Old Colony Metropolitan Planning Organization

Route 53 Corridor Study

May 2018

Communities of: Hanover
Pembroke
Duxbury
Kingston

Prepared Under through the Old Colony Unified Planning Work Program under MassDOT Contract 88826

Prepared By:
Old Colony Planning Council
70 School Street
Brockton, MA. 02301
508-583-1833 www.ocpcrpa.org

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Old Colony Planning Council
Title VI/ Nondiscrimination Coordinator
Pat Ciaramella
70 School Street
Brockton, MA 02301
508-583-1833 Extension 202
pciaramella@ocpcrpa.org

Title VI Specialist
MassDOT, Office of Diversity and Civil Rights
10 Park Plaza
Boston, MA 02116
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TTY: 857-368-0603
MASSDOT.CivilRights@state.ma.us

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Portuguese: Se esta informação é necessária em outro idioma, entre em contato com Pat Ciaramella em 508-583-1833 Ramal 202.

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Chinese Simplified: (mainland & Singapore): 如果这个信息是需要用另一种语言，请联系帕特Ciaramella在508-583-1833分机202。

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Haitian Creole: Si ou bezwen enfòmasyon sa a nan yon lòt lang, tanpri kontakte breve Ciaramella nan 508-583-1833 Ekstansyon 202.

Vietnamese: Nếu thông tin này là cần thiết trong một ngôn ngữ khác, xin vui lòng liên hệ với Pat Ciaramella tại 508-583-1833 mở rộng 202.

French: Si cette information est nécessaire dans une autre langue, s'il vous plaît communiquer avec Pat Ciaramella au 508-583-1833 extension 202.

Italian: Se questa informazione è necessaria in un'altra lingua, si prega di contattare Pat Ciaramella al 508-583-1833 Extension 202.

Khmer: ប្រសិនបើព័ត៌មាននេះត្រូវបានត្រូវការនៅក្នុងភាសាមួយផ្សេងទៀតសូមទាក់ទងជំាត់ Ciaramella នៅផ្នែកបន្ថែម 508-583-1833 202 ។

Arabic: إذا كانت هناك حاجة هذه المعلومات في لغة أخرى، يرجى الاتصال بات Ciaramella.202 امتداد 1833-583-508 في

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This report was prepared by the following members of the Old Colony Planning Council staff under the direction of Pat Ciaramella, Executive Director, and the supervision of Charles Kilmer, Assistant Director/Transportation Program Manager.

Report Preparation and Analysis

William McNulty, Senior Transportation Planner
wmcnulty@ocpcrpa.org

Ray Guarino, Senior Transportation Planner
rguarino@ocpcrpa.org

Data Collection

Kyle Mowatt, Transportation Planner
kmowatt@ocpcrpa.org

Paul Chenard, Transportation Planner
pchenard@ocpcrpa.org

Jimmy Pereira, Community/Transportation Planner
jpereira@ocpcrpa.org

Shawn Bailey, Assistant Transportation Planner
sbailey@ocpcrpa.org

Mapping and Graphics

Andrew Vidal, GIS Manager/Communications and IT Specialist
avidal@ocpcrpa.org

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Kenneth Tavares	Chairman, Board of Selectmen, Plymouth
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Eldon Moreira	Vice-Chairman, Board of Selectmen, West Bridgewater
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Jonathan Gulliver	Highway Administrator, MassDOT
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MassDOT	Derek Krevat
MassDOT District 5	Mary-Joe Perry
MassDOT District 5	Pamela Haznar, P.E.
MassDOT District 5	Timothy Kochan
BAT	Reinald Ledoux, Jr.
BAT	Kathy Riddell
BAT	Glenn Ann Geiler
FHWA	Jeff McEwen
FHWA	Nelson Hoffman
FTA	Mary Beth Mello
FTA	Peter Butler
FTA	Leah Sirmin
FTA	Kristin Wood
Brockton Traffic Commission	Captain Robert Dibari

OCPC Transportation Staff

Charles Kilmer, AICP	Assistant Director/ Transportation Program Manager
Shawn Bailey	Transportation Planner
Paul Chenard	Senior Transportation Planner
Ray Guarino	Senior Transportation Planner
William McNulty	Senior Transportation Planner
Jimmy Pereira	Community/Transportation Planner
Kyle Mowatt	Transportation Planner
Andrew Vidal	GIS Manager/ Communications and IT Specialist

Old Colony Planning Council (OCPC)

OCPC Officers

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Pat Ciaramella	Executive Director
Janet McGinty	Fiscal Officer
Brenda Robinson	Fiscal Officer
Patrick Hamilton	AAA Administrator
Lila Burgess	Ombudsman Program Director
Jane Selig	Ombudsman Program Assistant
Laurie Muncy	Principal Comprehensive Planner
Lisa Sullivan	Senior Planner
Bruce Hughes	Economic Development/ Community Planner
Jimmy Pereira	Community/Transportation Planner
Andrew Vidal	GIS Manager/ Communications and IT Specialist
Charles Kilmer, AICP	Assistant Director/ Transportation Program Manager
Ray Guarino	Senior Transportation Planner
William McNulty	Senior Transportation Planner
Paul Chenard	Senior Transportation Planner
Kyle Mowatt	Transportation Planner
Shawn Bailey	Transportation Planner

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Introduction

Study Area and Scope

The geographic scope of the Route 53 Corridor Study covers the entire length of Route 53 in the Old Colony region, from the Norwell Town Line on the northern end to the intersection of Route 53 and Route 3A at the southern end in Kingston. The study area is approximately 12 miles and includes Route 53 in the Towns of Hanover, Pembroke, Duxbury, and Kingston. The purpose of this planning level corridor study is to enhance circulation and traffic flow efficiency, improve safety, improve bicycle and pedestrian accommodation, and reduce gaps to essential services for the study area communities within the Route 53 corridor. The study was completed in cooperation with the Towns of Hanover, Pembroke, Duxbury, and Kingston, and includes public outreach with public meetings and stakeholder interviews. The study area is shown in Figure 1.

The Study will include a complete assessment of existing conditions, including but not necessarily limited to, capacity and efficiency (main line and intersection levels of service) analysis, crash rate and severity analysis, vehicular speed and heavy vehicle traffic analysis, bicycle and pedestrian conditions, and transit efficiency. Traffic and environmental impacts from any and all known future development along the Route 53 Corridor will be assessed. Any and all recommendations presented in the final report will be based on best engineering and planning practices and derived from a combination of the assessment of existing conditions plus future impacts, and consultation with stakeholders. The "Complete Streets" concept, (designing roads for all road users), traffic calming, access management, and reviews of local and state plans are utilized to develop specific improvement projects and to define long term vision for the study corridor.

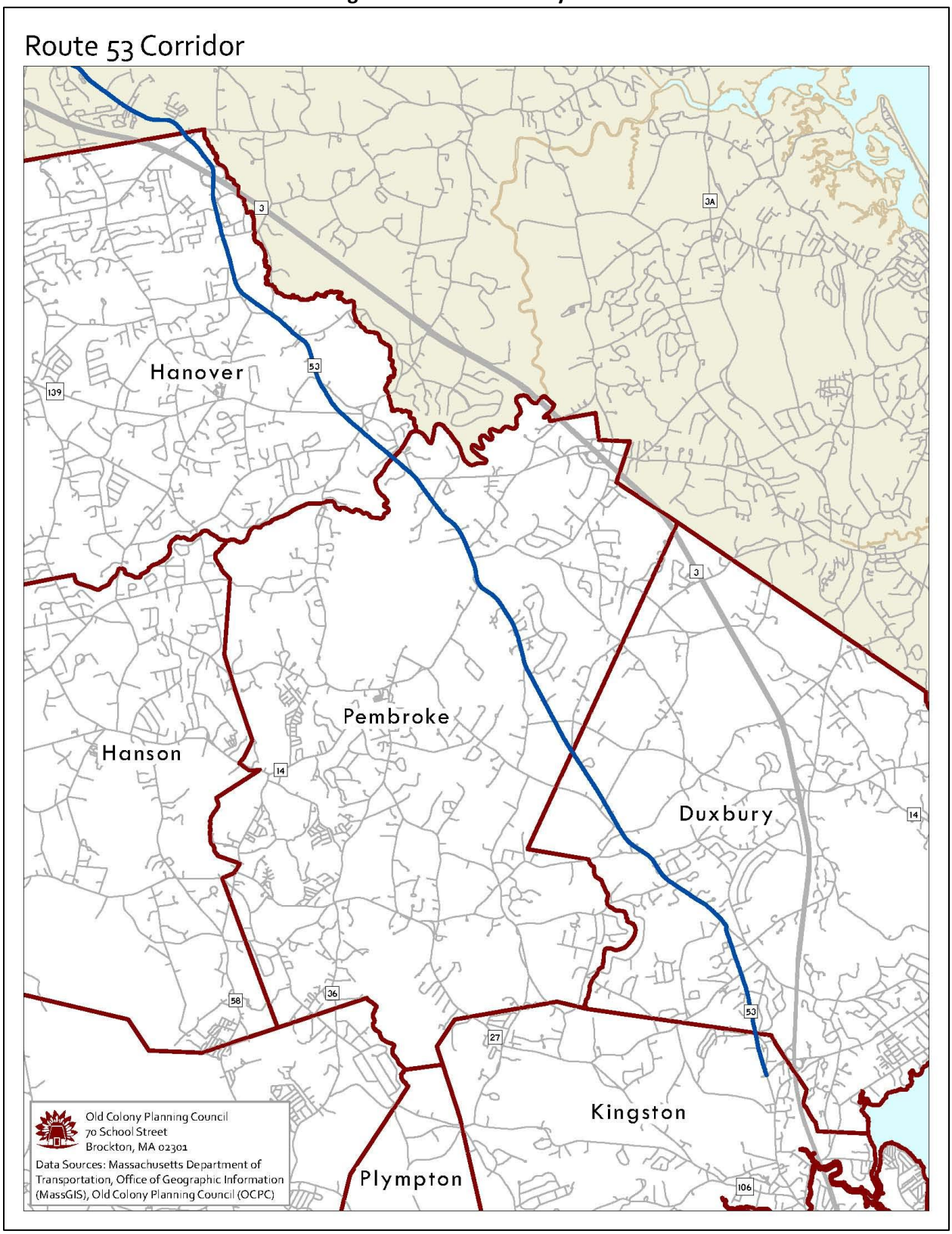
Community Profiles, Environmental Justice, and Title VI

Hanover

The 2010 Census population for Hanover was 14,000. Based on the 2010 Census data, there are no Environmental Justice areas or Title VI populations of significance within or abutting the study area. Based on 2011-2015 American Community Survey data, Hanover's median household income was $101,823 and 96.5 percent of the population self-identifying as "White" in the Census.

According to analysis performed using the Census Bureau's *Longitudinal Employment Household Dynamic (LEHD)* tool, most of the jobs based in Hanover are concentrated in areas along and to the east of the Route 53 corridor, particularly between the Norwell Town Line and Pond Street. While many Hanover residents commute out of town (particularly to points north of Hanover) for employment, nearly as many people from outside of Hanover come into the town for employment. Analysis of 2014 employment data indicates that 6,850 Hanover residents commuted out of town for employment, while 6,635 workers from out of town commuted into Hanover for jobs based in the town. An additional 638 Hanover residents commuted to jobs within the town.

Figure 1 – Route 53 Study Area



Pembroke

The 2010 Census population for Pembroke was 17,837. Based on the 2010 Census data, there is no Environmental Justice area or Title VI populations of significance within or abutting the study area. Pembroke's median household income was $90,790, based on 2011-2015 American Community Survey data, and 96.8 percent of the population identifying themselves as "White" in the Census.

According to analysis performed using the Census Bureau's *Longitudinal Employment Household Dynamic (LEHD)* tool, most of the jobs based in Pembroke are concentrated in the northeastern corner of town, along but especially east of the Route 53 Corridor. Pembroke, like many towns on the South Shore, is a typical "bedroom community" with a disproportionate number of residents commuting out of Pembroke for employment than commuters coming into town. Based on 2014 Labor Department data, 7,669 workers living in Pembroke travel out of town for employment (mostly to the northwest to Boston and locations along the Route 3 corridor), while 745 live and work within the Town. There were a total of 4,411 commuters coming into Pembroke for employment from outside communities.

Duxbury

The 2010 Census population for Duxbury was 15,059. Based on the 2010 Census data, there are no Environmental Justice areas or Title VI populations of significance within or abutting the study area. Based on 2011-2015 American Community Survey data, Duxbury's median household income was $120,253 and 97.3 percent of the population identifying themselves as "White" in the Census.

According to analysis performed using the Census Bureau's *Longitudinal Employment Household Dynamic (LEHD)* tool, most of the jobs based in Duxbury are located in areas along and to the east of the Route 3A corridor. Specifically, the Island Creek development area located on the southern end of the Route 3A corridor, Halls Corner to the east of Route 3A on Chestnut Street and Depot Street, and the school and library area on St. George Street are significant employment areas in the town. Duxbury, like many towns on the South Shore, is a typical "bedroom community" with a disproportionate number of residents commuting out of Duxbury for employment than commuters coming into Duxbury. Based on 2014 Labor Department data, 5,599 workers living in Duxbury travel out of town for employment (mostly to the northwest to Boston and locations along the Route 3 corridor), while 436 live and work within the Town. There were a total of 1,529 commuters coming into Duxbury for employment from outside communities.

Kingston

The 2010 Census population for Kingston was 12,529. Based on the 2010 Census data, there are no Environmental Justice areas or Title VI populations of significance within or abutting the study area. Kingston's median household income is $85,385 based on 2011-2015 American Community Survey data, and 96.1 percent of the population self-identified as "White" in the Census.

According to analysis performed using the Census Bureau's *Longitudinal Employment Household Dynamic (LEHD)* tool, there is a heavy concentration of jobs along Route 53 and at the junction of Route 53 and Route 3A. Kingston, like many towns on the South Shore, is a typical "bedroom community" with a disproportionate number of residents commuting out of Kingston for employment than commuters coming into town. Based on 2014 Labor Department data, 5,465 workers living in Kingston travel out of town for employment (mostly to the northwest to Boston but also southeastward towards North Plymouth), while 586 live and work within the Town. There were a total of 3,898 commuters coming into Kingston for employment from outside communities.

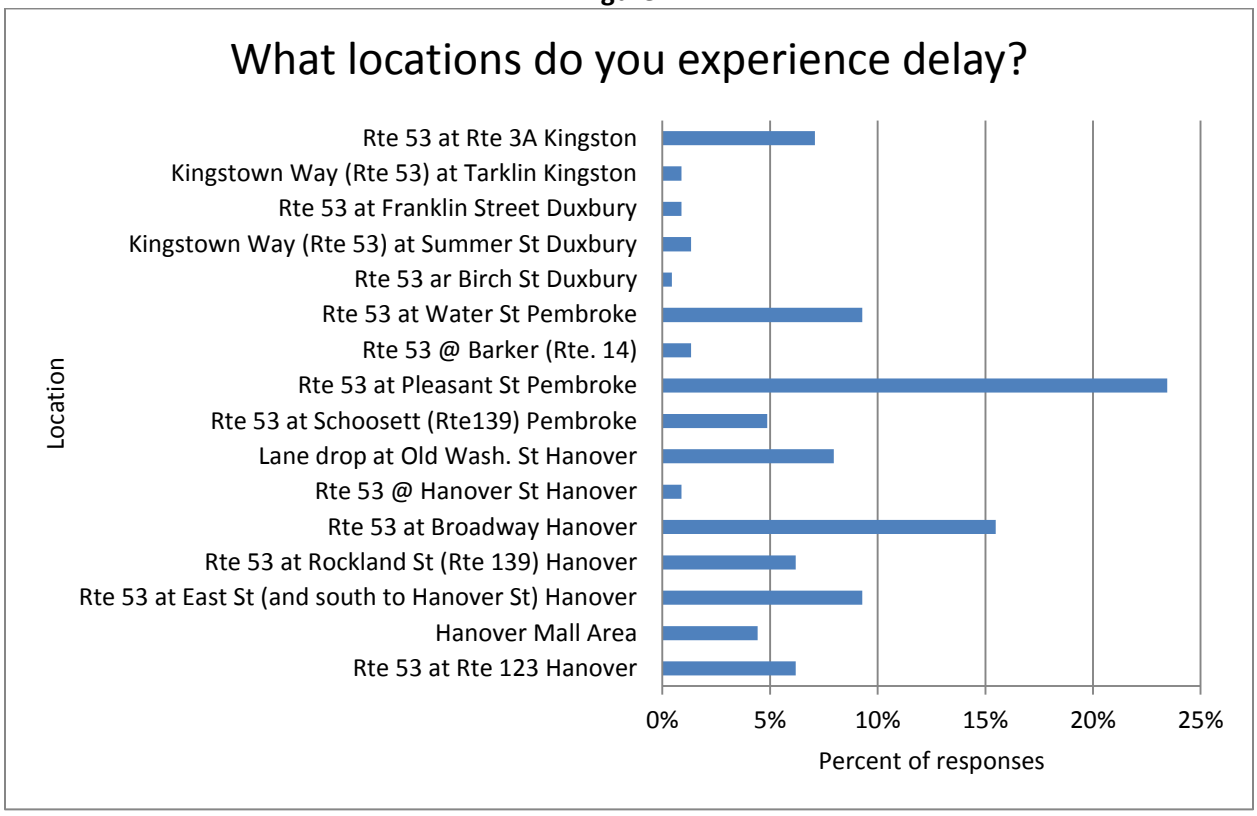
Public Outreach

Public Survey

OCPC developed an on-line questionnaire survey to help identify and prioritize problems and improvement strategies within the Route 53 corridor study area. The questionnaire was available through a link on the OCPC website. The survey was designed to raise awareness of the issues in the study area and to give the general public the opportunity to participate anonymously, although individuals were encouraged to leave contact information to provide additional input and keep them updated on study meetings. The survey was available electronically via a link on OCPC's website through Survey Monkey. There were 240 individuals who responded to the questionnaire. The following figures summarize the survey questions and responses:

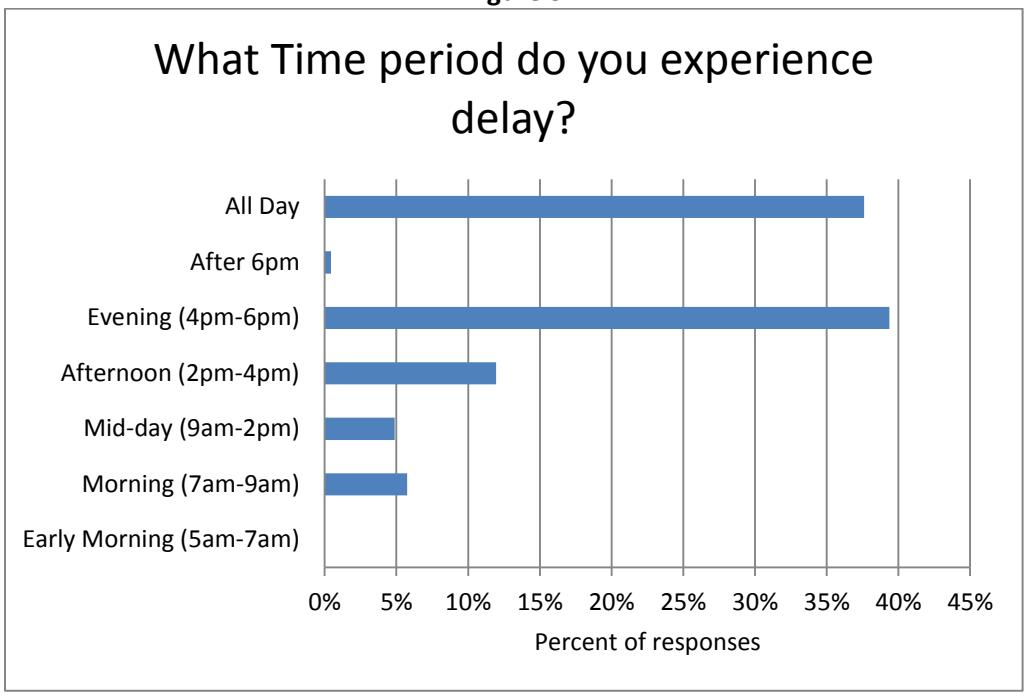
Question one: At what intersection or location do you experience congestion or delays within the Route 53 Corridor within the study area communities?

Figure 2



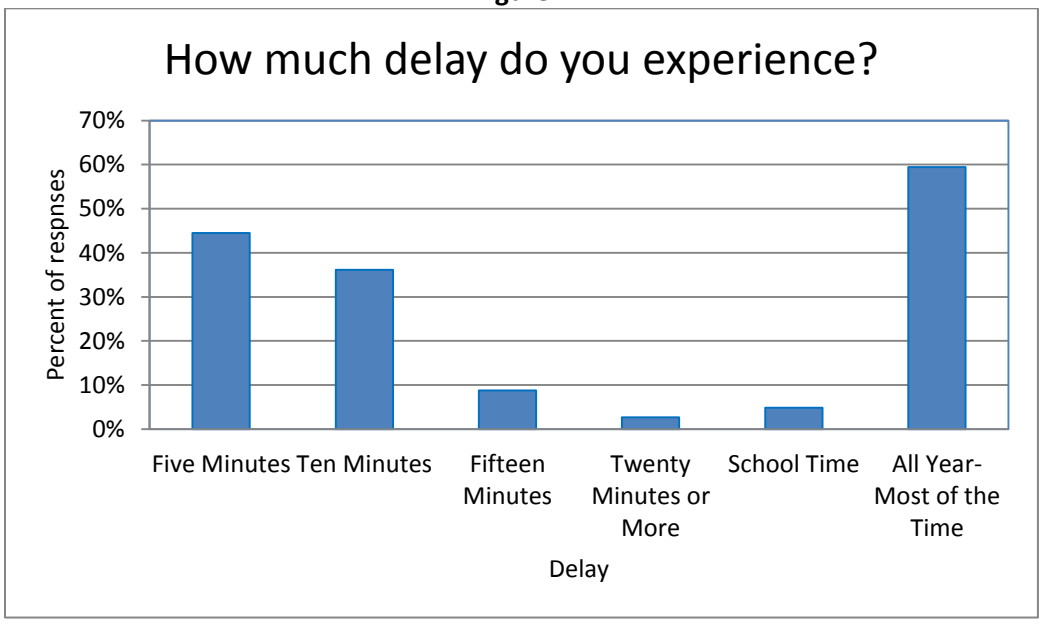
2. What time period do you typically experience traffic congestion?

Figure 3



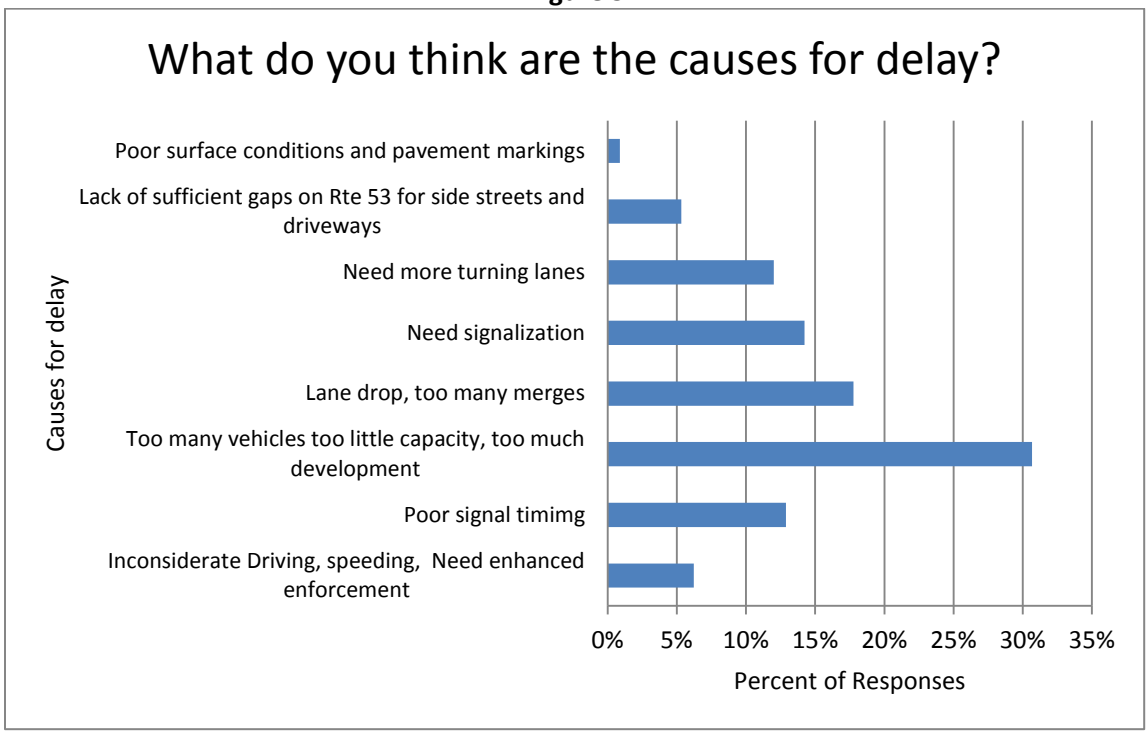
3. How much delay do you usually experience at this location and at what time of the year?

Figure 4



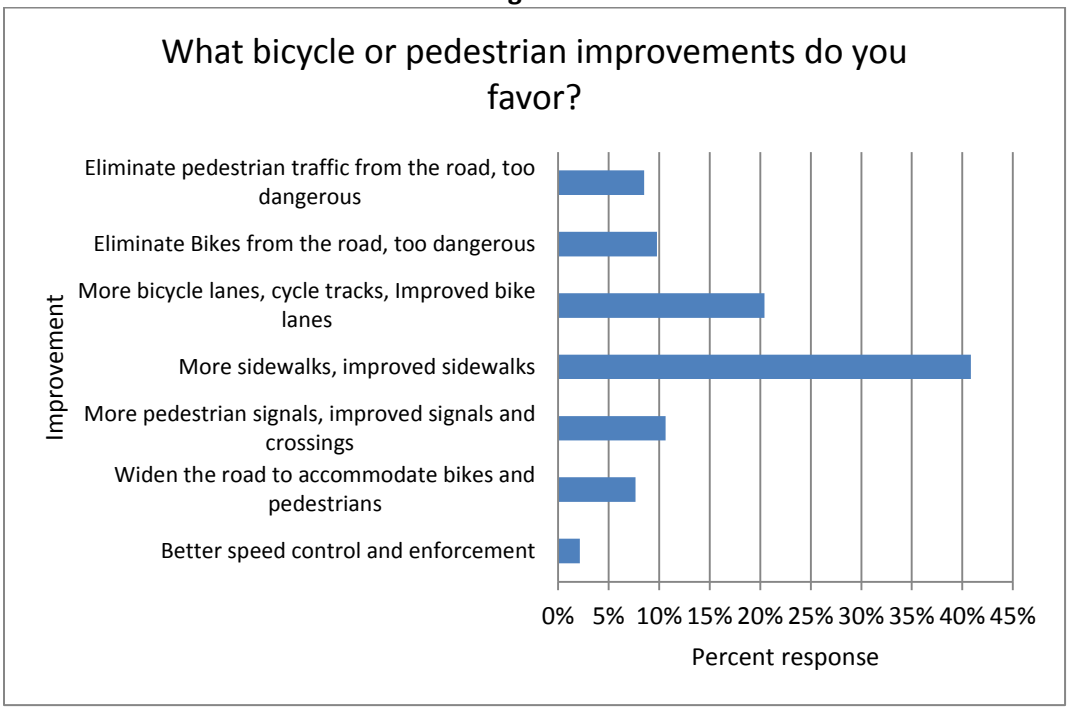
4. What do you believe is the root cause for congestion and delay?

Figure 5



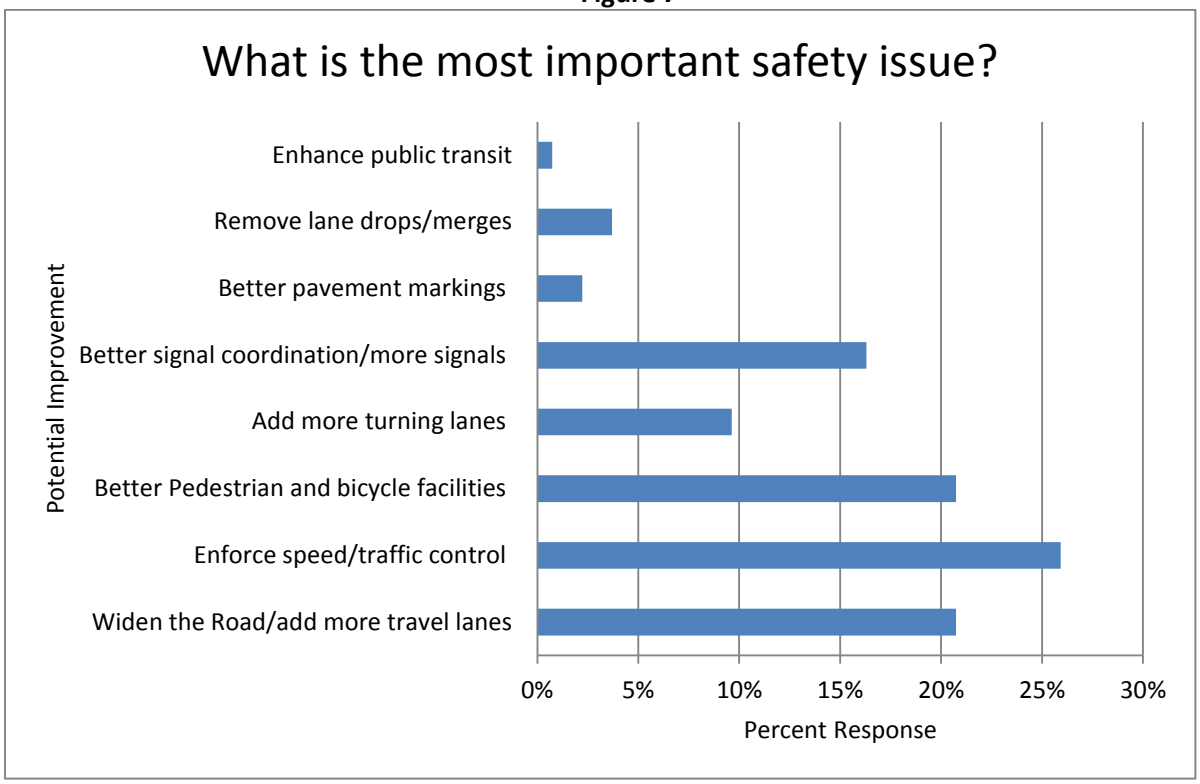
5. What improvements for safety and convenience do you think should be made in the study area for better walking and bicycling conditions?

Figure 6



6. What is the most important safety issue(s) on Route 53 (for vehicles, pedestrians, bicycles, or other), and what do you think are the best solutions to address the issue?

Figure 7



Previous Studies and Planned Development

Route 53 Corridor Transportation Plan (CTPS, 2003)

In November of 2003, the Route 53 Corridor Transportation Plan was completed by the Central Transportation Planning Staff (CTPS). The study area included Route 53 in Kingston, Duxbury, Pembroke, Hanover, Norwell, Hingham, Weymouth, Braintree, and Quincy. Some of the concerns cited in the study include congestion, poor traffic operations, and/or the frequency of vehicle crashes at major Route 53 intersections, including the Route 53/East Street intersection in Hanover, the Route 53/Broadway intersection in Hanover, the Route 53/Pleasant Street intersection in Pembroke, the Route 53/Winter Street intersection in Duxbury, and the Route 53/Tar Kiln Road intersection in Kingston. Also cited were a lack of sidewalks and the presence of inferior curb cuts along some sections of Route 53 as well as a lack of public transportation throughout the Route 53 corridor.

There were a number of Recommendations for Kingston, Duxbury, Pembroke, and Hanover. Some of the improvements have been implemented including the mitigation for the Stop and Shop supermarket in Hanover, which widened Route 53 to a four lane cross section between Route 123 and Route 3, and upgraded the intersection of Route 123 (Webster Street) at Route 53. Also, the study recommended widening Route 53 to a five lane cross section between Mill Street and Rawson Road in Hanover (four travel lanes, two for each direction ad a two-way center turning lane). This improvement has also been

completed along with the realignment of Pond Street with Old Washington Street in Hanover (the traffic signal was also upgraded and exclusive left- and right-turn lanes were added).

Other recommended improvements include:

- Roadway resurfacing and restriping within the corridor.
- Add bicycle accommodation throughout the corridor and restripe the lanes so that, wherever possible or when future roadway reconstruction occurs, an eight foot shoulder is added to both sides of the roadway.
- Between Rawson Road and Route 139 (Rockland Street) in Hanover, widen the roadway to a five-lane cross section, including two travel lanes in each direction and an unpaved median with room for left turns, widen the shoulders on both sides and add a sidewalk on the northbound side of Route 53.
- At Route 53 and East Street in Hanover, install a traffic signal and provide an exclusive pedestrian phase, upgrade turning lanes, and add lanes for bicyclists.
- At Route 53 and Broadway in Hanover, widen the intersection and add exclusive left- and right-turn lanes; change the signal timings and phasing; restriction of traffic at driveway adjacent to the intersection; and add markings and signs for bicyclists.
- Route 53 between Broadway in Hanover and Schoosett Street in Pembroke, widen the roadway to a four-lane cross section, including two travel lanes in each direction and eight foot wide shoulders. Add a sidewalk on the northbound side.
- At Route 53 and Pleasant Street in Pembroke, install a traffic signal with pedestrian phase, include pedestrian improvements (sidewalks), additional turning lanes, and add signs, and markings for bicyclists.
- At Route 53 and High Street in Duxbury, realign High Street so it intersects with Route 53 at a right angle.
- At Route 53 and Winter Street in Duxbury, install a traffic signal with pedestrian phase, provide sidewalks and crosswalks, and upgrade intersection for bicyclists.
- At Route 53 and Silver Birch Lane in Kingston, install a flashing beacon and enforce the posted speed limit.
- At Route 53 and Tar Kiln Road in Kingston, realign Tar Kiln Road so it intersects with Route 53 at a right angle, realign the CVS driveway away from Route 53 so it ties into Tar Kiln Road, and restripe the lanes so the Route 53 northbound outside lane becomes an exclusive right-turn lane to Tar Kiln Road.
- At Route 53 and Route 3A upgrade traffic signals, add exclusive left and right-turn lanes.
- Public transit recommendations include adding feeder bus service between passenger rail stations on the Kingston/Plymouth Line and local towns. These include Hanover via Rockland to Abington, South Duxbury via Pembroke to Hanson Station, and the Accord Industrial Park in Norwell to Abington Station.

Washington Street (Route 53) at Pleasant Street Road Safety Audit

A Road Safety Audit (RSA) was held for the intersection of Washington Street (Route 53) at Pleasant Street in Pembroke on June 6, 2014. The RSA was facilitated and prepared for MassDOT by an engineering consultant. The audit team consisted of representatives from state, regional and local agencies and included a cross section of engineering, planning and emergency response expertise. According to the FHWA, a Road Safety Audit (RSA) is the formal safety examination of an existing or future facility, (intersection or road segment), by an independent, multidisciplinary team. The purpose of the RSA is to identify potential safety issues and opportunities for safety improvements. A Road

Safety Audit was performed for the intersection of Washington Street (Route 53) at Pleasant Street in Pembroke because it had been identified as a high crash location within the Old Colony Planning Council (OCPC) region. Twenty-five percent design plans were submitted in 2013 for improvements for the intersection (MassDOT project number 607337), and the project was programmed in the Old Colony Transportation Improvement Program (TIP). This project was advertised for construction bid on March 17, 2018. The RSA identified potential short and long term safety improvements.

Pleasant Street connects to Oak Street, which functions as a heavily-traveled cut through route from Pembroke towards Route 139, Route 3 and Marshfield. It forms an unsignalized "T" type intersection with Washington Street (Route 53) in the northern section of Pembroke, with Pleasant Street on the westbound approach and Washington Street (Route 53) making up the northbound and southbound approaches. Pleasant Street is the minor street stop sign approach to the intersection. Washington Street (Route 53) provides a single lane approach on the northbound and southbound approaches to the intersection. Pleasant Street provides a single shared left and right turn lane on the westbound approach. Signage at the intersection includes Stop signs on both sides of the Pleasant Street approach, advance "Stop Ahead" signs on both sides of the Pleasant Street approach, and intersection warning signs with supplemental "Pleasant St" plaques on both sides of Route 53 approaching Pleasant Street. No crosswalks are provided at the intersection, and no sidewalks or other pedestrian accommodations are provided on either Route 53 or Pleasant Street. The shoulders are narrow, one to two feet wide on all the approaches except on the northbound approach, which has six to eight foot shoulders on both sides.

The crash data for the RSA were compiled from the Pembroke Police Department for the three year period 2011, 2012, and 2013. There were 25 crashes during the three year study period for the RSA. The most prevalent crash type involved angle-type crashes, which comprised 60 percent of the crashes. Thirteen of the 15 angle crashes at the intersection were between a vehicle turning left from Pleasant Street and a vehicle headed northbound on Route 53. One angle crash involved a southbound left turning vehicle and a northbound through vehicle, while another as between a vehicle turning right from Pleasant Street and a northbound through vehicle. There were seven rear-end crashes occurring at the intersection during the three year crash period. These included five on the southbound approach, one on the northbound approach, and one on the westbound approach.

The RSA stated that southbound rear-end crashes are likely related to drivers traveling southbound along Route 53 not expecting to encounter another vehicle stopped at the intersection waiting to turn left. There was a rear-end crash on both the northbound and Pleasant Street approaches. Two crashes involved Pleasant Street vehicles that ran through the intersection and struck the fence bordering the property directly across from the Pleasant Street approach. Local officials noted that the property owner has constructed a second fence as a buffer due to frequent vehicle strikes.

According to the RSA, a 40 mph speed limit for Route 53 was established from just south of Route 139 to just south of Pleasant Street via Special Speed Regulation No. 678-B; however, there are 45 mph speed limit signs posted in this area in conflict with the legally established regulation. A 35 mph limit is established for Pleasant Street, except for a reduction to 25 mph on the approach to Route 53.

According to the RSA, driver frustration, impatience, and aggression are the result of long delays and queuing on Pleasant Street, which occur due to heavy peak hour volumes on the major road, Washington Street (Route 53). The heavy Washington Street volumes leave very few acceptable gaps in the traffic for vehicles to utilize turning from Pleasant Street to Washington Street. Drivers forcing their

way onto Washington Street from Pleasant Street without utilizing safe gaps led to the history of angle crashes involving turning vehicles.

Speed was also cited as problematic at the intersection. Drivers traveling at or above the posted speed limit contributed to the lack of available gaps, creating challenges for drivers attempting to exit Pleasant Street and thereby contributing to the crash history. There is also a lack of turn lanes and there is limited shoulder space at the intersection. Drivers stopped to make a left turn to Pleasant Street from Route 53 block the southbound travel lane, which causes more aggressive drivers to attempt to pass in the shoulder. Audit participants noted that the shoulder is not of an adequate width for passing, and that uneven pavement in the shoulder further impedes passing.

Overgrown vegetation further restricts visibility along both Route 53 and Pleasant Street. Overgrowth of trees along Pleasant Street blocks visibility of the "Stop Ahead" and Stop signs for drivers approaching Route 53, and a large tree on the northeast corner of the intersection reduces visibility for vehicles turning left (and looking right) from Pleasant Street.

The RSA recommended a number of potential improvements for the town to move forward on including installing a fully actuated traffic signal at the intersection. The signal would relieve queuing on Pleasant Street and help alleviate angle type crashes. In addition, the RSA recommended providing dedicated turn lanes on Route 53. This includes widening Route 53 at the intersection to provide a southbound left turn lane and a northbound right turn lane, while maintaining a single through lane in each direction and a shoulder to accommodate bicycles. The southbound left turn lane will have a lead phase to allow protected turns to Pleasant Street. The right turn lane will help if drivers continue to errantly use their right turn signal when approaching Pleasant Street, since a driver that is actually making a right turn would be in the turn lane, whereas a through vehicle would remain in the through lane.

As a short-term, low cost approach, it was recommended that the town consider reducing the posted speed limit on Route 53, as well as continue its speed enforcement efforts, in lieu of signalization or in the interim before signalization. This would benefit vehicles attempting to find acceptable gaps to turn onto Route 53 from Pleasant Street.

As a long-term, high cost improvement, it was recommended that the town consider widening Route 53 to reconstruct shoulders on Route 53. This would eliminate the existing uneven pavement in the southbound shoulder, and would provide a minimum five foot width in accordance with MassDOT's current standard for bicycle accommodation. This improvement would include pedestrian accommodations including sidewalks, wheelchair ramps, and crosswalks across both Route 53 and Pleasant Street. The recommendations included upgrading street lighting at the intersection, where feasible.

Washington Street (Route 53) at University Sports Complex Traffic Study (VHB, 2014)

In October of 2014, the Town of Hanover submitted a Project Need Form (PNF) to District 5 of the Massachusetts Department of Transportation (MassDOT) for the purpose of improving traffic operations along Washington Street (Route 53) at the entrance to the University Sports Complex at Starland located at 645 Washington Street (Route 53). The University Sports Complex is an indoor/outdoor sports complex providing programs for baseball, basketball, soccer, volleyball, and lacrosse. The complex provides two driveways off of Route 53 for access to the site. The north-most access is located opposite

the Village Square commercial plaza and forms a four-way intersection with Route 53. The southern-most drive is located opposite a Toyota dealership and forms a four-way intersection with Route 53. Most of these intersections are unsignalized.

The complex provides programs for all age groups and includes laser tag, go-karts, miniature golf, rock wall climbing, bumper cars, batting cages, and a game arcade. The PNF states that the resultant traffic delays due to the many activities at the complex are significant during the weekdays as well as the weekends, with the levels-of-service at "F", or forced flow with very long delays at the sports complex driveways. This is due to the heavy volumes on Route 53 during the peak hours with few acceptable gaps in the traffic flow to utilize for vehicles exiting the sports complex. According to the PNF, the Hanover Police Department, in cooperation with the sports complex management, has set up an interim traffic plan. This requires that the northern-most driveway to operate as an exit only and the southern-most driveway to operate as an entrance only during the peak hours and on tournament days. A police detail is present during tournament days to enforce this traffic pattern.

The PNF also included a traffic study that outlines potential alternative improvements at entrances to the sports complex. Two improvement options were developed. These include:

- Install Route 53 southbound left turn lanes and northbound right turn lanes at both of the complex driveways off of Route 53.

- Widen Route 53 at the complex driveways to include a center Two Way Turning Lane (TWTL).

According to the PNF, option 2, the widening of Route 53 to include a TWTL, is the town's preferred option. The right turn lanes under option one were not deemed as necessary due to lighter volumes than the left turns into the site, and the TWTL's would assist in future development in the area.

Hanover Route 53 Corridor Study (VHB, 2015)

In 2015, a study of the Route 53 corridor in Hanover was completed for the town by an engineering consultant (VHB). The study assessed nine intersections in the corridor focusing on the impact of potential long term growth on traffic volumes and traffic operations within the corridor. The study resulted in a number of potential short-term and long-term improvements.
The short-term improvements included:

- Add a southbound left turn lane to the Route 53 (Washington Street) at East Street intersection to reduce conflicts with southbound through traveling vehicles and improve safety at the intersection.
- Improve signal timing and phasing at the Route 53 (Columbia Road) at Route 139 (Rockland Street) intersection to improve safety and operations.
- Improve signal timing and phasing at the Route 53 (Columbia Road) at Broadway intersection to improve safety and operations.

The study offered two options for potential long-term improvements. These include:

- Option 1: Widen Route 53 to include a Two-Way (center) Left-Turn Lane (TWLTL) providing a place for left-turning vehicles to queue thereby removing conflicts with through traffic, and resulting in improved safety along the Route 53 corridor.
- Option 2: Widen Route 53 to a Four-Lane Cross-Section providing additional capacity for vehicles traveling northbound and southbound along the Route 53 corridor.

Traffic Study for Route 53 at Route 139, Pembroke (OCPC)

A traffic study for the Route 53/Route 139 intersection was completed by OCPC for the Town of Pembroke through the OCPC Local Highway Planning Technical Assistance Program in 2013. The study was initiated by the town to evaluate the feasibility of providing a protected left turn (left turn on a green arrow) from the approach of Washington Street (Route 53) northbound, into the driveway of a commercial plaza that flanks the western side of the intersection. The study analysis indicated that reconfiguring the traffic signals and/or lane assignments at this intersection to include left turn protection from Washington Street (Route 53) northbound into the commercial plaza driveway could be feasible without substantial deterioration of the overall operations and level of service of the intersection.

Existing Conditions

Mainline Conditions

Route 53 is a Principal Arterial from the Norwell Town Line to Schoosett Street (Route 139) in Pembroke, and a Minor Arterial from Route 139 in Pembroke southward to its end at the intersection with Route 3A in Kingston. The entire length of Route 53 in this corridor study is under the jurisdiction of the Massachusetts Department of Transportation (MassDOT). Land use and zoning is primarily commercial along the corridor. The existing land use is shown in Figure 8. Route 53 extends from Quincy south to Route 3A in Kingston. The speed limit is posted at 35 miles per hour on Route 53 southbound in Hanover just south of the Norwell Town Line (before the Route 3 interchange). South of Route 3 in Hanover, Route 53 is a five-lane cross section, as it provides access to the Hanover Mall and other retail shops and eating places, as well as auto dealers medical offices, dental offices, and other office services. It is approximately 65 feet in width with very little room for shoulders (the shoulders vary between one to two feet wide). There are two northbound lanes, two southbound lanes, and a "two-way-turning lane" in the center allowing vehicles to access the many driveways and curb cuts along Route 53 from either northbound or southbound. The five-lane cross section on Route 53 is between Route 3 and Old Washington Street. The posted speed on Route 53 southbound in the five-lane cross section is 40 miles per hour (just south of the Hanover Mall).

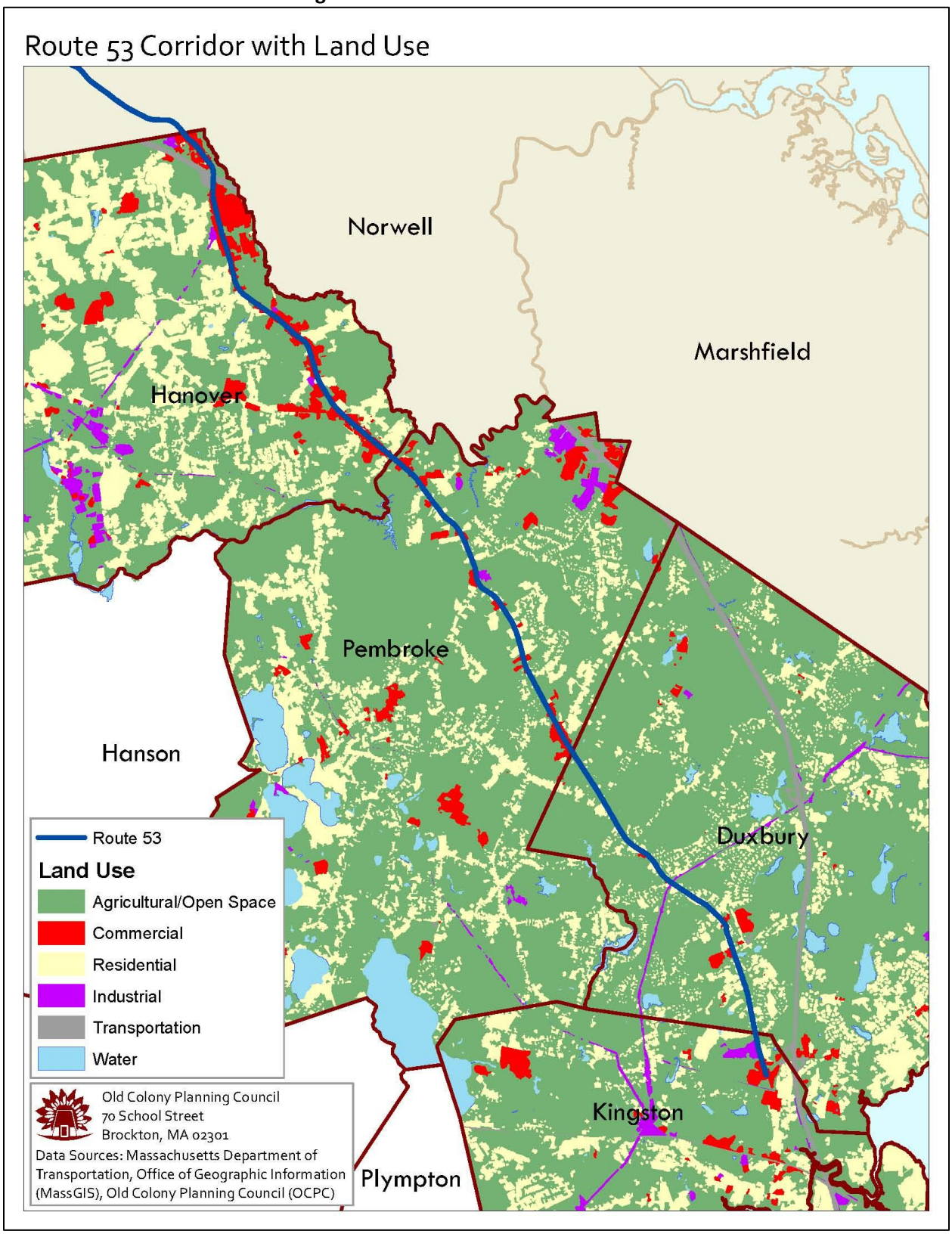
South of Old Washington Street, there is a lane drop at Rawson Road where Route 53 narrows to a two-lane cross section. Route 53 remains a two-lane cross section south to the Route 139 intersection. The width of the two-lane cross section in Hanover is approximately 31 to 32 feet, including two 12 foot travel lanes and one 5 foot shoulder intermittent between the northbound side or the southbound side. Route 53 goes to a four lane section south of Rockland Street (Route 139) to Broadway. South of Broadway to Pantooset Road, the cross section is inconsistent and varies between four, three and two lanes. There are numerous curb cuts into adjacent properties throughout Route 53 in Hanover, and little evidence of implementation of access management practices. The speed limit is posted at 40 miles per hour on Route 53 southbound in Hanover just north of the Route 53/Hanover Street intersection. The posted speed limit on Route 53 southbound is posted at 35 miles per hour southbound, just north of the Rockland Street (Route 139)/Route 53 intersection.

The speed limit for the northbound side of Route 53 in this location should be 45 miles per hour; however, the sign might have been knocked over due to an accident.

Route 53 is a two-lane cross section in Pembroke but widens to a four-lane cross section through the Schoosett Avenue (Route 139) intersection. The posted speed limit on Route 53 southbound, just south

of the Hanover Town Line is 35 miles per hour. South of the Route 53/Route 139 intersection it narrows back to a two-lane cross section. Route 53 south of Route 139 is approximately 32 feet wide with two 12 foot travel lanes and shoulders approximately two and a half feet wide and remains this way south through Pembroke into Duxbury. South of the Route 53 Schoosett intersection, the posted speed limit is 40 miles per hour southbound and 35 miles per hour northbound. The posted speed limit on Route 53 is 40 miles per hour for northbound and southbound travel just north of Barker Street (Route 14) in Pembroke. South of Barker Street (Route 14), the posted speed limit on Route 53 southbound is 50 miles per hour. Route 53 in Duxbury and Kingston keeps its two-lane, 32 feet wide with two 12 foot travel lanes and two and a half foot shoulder cross section to its terminus at the Route 3A intersection in Kingston.

Figure 8 – Route 53 Corridor Land Use



Community Health

The Health Impact Assessment (HIA) supports decision-making with information used by decision makers to shape improvements and recommendations that minimize adverse effects to public health and optimize beneficial policies.[1] As part of the Route 53 Corridor Study, an assessment of community health can assist in the process for developing recommendations, especially for non-motorized modes including walking and bicycling.

The components of an assessment include:

- Screening - This establishes the need for and value of conducting an HIA.
- Scoping - Identifies the populations that might be affected, determines the health effects evaluated, identifies research questions and plans to address them, identifies the data and methods to be used and alternatives to be assessed, and establishes the HIA team and a plan for stakeholder participation throughout the HIA process.
- Assessment - Involves describing the baseline health status of affected populations and characterizing the expected effects on health (and its determinants) of the proposed improvements and alternatives under consideration.
- Recommendations - Identify alternatives to the proposal or specific actions that could be taken to avoid, minimize, or mitigate adverse effects or to take advantage of opportunities for a proposal to improve health.
- Reporting - This is the communication of findings and recommendations to decision makers, the public, and other stakeholders.
- Monitoring - This consists of tracking the adoption and implementation of recommendations.

The Community Health section of this report will utilize some of the guidelines of the HIA; however, the scope will not be as broad as a full HIA report.

Public health improvement focuses on the promotion of good health and the prevention of accident and disease through changes in the built environment as well as through education and awareness training for at-risk populations. The improvement of the public health in a community requires that resources be focused on specific populations as opposed to health care treatment, which focuses mainly on the health of an individual. Improvements to the public health impact life expectancy as well as the quality of life as both behavior and the environment (and how people interact with the environment), influence health outcomes. Studies show that social, environmental, and behavioral factors make up 60 percent of the determinants of health, with genetics making up 20 percent, and access to healthcare making up 20 percent. Transportation facilities and systems (such as sidewalks, access to transit, safe bicycle paths, and safe street crossings) can influence the social, environmental, and behavioral factors that determine the quality of health.

The Route 53 corridor study communities do not have major hospitals within their borders. The closest include Beth Israel Deaconess Hospital-Plymouth (formerly Jordan Hospital) and South Shore Hospital in Weymouth. The Community Health section of this corridor study utilizes the community health assessments of these two hospital facilities closest to the corridor study area proximity.

[1] Improving Health in the U.S.; The Role of Health Impact Assessment, National Academy of Arts and Sciences, Page 5.

Beth Israel Deaconess Hospital-Plymouth (BID-Plymouth)

According to their Community Health Needs Assessment (CHNA), Beth Israel Deaconess Hospital-Plymouth (BID-Plymouth) is an acute care community hospital. It is a private, not-for-profit hospital, and treats all patients regardless of ability to pay. The hospital's vision is to "…use its considerable expertise, resources, and community support to create an integrated health system, whose purpose is to improve the health of the community it serves."[2] The purpose of both the BID Plymouth CHNA and its Community Health Improvement Plan (CHIP) is to provide better understanding of the health related needs and to address the needs of those living in its service area, with an emphasis on those who are most disadvantaged. BID-Plymouth's primary service area includes Carver, Duxbury, Kingston, and Plymouth (primary service area population 97,000, with Plymouth accounting for over half of the population at 57,000). The secondary service area includes Bourne, Halifax, Marshfield, Middleborough, Pembroke, Plympton, Sandwich, and Wareham. Both the primary and secondary service areas include three of the Route 53 corridor study area's communities (Kingston, Duxbury, and Pembroke).

Key health-related findings of the CHNA after data collection and analysis include:

- Opportunities exist to decrease alcohol and substance abuse. Within the service area, Carver and Wareham had significantly higher opioid-related utilization, compared to the Commonwealth overall.
- Opportunities exist to increase access to healthy food and physical activity. Physical inactivity and poor nutrition are the leading risk factors associated with obesity and chronic weight related health issues in the study area, (heart disease, hypertension, diabetes, cancer, and depression). Low income individuals and families, youth of all income levels, as well as low income and/or isolated older adults, were identified as at-risk with respect to food access by partners through the partner survey.
- Mental Illness is not always appropriately managed.
- Prevalence of chronic disease in Plymouth County and the Commonwealth overall are similar, with the exception of heart disease which was significantly more common in Plymouth County (6%) compared to the Commonwealth (4%).
- The town of Plymouth had significantly higher rates for all types of cancer, compared to the Commonwealth overall. Similarly, the town of Plymouth had significantly higher rates of hospitalizations for all cancer types, and specifically for breast cancer.
- There is a need for increased support for older adults.
- Two infectious diseases are of particular concern in the primary service area: Lyme disease and pneumonia.

The CHNA summarized the goals for each of the following priority areas.

Priority Area 1: Health Risk Factors
Goal 1: Increase awareness and educate public on health risk factors
Goal 2: Encourage physical activity
Goal 3: Promote healthy food choices
Goal 4: Support reduced tobacco use among adults
Goal 5: Assist in reducing number of individuals who are uninsured
Goal 6: Reduce barriers to accessing primary care

[2] BID-Plymouth Mission, Vision & Values.

Priority Area 2: Physical Health and Chronic Disease Management and Prevention
Goal 1: Improve chronic disease management
Goal 2: Improve care transitions for those with chronic health conditions
Goal 3: Provide education to community on cancer prevention
Goal 4: Increase incidence of cancer detection
Goal 5: Support cancer patients and caregivers
Goal 6: Support older adults and caregivers
Goal 7: Increase access to palliative care

Priority Area 3: Behavioral Health
Goal 1: Promote reduction of youth substance use and support improvements in mental and emotional well-being
Goal 2: Promote behavioral health/primary care integration
Goal 3: Provide access to appropriate treatment for patients with substance use disorders.
Goal 4: Identify those with or at risk of behavioral health condition(s) and provide enhanced care management
Goal 5: Increase community awareness of community health needs
Goal 6: Strengthen community partnerships

South Shore Hospital

According to its 2013 Community Health Needs Assessment, (CHNA), South Shore Hospital is the leading regional provider of acute, outpatient, home health, and hospice care to the approximately 700,000 residents in its primary and secondary service areas in southeastern Massachusetts. The Hospital is located at 55 Fogg Road in Weymouth, MA and operates several outpatient facilities in other parts of Weymouth and in Hingham. The Hospital generally considers its service area to cover 26 communities spanning from Quincy in the north, Plymouth to the south, the Route 24 corridor to the west, and the Atlantic Ocean to the east. This service area includes all of the Route 53 corridor study area communities.

According to the needs assessment, the data and analysis focused on five key social and physical determinants of health: Economic Stability, Education, Neighborhood and the Built Environment, Health and Health Care, and the Social and Community Context.

Some of the conclusions from the data collection and analysis of the CHNA include:

- The regional population is aging. Population growth is coming from those over age 45. The number of people below age 45 is decreasing.
- Unemployment and poverty levels vary widely across the region – with towns such as Duxbury and Cohasset at near full employment and Greater Brockton at 8.6% unemployment. 13.5% of the Greater Plymouth area lives below the federal poverty level.
- Seven out of ten families in the northern portion of the region have incomes above $50,000.
- Despite extremely high rates of health insurance coverage, many people cite lack of public transportation, language barriers, high copayments, and general lack of understanding the system as meaningful barriers to accessing medical and preventative services.
- There is a disparity in heart disease related to income – only 4% of adults making over $50,000 suffer heart disease versus 10% of adults who make below $50,000.
- Cohasset, Hull, and Scituate have suicide rates above the state average.
- Several area towns have higher drug and alcohol usage rates compared to the national average.

- 16.6% obesity rate in Blue Hills area of region and 59% overweight or obese rate in Plymouth area.
- Diabetes and asthma among African-Americans higher than the state average.
- Access to healthy food is a major obstacle in many towns.
- Many towns do not have water fluoridation.

The results of the CHNA for both the Beth Israel Deaconess Hospital-Plymouth (BID-Plymouth) and the South Shore Hospital show that there are areas of need in which transportation improvement recommendations in this corridor study can have a positive impact, such as increasing access to healthy physical activity (improved sidewalks and bicycle lanes or tracks), and reducing transportation barriers to access to health care with improved bus service.

In addition, evidence exists that adverse health effects associated with transportation often disproportionately affects Environmental Justice populations and this contributes to persistent racial, ethnic, and socioeconomic disparities in health.[3] These effects include heavy traffic volumes and truck volumes, which result in a disproportional amount of air pollution and particulates, resulting in high rates of asthma in these neighborhoods. Other key facts regarding Environmental Justice populations include:

- Households in poverty spend a higher proportion of their income on transportation expenses and are disproportionately represented by race/ethnicity with African-Americans and Hispanics experiencing the highest poverty rates. Limited vehicle availability and fewer affordable transportation options afflict this cost-sensitive group.
- Households in poverty are limited to a shorter radius of travel compared to higher income households. They have the lowest rates of single occupancy vehicle use and the highest usage of less costly travel modes: carpool, transit, bike and walk.
- Households in poverty have lower vehicle ownership rates, which has led to an increased use of alternative modes of transportation and higher vehicle occupancy rates.
- The pedestrian fatality rate for Latinos is over 60 percent higher than for whites, and for African Americans it is almost 75 percent higher than whites (nationally).
- The pedestrian fatality rate for low income counties is more than 80% higher than the national average.
- Children of color are more likely to live in communities with poor air quality and suffer from asthma.
- Families without cars depend on transit, pedestrian, and bicycle infrastructure to make it to work, school, and medical appointments safely and on time.
- Low-income children in urban areas are more likely to walk or bike to school and depend on safe and complete streets.[4]

These facts show that the modes that are alternative to the single occupancy vehicle, including walking, mass transit (including buses), and bicycling, are important to the study area communities, and therefore, this population is sensitive to the physical condition of the built environment, the availability of mass transit, sidewalk availability (as well as safe street crossings), and safe bicycle routes.
The findings, conclusions, and potential recommended improvements of this study will be described in more detail in subsequent sections; however, based on the existing physical conditions, there are a

[3] Improving Health in the U.S.; The Role of Health Impact Assessment, National Academy of Sciences, Page 28.
[4] "What is Public Health and How Does it Impact other Sectors?" Massachusetts Public Health Association, Community Health Training Institute.

number of general improvements necessary in the corridor that can be made for safe pedestrian travel. The key is to keep up with maintenance of infrastructure, (sidewalks, safe crossings, and traffic control), and to enhance infrastructure where necessary. Studies show that improved pedestrian infrastructure not only enhances safety and health, but improves access to mass transit and helps increase mass transit ridership. Necessary improvements include improving sidewalks, upgrading pedestrian signals (as well as traffic signals), adding new technology such as Rapid Rectangular Flashing Beacons for safe crossing (especially for safe crossings at the playgrounds and schools), and adding bus shelters where it is strategically feasible along bus routes.

Livability, Sustainability, and Complete Streets

The Old Colony Regional Transportation Plan includes goals to incorporate livability principles and sustainable practices into transportation plans and programs for maximizing the efficiency of existing transportation investments, providing better access within and between activity centers, reinvesting in aging suburban corridors, restoring complete streets and road networks, and maintaining a transportation system that provides reliable, safe access to jobs, education, health care, and goods and services.

Sustainability encourages alternative, non-motorized modes to conserve energy and reduce reliance on fossil fuels. Principles for creating more sustainable neighborhoods include designing streets and the rights-of-way to encourage shared pedestrian, bicycle, and vehicular use. A new design strategy, often referred to as "Complete Streets", enables safe road access and operation for all users including pedestrians, bicyclists, motorists, and public transportation users of all ages and abilities. Complete Streets make it easy to cross the street, walk, and bicycle to and from destinations (shops, work, school, etc.) by integrating safety for non-motorized travel in the design and construction of roads.

The Federal Highway Administration (FHWA) defines Livability in the following way: "Livability is about tying the quality and location of transportation facilities to broader opportunities such as access to good jobs, affordable housing, high quality schools, and safe streets. This includes addressing safety and capacity issues on all roads through better planning and design." Complete Streets techniques provide treatments and strategies for integrating non-motorized alternative transportation modes in the street system thereby enhancing livability and sustainability.

The MassDOT *Healthy Transportation Policy Directive* formalized MassDOT's commitment to the implementation and maintenance of transportation networks that serve all mode choices. The goals of the directive, in addition to promoting alternative mode choices, was to further MassDOT's GreenDOT Implementation Plan, the Commonwealth's Healthy Transportation Compact and statewide Mode Shift Goal, and to ensure all MassDOT projects are designed and implemented in a way that all road users s have access to safe and comfortable healthy transportation options. It defines healthy transportation modes (via GreenDOT) to include walking, bicycling, and utilization of transit. The recommendations for roadway improvements in this study are developed in conformance with these MassDOT's policy directives.

Environmental Issues and Constraints

Improvements to safety and/or to relieve traffic congestion should take into account the diversity of environmental features in a particular area. Drainage issues can be a concern especially in specific areas within the study area. The study area along Route 53 is well-developed in Hanover. The existence of the Route 3 Interchange with Route 53 encouraged development within this section of the corridor resulting in a heavily developed commercial corridor, including the Hanover Mall. There are brooks,

ponds and wetlands parallel to the Route 53 on the east side (behind the Hanover Mall). These include Jacobs Pond located northeast of the Route 53/Route 123 intersection, Third Herring Brook, which runs parallel to Route 53 behind the Hanover Mall between Jacobs Pond and Pattersons Pond and Mill Pond. Third Herring Brook then turns easterly into Old Pond Swamp. Silver Brook runs beneath Route 53 in Hanover just north of the Route 53/Old Washington Street/Pond Street intersection.

The North River runs beneath Route 53 at the town line between Hanover and Pembroke. It turns south west of Route 53 in Pembroke and runs parallel to Route 53 through the Canoe Club Reserve located just west of the Route 53/Schoosett intersection. Robinson's Creek and Howard pond are located to the east of Route 53 in Pembroke. Pudding Brook runs beneath Route 53 in Pembroke just north of the Route 53/Barker Street (Route 14) intersection. Pudding Brook runs into the Willow Brook Farm Preserve located adjacent to Route 53 (to the west) and north of Route 14 in Pembroke. To the east of Route 53, Pudding Brook connects to Stump Pond Reservoir. Also connecting to Stump Farm Reservoir is McFarland Brook, which runs west beneath Route 53 just north of the Route 53/Congress Street intersection in Pembroke. The Ashdod Forest is located to the east of Route 53 in Duxbury and the Thaddeus Chandler Sanctuary is located to the west of Route 53 in Duxbury. Both of these areas include a number of ponds, brooks, and wetlands. Route 53 in Duxbury and the southern portion of Pembroke is much less developed than in Hanover. Other environmental areas in Duxbury located to the east of Route 53 include the Fordville Conservation Area, the Duxbury Bogs, and the Old Meeting House Swamp. In Kingston, Mile Brook runs directly beneath the Route 53/Route 3A intersection.

Mass Transit

There is no mass transit provided in the Route 53 corridor. The closest fixed route bus service to the corridor is the Seaside Area Inter-link provided by GATRA, which services Route 3A in Kingston and Duxbury, and services Plain Street and Ocean Street in Marshfield. Busses on this route pass through the Kingstown Way (Route 53)/Route 3A intersection in Kingston, which represents the geographic limit of the study area.

Average Daily Traffic, Prevailing Speeds, and Heavy Vehicles

OCPC utilized automatic traffic recorders placed at various points along the Route 53 corridor to determine the average daily traffic (ADT) within the study area. The traffic recorders were installed for a 48-hour period and recorded traffic for both directions of travel in fifteen minute intervals. In addition, the traffic recorders were programmed to record vehicle speeds and the number of heavy vehicles in the traffic stream, as well as the traffic volumes. Table 1 shows the average daily traffic (Vehicles Per Day, VPD), 24-hour total for both directions of travel on Route 53 for the year 2018, as well as the prevailing 85^{th} percentile speeds (Miles Per Hour, MPH), and the percentage of heavy vehicles in the traffic flow. Table 1 also shows the average daily traffic, the prevailing 85^{th} percentile speeds, and the percentage of heavy vehicles for Route 53. The automatic traffic recorder count reports are included in the appendix to this study.

Table 1 – Average Daily Traffic, 85th Percentile Speeds and Heavy Vehicle Traffic 2018*

Route 53 Location	Average Weekday Daily Traffic	85th Percentile	% Heavy Vehicle Traffic
Washington Street (Route 53), North of East Street, Hanover	22,615	42 MPH	6.0%
Washington Street (Route 53), North of Hanover Street, Hanover	20,980	43 MPH	6.8%
Washington Street (Route 53), North of Congress Street (Route 14), Pembroke	7,925	51 MPH	9.4%
Washington Street (Route 53), at Duxbury Town Line, Pembroke	6,100	47 MPH	8.4%
Summer Street (Route 53), North of High Street, Duxbury	6,385	52 MPH	9.9%
Summer Street (Route 53), South of Franklin Street, Duxbury	8,230	47 MPH	5.8%
Kingstown Way (Route 53), at Kingston/Duxbury Town Line,	11,095	49 MPH	8.8%

*2016 traffic counts factored to the year 2018 using an average annual increase of 1 percent.

Table 1 shows that the highest volumes of traffic in the study area on Route 53 are in Hanover at the Washington Street (Route 53), North of East Street location, with 22,615 vehicles per day. The Washington Street (Route 53), North of Hanover Street location in Hanover had the second highest volumes with 20,980 vehicles per day. The heavy volumes are due to the trip generation of heavy retail on Route 53 (such as the Hanover Mall and other retail), as well as the traffic generated by the Route 3 interchange with Route 53 in Hanover just north of the Hanover Mall.

Table 1 shows that traffic volumes are significantly less on Route 53 in Pembroke with the Washington Street (Route 53), North of Congress Street (Route 14) location in Pembroke yielding 7,925 vehicles per day. Also, the volumes are 6,100 vehicles per day at Washington Street (Route 53) location on the Duxbury/Pembroke Town Line, and 6,385 vehicles per day at the Summer Street (Route 53), North of High Street location in Duxbury. The volumes become higher on Route 53 near Kingston as the Summer Street (Route 53), South of Franklin Street location in Duxbury has 8,230 vehicles per day and there are 11,095 vehicles per day at the Kingstown Way (Route 53) location at the Kingston/Duxbury Town Line.

The posted speed limit on Route 53 varies between 35 and 50 miles per hour. The highest speeds, as shown in Table 1, were recorded on Summer Street (Route 53), North of High Street in Duxbury, with the 85th Percentile Speeds at 52 miles per hour. Table 1 shows that the 85th Percentile speeds are highest on Route 53 in Pembroke, Duxbury, and Kingston, with the 85th Percentile speed varying between 47 and 52 miles per hour.

Table 1 shows that Route 53 is a heavily travelled route for trucks and heavy vehicles with the percentage of heavy vehicle traffic varying between 5.8 percent and 9.9 percent of the traffic flow. The Summer Street (Route 53), North of High Street location in Duxbury had the highest percentage of truck traffic in the traffic flow with 9.9 percent.

Intersection Levels-of-Service (LOS)

This study includes analysis at twenty-nine intersections (twenty-one signalized and eight un-signalized) in the Route 53 corridor study area. Level-of-service analyses (LOS) were completed for the study area

intersections to determine the operating conditions during the morning and afternoon peak hours. Level-of-service analysis is a qualitative and quantitative measure based on the analysis techniques published in the *Highway Capacity Manual* by the Transportation Research Board. Level-of-service is a general measure that summarizes the overall operation of an intersection or transportation facility. It is based upon the operational conditions of a facility including lane use, traffic control, and lane width. It takes into account such factors as operating speeds, traffic interruptions, and freedom to maneuver. Level-of-service represents a range of operating conditions and is summarized with letter grades from "A" to "F", with "A" being the most desirable. Level-of-service "E" represents the maximum flow rate or the capacity on a facility. Level-of-service "F" represents forced flow or bottleneck conditions. The following, from the *Highway Capacity Manual*, describes the characteristics of each level-of-service:

- LOS "A" represents free flow. Individual users are virtually unaffected by the presence of others in the traffic stream.
- LOS "B" is in the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is still relatively unaffected.
- LOS "C" is in the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream. Occasional backups occur behind turning vehicles.
- LOS "D" represents high-density, but stable, flow. Speed and freedom to maneuver are restricted, and the driver experiences a below average level of comfort and convenience as operations approach the capacity of the facility. Small increases in traffic flow will generally cause operational problems at this level.
- LOS "E" represents operating conditions at or near the capacity level. All speeds are reduced to a low, but relatively uniform level. Freedom to maneuver within the traffic stream is extremely limited, and generally requires forcing other vehicles to give way. Congestion levels and delay are very high.
- LOS "F" is representative of forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount that can traverse the point, resulting in lengthy queues and delay.

The LOS definitions describe conditions based on a number of operational parameters. There are certain parameters utilized as measures of effectiveness for specific facilities. In the case for intersections, two-lane highways, and arterials, which represent the physical conditions that typify the study area corridors, time delay, average stop delay, and average travel speed are used as measures of operational effectiveness to which levels-of-service are assigned. Table 2 shows the delay criteria for each level-of-service for both un-signalized and signalized intersections.

Table 2 - Level-of-Service Criteria Average Delay in Seconds

Level-of-Service	Stop Sign	Traffic Signal
A	0 to 10	0 to 10
B	>10 to 15	>10 to 20
C	>15 to 25	>20 to 35
D	>25 to 35	>35 to 55
E	>35 to 50	>55 to 80
F	>50	>80

Source: Highway Capacity Manual

Table 3 summarizes the signalized and unsignalized levels-of-service (LOS) for the study area intersections. The LOS that are at or below capacity (LOS "E" and "F"), are shown in shaded blocks.

Although LOS "D" indicates high traffic flows, with restricted freedom to maneuver, LOS "D" intersections are not at capacity.

Table 3 - Intersection Peak Hour Level-of-Service (LOS) Summary 2018

			AM Peak	PM Peak
Washington Street (Route 53) at Webster Street (Route 123)	Hanover	Signal	B	B
Washington Street (Route 53) at Route 3 Northbound Ramps	Hanover	Signal	C	B
Washington Street (Route 53) at Route 3 Southbound Ramps / Hanover Mall	Hanover	Signal	B	F
Washington Street (Route 53) at Hanover Mall Drive (Buffalo Wild Wings)	Hanover	Stop Sign	B	B
Washington Street (Route 53) at Woodland Drive	Hanover	Stop Sign	C	F
Washington Street (Route 53) at Hanover Mall Drive (Main Entrance)	Hanover	Signal	A	B
Washington Street (Route 53) at Hanover Mall Drive (AT&T / Trader Joes)	Hanover	Stop Sign	E	F
Washington Street (Route 53) at Mill Street	Hanover	Signal	B	C
Washington Street (Route 53) at Target Plaza	Hanover	Signal	A	B
Washington Street (Route 53) at Old Washington Street / Pond Street	Hanover	Signal	B	C
Washington Street (Route 53) at East Street	Hanover	Stop Sign	D	F
Washington Street (Route 53) at Hanover Street	Hanover	Stop Sign	F	F
Columbia Road (Route 53/139) at Rockland Street (Route 139)	Hanover	Signal	C	D
Columbia Road (Route 53/139) at Broadway	Hanover	Signal	E	D
Columbia Road (Route 53) at Old Washington Street	Pembroke	Stop Sign	E	F
Washington Street (Route 53) at Schoosett Street (Route 139)	Pembroke	Signal	C	C
Washington Street (Route 53) at Water Street	Pembroke	Stop Sign	D	F
Washington Street (Route 53) at Pleasant Street	Pembroke	Stop Sign	F	F
Washington Street (Route 53) at Barker Street (Route 14)	Pembroke	Signal	A	D
Washington Street (Route 53) at Congress Street (Route 14)	Pembroke	Stop Sign	C	C
Summer Street (Route 53) at High Street	Duxbury	Stop Sign	B	A
Summer Street (Route 53) at Franklin Street	Duxbury	Stop Sign	C	C
Summer Street (Route 53) at Valley Street	Duxbury	Stop Sign	B	B
Summer Street (Route 53) at Cross Street	Duxbury	Stop Sign	C	D
Summer Street (Route 53) at Birch Street	Duxbury	Stop Sign	C	B
Kingstown Way (Route 53) at Summer Street	Duxbury	Stop Sign	B	C
Kingstown Way (Route 53) at Winter Street	Duxbury	Roundabout	A	A
Summer Street (Route 53) at Tarkiln Road	Kingston	Stop Sign	F	F
Summer Street (Route 53) at Tremont Street (Route 3A)	Kingston	Signal	F	F

As shown in Table 3, the existing peak hour levels-of-service at signalized intersections in Hanover operate above LOS "E" and "F" except for the Washington Street (Route 53) at Route 3 Southbound Ramps/Hanover Mall intersection, which experiences LOS "F" during the p.m. peak hour, and the Columbia Road (Route 53/139) at Broadway intersection, which experiences LOS "E" during the morning peak hour. The signalized Columbia Road (Route 53/139) at Broadway intersection and the Columbia Road (Route 53/139) at Rockland Street (Route 139), both in Hanover, experience LOS "D" during the

existing p.m. peak hour. All of the Stop Sign controlled intersections in Hanover, except for the Washington Street (Route 53) at Hanover Mall Drive (Buffalo Wild Wings) intersection, experience LOS "F" during the p.m. peak hour. This is due to heavy traffic flow on Route 53 during the p.m. peak, which contains few gaps sufficient for side street traffic to enter the major street flow safely.

In Pembroke, the signalized intersections experience acceptable levels-of-service during the existing a.m. and p.m. peak hours. The Washington Street (Route 53) at Barker Street (Route 14) is the only signalized intersection with LOS "D", which occurs during the p.m. peak hour. The Stop Sign controlled intersections in Pembroke all experience LOS "F" conditions due to heavy traffic volumes on Route 53, which lack sufficient gaps for safe entry from the side streets during the peak hours. In Duxbury, the Route 53 study area intersections experience acceptable levels-of-service during the existing a.m. amd p.m. peak hours at both the signalized and unsignalized intersections, although the Summer Street (Route 53) at Cross Street intersection experiences LOS "D" during the afternoon peak hour. All the other Duxbury intersections experience LOS "C" or better during the morning and afternoon peak hour. Both of the study area intersections in Kingston experience LOS "F" (failed) conditions during the a.m. and p.m. peak hour. The Route 53/Tar Kiln Road intersection in Kingston is unsignalized (Stop Sign controlled) and the Route 53/Route 3A intersection is signalized.

Crash History

Crash data for the study area intersections within the Route 53 corridor study area was obtained for the latest available three-year period (2013-2014-2015) from the Massachusetts Department of Transportation (MassDOT). The data is made available by the Massachusetts Registry of Motor Vehicles and then compiled by MassDOT. The data was analyzed by OCPC in accordance with the standard practices published by the Institute of Transportation Engineers (ITE) in the *Manual of Traffic Engineering Studies.* Crash rates were calculated and compared with the average crash rates for Massachusetts and for MassDOT District 5.

Crash rates are used, according to the *Manual of Traffic Engineering Studies*, to characterize the crash exposure of a facility. Crash rates for intersections are calculated based on the average number of crashes per million entering vehicles (MEV). The statewide average crash rates are 0.77 MEV for signalized intersections and 0.58 MEV for un-signalized intersections. The MassDOT District 5 average crash rates are 0.76 MEV for signalized intersections and 0.58 MEV for un-signalized intersections.

The purposes for analyzing crash data include:

- To define and identify high crash locations.
- To justify the installation of traffic control devices.
- To evaluate the geometric design (including lane use) and proposed changes in traffic regulations.
- To justify expenditures for improvements that offer crash reduction or prevention.
- To identify a need for traffic enforcement.
- To identify needs in pedestrian and bicycle safety and certain actions causing crashes that can be prevented through driver and/or public education.

The number of crashes often increases as traffic volumes increase. Traffic growth creates more opportunities for crashes and therefore increases vehicle exposure to crashes. A particular condition that causes crashes at an intersection can become exacerbated with increased traffic, and frequency will therefore rise. The crash rate utilized for intersection analysis is the crash rate per million entering

vehicles, which is the average number of accidents per year (over three years) times one million, divided by the number of vehicles entering the intersection in a year.

Table 4 summarizes the number of crashes and corresponding crash rates for the study area corridor intersections for the three year history 2013, 2014, and 2015. Crash rates that exceed the statewide and District 5 crash rate averages are shaded in Table 4.

Table 4 - Intersection Crash Summary

	Intersection	Property Damage Only	Injury	Fatal	Total	Crash Rate (MEV)
1	Washington Street (Route 53) at Webster Street (Route 123), Hanover	8	4	1	13	0.25
2	Washington Street (Route 53) at Route 3 Exit 13 Northbound Ramps, Hanover	2	6	0	8	0.24
3	Washington Street (Route 53) at Route 3 Exit 13 Southbound Ramps / Hanover Mall, Hanover	4	4	0	8	0.15
4	Washington Street (Route 53) at Hanover Mall North Drive (By WalMart / Buffalo Wild Wings), Hanover	16	5	0	21	0.57
5	Washington Street (Route 53) and Woodland Drive, Hanover	4	0	0	4	0.14
6	Washington Street (Route 53) at Hanover Mall Main Entrance, Hanover	1	1	0	2	0.05
7	Washington Street (Route 53) and Hanover Mall South Drive (near Trader Joes / AT&T) and 1376 Washington Street (Retail Plaza), Hanover	5	4	0	9	0.28
8	Washington Street (Route 53) at Mill Street and Frank's Lane, Hanover	3	7	0	10	0.27
9	Washington Street (Route 53) at Target 1207 Washington Street, Hanover	3	3	0	6	0.22
10	Washington Street (Route 53) at Old Washington Street and Pond Street, Hanover	4	3	0	7	0.22
11	Washington Street (Route 53) and East Street, Hanover	3	0	0	3	0.12
12	Washington Street (Route 53) and Hanover Street, Hanover	2	4	0	6	0.26
13	Columbia Road and Washington Street (Route 53) at Rockland Street (Route 139), Hanover	9	5	0	14	0.43
14	Columbia Road (Route 53/139) at Broadway, Hanover	10	12	0	22	0.60
15	Columbia Road (Route 53/139) at Washington Street, Pembroke	4	3	0	7	0.25
16	Washington Street (Route 53) and Schoosett Street (Route 139), Pembroke	19	13	0	32	1.01
17	Washington Street (Route 53) and Water Street, Pembroke	6	6	0	12	0.59
18	Washington Street (Route 53) at Pleasant Street, Pembroke	17	7	0	24	1.01
19	Washington Street (Route 53) at Barker Street (Route 14), Pembroke	5	8	0	13	0.46
20	Washington Street (Route 53) at Congress Street (Route 14), Pembroke	4	5	0	9	0.90
22	Summer Street (Route 53) at High Street, Duxbury	0	0	0	0	0.00
21	Summer Street (Route 53) at Franklin Street, Duxbury	4	5	0	9	0.87
23	Summer Street (Route 53) at Valley Street, Duxbury	4	0	0	4	0.36
24	Summer Street (Route 53) at Cross Street, Duxbury	2	1	0	3	0.25
25	Summer Street (Route 53) at Birch Street, Duxbury	3	3	0	6	0.50
26	Summer Street (Route 53) at Kingstown Way, Duxbury	2	4	0	6	0.54
27	Kingstown Way (Route 53 at Winter Street, Duxbury	6	5	0	11	0.90
28	Summer Street (Route 53) at Tarkiln Road, Kingston	11	4	0	15	0.84
29	Summer Street (Route 53) at Duxbury Way (Route 3A), Kingston	19	2	0	21	0.63

Table 4 shows that the Washington Street (Route 53) and Schoosett Street (Route 139) intersection in Pembroke had the most crashes with 32 within the three year study period. The Washington Street (Route 53) at Pleasant Street intersection in Pembroke had the second highest amount of crashes with 24 and the Columbia Road (Route 53) at Broadway in Hanover had the third most crashes with 22. All of

these three intersections are included in the OCPC region's top 5 percent crash clusters. According to MassDOT, the "Top High Crash Intersection Locations" are based on a clustering of crashes that have been submitted to the statewide crash system at the Registry of Motor Vehicles and have been ranked based on the weighting of the number and severity of crashes. These three intersections within the Top 5 percent crash clusters for the OCPC region are eligible for Highway Safety Improvement Program (HSIP) funding. In addition to inclusion in the 5 percent crash clusters, the Washington Street (Route 53) at Schoosett Street (Route 139) intersection and the Washington Street (Route 53) at Pleasant Street intersection, both in Pembroke, had the highest crash rates in the study area with 1.01 crashes per million entering vehicles (MEV).

Pavement Conditions

OCPC uses pavement management software (PMS) to maintain a region-wide data base of pavement surface conditions for federal-aid roads. The PMS includes a data base that documents the severity of pavement deterioration and the extent of the deterioration on each road or road segment. The software estimates the implications for cost of maintenance and repair for the road segments based on the severity and extent of the deteriorations. The severity and extent of the pavement surface deterioration (road corridor surface condition) is obtained via a windshield survey of the road and the data is then entered into the PMS. The software calculates Pavement Condition Index (PCI) scores for the surveyed road segments (0 through 100).

The field survey evaluation severity criteria includes: potholes and patching, alligator cracking, distortion, rutting, weathering and block cracking, transverse and longitudinal cracking, bleeding and polished aggregate, surface wear and raveling, corrugations, and shoving and slippage. The PMS software calculates Pavement Condition Index (PCI) scores for the surveyed road segments as a deduction is assigned for each distress as well as the extent of the distress. Each road or road segment is placed in a condition category based on the calculated PCI. These categories include "POOR" (PCI = 0 to 60), "DEFICIENT" (PCI = 61 to 72), "FAIR" (PCI = 73 to 85), "GOOD" (PCI 86 to 92), and "EXCELLENT (PCI = 93 to 100). The software recommends a repair and associated cost for each road and/or road segment. The PMS repair and maintenance strategies fall under five general default strategies. These include:

1. Base Reconstruction – This is recommended for road segments with a PCI between 0 and 60. This is recommended for roads in need of base improvement. Typical repairs include full depth reconstruction and reclamation.
2. Structural Improvement (Rehabilitation) – This is recommended for road segments with a PCI between 61 and 72. This is recommended when the pavement surface structure is in need of added strength for existing traffic. Typical repairs may include overlay with or without milling.
3. Preventive Maintenance – This is recommended for road segments with a PCI between 73 and 85. The pavement surface may be in need of surface sealing, full depth patch and/or crack sealing. This could include minor leveling, as well as surface treatments such as chip seals, micro-surfacing, and thin overlays.
4. Routine Maintenance – This is recommended for road segments with a PCI between 86 and 92. This is recommended when the surface may be in need of crack sealing or minor localized repair. This work may include crack sealing and pothole and full depth patching.
5. No Immediate Maintenance or Repair – This category is for road segments with a PCI between 93 and 100, and the surface is considered in excellent condition.

OCPC's region-wide pavement management system includes all roads eligible for federal aid, including Route 53 in the Towns of Kingston, Duxbury, Pembroke, and Hanover. Table 5 summarizes the results of the Route 53 pavement management data collection and analysis for the Route 53 study area. Table 5 shows that the Pavement Condition Index (PCI), which characterizes the surface condition, as well as the recommended repair and the estimated cost of repair. Figures 9, 10, and 11 show the Route 53 corridor pavement conditions and the potential recommendations.

Route 53 in Kingston and Duxbury is in "Fair" condition requiring Preventive Maintenance. In Pembroke, Route 53 is mostly in "Excellent" condition south of Route 14 requiring no repair, except for a short section between Congress Street and 708 Washington Street, which is in "Fair" condition requiring Preventive Maintenance. North of Route 14 in Pembroke to the Hanover line, Route 53 is in "Fair" condition, which warrants Preventive Maintenance. In Hanover, the roadway surface conditions on Route 53 vary. Route 53 from the Pembroke line to Broadway is in "Good" condition with only Routine Maintenance required. North of Broadway, Route 53 is in "Fair" condition to Rawson Road, which requires Preventive Maintenance. Between Rawson Road and a point about 800 feet south of Mill Street, Route 53 is in "Good" condition requiring only Routine Maintenance. The worse road surface conditions within the Route 53 corridor study area are in Hanover in a section of the road beginning at a point 800 feet south of Mill Street north to the Route 3 Southbound off-ramps. This section is in "Poor" condition requiring base reconstruction. Route 53 north of the Route 3 Southbound off-ramps to Route 123 is in "Excellent" condition requiring no repair. Route 53 in Hanover from Route 123 to the Norwell line, the road surface is "Deficient" and Rehabilitation of the surface is recommended.

Table 5 - Pavement Management Sections

Route 53 Name	Town	Length (ft.)	Description of Segment	Current Condition	Recommended Repair	Estimated Cost of Repair	Current PCI
Washington Street	Hanover	489.48	Route 53 from Route 123 north to the Norwell Line	Deficient	Structural Improvement (Rehab)	$35,561.48	65
Washington Street	Hanover	3886.64	Route 53 from Route 3 SB off ramps to Route 123	Excellent	No Repair	$0.00	99
Washington Street	Hanover	3,432.06	Route 53 from about 800 feet south of Mill Street to Route 3 SB off ramps	Poor	Base Reconstruction	$990,045.16	58
Washington Street	Hanover	5,291.92	Route 53 from Rawson Road to about 800 feet south of Mill Street	Good	Routine Maintenance	$27,390.43	88
Columbia Road-Washington Street	Hanover	9037.82	Route 53 from Broadway to Rawson Road	Fair	Preventive Maintenance	$128,484.03	73 - 85
Columbia Road	Hanover	2,402.76	Route 53 from Pembroke line to Broadway	Good	Routine Maintenance	$7,796.16	89
Columbia Road-Washington Street	Pembroke	8,829.23	Route 53 from Route 14 to Hanover Line	Fair	Preventive Maintenance	$113,592.10	84
Washington Street	Pembroke	7781.08	Route 53 from 708 Washington Street to Route 14	Excellent	No repair	$0.00	95
Washington Street	Pembroke	1198.17	Route 53 from Congress Street to 708 Washington Street	Fair	Preventive Maintenance	$15,361.60	76
Washington Street	Pembroke	1951.87	Route 53 from Duxbury line to Congress Street	Excellent	No repair	$0.00	95
Kings Town Way-Summer Street	Duxbury	16,580.05	Route 53 from Kingston line to Pembroke line	Fair	Preventive Maintenance	$194,215.05	83
Summer Street	Kingston	1629.87	Route 53 from Route 3A to the Pembroke line	Fair	Preventive Maintenance	$20,844.31	79

Figure 9

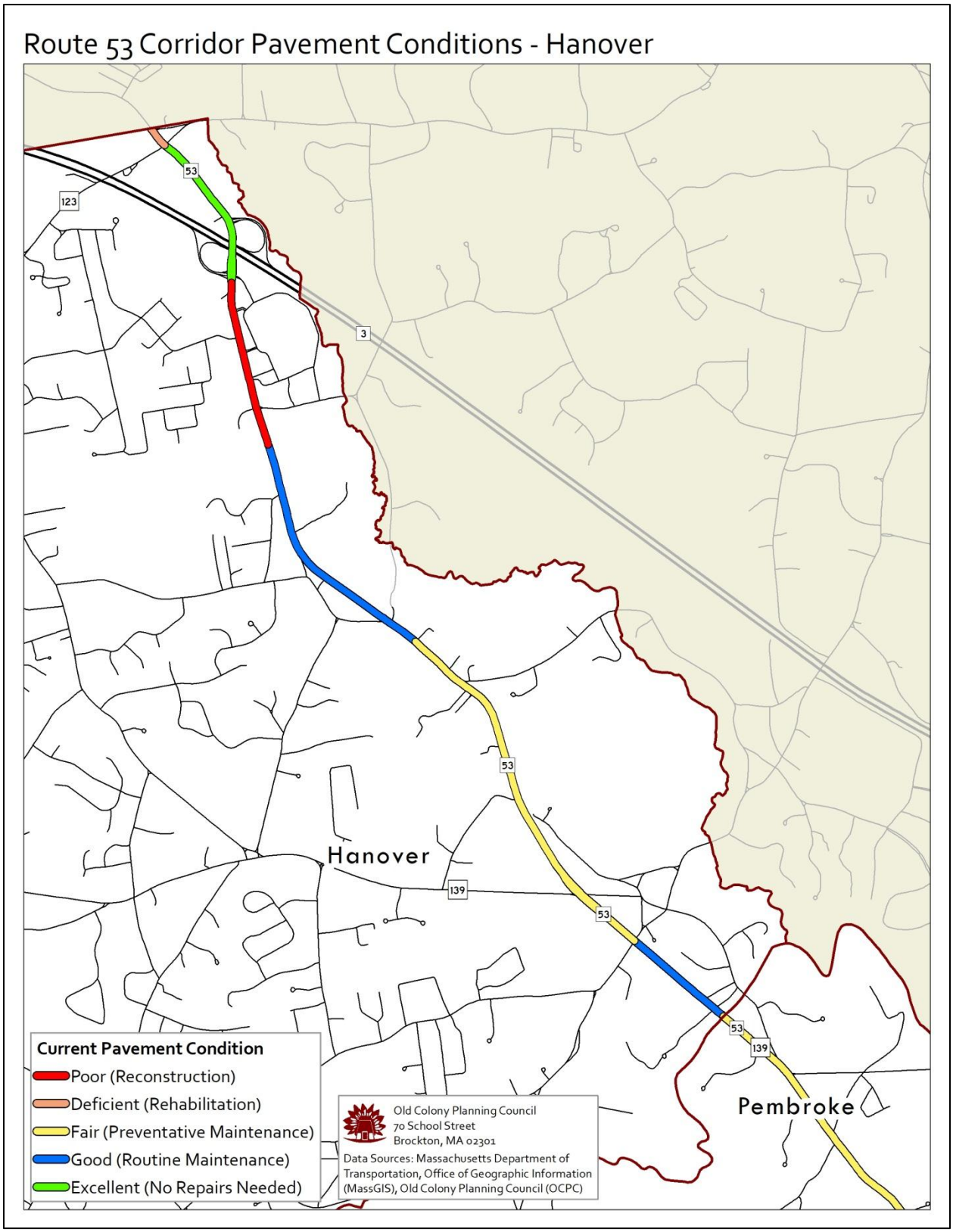

Route 53 Corridor Pavement Conditions - Hanover
53
123
3
53
Hanover
139
53
53
139
Pembroke
Current Pavement Condition
Poor (Reconstruction)
Deficient (Rehabilitation)
Fair (Preventative Maintenance)
Good (Routine Maintenance)
Excellent (No Repairs Needed)
Old Colony Planning Council
70 School Street
Brockton, MA 02301
Data Sources: Massachusetts Department of Transportation, Office of Geographic Information (MassGIS), Old Colony Planning Council (OCPC)

Figure 10

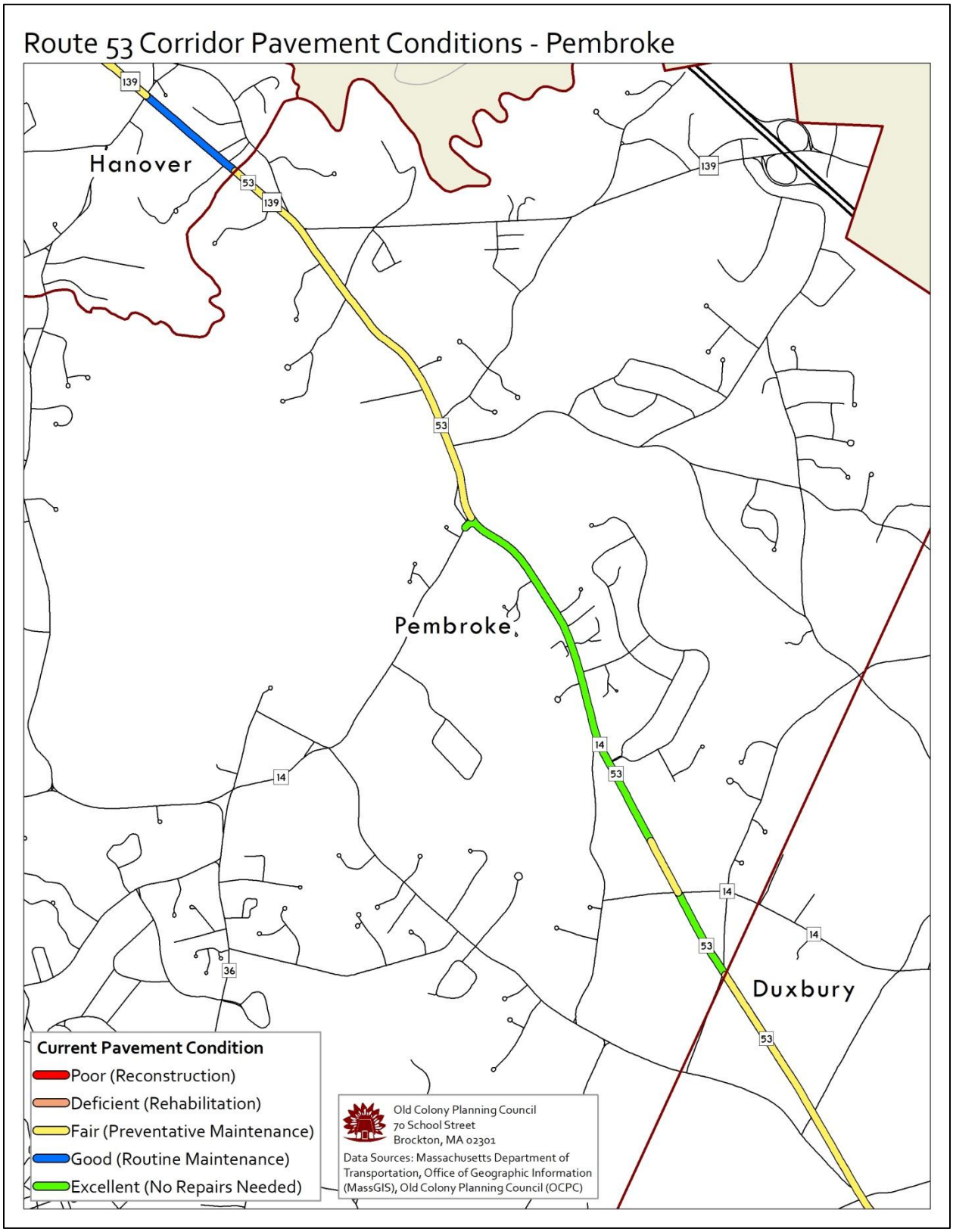
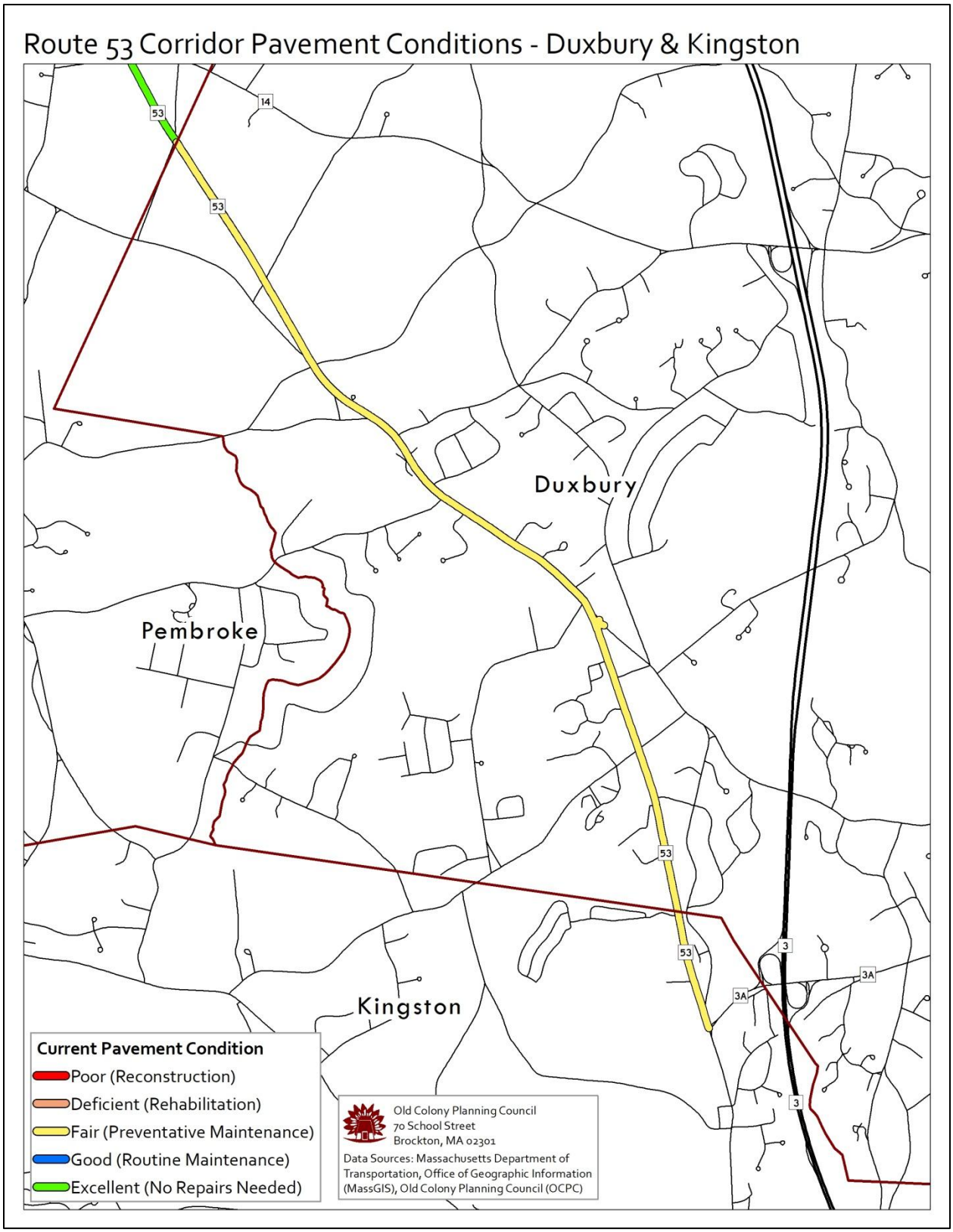

Route 53 Corridor Pavement Conditions - Pembroke
Hanover
Pembroke
Duxbury
139
53
14
36
Current Pavement Condition
Poor (Reconstruction)
Deficient (Rehabilitation)
Fair (Preventative Maintenance)
Good (Routine Maintenance)
Excellent (No Repairs Needed)
Old Colony Planning Council
70 School Street
Brockton, MA 02301
Data Sources: Massachusetts Department of Transportation, Office of Geographic Information (MassGIS), Old Colony Planning Council (OCPC)

Figure 11


Route 53 Corridor Pavement Conditions - Duxbury & Kingston
53
14
53
Duxbury
Pembroke
53
53
3
3A
3A
Kingston
3
Current Pavement Condition
Poor (Reconstruction)
Deficient (Rehabilitation)
Fair (Preventative Maintenance)
Good (Routine Maintenance)
Excellent (No Repairs Needed)
Old Colony Planning Council
70 School Street
Brockton, MA 02301
Data Sources: Massachusetts Department of Transportation, Office of Geographic Information (MassGIS), Old Colony Planning Council (OCPC)

Pedestrian and Bicycle Accommodations

The Route 53 corridor study area in the Towns of Hanover, Pembroke, Duxbury, and Kingston offers little for bicycle accommodations. The shoulders along the corridor are insufficient in providing the consistent five foot widths required by the MassDOT Design Guidebook for bicycle lanes. The provision of shoulders is sporadic and the width of the shoulders along both sides of the corridor varies between one foot and five feet, with very few sections providing the required five foot widths for bikes. In addition, there is no signage and there are no accommodations at intersections for bicycles. The speeds and the volumes of traffic on Route 53 are not ideal for bicycle travel for bicycle riders of all abilities. The 85th Percentile speeds vary. In Pembroke, Duxbury, and Kingston, the 85th percentile speeds are between 47 and 52 miles per hour, which are high. In addition, Route 53 traffic volumes are high, especially in Hanover in the vicinity of the Hanover Mall. Nevertheless, experienced bicycle riders can and do ride bicycles on corridors such as Route 53 with high volumes and high speeds. Wider shoulders, pavement markings (along the road and at intersections), and signage would greatly improve safety conditions for bicycle riders in the corridor.

Future Conditions and Traffic Operations

Future Traffic Analysis

A five-year time horizon (2022) has been chosen for analysis of future conditions, which is consistent with state guidelines for traffic studies. An average annual growth rate of 1.0 percent was used as a background growth rate to increase 2017 traffic to approximate future 2022 "No-Build" conditions. The average annual growth rate was derived from the overall regional growth for roads and arterials similar to the Route 53 study area based on previous traffic counts in the OCPC region and archived by OCPC in its automatic traffic count program.

"No-Build" conditions assume there are no improvements made to the intersection within the next five years. Table 6 summarizes the intersection levels-of-service for the study area intersections under "No-Build" peak hour conditions. Failed traffic operations at intersections in Table 6 (LOS "E" and "F") are shown in shaded blocks. Level-of-Service "D" represents long delays and back-ups with volumes approaching congestion.

Table 6 - No-Build Year 2022 Intersection Peak Hour LOS

Intersection	Community	Traffic Control	Existing AM LOS	Existing PM LOS	No-Build AM LOS	No-Build PM LOS
Washington Street (Route 53) at Webster Street (Route 123)	Hanover	Signal	B	B	B	B
Washington Street (Route 53) at Route 3 Northbound Ramps	Hanover	Signal	C	B	D	B
Washington Street (Route 53) at Route 3 Southbound Ramps / Hanover Mall	Hanover	Signal	B	F	B	F
Washington Street (Route 53) at Hanover Mall Drive (Buffalo Wild Wings)	Hanover	Stop Sign	B	B	B	B
Washington Street (Route 53) at Woodland Drive	Hanover	Stop Sign	C	F	D	F
Washington Street (Route 53) at Hanover Mall Drive (Main Entrance)	Hanover	Signal	A	B	A	B
Washington Street (Route 53) at Hanover Mall Drive (AT&T / Trader Joes)	Hanover	Stop Sign	E	F	E	F
Washington Street (Route 53) at Mill Street	Hanover	Signal	B	C	B	C
Washington Street (Route 53) at Target Plaza	Hanover	Signal	A	B	A	B
Washington Street (Route 53) at Old Washington Street / Pond Street	Hanover	Signal	B	C	B	C
Washington Street (Route 53) at East Street	Hanover	Stop Sign	D	F	D	F
Washington Street (Route 53) at Hanover Street	Hanover	Stop Sign	F	F	F	F
Columbia Road (Route 53/139) at Rockland Street (Route 139)	Hanover	Signal	C	D	C	E
Columbia Road (Route 53/139) at Broadway	Hanover	Signal	E	D	E	D
Columbia Road (Route 53) at Old Washington Street	Pembroke	Stop Sign	E	F	F	F
Washington Street (Route 53) at Schoosett Street (Route 139)	Pembroke	Signal	C	C	C	C
Washington Street (Route 53) at Water Street	Pembroke	Stop Sign	D	F	D	F
Washington Street (Route 53) at Pleasant Street	Pembroke	Stop Sign	F	F	F	F
Washington Street (Route 53) at Barker Street (Route 14)	Pembroke	Signal	B	C	B	D
Washington Street (Route 53) at Congress Street (Route 14)	Pembroke	Stop Sign	C	C	C	C
Summer Street (Route 53) at High Street	Duxbury	Stop Sign	B	A	B	A
Summer Street (Route 53) at Franklin Street	Duxbury	Stop Sign	C	C	C	C
Summer Street (Route 53) at Valley Street	Duxbury	Stop Sign	B	B	B	B
Summer Street (Route 53) at Cross Street	Duxbury	Stop Sign	C	D	C	D
Summer Street (Route 53) at Birch Street	Duxbury	Stop Sign	C	B	C	C
Kingstown Way (Route 53) at Summer Street	Duxbury	Stop Sign	B	C	B	C
Kingstown Way (Route 53) at Winter Street	Duxbury	Round-about	A	A	A	A
Summer Street (Route 53) at Tarkiln Road	Kingston	Stop Sign	F	F	F	F
Summer Street (Route 53) at Tremont Street (Route 3A)	Kingston	Signal	F	F	F	F

Table 6 shows that the intersection peak hour LOS will remain consistent within the study areas with some intersections experiencing a drop in LOS. These include the Columbia Road (Route 53/139) at Rockland Street (Route 139) intersection in Hanover, which drops from LOS "D" to "E during the 2022 p.m. peak, the Columbia Road (Route 53) at Old Washington Street intersection in Pembroke, which drops from LOS "E" to "F" during the 2022 a.m. peak, the Washington Street (Route 53) at Barker Street (Route 14) intersection in Pembroke, which drops from LOS "C" to "D" during the 2022 p.m. peak, and the Summer Street (Route 53) at Birch Street intersection in Duxbury, which drops from LOS "B" to "C" during the 2022 peak.

Conclusions and Recommendations

A number of alternative recommendations are considered in this study based on the public outreach program, which included a public survey, a review of studies and previous plans, and stakeholder meetings. In addition, improvement techniques and best practices to ameliorate specific congestion and safety problems were derived from those outlined in the National Cooperative Highway Research Program (NCHRP) Report 500 series. These NCHRP reports document best practices in different areas of emphasis (safety at signalized intersections, un-signalized intersections, pedestrian and bicycle safety, etc.) "Build" analysis conditions assume potential improvements are in place. "Build" peak hour levels-of-service were performed using the "No-Build" volumes assuming "Build" conditions are implemented (signalization, widening and additional lanes, etc).

Corridor Wide Issues and Recommendations

Heavy morning and afternoon peak period traffic volumes within the Route 53 corridor combined with lane drops and the limited availability of dedicated turning lanes results in traffic congestion and vehicle queuing along specific locations in the corridor. Also, vehicles attempting to enter Route 53 from the side streets or driveways during the morning and afternoon peak hours experience frustration due to the lack of sufficient gaps in the Route 53 traffic stream. This creates "forced flow" conditions on the unsignalized side roads where vehicles force their way to the main Route 53 traffic flow creating unsafe turning movements, especially in the sections of Route 53 in Hanover and Pembroke.

Corridor-wide improvements include pavement resurfacing, restriping faded lines and pavement markings, replacing faded signs and updating retro-reflectivity of signs to the latest MUTCD standards, updating signal-timing and phasing, including signal coordination, and updating antiquated signal equipment including overhead signal facing.

The Route 53 study area communities should work with state agencies and developers to implement short-term and long-term improvements to the overall safety, physical conditions, and traffic operations within the corridor for motor vehicle traffic and non-motorized users. MassDOT typically categorizes short-term (<1 year), midterm (1 to 3 years), or long-term (typically >3 years). Long-term improvements are typically considered to be substantial improvements with an expected time frame for implementation greater than 3 years. The costs are categorized as low (<$10,000), medium ($10,001 to $50,000), or high (>$50,000).

The following overall improvements were identified in regards to traffic, pedestrian, and bicyclist safety and operation:

Overall short-term improvements:

- Pavement marking revision and re-striping (centerlines, crosswalks, fog lines, side street stop lines), and improved markings for bicycle lanes.
- Evaluate potential changes in lane usage.
- New and revised signing upgraded to meet MUTCD reflectivity standards.
- Replace missing or damaged signs and or post legal limit signs where none exist.
- Post signs for shared use bicycle paths where feasible.
- Improve lighting along the road and at intersections.
- Construct, reconstruct, and replace sidewalks and add curb ramps in conformance with the Americans with Disabilities Act.
- Enhance speed management by providing immediate and strict speed enforcement.
- Traffic signal updates and modifications (improvements to equipment, coordination, and timing and phasing).
- Enhance street lighting in the corridor.
- Trim roadside vegetation to improve sight lines and visibility at intersections and sign visibility.

Overall long-term improvements:

- Continue to utilize pavement management system. Reconstruction is recommended for Route 53 pavement in Hanover in the vicinity of the Hanover Mall. Preventative Maintenance is recommended for Route 53 pavement in Hanover, Pembroke, and Duxbury.
- Request that OCPC routinely monitor traffic conditions as part of its regional growth monitoring efforts.
- Consider eliminating lane drops through road widening.
- Hanover, Pembroke, Duxbury, and Kingston should continue to participate in the Joint Transportation Committee (JTC) and Metropolitan Planning Organization (MPO) meetings.

Potential Recommendations Summary

Table 7 summarizes the recommended improvements, their impacts, and estimated implementation periods for the study area corridor and intersections.

Table 7 – Potential Recommendations Summary

Location	Findings	Potential Recommendations	Future Plans
Route 53 Resurfacing from the Route 3 interchange ramps south to a point about 740 feet south of Mill Street.	OCPC pavement management system identified this section as being in poor condition.	OCPC's pavement management system recommends pavement improvements for this section of Route 53.	The resurfacing of Route 53 (Mill and Overlay) in Hanover has been identified as a project (607715) in the Old Colony Transportation Improvement Program (TIP).
Pavement Improvements in the Route 53 Corridor (various locations).	There are extensive sections that are in "Fair" condition at various locations. These include Route 53 in Hanover from Broadway to Rawson Road, Route 53 in Pembroke from Route 14 to Hanover Line (and a small section in Pembroke from Congress Street to 708 Washington Street), Route 53 in Duxbury from Kingston line to Pembroke line, and in Kingston from Route 3A to the Pembroke line.	OCPC's pavement management system recommends "Preventive Maintenance" for these portions of Route 53.	
Widen Route 53 at the University Sports Complex, Hanover.	The traffic delays due to the many activities at the complex are significant during the weekdays as well as the weekends, with the levels-of-service at "F", or forced flow with very long delays at the sports complex driveways.	The proposed improvements in the study to ameliorate the traffic problems included widen Route 53 to three lanes and add a TWTL, as well as installing left turn lanes for both the north and south driveways.	The Town of Hanover submitted a Project Need Form (PNF) to MassDOT District 5 to begin the process for programming improvements.
Washington Street (Route 53) at East Street, Hanover.	This intersection operates with failing levels-of-service during the afternoon peak hour. The heavy traffic volume on Route 53 makes it very difficult for drivers to exit East Street during peak times. The intersection does not contain any accommodation for pedestrians, bicyclists, or the ADA community. None of the approaches contain sidewalks, bicycle lanes, or bicycle accommodating shoulders.	Potential improvements for safety and traffic flow recommended for this location include signalization as well as accommodation for pedestrians, bicyclists, including sidewalks. The Build analysis shows improvements in the LOS to acceptable levels in both the a.m. and p.m. peak hours with a signal.	
Washington Street (Route 53) at Schoosett Street (Route 139), Pembroke.	The intersection operates with level of service ratings of "C" during the a.m. and p.m. peak hours. Field observation showed that the southbound queue of Washington Street (Route 53) occasionally backs up several hundred feet during a red cycle. The crash rate based on this data set is 1.01 crashes per million entering vehicles, which is above the MassDOT District 5 average of 0.76/MEV for signalized intersections.	The recommendation for this intersection is to conduct a Road Safety Audit (RSA) for the intersection and to provide a left turn lane and protected left arrow for northbound Route 53 traffic turning into plaza, as well as provide signal accommodation for pedestrians.	

Table 7 – Potential Recommendations Summary (continued)

Location	Findings	Potential Recommendations	Future Plans
Washington Street at Pleasant Street, Pembroke.	This intersection experiences poor LOS on the Pleasant Street side street approach. Driver frustration, impatience, and aggression results from long delays and queuing on Pleasant Street, due to heavy peak hour volumes on Washington Street (Route 53), which has few acceptable gaps for turning movements. Speed was also cited as problematic at the intersection.	Signalize and reconstruct the intersection to provide a left turn lane and protected left arrow for southbound Route 53 traffic turning into Pleasant Street and an exclusive right turn lane northbound from Route 53 to Pleasant Street, as well as provide signal accommodation for pedestrians.	A Road Safety Audit (RSA) was completed for this intersection on June 6, 2014. This project was advertised for construction bids on March 17, 2018.
Roundabout or Signalization at Route 53 and Congress Street (Route 14), Pembroke	The existing and 2022 No-Build peak hour a.m. and p.m. LOS are estimated at LOS "C"; however, the intersection has a crash rate that is higher than average (0.57) at 0.90.	Install traffic signals or a modern roundabout. This includes sidewalks and bicycle accommodations as well as the implementation of access management to restrict turning movements in and out of driveways in close proximity to the intersection. The signalized Build scenario includes adding exclusive left turn lanes to the Route 53 northbound and southbound approaches, and an exclusive right turn lane on the Congress Street (Route 14) westbound approach. A Road Safety Audit for this location could discern additional safety measures.	
Roundabout at Summer Street (Route 53) and Franklin Street, Duxbury	The existing and 2022 No-Build peak hour a.m. and p.m. LOS are estimated at LOS "C"; however, the intersection has a crash rate that is higher than average (0.57) at 0.87.	Realign High Street to intersect Summer Street at a right angle, add flashing beacons (yellow facing Summer Street and Red facing Franklin Street), eliminate the crest on Summer Street (Route 53), and raise the profile of the Franklin Street approaches so vehicles can see beyond the crest on Summer Street. Also, construct a modern roundabout as an alternative.	
Route 53 at Tar Kiln Road, Kingston	The intersection experiences LOS "F" on the side street approach, (Tar Kiln Road), during the a.m. and p.m. peak hours under existing conditions and the LOS is expected to remain at LOS "F" under 2022 No-Build conditions. The crash rate is 0.84, which is above the District 5 average of 0.57. The close proximity of the pharmacy driveway off of Tar Kiln to the intersection contributes to the above average crash rate due to unconventional turning movements in and out of the driveway into the intersection that interfere with intersection operations.	Recommendations include realigning Tar Kiln Road so it intersects with Route 53 at a right angle, moving the pharmacy driveway away from Route 53, widening the Tar Kiln approach to include an exclusive left and right turn lane, and restriping the lanes so the Route 53 northbound outside lane becomes an exclusive right-turn lane to Tar Kiln.	
Route 53 at Route 3A, Kingston	The intersection experiences LOS "F" during the a.m. and p.m. peak hours under existing conditions and the LOS is expected to remain at LOS "F" under 2022 No-Build conditions.	Widen the eastbound, westbound, and southbound approaches to include an exclusive left turn lane, a through lane and an exclusive right turn lane. Add emergency signal preemption (Opticom) at this location.	

Resurfacing Route 53

Route 53 at the Hanover Mall

The pavement management data collection recorded poor conditions for the roadway pavement surface from the Route 3 interchange ramps south to a point about 740 feet south of Mill Street. OCPC's pavement management system recommends pavement improvements for this section of Route 53. The resurfacing of Route 53 (Mill and Overlay) in Hanover has been identified as a project (607715) in the Old Colony Transportation Improvement Program (TIP). This project is estimated at 1.6 million dollars and is currently in the design phase (the project limits are not yet available), and the program year has yet to be determined.

Pavement Improvements in the Route 53 Corridor

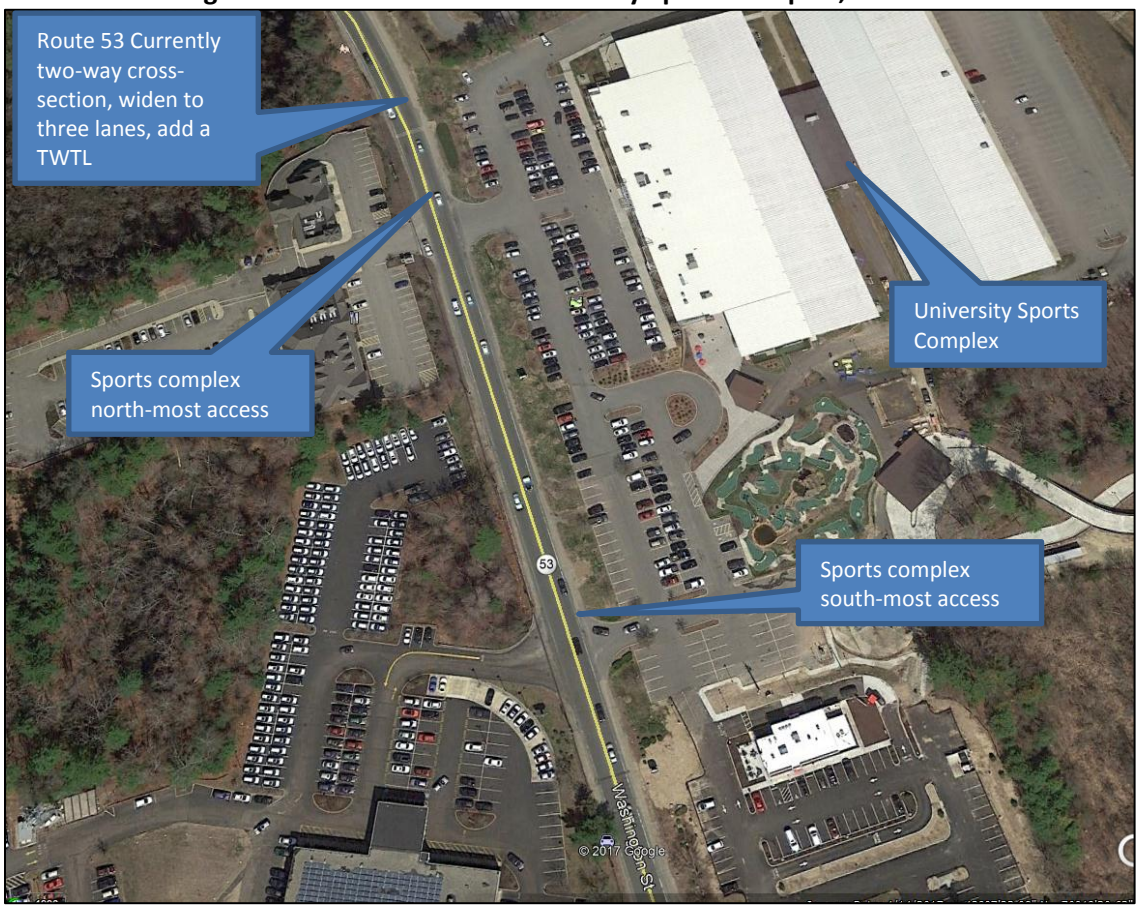
The pavement surface conditions within the Route 53 corridor in the study area communities vary; however, there are extensive sections that are in "Fair" condition. OCPC's pavement management system recommends "Preventive Maintenance" for these portions of Route 53. These include Route 53 in Hanover from Broadway to Rawson Road, Route 53 in Pembroke from Route 14 to the Hanover Line (and a small section in Pembroke from Congress Street to 708 Washington Street), Route 53 in Duxbury from Kingston line to the Pembroke line, and in Kingston from Route 3A to the Pembroke line. Preventive Maintenance can include surface sealing, full depth patch, and/or crack sealing. In addition, it can include minor leveling, as well as chip seals, micro-surfacing, and thin overlays.

Widen Route 53 at the University Sports Complex

Just south of the Route 53/Old Washington Street intersection in Hanover, the Route 53 corridor transitions to a two-lane cross-section, (at the intersection of Rawson Road, which is a dead-end street). Route 53 is a five-lane cross section north of the Route 53/Old Washington Street intersection to Route 3, with two lanes of travel for each direction and a Two-Way Turning Lane (TLTL) in the center for vehicles turning in and out of side roads and driveways. The University Sports Complex is located on the east side of Route 53 at 645 Washington Street, just south of the Route 53/East Street intersection in the two lane section of Route 53. The sports complex has two access points, both are unsignalized. The north most access is signed "exit only" from the sports complex. The Village Square access drive is opposite this exit from the Sports Complex and forms a four-way intersection with Route 53 and the sports complex exit. The south-most access drive to the sports complex is signed "entrance only", although the pavement markings direct vehicles on the site to enter and exit from this drive. An access driveway for a Toyota dealership is located opposite this sports complex south entrance to form an unsignalized four-way intersection with Route 53. This portion of Route 53, as well as the two access points to the sports complex, from the intersection of East Street south to Hanover Street, was cited by survey respondents in OCPC's public survey for this study, as one of the worse locations for traffic delay and congestion.

As previously cited, the Town of Hanover submitted a Project Need Form (PNF) to MassDOT District 5 to improve traffic operations along Washington Street (Route 53) at the entrance and exit to the University Sports Complex. The traffic delays due to the many activities at the complex are significant during the weekdays as well as the weekends, with the levels-of-service at "F", or forced flow with very long delays at the sports complex driveways. The town preferred alternative improvement in the PNF includes widening Route 53 in the vicinity of the complex to include a center Two Way Turning Lane (TWTL). Figure 12 shows the approximate location of the roadway widening.

Figure 12 – Route 53 at the University Sports Complex, Hanover



In September of 2017, a Design Exception Report for Route 53 Improvements (beginning just south of the East Street intersection extending south towards Hanover Street for approximately 2,125 feet), was completed for the Massachusetts Department of Transportation. According to the report, the existing roadway pavement width of Route 53 (Washington Street) (in the vicinity of the University Sports Complex) is approximately 32-feet. The existing lane width consists of two 12 foot travel lanes (one in each direction) with shoulders varying between 2 feet and 6 feet. The purpose of the report was to propose Route 53 proposed improvements to mitigate traffic congestion for events held at the University Sports Complex.

The traffic study concluded that vehicles traveling south on Route 53 cannot pass vehicles queuing to turn left into the University Sports Complex. In addition, there are insufficient opportunities for the left turning vehicles to perform the maneuver safely, due to the high travel volumes on Route 53 (the town regularly dispatched police details to alleviate the traffic delays.

The proposed improvements in the study to ameliorate the traffic problems included widen Route 53 to three lanes and add a TWTL, as well as installing left turn lanes for both the north and south driveways. This would move the queued left turning vehicles out of the through travel lane to allow the Route 53 southbound traffic to pass without delay. Currently, the road does not accommodate bicycling. The shoulder width varies and the shoulder pavement is in poor condition. In addition, there are no pedestrian accommodations. The proposed improvements are designed to address the lack of both bicycle and pedestrian accommodations.

According to the traffic study, the State Highway right-of-way is approximately 80 feet wide from the north end of the project near East Street to the entrance to the Briarwood Child Academy, and approximately 60 feet wide from this point to the end of the project limits in the south. The study states that the proposed roadway improvements involve minor widening of the roadway to provide multimodal accommodations within the project for pedestrians, bicyclists and motorists. This includes minimum eleven foot wide lanes and five foot shoulders for bicycle accommodation in each direction. This will require a design exception per Engineering Directive E-14-006. An asphalt walkway on both sides of Route 53 is proposed to provide a continuous accessible pedestrian connection to the retail and commercial properties between the intersection at East Street and the intersection at Hanover Street within the project limits.

Washington Street (Route 53) at East Street, Hanover

The intersection of Washington Street (Route 53) and East Street is a three-way ("T"-type) intersection, controlled by a Stop Sign on the East Street approach to Route 53. The Route 53 northbound and southbound approaches provide a single shared use lane. East Street is a two-lane collector road. The East Street eastbound approach has a median island and widens as it approaches Route 53, creating enough width for a de-facto right turn lane. According to MassDOT crash records; there were 3 crashes on record at the intersection from 2013 through 2015. The crash rate based on this data set is 0.12 crashes per million entering vehicles, which is below the MassDOT District 5 average of 0.58/MEV for un-signalized intersections. The intersection does not contain any accommodation for pedestrians, bicyclists, or the ADA community. None of the approaches contain sidewalks, bicycle lanes, or bicycle accommodating shoulders.

The intersection operates with failing levels-of-service during the afternoon peak hour. The heavy traffic volume on Route 53 makes it very difficult for drivers to exit East Street during peak times. Table 8 summarizes levels-of-service, forecasted level-of-service "D" for the a.m. peak hour and "F" for the p.m. peak hour though 2022 in the "No-Build" scenario. The 2022 "Build" scenario assumes the installation of a traffic signal for this location. The volumes for this intersection satisfy Warrant 1, Eight-Hour Vehicular Volume, Warrant 2, Four-Hour Vehicular Volume, and Warrant 3, Peak Hour of the Manual on Uniform Traffic Control Devices (MUTCD). Table 8 summarizes the a.m. and p.m. peak hour for the 2022 "Build" scenario.

Table 8 – Washington Street (Route 53) at East Street, Hanover

Jurisdiction	AM Peak LOS (Minor Street)	PM Peak LOS (Minor Street)	No-Build 2022 AM (Minor Street)LOS	No-Build 2022 PM (Minor Street)LOS	Build 2022 AM LOS (Signal)	Build 2022 PM LOS (Signal)	Crash Rate	Number of Crashes (3 Years)
Hanover	D	F	D	F	A	C	0.12	3

The intersection is currently operating with a failing level of service during the peak p.m. hour. Potential improvements for safety and traffic flow recommended for this location include signalization as well as accommodation for pedestrians, bicyclists, including sidewalks. The "Build" analysis shows improvements in the LOS to acceptable levels in both the a.m. and p.m. peak hours with a signal.

Figure 13 – Route 53/East Street Intersection, Hanover

Washington Street (Route 53) at Schoosett Street (Route 139), Pembroke

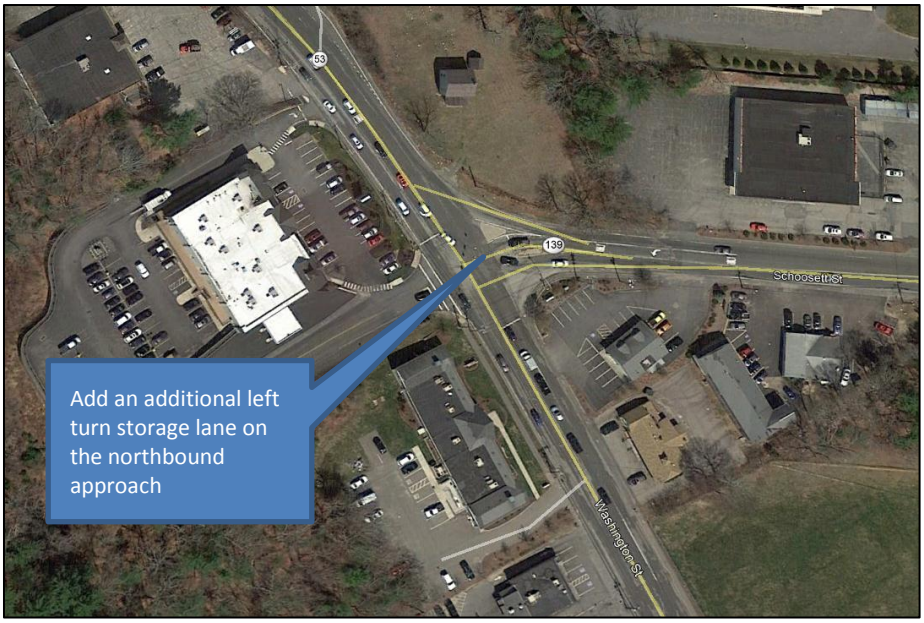
Washington Street (Route 53) and Schoosett Street (Route 139) form a four-way signalized intersection in Pembroke. A driveway into a commercial plaza opposite Schoosett Street (Route 139) forms the western leg of the intersection. According to MassDOT crash records, there were 32 crashes on record at the intersection from 2013 through 2015. The crash rate based on this data set is 1.01 crashes per million entering vehicles, which is above the MassDOT District 5 average of 0.76/MEV for signalized intersections. The intersection has a crosswalk on its western leg, crossing the driveway to the plaza at 75 Washington Street. Both sides of Washington Street (Route 53) south of the intersection have sidewalks, and the eastbound side of Schoosett Street has a sidewalk; however, the sidewalk terminates about 50 feet before the intersection. The traffic signal system, although actuated, does not include any accommodation for pedestrians or bicyclists.

The intersection operates with level of service ratings of "C" during the a.m. and p.m. peak hours. Field observation showed that the southbound queue of Washington Street (Route 53) occasionally backs up several hundred feet during a red cycle; however, the subsequent green cycle typically clears the queue. The recommendation for this intersection is to provide a left turn lane and protected left arrow for northbound Route 53 traffic turning into plaza, as well as provide signal accommodation for pedestrians. A Road Safety Audit (RSA) should be conducted for this intersection to discern additional safety measures. Table 9 summarizes existing level of service and forecasted "No-Build" and "Build" levels-of-service through 2022.

Table 9 – Washington Street (Route 53) at Schoosett Street (Route 139), Pembroke

Jurisdiction	AM Peak LOS (Minor Street)	PM Peak LOS (Minor Street)	No-Build 2022 AM (Minor Street)LOS	No-Build 2022 PM (Minor Street)LOS	Build 2022 AM LOS (Signal)	Build 2022 PM LOS (Signal)	Crash Rate	Number of Crashes (3 Years)
Pembroke	C	C	C	C	C	C	1.01	32

Figure 14 - Washington Street (Route 53) at Schoosett Street (Route 139), Pembroke



Reconstruction of Washington Street at Pleasant Street, Pembroke (Old Colony TIP)

The intersection of Washington Street (Route 53) and Pleasant Street is a 3-way ("T"-type) intersection, controlled by a Stop Sign on the Pleasant Street approach to Route 53. Stop signs are posted on both sides of the Pleasant Street approach for better traffic control visibility. There is also a driveway for a residence with horse corrals off of Washington Street (Route 53) opposite Pleasant Street. Washington Street (Route 53) provides a single shared use lane on the northbound and southbound approaches to the intersection. Pleasant Street provides a single use shared lane to the westbound approach to the intersection. The intersection operates with failing levels of service (LOS "F") during the a.m. and p.m. peak hours, with long delays and back-ups on the Pleasant Street approach. The heavy traffic volume on Route 53 makes it difficult for drivers to exit Pleasant Street during peak times. Table 10 summarizes existing levels-of-service, forecasted level of service though 2022 with a "No-Build" scenario, and the signalized "Build" scenario.

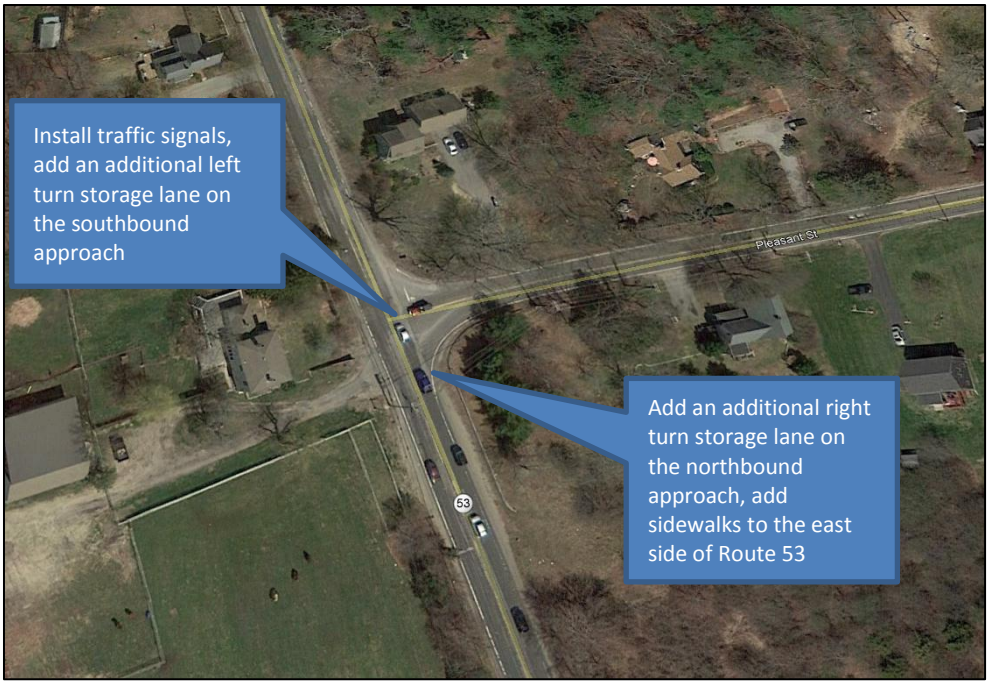
Table 10 – Washington Street (Route 53) at Pleasant Street, Pembroke

Jurisdiction	AM Peak LOS (Minor Street)	PM Peak LOS (Minor Street)	No-Build 2022 AM (Minor Street)LOS	No-Build 2022 PM (Minor Street)LOS	Build 2022 AM LOS (Signal)	Build 2022 PM LOS (Signal)	Crash Rate	Number of Crashes (3 Years)
Pembroke	F	F	F	F	B	C	1.01	24

There are no sidewalks or pedestrian accommodations at the intersection. Washington Street (Route 53) includes a two to three foot shoulder on the side of the road on both the northbound and southbound direction. Pleasant Street lacks shoulders on either side of the road. The speed limit is posted at 40 miles per hour on the northbound and southbound sides of Washington Street (Route 53) just south of this intersection. According to MassDOT crash records, there were 24 crashes on record at the intersection from 2013 through 2015. The crash rate based on this data set is 1.01 crashes per million entering vehicles, which is above the MassDOT District 5 average of 0.58/MEV for un-signalized intersections.

A Road Safety Audit (RSA) was completed for this intersection on June 6, 2014 (as previously cited in this report). The RSA documented driver frustration, impatience, and aggression resulting from long delays and queuing on Pleasant Street, which occur due to heavy peak hour volumes on the major road, Washington Street (Route 53), which has few acceptable gaps for turning movements. Speed was also cited as problematic at the intersection. The recommendation for this intersection is to reconstruct the intersection, install traffic signals, and provide a left turn lane and protected left arrow for southbound Route 53 traffic turning into Pleasant Street and also an exclusive right turn lane on the northbound approach from Route 53 to Pleasant Street, as well as provide signal accommodation for pedestrians. The volumes at the intersection meet the threshold for the MUTCD signal Warrants 1, 2, and 3. The Warrant analyses were conducted by OCPC and is included in the appendix to this report. The project is included in the FFY 2018-2022 Old Colony Transportation Improvement Program (TIP) and is intended to address ongoing safety issues and a lack of bicycle and pedestrian accommodation through the installation of traffic signals, left turn lanes, minor widening to provide minimal bike accommodating shoulders and a sidewalk on the east side of Washington Street (Route 53). This project was advertised for construction bids on March 17, 2018.

Figure 15 – Washington Street (Route 53) at Pleasant Street, Pembroke



Roundabout or Signalization at Route 53 and Congress Street (Route 14), Pembroke

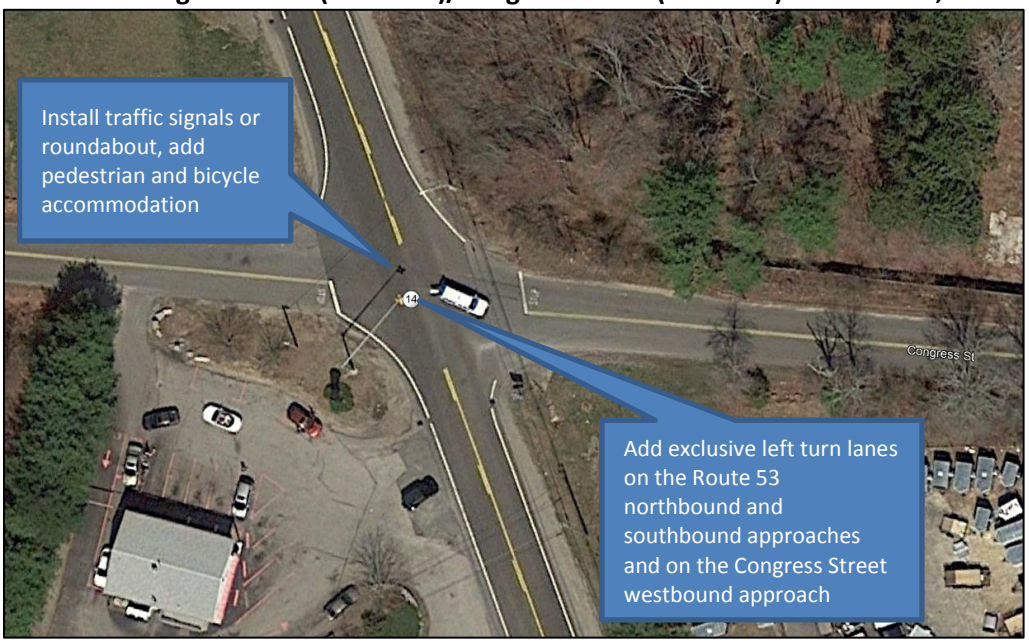
Washington Street (Route 53) and Congress Street (Route 14) form a four-way Stop Sign controlled intersection in Pembroke. The intersection is Stop Sign controlled on the Congress Street (minor street) approaches with a flashing beacon overhead; flashing yellow on the Washington Street (Route 53) northbound and southbound approaches and flashing red on the Congress Street eastbound and westbound approaches. Washington Street (Route 53) is approximately 32 feet wide on the northbound and southbound approaches to the intersection with two twelve foot lanes (one shared approach lane), and four foot paved shoulders on each side of the road. Congress Street also provides a single shared use lane to the intersection on the eastbound and westbound approaches to the intersection. Congress Street is approximately 22 feet wide with no shoulders. Congress Street (Route 14) is a collector road that provides access between Route 53 and Route 3 in Duxbury. Although the existing and 2022 No-"Build" peak hour a.m. and p.m. LOS are estimated at LOS "C", the intersection has a crash rate that is higher than average at 0.90. The District 5 average is 0.57 crashes per million entering vehicles.

A Road Safety Audit (RSA) for this intersection can discern safety measures including low cost improvements. Potential recommended improvements for the intersection that includes higher costs would be to install traffic signals or reconstruct and install a modern roundabout. The potential recommended improvements should include sidewalks and bicycle accommodations as well as the implementation of access management to restrict turning movements in and out of driveways in close proximity to the intersection. The signalized "Build" scenario includes adding exclusive left turn lanes to the Route 53 northbound and southbound approaches, and an exclusive right turn lane on the Congress Street (Route 14) westbound approach. The intersection meets the threshold for Traffic Signal Warrant 1, Eight-Hour Vehicular Volume, and Warrant 7, Crash Experience, as published in the MUTCD. Table 11 summarizes the LOS and the crash data for the intersection, including "No-Build" and "Build" scenarios.

Table 11 – Washington Street (Route 53) at Congress Street, Pembroke

Jurisdiction	AM Peak LOS (Minor Street)	PM Peak LOS (Minor Street)	No-Build 2022 AM (Minor Street)LOS	No-Build 2022 PM (Minor Street)LOS	Build 2022 AM LOS (Signal)	Build 2022 PM LOS (Signal)	Build 2022 AM LOS (Roundabout)	Build 2022 PM LOS (Roundabout)	Crash Rate	Number of Crashes (3 Years)
Pembroke	C	C	C	C	A	A	A	A	0.90	9

Figure 16 - Washington Street (Route 53)/Congress Street (Route 14) intersection, Pembroke



Summer Street (Route 53) and Franklin Street, Duxbury

Summer Street (Route 53) meets Franklin Street in Duxbury, just south of the Pembroke line and approximately 200 feet south of High Street, to form a four-way Stop Sign controlled intersection. Summer Street (Route 53) provides a single shared use lane on the northbound and southbound approaches to the intersection. Summer Street (Route 53) is approximately 32 feet wide with two twelve foot travel lanes and four foot shoulders on both sides of the road. Franklin Street is approximately 24 feet wide providing two travel lanes with no shoulders. The posted speed limit on Franklin Street is 30 miles per hour. Franklin Street is classified as a collector road, which connects between Route 27 and Route 14. There are no pedestrian or bicycle accommodations at the intersection.

The sight lines at this intersection are hindered by a crest in the grade on the Summer Street (Route 53) southbound approach, just before the High Street intersection. Looking northbound from the Franklin Street eastbound and westbound stop controlled approaches to the intersection, vehicles travelling southbound are not visible below a crest in the road. Visibility is further distracted by High Street, which intersects Summer Street obliquely. The view from the Franklin Street eastbound and westbound approaches looking northbound appears as though High Street is the southbound approach to the intersection, while Summer Street southbound vehicles are not seen below the crest on Summer Street. Southbound vehicles appear suddenly above the crest as vehicles on the eastbound and westbound stop signs begin to move through the intersection.

Potential improvements include realign High Street to intersect Summer Street at a right angle, add flashing beacons to the intersection (yellow facing Summer Street and Red facing Franklin Street), smooth out the crest on Summer Street (Route 53), and raise the profile of the Franklin Street approaches so stopped vehicles can see beyond the crest on Summer Street.

Another potential improvement for this intersection, if the other measures fail to mitigate the safety problems, includes the construction of a modern roundabout. Table 12 compares the levels-of-service

from the existing, "No-Build", and "Build" scenarios for the a.m. and p.m. peak hours. It shows that the LOS will improve from LOS "C" during the a.m. and p.m. existing and "No-Build" scenarios to LOS "A" under the "Build" scenario with the implementation of the roundabout.

Table 12 – Summer Street (Route 53) at Franklin Street, Duxbury

Jurisdiction	AM Peak LOS (Minor Street)	PM Peak LOS (Minor Street)	No-Build 2022 AM (Minor Street)LOS	No-Build 2022 PM (Minor Street)LOS	Build 2022 AM LOS (Roundabout)	Build 2022 PM LOS (Roundabout)	Crash Rate	Number of Crashes (3 Years)
Duxbury	C	C	C	C	A	A	0.87	9

Figure 17 – Summer Street (Route 53) at Franklin Street Intersection , Duxbury

Improvements at Route 53 and Tar Kiln Road, Kingston

Tar Kiln Road is a local road that forms a Stop Sign controlled "Y" type intersection with Summer Street (Route 3A) in Kingston. This intersection is located in close proximity, (about 350 feet north), of the Summer Street (Route 53)/Route 3A intersection in Kingston. Tar Kiln Road does not intersect at a right angle (Tar Kiln Road runs southwest creating a "Y" type intersection with Route 53), and a driveway to and from a CVS is located off of Tar Kiln at a point about 15 feet east from where Tar Kiln intersects Route 53.

This intersection experiences LOS "F" on the side street approach, (Tar Kiln Road), during the a.m. and p.m. peak hours under existing conditions and the LOS is expected to remain at LOS "F" under 2022 "No-Build" conditions. In addition, the crash rate is 0.84, which is above the District 5 average of 0.57 crashes per million entering vehicles. The close proximity of the pharmacy driveway off of Tar Kiln to

the intersection contributes to the above average crash rate due to unconventional turning movements in and out of the driveway into the intersection that interfere with intersection operations. Table 13 summarizes the existing and future LOS for the intersection.

Table 13 – Summer Street (Route 53) at Tar Kiln Road, Kingston

Jurisdiction	AM Peak LOS (Minor Street)	PM Peak LOS (Minor Street)	No-Build 2022 AM LOS (Minor Street)	No-Build 2022 PM LOS (Minor Street)	Build 2022 AM LOS (Add Exclusive Left and Right Lanes)	Build 2022 PM LOS (Add Exclusive Left and Right Lanes)	Crash Rate	Number of Crashes (3 Years)
Kingston	F	F	F	F	F	E	0.84	15

Figure 18 shows the Summer Street (Route 53/Tar Kiln Intersection.

Figure 18 – Summer Street (Route 53) at Tar Kiln Road, Kingston

This intersection was included in a 2003 Corridor Study for Route 53 completed by the Central Transportation Planning Staff. The study cited congestion, poor traffic operations, and frequency of vehicle crashes at this intersection. The study included a number of recommendations including realigning Tar Kiln Road so it intersects with Route 53 at a right angle, moving the pharmacy driveway away from Route 53, and restriping the lanes so the Route 53 northbound outside lane becomes an exclusive right-turn lane to Tar Kiln. The study recommended that if a signal is considered for the Route 53/Tar Kiln intersection that this signal should be coordinated with the existing signal at the Route 53/Route 3A intersection, which his located about 350 feet to the south.

Route 53 at Route 3A, Kingston

Route 3A is a minor arterial providing regional north south access in Southeastern Massachusetts including Plymouth, Kingston, and Duxbury. It connects to Route 3 in Duxbury just one-quarter mile east of the Route 53/Route 3A intersection in Kingston. Route 53 and Route 3A form a four-way signalized intersection (with the supermarket plaza driveway making up the western leg of the intersection). The LOS under existing a.m. and p.m. peak hour conditions is at LOS "F". The intersection experiences heavy

left and right turn intersection volumes, especially on the Route 53 southbound approach and the Route 3A westbound approach, as vehicles access the Route 3 interchange off of Route 3A in Duxbury. The northbound and southbound approaches currently have exclusive left turn lanes. The eastbound lane (the supermarket driveway) provides a shared left-through lane and an exclusive right turn lane. The westbound Route 3A approach provides two lanes, including a combined left-through lane and combined right-through lane. The 2003 Corridor Study for Route 53 completed by the Central Transportation Planning Staff recommended widening the westbound approach to provide three lanes including an exclusive left turn, and through lane, and an exclusive right turn. The study recommended the same lane configuration for the Route 53 southbound approach and the supermarket eastbound approach. In addition, emergency signal preemption (Opticom) should be added at this location. These improvements improved the LOS from a LOS "F" to LOS "D" during the a.m. peak "Build" and LOS "E" during the p.m. peak "Build" conditions. Table 14 compares the existing and future LOS, and Figure 19 shows the Route 53/Route 3A intersection.

Table 14 – Summer Street (Route 53) at Route 3A, Kingston

Jurisdiction	AM Peak LOS	PM Peak LOS	No-Build 2022 AM LOS	No-Build 2022 PM LOS	Build 2022 AM LOS	Build 2022 PM LOS	Crash Rate	Number of Crashes (3 Years)
Kingston	F	F	F	F	D	E	0.63	21

Figure 19 - Route 53 at Route 3A, Kingston

Funding for Improvements

The implementation of projects includes taking transportation improvements from the concept stage through to design and construction. Funding is an essential element in ensuring the implementation of recommended improvements. The *MassDOT Project Development and Design Guide* explains the project development process in Massachusetts and design standards for transportation projects. The MassDOT project development process consists of eight steps:

I. Problem/Need/Opportunity Identification (A Project Need Form is submitted to MassDOT)
II. Planning (A project planning report is completed)

III. Project Initiation (A Project Initiation Form is submitted to MassDOT)

- Identification of Appropriate Funding
- Definition of Appropriate Next Steps
- Project Review Committee Action

VI. Environmental Design and ROW Process (Includes Plans, Specifications, and Estimates, P, S, & E)

- Environmental Studies and Permits
- Right-of-Way Plans
- Permits

V. Programming (Old Colony TIP and State Transportation Improvement Program, STIP)

- Programming of Funds

VI. Procurement (Construction bids and contractor selection)
VII. Construction
VIII. Project Assessment

On sections of roadway owned and maintained by the municipality, the community typically initiates a project by completing and submitting the Project Need Form (available in the Appendix), as well as providing for project planning and design. Similarly, for state owned facilities, the MassDOT initiates projects and provides planning and design on their section of roads.

Many funding options are available for project construction, and are outlined below. Note that some funding programs, such as the Congestion Mitigation and Air Quality (CMAQ) Program, are for specific types of projects that meet specific criteria, while other programs such as Chapter 90 can be utilized on a much broader range of projects. Federal aid eligible regional transportation needs have outpaced available funding in the Transportation Improvement Program (TIP) for the past several years. All projects on the TIP go through a comprehensive evaluation process to determine priority for funding; therefore, the programming of the TIP is a competitive process. In general, the process to fund a project through the TIP may take up to five years. Therefore, due to this limitation of TIP funding, communities are encouraged to seek alternate funding avenues for their high priority projects. Examples of such options include using Chapter 90 funds, developer mitigation, or public/private partnerships with local stakeholders.

Funding Programs

- Capital Improvement Program (CIP) and Local Funding: This program has historically been utilized to help provide the design and engineering of highway projects.
- Exactions (Developer Mitigation Agreements): Communities have increasingly turned to exactions as a means to meet new infrastructure and public service needs. Cities and towns use developer exactions as a strategy to offset the burdens of new development on the community. Exactions contribute to regional equity by ensuring that a new development pays a fair share of the public costs that they generate. Exactions consist of a developer's payment of funds to offset the cost of necessary construction, design, or maintenance of public infrastructure directly connected to the new development. Developers commit to an agreement for funding or constructing off-site improvements in exchange for the approvals to proceed with a development project.
- Bridge Replacement and Rehabilitation Program: This program provides funds for rehabilitation and replacement of any bridge on a public road. Bridges on the federal aid system or off the federal aid system are eligible for these funds.

- Chapter 90: This program provides State funding for highway construction, preservation, and improvement projects that create or extend the life of capital facilities. The level of funding is determined by a formula that is based upon public way mileage, population and level of employment in each community. The Chapter 90 Program is a reimbursement program, as the community must initially pay the cost of a particular project.
- Community Development Block Grant (CDBG) Program: This program provides for the development or expansion of economic opportunities and the provision of decent housing and public facilities. Eligible use of funds includes community development (construction or reconstruction of streets, water and sewer facilities, neighborhood centers, recreation facilities, and other public works).
- Congestion Mitigation and Air Quality Improvement Program (CMAQ): This directs funds toward transportation projects in Clean Air Act non-attainment areas for ozone and carbon monoxide. OCPC is located in the Boston non-attainment area for ozone.
- Highway Safety Improvement Program (HSIP): This program is a core Federal-aid program with the objective of achieving a significant reduction in traffic fatalities and injuries.
- National Highway System (NHS): This consists primarily of existing Interstate Highway routes and portions of the Primary System. This program was established to focus federal resources on roads that are the most important to interstate travel, national defense, inter-modal connections, and international commerce.
- Non-Federal Aid (NFA): This program provides state funds for projects that due to federal fiscal constraints would not be able to receive federal funding. Projects under this category are listed for informational purposes only.
- Surface Transportation Program (STP): This is a block grant type program that may be used for any roads (including NHS) that are not functionally classified as local or rural minor collectors. These roads are collectively referred to as federal-aid eligible roads.
- Transportation Alternative Program (TAP): The TAP program provides Federal-aid funding for programs and projects defined as transportation alternatives, including on and off road pedestrian and bicycle facilities, infrastructure projects for improving non-driver access to public transportation and enhanced mobility, community improvement activities, and environmental mitigation; recreational trail program projects; safe routes to school projects; and projects for planning, designing, or constructing boulevards and other roadways largely in the right-of-way of former Interstate System routes or other divided highways.
- Transportation Bond Bill (TBB): This authorizes and directs the MassDOT to expend monies for transportation projects such as reconstruction, resurfacing, rehabilitation or improvements of highways, bridges, and parking facilities. From this, the State will issue either general obligation or special obligation bonds.
- Federal appropriations: These allocate federal funding for federal aid eligible projects.
- Massachusetts Complete Streets Program: This program provides $12.5 million dollars for two years beginning in 2016 to municipalities to implement Complete Streets projects. Municipalities must adopt Complete Streets policies and send staff for training for eligibility.
- MassWorks Infrastructure Program: In September of 2010, the MassWorks Infrastructure Program was instituted to provide a one-stop shop for municipalities and other eligible public entities seeking public infrastructure funding to support economic development and job creation in Massachusetts. The Program is an administrative consolidation of six former grant programs:

    1. Public Works Economic Development Grant (PWED)

2. Community Development Action Grant (CDAG)
3. Growth Districts Initiative (GDI) Grant Program
4. Massachusetts Opportunity Relocation and Expansion Program (MORE)
5. Small Town Rural Assistance Program (STRAP)
6. Transit Oriented Development (TOD) Program

The MassWorks Infrastructure Program is administered by the Executive Office of Housing and Economic Development, in cooperation with the Department of Transportation and Executive Office for Administration & Finance.

Appendices

A. OCPC Automatic Traffic Recorder Counts
B. OCPC Turning Movement Counts
C. OCPC Intersection Levels-of-Service
D. Signal Warrant Analysis
E. OCPC Intersection Crash Rate Calculation
F. MassDOT Project Need Form
G. MassDOT Project Initiation Form