Intersection Delay, s/veh	22.6							
Intersection LOS	С							
Approach		EB		WB		NB		NW
Entry Lanes		2		2		1		1
Conflicting Circle Lanes		2		2		2		2
Adj Approach Flow, veh/h		1824		720		14		508
Demand Flow Rate, veh/h		1842		734		14		519
Vehicles Circulating, veh/h		55		494		1875		900
Vehicles Exiting, veh/h		1173		925		22		989
Follow-Up Headway, s		3.186		3.186		3.186		3.186
Ped Vol Crossing Leg, #/h		0		0		0		0
Ped Cap Adj		1.000		1.000		1.000		1.000
Approach Delay, s/veh		23.3		11.0		12.6		37.2
Approach LOS		С		В		В		E
Lane	Left	Right	Left	Right	Left		Left	
Designated Moves	LT	TR	LT	TR	LR		LR	
Assumed Moves	LT	R	LT	TR	LR		LR	
RT Channelized								
Lane Util	0.481	0.519	0.470	0.530	1.000		1.000	
Critical Headway, s	4.293	4.113	4.293	4.113	4.113		4.113	
Entry Flow, veh/h	886	956	345	389	14		519	
Cap Entry Lane, veh/h	1084	1087	780	800	304		602	
Entry HV Adj Factor	0.990	0.991	0.981	0.981	1.000		0.979	
Flow Entry, veh/h	877	947	338	382	14		508	
Cap Entry, veh/h	1074	1077	765	784	304		589	
V/C Ratio	0.817	0.879	0.442	0.486	0.046		0.862	
Control Delay, s/veh	20.4	26.0	10.6	11.3	12.6		37.2	
LOS	С	D	В	В	В		E	
95th %tile Queue, veh	10	12	2	3	0		10	

Intersection Capacity Analysis 3. Summer St @ Rockland St

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	ሻ	≜ ↑₽		ሻ	≜ ↑₽			र्	1		र्भ	1
Volume (vph)	58	745	24	110	474	8	15	29	85	7	23	30
Satd. Flow (prot)	1728	3435	0	1694	3378	0	0	1831	1583	0	2026	1743
Flt Permitted	0.433			0.229				0.888			0.926	
Satd. Flow (perm)	787	3435	0	408	3378	0	0	1654	1562	0	1898	1743
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)			2	2					1	1		
Peak Hour Factor	0.91	0.91	0.91	0.83	0.83	0.83	0.75	0.75	0.75	0.88	0.88	0.88
Heavy Vehicles (%)	1%	1%	1%	3%	3%	3%	2%	2%	2%	5%	5%	5%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	64	845	0	133	581	0	0	59	113	0	34	34
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	Perm
Protected Phases	5	2		1	6			3			3	
Permitted Phases	2			6			3		3	3		3
Detector Phase	5	2		1	6		3	3	3	3	3	3
Switch Phase												
Minimum Initial (s)	4.0	15.0		4.0	15.0		8.0	8.0	8.0	8.0	8.0	8.0
Minimum Split (s)	8.0	20.0		8.0	20.0		13.0	13.0	13.0	13.0	13.0	13.0
Total Split (s)	14.0	55.0		14.0	55.0		25.0	25.0	25.0	25.0	25.0	25.0
Total Split (%)	12.0%	47.0%		12.0%	47.0%		21.4%	21.4%	21.4%	21.4%	21.4%	21.4%
Yellow Time (s)	3.0	4.0		3.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Lost Time (s)	4.0	5.0		4.0	5.0			5.0	5.0		5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Recall Mode	None	Min		Min	Min		None	None	None	None	None	None
Act Effct Green (s)	34.8	26.9		38.7	35.6			12.9	12.9		12.9	12.9
Actuated g/C Ratio	0.57	0.44		0.63	0.58			0.21	0.21		0.21	0.21
v/c Ratio	0.12	0.56		0.32	0.30			0.17	0.34		0.09	0.09
Control Delay	8.1	17.0		9.7	12.8			28.5	30.8		28.0	28.2
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Delay	8.1	17.0		9.7	12.8			28.5	30.8		28.0	28.2
LOS	А	В		А	В			С	С		С	С
Approach Delay		16.4			12.3			30.0			28.1	
Approach LOS		В			В			С			С	
Queue Length 50th (ft)	6	104		14	63			16	32		9	9
Queue Length 95th (ft)	43	317		72	181			62	105		48	48
Internal Link Dist (ft)		378			358			249			637	
Turn Bay Length (ft)	150			150					50			75
Base Capacity (vph)	693	2867		518	2820			646	610		741	681
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	0.09	0.29		0.26	0.21			0.09	0.19		0.05	0.05
Intersection Summary												

Intersection Summary

Cycle Length: 117 Actuated Cycle Length: 61.2

Lane Configurations Volume (vph) Satd. Flow (prot) Fit Permitted Satd. Flow (perm) Satd. Flow (RTOR) Confi. Peds. (#/hr) Peak Hour Factor Heavy Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Protected Phases Petector Phase Winimum Initial (s) 4.0 Minimum Split (s) 23.0 Total Split (s) 23.0 Total Split (s) 2.0 All-Red Time (s) Lead-Lag Uetwork (s) Total Lost Time (s) Lead-Lag Uptimize? Recall Mode None Act Effct Green (s) Actuated g/C Ratio Vic Ratio Control Delay Uueue Delay Total Delay LOS Approach LOS Queue Length 50th (ft) Iurn Byte (ft) Starvation Cap Reductn Split Reductn Reduced Vic Ratio Intersection Summary Intersection Intersection Intersection Summary Intersection Intersection Summary Intersection Inter	Lane Group	ø9
Volume (vph)Satd. Flow (prot)Fit PermittedSatd. Flow (perm)Satd. Flow (perm)Satd. Flow (RTOR)Confl. Peds. (#/hr)Peak Hour FactorHeavy Vehicles (%)Shared Lane Traffic (%)Lane Group Flow (vph)Turn TypeProtected Phases9Permitted PhasesDetector PhaseSwitch PhaseSwitch PhaseMinimum Initial (s)4.0Minimum Split (s)23.0Total Split (s)23.0Total Split (s)23.0Total Split (s)20%Yellow Time (s)0.0Lost Time (s)0.0Lost Time (s)0.0Lost Time (s)10tal Lost Time (s)Lead/LagLead/LagLead/LagLead/LagLead/LagLead/LagLead/LagLead/LagLead/LagLead/LagLead/LagLead/LagLead/LagLead/LagLead/LagLead/LagLead/LagLost Time (s)Actuated g/C Ratiov/c RatioControl DelayLosApproach LOSOueue Length 95th (ft)Internal Link Dist (ft)Turn Bay Length (ft)Base Capacity (vph)Starvation Cap ReductnSpillback Cap ReductnSpillback Cap ReductnSpillback Cap Reductn	LaneConfigurations	
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Storage Cap Reductn Reduced v/c Ratio		
Reduced v/c Ratio		
Intersection Summary	Reduced v/c Ratio	
	Intersection Summary	

Intersection Capacity Analysis 3. Summer St @ Rockland St

Natural Cycle: 65		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.56		
Intersection Signal Delay: 16.5	Intersection LOS: B	
Intersection Capacity Utilization 48.1%	ICU Level of Service A	
Analysis Period (min) 15		

Splits and Phases: 4: Summer St & Rockland St & Martins Ln

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14 s	55 s	25 s	23 s
▶ ø5	€ ø6		
14 s	55 s		

Intersection Capacity Analysis 4. Rockland St @ G. W. Blvd

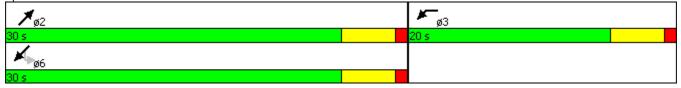
	*	۲	*	/	6	*
Lane Group	WBL	WBR	NET	NER	SWL	SWT
Lane Configurations	Ϋ́	TH DIC	≜ î≽		0112	
Volume (vph)	106	23	665	177	18	481
Satd. Flow (prot)	3173	0	3312	0	0	3414
Flt Permitted	0.961	0	5512	0	0	0.906
Satd. Flow (perm)	3173	0	3312	0	0	3100
Satd. Flow (RTOR)	27	U	96	0	0	5100
Peak Hour Factor	0.85	0.85	90 0.90	0.90	0.83	0.83
Heavy Vehicles (%)	0.85	0.85	2%	0.90	0.83	0.83
Shared Lane Traffic (%)	07C	3%	270	Z 70	Ζ70	Ζ70
. ,	152	0	936	0	0	602
Lane Group Flow (vph)		U		U		
Turn Type	Prot		NA		Perm	NA
Protected Phases	3		2		,	6
Permitted Phases	-		^		6	
Detector Phase	3		2		6	6
Switch Phase						
Minimum Initial (s)	7.0		7.0		7.0	7.0
Minimum Split (s)	12.0		12.0		12.0	12.0
Total Split (s)	20.0		30.0		30.0	30.0
Total Split (%)	40.0%		60.0%		60.0%	60.0%
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			0.0
Total Lost Time (s)	5.0		5.0			5.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	Min		None		None	None
Act Effct Green (s)	9.0		16.3		None	16.3
Actuated g/C Ratio	0.25		0.46			0.46
v/c Ratio	0.23		0.40			0.40
	11.0		8.0			7.3
Control Delay						
Queue Delay	0.0		0.0			0.0
Total Delay	11.0		8.0			7.3
LOS	В		А			A
Approach Delay	11.0		8.0			7.3
Approach LOS	В		А			А
Queue Length 50th (ft)	9		52			34
Queue Length 95th (ft)	28		96			58
Internal Link Dist (ft)	100		657			589
Turn Bay Length (ft)						
Base Capacity (vph)	1390		2419			2240
Starvation Cap Reductn	0		0			0
Spillback Cap Reductn	0		0			0
Storage Cap Reductn	0		0			0
Reduced v/c Ratio	0.11		0.39			0.27
	0.11		0.37			0.27
Intersection Summary						
Cycle Length: 50						
Actuated Cycle Length: 35.	6					
Natural Cycle: 40	.0					

Baseline

Intersection Capacity Analysis 4. Rockland St @ G. W. Blvd

Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.60		
Intersection Signal Delay: 8.0	Intersection LOS: A	
Intersection Capacity Utilization 40.6%	ICU Level of Service A	
Analysis Period (min) 15		

Splits and Phases: 13:



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Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	
Lane Configurations	ŧ₽		5	† †	Y		
Volume (vph)	595	83	34	402	50	22	
Satd. Flow (prot)	3393	0	1728	3455	1975	0	
Flt Permitted			0.322		0.967		
Satd. Flow (perm)	3393	0	586	3455	1975	0	
Satd. Flow (RTOR)	20				22		
Peak Hour Factor	0.89	0.89	0.92	0.92	0.72	0.72	
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	762	0	37	437	100	0	
Turn Type	NA		pm+pt	NA	Prot		
Protected Phases	2		1	6	3		
Permitted Phases			6				
Detector Phase	2		1	6	3		
Switch Phase	_			5	-		
Minimum Initial (s)	40.0		8.0	40.0	8.0		
Minimum Split (s)	46.0		12.0	46.0	13.0		
Total Split (s)	46.0		24.0	70.0	25.0		
Total Split (%)	48.4%		25.3%	73.7%	26.3%		
Yellow Time (s)	4.0		3.0	4.0	3.0		
All-Red Time (s)	2.0		1.0	2.0	2.0		
Lost Time Adjust (s)	0.0		0.0	0.0	0.0		
Total Lost Time (s)	6.0		4.0	6.0	5.0		
Lead/Lag	Lag		Lead	2.2			
Lead-Lag Optimize?	Yes		Yes				
Recall Mode	Min		None	None	None		
Act Effct Green (s)	45.0		50.0	49.2	9.5		
Actuated g/C Ratio	0.68		0.76	0.75	0.14		
v/c Ratio	0.33		0.06	0.17	0.33		
Control Delay	7.2		3.1	3.6	24.8		
Queue Delay	0.0		0.0	0.0	0.0		
Total Delay	7.2		3.1	3.6	24.8		
LOS	A		A	A	2 1.0 C		
Approach Delay	7.2			3.6	24.8		
Approach LOS	A			A	2 1.0 C		
Queue Length 50th (ft)	49		3	26	25		
Queue Length 95th (ft)	138		11	46	56		
Internal Link Dist (ft)	1154			331	60		
Turn Bay Length (ft)	1101		200	001	00		
Base Capacity (vph)	2326		796	3263	622		
Starvation Cap Reductn	0		0	0	022		
Spillback Cap Reductn	0		0	0	0		
Storage Cap Reductn	0		0	0	0		
Reduced v/c Ratio	0.33		0.05	0.13	0.16		
Intersection Summary	0.00		0.00	0.10	0.10		
· · · · · · · · · · · · · · · · · · ·							
Cycle Length: 95)						
Actuated Cycle Length: 65.8	כ						

Natural Cycle: 75

Baseline_PM

Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.33	
Intersection Signal Delay: 7.2	Intersection LOS: A
Intersection Capacity Utilization 49.2%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 3: Rockland Cir & G W Blvd

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24 s	46 s	25 s	
↓ ø6			
70 s			

Intersection Capacity Analysis 6. G. W. Blvd @ Wharf Ave

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		\$			र्स	1		đ þ			4î þ	
Volume (vph)	13	6	7	35	2	15	5	593	13	17	402	10
Satd. Flow (prot)	0	1920	0	0	1609	1432	0	3459	0	0	3553	0
Flt Permitted		0.815			0.762			0.953			0.925	
Satd. Flow (perm)	0	1602	0	0	1282	1412	0	3297	0	0	3293	0
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)	1		1	1		1			2	2		
Peak Hour Factor	0.65	0.65	0.65	0.72	0.72	0.72	0.92	0.92	0.92	0.95	0.95	0.95
Heavy Vehicles (%)	5%	5%	5%	9%	9%	9%	4%	4%	4%	1%	1%	1%
Parking (#/hr)										0		
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	40	0	0	52	21	0	664	0	0	452	0
Turn Type	Perm	NA		Perm	NA	Perm	Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		
Detector Phase	4	4		8	8	8	2	2		6	6	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	33.0	33.0		33.0	33.0	
Minimum Split (s)	9.0	9.0		9.0	9.0	9.0	38.0	38.0		38.0	38.0	
Total Split (s)	15.0	15.0		15.0	15.0	15.0	38.0	38.0		38.0	38.0	
Total Split (%)	21.4%	21.4%		21.4%	21.4%	21.4%	54.3%	54.3%		54.3%	54.3%	
Yellow Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)		0.0			0.0	0.0		0.0			0.0	
Total Lost Time (s)		5.0			5.0	5.0		5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	
Act Effct Green (s)		7.5			7.6	7.6		41.8			41.8	
Actuated g/C Ratio		0.13			0.14	0.14		0.75			0.75	
v/c Ratio		0.19			0.30	0.11		0.27			0.18	
Control Delay		24.6			27.4	23.8		5.8			5.4	
Queue Delay		0.0			0.0	0.0		0.0			0.0	
Total Delay		24.6			27.4	23.8		5.8			5.4	
LOS		С			С	С		А			А	
Approach Delay		24.6			26.4			5.8			5.4	
Approach LOS		С			С			А			А	
Queue Length 50th (ft)		11			14	6		35			22	
Queue Length 95th (ft)		30			40	21		134			88	
Internal Link Dist (ft)		20			82			386			422	
Turn Bay Length (ft)												
Base Capacity (vph)		292			233	257		2481			2478	
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		0.14			0.22	0.08		0.27			0.18	
Intersection Summary												
Cycle Length: 70												

Baseline_PM

Lane Group	ø9	
Lane Configurations		
Volume (vph)		
Satd. Flow (prot)		
Flt Permitted		
Satd. Flow (perm)		
Satd. Flow (RTOR)		
Confl. Peds. (#/hr)		
Peak Hour Factor		
Heavy Vehicles (%)		
Parking (#/hr)		
Shared Lane Traffic (%)		
Lane Group Flow (vph)		
Turn Type		
Protected Phases	9	
Permitted Phases		
Detector Phase		
Switch Phase		
Minimum Initial (s)	4.0	
Minimum Split (s)	17.0	
Total Split (s)	17.0	
Total Split (%)	24%	
Yellow Time (s)	2.0	
All-Red Time (s)	1.0	
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)		
Turn Bay Length (ft)		
Base Capacity (vph)		
Starvation Cap Reductn		
Spillback Cap Reductn		
Storage Cap Reductn		
Reduced v/c Ratio		
Intersection Summary		

Intersection Capacity Analysis 6. G. W. Blvd @ Wharf Ave

11/21/2015

Actuated Cycle Length: 55.6		
Natural Cycle: 65		
Control Type: Semi Act-Uncoord		
Maximum v/c Ratio: 0.30		
Intersection Signal Delay: 7.5	Intersection LOS: A	
Intersection Capacity Utilization 46.7%	ICU Level of Service A	
Analysis Period (min) 15		

Splits and Phases: 7: G W Blvd & Wharf Ave

▲ ¶ _{ø2}	↓ _{ø4}	∦\$ ø9
38 s	15 s	17 s
ø6	∲ ø8	
38 s	15 s	

APPENDIX D

Intersection Capacity Analyses Summer Saturday Midday Peak Hour 2015 Existing Conditions

Intersection Capacity Analysis 1. Summer St @ North St

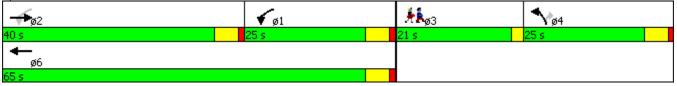
Lane Group EBT EBR WBL WBT NBL NBR o3 Lane Configurations 1261 67 184 777 200 567 Satd. Flow (prot) 3080 0 0 2899 1608 1439 FIL Permitted 0.502 0.950 567 576 576 Satd. Flow (RTOR) 5 576 576 576 576 Confl. Peds. (#/hr) 7 7 49 18 Peak Hour Factor 0.94 0.93 0.93 0.94 0.94 Peak Hour Factor 0.94 0.94 0.94 0.94 1% 2% 1% 1% Parking (#/hr) 0 1033 213 603 1urn Type NA D.P+P NA Prot Perm Protected Phases 2 1 6 4 4 940 21.0 14.0 21.0 14.0 21.0 14.0 21.0 14.0 21.0 14.0 21.0		-	\mathbf{F}	4	-	1	۲	
Lane Configurations 1 2 4 7 7 200 567 Satd. Flow (prot) 3080 0 0 2899 1608 1439 Fill Permitted 0.502 0.950 Satd. Flow (perm) 3080 0 0 1468 1477 1380 Satd. Flow (RTOR) 5 576 576 576 576 Confl. Peds. (#hn) 7 7 49 18 Peak Hour Factor 0.94 0.93 0.93 0.94 0.94 Peak Hour Factor 0.94 0.94 0.93 0.93 0.94 0.94 Parking (#/hr) 0 5 58.6% 1% 1% Permitted Phases 2 1 6 4 3 Permitted Phases 2 1 6 4 4 Switch Phase 30.040 25.0 65.0 25.0 25.0 25.0 25.0 25.0 25.0 25.0 25.0 25.0 25.0 25.0 25.0 2	Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3
Volume (vph) 1261 67 184 777 200 567 Satd. Flow (prot) 3080 0 0 1608 1439 FIL Permitted 0.500 0.950 567 Satd. Flow (perm) 3080 0 0 1468 1477 1380 Satd. Flow (RTOR) 5 576 576 576 Confl. Peds. (#/hr) 7 7 49 18 Peak Hour Factor 0.94 0.93 0.93 0.94 1% Parking (#/hr) 7 7 49 18 Presected thase 2 1/h 1% Lane Group Flow (vph) 1412 0 0 1033 213 603 Turn Type NA D.P+P NA Port Perm Protected Phases 2 1 6 4 4 Switch Phase 2 1 6 4 4 21.0 10.1 10.0 1.0 1.0 1.0 1.0 1								~~~
Sald. Flow (prot) 3080 0 0 2899 1608 1439 Flt Permitted 0.502 0.950 Satd. Flow (RTOR) 5 576 Confl. Peds. (#/hr) 7 7 49 18 Peak Hour Factor 0.94 0.93 0.93 0.94 0.94 Parking (#/hr) 7 7 7 49 18 Parking (#/hr) 1% 2% 2% 1% 1% Parking (#/hr) 1% 2% 2% 1% 1% Parking (#/hr) 1412 0 0 1033 213 603 Turn Type NA D.P+P NA Port Perm Protected Phases 2 1 6 4 3 Permitted Phases 2 1 6 4 3 Winimum Initial (s) 8.0 4.0 8.0 9.0 9.0 4.0 Minimum Split (s) 33.0 9.0 13.0 14.0 14.0 21.0 Total Split (s) 0.0 25.0 <td< td=""><td></td><td></td><td>67</td><td>184</td><td></td><td></td><td></td><td></td></td<>			67	184				
Fit Permitted 0.502 0.950 Satd. Flow (perm) 3080 0 0 1468 1477 1380 Satd. Flow (RTOR) 5 576 576 Confl. Peds. (#hr) 7 7 49 18 Peak Hour Factor 0.94 0.94 0.93 0.93 0.94 0.94 Parking (#hr) 1% 1% 2% 2% 1% 1% Parking (#hr) 1412 0 0 1033 213 603 Turn Type NA D.P+P NA Prot Perm Protected Phases 2 1 6 4 3 Permitted Phases 2 1 6 4 4 Switch Phase 2 1 6 4 4 Switch Phase 2 1 6 4 4 Switch Phase 2 1 6 4 4 Winimum Initial (6) 8.0 4.0 8.0 9.0 9.0 4.0 Minimum Initial (5) 10.0 1.0								
Satd. Flow (Perm) 3080 0 0 1468 1477 1380 Satd. Flow (RTOR) 5 576 576 Conll. Peds. (#hr) 7 7 49 18 Peak Hour Factor 0.94 0.93 0.93 0.94 0.94 Heavy Vehicles (%) 1% 1% 2% 1% 1% Parking (#hr) 0 1033 213 603	ų <i>i</i>	0000	U	0			1 107	
Satd. Flow (RTOR) 5 576 Confl. Peds. (#/hr) 7 7 49 18 Peak Hour Factor 0.94 0.94 0.93 0.93 0.94 0.94 Heavy Vehicles (%) 1% 2% 1% 1% Parking (#/hr) 0 1033 213 603 Lane Group Flow (vph) 1412 0 0 1033 213 603 Turn Type NA D.P+P NA Prot Perm Protected Phases 2 1 6 4 3 2 3 603 Turn Type NA D.P+P NA Port Perm Protected Phases 2 1 6 4 4 2 2 4 2 2 1 6 4 4 2 2 1 6 4 4 2 2 1 6 4 4 2 2 1 6 4 4 2 2 1 6 4 4 2 2 1 6 4 2 2 1 <td></td> <td>3080</td> <td>0</td> <td>0</td> <td></td> <td></td> <td>1380</td> <td></td>		3080	0	0			1380	
Confl. Peds. (#/hr) 7 7 49 18 Peak Hour Factor 0.94 0.94 0.93 0.93 0.94 0.94 Heavy Vehicles (%) 1% 1% 2% 1% 1% 1% Parking (#hr) 0 0 1033 213 603 1urn Type NA D.P+P NA Prot Perm Protected Phases 2 1 6 4 3 Permitted Phases 2 1 6 4 4 Switch Phase 2 1 6 4 4 Switch Phase 2 1 6 4 4 Switch Phase 2 1 6 4 4 Minimum Initial (s) 8.0 4.0 8.0 9.0 9.0 4.0 Minimum Initial (s) 8.0 9.0 25.0 25.0 25.0 21.0 Total Split (s) 1.0 1.0 1.0 1.0 1.0 1.0			U	0	1100	1177		
Peak Hour Factor 0.94 0.94 0.93 0.93 0.94 0.94 Heavy Vehicles (%) 1% 1% 2% 1% 1% 1% Parking (#/hr) 0 0 1033 213 603 1un Type NA D.P+P NA Prot Perm Protected Phases 2 1 6 4 3 Permited Phases 2 4 Detector Phase 2 1 6 4 4 Switch Phase 4 Minimum Initial (s) 8.0 4.0 8.0 9.0 9.0 4.0 Minimum Split (s) 13.0 9.0 13.0 14.0 14.0 21.0 Total Split (%) 36.0% 22.5% 58.6% 22.5% 19% 19% Yellow Time (s) 1.0 1.0 1.0 1.0 1.0 1.0 1.0 Lost Time Adjust (s) 0.0 0.0 0.0 0.0 0.0 1.0 1.0 1.0 1.0 </td <td>· ,</td> <td>Ŭ</td> <td>7</td> <td>7</td> <td></td> <td>49</td> <td></td> <td></td>	· ,	Ŭ	7	7		49		
Heavy Vehicles (%) 1% 1% 2% 2% 1% 1% Parking (#/hr) 0 0 1033 213 603 Shared Lane Traffic (%) 1412 0 0 1033 213 603 Lane Group Flow (vph) 1412 0 0 1033 213 603 Turn Type NA D.P+P NA Prot Perm Protected Phases 2 1 6 4 3 Detector Phase 2 1 6 4 4 Switch Phase 2 1 6 4 4 Minimum Initial (s) 8.0 4.0 8.0 9.0 9.0 4.0 Minimum Split (s) 13.0 9.0 13.0 14.0 14.0 21.0 Total Split (%) 36.0% 22.5% 58.6% 22.5% 22.5% 19% Yellow Time (s) 1.0 1.0 1.0 1.0 1.0 1.0 1.0 Lead/Lag Ditimize? Yes Yes Yes Yes Yes Yes <td></td> <td>0 94</td> <td></td> <td></td> <td>0.93</td> <td></td> <td></td> <td></td>		0 94			0.93			
Parking (#/hr) 0 Shared Lane Traffic (%) 1412 0 0 1033 213 603 Lane Group Flow (vph) 1412 0 0 1033 213 603 Turn Type NA D.P+P NA Prot Permitted Phases 2 4 Detector Phase 2 1 6 4 4 Switch Phase 2 1 6 4 4 Switch Phase 2 1 6 4 4 Minimun Initial (s) 8.0 4.0 8.0 9.0 9.0 4.0 Minimun Initial (s) 8.0 4.0 8.0 9.0 9.0 4.0 Vellow Time (s) 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 1.0 1.0 1.0 1.0 0.0 0.0 0.0 1.0 1.0 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>								
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Lane Group Flow (vph) 1412 0 0 1033 213 603 Turn Type NA D.P+P NA Prot Perm Protected Phases 2 1 6 4 3 Permitted Phases 2 1 6 4 4 Switch Phase 2 1 6 4 4 Switch Phase 2 1 6 4 4 Switch Phase 1 6 4 4 Switch Phase					Ū			
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Detector Phase 2 1 6 4 4 Switch Phase Minimum Initial (s) 8.0 4.0 8.0 9.0 9.0 4.0 Minimum Initial (s) 8.0 4.0 8.0 9.0 13.0 14.0 21.0 Total Split (s) 40.0 25.0 65.0 25.0 25.0 21.0 Total Split (%) 36.0% 22.5% 58.6% 22.5% 19% Yellow Time (s) 4.0 4.0 4.0 4.0 2.0 2.1.0 All-Red Time (s) 1.0 1.0 1.0 1.0 1.0 0.0 2.0 Vellow Time (s) 5.0<		Z			0	т	4	5
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Total Split (s)40.025.065.025.025.021.0Total Split (%) 36.0% 22.5% 58.6% 22.5% 22.5% 22.5% 19% Yellow Time (s) 4.0 4.0 4.0 4.0 4.0 22.5% 22.5% 22.5% 19% Yellow Time (s) 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.0 0.0 Lost Time (s) 5.0 5.0 5.0 5.0 5.0 5.0 5.0 Lead/LagLeadLagLagLagLeadLead-Lag Optimize?YesYesYesYesYesRecall ModeMinNoneMinNoneNoneNoneAct Effct Green (s) 59.6 59.6 16.7 16.7 $Actaated g/C Ratio0.640.640.640.180.18v/c Ratio0.721.69dl0.740.84Control Delay17.183.955.616.5Queue Delay0.00.00.00.00.00.00.0Total Delay17.183.926.7Approach Delay17.183.926.7Approach Delay17.183.926.725.616.520.2525.6Queue Length Soth (ft)210-3271091220.2520.2520.25Queue Length Soth (ft)51621.25352752352.752$								
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Lead-Lag Optimize? Yes Yes Yes Yes Yes Yes Recall Mode Min None Min None None None None Act Effct Green (s) 59.6 59.6 16.7 16.7 Actuated g/C Ratio 0.64 0.64 0.18 0.18 v/c Ratio 0.72 1.69dl 0.74 0.84 Control Delay 17.1 83.9 55.6 16.5 Queue Delay 0.0 0.0 0.0 0.0 Total Delay 17.1 83.9 25.6 16.5 LOS B F E B Approach Delay 17.1 83.9 26.7 Approach LOS B F C Queue Length 50th (ft) 210 ~327 109 12 Queue Length 95th (ft) 537 #629 #253 #216 Internal Link Dist (ft) 764 218 85 Turn Bay Length (ft) Base Capacity (vph)	.,			lao	0.0			Lead
Recall Mode Min None Min None								
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Actuated g/C Ratio 0.64 0.64 0.18 0.18 v/c Ratio 0.72 1.69dl 0.74 0.84 Control Delay 17.1 83.9 55.6 16.5 Queue Delay 0.0 0.0 0.0 0.0 Total Delay 17.1 83.9 55.6 16.5 LOS B F E B Approach Delay 17.1 83.9 26.7 Approach LOS B F C Queue Length 50th (ft) 210 ~327 109 12 Queue Length 95th (ft) 537 #629 #253 #216 Internal Link Dist (ft) 764 218 85 Turn Bay Length (ft) 85 752 Starvation Cap Reductn 0 0 0 Spillback Cap Reductn 0 0 0 0 0 0 Storage Cap Reductn 0 0 0 0 0 0 0 Reduced v/c Ratio 0.72 1.07 0.61 0.80 Intersection Summary				NONC				NONC
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Approach Delay 17.1 83.9 26.7 Approach LOS B F C Queue Length 50th (ft) 210 -327 109 12 Queue Length 95th (ft) 537 #629 #253 #216 Internal Link Dist (ft) 764 218 85 Turn Bay Length (ft) Base Capacity (vph) 1962 965 352 752 Starvation Cap Reductn 0 0 0 0 0 Spillback Cap Reductn 0 0 0 0 0 Reduced v/c Ratio 0.72 1.07 0.61 0.80								
Approach LOS B F C Queue Length 50th (ft) 210 ~327 109 12 Queue Length 95th (ft) 537 #629 #253 #216 Internal Link Dist (ft) 764 218 85 Turn Bay Length (ft) 85 752 Base Capacity (vph) 1962 965 352 752 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 0.72 1.07 0.61 0.80							D	
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Starvation Cap Reductn 0 0 0 0 Spillback Cap Reductn 0		10/0			0/5	252	750	
Spillback Cap Reductn000Storage Cap Reductn000Reduced v/c Ratio0.721.070.610.80Intersection Summary								
Storage Cap Reductn000Reduced v/c Ratio0.721.070.610.80Intersection Summary								
Reduced v/c Ratio0.721.070.610.80Intersection Summary								
Intersection Summary								
	Reduced V/C Ratio	0.72			1.07	0.61	0.80	
Cycle Length: 111								
	Cycle Length: 111							

Summer Saturday Peak-Hour Baseline

Intersection Capacity Analysis 1. Summer St @ North St

Actuated Cycle Length: 93.6	
Natural Cycle: 130	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 1.11	
Intersection Signal Delay: 40.6	Intersection LOS: D
Intersection Capacity Utilization 95.7%	ICU Level of Service F
Analysis Period (min) 15	
~ Volume exceeds capacity, queue is theoretically infinite.	
Queue shown is maximum after two cycles.	
# 95th percentile volume exceeds capacity, queue may be	e longer.
Queue shown is maximum after two cycles.	
dl Defacto Left Lane. Recode with 1 though lane as a left I	lane.

Splits and Phases: 1: North St & Otis St/Summer St



tersection Delay, s/veh 42.2 E pproach EB WB NB NW ntry Lanes 2 2 1 1 onflicting Circle Lanes 2 <									
Itersection LOS E pproach EB WB NB NW ntry Lanes 2 2 1 1 onflicting Circle Lanes 2	Intersection	40.0							
proach EB WB NB NW ntry Lanes 2 2 1 1 onflicting Circle Lanes 2									
Intry Lanes 2 2 1 1 onflicting Circle Lanes 2	Intersection LOS	Ł							
onflicting Circle Lanes 2 <th2< th=""> 2 2 2</th2<>	Approach		EB		WB		NB	NV	V
dj Approach Flow, veh/h19988558460emand Flow Rate, veh/h20188638465ehicles Circulating, veh/h5646520201485ehicles Circulating, veh/h1272148554543ollow-Up Headway, s3.1863.1863.1863.186ed Vol Crossing Leg, #/h0000ed Vol Crossing Leg, #/h0000proach Delay, s/veh35.112.313.6129.2pproach LOSEBBFaneLeftRightLeftRightLeftesignated MovesLTTTLRLRssumed MovesLTTRLTTRLRane Util0.4700.5300.4700.5301.0001.000ritical Headway, s4.2934.1134.1134.1134.113ntry Flow, veh/h94810704064578465ap Entry Lane, veh/h10831087797816275400ntry HV Adj Factor0.9910.9900.9911.0000.989low Entry, veh/h93910594024538460ap Entry, veh/h10731075789809275395/C Ratio0.8750.9850.5090.5600.0291.164ontrol Delay, s/veh25.643.511.712.813.6129.2OSD <td>Entry Lanes</td> <td></td> <td>2</td> <td></td> <td>2</td> <td></td> <td>1</td> <td></td> <td>1</td>	Entry Lanes		2		2		1		1
emand Flow Rate, veh/h20188638465ehicles Circulating, veh/h5646520201485ehicles Exiting, veh/h1272148554543ollow-Up Headway, s3.1863.1863.1863.186ollow-Up Headway, s3.1863.1863.1863.186ed Cap Adj1.000000proach Delay, s/veh35.112.313.6129.2pproach LOSEBBFaneLeftRightLeftRightLeftesignated MovesLTTRLRLRssumed MovesLTTRLRLRT Channelized	Conflicting Circle Lanes		2		2		2	-	2
ehicles Circulating, veh/h 56 465 2020 1485 ehicles Exiting, veh/h 1272 1485 54 543 ollow-Up Headway, s 3.186 3.186 3.186 3.186 3.186 ed Vol Crossing Leg, #/h 0 0 0 0 0 0 ed Cap Adj 1.000 1.000 1.000 1.000 1.000 1.000 pproach Delay, s/veh 35.1 12.3 13.6 129.2 pproach LOS E B B F ane Left Right Left Right Left Left esignated Moves LT TR LT TR LR LR ssumed Moves LT TR LT TR LR LR ritical Headway, s 4.293 4.113 4.293 4.113 4.113 4.113 ap Entry Lane, veh/h 948 1070 406 457 8 465 ap Entry Lane, veh/h 10	Adj Approach Flow, veh/h		1998		855		8	460)
ehicles Exiting, ver/h1272148554543ollow-Up Headway, s3.1863.1863.1863.1863.186ed Vol Crossing Leg, #/h00000ed Cap Adj1.0001.0001.0001.0001.000pproach Delay, s/veh35.112.313.6129.2pproach LOSEBBFaneLeftRightLeftRightLeftesignated MovesLTTRLTTRLRssumed MovesLTTRLTTRLRane Util0.4700.5300.4700.5301.0001.000ritical Headway, s4.2934.1134.1134.1134.113ntry Flow, veh/h94810704064578465ap Entry Lane, veh/h1083797816275400ntry Flow, veh/h93910594024538460ap Entry, veh/h10731075789809275395(C Ratio0.8750.9850.5090.5600.0291.164ontrol Delay, s/veh25.643.511.712.813.6129.2OSDEBBBF	Demand Flow Rate, veh/h		2018		863		8	46	5
ollow-Up Headway, s 3.186 3.100 1.000 0.989 1.00 <td>Vehicles Circulating, veh/h</td> <td></td> <td>56</td> <td></td> <td>465</td> <td></td> <td>2020</td> <td>148</td> <td>ō</td>	Vehicles Circulating, veh/h		56		465		2020	148	ō
ed Vol Crossing Leg, #/h00000ed Cap Adj1.0001.0001.0001.000pproach Delay, s/veh 35.1 12.313.6129.2pproach LOSEBBFaneLeftRightLeftRightLeftesignated MovesLTTRLTTRLRSsumed MovesLTTRLTTRLRT Channelizedane Util0.4700.5300.4700.5301.000ane Util0.4700.5300.4700.5301.0001.000ritical Headway, s4.2934.1134.1134.1134.113ntry Flow, veh/h94810704064578465ap Entry Lane, veh/h10831087797816275400ntry HV Adj Factor0.9910.9900.9911.0000.989low Entry, veh/h93910594024538460ap Entry, veh/h10731075789809275395/C Ratio0.8750.9850.5090.5600.0291.164ontrol Delay, s/veh25.643.511.712.813.6129.2OSDEBBBF	Vehicles Exiting, veh/h		1272		1485		54	543	3
ed Cap Adj 1.000 1.000 1.000 1.000 pproach Delay, s/veh 35.1 12.3 13.6 129.2 pproach LOS E B B F ane Left Right Left Right Left Left esignated Moves LT TR LT TR LR LR ssumed Moves LT TR LT TR LR LR T Channelized	Follow-Up Headway, s		3.186		3.186	3	8.186	3.180	5
pproach Delay, s/veh 35.1 12.3 13.6 129.2 pproach LOS E B B B F ane Left Right Left Right Left	Ped Vol Crossing Leg, #/h		0		0		0	()
pproach LOS E B B F ane Left Right Left Right Left Left </td <td>Ped Cap Adj</td> <td></td> <td>1.000</td> <td></td> <td>1.000</td> <td>1</td> <td>.000</td> <td>1.000</td> <td>)</td>	Ped Cap Adj		1.000		1.000	1	.000	1.000)
Ane Left Right Left Right Left Left Left esignated Moves LT TR LT TR LR LR ssumed Moves LT TR LT TR LR LR T Channelized 0.470 0.530 0.470 0.530 1.000 1.000 ritical Headway, s 4.293 4.113 4.293 4.113 4.113 4.113 ntry Flow, veh/h 948 1070 406 457 8 465 ap Entry Lane, veh/h 1083 1087 797 816 275 400 low Entry, veh/h 939 1059 402 453 8 460 ap Entry, veh/h 939 1059 402 453 8 460 ap Entry, veh/h 1073 1075 789 809 275 395 /C Ratio 0.875 0.985 0.509 0.560 0.029 1.164	Approach Delay, s/veh		35.1		12.3		13.6	129.2	2
esignated Moves LT TR LT TR LR LR ssumed Moves LT TR LT TR LR LR T Channelized	Approach LOS		E		В		В	ŀ	=
Ssumed Moves LT TR LT TR LR LR T Channelized	Lane	Left	Right	Left	Right	Left		Left	
T Channelized ane Util 0.470 0.530 0.470 0.530 1.000 1.000 ritical Headway, s 4.293 4.113 4.113 4.113 4.113 ntry Flow, veh/h 948 1070 406 457 8 465 ap Entry Lane, veh/h 1083 1087 797 816 275 400 ntry HV Adj Factor 0.991 0.990 0.991 1.000 0.989 low Entry, veh/h 939 1059 402 453 8 460 ap Entry, veh/h 1073 1075 789 809 275 395 /C Ratio 0.875 0.985 0.509 0.560 0.029 1.164 ontrol Delay, s/veh 25.6 43.5 11.7 12.8 13.6 129.2 OS D E B B B F	Designated Moves	LT	TR	LT	TR	LR		LR	
ane Util0.4700.5300.4700.5301.0001.000ritical Headway, s4.2934.1134.2934.1134.1134.113ntry Flow, veh/h94810704064578465ap Entry Lane, veh/h10831087797816275400ntry HV Adj Factor0.9910.9900.9900.9911.0000.989low Entry, veh/h93910594024538460ap Entry, veh/h10731075789809275395/C Ratio0.8750.9850.5090.5600.0291.164ontrol Delay, s/veh25.643.511.712.813.6129.2OSDEBBBF	Assumed Moves	LT	TR	LT	TR	LR		LR	
ritical Headway, s4.2934.1134.2934.1134.1134.113ntry Flow, veh/h94810704064578465ap Entry Lane, veh/h10831087797816275400ntry HV Adj Factor0.9910.9900.9900.9911.0000.989low Entry, veh/h93910594024538460ap Entry, veh/h10731075789809275395/C Ratio0.8750.9850.5090.5600.0291.164ontrol Delay, s/veh25.643.511.712.813.6129.2OSDEBBBF	RT Channelized								
ntry Flow, veh/h 948 1070 406 457 8 465 ap Entry Lane, veh/h 1083 1087 797 816 275 400 ntry HV Adj Factor 0.991 0.990 0.990 0.991 1.000 0.989 low Entry, veh/h 939 1059 402 453 8 460 ap Entry, veh/h 1073 1075 789 809 275 395 /C Ratio 0.875 0.985 0.509 0.560 0.029 1.164 ontrol Delay, s/veh 25.6 43.5 11.7 12.8 13.6 129.2 OS D E B B B F	Lane Util	0.470	0.530	0.470	0.530	1.000		1.000	
ap Entry Lane, veh/h 1083 1087 797 816 275 400 ntry HV Adj Factor 0.991 0.990 0.991 1.000 0.989 low Entry, veh/h 939 1059 402 453 8 460 ap Entry, veh/h 1073 1075 789 809 275 395 /C Ratio 0.875 0.985 0.509 0.560 0.029 1.164 ontrol Delay, s/veh 25.6 43.5 11.7 12.8 13.6 129.2 OS D E B B B F	Critical Headway, s	4.293	4.113	4.293	4.113	4.113		4.113	
Intry HV Adj Factor 0.991 0.990 0.991 1.000 0.989 Iow Entry, veh/h 939 1059 402 453 8 460 ap Entry, veh/h 1073 1075 789 809 275 395 /C Ratio 0.875 0.985 0.509 0.560 0.029 1.164 ontrol Delay, s/veh 25.6 43.5 11.7 12.8 13.6 129.2 OS D E B B B F	Entry Flow, veh/h	948	1070	406	457	8		465	
Iow Entry, veh/h 939 1059 402 453 8 460 ap Entry, veh/h 1073 1075 789 809 275 395 /C Ratio 0.875 0.985 0.509 0.560 0.029 1.164 ontrol Delay, s/veh 25.6 43.5 11.7 12.8 13.6 129.2 OS D E B B B F	Cap Entry Lane, veh/h	1083	1087	797	816	275		400	
ap Entry, veh/h 1073 1075 789 809 275 395 /C Ratio 0.875 0.985 0.509 0.560 0.029 1.164 ontrol Delay, s/veh 25.6 43.5 11.7 12.8 13.6 129.2 OS D E B B B F	Entry HV Adj Factor	0.991	0.990	0.990	0.991	1.000		0.989	
/C Ratio 0.875 0.985 0.509 0.560 0.029 1.164 ontrol Delay, s/veh 25.6 43.5 11.7 12.8 13.6 129.2 OS D E B B B F	Flow Entry, veh/h	939	1059	402	453	8		460	
/C Ratio 0.875 0.985 0.509 0.560 0.029 1.164 ontrol Delay, s/veh 25.6 43.5 11.7 12.8 13.6 129.2 OS D E B B B F	Cap Entry, veh/h	1073	1075	789	809	275		395	
OS DE BB BF	V/C Ratio	0.875	0.985	0.509	0.560	0.029		1.164	
	Control Delay, s/veh	25.6	43.5	11.7	12.8	13.6		129.2	
	LOS			В	В	В		-	
51n %tile Queue, ven 12 19 3 4 0 18	95th %tile Queue, veh	12	19	3	4	0		18	

Intersection Capacity Analysis 3. Summer St @ Rockland St

	٦	-	\mathbf{F}	4	+	•	•	Ť	1	1	ŧ	~
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	ሻ	≜1 }-		ሻ	↑ Ъ			र्भ	1		र्	1
Volume (vph)	55	1344	25	112	693	7	17	28	104	7	25	22
Satd. Flow (prot)	1728	3443	0	1728	3448	0	0	1864	1615	0	2088	1794
Flt Permitted	0.328			0.093				0.888			0.940	
Satd. Flow (perm)	596	3443	0	169	3448	0	0	1687	1593	0	1984	1794
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)			2	2					1	1		
Peak Hour Factor	0.95	0.95	0.95	0.89	0.89	0.89	0.85	0.85	0.85	0.90	0.90	0.90
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	0%	0%	0%	2%	2%	2%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	58	1441	0	126	787	0	0	53	122	0	36	24
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	Perm
Protected Phases	5	2		1	6			3			3	
Permitted Phases	2			6			3		3	3		3
Detector Phase	5	2		1	6		3	3	3	3	3	3
Switch Phase												
Minimum Initial (s)	4.0	15.0		4.0	15.0		8.0	8.0	8.0	8.0	8.0	8.0
Minimum Split (s)	8.0	20.0		8.0	20.0		13.0	13.0	13.0	13.0	13.0	13.0
Total Split (s)	14.0	55.0		14.0	55.0		25.0	25.0	25.0	25.0	25.0	25.0
Total Split (%)	12.0%	47.0%		12.0%	47.0%		21.4%	21.4%	21.4%	21.4%	21.4%	21.4%
Yellow Time (s)	3.0	4.0		3.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Lost Time (s)	4.0	5.0		4.0	5.0			5.0	5.0		5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Recall Mode	None	Min		Min	Min		None	None	None	None	None	None
Act Effct Green (s)	55.6	48.8		58.8	52.2			13.1	13.1		13.1	13.1
Actuated g/C Ratio	0.64	0.56		0.68	0.60			0.15	0.15		0.15	0.15
v/c Ratio	0.13	0.74		0.53	0.38			0.21	0.51		0.12	0.09
Control Delay	7.5	20.0		18.1	12.4			37.6	44.4		36.1	36.0
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Delay	7.5	20.0		18.1	12.4			37.6	44.4		36.1	36.0
LOS	A	В		В	В			D	D		D	D
Approach Delay		19.5		_	13.2			42.3	_		36.1	_
Approach LOS		В			B			D			D	
Queue Length 50th (ft)	7	245		15	96			24	59		16	11
Queue Length 95th (ft)	39	#721		91	274			68	136		54	41
Internal Link Dist (ft)	07	378		,,	358			249	100		637	
Turn Bay Length (ft)	150	070		150	000			217	50		007	75
Base Capacity (vph)	546	2052		303	2092			402	379		473	427
Starvation Cap Reductn	0	0		0	0			402	0		0	127
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	0.11	0.70		0.42	0.38			0.13	0.32		0.08	0.06
Intersection Summary Cycle Length: 117												

Actuated Cycle Length: 86.7

Summer Saturday Peak-Hour Baseline

Lane Group	ø9
Lane [®] Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
Shared Lane Traffic (%	6)
Lane Group Flow (vph))
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	23.0
Total Split (s)	23.0
Total Split (%)	20%
Yellow Time (s)	2.0
All-Red Time (s)	0.0
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)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reduct	tn
Spillback Cap Reductr	
Storage Cap Reductn	
Reduced v/c Ratio	
Intersection Summary	
intersection summary	

Natural Cycle: 90					
Control Type: Actuated-Uncoordinated					
Maximum v/c Ratio: 0.74					
Intersection Signal Delay: 19.2	Intersection LOS: B				
Intersection Capacity Utilization 64.9%	ICU Level of Service C				
Analysis Period (min) 15					
# 95th percentile volume exceeds capacity, queue may be longer.					
Queue shown is maximum after two cycles.					

Splits and Phases: 4: Summer St & Rockland St & Martins Ln

√ ø1	_{ø2}	↓↑ _{ø3}	₩\$ ø9
14 s	55 s	25 s	23 s
▶ ø5	₩ ø6		
14 s	55 s		

Intersection Capacity Analysis 4. Rockland St @ G. W. Blvd

	*	۲	×	/	6	*
Lane Group	WBL	WBR	NET	NER	SWL	SWT
Lane Configurations	<u>אשר</u>	WDIX	≜ ↑		JVL	 €
Volume (vph)	26	129	T Þ 1223	202	23	H T 718
Satd. Flow (prot)	3062	0	3383	202	23	3448
Flt Permitted	0.992	0	3303	U	U	0.877
Satd. Flow (perm)	3062	0	3383	0	0	3030
Satd. Flow (RTOR)	3002	U	53	U	U	3030
Peak Hour Factor	0.88	0.88	0.92	0.92	0.88	0.88
Heavy Vehicles (%)	0.88	0.00	0.92	1%	0.88	0.00
Shared Lane Traffic (%)	170	170	170	170	170	170
Lane Group Flow (vph)	177	0	1549	0	0	842
	Prot	U	1549 NA	U	Perm	842 NA
Turn Type Protected Phases	P101 3		NA 2		Pelill	NA 6
Protected Phases Permitted Phases	3		2		L	0
)		1		6	1
Detector Phase	3		2		6	6
Switch Phase	7.0		7.0		7.0	7.0
Minimum Initial (s)	7.0		7.0		7.0	7.0
Minimum Split (s)	12.0		12.0		12.0	12.0
Total Split (s)	20.0		30.0		30.0	30.0
Total Split (%)	40.0%		60.0%		60.0%	60.0%
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			0.0
Total Lost Time (s)	5.0		5.0			5.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	Min		None		None	None
Act Effct Green (s)	9.4		24.4			24.4
Actuated g/C Ratio	0.21		0.56			0.56
v/c Ratio	0.26		0.81			0.50
Control Delay	13.2		12.9			7.5
Queue Delay	0.0		0.0			0.0
Total Delay	13.2		12.9			7.5
LOS	В		В			А
Approach Delay	13.2		12.9			7.5
Approach LOS	В		В			A
Queue Length 50th (ft)	15		133			56
Queue Length 95th (ft)	34		#260			98
Internal Link Dist (ft)	100		657			589
Turn Bay Length (ft)	100		007			507
Base Capacity (vph)	1072		1960			1735
Starvation Cap Reductn	0		1900			0
Spillback Cap Reductin	0		0			0
Storage Cap Reductin	0		0			0
Reduced v/c Ratio	0.17		0.79			0.49
	0.17		0.79			0.49
Intersection Summary						
Cycle Length: 50						
Actuated Cycle Length: 43.	.8					
Natural Cycle: 40						
,						

Summer Saturday Peak-Hour Baseline

Intersection Capacity Analysis 4. Rockland St @ G. W. Blvd

Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.81	
Intersection Signal Delay: 11.1	Intersection LOS: B
Intersection Capacity Utilization 54.4%	ICU Level of Service A
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be lo	nger.
Queue shown is maximum after two cycles.	

Splits and Phases: 13:

≠ø2	K _{ø3}	
30 s	20 s	
K 96		
30 s		

	-	\mathbf{F}	4	-	1	1
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	≜ †⊅		1	1	Y	
Volume (vph)	1170	100	25	675	60	25
Satd. Flow (prot)	3410	0	1728	3455	1977	23
Flt Permitted	5110	U	0.157	3433	0.966	U
Satd. Flow (perm)	3410	0	286	3455	1977	0
Satd. Flow (RTOR)	13	0	200	3433	20	0
Peak Hour Factor	1.00	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%
Shared Lane Traffic (%)	170	170	170	170	170	170
Lane Group Flow (vph)	1279	0	27	734	92	0
Turn Type	NA	0		NA	Prot	0
Protected Phases	2		pm+pt 1	6	3	
Protected Phases Permitted Phases	Z		•	U	3	
)		6	4	2	
Detector Phase	2		I	6	3	
Switch Phase	40.0		0.0	10.0	0.0	
Minimum Initial (s)	40.0		8.0	40.0	8.0	
Minimum Split (s)	46.0		12.0	46.0	13.0	
Total Split (s)	46.0		24.0	70.0	25.0	
Total Split (%)	48.4%		25.3%	73.7%	26.3%	
Yellow Time (s)	4.0		3.0	4.0	3.0	
All-Red Time (s)	2.0		1.0	2.0	2.0	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	6.0		4.0	6.0	5.0	
Lead/Lag	Lag		Lead			
Lead-Lag Optimize?	Yes		Yes			
Recall Mode	Min		None	None	None	
Act Effct Green (s)	45.0		49.9	49.2	9.2	
Actuated g/C Ratio	0.69		0.76	0.75	0.14	
v/c Ratio	0.55		0.07	0.28	0.31	
Control Delay	9.3		3.1	3.9	24.9	
Queue Delay	0.0		0.0	0.0	0.0	
Total Delay	9.3		3.1	3.9	24.9	
LOS	А		А	А	С	
Approach Delay	9.3			3.9	24.9	
Approach LOS	А			А	С	
Queue Length 50th (ft)	99		2	45	23	
Queue Length 95th (ft)	285		8	79	69	
Internal Link Dist (ft)	1154			331	60	
Turn Bay Length (ft)			200			
Base Capacity (vph)	2344		663	3269	624	
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	0.55		0.04	0.22	0.15	
Intersection Summary						
Cycle Length: 95						
Actuated Cycle Length: 65	.5					
Natural Cycle: 75						

Summer Saturday Noon Baseline

Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.55	
Intersection Signal Delay: 8.1	Intersection LOS: A
Intersection Capacity Utilization 51.4%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 3: Rockland Cir & G W Blvd

√ ø1	→ ø2	1 ø3
24 s	46 s	25 s
₩ ø6		
70 s		

Intersection Capacity Analysis 6. G. W. Blvd @ Wharf Ave

		-	•	-	-			T		*	Ŧ	-
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		\$			ا	1		4î b			र्स कि	
Volume (vph)	10	10	29	138	6	32	18	910	262	23	639	17
Satd. Flow (prot)	0	1709	0	0	1735	1546	0	3431	0	0	3549	0
Flt Permitted		0.912			0.688			0.940			0.889	
Satd. Flow (perm)	0	1567	0	0	1125	1476	0	3228	0	0	3161	0
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)	16		55	55		16	22		9	9		22
Peak Hour Factor	0.75	0.75	0.75	0.88	0.88	0.88	0.95	0.95	0.95	0.91	0.91	0.91
Heavy Vehicles (%)	6%	6%	6%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Parking (#/hr)										0		
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	65	0	0	164	36	0	1253	0	0	746	0
Turn Type	Perm	NA		Perm	NA	Perm	Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		
Detector Phase	4	4		8	8	8	2	2		6	6	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	33.0	33.0		33.0	33.0	
Minimum Split (s)	9.0	9.0		9.0	9.0	9.0	38.0	38.0		38.0	38.0	
Total Split (s)	15.0	15.0		15.0	15.0	15.0	38.0	38.0		38.0	38.0	
Total Split (%)	21.4%	21.4%		21.4%	21.4%	21.4%	54.3%	54.3%		54.3%	54.3%	
Yellow Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)		0.0			0.0	0.0		0.0			0.0	
Total Lost Time (s)		5.0			5.0	5.0		5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	
Act Effct Green (s)		10.2			10.2	10.2		36.3			36.3	
Actuated g/C Ratio		0.16			0.16	0.16		0.58			0.58	
v/c Ratio		0.26			0.90	0.15		0.67			0.41	
Control Delay		27.4			77.9	26.3		13.6			9.8	
Queue Delay		0.0			0.0	0.0		0.0			0.0	
Total Delay		27.4			77.9	26.3		13.6			9.8	
LOS		С			E	С		В			А	
Approach Delay		27.4			68.6			13.6			9.8	
Approach LOS		С			E			В			А	
Queue Length 50th (ft)		18			49	10		104			50	
Queue Length 95th (ft)		49			#180	38		318			156	
Internal Link Dist (ft)		20			82			386			422	
Turn Bay Length (ft)												
Base Capacity (vph)		253			182	239		1868			1829	
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		0.26			0.90	0.15		0.67			0.41	
Intersection Summary												
Cycle Length: 70												

Summer Saturday Noon Baseline

Lane Group	ø9	
Lane Configurations		
Volume (vph)		
Satd. Flow (prot)		
Flt Permitted		
Satd. Flow (perm)		
Satd. Flow (RTOR)		
Confl. Peds. (#/hr)		
Peak Hour Factor		
Heavy Vehicles (%)		
Parking (#/hr)		
Shared Lane Traffic (%)		
Lane Group Flow (vph)		
Turn Type		
Protected Phases	9	
Permitted Phases		
Detector Phase		
Switch Phase		
Minimum Initial (s)	4.0	
Minimum Split (s)	17.0	
Total Split (s)	17.0	
Total Split (%)	24%	
Yellow Time (s)	2.0	
All-Red Time (s)	1.0	
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)		
Turn Bay Length (ft)		
Base Capacity (vph)		
Starvation Cap Reductn		
Spillback Cap Reductn		
Storage Cap Reductn		
Reduced v/c Ratio		
Intersection Summary		

Intersection Capacity Analysis 6. G. W. Blvd @ Wharf Ave

Actuated Cycle Length: 62.8	
Natural Cycle: 70	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.90	
Intersection Signal Delay: 17.6	Intersection LOS: B
Intersection Capacity Utilization 69.8%	ICU Level of Service C
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be lo	nger.
Queue shown is maximum after two cycles.	
-	

Splits and Phases: 7: G W Blvd & Wharf Ave

↑ _{ø2}	⊥ _{ø4}	ÅÅ ø9	
38 s	15 s	17 s	
↓ ø6	∲ ø8		
38 s	15 s		

Intersection Capacity Analysis 7. Otis St (Rt 3A) @ Hingham Bathing Beach

11/21/2015

	•	۰.	1	1	1	ţ	
Lane Group	WBL	WBR	NBT	NBR	SBL	SBT	ø3
Lane Configurations	Y		† 1			41	
Volume (vph)	132	98	832	177	76	1212	
Satd. Flow (prot)	1665	0	3365	0	0	3445	
Flt Permitted	0.972	U	0000	0	U	0.743	
Satd. Flow (perm)	1660	0	3365	0	0	2567	
Satd. Flow (RTOR)	1000	0	33	0	0	2307	
Confl. Peds. (#/hr)	4		55				
Peak Hour Factor	0.91	0.91	0.89	0.89	0.95	0.95	
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	
Shared Lane Traffic (%)	170	170	170	170	170	170	
Lane Group Flow (vph)	253	0	1134	0	0	1356	
Turn Type	253 Prot	U	NA	U	Perm	NA	
Protected Phases					Pelill		3
Protected Phases Permitted Phases	4		2		1	6	ა
	A		2		6	,	
Detector Phase	4		2		6	6	
Switch Phase	1.0		10.0		40.0	40.0	1.0
Minimum Initial (s)	4.0		40.0		40.0	40.0	4.0
Minimum Split (s)	13.0		45.0		45.0	45.0	25.0
Total Split (s)	25.0		45.0		45.0	45.0	25.0
Total Split (%)	26.3%		47.4%		47.4%	47.4%	26%
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						Lead
Lead-Lag Optimize?	Yes						Yes
Recall Mode	None		Мах		Max	Max	None
Act Effct Green (s)	16.1		41.0			41.0	
Actuated g/C Ratio	0.23		0.58			0.58	
v/c Ratio	0.67		0.58			0.92	
Control Delay	36.6		13.2			27.8	
Queue Delay	0.0		0.0			0.0	
Total Delay	36.6		13.2			27.8	
LOS	D		В			С	
Approach Delay	36.6		13.2			27.8	
Approach LOS	D		B			C	
Queue Length 50th (ft)	91		122			213	
Queue Length 95th (ft)	#250		375			#675	
Internal Link Dist (ft)	1		775			511	
Turn Bay Length (ft)	1		115			511	
Base Capacity (vph)	480		1954			1480	
Starvation Cap Reductn	400		1954			0	
Spillback Cap Reductin	0		0			0	
	0		0			0	
Storage Cap Reductn Reduced v/c Ratio							
	0.53		0.58			0.92	
Intersection Summary							
Cycle Length: 95							
Actuated Cycle Length: 71	.1						

Summer Saturday Peak-Hour Baseline

Intersection Capacity Analysis 7. Otis St (Rt 3A) @ Hingham Bathing Beach

Natural Cycle: 125				
Control Type: Semi Act-Uncoord				
Maximum v/c Ratio: 0.92				
Intersection Signal Delay: 22.6	Intersection LOS: C			
Intersection Capacity Utilization 94.9%	ICU Level of Service F			
Analysis Period (min) 15				
# 95th percentile volume exceeds capacity, queue may be longer.				
Queue shown is maximum after two cycles.				

Splits and Phases: 17:

↑ ø2	<mark>∦k</mark> ø3	√ ø4
45 s	25 s	25 s
↓ ø6		
45 s		

APPENDIX E

Segment Crash Rate Worksheets

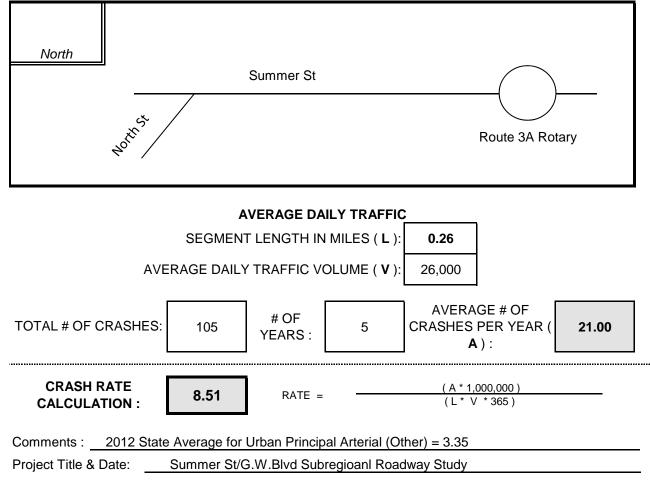


SEGMENT CRASH RATE WORKSHEET

CITY/TOWN : Hingham		COUNT DATE :	NA (2012)				
DISTRICT : 5							
~ SEGMENT DATA ~							
ROADWAY NAME:	Summer Street between North Street a	and Route 3A Rotary					
START POINT: West of North Street							
END POINT: East of Route 3A Rotary							

FUNCTIONAL CLASSIFICATION OF ROADWAY: Urban Principal Arterial - Other

ROADWAY DIAGRAM (LABEL ROADWAY AND CROSS STREETS)





SEGMENT CRASH RATE WORKSHEET

CITY/TOWN : Hingham-Hull

COUNT DATE : _____ NA (2012)

DISTRICT : 5

~ SEGMENT DATA ~

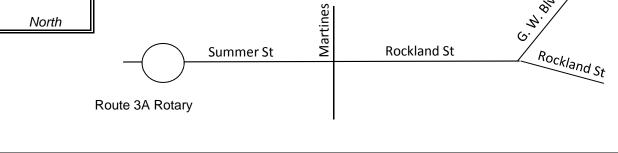
Summer Street/Rockland Street between Route 3A Rotary and G. W. Boulevard ROADWAY NAME:

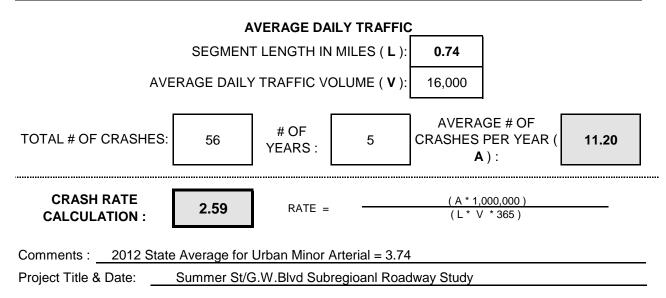
START POINT: East of Route 3A Rotary

END POINT: East of Rockland Street

FUNCTIONAL CLASSIFICATION OF ROADWAY: Urban Minor Arterial - Other

ROADWAY DIAGRAM (LABEL ROADWAY AND CROSS STREETS) G. N. Bhyd Ц







SEGMENT CRASH RATE WORKSHEET

CITY/TOWN : Hingham-Hull

COUNT DATE : NA (2012)

DISTRICT : 5

~ SEGMENT DATA ~

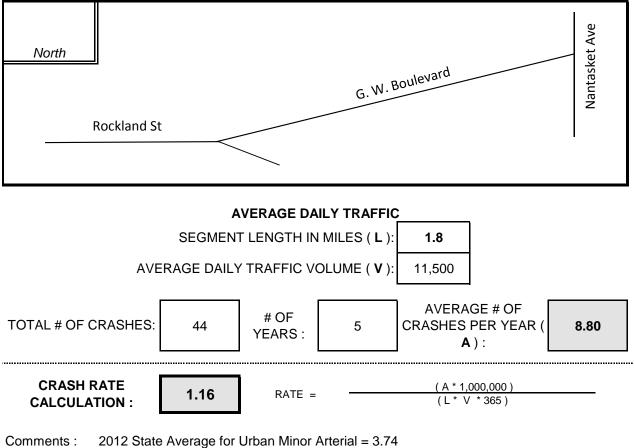
ROADWAY NAME: G. W. Boulevard from Rockland Street to Nantasket Avenue

START POINT: East of Rockland Street

END POINT: North of Nantasket Avenue

FUNCTIONAL CLASSIFICATION OF ROADWAY: Urban Minor Arterial - Other





Project Title & Date: _____ Summer St/G.W.Blvd Subregioanl Roadway Study

APPENDIX F

Intersection Crash Rate Worksheets



CITY/TOWN : Hingham				COUNT DA	TE:	6/14/2015				
DISTRICT : 5	UNSIGN	ALIZED :		SIGNA	LIZED :	X				
		~ IN	TERSECTION	I DATA ~						
MAJOR STREET :	Summer St									
MINOR STREET(S) :	North St									
INTERSECTION DIAGRAM (Label Approaches)	North Summer St									
			PEAK HOUF							
APPROACH :	1	2	3	4	5	Total Peak Hourly				
DIRECTION :						Approach Volume				
PEAK HOURLY VOLUMES (AM/PM) :						2,478				
"K "FACTOR :	0.090	INTERS	SECTION ADT APPROACH	. ,	AL DAILY	27,528				
TOTAL # OF CRASHES :	34	# OF YEARS :	5	CRASHES	GE # OF PER YEAR (.):	6.80				
CRASH RATE CALCU	LATION :	0.78	RATE =	<u>(A * 1,0</u> (V	000,000) * 365)					
Comments : <u>2010 Avera</u> Project Title & Date:			OT District 5 S		ersections = ().77				



CITY/TOWN : <u>Hingham</u>				COUNT DA	TE:	6/14/2015
DISTRICT : 5	UNSIGN	ALIZED :	X	SIGNA	LIZED :	
		~ 11	TERSECTION	I DATA ~		
MAJOR STREET :	Summer St					
MINOR STREET(S) :	Water St					
INTERSECTION DIAGRAM (Label Approaches)	North		Marken and Andrews	Summer St		
			PEAK HOUF			
APPROACH :	1	2	3	4	5	Total Peak Hourly
DIRECTION :						Approach Volume
PEAK HOURLY VOLUMES (AM/PM) :						2,581
"K "FACTOR :	0.090	INTERS	SECTION ADT APPROACH	· · ·	AL DAILY	28,672
TOTAL # OF CRASHES :	12	# OF YEARS :	5	CRASHES	GE # OF PER YEAR (.):	2.40
CRASH RATE CALCU	LATION :	0.26	RATE =	<u>(A*1,0</u> (V	000,000) * 365)	
Comments : 2010 Avera Project Title & Date:			OOT District 5 L bregioanl Road		Intersections	= 0.58



CITY/TOWN : <u>Hingham</u>				COUNT DA	TE:	6/14/2015
DISTRICT : 5	UNSIGN	ALIZED :		SIGNA	LIZED :	X
		~ IN	TERSECTION	I DATA ~		
MAJOR STREET :	Summer St					
MINOR STREET(S) :	North St					
INTERSECTION DIAGRAM (Label Approaches)	North		Summer St		Summer St	
			PEAK HOUF			
APPROACH :	1	2	3	4	5	Total Peak Hourly
DIRECTION :						Approach Volume
PEAK HOURLY VOLUMES (AM/PM) :						2,518
"K "FACTOR :	0.090	INTERS	ECTION ADT APPROACH	. ,	AL DAILY	27,972
TOTAL # OF CRASHES :	59	# OF YEARS :	5	CRASHES	GE # OF PER YEAR (.):	11.80
CRASH RATE CALCU	LATION :	1.33	RATE =	<u>(A*1,(</u> (V	000,000) * 365)	
Comments : <u>2010 Avera</u> Project Title & Date:			OT District 5 L		Intersections	= 0.58



CITY/TOWN : <u>Hingham</u>				COUNT DA	TE :	6/14/2015
DISTRICT : 5	UNSIGN	ALIZED :		SIGNA	LIZED :	X
		~ IN	TERSECTION	I DATA ~		
MAJOR STREET :	Summer St					
MINOR STREET(S) :	Rockland St/	Martins Ln				
INTERSECTION DIAGRAM (Label Approaches)	North		Summer St	Martins Ln	Rockland St	
			PEAK HOUF			
APPROACH :	1	2	3	4	5	Total Peak Hourly
DIRECTION :						Approach Volume
PEAK HOURLY VOLUMES (AM/PM) :						1,552
"K "FACTOR :	0.090	INTERS	ECTION ADT APPROACH	· /	AL DAILY	17,244
TOTAL # OF CRASHES :	18	# OF YEARS :	5	CRASHES	GE # OF PER YEAR(、):	3.60
CRASH RATE CALCU	LATION :	0.66	RATE =	<u>(A*1,</u> (V	000,000) * 365)	
Comments : 2010 Avera	age Crash Ra	te for MassD	OT District 5 S	Signalized Int	ersections = 0).77
Project Title & Date:	Summer St/C	G.W.Blvd Sub	oregioanl Road	lway Study		



CITY/TOWN : <u>Hingham</u>				COUNT DA	TE:	6/14/2015
DISTRICT : 5	UNSIGN	IALIZED :		SIGNA	LIZED :	X
		~ IN]	FERSECTION	I DATA ~		
MAJOR STREET :	Rockland St	/G. W. Blvd				
MINOR STREET(S) :	Rockland St					
INTERSECTION DIAGRAM (Label Approaches)	North	Rockland St	Roca	G. W. Blvd		
			PEAK HOUF			
APPROACH :	1	2	3	4	5	Total Peak Hourly Approach
DIRECTION :						Volume
PEAK HOURLY VOLUMES (AM/PM) :						1,408
"K "FACTOR :	0.090	INTERS	ECTION ADT APPROACH	. ,	AL DAILY	15,639
TOTAL # OF CRASHES :	15	# OF YEARS :	5	CRASHES	GE # OF PER YEAR () :	3.00
CRASH RATE CALCU	ILATION :	0.60	RATE =	<u>(A * 1,0</u> (V	000,000) * 365)	
Comments : 2010 Avera	age Crash Ra	te for MassD0	OT District 5 S	Signalized Int	ersections = 0).77
Project Title & Date:	Summer St/0	G.W.Blvd Sub	regioanl Road	lway Study		



CITY/TOWN : Hull				COUNT DA	ГЕ:	9/3/2015
DISTRICT : 5	UNSIGN	ALIZED :	X	SIGNA	LIZED :	
		~ IN1	TERSECTION	I DATA ~		
MAJOR STREET :	G. W. Blvd					
MINOR STREET(S) :	Logan Ave/B	arnstable Rd				
INTERSECTION DIAGRAM (Label Approaches)	North	G. W. Blvd	Logan Ave	G. W. Blvd		
APPROACH :	1	2	PEAK HOUF	4	5	Total Peak Hourly
DIRECTION :						Approach Volume
PEAK HOURLY VOLUMES (AM/PM) :						1,165
"K "FACTOR :	0.090	INTERSI	ECTION ADT APPROACH	. ,	L DAILY	12,944
TOTAL # OF CRASHES :	6	# OF YEARS :	5	CRASHES	GE # OF PER YEAR () :	1.20
CRASH RATE CALCU	LATION :	0.29	RATE =	<u>(A*1,0</u> (V)	000,000) * 365)	
Comments : <u>2010 Avera</u> Project Title & Date:		te for MassD0 G.W.Blvd Sub			ntersections	= 0.58



CITY/TOWN : Hull				COUNT DA	TE:	6/14/2015
DISTRICT : 5	UNSIGN	ALIZED :		SIGNA	LIZED :	X
		~ IN	TERSECTION	I DATA ~		
MAJOR STREET :	G. W. Blvd					
MINOR STREET(S) :	Rockland Cir	cle				
INTERSECTION DIAGRAM (Label Approaches)	North		G. W. Blvd	Rockland Cir		
			PEAK HOUF			
APPROACH :	1	2	3	4	5	Total Peak Hourly
DIRECTION :						Approach Volume
PEAK HOURLY VOLUMES (AM/PM) :						1,117
"K "FACTOR :	0.090	INTERS	ECTION ADT APPROACH	. ,	AL DAILY	12,406
TOTAL # OF CRASHES :	3	# OF YEARS :	5	CRASHES	GE # OF PER YEAR () :	0.60
CRASH RATE CALCU	LATION :	0.15	RATE =	<u>(A*1,0</u> (V	000,000) * 365)	
Comments : <u>2010 Avera</u> Project Title & Date:			OT District 5 S		ersections = ().77



CITY/TOWN : Hull					COUNT DA	TE:	6/14/2015
DISTRICT : 5	UNSIGN	ALIZED :			SIGNA	LIZED :	X
		~ INT	ERSEC		I DATA ~		
MAJOR STREET :	G. W. Blvd						
MINOR STREET(S) :	Wharf Ave						
INTERSECTION DIAGRAM	North		eamboa	at Wh			
(Label Approaches)		G. W. Blvd		/e	G. W. Blvd		
				Wharf Ave			
			PEAK	HOUF			
APPROACH :	1	2	3		4	5	Total Peak Hourly
DIRECTION :							Approach Volume
PEAK HOURLY VOLUMES (AM/PM) :							1,056
"K "FACTOR :	0.090	INTERSE			(V)= TOTA I VOLUME:	AL DAILY	11,728
TOTAL # OF CRASHES :	10	# OF YEARS :	5		CRASHES	GE # OF PER YEAR () :	2.00
CRASH RATE CALCU	ILATION :	0.54	R	ATE =	<u>(A*1,0</u> (V)	000,000) * 365)	
Comments : 2010 Avera	age Crash Ra	te for MassDC	OT Distr	ict 5 S	Signalized Inte	ersections = C).77
Project Title & Date:	Summer St/0	G.W.Blvd Sub	regioanl	Road	lway Study		



CITY/TOWN : Hull				COUNT DA	TE :	6/14/2015
DISTRICT : 5	UNSIGN	ALIZED :	X	SIGNA	LIZED :	
		~ IN	TERSECTION	I DATA ~		
MAJOR STREET :	G. W. Blvd					
MINOR STREET(S) :	Bay St/Nanta	isket Ave				
INTERSECTION DIAGRAM (Label Approaches)	G	. W. Blvd	Bay St	Nantask	et Ave	
			PEAK HOUF			
APPROACH :	1	2	3	4	5	Total Peak Hourly
DIRECTION :						Approach Volume
PEAK HOURLY VOLUMES (AM/PM) :						906
"K" FACTOR :	0.090	INTERS	SECTION ADT APPROACH	· ,	AL DAILY	10,061
TOTAL # OF CRASHES :	8	# OF YEARS :	5	CRASHES	GE # OF PER YEAR (.):	1.60
CRASH RATE CALCU	LATION :	0.50	RATE =	<u>(A*1,0</u> (V	000,000) * 365)	
Comments : 2010 Avera	age Crash Ra	te for MassD	OT District 5 L	Jnsignalized	Intersections	= 0.58
Project Title & Date:	Summer St/C	G.W.Blvd Sul	bregioanl Road	dway Study		

APPENDIX G

Crash Statistics Major Intersections in the Study Corridor MassDOT Crash Data 2008–12

Statistics Period	1	2008	2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
Total number of	crashes	7	15	10	11	3	46	9.2	100.0%
Severity	Property damage only	5	13	9	8	2	37	7.4	80.4%
	Non-fatal injury	2	2	0	3	1	8	1.6	17.4%
	Fatality	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	0	0	1	0	0	1	0.2	2.2%
Collision type	Single vehicle	0	2	3	3	1	9	1.8	19.6%
	Rear-end	5	9	4	5	0	23	4.6	50.0%
	Angle	2	2	0	1	0	5	1.0	10.9%
	Sideswipe, same direction	0	1	2	0	1	4	0.8	8.7%
	Sideswipe, opposite direction	0	1	0	1	0	2	0.4	4.3%
	Head-on	0	0	1	1	0	2	0.4	4.3%
	Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	0	0	0	0	1	1	0.2	2.2%
Involved pedest	rian(s)	0	2	0	1	0	3	0.6	6.5%
Involved cyclist	(s)	0	0	0	0	0	0	0.0	0.0%
Occurred during	y weekday peak periods*	1	7	5	3	2	18	3.6	39.1%
Wet or icy paver	ment conditions	0	3	2	2	1	8	1.6	17.4%
Dark conditions	(lit or unlit)	2	4	2	4	0	12	2.4	26.1%

TABLE G-1 Summer Street at North Street and at Water Street, Hingham

 TABLE G-2

 Summer Street at Chief Justice Cushing Highway (Route 3A Rotary), Hingham

Statistics Period	1	2008	2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
Total number of	crashes	14	8	17	6	4	49	9.8	100.0%
Severity	Property damage only	8	6	12	4	4	34	6.8	69.4%
	Non-fatal injury	6	2	5	2	0	15	3.0	30.6%
	Fatality	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	0	0	0	0	0	0	0.0	0.0%
Collision type	Single vehicle	3	0	1	2	0	6	1.2	12.2%
	Rear-end	2	1	4	1	2	10	2.0	20.4%
	Angle	3	4	5	1	1	14	2.8	28.6%
	Sideswipe, same direction	6	3	7	1	1	18	3.6	36.7%
	Sideswipe, opposite direction	0	0	0	0	0	0	0.0	0.0%
	Head-on	0	0	0	0	0	0	0.0	0.0%
	Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	0	0	0	1	0	1	0.2	2.0%
Involved pedest	rian(s)	0	0	0	1	0	1	0.2	2.0%
Involved cyclist((s)	1	1	1	0	0	3	0.6	6.1%
Occurred during	y weekday peak periods*	5	3	7	1	0	16	3.2	32.7%
Wet or icy paven	ment conditions	1	3	3	2	0	9	1.8	18.4%
Dark conditions	(lit or unlit)	4	0	0	1	3	8	1.6	16.3%

TABLE G-3 Summer Street at Martins Lane, Hingham

	2008	2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
crashes	5	4	2	3	4	18	3.6	100.0%
Property damage only	2	3	2	2	3	12	2.4	66.7%
Non-fatal injury	3	1	0	1	0	5	1.0	27.8%
Fatality	0	0	0	0	0	0	0.0	0.0%
Not reported/unknown	0	0	0	0	1	1	0.2	5.6%
Single vehicle	1	1	0	0	1	3	0.6	16.7%
Rear-end	2	3	1	2	3	11	2.2	61.1%
Angle	1	0	1	0	0	2	0.4	11.1%
Sideswipe, same direction	0	0	0	0	0	0	0.0	0.0%
Sideswipe, opposite direction	0	0	0	1	0	1	0.2	5.6%
Head-on	1	0	0	0	0	1	0.2	5.6%
Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
Not reported/unknown	0	0	0	0	0	0	0.0	0.0%
ian(s)	0	0	0	0	0	0	0.0	0.0%
s)	0	0	0	0	0	0	0.0	0.0%
weekday peak periods*	0	1	1	1	1	4	0.8	22.2%
nent conditions	0	1	0	1	0	2	0.4	11.1%
(lit or unlit)	2	0	0	1	1	4	0.8	22.2%
	crashes Property damage only Non-fatal injury Fatality Not reported/unknown Single vehicle Rear-end Angle Sideswipe, same direction Sideswipe, opposite direction Head-on Rear-to-rear Not reported/unknown ian(s) s) weekday peak periods* nent conditions	crashes5Property damage only2Non-fatal injury3Fatality0Not reported/unknown0Single vehicle1Rear-end2Angle1Sideswipe, same direction0Sideswipe, opposite direction0Head-on1Rear-to-rear0Not reported/unknown0ian(s)0o0weekday peak periods*0o0nent conditions0	crashes 5 4 Property damage only 2 3 Non-fatal injury 3 1 Fatality 0 0 Not reported/unknown 0 0 Single vehicle 1 1 Rear-end 2 3 Angle 1 0 Sideswipe, same direction 0 0 Sideswipe, opposite direction 0 0 Head-on 1 0 Rear-to-rear 0 0 Not reported/unknown 0 0 weekday peak periods* 0 1	crashes 5 4 2 Property damage only 2 3 2 Non-fatal injury 3 1 0 Fatality 0 0 0 Not reported/unknown 0 0 0 Single vehicle 1 1 0 Rear-end 2 3 1 Angle 1 0 1 Sideswipe, same direction 0 0 0 Sideswipe, opposite direction 0 0 0 Head-on 1 0 0 0 Rear-to-rear 0 0 0 0 Not reported/unknown 0 0 0 0 weekday peak periods* 0 1 1 1	crashes 5 4 2 3 Property damage only 2 3 2 2 Non-fatal injury 3 1 0 1 Fatality 0 0 0 0 Not reported/unknown 0 0 0 0 Single vehicle 1 1 0 0 Rear-end 2 3 1 2 Angle 1 0 1 0 Sideswipe, same direction 0 0 0 0 Sideswipe, opposite direction 0 0 0 0 Head-on 1 0 0 0 0 Not reported/unknown 0 0 0 0 0 Not reported/unknown 0 0 0 0 0 0 s) 0 0 0 0 0 0 0 weekday peak periods* 0 1 1 1	crashes 5 4 2 3 4 Property damage only 2 3 2 2 3 Non-fatal injury 3 1 0 1 0 Fatality 0 0 0 0 0 0 Not reported/unknown 0 0 0 0 1 0 Single vehicle 1 1 0 0 1 1 Rear-end 2 3 1 2 3 Angle 1 0 1 0 0 Sideswipe, same direction 0 0 0 0 0 Bear-to-rear 0 0 0 0 0 0 Not reported/unknown 0 0 0 0 0 0 s) 0 0 0 0 0 0 0 weekday peak periods* 0 1 1 1 1 0 <td>crashes 5 4 2 3 4 18 Property damage only 2 3 2 2 3 12 Non-fatal injury 3 1 0 1 0 5 Fatality 0 0 0 0 0 0 0 0 Not reported/unknown 0 0 0 0 1 1 1 0 <t< td=""><td>crashes 5 4 2 3 4 18 3.6 Property damage only 2 3 2 2 3 12 2.4 Non-fatal injury 3 1 0 1 0 5 1.0 Fatality 0</td></t<></td>	crashes 5 4 2 3 4 18 Property damage only 2 3 2 2 3 12 Non-fatal injury 3 1 0 1 0 5 Fatality 0 0 0 0 0 0 0 0 Not reported/unknown 0 0 0 0 1 1 1 0 <t< td=""><td>crashes 5 4 2 3 4 18 3.6 Property damage only 2 3 2 2 3 12 2.4 Non-fatal injury 3 1 0 1 0 5 1.0 Fatality 0</td></t<>	crashes 5 4 2 3 4 18 3.6 Property damage only 2 3 2 2 3 12 2.4 Non-fatal injury 3 1 0 1 0 5 1.0 Fatality 0

Statistics Period	d	2008	2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
Total number of crashes		4	2	2	5	2	15	3.0	100.0%
Severity	Property damage only	1	1	1	3	1	7	1.4	46.7%
	Non-fatal injury	1	1	1	2	1	6	1.2	40.0%
	Fatality	1	0	0	0	0	1	0.2	6.7%
	Not reported/unknown	1	0	0	0	0	1	0.2	6.7%
Collision type	Single vehicle	1	1	1	1	2	6	1.2	40.0%
	Rear-end	0	1	1	1	0	3	0.6	20.0%
	Angle	1	0	0	2	0	3	0.6	20.0%
	Sideswipe, same direction	1	0	0	1	0	2	0.4	13.3%
	Sideswipe, opposite direction	0	0	0	0	0	0	0.0	0.0%
	Head-on	1	0	0	0	0	1	0.2	6.7%
	Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	0	0	0	0	0	0	0.0	0.0%
Involved pedest	trian(s)	0	0	0	0	0	0	0.0	0.0%
Involved cyclist(s)		0	0	0	0	0	0	0.0	0.0%
Occurred during weekday peak periods*		1	1	0	0	1	3	0.6	20.0%
Wet or icy pave	ment conditions	0	0	0	1	1	2	0.4	13.3%
Dark conditions	s (lit or unlit)	2	1	1	2	1	7	1.4	46.7%

TABLE G-4 Rockland Street at George Washington Boulevard, Hingham

Dark conditions (lit or unlit) * Peak periods are defined as 07:00–10:00 and 15:30–18:30.

Statistics Period Total number of crashes		2008	2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
		1	1	0	1	0	3	0.6	100.0%
Severity	Property damage only		1	0	1	0	3	0.6	100.0%
	Non-fatal injury	0	0	0	0	0	0	0.0	0.0%
	Fatality	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	0	0	0	0	0	0	0.0	0.0%
Collision type	Single vehicle	0	0	0	0	0	0	0.0	0.0%
	Rear-end	0	1	0	0	0	1	0.2	33.3%
	Angle	0	0	0	1	0	1	0.2	33.3%
	Sideswipe, same direction	0	0	0	0	0	0	0.0	0.0%
	Sideswipe, opposite direction	0	0	0	0	0	0	0.0	0.0%
	Head-on	0	0	0	0	0	0	0.0	0.0%
	Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	1	0	0	0	0	1	0.2	33.3%
Involved pedest	rian(s)	0	0	0	0	0	0	0.0	0.0%
Involved cyclist(s)		0	0	0	0	0	0	0.0	0.0%
Occurred during weekday peak periods*		1	1	0	0	0	2	0.4	66.7%
Wet or icy paver	ment conditions	1	0	0	0	0	1	0.2	33.3%
Dark conditions	(lit or unlit)	1	0	0	0	0	1	0.2	33.3%

TABLE G-5 George Washington Boulevard at Rockland Circle, Hull

Statistics Period	ł	2008	2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
Total number of crashes		4	2	1	3	0	10	2.0	100.0%
Severity	Property damage only	3	1	0	2	0	6	1.2	60.0%
	Non-fatal injury	1	1	1	1	0	4	0.8	40.0%
	Fatality	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	0	0	0	0	0	0	0.0	0.0%
Collision type	Single vehicle	0	1	1	0	0	2	0.4	20.0%
	Rear-end	1	0	0	2	0	3	0.6	30.0%
	Angle	0	1	0	0	0	1	0.2	10.0%
	Sideswipe, same direction	0	0	0	1	0	1	0.2	10.0%
	Sideswipe, opposite direction	2	0	0	0	0	2	0.4	20.0%
	Head-on	0	0	0	0	0	0	0.0	0.0%
	Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	1	0	0	0	0	1	0.2	10.0%
Involved pedest	rian(s)	0	0	0	0	0	0	0.0	0.0%
Involved cyclist	(s)	0	0	0	0	0	0	0.0	0.0%
Occurred during	y weekday peak periods*	0	0	1	2	0	3	0.6	30.0%
Wet or icy paver	ment conditions	0	1	0	0	0	1	0.2	10.0%
Dark conditions		1	0	0	1	0	2	0.4	20.0%

TABLE G-6 George Washington Boulevard at Wharf Avenue, Hull

 TABLE G-7

 George Washington Boulevard at Nantasket Avenue and Bay Street, Hull

Statistics Period	Statistics Period		2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
Total number of crashes		6	2	4	3	0	15	3.0	100.0%
Severity	Property damage only	4	1	4	3	0	12	2.4	80.0%
	Non-fatal injury	2	0	0	0	0	2	0.4	13.3%
	Fatality	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	0	1	0	0	0	1	0.2	6.7%
Collision type	Single vehicle	3	0	0	1	0	4	0.8	26.7%
	Rear-end	2	0	2	2	0	6	1.2	40.0%
	Angle	0	2	1	0	0	3	0.6	20.0%
	Sideswipe, same direction	0	0	1	0	0	1	0.2	6.7%
	Sideswipe, opposite direction	0	0	0	0	0	0	0.0	0.0%
	Head-on	0	0	0	0	0	0	0.0	0.0%
	Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	1	0	0	0	0	1	0.2	6.7%
Involved pedest	rian(s)	0	0	0	0	0	0	0.0	0.0%
Involved cyclist((s)	1	0	0	0	0	1	0.2	6.7%
Occurred during	y weekday peak periods*	1	1	0	2	0	4	0.8	26.7%
Wet or icy paver	ment conditions	1	0	2	0	0	3	0.6	20.0%
Dark conditions	(lit or unlit)	2	0	1	0	0	3	0.6	20.0%

APPENDIX H

Collision Diagrams Major Intersections and Segments in the Corridor

FIGURE H-1 Collision Diagram: Summer Street at North Street and at Water Street Hingham Police Reports: March 2010–April 2015

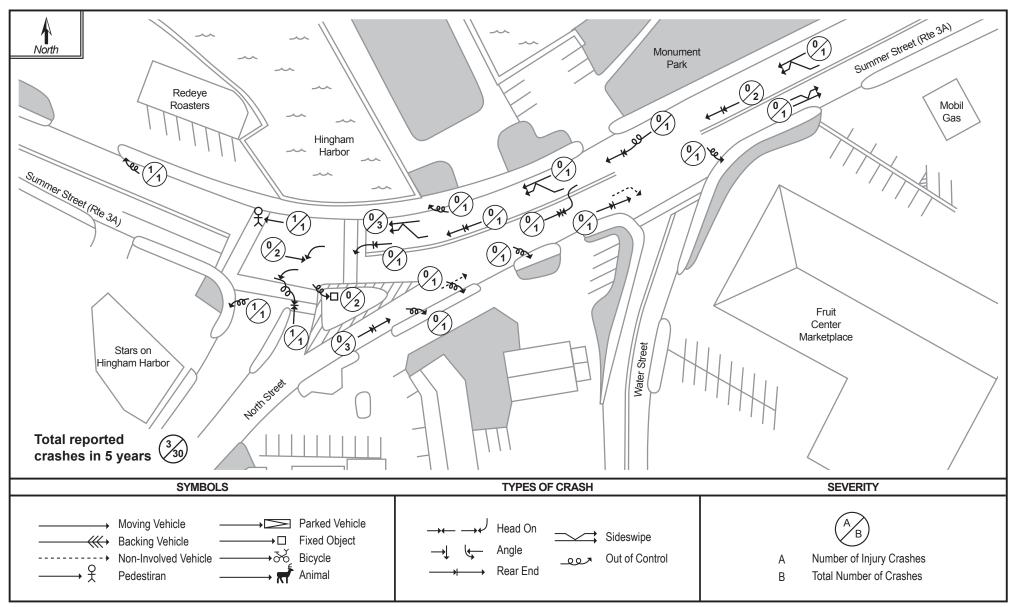


FIGURE H-2 Collision Diagram: Summer Street at Route 3A Rotary Hingham Police Reports: March 2010–April 2015

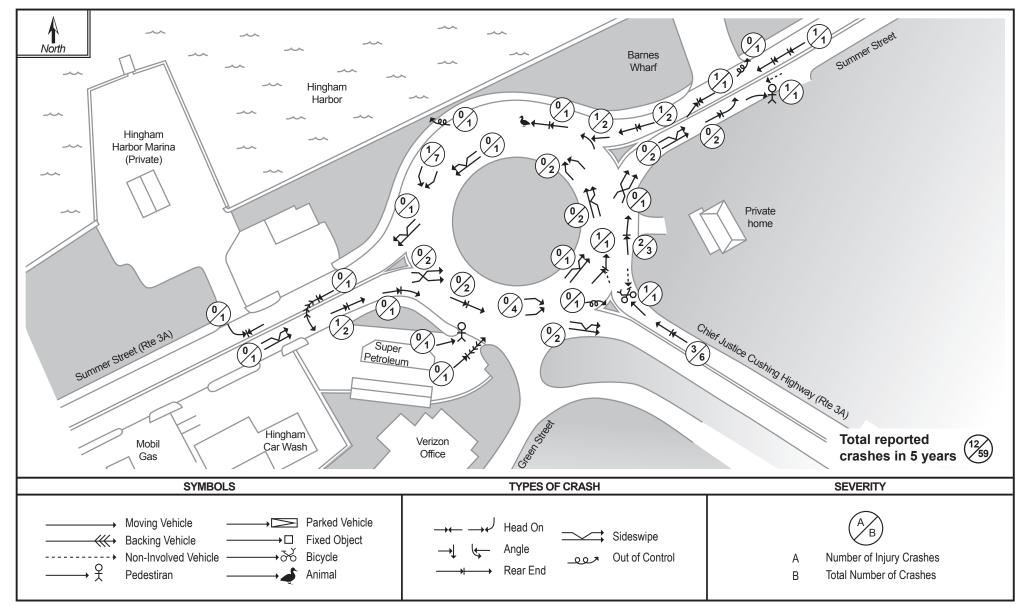


FIGURE H-3 Collision Diagram: Summer Street between Route 3A Rotary and Martins Lane Hingham Police Reports: March 2010–April 2015

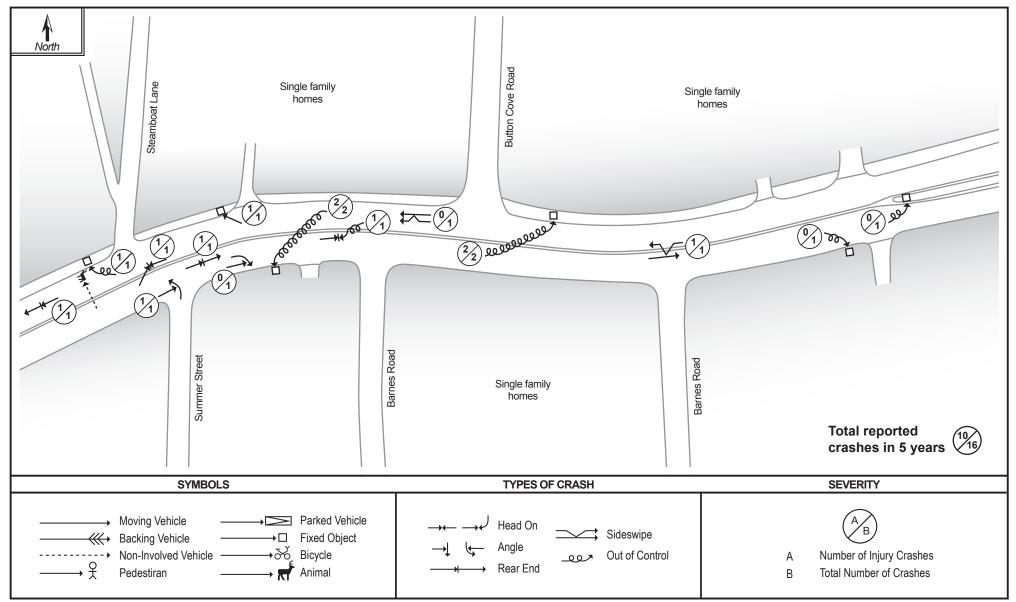


FIGURE H-4 Collision Diagram: Summer Street at Rockland Street/Martins Lane Hingham Police Reports: March 2010–April 2015

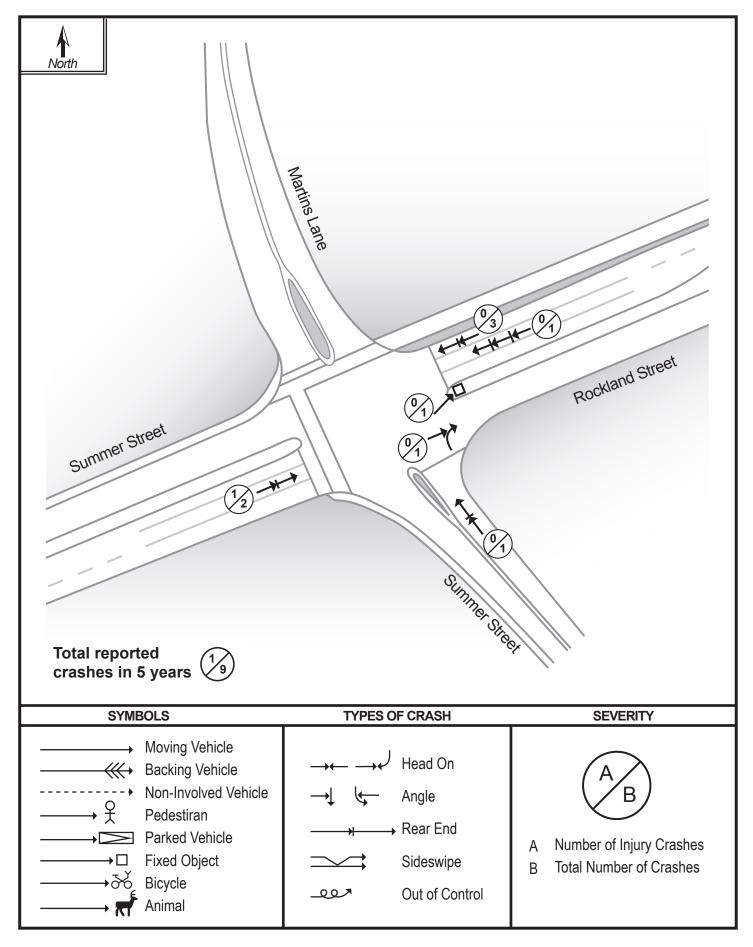


FIGURE H-5 Collision Diagram: Rockland Street at George Washington Boulevard Hingham Police Reports: March 2010–April 2015

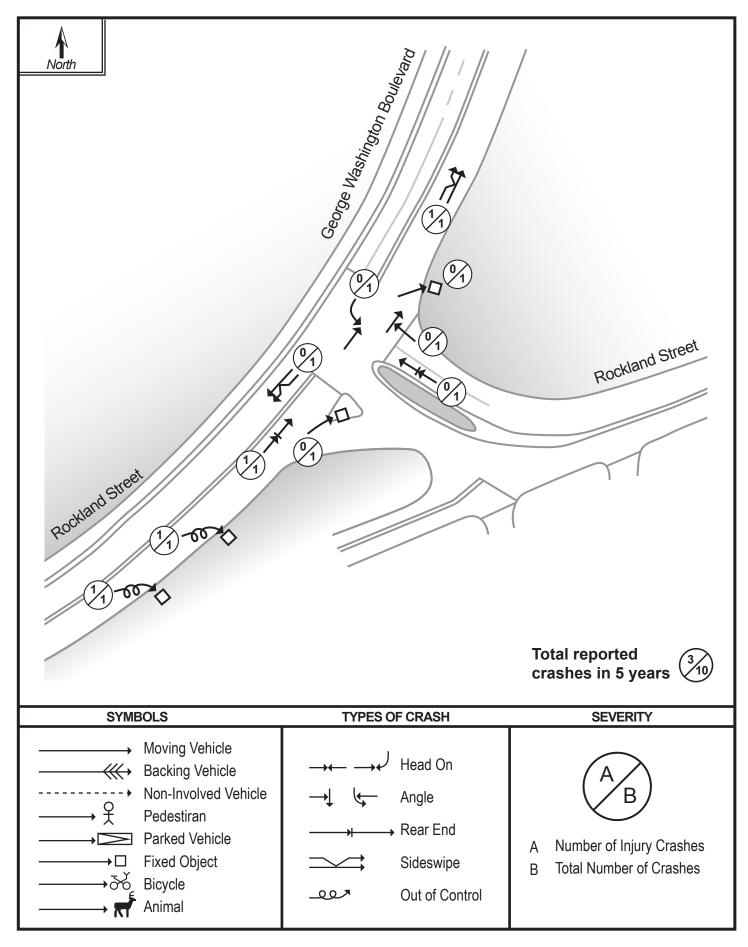


FIGURE H-6 Collision Diagram: George Washington Boulevard in the Vicinity of District Court Hingham Police Reports: March 2010–April 2015

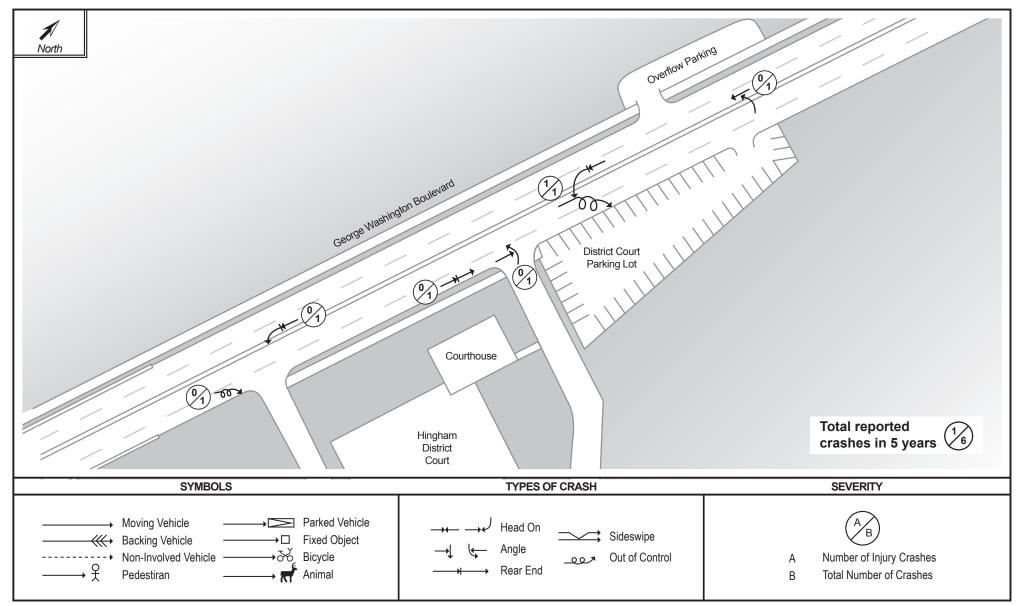


FIGURE H-7 Collision Diagram: George Washington Boulevard between Weir River and Rockland Circle Hull Police Reports: 2009–2011 and 2013–May 2015

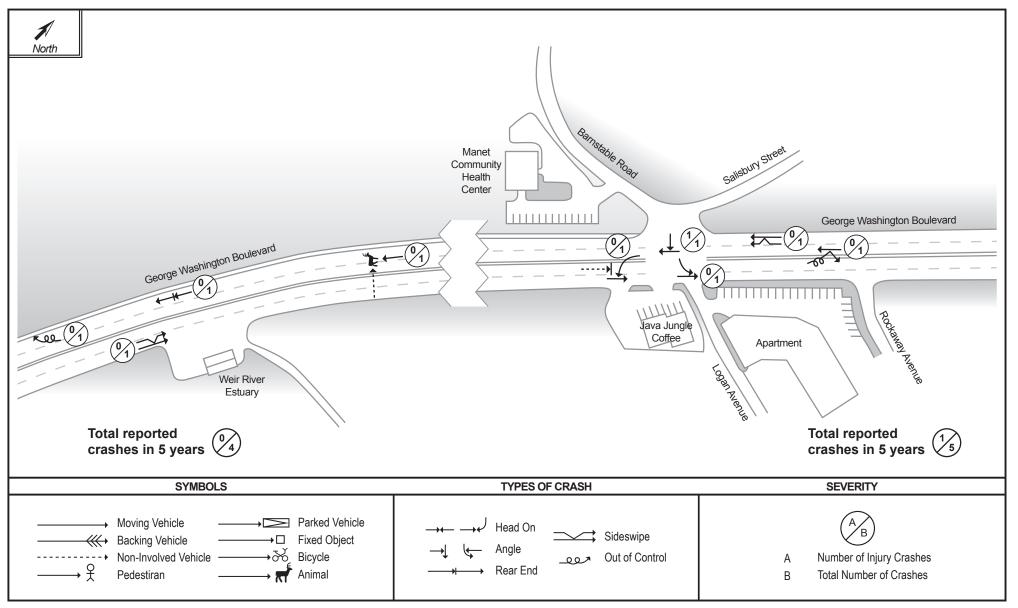


FIGURE H-8 Collision Diagram: George Washington Boulevard at Rockland Circle Hull Police Reports: 2009–2011 and 2013–May 2015

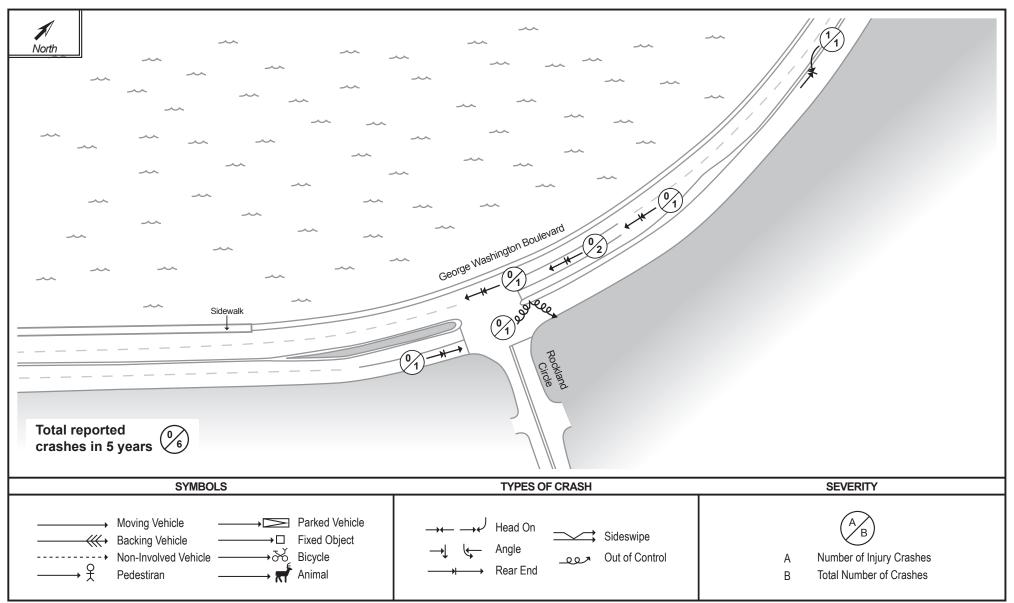


FIGURE H-9 Collision Diagram: George Washington Boulevard at Wharf Avenue and at Bay Street/Nantasket Avenue Hull Police Reports: 2009–2011 and 2013–May 2015

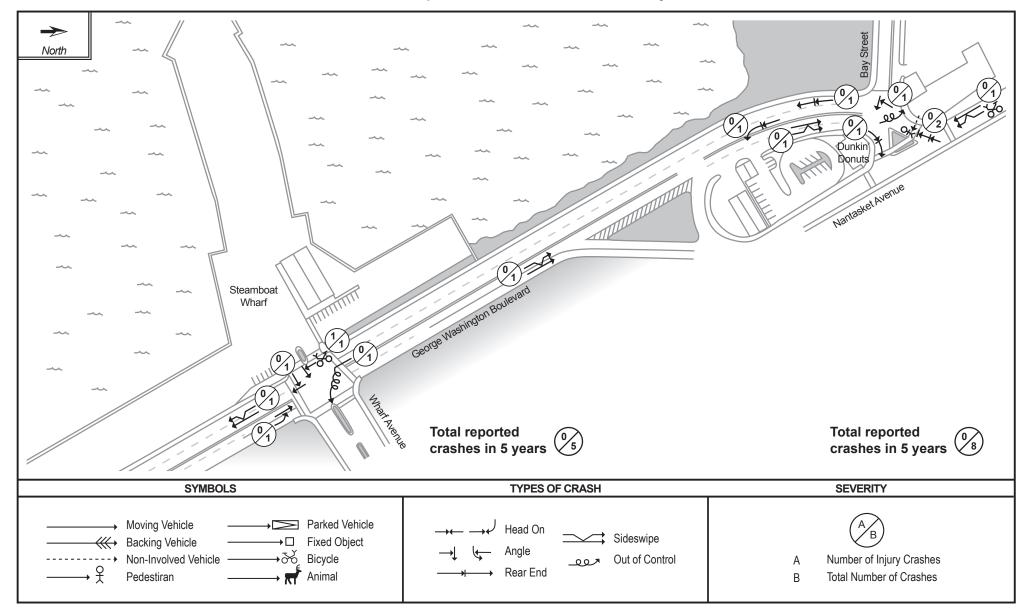
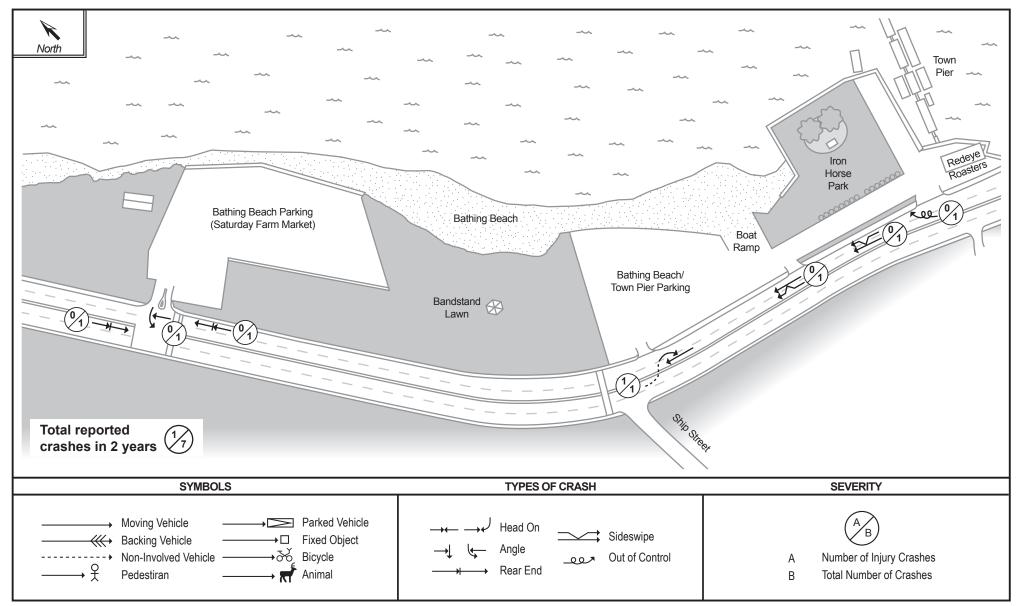


FIGURE H-10 Collision Diagram: Otis Street (Route 3A) between Bathing Beach Driveway and North Street Hingham Police Reports: March 2013–April 2015



APPENDIX I

Intersection Capacity Analyses Weekday AM Peak Hour Projected 2040 Traffic Conditions with Proposed Improvements

Intersection Capacity Analysis 1. Summer St @ North St

	-	\mathbf{r}	4	+	1	1		
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3	
Lane Configurations	≜ †₽			 •↑Ъ	Ĭ	1		1
Volume (vph)	572	50	398	1246	79	227		
Confl. Peds. (#/hr)	012	3	3	1210	.,			
Peak Hour Factor	0.95	0.95	0.93	0.93	0.87	0.87		
Growth Factor	105%	105%	105%	105%	105%	105%		
Heavy Vehicles (%)	2%	2%	1%	1%	3%	3%		
Shared Lane Traffic (%)	270	270	170	170	070	070		
Lane Group Flow (vph)	687	0	0	1856	95	274		
Turn Type	NA	Ū	pm+pt	NA	Prot	pt+ov		
Protected Phases	2		ppt 1	6	4	4 1	3	
Permitted Phases	2		6	0	•		0	
Detector Phase	2		1	6	4	41		
Switch Phase	L		1	0	т			
Minimum Initial (s)	8.0		4.0	8.0	9.0		4.0	
Minimum Split (s)	13.0		9.0	13.0	14.0		21.0	
Total Split (s)	55.0		20.0	75.0	14.0		21.0	
Total Split (%)	50.0%		18.2%	68.2%	14.0		19%	
Yellow Time (s)	4.0		4.0	4.0	4.0		2.0	
All-Red Time (s)	4.0		4.0	4.0	4.0		0.0	
Lost Time Adjust (s)	0.0		1.0	0.0	0.0		0.0	
Total Lost Time (s)	5.0			5.0	5.0			
Lead/Lag	Lead		Lag	5.0	Lag		Lead	
Lead-Lag Optimize?	Yes		Yes		Yes		Yes	
Recall Mode	Min		None	Min	None		None	
Act Effct Green (s)	27.7		NOUG	70.6	9.1	51.2	None	
	0.30			0.76	0.10	0.55		
Actuated g/C Ratio v/c Ratio	0.30			0.76	0.10	0.55		
				0.99 36.7		0.35 14.0		
Control Delay	34.8				61.0			
Queue Delay	0.0			0.0	0.0	0.0		
Total Delay	34.8			36.7	61.0	14.0		
LOS Approach Dolou	C			D	E	В		
Approach Delay	34.8			36.7	26.1			
Approach LOS	C			D	С	70		
Queue Length 50th (ft)	180			246 #1025	52 #145	72		
Queue Length 95th (ft)	267			#1025	#145	159		
Internal Link Dist (ft)	764			218	85			
Turn Bay Length (ft)	4 / 4 4			1074	450	770		
Base Capacity (vph)	1644			1871	153	773		
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	0.42			0.99	0.62	0.35		
Intersection Summary								
Cycle Length: 110								
Actuated Cycle Length: 93.	.3							
Natural Cycle: 150								
Control Type: Actuated-Une	coordinated							
Maximum v/c Ratio: 0.99								
								_

2040 AM Alt1 Final

Intersection Capacity Analysis 1. Summer St @ North St

Intersection Signal Delay: 34.9	Intersection LOS: C
Intersection Capacity Utilization 94.0%	ICU Level of Service F
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be lo	nger.
Queue shown is maximum after two cycles.	

Splits and Phases: 1: North St & Otis St/Summer St

→ _{ø2}	€ ø1		ø4
55 s	20 s	21 s	14 s
₩ Ø6			
75 s			

Intersection Capacity Analysis 2. Summer St @ CJC Hwy

11/22/2015	2/2015
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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	ሻ	- † †	1	٦	≜ ⊅		۳	\$			ب	7
Volume (vph)	10	334	414	60	689	10	871	5	24	5	5	20
Satd. Flow (prot)	1711	3355	1501	1728	3448	0	1681	1621	0	0	1757	1531
Flt Permitted	0.193			0.360			0.950	0.955			0.976	
Satd. Flow (perm)	348	3355	1501	655	3448	0	1681	1621	0	0	1757	1531
Satd. Flow (RTOR)			511		1			3				138
Peak Hour Factor	0.92	0.85	0.85	0.92	0.92	0.92	0.96	0.92	0.96	0.92	0.92	0.92
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	2%	4%	4%	1%	1%	2%	2%	2%	2%	2%	2%	2%
Shared Lane Traffic (%)							48%					
Lane Group Flow (vph)	11	413	511	68	797	0	496	489	0	0	12	23
Turn Type	pm+pt	NA	Perm	pm+pt	NA		Split	NA		Split	NA	Perm
Protected Phases	5	2		1	6		7	7		8	8	
Permitted Phases	2		2	6								8
Detector Phase	5	2	2	1	6		7	7		8	8	8
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		3.0	3.0	3.0
Minimum Split (s)	8.0	30.5	30.5	8.0	21.0		21.0	21.0		9.0	9.0	9.0
Total Split (s)	8.0	34.0	34.0	8.0	34.0		36.0	36.0		9.0	9.0	9.0
Total Split (%)	7.2%	30.6%	30.6%	7.2%	30.6%		32.4%	32.4%		8.1%	8.1%	8.1%
Yellow Time (s)	3.0	4.0	4.0	3.0	4.0		4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	0.0
Total Lost Time (s)	4.0	5.0	5.0	4.0	5.0		5.0	5.0			5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lead	Lead		Lag	Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes	Yes	Yes
Recall Mode	None	Min	Min	Min	Min		None	None		None	None	None
Act Effct Green (s)	22.7	17.5	17.5	26.3	24.7		32.3	32.3			4.2	4.2
Actuated g/C Ratio	0.30	0.23	0.23	0.35	0.32		0.42	0.42			0.06	0.06
v/c Ratio	0.06	0.54	0.69	0.24	0.71		0.70	0.71			0.12	0.11
Control Delay	19.9	29.3	8.3	21.4	28.7		29.0	29.6			45.4	1.0
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	0.0
Total Delay	19.9	29.3	8.3	21.4	28.7		29.0	29.6			45.4	1.0
LOS	В	С	А	С	С		С	С			D	А
Approach Delay		17.7			28.1			29.3			16.2	
Approach LOS		В			С			С			В	
Queue Length 50th (ft)	3	89	0	21	166		194	192			5	0
Queue Length 95th (ft)	17	158	57	62	#354		#586	#589			28	0
Internal Link Dist (ft)		641			654			102			1	
Turn Bay Length (ft)	100		150	100								
Base Capacity (vph)	178	1330	903	284	1367		712	688			96	214
Starvation Cap Reductn	0	0	0	0	0		0	0			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	0.06	0.31	0.57	0.24	0.58		0.70	0.71			0.13	0.11
Intersection Summary												

Intersection Summary Cycle Length: 111 Actuated Cycle Length: 76.2

2040 AM Alt1 Final

LangConfigurations Volume (vph) Satd. Flow (prot) Filt Permitted Satd. Flow (perm) Satd. Flow (RTOR) Peak Hour Factor Growth Factor Heavy Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 3 Permitted Phases 3 Detector Phase 3 Switch Phase Minimun Initial (s) 4.0 Minimun Initial (s) 4.0 Minimun Initial (s) 24.0 Total Split (s) 24.0 Total Split (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) 1.0 Lost Time (s) 2.0 All-Red Time (s) 1.0 Lead/Lag
Volume (vph) Satd. Flow (prof) Fit Permitted Satd. Flow (perm) Satd. Flow (RTOR) Peak Hour Factor Growth Factor Heavy Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 3 Permitted Phases Detector Phase Switch Phase Minimun Initial (s) 4.0 Minimun Initial (s) 24.0 Total Split (%) 22% Yellow Time (s) 1.0 Lost Time Aglust (s) Total Split (%) 2.0 Ail-Red Time (s) 1.0 Lost Time Aglust (s) Total Split (%) 2.0 Ail-Red Time (s) 1.0 Lost Time (s) Lead/Lag Optimize? Recall Mode None Act Effet Green (s) Actuated g/C Ratio v/c Ratio Control Delay Queue Delay
Satd. Flow (prot) FIP Permitted Satd. Flow (perm) Satd. Flow (RTOR) Peak Hour Factor Growth Factor Heavy Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Oetector Phase Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 24.0 Total Split (%) 22% Yellow Time (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) 1.0 Load Lag Optimize? Eacd-Lag Optimize? Recall Mode None Act Effet Green (s) Actuated g/C Ratio Vvic Ratio Control Delay Queue Delay Total Delay Dueue Delay Total Delay
Fit Permitted Satd. Flow (perm) Satd. Flow (RTOR) Peak Hour Factor Growth Factor Heavy Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 0 Detector Phase Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 24.0 Total Split (s) 24.0 Total Split (s) 24.0 Total Split (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) 1.0 Lost Time (s) 1.0 Lead/Lag Lead-Lag Optimize? Recall Mode None Act Effct Green (s) Actuated g/C Ratio V/c Ratio Control Delay Oucue Delay Total Delay Dueue Delay Total Delay Lost Lost
Satd. Flow (perm) Satd. Flow (RTOR) Peak Hour Factor Growth Factor Heavy Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Detector Phase Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 24.0 Total Split (%) 22% Yellow Time (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) 1.0 Total Split (%) 2.0 All-Red Time (s) 1.0 Lead/Lag Lead/Lag Lead/Lag Lead/Lag Lead/Lag None Act Efft Green (s) Actuated g/C Ratio V/c Ratio Control Delay Queue Delay Total Delay Queue Delay Total Delay Los Lead/Lag Lead/Lag Lead/Lag Lead/Lag Lead/Lag Lead/Lag Lead/Lag Lead/Lag Lead/Lag Lobal Delay Lobal Delay
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Peak Hour Factor Growth Factor Heavy Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Detector Phase Switch Phase Minimum Initial (s) 4.0 Minimum Initial (s) 4.0 Minimum Split (s) 24.0 Total Split (s) 24.0 Total Split (s) 2.0 All-Red Time (s) Lost Time (s) Lead-Lag Optimize? Recall Mode None Act Laft Green (s) Actuated g/C Ratio V/c Ratio Control Delay Queue Delay Total Delay Los
Growth Factor Heavy Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Detector Phase Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 24.0 Total Split (s) 24.0 Total Split (s) 22% Yellow Time (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) 1.0 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 Loes Loes Lead/Leag Lead-Lag Optimize?
Heavy Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Detector Phase Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 24.0 Total Split (s) 24.0 Total Split (s) 24.0 Total Split (%) 22% Yellow Time (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) 1.0 Lost Time (s) 1.0 Lead-Lag Optimize? Recall Mode Recall Mode None Act Effct Green (s) Actuated g/C Ratio v/c Ratio Control Delay Queue Delay Total Delay Lost Lost Joint Delay Queue Delay Total Delay
Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Detector Phase Switch Phase Minimum Initial (s) 4.0 Minimum Initial (s) 4.0 Minimum Split (s) 24.0 Total Split (s) 24.0 Total Split (s) 24.0 Total Split (s) 2.0 All-Red Time (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) 1.0 Lead/Lag Lead/Lag Lead/Lag None Act Effct Green (s) Actuated g/C Ratio v/c Ratio Control Delay Queue Delay Total Delay Loes Load Load Load
Lane Group Flow (vph) Turn Type Protected Phases Detector Phase Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 24.0 Total Split (s) 24.0 Total Split (s) 22% Yellow Time (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) Total Lost Time (s) Total Lost Time (s) 1.0 Lead/Lag Lead-Lag Optimize? Recall Mode None Actuated g/C Ratio V/c Ratio V/c Ratio Control Delay Queue Delay Total Delay Lost Los Lead/Lag Lead/Log Lead/Lag None Actuated g/C Ratio None Actuated g/C Ratio None Actuated g/C Ratio Los V/c Ratio Los Control Delay Los Queue Delay Los Total Delay Los
Turn Type Protected Phases Detector Phase Switch Phase Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 24.0 Total Split (s) 24.0 Total Split (s) 24.0 Total Split (s) 22% Yellow Time (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) 1.0 Lost Time (s) 1.0 Lead/Lag Eead-Lag Optimize? Recall Mode None Actuated g/C Ratio V/c Ratio Control Delay Queue Delay Total Delay Los Los Los
Protected Phases3Permitted PhasesDetector PhaseSwitch PhaseMinimum Initial (s)4.0Minimum Split (s)24.0Total Split (s)24.0Total Split (s)22%Yellow Time (s)2.0All-Red Time (s)1.0Lost Time Adjust (s)1.0Total Lost Time (s)1.0Lead/LagEead/LagLead/LagNoneAct Effct Green (s)Actuated g/C RatioV/c RatioV/c RatioControl DelayQueue DelayTotal DelayLosLosLos
Permitted Phases Detector Phase Switch Phase Minimun Initial (s) 4.0 Minimum Split (s) 24.0 Total Split (s) 24.0 Total Split (s) 24.0 Total Split (%) 22% Yellow Time (s) 2.0 All-Red Time (s) 1.0 Lost Time Adjust (s) 1.0 Lost Time (s) 1.0 Lead/Lag Image: Comparison of the state of the st
Detector PhaseSwitch PhaseMinimum Initial (s)4.0Minimum Split (s)24.0Total Split (s)24.0Total Split (%)22%Yellow Time (s)2.0All-Red Time (s)1.0Lost Time Adjust (s)Total Lost Time (s)Total Lost Time (s)Lead/LagLead/LagRecall ModeAct Effct Green (s)Actuated g/C RatioV/c RatioControl DelayQueue DelayTotal DelayLOSLos
Switch PhaseMinimum Initial (s)4.0Minimum Split (s)24.0Total Split (s)24.0Total Split (%)22%Yellow Time (s)2.0All-Red Time (s)1.0Lost Time Adjust (s)1.0Total Lost Time (s)Lead/LagLead/LagRecall ModeRecall ModeNoneAct Effct Green (s)Actuated g/C RatioV/c RatioV/c RatioControl DelayQueue DelayTotal DelayLOS
Minimum Initial (s)4.0Minimum Split (s)24.0Total Split (s)24.0Total Split (%)22%Yellow Time (s)2.0All-Red Time (s)1.0Lost Time Adjust (s)1.0Total Lost Time (s)Lead/LagLead/LagImage: Comparison of the second of
Minimum Split (s)24.0Total Split (s)24.0Total Split (%)22%Yellow Time (s)2.0All-Red Time (s)1.0Lost Time Adjust (s)1.0Total Lost Time (s)Lead/LagLead/LagImage: Comparison of the second se
Total Split (s)24.0Total Split (%)22%Yellow Time (s)2.0All-Red Time (s)1.0Lost Time Adjust (s)
Total Split (%)22%Yellow Time (s)2.0All-Red Time (s)1.0Lost Time Adjust (s)Total Lost Time (s)Lead/LagLead-Lag Optimize?Recall ModeNoneAct Effct Green (s)Actuated g/C RatioV/c RatioV/c RatioControl DelayQueue DelayQueue DelayTotal DelayLOSLOS
Yellow Time (s)2.0All-Red Time (s)1.0Lost Time Adjust (s)
All-Red Time (s) 1.0 Lost Time Adjust (s)
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
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
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
Lead-Lag Optimize? Recall Mode None Act Effct Green (s) Actuated g/C Ratio v/c Ratio Control Delay Queue Delay Total Delay LOS
Recall Mode None Act Effct Green (s) Actuated g/C Ratio V/c Ratio V/c Ratio Vontrol Delay Volueue Delay Oueue Delay Volueue Delay Total Delay Volueue Delay
Act Effct Green (s) Actuated g/C Ratio v/c Ratio Control Delay Queue Delay Total Delay LOS
Actuated g/C Ratio v/c Ratio Control Delay Queue Delay Total Delay LOS
v/c Ratio Control Delay Queue Delay Total Delay LOS
Control Delay Queue Delay Total Delay LOS
Queue Delay Total Delay LOS
Queue Delay Total Delay LOS
Total Delay LOS
LOS
Approach Delay
Approach LOS
Queue Length 50th (ft)
Queue Length 95th (ft)
Internal Link Dist (ft)
Turn Bay Length (ft)
Base Capacity (vph)
Starvation Cap Reductn
Spillback Cap Reductn
Storage Cap Reductn
Reduced v/c Ratio
Intersection Summary

Natural Cycle: 105	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.71	
Intersection Signal Delay: 24.9	Intersection LOS: C
Intersection Capacity Utilization 68.2%	ICU Level of Service C
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be l	onger.
Queue shown is maximum after two cycles.	

Splits and Phases: 3: Chief Justice Cushingh Hwy & Summer St

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8 s -		34 s	24 s	36 s	9s
و	ø5	★ ø6			
8 s -		34 s			

Intersection Capacity Analysis 3. Summer St @ Rockland St

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	۲	¢î≽		٦	eî 👘			र्स	1		र्भ	1
Volume (vph)	26	378	11	136	742	10	17	27	57	11	42	39
Satd. Flow (prot)	1694	3374	0	1728	1815	0	0	1775	1538	0	2088	1794
Flt Permitted	0.207			0.457				0.848			0.918	
Satd. Flow (perm)	369	3374	0	831	1815	0	0	1534	1538	0	1938	1794
Satd. Flow (RTOR)												
Peak Hour Factor	0.93	0.93	0.93	0.90	0.90	0.90	0.84	0.84	0.84	0.92	0.92	0.92
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	3%	3%	3%	1%	1%	1%	5%	5%	5%	2%	2%	2%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	29	439	0	159	878	0	0	55	71	0	61	45
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	Perm
Protected Phases	5	2		1	6			3			3	
Permitted Phases	2			6			3		3	3		3
Detector Phase	5	2		1	6		3	3	3	3	3	3
Switch Phase												
Minimum Initial (s)	4.0	15.0		4.0	15.0		8.0	8.0	8.0	8.0	8.0	8.0
Minimum Split (s)	8.0	20.0		8.0	20.0		13.0	13.0	13.0	13.0	13.0	13.0
Total Split (s)	8.0	51.0		10.0	53.0		26.0	26.0	26.0	26.0	26.0	26.0
Total Split (%)	7.3%	46.4%		9.1%	48.2%		23.6%	23.6%	23.6%	23.6%	23.6%	23.6%
Yellow Time (s)	3.0	4.0		3.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Lost Time (s)	4.0	5.0		4.0	5.0			5.0	5.0		5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag							_
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Nees	News	Neee	News	News	Nene
Recall Mode	None	Min		Min	Min		None	None	None	None	None	None
Act Effct Green (s)	48.3	43.1		53.5	51.8			10.6	10.6		10.6	10.6
Actuated g/C Ratio	0.65	0.58		0.72 0.24	0.70			0.14	0.14 0.32		0.14 0.22	0.14
v/c Ratio	0.09 7.4	0.22		0.24	0.69			0.25 35.7	0.32 37.0		0.22 34.4	0.18
Control Delay	0.0	10.6 0.0		0.0	17.0 0.0			35.7 0.0	0.0		0.0	34.1 0.0
Queue Delay	7.4	10.6		7.2	17.0			35.7	37.0		34.4	34.1
Total Delay LOS	7.4 A	10.0 B		7.2 A	Т7.0 В			55.7 D	57.0 D		54.4 C	54.1 C
Approach Delay	A	10.4		A	15.5			36.5	D		34.3	C
Approach LOS		10.4 B			15.5 B			50.5 D			54.5 C	
Queue Length 50th (ft)	3	43		16	163			21	27		23	17
Queue Length 95th (ft)	22	135		86	#889			66	81		75	60
Internal Link Dist (ft)	22	378		00	358			249	01		637	00
Turn Bay Length (ft)	150	570		150	330			247	50		007	75
Base Capacity (vph)	317	2210		678	1274			458	460		579	536
Starvation Cap Reductn	0	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	0.09	0.20		0.23	0.69			0.12	0.15		0.11	0.08
Intersection Summary												

Cycle Length: 110 Actuated Cycle Length: 73.8

Lane Group	ø9
LaneConfigurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
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)	4.0
Minimum Split (s)	23.0
Total Split (s)	23.0
Total Split (%)	21%
Yellow Time (s)	2.0
All-Red Time (s)	0.0
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)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	
Intersection Summary	

Natural Cycle: 90		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.69		
Intersection Signal Delay: 16.8	Intersection LOS: B	
Intersection Capacity Utilization 67.5%	ICU Level of Service C	
Analysis Period (min) 15		
# 95th percentile volume exceeds capacity, queue m	ay be longer.	
Queue shown is maximum after two cycles.		

Splits and Phases: 4: Summer St & Rockland St & Martins Ln

√ ø1	_{ø2}	ø3	ÅÅ ø9
10 s	51 s	26 s	23 s
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8 s <mark>-</mark> 53	is a second s		

Intersection Capacity Analysis 4. Rockland St @ G. W. Blvd

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		—		1	-			
Lane Group	WBL	WBR	NET	NER	SWL	SWT	ø3	
Lane Configurations	۲	1	†	1	۲	1		
Volume (vph)	180	21	359	87	10	688		
Satd. Flow (prot)	1711	1531	1801	1531	1711	1801		
Flt Permitted	0.950				0.457			
Satd. Flow (perm)	1706	1531	1801	1531	823	1801		
Satd. Flow (RTOR)		29		100				
Confl. Peds. (#/hr)	1							
Peak Hour Factor	0.77	0.77	0.91	0.91	0.90	0.90		
Growth Factor	105%	105%	105%	105%	105%	105%		
Shared Lane Traffic (%)								
Lane Group Flow (vph)	245	29	414	100	12	803		
Turn Type	Prot	Perm	NA	Perm	Perm	NA		
Protected Phases	4		2			6	3	
Permitted Phases		4		2	6			
Detector Phase	4	4	2	2	6	6		
Switch Phase								
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	4.0	
Minimum Split (s)	12.0	12.0	12.0	12.0	12.0	12.0	23.0	
Total Split (s)	20.0	20.0	52.0	52.0	52.0	52.0	23.0	
Total Split (%)	21.1%	21.1%	54.7%	54.7%	54.7%	54.7%	24%	
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	2.0	
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0		
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0		
Lead/Lag	Lag	Lag					Lead	
Lead-Lag Optimize?	Yes	Yes					Yes	
Recall Mode	Min	Min	None	None	None	None	None	
Act Effct Green (s)	15.5	15.5	34.6	34.6	34.6	34.6		
Actuated g/C Ratio	0.25	0.25	0.55	0.55	0.55	0.55		
v/c Ratio	0.58	0.07	0.42	0.11	0.03	0.82		
Control Delay	32.7	11.9	10.7	2.6	8.4	21.1		
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0		
Total Delay	32.7	11.9	10.7	2.6	8.4	21.1		
LOS	С	В	В	A	А	С		
Approach Delay	30.5		9.1			20.9		
Approach LOS	С		A			С		
Queue Length 50th (ft)	75	0	71	0	2	192		
Queue Length 95th (ft)	#208	18	216	23	12	#630		
Internal Link Dist (ft)	100		657			589		
Turn Bay Length (ft)				250	50			
Base Capacity (vph)	426	403	1406	1217	642	1406		
Starvation Cap Reductn	0	0	0	0	0	0		
Spillback Cap Reductn	0	0	0	0	0	0		
Storage Cap Reductn	0	0	0	0	0	0		
Reduced v/c Ratio	0.58	0.07	0.29	0.08	0.02	0.57		
Interception Summery	0.00			2.00	5.02			

Intersection Summary

Cycle Length: 95 Actuated Cycle Length: 63.2

Natural Cycle: 90		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.82		
Intersection Signal Delay: 18.8	Intersection LOS: B	
Intersection Capacity Utilization 56.8%	ICU Level of Service B	
Analysis Period (min) 15		
# 95th percentile volume exceeds capacity, queue may b	e longer.	
Queue shown is maximum after two cycles.		

Splits and Phases: 13: Rockland St & G W Blvd

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Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3	
Lane Configurations	<u> </u>	1	<u></u>		<u>אוטר</u>	101		-
Volume (vph)	270	32	26	632	62	25		
Satd. Flow (prot)	1749	1487	1728	1818	2025	1812		
Flt Permitted	(77)	107	0.526	1010	0.950	1012		
Satd. Flow (perm)	1749	1487	957	1818	2025	1766		
Satd. Flow (RTOR)	1/4/	37	757	1010	2025	30		
Confl. Peds. (#/hr)		57				1		
Peak Hour Factor	0.92	0.92	0.93	0.93	0.87	0.87		
Growth Factor	105%	105%	105%	105%	105%	105%		
Heavy Vehicles (%)	5%	5%	103 %	1%	1%	1%		
Shared Lane Traffic (%)	570	570	170	170	170	170		
Lane Group Flow (vph)	308	37	29	714	75	30		
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm		
Protected Phases	2	FCIIII	рт+рі 1	6	4	генн	3	
Permitted Phases	Z	2	6	0	4	4	3	
Detector Phase	2	2	0	6	4	4		
Switch Phase	2	Z	I	0	4	4		
	40.0	40.0	4.0	40.0	8.0	8.0	4.0	
Minimum Initial (s)	40.0 46.0		4.0 8.0				4.0 21.0	
Minimum Split (s)		46.0		46.0	13.0	13.0		
Total Split (s)	66.0	66.0	8.0	74.0	15.0	15.0	21.0	
Total Split (%)	60.0%	60.0%	7.3%	67.3%	13.6%	13.6%	19%	
Yellow Time (s)	4.0	4.0	3.0	4.0	3.0	3.0	2.0	
All-Red Time (s)	2.0	2.0	1.0	2.0	2.0	2.0	1.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0		
Total Lost Time (s)	6.0	6.0	4.0	6.0	5.0	5.0	1	
Lead/Lag	Lag	Lag	Lead		Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes	
Recall Mode	Min	Min	None	None	None	None	None	
Act Effct Green (s)	46.2	46.2	49.7	49.0	9.0	9.0		
Actuated g/C Ratio	0.68	0.68	0.73	0.72	0.13	0.13		
v/c Ratio	0.26	0.04	0.04	0.54	0.28	0.12		
Control Delay	8.9	4.1	5.3	9.6	32.8	14.2		
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0		
Total Delay	8.9	4.1	5.3	9.6	32.8	14.2		
LOS	А	А	А	А	С	В		
Approach Delay	8.4			9.4	27.5			
Approach LOS	А			А	С			
Queue Length 50th (ft)	36	0	2	113	24	0		
Queue Length 95th (ft)	172	16	18	413	81	25		
Internal Link Dist (ft)	1154			331	60			
Turn Bay Length (ft)		150	200					
Base Capacity (vph)	1580	1347	746	1722	306	292		
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	0.19	0.03	0.04	0.41	0.25	0.10		
Intersection Summary								
Cycle Length: 110								
egale Longan The								

Intersection Capacity Analysis 5. G. W. Blvd @ Rockland Circle

Actuated Cycle Length: 67.9		
Natural Cycle: 90		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.54		
Intersection Signal Delay: 10.7	Intersection LOS: B	
Intersection Capacity Utilization 50.8%	ICU Level of Service A	
Analysis Period (min) 15		

Splits and Phases: 3: Rockland Cir & G W Blvd

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Intersection Capacity Analysis 6. G. W. Blvd @ Wharf Ave

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		\$			र्स	1	<u>۲</u>	∱ ⊅		1	eî 👘	
Volume (vph)	2	0	5	15	4	16	1	276	12	22	634	5
Satd. Flow (prot)	0	1703	0	0	1621	1432	1736	3447	0	1787	1879	0
Flt Permitted							0.950			0.950		
Satd. Flow (perm)	0	1721	0	0	1675	1408	1736	3447	0	1726	1879	0
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)	1		1	1		1			4	4		
Peak Hour Factor	0.88	0.88	0.88	0.80	0.80	0.80	0.88	0.88	0.88	0.92	0.92	0.92
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	10%	10%	10%	9%	9%	9%	4%	4%	4%	1%	1%	1%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	8	0	0	25	21	1	343	0	25	730	0
Turn Type	Perm	NA		Perm	NA	Perm	Prot	NA		Prot	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8		8						
Detector Phase	4	4		8	8	8	5	2		1	6	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	33.0		4.0	33.0	
Minimum Split (s)	9.0	9.0		9.0	9.0	9.0	8.0	38.0		8.0	38.0	
Total Split (s)	12.0	12.0		12.0	12.0	12.0	8.0	69.0		8.0	69.0	
Total Split (%)	10.9%	10.9%		10.9%	10.9%	10.9%	7.3%	62.7%		7.3%	62.7%	
Yellow Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	1.0	2.0		1.0	2.0	
Lost Time Adjust (s)		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Total Lost Time (s)		5.0			5.0	5.0	4.0	5.0		4.0	5.0	
Lead/Lag							Lead	Lag		Lead	Lag	
Lead-Lag Optimize?							Yes	Yes		Yes	Yes	
Recall Mode	None	None		None	None	None	None	Min		None	Min	
Act Effct Green (s)		6.6			6.9	6.9	4.3	48.1		4.3	48.1	
Actuated g/C Ratio		0.12			0.12	0.12	0.08	0.84		0.08	0.84	
v/c Ratio		0.04			0.12	0.12	0.01	0.12		0.19	0.46	
Control Delay		29.4			29.4	30.0	34.0	4.2		33.8	7.3	
Queue Delay		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Total Delay		29.4			29.4	30.0	34.0	4.2		33.8	7.3	
LOS		С			С	С	С	А		С	А	
Approach Delay		29.4			29.7			4.3			8.2	
Approach LOS		С			С			А			А	
Queue Length 50th (ft)		2			4	4	0	0		5	0	
Queue Length 95th (ft)		18			35	31	6	71		40	439	
Internal Link Dist (ft)		20			82			386			422	
Turn Bay Length (ft)							50			50		
Base Capacity (vph)		228			222	187	131	3238		135	1765	
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		0.04			0.11	0.11	0.01	0.11		0.19	0.41	
Intersection Summary												
Cycle Length: 110												

Cycle Length: 110

2040 AM Alt1

FIL Permittad Sald. Flow (perm) Sald. Flow (PtOP) Confl. Peds. (#/h) Peak Hour Factor Growth Factor Growth Factor Growth Factor Growth Factor Growth Factor Deak Hour Factor Growth Factor Una Group Flow (rph) Turn Type Permitted Phases Detector Phase Switch Switch Switch Switch Switch Switch Swit	Lane Group	ø9	
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Lead/Lag Vone Recall Mode None Act Effct Green (s) Act atted g/C Ratio Actuated g/C Ratio Control Delay Oueue Delay Control Delay LOS Approach Delay LOS Control Delay Queue Length 50th (ft) Control Delay Queue Length S0th (ft) Control Delay Queue Length S0th (ft) Control Delay Suration Cap Reductn Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Storage Cap Reductn Reductn Reduced v/c Ratio Control Delay			
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Recall Mode None Act Effct Green (s) Actuated g/C Ratio Actuated g/C Ratio V/c Ratio Control Delay Control Delay Queue Delay Total Delay Total Delay Proach Delay LOS Approach Delay Approach Delay Proach LOS Queue Length 50th (ft) Proach LOS Queue Length 95th (ft) Proach LOS Spillback Cap Reductn Proach LOS Spillback Cap Reductn Proach LOS Storage Cap Reductn Proach LOS Reduced v/c Ratio Proach LOS			
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) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Storage Cap Reductn	Recall Mode	None	
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) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Storage Cap Reductn			
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) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn			
Queue Delay Total Delay LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn	v/c Ratio		
Queue Delay Total Delay LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn	Control Delay		
Total Delay LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn			
LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn			
Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	LOS		
Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Approach Delay		
Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio			
Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio			
Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Queue Length 95th (ft)		
Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Internal Link Dist (ft)		
Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Turn Bay Length (ft)		
Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Base Capacity (vph)		
Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Starvation Cap Reductn		
Storage Cap Reductn Reduced v/c Ratio			
Reduced v/c Ratio	Storage Cap Reductn		
Intersection Summary	Reduced v/c Ratio		
Intersection Summary			
	intersection Summary		

Intersection Capacity Analysis 6. G. W. Blvd @ Wharf Ave

Actuated Cycle Length: 57.2		
Natural Cycle: 80		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.46		
Intersection Signal Delay: 8.0	Intersection LOS: A	
Intersection Capacity Utilization 47.0%	ICU Level of Service A	
Analysis Period (min) 15		

Splits and Phases: 7: G W Blvd & Wharf Ave

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8 s 🛛	69 s	12 s	21 s
1 ø5	↓ ø6	¢8	
8 s 🛛	69 s	12 s	

APPENDIX J

Intersection Capacity Analyses Weekday PM Peak Hour Projected 2040 Traffic Conditions with Proposed Improvements

Intersection Capacity Analysis 1. Summer St @ North St

	→	\mathbf{F}	4	-	1	1		
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3	
Lane Configurations	† 1>			 ↑Ъ	<u> </u>	1	~~~	
Volume (vph)	1137	53	298	617	118	412		
Satd. Flow (prot)	3085	0	0	3030	1608	1439		
Flt Permitted	0000	Ű	Ū	0.516	0.950	1107		
Satd. Flow (perm)	3085	0	0	1589	1572	1439		
Satd. Flow (RTOR)	5	0	U	1007	1072	332		
Confl. Peds. (#/hr)	0	1	1		9	552		
Peak Hour Factor	0.95	0.95	0.87	0.87	0.81	0.81		
Growth Factor	105%	105%	105%	105%	105%	105%		
Heavy Vehicles (%)	1%	1%	2%	2%	1%	1%		
Adj. Flow (vph)	1257	59	360	745	153	534		
Shared Lane Traffic (%)	1207	57	500	745	155	554		
Lane Group Flow (vph)	1316	0	0	1105	153	534		
Turn Type	NA	U	pm+pt	NA	Prot	pt+ov		
Protected Phases	2		pin+pi 1	6	4	μι+υν 4 1	3	
Permitted Phases	Z		6	U	4	41	3	
Detector Phase	2		0	6	4	41		
Switch Phase	Z		I	0	4	4 1		
	0.0		4.0	0.0	0.0		4.0	
Minimum Initial (s)	8.0		4.0	8.0	9.0		4.0	
Minimum Split (s)	13.0		9.0	13.0	14.0		21.0	
Total Split (s)	51.0		20.0	71.0	18.0		21.0	
Total Split (%)	46.4%		18.2%	64.5%	16.4%		19%	
Yellow Time (s)	4.0		4.0	4.0	4.0		2.0	
All-Red Time (s)	1.0		1.0	1.0	1.0		0.0	
Lost Time Adjust (s)	0.0			0.0	0.0			
Total Lost Time (s)	5.0			5.0	5.0			
Lead/Lag	Lead		Lag		Lag		Lead	
Lead-Lag Optimize?	Yes		Yes		Yes		Yes	
Recall Mode	Min		None	Min	None		None	
Act Effct Green (s)	46.5			65.3	12.4	30.4		
Actuated g/C Ratio	0.51			0.72	0.14	0.33		
v/c Ratio	0.84			1.08dl	0.70	0.76		
Control Delay	27.0			20.0	57.9	17.7		
Queue Delay	0.0			0.0	0.0	0.0		
Total Delay	27.0			20.0	57.9	17.7		
LOS	С			С	E	В		
Approach Delay	27.0			20.0	26.7			
Approach LOS	С			С	С			
Queue Length 50th (ft)	309			108	82	90		
Queue Length 95th (ft)	#656			#338	#181	142		
Internal Link Dist (ft)	764			218	85			
Turn Bay Length (ft)								
Base Capacity (vph)	1573			1377	231	709		
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	0.84			0.80	0.66	0.75		
Intersection Summary								

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Intersection Capacity Analysis 1. Summer St @ North St

Cycle Length: 110						
Actuated Cycle Length: 91.3						
Natural Cycle: 110						
Control Type: Actuated-Uncoordinated						
Maximum v/c Ratio: 0.84						
Intersection Signal Delay: 24.4	Intersection LOS: C					
Intersection Capacity Utilization 88.8%	ICU Level of Service E					
Analysis Period (min) 15						
# 95th percentile volume exceeds capacity, queue may be longer.						
Queue shown is maximum after two cycles.						
dl Defacto Left Lane. Recode with 1 though lane as a left lane.						

Splits and Phases: 1: North St & Otis St/Summer St

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51 s	20 s	21 s	18 s
₹ ø6			
71 s			

Intersection Capacity Analysis 2. Summer St @ CJC Hwy

11/19/2015	1	1	/1	9	12	01	15
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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	ሻ	- † †	1	٦	≜ ⊅		٦	\$			र्स	1
Volume (vph)	10	753	824	43	508	0	408	10	14	10	5	25
Satd. Flow (prot)	1711	3455	1546	1711	3421	0	1681	1621	0	0	1745	1531
Flt Permitted	0.373			0.199			0.950	0.957			0.969	
Satd. Flow (perm)	672	3455	1546	358	3421	0	1681	1621	0	0	1745	1531
Satd. Flow (RTOR)			759					3				139
Peak Hour Factor	0.92	0.87	0.87	0.80	0.80	0.92	0.85	0.92	0.85	0.92	0.92	0.92
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	2%	1%	1%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Adj. Flow (vph)	11	909	994	56	667	0	504	11	17	11	6	29
Shared Lane Traffic (%)							47%					
Lane Group Flow (vph)	11	909	994	56	667	0	267	265	0	0	17	29
Turn Type	pm+pt	NA	Perm	pm+pt	NA		Split	NA		Split	NA	Perm
Protected Phases	5	2		1	6		7	7		8	8	
Permitted Phases	2		2	6								8
Detector Phase	5	2	2	1	6		7	7		8	8	8
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	8.0	20.0	20.0	8.0	20.0		9.0	9.0		9.0	9.0	9.0
Total Split (s)	8.0	46.0	46.0	8.0	46.0		23.0	23.0		9.0	9.0	9.0
Total Split (%)	7.3%	41.8%	41.8%	7.3%	41.8%		20.9%	20.9%		8.2%	8.2%	8.2%
Yellow Time (s)	3.0	4.0	4.0	3.0	4.0		4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	0.0
Total Lost Time (s)	4.0	5.0	5.0	4.0	5.0		5.0	5.0			5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lead	Lead		Lag	Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes	Yes	Yes
Recall Mode	None	Min	Min	Min	Min		None	None		None	None	None
Act Effct Green (s)	43.1	38.0	38.0	46.6	45.0		18.6	18.6			4.1	4.1
Actuated g/C Ratio	0.52	0.46	0.46	0.56	0.54		0.22	0.22			0.05	0.05
v/c Ratio	0.03	0.58	0.89	0.21	0.36		0.71	0.73			0.20	0.14
Control Delay	11.5	19.6	17.1	12.4	13.8		45.6	46.5			49.6	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	0.0
Total Delay	11.5	19.6	17.1	12.4	13.8		45.6	46.5			49.6	1.4
LOS	В	В	В	В	В		D	D			D	А
Approach Delay		18.3			13.7			46.1			19.2	
Approach LOS		В			В			D			В	
Queue Length 50th (ft)	2	175	90	12	94		144	142			9	0
Queue Length 95th (ft)	14	316	#501	37	197		#318	#355			35	0
Internal Link Dist (ft)		630			618			73			1	
Turn Bay Length (ft)	100		150	100							-	
Base Capacity (vph)	400	1760	1160	268	1939		375	364			86	208
Starvation Cap Reductn	0	0	0	0	0		0	0			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	0.03	0.52	0.86	0.21	0.34		0.71	0.73			0.20	0.14
Intersection Summary												
Cycle Length: 110												

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Synchro 8 Report Page 1

Lane Group	ø3	
LaneConfigurations		
Volume (vph)		
Satd. Flow (prot)		
Flt Permitted		
Satd. Flow (perm)		
Satd. Flow (RTOR)		
Peak Hour Factor		
Growth Factor		
Heavy Vehicles (%)		
Adj. Flow (vph)		
Shared Lane Traffic (%)		
Lane Group Flow (vph)		
Turn Type		
Protected Phases	3	
Permitted Phases	0	
Detector Phase		
Switch Phase		
Minimum Initial (s)	4.0	
Minimum Split (s)	24.0	
Total Split (s)	24.0	
Total Split (%)	22%	
Yellow Time (s)	2.0	
All-Red Time (s)	1.0	
Lost Time Adjust (s)	1.0	
Total Lost Time (s)		
Lead/Lag		
Lead-Lag Optimize?		
Recall Mode	None	
Act Effct Green (s)	None	
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)		
Turn Bay Length (ft)		
Base Capacity (vph)		
Starvation Cap Reductn		
Spillback Cap Reductin		
Storage Cap Reductn		
Reduced v/c Ratio		
Intersection Summary		

Intersection Capacity Analysis 2. Summer St @ CJC Hwy

Actuated Cycle Length: 83							
Natural Cycle: 90							
Control Type: Actuated-Uncoordinated							
Maximum v/c Ratio: 0.89							
Intersection Signal Delay: 21.9	Intersection LOS: C						
Intersection Capacity Utilization 71.9%	ICU Level of Service C						
Analysis Period (min) 15							
# 95th percentile volume exceeds capacity, queue may be longer.							
Queue shown is maximum after two cycles.							

Splits and Phases: 3: Chief Justice Cushingh Hwy & Summer St

✓ ø1		↑ _{ø7}	1 ø8
8s <mark>4</mark> 6s	24 s	23 s	9 s
▶ _{ø5} ★ _{ø6}			
8s <mark>4</mark> 6s			

Intersection Capacity Analysis 3. Summer St @ Rockland St

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	ľ	≜ î∌		ľ	el el			ا	1		ا	1
Volume (vph)	58	745	24	110	474	8	15	29	85	7	23	30
Satd. Flow (prot)	1728	3435	0	1694	1780	0	0	1831	1583	0	2028	1743
Flt Permitted	0.309			0.232				0.884			0.926	
Satd. Flow (perm)	562	3435	0	413	1780	0	0	1647	1561	0	1898	1743
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)			2	2					1	1		
Peak Hour Factor	0.91	0.91	0.91	0.83	0.83	0.83	0.75	0.75	0.75	0.88	0.88	0.88
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	1%	1%	1%	3%	3%	3%	2%	2%	2%	5%	5%	5%
Adj. Flow (vph)	67	860	28	139	600	10	21	41	119	8	27	36
Shared Lane Traffic (%)												
Lane Group Flow (vph)	67	888	0	139	610	0	0	62	119	0	35	36
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	Perm
Protected Phases	5	2		1	6			3			3	
Permitted Phases	2			6			3		3	3		3
Detector Phase	5	2		1	6		3	3	3	3	3	3
Switch Phase												
Minimum Initial (s)	4.0	15.0		4.0	15.0		8.0	8.0	8.0	8.0	8.0	8.0
Minimum Split (s)	8.0	20.0		8.0	20.0		13.0	13.0	13.0	13.0	13.0	13.0
Total Split (s)	10.0	57.0		10.0	57.0		20.0	20.0	20.0	20.0	20.0	20.0
Total Split (%)	9.1%	51.8%		9.1%	51.8%		18.2%	18.2%	18.2%	18.2%	18.2%	18.2%
Yellow Time (s)	3.0	4.0		3.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Lost Time (s)	4.0	5.0		4.0	5.0			5.0	5.0		5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Recall Mode	None	Min		Min	Min		None	None	None	None	None	None
Act Effct Green (s)	37.7	30.2		39.8	36.2			12.7	12.7		12.7	12.7
Actuated g/C Ratio	0.60	0.48		0.63	0.57			0.20	0.20		0.20	0.20
v/c Ratio	0.15	0.54		0.35	0.60			0.19	0.38		0.09	0.10
Control Delay	7.5	14.8		9.7	18.2			31.1	34.0		30.5	30.7
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Delay	7.5	14.8		9.7	18.2			31.1	34.0		30.5	30.7
LOS	A	B		A	B			С	C		C	C
Approach Delay		14.3			16.6			33.0	Ŭ		30.6	Ŭ
Approach LOS		B			B			C			C	
Queue Length 50th (ft)	7	112		15	165			19	37		10	11
Queue Length 95th (ft)	40	287		68	416			67	116		52	53
Internal Link Dist (ft)	UF	378		00	358			249	110		637	55
Turn Bay Length (ft)	150	570		150	550			277	50		007	75
Base Capacity (vph)	473	2844		404	1473			464	440		535	491
Starvation Cap Reductn	473	2044		404	0			404	440		0	471
Spillback Cap Reductn	0	0		0	0			0	0		0	0
Storage Cap Reductin	0	0		0	0			0	0		0	0
Reduced v/c Ratio	0.14	0.31		0.34	0.41			0.13	0.27		0.07	0.07
Intersection Summary												

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Lane Configurations Volume (vph) Satd. Flow (prot) Flt Permitted Satd. Flow (perm) Satd. Flow (RTOR)
Volume (vph) Satd. Flow (prot) Flt Permitted Satd. Flow (perm) Satd. Flow (RTOR)
Satd. Flow (prot) Flt Permitted Satd. Flow (perm) Satd. Flow (RTOR)
Flt Permitted Satd. Flow (perm) Satd. Flow (RTOR)
Satd. Flow (RTOR)
Satd. Flow (RTOR)
Confl. Peds. (#/hr)
Peak Hour Factor
Growth Factor
Heavy Vehicles (%)
Adj. Flow (vph)
Shared Lane Traffic (%)
Lane Group Flow (vph)
Turn Type
Protected Phases 9
Permitted Phases
Detector Phase
Switch Phase
Minimum Initial (s) 4.0
Minimum Split (s) 23.0
Total Split (s) 23.0
Total Split (%) 21%
Yellow Time (s) 2.0
All-Red Time (s) 0.0
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)
Turn Bay Length (ft)
Base Capacity (vph) Starvation Cap Reductn
Spillback Cap Reductn
Storage Cap Reductn Reduced v/c Ratio
Intersection Summary

Intersection Capacity Analysis 3. Summer St @ Rockland St

Cycle Length: 110		
Actuated Cycle Length: 63.3		
Natural Cycle: 80		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.60		
Intersection Signal Delay: 17.5	Intersection LOS: B	
Intersection Capacity Utilization 52.5%	ICU Level of Service A	
Analysis Period (min) 15		

Splits and Phases: 4: Summer St & Rockland St & Martins Ln

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10 s	57 s	20 s	23 s
	∳ ø6		
10 s	57 s		

Intersection Capacity Analysis 4. G. W. Blvd @ Rockland St

	۲	۲	×	/	6	¥		
Lane Group	WBL	WBR	NET	NER	SWL	SWT	ø3	
Lane Configurations	۲	1	↑	1	7	1		-
Volume (vph)	106	23	665	177	18	481		
Satd. Flow (prot)	1662	1487	1801	1531	1711	1801		
Flt Permitted	0.950	1107			0.187	1001		
Satd. Flow (perm)	1662	1487	1801	1531	337	1801		
Satd. Flow (RTOR)	1002	28	1001	206	007	1001		
Peak Hour Factor	0.85	0.85	0.90	0.90	0.83	0.83		
Growth Factor	105%	105%	105%	105%	105%	105%		
Heavy Vehicles (%)	5%	5%	2%	2%	2%	2%		
Adj. Flow (vph)	131	28	776	206	23	608		
Shared Lane Traffic (%)		20		200	20	000		
Lane Group Flow (vph)	131	28	776	206	23	608		
Turn Type	Prot	Perm	NA	Perm	Perm	NA		
Protected Phases	4		2			6	3	
Permitted Phases		4	2	2	6	Ū	U	
Detector Phase	4	4	2	2	6	6		
Switch Phase	Т	Т	2	L	0	0		
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	4.0	
Minimum Split (s)	12.0	12.0	12.0	12.0	12.0	12.0	23.0	
Total Split (s)	12.0	16.0	56.0	56.0	56.0	56.0	23.0	
Total Split (%)	16.8%	16.8%	58.9%	58.9%	58.9%	58.9%	24%	
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	2.0	
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	1.0	
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0		
Lead/Lag	Lag	Lag	0.0	0.0	0.0	0.0	Lead	
Lead-Lag Optimize?	Yes	Yes					Yes	
Recall Mode	Min	Min	None	None	None	None	None	
Act Effct Green (s)	11.4	11.4	30.2	30.2	30.2	30.2	Tono	
Actuated g/C Ratio	0.21	0.21	0.55	0.55	0.55	0.55		
v/c Ratio	0.21	0.08	0.78	0.22	0.00	0.61		
Control Delay	29.2	13.3	17.2	2.0	9.0	12.1		
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0		
Total Delay	29.2	13.3	17.2	2.0	9.0	12.1		
LOS	27.2 C	13.5 B	B	2.0 A	A	12.1 B		
Approach Delay	26.4	U	14.0	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	/ \	12.0		
Approach LOS	20.4 C		14.0 B			12.0 B		
Queue Length 50th (ft)	32	0	142	0	3	96		
Queue Length 95th (ft)	#135	23	483	29	18	281		
Internal Link Dist (ft)	100	25	657	21	10	589		
Turn Bay Length (ft)	100		037	250	50	507		
Base Capacity (vph)	366	349	1622	1400	303	1622		
Starvation Cap Reductn	300 0	549 0	1022	1400	303 0	1022		
Spillback Cap Reductin	0	0	0	0	0	0		
Storage Cap Reductin	0	0	0	0	0	0		
Reduced v/c Ratio	0.36	0.08	0.48	0.15	0.08	0.37		
	0.50	0.00	0.40	0.15	0.00	0.37		
Intersection Summary								
Cycle Length: 95								

2040 PM Alt1 Final

Actuated Cycle Length: 54.9	
Natural Cycle: 75	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.78	
Intersection Signal Delay: 14.4	Intersection LOS: B
Intersection Capacity Utilization 51.2%	ICU Level of Service A
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be lo	nger.
Queue shown is maximum after two cycles.	

Splits and Phases: 13: Rockland St & G. W. Blvd

≯ ø2	₩A _{ø3}	▶ ²⁷ ø4
56 s	23 s	16 s
₩ ₉₆		
56 s		

	-	\mathbf{r}	1	-	1	1		
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3	
Lane Configurations		1	<u> </u>	<u> </u>	<u> </u>	1	00	_
Volume (vph)	595	83	34	402	50	22		
Satd. Flow (prot)	1818	1546	1728	1818	2025	1812		
Flt Permitted	1010	1540	0.267	1010	0.950	1012		
Satd. Flow (perm)	1818	1546	486	1818	2025	1812		
Satd. Flow (RTOR)	1010	73	400	1010	2025	32		
Peak Hour Factor	0.89	0.89	0.92	0.92	0.72	0.72		
Growth Factor	105%	105%	105%	105%	105%	105%		
Heavy Vehicles (%)	105 %	105 %	105 %	105 %	105 %	105 %		
Adj. Flow (vph)	702	98	39	459	73	32		
Shared Lane Traffic (%)	102	90	37	409	13	32		
. ,	702	98	39	459	73	32		
Lane Group Flow (vph)	NA	Perm		459 NA	Prot	Perm		
Turn Type Protected Phases	NA 2	Pelill	pm+pt 1	NA 6	P101 4	Pellii	3	
	2	2	-	0	4	Λ	3	
Permitted Phases	0	2 2	6	1	Λ	4		
Detector Phase	2	2	I	6	4	4		
Switch Phase	0.0	0.0	4.0	0.0	0.0	0.0	4.0	
Minimum Initial (s)	8.0	8.0	4.0	8.0	8.0	8.0	4.0	
Minimum Split (s)	46.0	46.0	8.0	46.0	13.0	13.0	21.0	
Total Split (s)	68.0	68.0	8.0	76.0	13.0	13.0	21.0	
Total Split (%)	61.8%	61.8%	7.3%	69.1%	11.8%	11.8%	19%	
Yellow Time (s)	4.0	4.0	3.0	4.0	3.0	3.0	2.0	
All-Red Time (s)	2.0	2.0	1.0	2.0	2.0	2.0	1.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0		
Total Lost Time (s)	6.0	6.0	4.0	6.0	5.0	5.0		
Lead/Lag	Lag	Lag	Lead		Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes	
Recall Mode	Min	Min	None	None	None	None	None	
Act Effct Green (s)	34.9	34.9	37.7	37.6	8.5	8.5		
Actuated g/C Ratio	0.68	0.68	0.73	0.73	0.17	0.17		
v/c Ratio	0.57	0.09	0.09	0.35	0.22	0.10		
Control Delay	9.9	2.7	2.9	4.8	24.9	11.1		
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0		
Total Delay	9.9	2.7	2.9	4.8	24.9	11.1		
LOS	А	А	А	А	С	В		
Approach Delay	9.0			4.6	20.7			
Approach LOS	А			А	С			
Queue Length 50th (ft)	104	2	3	56	20	0		
Queue Length 95th (ft)	268	19	8	91	48	15		
Internal Link Dist (ft)	1154			331	60			
Turn Bay Length (ft)		150	200					
Base Capacity (vph)	1801	1532	458	1818	334	326		
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	0.39	0.06	0.09	0.25	0.22	0.10		
Intersection Summary								
Cycle Length: 110								

2040 PM Alt1

Intersection Capacity Analysis 5. G. W. Blvd @ Rockland Circle

Actuated Cycle Length: 51.5		
Natural Cycle: 90		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.57		
Intersection Signal Delay: 8.4	Intersection LOS: A	
Intersection Capacity Utilization 48.7%	ICU Level of Service A	
Analysis Period (min) 15		

Splits and Phases: 3: Rockland Cir & G W Blvd

✓ ø1 → ø2	ÅÅ ø3	▲ ∕ø4
8 s 68 s	21 s	13 s
√ ø6		
76 s		

Intersection Capacity Analysis 6. G. W. Blvd @ Wharf Ave

	۶	-	\mathbf{r}	4	+	×	•	†	1	1	ţ	~
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		\$			र्भ	1	۲	≜î ≽		5	4Î	
Volume (vph)	13	6	7	35	2	15	5	593	13	17	402	10
Satd. Flow (prot)	0	1920	0	0	1609	1432	1736	3459	0	1608	1874	0
Flt Permitted		0.814			0.778		0.950			0.950		-
Satd. Flow (perm)	0	1599	0	0	1307	1412	1736	3459	0	1596	1874	0
Satd. Flow (RTOR)												-
Confl. Peds. (#/hr)	1		1	1		1			2	2		
Peak Hour Factor	0.65	0.65	0.65	0.72	0.72	0.72	0.92	0.92	0.92	0.95	0.95	0.95
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	5%	5%	5%	9%	9%	9%	4%	4%	4%	1%	1%	1%
Parking (#/hr)										0		
Adj. Flow (vph)	21	10	11	51	3	22	6	677	15	19	444	11
Shared Lane Traffic (%)					-		-					
Lane Group Flow (vph)	0	42	0	0	54	22	6	692	0	19	455	0
Turn Type	Perm	NA	0	Perm	NA	Perm	Prot	NA	Ū	Prot	NA	Ŭ
Protected Phases	1 01111	4		1 01111	8		5	2		1	6	
Permitted Phases	4	•		8	U	8	0	-			0	
Detector Phase	4	4		8	8	8	5	2		1	6	
Switch Phase	•	•		Ū	0	Ū	0	2			Ū	
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	8.0		4.0	8.0	
Minimum Split (s)	9.0	9.0		9.0	9.0	9.0	8.0	38.0		8.0	38.0	
Total Split (s)	22.0	22.0		22.0	22.0	22.0	10.0	64.0		10.0	64.0	
Total Split (%)	18.6%	18.6%		18.6%	18.6%	18.6%	8.5%	54.2%		8.5%	54.2%	
Yellow Time (s)	3.0	3.0		3.0	3.0	3.0	3.5	3.0		3.5	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	0.5	2.0		0.5	2.0	
Lost Time Adjust (s)	2.0	0.0		2.0	0.0	0.0	0.0	0.0		0.0	0.0	
Total Lost Time (s)		5.0			5.0	5.0	4.0	5.0		4.0	5.0	
Lead/Lag		5.0			5.0	5.0	Lead	Lag		Lead	Lag	
Lead-Lag Optimize?							Yes	Yes		Yes	Yes	
Recall Mode	None	None		None	None	None	None	Min		None	Min	
Act Effct Green (s)	NOTIC	8.3		NUTC	8.5	8.5	6.5	27.9		6.7	27.9	
Actuated g/C Ratio		0.20			0.20	0.20	0.16	0.67		0.16	0.67	
v/c Ratio		0.20			0.20	0.20	0.10	0.30		0.10	0.36	
Control Delay		20.2			21.2	20.4	24.2	8.6		23.9	10.4	
Queue Delay		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Total Delay		20.2			21.2	20.4	24.2	8.6		23.9	10.4	
LOS		20.2 C			21.2 C	20.4 C	24.2 C	A		23.7 C	B	
Approach Delay		20.2			21.0	C	C	8.7		C	10.9	
Approach LOS		20.2 C			21.0 C			0.7 A			10.9 B	
Queue Length 50th (ft)		6			8	3	1	35		3	ь 47	
Queue Length 95th (ft)		33			45	24	15	186		30	278	
Internal Link Dist (ft)		20			43 82	24	15	386		30	422	
Turn Bay Length (ft)		20			02		50	300		50	422	
		755			617	667		3274		268	1774	
Base Capacity (vph)							289					
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 21		0	0 26	
Reduced v/c Ratio		0.06			0.09	0.03	0.02	0.21		0.07	0.26	

2040 PM Alt1

Synchro 8 Report Page 1

Intersection Capacity Analysis 6. G. W. Blvd @ Wharf Ave

Intersection Summary	
Cycle Length: 118	
Actuated Cycle Length: 41.6	
Natural Cycle: 80	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.36	
Intersection Signal Delay: 10.6	Intersection LOS: B
Intersection Capacity Utilization 39.4%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 7: G W Blvd & Wharf Ave

øı	ø2	_{ø4}	
10 s	64 s	22 s	22 s
ø5		4 ø8	
10 s	64 s	22 s	

Lane Group	ø9
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Parking (#/hr)	
Adj. Flow (vph)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	19%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	1.0
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	Nana
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)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

APPENDIX K

Intersection Capacity Analyses Summer Saturday Midday Peak Hour Projected 2040 Traffic Conditions with Proposed Improvements

Intersection Capacity Analysis 1. Summer St @ North St

	-	\mathbf{F}	4	←	•	1		
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3	ļ
Lane Configurations	≜ †⊅			-î†	٦	1		
Volume (vph)	1261	67	316	777	200	567		
Satd. Flow (prot)	3080	0	0	2884	1608	1439		
Flt Permitted			Ű	0.521	0.950			
Satd. Flow (perm)	3080	0	0	1524	1442	1439		
Satd. Flow (RTOR)	5	Ū	Ű	1021		308		
Confl. Peds. (#/hr)		7	7		49	18		
Peak Hour Factor	0.94	0.94	0.93	0.93	0.94	0.94		
Growth Factor	105%	105%	105%	105%	105%	105%		
Heavy Vehicles (%)	1%	1%	2%	2%	1%	1%		
Parking (#/hr)	170	170	270	0	170	.,,,		
Shared Lane Traffic (%)								
Lane Group Flow (vph)	1484	0	0	1234	223	633		
Turn Type	NA	Ũ	pm+pt	NA	Prot	pt+ov		
Protected Phases	2		1 1	6	4	4 1	3	
Permitted Phases	£		6	U U			0	
Detector Phase	2		1	6	4	4 1		
Switch Phase	£			5				
Minimum Initial (s)	8.0		4.0	8.0	9.0		4.0	
Minimum Split (s)	13.0		9.0	13.0	14.0		21.0	
Total Split (s)	55.0		22.0	77.0	22.0		21.0	
Total Split (%)	45.8%		18.3%	64.2%	18.3%		18%	
Yellow Time (s)	43.070		4.0	4.0	4.0		2.0	
All-Red Time (s)	1.0		1.0	1.0	1.0		0.0	
Lost Time Adjust (s)	0.0			0.0	0.0		0.0	
Total Lost Time (s)	5.0			5.0	5.0			
Lead/Lag	Lead		Lag	0.0	Lag		Lead	
Lead-Lag Optimize?	Yes		Yes		Yes		Yes	
Recall Mode	Min		None	Min	None		None	
Act Effct Green (s)	50.4			72.6	17.2	37.6		
Actuated g/C Ratio	0.47			0.68	0.16	0.35		
v/c Ratio	1.02			1.30dl	0.87	0.90		
Control Delay	59.5			46.5	77.2	33.2		
Queue Delay	0.0			0.0	0.0	0.0		
Total Delay	59.5			46.5	77.2	33.2		
LOS	57.5 E			40.5 D	E	55.2 C		
Approach Delay	59.5			46.5	44.7	U		
Approach LOS	57.5 E			40.3 D	44.7 D			
Queue Length 50th (ft)	448			165	137	195		
Queue Length 95th (ft)	#856			#631	#335	#391		
Internal Link Dist (ft)	#050 764			213	#335 85	11371		
Turn Bay Length (ft)	704			213	00			
Base Capacity (vph)	1449			1247	256	703		
Starvation Cap Reductn	0			1247	250	0		
Spillback Cap Reductin	0			0	0	0		
Storage Cap Reductin	0				0	0		
Reduced v/c Ratio				0 0.99	0.87	0.90		
	1.02			0.99	0.87	0.90		
Intersection Summary								

2040 Summer Saturday Peak-Hour with Proposed Improvements

Intersection Capacity Analysis 1. Summer St @ North St

Cycle Length: 120						
Actuated Cycle Length: 107.4						
Natural Cycle: 130						
Control Type: Actuated-Uncoordinated						
Maximum v/c Ratio: 1.02						
Intersection Signal Delay: 51.5	Intersection LOS: D					
Intersection Capacity Utilization 104.4%	ICU Level of Service G					
Analysis Period (min) 15						
# 95th percentile volume exceeds capacity, queue may be lo	nger.					
Queue shown is maximum after two cycles.						
dl Defacto Left Lane. Recode with 1 though lane as a left lane.						

Splits and Phases: 1: North St & Otis St/Summer St

→ ø2	€ ø1		₩ ø4
55 s	22 s	21 s	22 s
₩ ø6			
77 s			

Intersection Capacity Analysis 2. Summer St @ CJC Hwy

	۲	→	7	۶.	╉	*	` +	×	4	*	×	4
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations	7	††	1	7	A			र्स	1	<u>۲</u>	\$	
Volume (vph)	40	1357	501	48	679	10	10	10	40	387	10	4
Satd. Flow (prot)	1711	3455	1546	1728	3448	0	0	1757	1531	1698	1644	0
Flt Permitted	0.264			0.089				0.976		0.950	0.955	
Satd. Flow (perm)	475	3455	1546	162	3448	0	0	1757	1531	1698	1644	0
Satd. Flow (RTOR)			256		1				139		1	
Peak Hour Factor	0.92	0.94	0.94	0.85	0.85	0.92	0.92	0.92	0.92	0.85	0.92	0.85
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	2%	1%	1%	1%	1%	2%	2%	2%	2%	1%	2%	1%
Shared Lane Traffic (%)										48%		
Lane Group Flow (vph)	46	1516	560	59	850	0	0	22	46	249	245	0
Turn Type	pm+pt	NA	Perm	pm+pt	NA		Split	NA	Perm	Split	NA	
Protected Phases	5	2		1	6		. 4	4		. 8	8	
Permitted Phases	2		2	6					4			
Detector Phase	5	2	2	1	6		4	4	4	8	8	
Switch Phase												
Minimum Initial (s)	4.0	8.0	8.0	4.0	8.0		4.0	4.0	4.0	8.0	8.0	
Minimum Split (s)	8.0	13.0	13.0	8.0	13.0		9.0	9.0	9.0	13.0	13.0	
Total Split (s)	8.0	46.0	46.0	8.0	46.0		9.0	9.0	9.0	23.0	23.0	
Total Split (%)	7.3%	41.8%	41.8%	7.3%	41.8%		8.2%	8.2%	8.2%	20.9%	20.9%	
Yellow Time (s)	3.0	4.0	4.0	3.0	4.0		4.0	4.0	4.0	4.0	4.0	
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0	
Total Lost Time (s)	4.0	5.0	5.0	4.0	5.0			5.0	5.0	5.0	5.0	
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lag	Lag	Lag			
Lead-Lag Optimize?		- 3	- 3		- 3		- 5	- 3	- 5			
Recall Mode	None	Min	Min	Min	Min		None	None	None	None	None	
Act Effct Green (s)	46.6	41.5	41.5	48.4	45.1			4.1	4.1	17.3	17.3	
Actuated g/C Ratio	0.53	0.48	0.48	0.56	0.52			0.05	0.05	0.20	0.20	
v/c Ratio	0.15	0.92	0.64	0.36	0.48			0.27	0.23	0.74	0.75	
Control Delay	12.0	33.8	14.5	17.3	17.4			52.6	2.6	49.4	50.5	
Queue Delay	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0	
Total Delay	12.0	33.8	14.5	17.3	17.4			52.6	2.6	49.4	50.5	
LOS	В	С	В	В	В			D	A	D	D	
Approach Delay	_	28.2	_	_	17.4			18.8		_	49.9	
Approach LOS		С			В			В			D	
Queue Length 50th (ft)	10	385	112	13	161			12	0	132	129	
Queue Length 95th (ft)	36	#758	318	41	282			41	0	#288	#318	
Internal Link Dist (ft)		610	0.0		627			20	0	# 1 00	83	
Turn Bay Length (ft)	100	0.10	150	100	027			20				
Base Capacity (vph)	311	1646	870	162	1782			81	203	355	344	
Starvation Cap Reductn	0	0	0	0	0			0	0	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	0.15	0.92	0.64	0.36	0.48			0.27	0.23	0.70	0.71	
	0.10	0.72	0.01	0.00	0.10			5.27	0.20	0.70	0.71	
Intersection Summary												
Cycle Length: 110 Actuated Cycle Length: 87.2												

Actuated Cycle Length: 87.2

2040 Summer Saturday Peak-Hour with Proposed Improvements

Lane Group	ø3	
Lane Configurations		
Volume (vph)		
Satd. Flow (prot)		
Flt Permitted		
Satd. Flow (perm)		
Satd. Flow (RTOR)		
Peak Hour Factor		
Growth Factor		
Heavy Vehicles (%)		
Shared Lane Traffic (%)		
Lane Group Flow (vph)		
Turn Type		
Protected Phases	3	
Permitted Phases		
Detector Phase		
Switch Phase		
Minimum Initial (s)	4.0	
Minimum Split (s)	24.0	
Total Split (s)	24.0	
Total Split (%)	22%	
Yellow Time (s)	2.0	
All-Red Time (s)	1.0	
Lost Time Adjust (s)		
Total Lost Time (s)		
Lead/Lag	Lead	
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)		
Turn Bay Length (ft)		
Base Capacity (vph)		
Starvation Cap Reductn		
Spillback Cap Reductn		
Storage Cap Reductn		
Reduced v/c Ratio		
Intersection Summary		

Intersection Capacity Analysis 2. Summer St @ CJC Hwy

Natural Cycle: 110		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.92		
Intersection Signal Delay: 28.3	Intersection LOS: C	
Intersection Capacity Utilization 68.5%	ICU Level of Service C	
Analysis Period (min) 15		
# 95th percentile volume exceeds capacity, queue may	be longer.	
Queue shown is maximum after two cycles.		

Splits and Phases: 3: Summer St

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8 s 🛛	46 s	24 s	9 s 🛛	23 s
لگ _{ø5}	4 ø6			
8 s 🛛	46 s			

Intersection Capacity Analysis 3. Summer St @ Rockland St

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	1	≜ î≽		٦	el 🗧			र्च	1		र्भ	7
Volume (vph)	55	1344	25	112	693	7	17	28	104	7	25	22
Satd. Flow (prot)	1728	3443	0	1728	1817	0	0	1866	1615	0	2088	1794
Flt Permitted	0.228			0.087				0.861			0.922	
Satd. Flow (perm)	415	3443	0	158	1817	0	0	1636	1615	0	1945	1794
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)			2	2					1	1		
Peak Hour Factor	0.95	0.95	0.95	0.89	0.89	0.89	0.85	0.85	0.85	0.90	0.90	0.90
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	0%	0%	0%	2%	2%	2%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	61	1513	0	132	826	0	0	56	128	0	37	26
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	pt+ov	Perm	NA	Prot
Protected Phases	5	2		1	6			3	31		3	3
Permitted Phases	2			6			3			3		
Detector Phase	5	2		1	6		3	3	31	3	3	3
Switch Phase												
Minimum Initial (s)	4.0	15.0		4.0	15.0		8.0	8.0		8.0	8.0	8.0
Minimum Split (s)	8.0	20.0		8.0	20.0		13.0	13.0		13.0	13.0	13.0
Total Split (s)	8.0	63.0		11.0	66.0		13.0	13.0		13.0	13.0	13.0
Total Split (%)	7.3%	57.3%		10.0%	60.0%		11.8%	11.8%		11.8%	11.8%	11.8%
Yellow Time (s)	3.5	4.0		3.0	4.0		4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	0.5	1.0		1.0	1.0		1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0			0.0	0.0
Total Lost Time (s)	4.0	5.0		4.0	5.0			5.0			5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Recall Mode	None	Min		Min	Min		None	None		None	None	None
Act Effct Green (s)	52.6	47.4		58.4	52.1			8.3	18.5		8.3	8.3
Actuated g/C Ratio	0.65	0.59		0.73	0.65			0.10	0.23		0.10	0.10
v/c Ratio	0.18	0.74		0.54	0.70			0.33	0.35		0.18	0.14
Control Delay	5.7	15.9		17.9	15.5			45.6	29.9		42.2	42.0
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Delay	5.7	15.9		17.9	15.5			45.6	29.9		42.2	42.0
LOS	А	В		В	В			D	С		D	D
Approach Delay		15.6			15.8			34.7			42.1	
Approach LOS		В			В			С			D	
Queue Length 50th (ft)	5	227		11	211			25	50		17	12
Queue Length 95th (ft)	31	558		#101	629			76	98		59	46
Internal Link Dist (ft)		424			358			249			637	
Turn Bay Length (ft)	150			150					50			75
Base Capacity (vph)	339	2584		257	1434			169	382		201	185
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	0.18	0.59		0.51	0.58			0.33	0.34		0.18	0.14
Intersection Summary												
Cycle Length: 110												
Sjolo Longin. TTO												

2040 Summer Saturday Peak-Hour with Proposed Improvements

Lang Configurations Volume (vph) Sald. Flow (prof) FIL Permitted Sald. Flow (prof) Sald. Flow (prof) Sald. Flow (PTOR) Confl. Peds. (#hn) Peak Hour Factor Growth Factor Heavy Vehicles (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Potelected Phases Detector Phase Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 23.0 Total Split (s) 23.0 Total Split (s) 23.0 Total Split (s) 2.0 All-Red Time (s) 0.0 Lost Time Adjust (s) Total Split (%) Total Lost Time (s) 0.0 Lead/Lag Lead/Lag Lead/Lag None Actuate g/C Ratio V/C Ratio Contol Delay Oueue Delay Oueue Delay Total Delay Lead/Lag Contol Delay Oueue Length Stht (th) Coueue Length Stht (th)	Lane Group	ø9		
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Storage Cap Reductn Reduced v/c Ratio				
Reduced v/c Ratio				
Reduced v/c Ratio	Storage Cap Reductn			
Intersection Summary				
intersection summary	Intersection Summary			
	Intersection Summary			

Actuated Cycle Length: 80.4						
Natural Cycle: 90						
Control Type: Actuated-Uncoordinated						
Maximum v/c Ratio: 0.74						
Intersection Signal Delay: 17.5	Intersection LOS: B					
Intersection Capacity Utilization 67.2%	ICU Level of Service C					
Analysis Period (min) 15						
# 95th percentile volume exceeds capacity, queue may be longer.						
Queue shown is maximum after two cycles.						

Splits and Phases: 4: Summer St & Rockland St & Martins Ln

	1	∦≜ ø9
11 s 63 s	13 s	23 s
▶ø5 ▼ ø6		
8 s 66 s		

Intersection Capacity Analysis 4. Rockland St @ G. W. Blvd

	*	۲	×	/	6	*	
Lane Group	WBL	WBR	NET	NER	SWL	SWT	ø3
Lane Configurations	<u>1102</u>	1	1	1	<u> </u>	<u>+</u>	
Volume (vph)	26	129	1223	202	23	718	
Satd. Flow (prot)	1728	1546	1818	1546	1728	1818	
Flt Permitted	0.950	1340	1010	1540	0.072	1010	
Satd. Flow (perm)	1728	1546	1818	1546	131	1818	
Satd. Flow (RTOR)	1720	1540	1010	1340	131	1010	
Peak Hour Factor	0.88	0.88	0.92	0.92	0.88	0.88	
Growth Factor	105%	105%	105%	105%	105%	105%	
Heavy Vehicles (%)	105 %	105 %	105 %	105 %	105 %	105 %	
Shared Lane Traffic (%)	1 /0	1 /0	1 /0	1 /0	1 /0	1 /0	
	31	154	1396	231	27	857	
Lane Group Flow (vph)	Prot		NA			NA	
Turn Type		Perm		Perm	Perm		n
Protected Phases	4	4	2	0	1	6	3
Permitted Phases	Λ	4	C	2 2	6	/	
Detector Phase	4	4	2	2	6	6	
Switch Phase	7.0	7.0	7.0	7.0	7.0	7.0	4.0
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	4.0
Minimum Split (s)	12.0	12.0	12.0	12.0	12.0	12.0	23.0
Total Split (s)	12.0	12.0	60.0	60.0	60.0	60.0	23.0
Total Split (%)	12.6%	12.6%	63.2%	63.2%	63.2%	63.2%	24%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	
Lead/Lag	Lag	Lag					Lead
Lead-Lag Optimize?	Yes	Yes					Yes
Recall Mode	Min	Min	None	None	None	None	None
Act Effct Green (s)	7.1	7.1	55.5	55.5	55.5	55.5	
Actuated g/C Ratio	0.09	0.09	0.73	0.73	0.73	0.73	
v/c Ratio	0.19	0.54	1.05	0.20	0.28	0.64	
Control Delay	37.4	14.6	52.8	2.6	15.6	9.7	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	37.4	14.6	52.8	2.6	15.6	9.7	
LOS	D	В	D	А	В	А	
Approach Delay	18.5		45.6			9.9	
Approach LOS	В		D			А	
Queue Length 50th (ft)	13	0	~472	8	3	124	
Queue Length 95th (ft)	44	54	#1276	52	32	486	
Internal Link Dist (ft)	100		459			589	
Turn Bay Length (ft)				200	50		
Base Capacity (vph)	161	283	1330	1167	96	1330	
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	0.19	0.54	1.05	0.20	0.28	0.64	
Intersection Summary							
Cycle Length: 95							
Actuated Cycle Length: 75.8	3						

2040 Summer Saturday Peak-Hour with Proposed Improvements

Natural Cycle: 150					
Control Type: Actuated-Uncoordinated					
Maximum v/c Ratio: 1.05					
Intersection Signal Delay: 32.1	Intersection LOS: C				
Intersection Capacity Utilization 84.3%	ICU Level of Service E				
Analysis Period (min) 15					
~ Volume exceeds capacity, queue is theoretically inf	finite.				
Queue shown is maximum after two cycles.					
# 95th percentile volume exceeds capacity, queue may be longer.					
Queue shown is maximum after two cycles.					
Queue shown is maximum after two cycles.					

Splits and Phases: 13:

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Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3	
Lane Configurations	<u> </u>	1	<u> </u>	1	Ĭ	1		
Volume (vph)	1170	100	25	675	60	25		
Satd. Flow (prot)	1818	1546	1728	1818	2025	1812		
Flt Permitted	1010	1010	0.057	1010	0.950	1012		
Satd. Flow (perm)	1818	1546	104	1818	2025	1812		
Satd. Flow (RTOR)	1010	49	101	1010	2020	29		
Peak Hour Factor	1.00	0.92	0.92	0.92	0.92	0.92		
Growth Factor	105%	105%	105%	105%	105%	105%		
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%		
Shared Lane Traffic (%)	170	170	170	170	170	170		
Lane Group Flow (vph)	1228	114	29	770	68	29		
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm		
Protected Phases	2	1 01111	1	6	4	1 01111	3	
Permitted Phases	2	2	6	5		4	U	
Detector Phase	2	2	1	6	4	4		
Switch Phase	2	2		0	т	т		
Minimum Initial (s)	40.0	40.0	4.0	40.0	8.0	8.0	4.0	
Minimum Split (s)	46.0	46.0	8.0	46.0	13.0	13.0	21.0	
Total Split (s)	68.0	68.0	8.0	76.0	13.0	13.0	21.0	
Total Split (%)	61.8%	61.8%	7.3%	69.1%	11.8%	11.8%	19%	
Yellow Time (s)	4.0	4.0	3.0	4.0	3.0	3.0	2.0	
All-Red Time (s)	2.0	2.0	1.0	2.0	2.0	2.0	1.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	1.0	
Total Lost Time (s)	6.0	6.0	4.0	6.0	5.0	5.0		
Lead/Lag	Lag	Lag	Lead	0.0	Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes	
Recall Mode	Min	Min	None	None	None	None	None	
Act Effct Green (s)	67.2	67.2	70.9	70.1	8.1	8.1		
Actuated g/C Ratio	0.76	0.76	0.80	0.79	0.09	0.09		
v/c Ratio	0.89	0.10	0.18	0.53	0.37	0.15		
Control Delay	23.1	4.1	6.3	7.4	46.8	18.2		
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0		
Total Delay	23.1	4.1	6.3	7.4	46.8	18.2		
LOS	C	A	A	A	D	B		
Approach Delay	21.5			7.3	38.3	2		
Approach LOS	C			A	D			
Queue Length 50th (ft)	343	6	2	121	33	0		
Queue Length 95th (ft)	#1276	45	16	424	91	29		
Internal Link Dist (ft)	1154		10	331	60	21		
Turn Bay Length (ft)	1104	150	200	551	00	25		
Base Capacity (vph)	1382	1187	157	1513	185	192		
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	0.89	0.10	0.18	0.51	0.37	0.15		
Intersection Summary								
Cycle Length: 110								

Cycle Length: 110 Actuated Cycle Length: 88.4

2040 Summer Saturday Alt 1

Natural Cycle: 140	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.89	
Intersection Signal Delay: 17.2	Intersection LOS: B
Intersection Capacity Utilization 80.5%	ICU Level of Service D
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be lo	nger.
Queue shown is maximum after two cycles.	

Splits and Phases: 3: Rockland Cir & G W Blvd

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Intersection Capacity Analysis 6. G. W. Blvd @ Wharf Ave

11/22/201	5
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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		÷			र्स	1	۲	≜ î≽		۲	ef 👘	
Volume (vph)	10	10	29	138	6	32	18	910	262	23	639	17
Satd. Flow (prot)	0	1665	0	0	1735	1546	1728	3430	0	1608	1872	0
Flt Permitted		0.927			0.752		0.950			0.950		
Satd. Flow (perm)	0	1553	0	0	1196	1487	1545	3430	0	1576	1872	0
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)	16		55	55		16	22		9	9		22
Peak Hour Factor	0.75	0.75	0.75	0.88	0.88	0.88	0.95	0.95	0.95	0.91	0.91	0.91
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	6%	6%	6%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Parking (#/hr)										0		
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	69	0	0	172	38	20	1296	0	27	757	0
Turn Type	Perm	NA		Perm	NA	Perm	Prot	NA		Prot	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8		8						
Detector Phase	4	4		8	8	8	5	2		1	6	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	8.0		4.0	8.0	
Minimum Split (s)	9.0	9.0		9.0	9.0	9.0	8.0	38.0		8.0	38.0	
Total Split (s)	25.0	25.0		25.0	25.0	25.0	8.0	56.0		8.0	56.0	
Total Split (%)	22.7%	22.7%		22.7%	22.7%	22.7%	7.3%	50.9%		7.3%	50.9%	
Yellow Time (s)	3.0	3.0		3.0	3.0	3.0	3.5	3.0		3.5	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	0.5	2.0		0.5	2.0	
Lost Time Adjust (s)	2.0	0.0		2.0	0.0	0.0	0.0	0.0		0.0	0.0	
Total Lost Time (s)		5.0			5.0	5.0	4.0	5.0		4.0	5.0	
Lead/Lag		0.0			0.0	0.0	Lead	Lag		Lead	Lag	
Lead-Lag Optimize?							Yes	Yes		Yes	Yes	
Recall Mode	None	None		None	None	None	None	Min		None	Min	
Act Effct Green (s)	None	18.2		None	18.2	18.2	4.4	43.9		4.4	45.3	
Actuated g/C Ratio		0.21			0.21	0.21	0.05	0.51		0.05	0.53	
v/c Ratio		0.21			0.21	0.12	0.03	0.73		0.33	0.33	
Control Delay		36.1			51.1	35.5	55.5	21.9		60.0	25.3	
Queue Delay		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Total Delay		36.1			51.1	35.5	55.5	21.9		60.0	25.3	
LOS		50.1 D			D	55.5 D	55.5 E	21.7 C		00.0 E	25.5 C	
Approach Delay		36.1			48.3	U	L	22.4		L	26.5	
Approach LOS		50.1 D			40.3 D			22.4 C			20.5 C	
		38				21	10	373		10	362	
Queue Length 50th (ft) Queue Length 95th (ft)		38 67			107 #211	50	13 39	464		18 #55	362 #664	
						50	39			#33		
Internal Link Dist (ft)		20			82		100	386		100	422	
Turn Bay Length (ft)		200			207	202	100	2240		100	1040	
Base Capacity (vph)		399			307	382	88	2248		82	1243	
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		0.17			0.56	0.10	0.23	0.58		0.33	0.61	
Intersection Summary												

2040 Summer Saturday Alt 1

Lane Group	ø9	
Lane Configurations		
Volume (vph)		
Satd. Flow (prot)		
Flt Permitted		
Satd. Flow (perm)		
Satd. Flow (RTOR)		
Confl. Peds. (#/hr)		
Peak Hour Factor		
Growth Factor		
Heavy Vehicles (%)		
Parking (#/hr)		
Shared Lane Traffic (%)		
Lane Group Flow (vph)		
Turn Type		
Protected Phases	9	
Permitted Phases	,	
Detector Phase		
Switch Phase		
Minimum Initial (s)	4.0	
Minimum Split (s)	21.0	
Total Split (s)	21.0	
Total Split (%)	19%	
Yellow Time (s)	2.0	
All-Red Time (s)	1.0	
Lost Time Adjust (s)	1.0	
Total Lost Time (s)		
Lead/Lag		
Lead-Lag Optimize?		
Recall Mode	None	
Act Effct Green (s)	NUTE	
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)		
Turn Bay Length (ft)		
Base Capacity (vph)		
Starvation Cap Reductn		
Spillback Cap Reductn		
Storage Cap Reductn		
Reduced v/c Ratio		
Intersection Summary		

Cycle Length: 110		
Actuated Cycle Length: 85.4		
Natural Cycle: 90		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.76		
Intersection Signal Delay: 26.4	Intersection LOS: C	
Intersection Capacity Utilization 59.8%	ICU Level of Service B	
Analysis Period (min) 15		
# 95th percentile volume exceeds capacity, queue ma	ay be longer.	
Queue shown is maximum after two cycles.		

Splits and Phases: 7: G W Blvd & Wharf Ave

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8 s 🛛	56 s	25 s	

Intersection Capacity Analysis 7. Otis St (Rt 3A) @ Hingham Bathing Beach

11/22/2015

Lane Group WBL WBR NBR SBL SBL s3 Lane Configurations ✓ ↑↑ ↓↑ ↓↑ ↓↑ Satk Flow (prot) 1665 0 3365 0 0 3445 Fit Permitted 0.972 0.714 Satk Flow (prom) 1660 0 3365 0 0 2467 Satk Flow (perm) 1660 0 3365 0 0 2467 Satk Flow (perm) 1660 0 3365 0 0 2467 Satk Flow (Perm) 1660 0 3365 0 0 2467 Satk Flow (Perm) 167 105% 105% 105% 105% 105% Conth Peds, (Hrh) 4 160 1424 170 171 180 180 Lane Corup Flow (vph) 255 0 1191 0 1424 170 1245 Turn Type Prot NA Permitud Prases 6 3		4	•	Ť	1	1	Ļ			
Lane Configurations Y Ap Ap Ap Volume (vph) 132 98 832 177 76 1212 Satd. Flow (prot) 1665 0 3365 0 0 2445 FIL Permitted 0.972 0.714 5 0.714 Satd. Flow (PTOR) 33 0 0 2467 Satd. Flow (RTOR) 33 0 0 95 0.95 Growth Factor 105% 105% 105% 105% 105% 105% Heary Vehicles (%) 1% 1% 1% 1% 1% 1% Shared Lane Traffic (%) 1 1% 1% 1% 1% 1% Lane Group Flow (vph) 265 0 1191 0 1424 1 Lane Group Flow (vph) 265 0 149 1% 1% 1% Protected Phases 4 2 6 6 250 101 Dataspit (s) 13.0	Lane Group	WBL	WBR	NBT	NBR	SBL	SBT	ø3		
Volume (vph) 132 98 832 177 76 1212 Satd. Flow (prot) 1665 0 3365 0 0 3445 File Permitted 0.972 0.714										
Satu Flow (prot) 1665 0 3365 0 0 3445 FIP Permitted 0.972 0.714 0.714 Satu Flow (Porm) 1660 0 3365 0 0 2467 Satu Flow (RTOR) 0.91 0.89 0.89 0.95 0.95 0.95 Growth Factor 105% 105% 105% 105% 105% 105% Lane Group Flow (rph) 265 0 1191 0 0 1424 Turn Type Prot NA Perm NA Permitted Phases 6 3 Permitted Phase 6 3 6 6 3 6 6 3 Protected Phase 4 2 6 7 7 6 5 0 5 0 5 7			98		177	76				
FIP Emmitted 0.972 0.714 Satd. Flow (perm) 1660 0 335 Confl. Peds. (#hr) 4										
Satd. Flow (PTOR) 333 Confl. Peds. (#hr) 4 Peak Hour Factor 0.91 0.89 0.89 0.95 Growth Factor 105% 105% 105% 105% 105% Heavy Vehicles (%) 1% 1% 1% 1% 1% 1% Shared Lane Traffic (%) Lane Group Flow (vph) 265 0 1191 0 0 1424 Turn Type Prot NA Perm NA Permitted Phases 6 3 Permitted Phases 4 2 6 3 3 50.0 105.0 45.0 45.0 25.0 Total Split (s) 13.0 45.0 45.0 45.0 25.0 10.1 10.0	ü ,		Ū		•	Ŭ				
Satd. Flow (RTOR) 33 Confl. Peds. (#hrt) 4 Peak Hour Factor 0.91 0.91 0.89 0.95 0.95 Growth Factor 105% 105% 105% 105% 105% 105% Heavy Vehicles (%) 1% 1% 1% 1% 1% 1% Stand Lane Traffic (%) 1 0 0 1424 Turn Type Prot NA Perm NA Protected Phases 4 2 6 3 Portited Phases 4 2 6 3 Protected Phase 4 2 6 3 Minimum Initial (s) 4.0 40.0 40.0 40.0 Minimum Split (s) 13.0 45.0 45.0 25.0 Total Split (%) 26.3% 47.4% 47.4% 47.4% 26% Yellow Time (s) 1.0 1.0 1.0 1.0 1.0 1.0 Lotal Split (%) 26.0			0	3365	0	0				
Confl. Peds. (#hr) 4 Peak Hour Factor 0.91 0.91 0.89 0.95 0.95 Growth Factor 105% 105% 105% 105% 105% Heavy Vehicles (%) 1% 1% 1% 1% 1% Lane Group Floot NA Perm NA Protected Phases 6 3 Permitted Phases 6 5 Detector Phase 4 2 6 6 Switch Phase 13.0 45.0 45.0 45.0 25.0 Total Split (s) 13.0 45.0 45.0 45.0 25.0 Total Split (s) 25.0 45.0 45.0 45.0 45.0 Total Split (s) 26.3% 47.4% 47.4% 47.4% 26% Yellow Time (s) 1.0 1.0 1.0 1.0 1.0 1.0 Lead/Lag Optimize? Yes Yes Yes Yes Yes Recall Mode None Max Max None Act Effct Green (s) 16.7 41.0 Act 1.0	ŭ /	1000	Ŭ		Ű	Ŭ	2101			
Peak Hour Factor 0.91 0.91 0.89 0.89 0.95 0.95 Growth Factor 105% 105% 105% 105% 105% 105% Heavy Vehicles (%) 1% 1% 1% 1% 1% 1% Shared Lane Traffic (%) 2 6 3 1		4		00						
Growth Factor 105%			0.91	0.89	0.89	0.95	0.95			
Heavy Vehicles (%) 1% 1% 1% 1% 1% 1% Shared Lane Traffic (%) Lane Group Flow (vph) 265 0 1191 0 0 1424 Turn Type Prot NA Perm NA Protected Phases 4 2 6 3 Permitted Phases 6 5 Switch Phase 6 5 Minimum Initial (s) 4.0 40.0 40.0 40.0 Minimum Split (s) 13.0 45.0 45.0 25.0 Total Split (%) 26.3% 47.4% 47.4% 47.4% 26% Yellow Time (s) 4.0 4.0 4.0 4.0 4.0 Last Time A(s) 5.0 5.0 5.0 5.0 Lead/Lag Lag Lead Lead Lead Lead Lead/Lag Lag Log Log Log Log Queue Delay 0.0 0.0 0.0 O O O Lead/Lag Optimize? Yes Yes Yes Yes Yes										
Shared Lane Traffic (%) Lane Group Flow (vph) 265 0 1191 0 0 1424 Lane Group Flow (vph) 265 0 1191 0 0 1424 Protected Phases 4 2 6 3 Permited Phases 6 6 Switch Phase 6 6 Switch Phase 4 2 6 6 Switch Phase 4 0 40.0 40.0 40.0 40.0 Claid Split (\$) 26.3% 47.4% 47.4% 47.4% 26% Yellow Time (\$) 1.0 1.0 1.0 1.0 1.0 Lost Time (\$) 0.0 0.0 0.0 0.0 0.0 Load Lag Lag Max Max Max None Act Effct Gr										
Lane Group Flow (vph) 265 0 1191 0 0 1424 Tum Type Prot NA Perm NA Protected Phases 4 2 6 3 Permitted Phases 6 5 Switch Phase 4 2 6 6 Switch Phase 4 2 6 6 Minimum Initial (s) 4.0 40.0 40.0 40.0 40.0 Minimum Split (s) 13.0 45.0 45.0 45.0 25.0 Total Split (%) 26.3% 47.4% 47.4% 47.4% 26% 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 Lead Lag Optimize? Yes Yes Recail Mode None Act Effct Green (s) 16.7 41.0 41.0 Actuated g/C Ratio 0.63 0.62 1.01 Control Delay 36.9 14.1		170	170	170	170	170	170			
Turn Type Prot NA Perm NA Protected Phases 6 3 Detector Phase 4 2 6 6 Detector Phase 4 2 6 6 Switch Phase		265	0	1101	0	0	1424			
Protected Phases 4 2 6 3 Permited Phases 6 Detector Phase 4 2 6 6 Minimum Initial (s) 40 400 400 400 400 4.0 Minimum Split (s) 13.0 45.0 45.0 45.0 25.0 Total Split (s) 25.0 45.0 45.0 45.0 25.0 Total Split (s) 26.3% 47.4% 47.4% 47.4% 26% 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 Lost Time Adjust (s) 0.0 0.0 Total Lost Time (s) 5.0 5.0 5.0 Lead/Lag Lag Lead Lead-Lag Optimize? Yes Recall Mode None Max Max Max None Act EffC Green (s) 16.7 41.0 41.0 Actuated g/C Ratio 0.23 0.57 0.57 Ve Ratio 0.68 0.62 1.01 Control Delay 36.9 14.1 46.0 Queue Delay 0.0 0.0 Los D B D Approach Delay 36.9 14.1 46.0 LOS D B D Approach Delay 36.9 14.1 46.0 LOS D B D Sanzai D B D Approach LOS D B D Sanzai D B D Approach LOS D A D Staryation Cap Reductn 0 0 Queue Length 50th (ft) 475 1936 1409 Staryation Cap Reductn 0 0 Storage Cap Reductn 0 0 Reduced Vic Ratio 0.56 0.62 1.01 Intersection Summary			U		0					
Permitted Phases 6 Detector Phase 4 2 6 6 Switch Phase								3		
Detector Phase 4 2 6 6 Switch Phase				2		6	U	5		
Switch Phase Minimum Initial (s) 4.0 40.0 40.0 40.0 4.0 Minimum Split (s) 13.0 45.0 45.0 25.0 Total Split (s) 26.3% 47.4% 47.4% 47.4% 26% 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) 5.0 5.0 5.0 5.0 1.0 Lost Time Adjust (s) 5.0 5.0 5.0 5.0 1.0 Lead/Lag Lag Lead Lead Lead Lead Lead 1.0 <td< td=""><td></td><td>1</td><td></td><td>2</td><td></td><td></td><td>6</td><td></td><td></td><td></td></td<>		1		2			6			
Minimum Initial (s) 4.0 40.0 40.0 40.0 4.0 Minimum Split (s) 13.0 45.0 45.0 45.0 25.0 Total Split (s) 26.3% 47.4% 47.4% 47.4% 26% 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 1.0 1.0 1.0 Lost Time (s) 5.0 5.0 5.0 5.0 5.0 5.0 5.0 Lead/Lag Lag Lag Lead Lead Lead Lead Lead Lead Lead Lag Optimize? Yes Ye		4		2		U	U			
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2040 Summer Saturday Peak-Hour

Intersection Capacity Analysis 7. Otis St (Rt 3A) @ Hingham Bathing Beach

Actuated Cycle Length: 71.7	
Natural Cycle: 145	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 1.01	
Intersection Signal Delay: 32.0	Intersection LOS: C
Intersection Capacity Utilization 97.3%	ICU Level of Service F
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be long	ger.
Queue shown is maximum after two cycles.	

Splits and Phases: 17:		
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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. 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.	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. 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	1 to 3 months Project Planning Report: 3 to 24+ months
a detailed analysis of alternatives and their impacts.	associated with the proposed solution or a narrow family of alternatives. More complex projects will likely require a detailed alternatives analysis.	
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. Step VII: Construction The construction process is initiated including public notification and any anticipated public involvement. Construction continues to project completion.	Administration of competing projects can influence the advertising schedule. The duration for this step is entirely dependent upon project complexity and phasing.	1 to 12 months 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