March 2015

Hanover

Route 53 Corridor Study

Prepared for Town of Hanover, MA

Prepared by vhb

Corridor Planning Study

Route 53 Corridor Study Hanover, MA

Prepared for **The Town of Hanover**
Hanover, MA

Prepared by

Watertown, MA

March 2015

Table of Contents

Tables

Figures

1

Introduction

Vanasse Hangen Brustlin, Inc. (VHB) was retained by the Town of Hanover to evaluate the Route 53 corridor and develop potential conceptual improvement options from Old Washington Street/ Pond Street to the Pembroke Town Line. The evaluation focuses on how potential long-term land use growth could increase traffic volumes and impact traffic operations along the Route 53 corridor. This report presents the findings and recommendations of the study, which assessed nine intersections along Route 53.

This report consists of the following six chapters:

Chapter 1 – Introduction – discusses the study methodology and summarizes the key findings;

Chapter 2 – 2014 Existing Conditions – presents traffic data, an assessment of how well the roadways and intersections handle peak traffic demands and where bottlenecks occur, and establishes a baseline for evaluating potential improvement options;

Chapter 3 –Future Conditions – presents a 2024 No-Build forecast of future traffic demands based on known developments in the area; and discusses the development and analysis of a Maximum Build-out scenario for currently vacant or underdeveloped parcels along or immediately adjacent to the Route 53 corridor;

Chapter 4 –Traffic Operations – presents traffic operations analysis of the 2014 Existing, 2024 No-Build, and Build-Out conditions;

Chapter 5 – Conceptual Improvements – summarizes several actions that the Town could consider in the near-term to improve traffic flow; presents two long-term corridor improvement options for the Town's consideration; and

Chapter 6 – Conclusions and Next Steps – provides an overview of the study conclusions and actions needed to implement the improvements evaluated in this study.

Study Methodology

As an initial step, an extensive data collection effort was conducted. This effort included field reviews of intersection and roadway geometry along with traffic operations. Peak period traffic volume data were collected at the nine study area intersections and signal inventories were conducted at the three signalized intersections within the study area. Finally, a traffic operations model was developed to assess how well the intersections in the study area handle the peak period traffic demands placed on them.

The second component of the Corridor Study is a review of the future traffic conditions along Route 53. The future horizon year, future traffic volume projections along Route 53, and currently vacant or underdeveloped parcels along or immediately adjacent to the Route 53 corridor for the Maximum Build-out were identified. The data presented is based on research of historic traffic conditions, available GIS information, and input from Town of Hanover officials.

Lastly, VHB identified short-term improvements and conceptual corridor improvements for the Route 53 corridor. The short-term improvements focus on low cost improvements to the existing infrastructure that can be completed in the near future (a ten-year horizon). The conceptual corridor improvements look at geometric improvements, in addition to the short-term improvements, to the Route 53 corridor to increase capacity and improve operations under the Maximum Build-out condition (long-term horizon).

Study Findings

Through field inventories, signal reviews, and discussions with Town officials, short-term and long-term opportunities to improve traffic flow along Route 53 were identified.

The following short-term improvements were identified:

- **Route 53 (Washington Street) at East Street:** the addition of a southbound left-turn storage lane to reduce conflicts with southbound through traveling vehicles and improve safety at the intersection;
- **Route 53 (Columbia Road) at Route 139 (Rockland Street):** signal timing and phasing improvements which are projected to result in improved intersection operations and safety; and
- **Route 53 (Columbia Road) at Broadway:** signal timing and phasing improvements which are projected to result in improved intersection operations and safety.

The following long-term improvements are presented for consideration:

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

2

2014 Existing Conditions

The first component of the Corridor Study is a review of the existing transportation infrastructure, traffic, and safety conditions along Route 53. This chapter defines the study area and describes the existing condition of roadway and intersection infrastructure along Route 53; quantifies existing traffic conditions; presents a safety review as of spring 2014; and summarizes previous planning efforts along Route 53 within the study area by the Town of Hanover. The data and observations presented were compiled from field reviews and a data collection program, complemented by input from Town of Hanover officials.

Existing Transportation Infrastructure

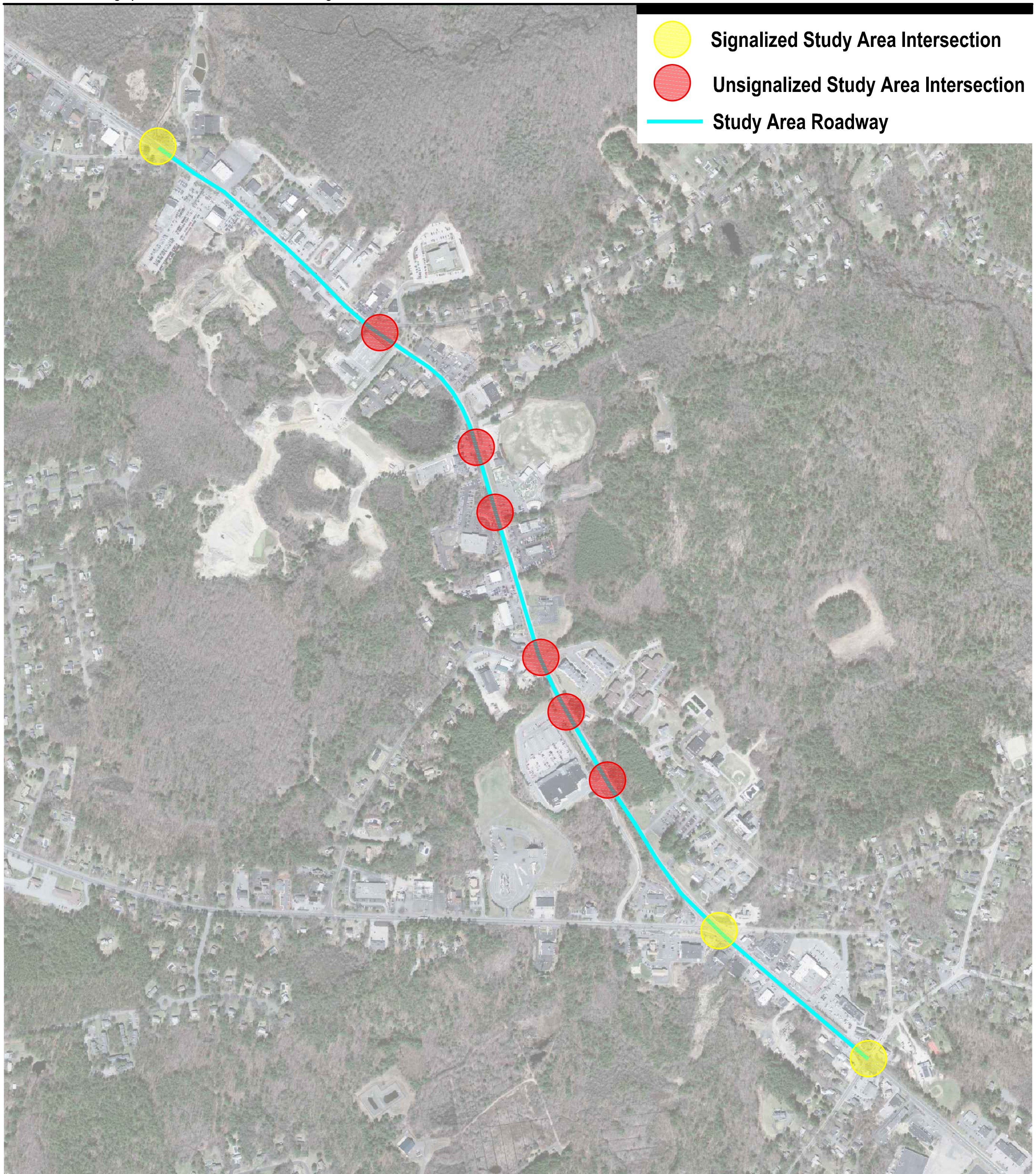
As shown in Figure 1, the study area for this effort if Route 53 from Old Washington Street/ Pond Street to the Pembroke Town Line. This section details study area roadway and intersection conditions and includes a summary of signal reviews completed as part of this study.

Route 53

Route 53 is an urban principal arterial under State jurisdiction and generally runs in a north-south direction. To the north, Route 53 provides access to Route 3 which connects to points north and south, including the City of Boston. To the south Route 53 becomes Route 3A which provides access to points south, including Cape Cod.

Route 53 is part of the National Highway System (NHS): a system of roadways important to the nation's economy, defense, and mobility. NHS roadways are subject to unique design requirements. Designs that deviate from the NHS design standards may be considered based on the conditions, context, and consequences of a project. A

\\mawatr\ts\12511.01\graphics\FIGURES\Networks_060414.dwg

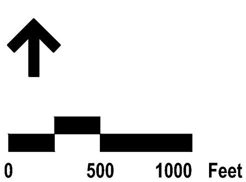


Vanasse Hangen Brustlin, Inc.

Study Area

Figure 1

Route 53 Corridor Study
Hanover, Massachusetts



design exception states the reason(s) for a specific deviation from an established standard for a specific highway feature and may also include features to mitigate any negative effects.

Land uses along Route 53 consist of primarily retail and commercial uses. Additionally, there are several vacant or undeveloped parcels along Route 53 which have the potential to be developed and/ or occupied in the future. Parking is not permitted along either side Route 53 within the project limits.

Sidewalks are provided along segments of Route 53. Along the northbound side of Route 53, a sidewalk is present from Rockland Street (Route 139) in the south to the Cardinal Cushing Centers' driveway in the north. Along the southbound side of Route 53, sidewalks exist from the project limit in the north to the southern property limit of the Toyota Dealership and from approximately 150 feet north of the intersection with Rockland Street (Route 139) to the intersection with Rockland Street (Route 139). Crosswalks are provided infrequently within the study area corridor and are located across: the eastbound approach of Route 53 and Old Washington Street/ Pond Street; the southbound and westbound approaches of Route 53 at Rockland Street (Route 139); and across all approaches of Route 53 at Broadway. No formal bicycle accommodations are available along Route 53 within the study area limits.

Route 53 consists of two travel lanes in each direction from the northern project limit to the intersection with Old Washington Street/ Pond Street. Between the intersections with Old Washington Street/ Pond Street and Rockland Street (Route 139), Route 53 has one travel lane in each direction. Additional turning lanes are provided at the intersections with Old Washington Street/ Pond Street and Rockland Street (Route 139). From Rockland Street (Route 139) to Broadway Route 53 consists of two travel lanes in each direction. Roadway widths range from 44 to 60 feet in areas with two travel lanes in each direction and from 25 to 44 feet in areas with one travel lane in each direction.

Posted speed limits along Route 53 vary within the study area. Traveling in the northbound direction beginning at the southern project limit, the posted speed limits are as follows: 45 mph just north of the Cardinal Cushing Centers' driveway, 35 mph between the University Sports Complex at Starland (Starland) driveways, and 40 mph just north of East Street. Traveling in the southbound direction beginning at the northern project limit, the posted speed limits are as follows: 40 mph between the Starland driveways, and 35 mph just north of the Cardinal Cushing Centers' driveway.

Study Area Intersections

The study area included the following nine intersections:

1. Route 53 (Washington Street) at Old Washington Street/ Pond Street – *signalized*
2. Route 53 (Washington Street) at East Street – *unsignalized*
3. Route 53 (Washington Street) at Starland driveway north – *unsignalized*
4. Route 53 (Washington Street) at Starland driveway south – *unsignalized*
5. Route 53 (Washington Street) at Hanover Street/ North Pointe – *unsignalized*
6. Route 53 (Columbia Road) at Shaw's driveway north – *unsignalized*
7. Route 53 (Columbia Road) at Shaw's driveway south – *unsignalized*
8. Route 53 (Columbia Road) at Rockland Street (Route 139) – *signalized*
9. Route 53 (Columbia Road) at Broadway – *signalized*

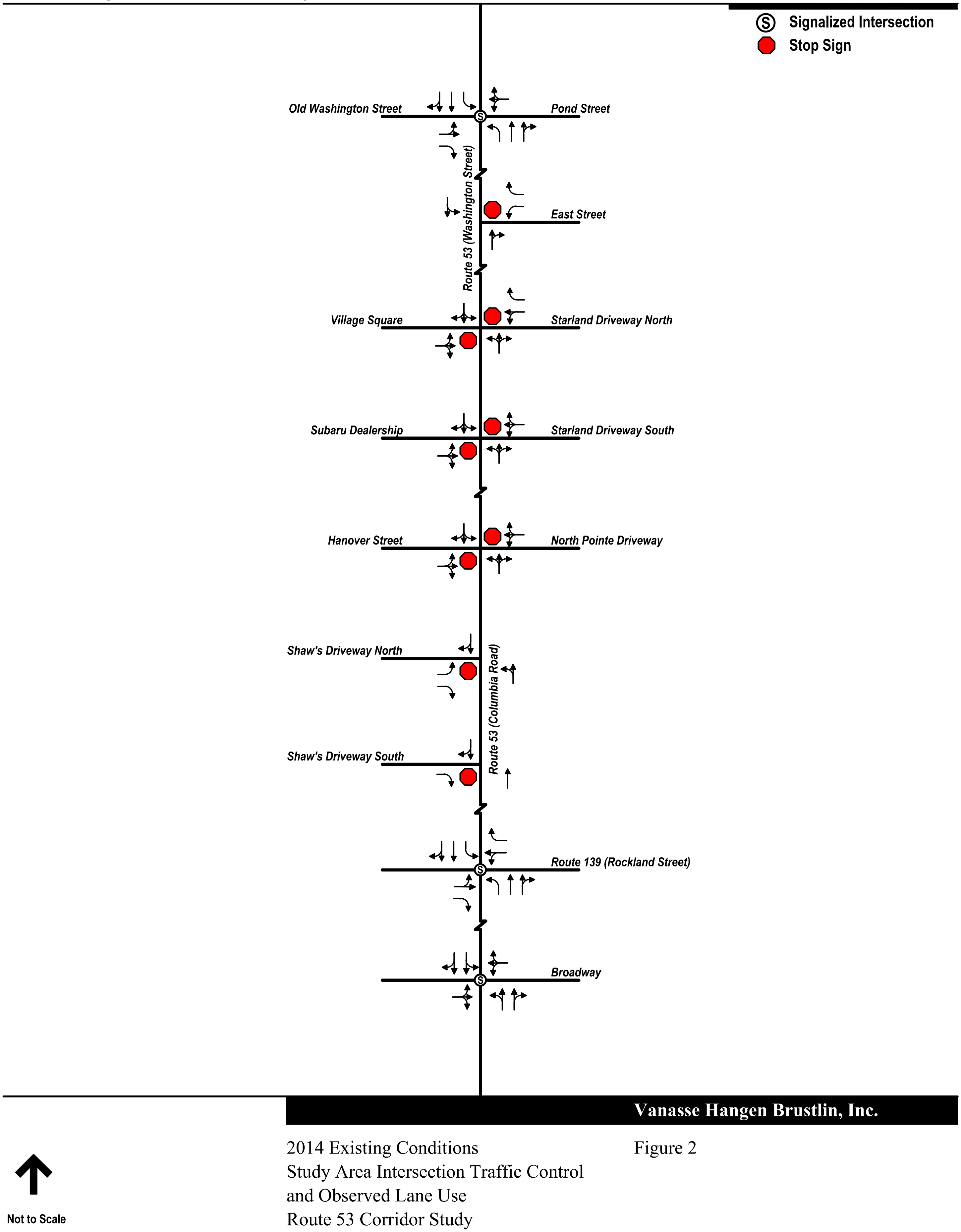
Figure 2 depicts the traffic control and observed lane use at the study area intersections.

Signalized Intersection Review

The traffic signal and controller equipment at the three signalized intersections within the study area were reviewed. The following are notable issues:

- **Lack of Time of Day Programming:** All study area signalized intersections operate with one set of timings all day which do not account for changes in traffic demands during peak periods.
- **Route 53 (Columbia Road) at Rockland Street (Route 139):** In addition to the issue noted above, there are no signal heads to indicate the split phasing on Route 139 and yellow and red clearance timings and pedestrian clearance timings should be re-evaluated and potentially adjusted.
- **Route 53 (Columbia Road) at Broadway:** In addition to the issue noted above, the cycle length, yellow and red clearance timings, and pedestrian clearance timings should be re-evaluated and potentially adjusted.

Due to the age of the infrastructure, the intersections of Route 53 at Rockland Street (Route 139) and Broadway are not entirely compliant with standards established by the Americans with Disabilities Act (ADA). These non-compliance issues are common in many municipalities where signal and roadway infrastructure has not been upgraded in the past 10 years.



Vanasse Hangen Brustlin, Inc.

2014 Existing Conditions
Study Area Intersection Traffic Control
and Observed Lane Use
Route 53 Corridor Study
Hanover, Massachusetts

Figure 2

Existing Traffic Demands

Automatic traffic recorder (ATR) counts were conducted at three locations along Route 53 for a 4-day period (Thursday to Sunday) in April and May 2014. A summary of the ATR traffic data are presented in Table 1 and a representative location is summarized graphically in Figure 3. Graphs depicting the other two ATR count locations are included in the Appendix of this document.

As shown, Route 53 carries approximately 20,200 to 20,900 vehicles per day on a typical weekday; 20,100 to 24,300 vehicles per day on Saturdays; and 15,400 to 18,900 vehicles per day on Sundays. The weekday morning peak hours show a higher directional distribution in the northbound direction, ranging from 63 to 66 percent, and the weekday evening peak hours show higher directional distribution in the southbound direction, ranging from 60 to 61 percent. The Saturday midday peak hours show a higher direction distribution in the southbound direction, ranging from 51 to 55 percent, while the Sunday midday peak hours show that the traffic is approximately split between both directions.

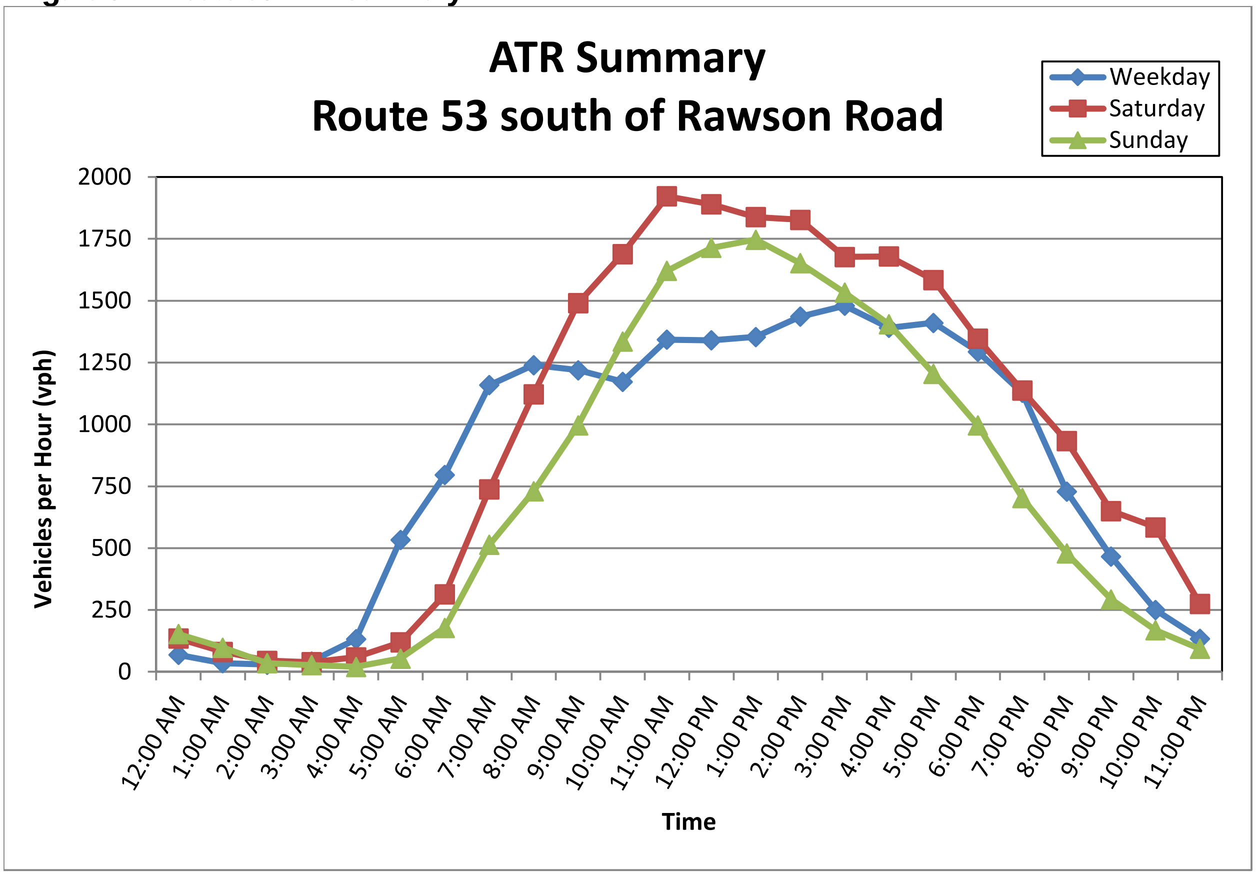
The 85th percentile speeds on weekdays and Saturdays range from 40 to 44 mph in the northbound direction and 39 to 42 mph in the southbound direction. Speeds on Sundays are generally lower, ranging from 37 to 41 mph northbound and 36 to 39 mph southbound.

Table 1 ATR Summary

Location	Peak Hour	Daily [a]	Speed [b]		Volume [c]	K Factor [d]	Dir. Dist. [e]
Route 53 south of Rawson Road	Weekday Morning	20,200	43 NB	41 SB	1,260	6.2%	66% NB
	Weekday Evening	20,200	43 NB	41 SB	1,475	7.3%	61% SB
	Saturday Midday	23,200	40 NB	41 SB	1,890	8.2%	51% SB
	Sunday Midday	17,800	41 NB	42 SB	1,820	10.3%	51% NB
Route 53 between Starland Driveways	Weekday Morning	20,200	44 NB	41 SB	1,185	5.9%	68% NB
	Weekday Evening	20,200	44 NB	41 SB	1,640	8.1%	61% SB
	Saturday Midday	20,100	41 NB	39 SB	1,550	7.7%	55% SB
	Sunday Midday	15,400	42 NB	40 SB	1,450	9.4%	52% SB
Route 53 South of Rockland Road (Route 139)	Weekday Morning	20,900	41 NB	36 SB	1,355	6.5%	63% NB
	Weekday Evening	20,900	41 NB	36 SB	1,420	6.8%	60% SB
	Saturday Midday	24,300	37 NB	39 SB	1,945	8.0%	51% SB
	Sunday Midday	18,900	38 NB	39 SB	1,775	9.4%	50% NB

Source: Vanasse Hangen Brustlin, Inc. based on automatic traffic recorder (ATR) counts conducted in April and May 2014
a average daily traffic (ADT) volume expressed in vehicles per day
b 85th percentile speeds
c peak period traffic volumes expressed in vehicles per hour
d percent of daily traffic that occurs during the peak period
e directional distribution of peak period traffic
Note: peak hours do not necessarily coincide with the peak hours of the individual intersection turning movement counts

Figure 3 Route 53 ATR Summary



Source: Vanasse Hangen Brustlin, Inc. Based on automatic traffic recorder (ATR) counts conducted in April and May 2014

Manual turning movement counts (TMCs) were collected during the weekday morning (7:00 to 9:00 AM), weekday evening (4:00 to 6:00 PM, and Saturday midday (11:00 AM to 1:00 PM) peak periods in April 2014 to quantify current traffic volumes traveling through the key intersections in the study area. Traffic volume data is included in the Appendix.

A review of the data indicates that the weekday morning peak hour occurred from 8:00 to 9:00 AM; the weekday evening peak hour occurred from 4:30 to 5:30 PM; and the Saturday midday peak hour was from 11:45 AM to 12:45 PM. The data was used to establish the existing traffic conditions for the peak hour traffic analysis of study area intersections.

To evaluate the potential for seasonal fluctuation of traffic volumes on roadways near the project site, MassDOT seasonal traffic data were reviewed. This data is based on MassDOT's statewide traffic data inventory and indicates that traffic volumes in April are approximately eight percent *higher* than the yearly average conditions. To be conservative, the traffic volumes collected in April were not adjusted. Figures 4 through 6 reflect the 2014 Existing traffic volumes for each of the three peak hours studied.

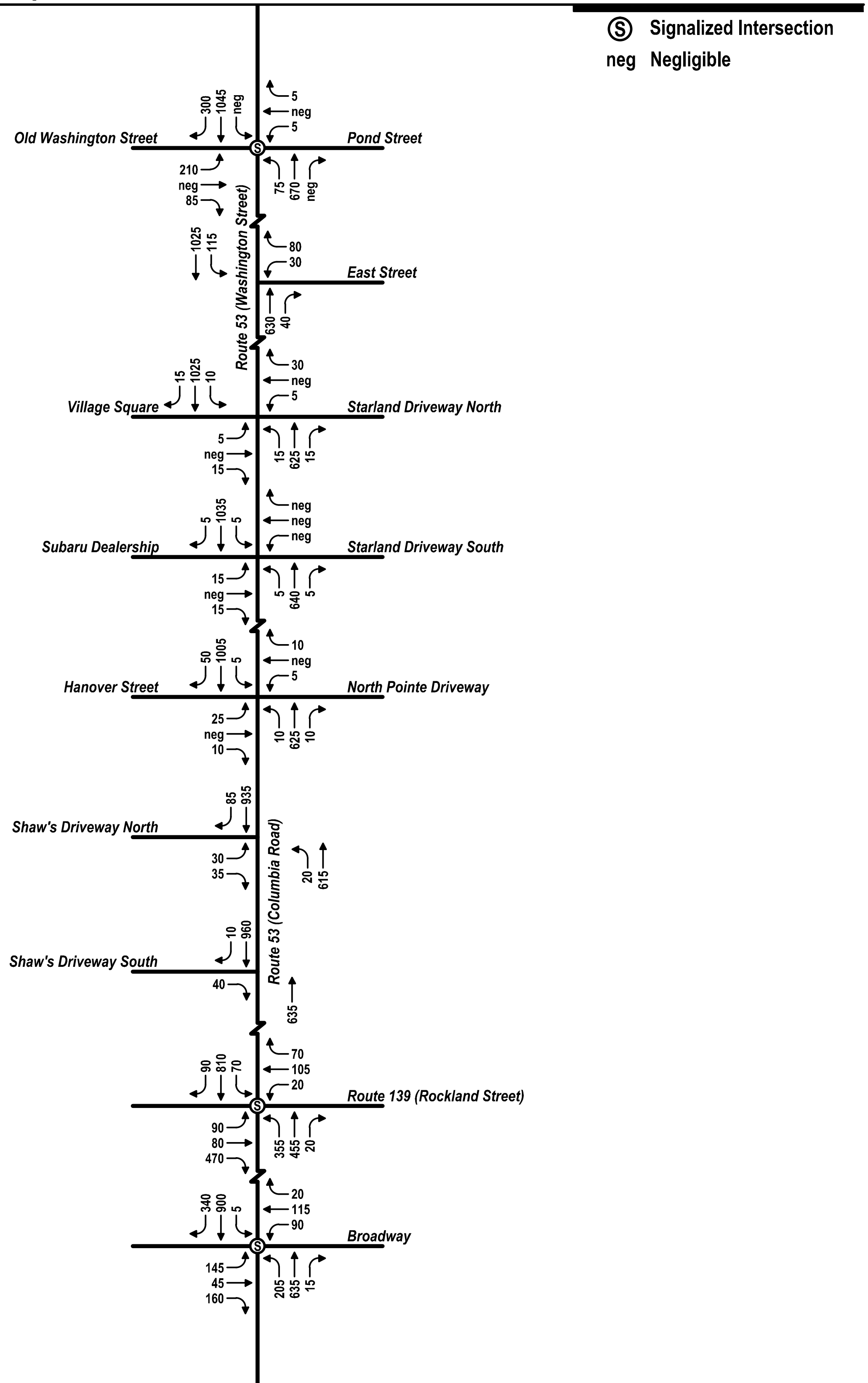
Vanasse Hangen Brustlin, Inc.

Not to Scale

2014 Existing Conditions
Weekday Morning
Peak Hour Traffic Volumes
Route 53 Corridor Study
Hanover, Massachusetts

Figure 4

\\mawatr\ts\12511.01\graphics\FIGURES\Networks_060414.dwg

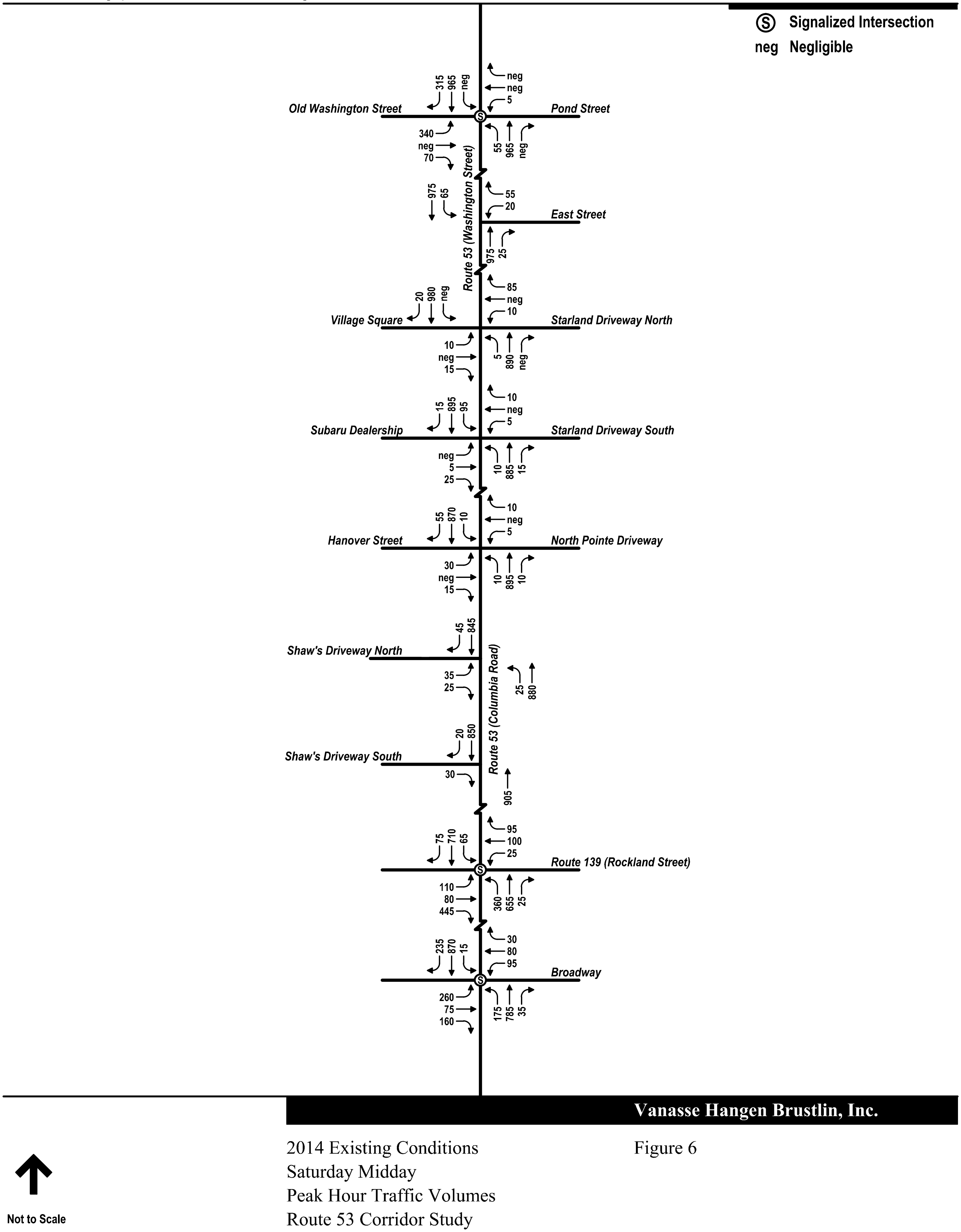


Vanasse Hangen Brustlin, Inc.

2014 Existing Conditions
Weekday Evening
Peak Hour Traffic Volumes
Route 53 Corridor Study
Hanover, Massachusetts

Figure 5

Not to Scale



Vanasse Hangen Brustlin, Inc.

2014 Existing Conditions
Saturday Midday
Peak Hour Traffic Volumes
Route 53 Corridor Study
Hanover, Massachusetts

Figure 6

As part of a separate effort, TMCs were also conducted in October and December 2013 the intersections of Route 53 with both the northern and southern Starland driveways. A comparison of the October 2013 counts to the May 2014 counts show similar volumes for all movements at the intersections. The December 2013 counts were conducted during a tournament day at the Starland facility, and therefore show higher traffic volumes entering and exiting from the Starland driveways. Volumes along Route 53 were generally consistent between all three sets of counts.

Pedestrian and bicycle volumes were minimal during the peak hours. Less than 5 pedestrians or bicyclists were observed at each intersection during peak hour periods, with the exception of Route 53 (Washington Street) at the Starland northern driveway during the Saturday midday peak hour. Ten pedestrians were observed crossing the northbound approach and 53 pedestrians were observed crossing the southbound approach of the intersection. It should be noted that a basketball tournament at the Starland complex during data collection efforts could have influenced pedestrian volumes at this location.

Safety Review

This section summarizes a safety review of the corridor which includes a summary of recent vehicular crash history and evaluation of available sight distance for unsignalized study area intersections.

Crash Data

To identify potential vehicle crash trends and/or roadway deficiencies in the project study area, the most current vehicle crash data for the study area intersections was obtained from MassDOT for the years 2009 to 2012. Crash data is included in the Appendix to this report.

Crash rates are calculated based on the number of crashes at an intersection and the volume of traffic traveling through that intersection on a daily basis. Rates that exceed MassDOT's average rate of crashes at an intersection in the district in which the town or city is located (District 5 for the Town of Hanover) could indicate safety or geometric issues for a particular intersection. The latest published crash rate by MassDOT in District 5 is 0.77 for signalized intersections and 0.58 for unsignalized intersections. These rates imply that, on average, 0.77 crashes occurred per million vehicles entering signalized intersections throughout District 5, and 0.58 crashes occurred per million vehicles entering unsignalized intersections in the District. Crash rate calculations are included in the Appendix. It should be noted that the location for some crashes cannot be precisely determined from the database and that not all crashes are reported; particularly those with property damage totaling less than $1,000. A summary of the study intersections' vehicle crash history is presented in Table 2.

As shown in Table 2, calculated crash rates for two of the study area intersections are greater than the MassDOT District 5 average crash rates. One collision with pedestrian occurred at the intersection of Route 53 (Columbia Road) and Broadway, resulting in a non-fatal injury. The vehicle was recorded as travelling westbound and making a right-turn at the time of the incident.

Trends in the crash data were identified for the two study area intersections with calculated crash rates higher than the MassDOT average crash rates.

- **Route 53 (Columbia Road) at Rockland Street (Route 139):** Crashes at this location were primarily angle and rear-end collisions that resulted in property damage only. Most crashes occurred on weekdays outside of peak periods and under dry conditions.

- **Route 53 (Columbia Road) at Broadway:** Crashes at this location were primarily angle and rear-end collisions. According to the data, 21 crashes resulted in non-fatal injuries and 24 crashes resulted in property damage only; one collision involved a pedestrian. Most crashes occurred on weekdays outside of peak periods and under dry conditions.

The remaining seven intersections in the study area operate as safely as – or safer than – intersections with similar traffic volumes in the same district. No crashes were reported at the intersections of Route 53 at Shaw's driveway north and Route 53 at Shaw's driveway south. Overall, the majority of crashes were angle and rear-end collisions that occurred under dry conditions.

Table 2 Vehicle Crash Summary (2009 to 2012)

	Route 53 at Old Washington Street	Route 53 at East Street	Route 53 at Northern Starland Driveway	Route 53 at Southern Starland Driveway	Route 53 at Hanover Street	Route 53 at Route 139	Route 53 at Broadway
District 5 Average Crash Rate [1,2]	0.77	0.58	0.58	0.58	0.58	0.77	0.77
MassDOT Calculated Crash Rate	0.28	0.22	0.20	0.03	0.39	0.80	1.06
Year							
2009	2	1	2	0	4	5	14
2010	1	3	1	1	3	12	10
2011	3	2	3	0	3	14	14
2012	5	1	0	0	1	3	8
Total	11	7	6	1	11	34	46
Collision Type							
Angle	7	2	3	0	0	13	27
Head-on	0	0	1	0	1	0	2
Rear-end	3	2	2	1	9	17	11
Sideswipe, opposite direction	1	0	0	0	0	1	2
Sideswipe, same direction	0	0	0	0	0	1	1
Single vehicle crash	0	3	0	0	1	2	3
Unknown/Not Reported	0	0	0	0	0	0	0
Total	11	7	6	1	11	34	46
Crash Severity							
Fatal injury	0	0	0	0	0	0	0
Non-fatal injury	6	2	3	1	5	6	21
Property Damage Only	5	3	3	0	4	26	24
Unknown/Not Reported	0	2	0	0	2	2	1
Total	11	7	6	1	11	34	46
Time of Day							
Weekday, 7:00 AM - 9:00 AM	1	0	0	0	0	3	6
Weekday, 4:00 PM - 6:00 PM	2	1	3	0	3	8	3
Saturday, 11:00 AM - 2:00 PM	0	0	0	0	2	1	2
Weekday, other time	6	3	2	1	4	17	24
Weekend, other time	2	3	1	0	2	5	11
Total	11	7	6	1	11	34	46
Pavement Conditions							
Dry	9	4	6	1	9	21	34
Wet	2	3	0	0	2	12	12
Snow/Ice	0	0	0	0	0	1	0
Other	0	0	0	0	0	0	0
Unknown/Not Reported	0	0	0	0	0	0	0
Total	11	7	6	1	11	34	46
Non-Motorist (Bike, Pedestrian)	0	0	0	0	0	0	1

Source: Massachusetts Department of Transportation Crash Data 2009-2012.

1. Crash rate, expressed in crashes per million entering vehicles, determined using MassDOT methods.
2. MassDOT District 5 average crash rate for signalized and unsignalized intersections (http://www.mhd.state.ma.us).

MassDOT 2012 Top Crash Locations Report

MassDOT published a *2012 Top Crash Locations Report* in September 2014, ranking the Top 200 Intersection Locations based on crash data from the years 2010 to 2012. The reports have been published yearly since 2006. In order to determine an intersection's ranking, MassDOT created a comprehensive method to locate crash clusters. This method uses a 25 meter search distance to locate adjacent crashes, and then merges the areas together to create a crash cluster. The clusters are then named based on the first and second highest functional classification roadways within the cluster and ranked by the number of Equivalent Property Damage Only (EPDO) crashes; where fatal crashes are weighted by 10, injury crashes are weighted by 5 and property damage only and non-reported crashes are weighted by 1. Therefore, each cluster can contain multiple intersections or segments of roadway located near the main intersection.

No study area intersections appear on the 2012 Top Crash Locations Report, however the study area intersection of Columbia Road (Route 53) at Broadway appears on the 2011 Top Crash Locations Report. It should be noted that no other study area intersections appear on the list in any report from 2006 through 2012.

Highway Safety Improvement Program (HSIP)

The Highway Safety Improvement Program's (HSIP) purpose is "to achieve a significant reduction in traffic fatalities and injuries on all public roads, including non-State-owned public roads and roads on tribal lands. The HSIP requires a data-driven, strategic approach to improving highway safety on all public roads that focuses on performance."[1] HSIP was continued by the Moving Ahead for Progress in the 21st Century Act (MAP-21) on October 1, 2012 which included some changes to the overall program. The new approach includes providing a lump sum total of funding to each state with predetermined amounts to be set aside for specific uses. In order to be eligible for funding, states are required to maintain, regularly update, and implement a State Strategic Highway Safety Plan (SHSP) which must be submitted yearly. Additionally, states must have a safety data system which can identify problems and analyze countermeasures on all public roads, among other things. Funding is eligible to any highway safety improvement project, which is defined as any strategy, activity, or project on a public road that is consistent with the data-driven SHSP and corrects or improves a hazardous road location or feature or addresses a highway safety problem.

Table 3 shows the locations within the study area that are included on the HSIP crash cluster list and their respective Equivalent Property Damage Only (EPDO) ranking.

[1] USDOT FHWA website <http://www.fhwa.dot.gov/map21/factsheets/hsip.cfm>

Table 3 2011 HSIP Crash Clusters

EPDO Range	Town	Location
50-150	Hanover	Columbia Road (Route 53) at Broadway
>50	Hanover	Columbia Road (Route 53) at Rockland Street (Route 139)

Source: MassDOT. <http://services.massdot.state.ma.us/maptemplate/topcrashlocations/ >

Sight Distance Evaluation

Sight distance analysis, in conformance with guidelines of American Association of State Highway and Transportation Officials (AASHTO)[2] was performed for the six unsignalized study area intersections. Speed observations recorded during the data collection (Table 1) were used to calculate the required stopping sight distance (SSD) and intersection sight distance (ISD). SSD is the distance required for a vehicle approaching an intersection from either direction to perceive, react, and come to a complete stop before colliding with the exiting vehicle from a driveway or minor street. ISD is the distance that is based on the time required for perception, reaction and completion of the desired critical exiting maneuver (in this case, a left turn) once the driver on a minor street approach or driveway decides to execute the maneuver. Calculation for the critical ISD includes the time to (1) turn left, and to clear the near half of the intersection without conflicting with the vehicles approaching from the left; and (2) upon turning left, to accelerate to the operating speed on the roadway without causing approaching vehicles on the main road to unduly reduce their speed. According to AASHTO:

> *"If the available sight distance for an entering or crossing vehicle is at least equal to the appropriate stopping sight distance for the major road, then drivers have sufficient sight distance to anticipate and avoid collisions. However, in some cases, a major-road vehicle may need to stop or slow to accommodate the maneuver by a minor-road vehicle. To enhance traffic operations, intersection sight distances that exceed stopping sight distances are desirable along the major road."*

Table 4 summarizes the available and required SSD and ISD for the six unsignalized study area intersections and the sight distance worksheets are included in the Appendix.

2 A Policy on the Geometric Design of Highways and Streets, American Association of State Highway and Transportation Officials, 2011

Table 4 Sight Distance Analysis Summary

Intersection	Stopping Sight Distance: Traveling	Stopping Sight Distance: Required	Stopping Sight Distance: Measured [4]	Intersection Sight Distance: Looking	Intersection Sight Distance: Required	Intersection Sight Distance: Measured
Route 53 at East Street [1]	northbound	340	635	left (south)	475	445
	southbound	315	220	right (north)	475	480
Route 53 at Starland North Driveway [2]	northbound	350	500+	left (south)	490	700+
	southbound	315	500	right (north)	490	500
Route 53 at Starland South Driveway [2]	northbound	350	500	left (south)	490	700+
	southbound	315	500	right (north)	490	500
Route 53 at Hanover Street [2]	northbound	350	700+	left (north)	490	700+
	southbound	315	415	right (south)	490	415
Route 53 at Shaw's North Driveway [2]	northbound	350	415	left (north)	490	150
	southbound	315	580	right (south)	490	580
Route 53 at Shaw's South Driveway [2,3]	southbound	315	580	left (north)	490	145

Source: based on guidelines established in A Policy on the Geometric Design of Highways and Streets, American Association of State Highway and Transportation Officials [AASHTO], 2011
Note: Shaded cells denote locations where sight distance does not meet the requirements
1 required sight distance in feet, based on an 85th percentile speed of 43 mph traveling northbound and 41 mph traveling southbound
2 required sight distance in feet, based on an 85th percentile speed of 44 mph traveling northbound and 41 mph traveling southbound
3 right in/right out only driveway
4 in feet

The sight distance measurements summarized in Table 4 indicate that required SSD is met at all the study area intersections with the exception of Route 53 at East Street when traveling southbound due to the horizontal alignment of the roadway. The required ISD is not met at the following four intersections:

- **Route 53 at East Street looking left (south):** The limiting factor is the horizontal alignment of Route 53.
- **Route 53 at Hanover Street looking right (south):** The limiting factor is the vertical alignment of Route 53.
- **Route 53 at Shaw's North Driveway looking left (north):** The limiting factor is the vertical alignment of Route 53.
- **Route 53 at Shaw's South Driveway looking left (north):** The limiting factor is the vegetation along the frontage of the Shaw's property.

3

Future Conditions

The second component of the Corridor Study is a review of the future traffic conditions along Route 53. This chapter identifies the future horizon year; projects the future traffic volumes along Route 53; and summarizes the Maximum Build-out scenario for currently vacant or underdeveloped parcels along or immediately adjacent to the Route 53 corridor. The data presented is based on research of historic traffic conditions, available GIS information, and input from Town of Hanover officials.

2024 No-Build Conditions

A ten-year horizon was selected to establish the 2024 No-Build year. Traffic volumes along the Route 53 corridor were projected to the 2024 No-Build year and are assumed to include all existing traffic, any new traffic due to regional and area background traffic growth, and traffic related to any specific nearby development projects expected to be complete by the 2024 horizon year.

Roadway Conditions

Based on a review of previously submitted traffic studies and discussions with Town of Hanover officials, there are no roadway improvement projects planned in the study area during the future planning horizon.

Historic Traffic Growth

Through research of historic traffic volumes on nearby roadways and discussions with Town of Hanover officials, a historic growth rate of 0.5 percent per year was identified.

Site-Specific Growth

Based on discussions with Town of Hanover officials, there are two development projects planned within the study area that would impact traffic volumes along the Route 53 corridor:

- **Village at Seven Springs**, a residential development of 130 condos is currently under construction. The development is located just south of East Street on the western side of Route 53.
- **Cardinal Cushing 40B**, a proposed residential development of 37 units. The development is proposed to be located on the existing Cardinal Cushing site located north of Route 139 on the eastern side of Route 53.

2024 No-Build Traffic Volumes

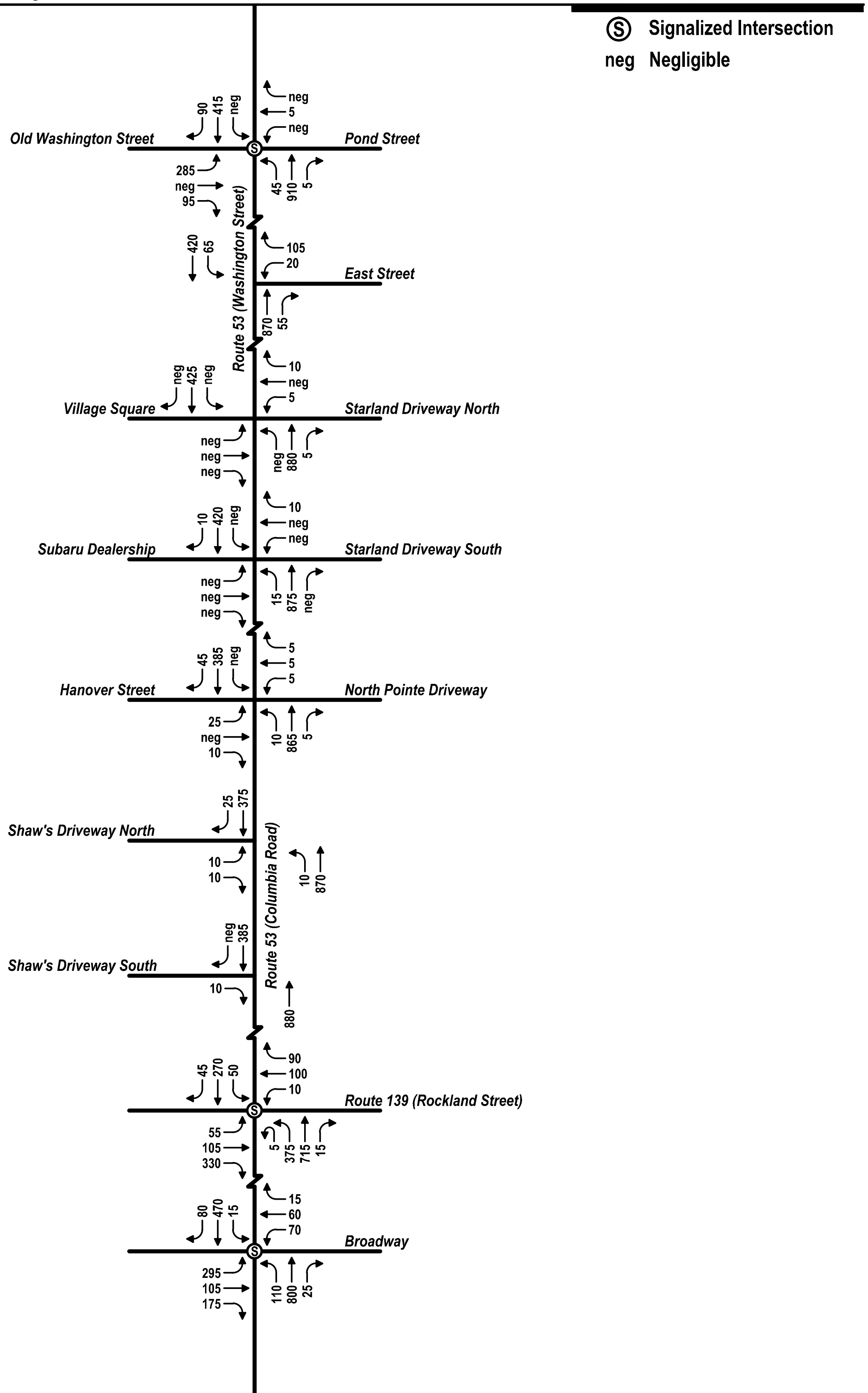
The 2024 No-Build traffic volumes were developed by applying the 0.5 percent annual growth rate over the 10-year study horizon to the 2014 Existing conditions traffic volumes and adding the traffic volumes associated with the two site-specific projects discussed above. Figures 7, 8, and 9 show the resulting 2024 No-Build peak hour traffic volumes.

Maximum Build-out Scenario

In coordination with the Town of Hanover, a Maximum Build-out Scenario for currently vacant or undeveloped parcels along or immediately adjacent to the Route 53 within study area corridor was developed. This section discusses the methodology and results of the build-out evaluation and the resulting impact to traffic volumes along the Route 53 corridor.

Methodology

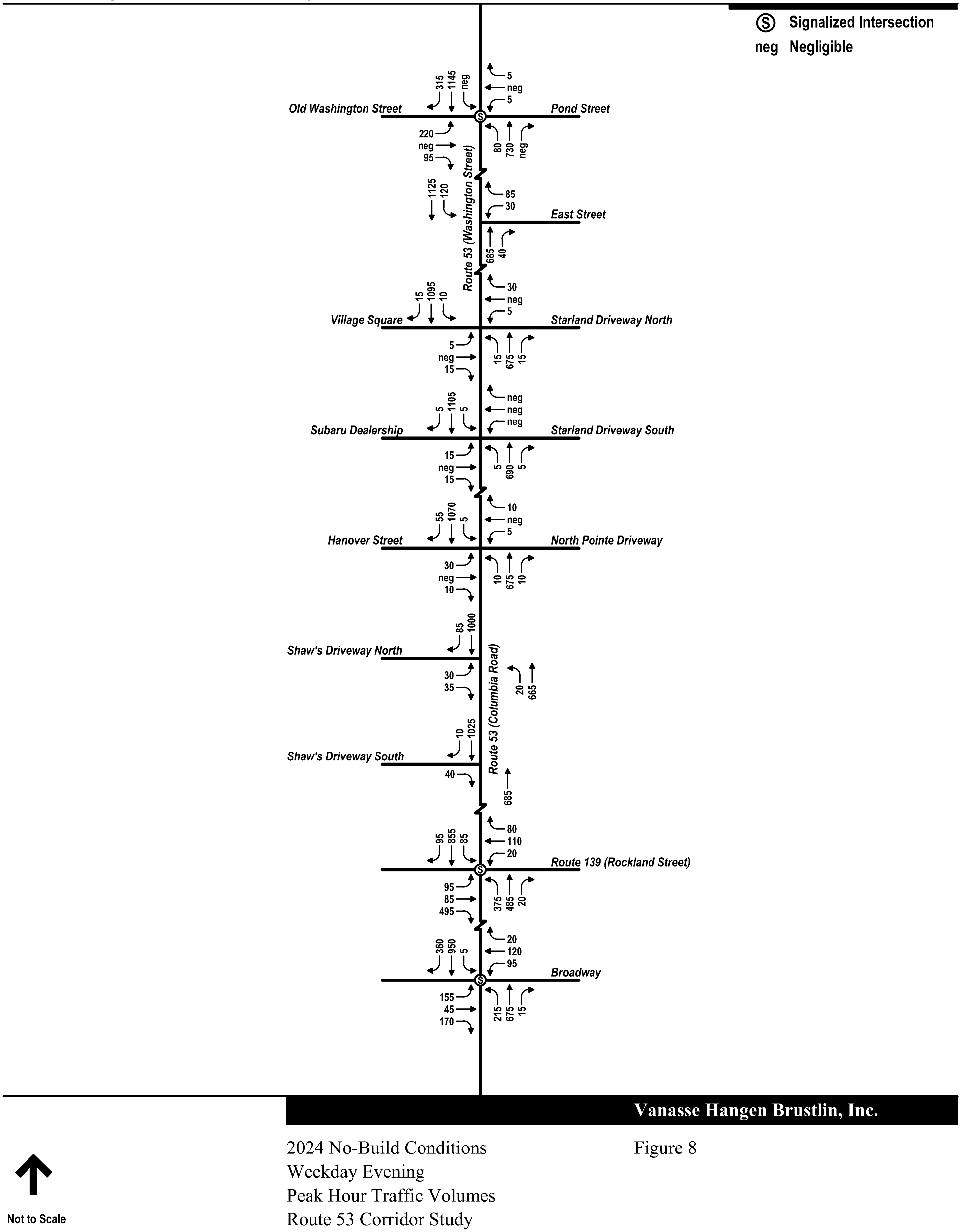
The Town of Hanover's Planning Department identified eight currently vacant or undeveloped sites within the study area to be included in the build-out evaluation. As shown in Figure 10, two of these sites (Site 1 and Site 8) consist of multiple, adjacent parcels that were consolidated to maximize build-out potential.



Not to Scale

2024 No-Build Conditions
Weekday Morning
Peak Hour Traffic Volumes
Route 53 Corridor Study
Hanover, Massachusetts

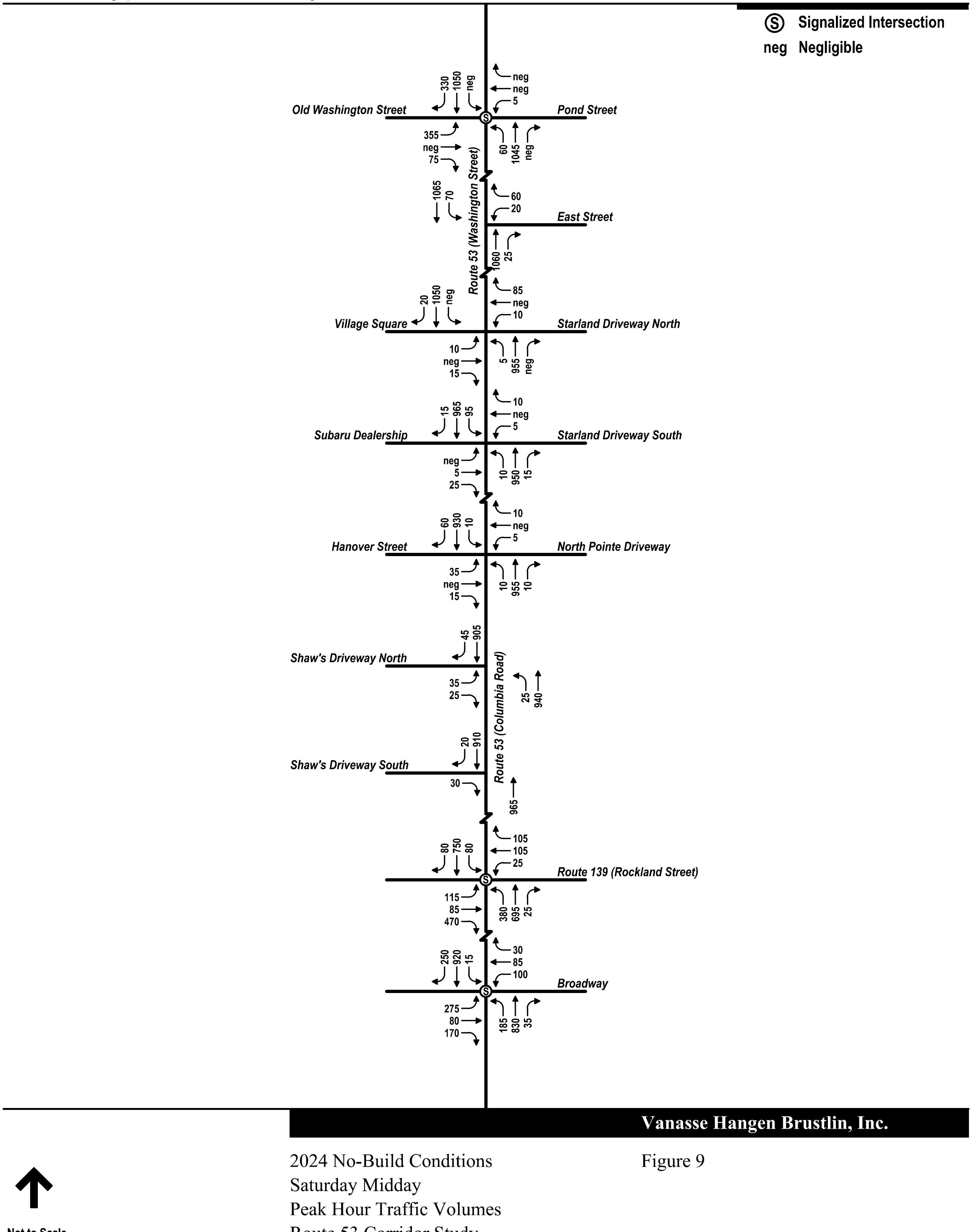
Figure 7



Vanasse Hangen Brustlin, Inc.

2024 No-Build Conditions
Weekday Evening
Peak Hour Traffic Volumes
Route 53 Corridor Study
Hanover, Massachusetts

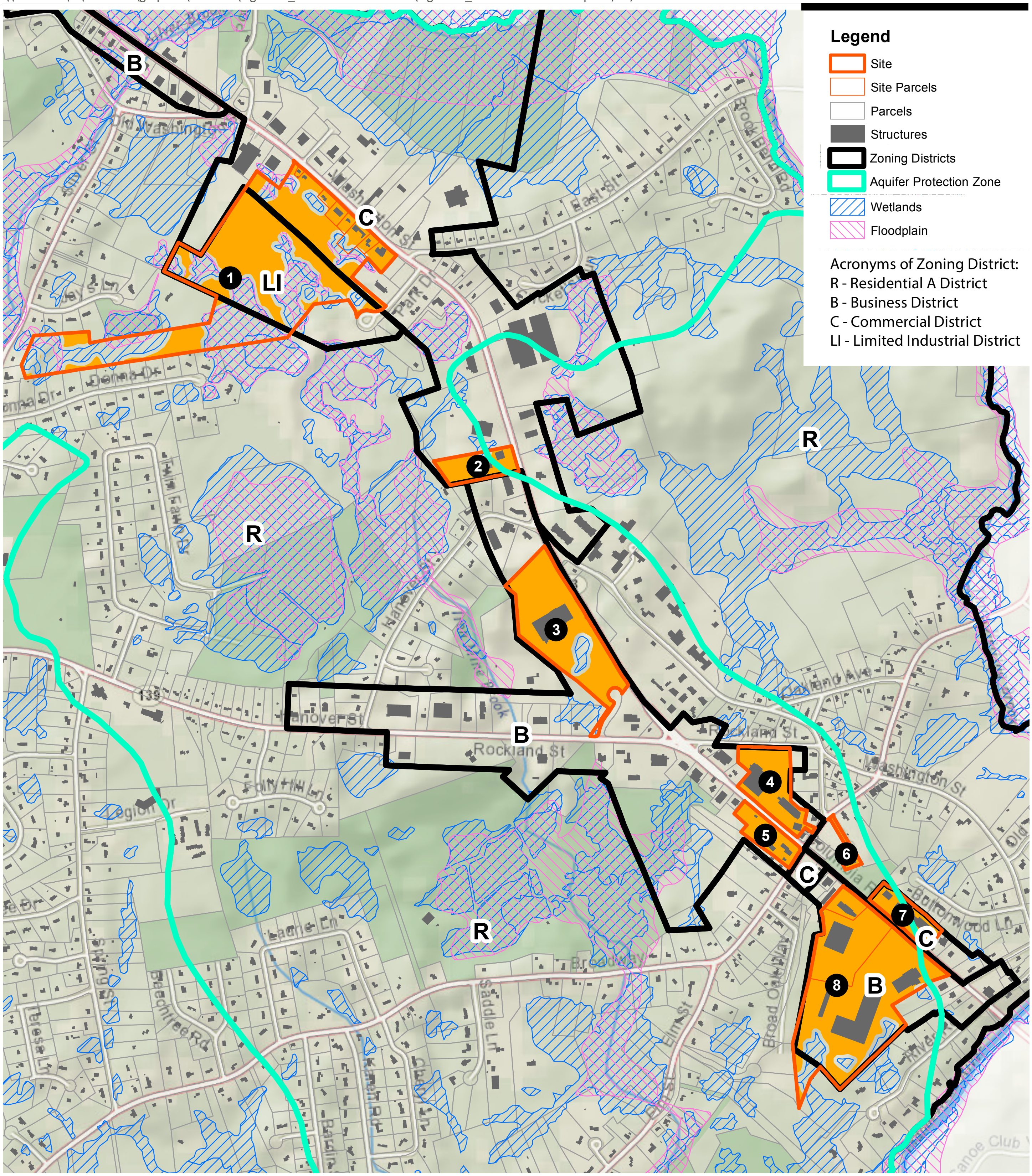
Figure 8



Vanasse Hangen Brustlin, Inc.

2024 No-Build Conditions
Saturday Midday
Peak Hour Traffic Volumes
Route 53 Corridor Study
Hanover, Massachusetts

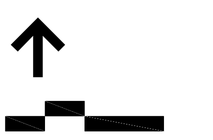
Figure 9



Vanasse Hangen Brustlin, Inc.

Build-Out Parcels

Figure 10



Route 53 Corridor Study
Hanover, Massachusetts

As a first step, the total square footage of each site was determined. Portions of the site identified as wetlands and/or floodplain[3] were discounted from the total buildable area.

The applicable zoning regulations including allowable uses, dimensional requirements, and parking requirements for each site were then reviewed. The build-out sites fall within four zoning districts: Residential A, Limited Industrial, Commercial, and Business. Portions of some sites also fall within an Aquifer Protection Zone which is subject to different regulations and was accounted for.

To inform traffic generation for the Maximum Build-out condition, potential development for the sites zoned Commercial and Business were summarized into three land use scenarios: service, retail, and office, all of which generate trips at different rates.

A portion of Site 1 is the only site falling within a Limited Industrial District. Office use was assumed for this portion of Site 1.

Site 6 (a former school building) is too small for a single family lot. Instead, renovation of the existing structure into 11 residential units is assumed; redevelopment in this manner would require relief from zoning regulations. Due to inadequate lot size, wetland conditions, and/or limited access, this is the only site deemed suitable for residential development in the study area.

Table 5 summarizes the results of the build-out evaluation on a site-by-site basis. The development potential is summarized by land use. In reality, an individual site may include one or a combination of the allowable land uses presented below. Detailed results of the build-out evaluation are included in the Appendix.

[3] Environmental constraints mapping based on readily available MassGIS data.

Table 5 Build-out Evaluation Summary

Site	Build-out Potential by Land Use: Service (sf)	Retail (sf)	Office (sf)	Residential (units)
Site 1	103,110[1]	128,880[1]	332,940	n/a
Site 2	29,910	37,380	42,420	n/a
Site 3	118,790	148,490	168,490	n/a
Site 4	51,670	64,590	73,290	n/a
Site 5	24,700	30,870	35,030	n/a
Site 6	n/a	n/a	n/a	11
Site 7	29,010	36,260	41,150	n/a
Site 8	232,500	290,620	329,780	n/a

1 Site 1 could also accommodate 186,690 sf of office space in the Limited Industrial portion of the site.
sf square footage

The build-out evaluation results and allowable land uses were reviewed in the contexts of existing development along the Route 53 corridor and development trends and potential in the region as a whole. Based on discussions with the Town of Hanover, it was determined that retail land uses were the most compatible and presented the most potential. As such, retail development for all applicable sites was assumed for trip generation of the Maximum Build-out condition, discussed below.

Trip Generation

To assess the cumulative traffic impacts of the Maximum Build-out condition, trip estimates for each site were developed based on standard rates from the Institute of Transportation Engineers (ITE) *Trip Generation*[4]. The appropriate ITE land use codes for the build-out sites include:

- **Residential: Site 6 only –** ITE LUC 230 "Residential Condominium/ Townhouse"
- **Office: Portion of Site 1 only –** ITE LUC 710 "General Office Building"
- **Retail: Sites 1-5, 7-8–** ITE LUC 820 "Shopping Center"

4 Trip Generation; Ninth Edition; Institute of Transportation Engineers; Washington, D.C.; 2012.

After the initial calculation of the base trip generation using ITE data, further adjustments were made. Not all of the traffic generated by the build-out sites will be new to the area roadways. A portion of the vehicle-trips generated by retail land uses will likely be drawn from those motorists already on the roadways adjacent to the sites that are 'attracted' to the services being offered at the sites as they are passing through the area. The primary origin and destination for these trips is elsewhere and the primary trip will be resumed following the visit to the retail center. For this evaluation a 25 percent pass-by rate was assumed, though ITE data indicate that a greater occurrence of pass-by traffic is possible for retail uses.

As shown in Table 6, the Maximum Build-out retail scenario is estimated to generate approximately 23,790 new vehicle weekday daily trips. Of this total, it is estimated that approximately 814 new vehicle trips (597 entering/ 217 exiting) during the weekday morning peak hour; and 2,164 new vehicle trips (932 entering/ 1,232 exiting) during the weekday evening peak hour would be generated. Approximately 25,818 new vehicle trips would be generated on a Saturday. Of this total, it is estimated that approximately 2,521 new vehicle trips (1,330 entering/ 1,191 exiting) would be generated during the Saturday midday peak hour. This generation reflects the typical lack of activity for retail land uses during the weekday morning peak periods. The project trip generation worksheets have been included in the Appendix.

Table 6 Trip Generation Summary

Time Period	Gross Trips [1]	Pass-by Trips [2]	Net New Trips
Weekday Daily	31,000	7,210	23,790
Weekday Morning			
Enter	680	85	595
Exit	300	85	215
Total	980	170	810
Weekday Evening			
Enter	1,245	315	930
Exit	1,545	315	1,230
Total	2,790	630	2,160
Saturday Daily	34,255	8,440	25,815
Saturday Midday			
Enter	1,740	410	1,330
Exit	1,600	410	1,190
Total	3,340	820	2,520

1 Trip Generation estimate based on ITE LUC 230, 710, and 820.

2 Pass-by rate of 25% applied only to retail trips

■

Trip Distribution and Assignment

The routes which vehicles approach and depart from a site are largely based on the land use of the site. VHB identified a trip distribution pattern for each type of land use under the Maximum Build-out scenario: residential, office, and retail. For trips destined for residential uses along the Route 53 corridor, VHB utilized the distribution provided in the *Traffic Impact and Access Study for the Proposed Village Commons Residential Development*[5] which was included as part of the site specific growth for this project. Trips destined for office uses are expected to be predominately home-to-work trips in the morning and work-to-home trips in the evening. Accordingly, the trip distribution for office trips is based on journey-to-work data for the Town of Hanover based on the American Community Survey[6]. For trips destined for retail uses, future traffic patterns are expected to reflect existing traffic patterns along the Route 53 corridor. Retail trips were distributed accordingly.

▼

5 Traffic Impact and Access Study Proposed Village Commons Residential Development; Vanasse & Associates, Inc., April 2014.

6 2006-2010 American Community Survey 5-Year Estimate Means of Transportation (Mode Share) for home-based work trips

Table 7 and Figure 11 present the trip distribution patterns utilized. The trip distribution calculations are provided in the Appendix.

Table 7 Trip Distribution Summary

		Percent of New Site Generated Traffic Assigned to Route by Land Use		
Travel Route	Direction (To/From)	Residential	Office	Retail
Route 53	North	70%	32%	27%
Route 53	South	10%	39%	32%
Old Washington Street	West	5%	1%	3%
East Street	East	0%	1%	4%
Hanover Street	West	5%	1%	1%
Route 139	West	5%	23%	15%
Route 139	East	1%	1%	3%
Broadway	West	4%	1%	13%
Broadway	East	0%	1%	2%

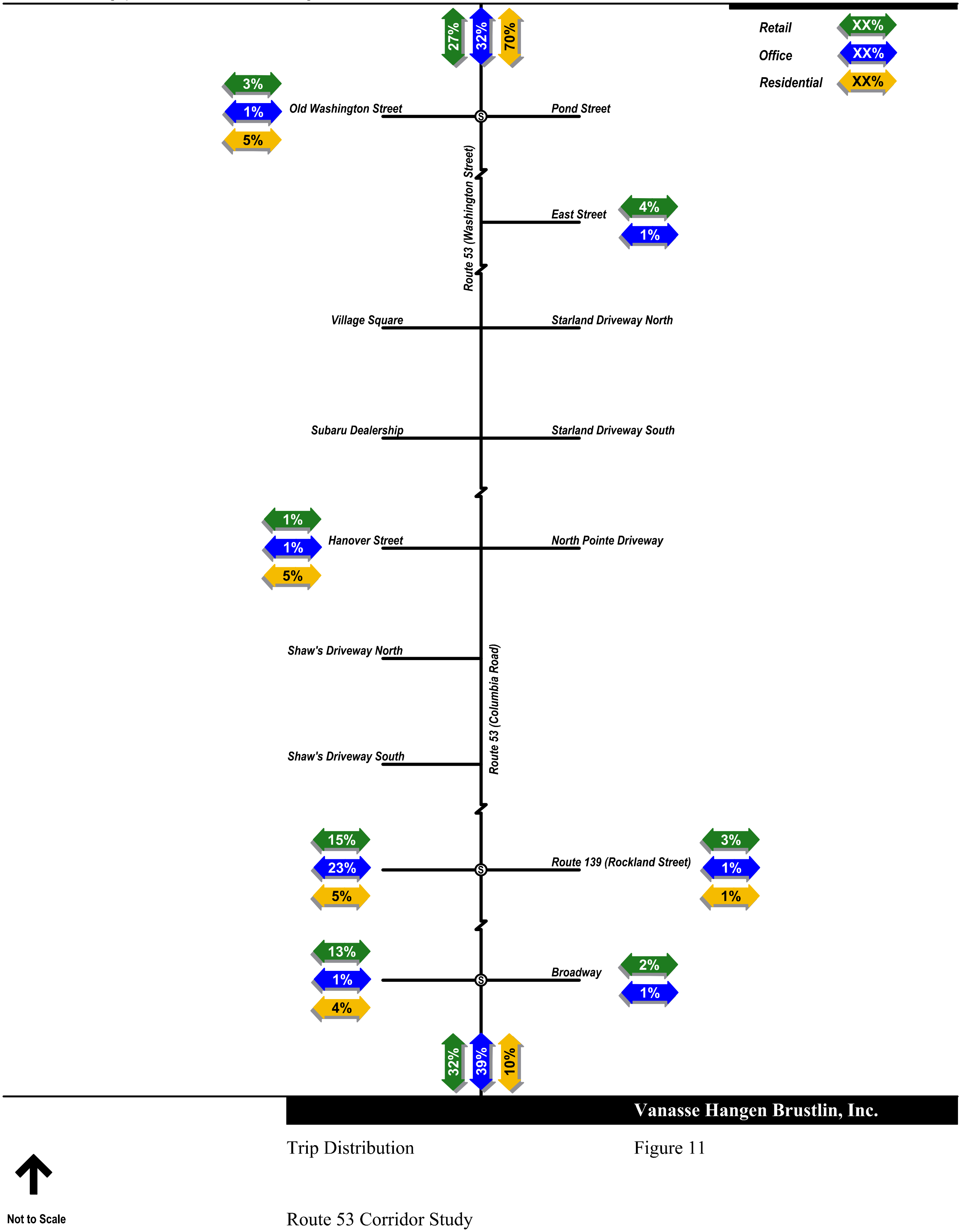
1 Trip Generation estimate based on ITE LUC 230, 710, and 820.

2 Pass-by rate of 25% applied only to retail trips

As shown in Table 7, the majority of trips enter and exit the Route 53 corridor via Route 53 from the north and south. Route 139 to and from the west carries a portion of the office and retail trips, while the rest of the access and egress points to and from the corridor are projected to accommodate less than 15 percent of the build-out site-generated trips.

The build-out site-generated traffic volumes from Table 6 were assigned to the roadway network according to the distributions provided in Table 7 and added to the 2024 No-Build traffic volumes to develop peak hour Maximum Build-out traffic volume networks. Figures 12, 13, and 14 show the resulting Maximum Build-out traffic volumes for the weekday morning, weekday evening, and Saturday midday peak hours, respectively.

\\mawatr\TS\12511.01\graphics\FIGURES\Networks_060414.dwg

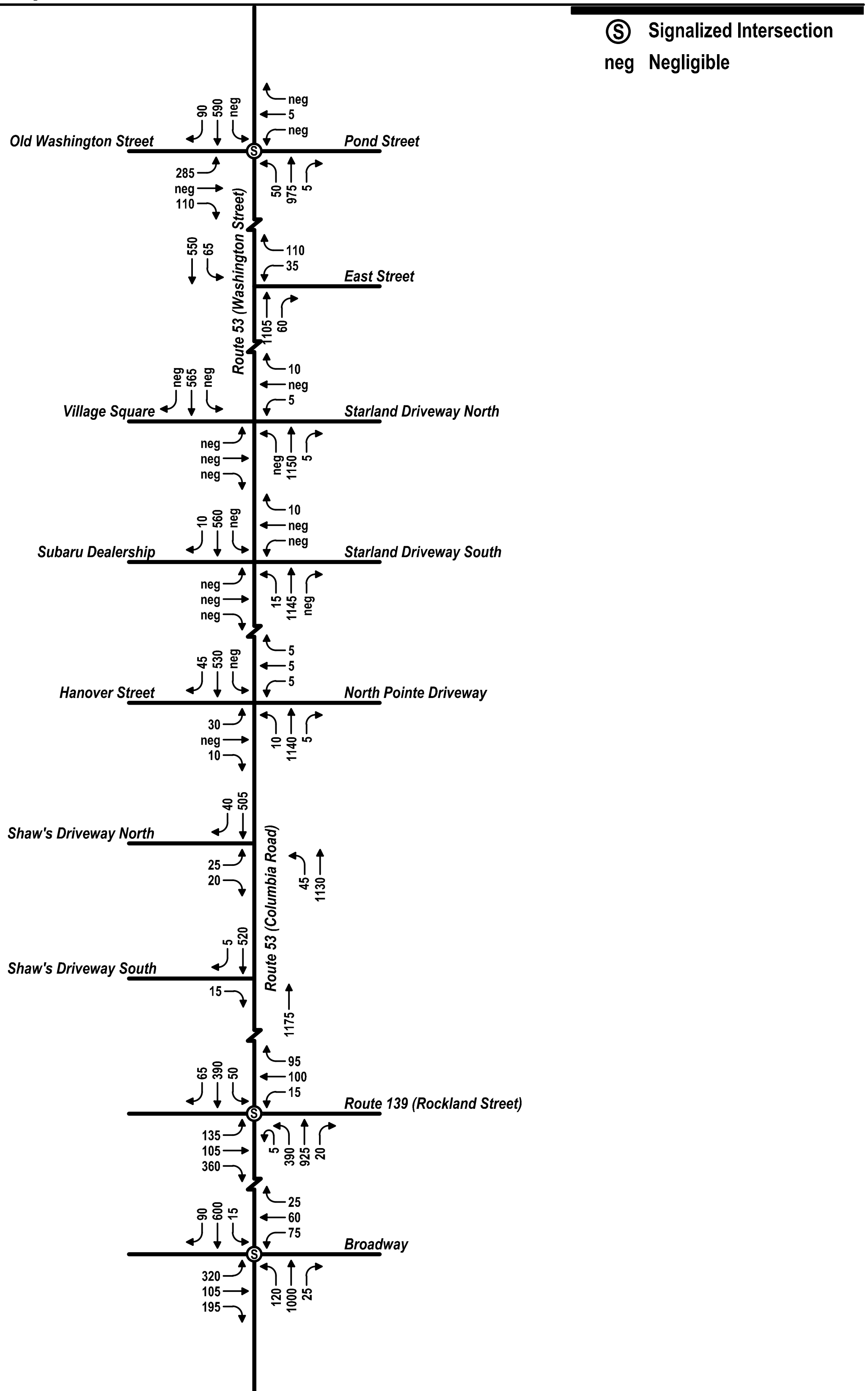


Vanasse Hangen Brustlin, Inc.

Trip Distribution

Figure 11

Route 53 Corridor Study
Hanover, Massachusetts

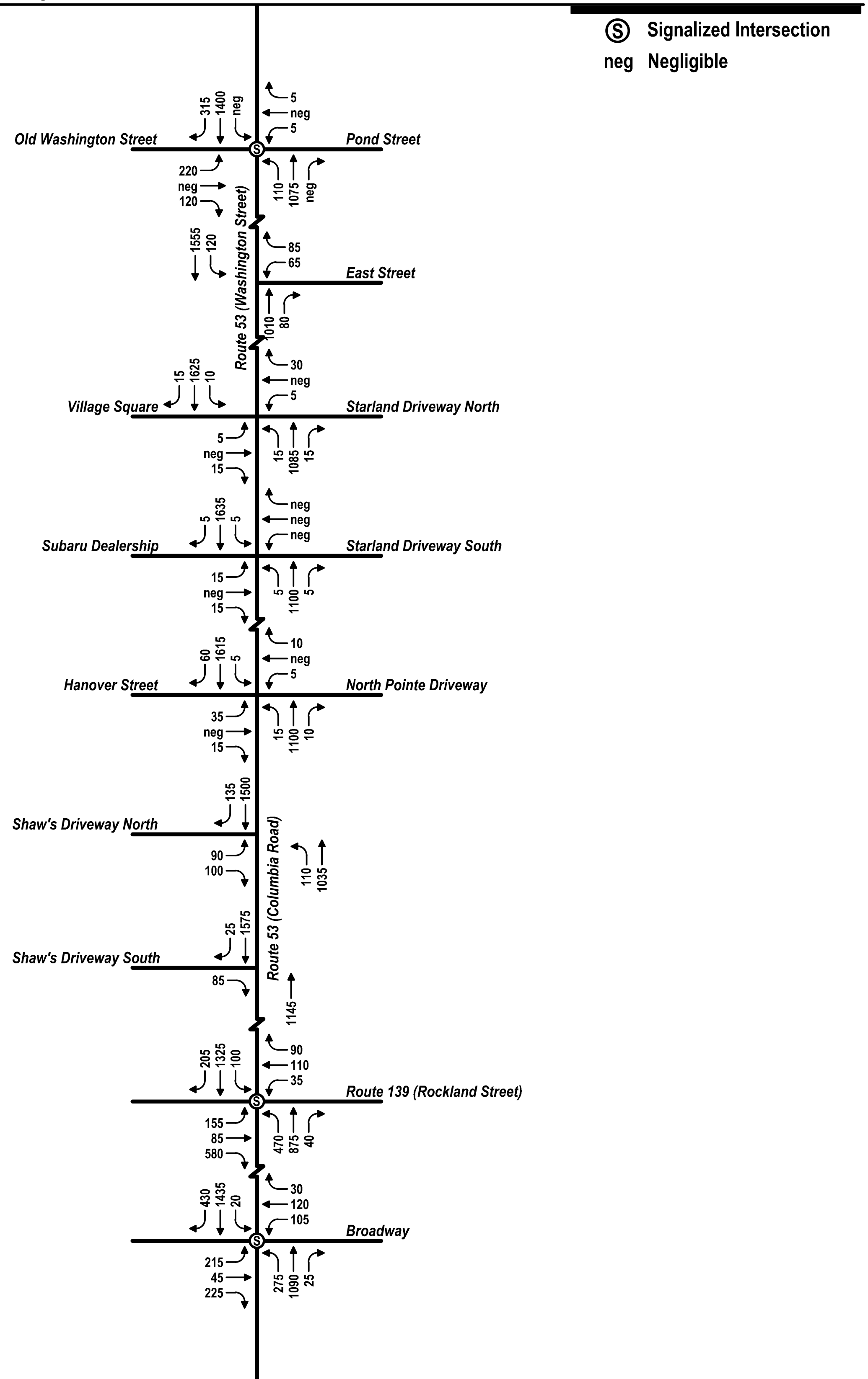


Vanasse Hangen Brustlin, Inc.

Not to Scale

Maximum Build-Out Conditions
Weekday Morning
Peak Hour Traffic Volumes
Route 53 Corridor Study
Hanover, Massachusetts

Figure 12

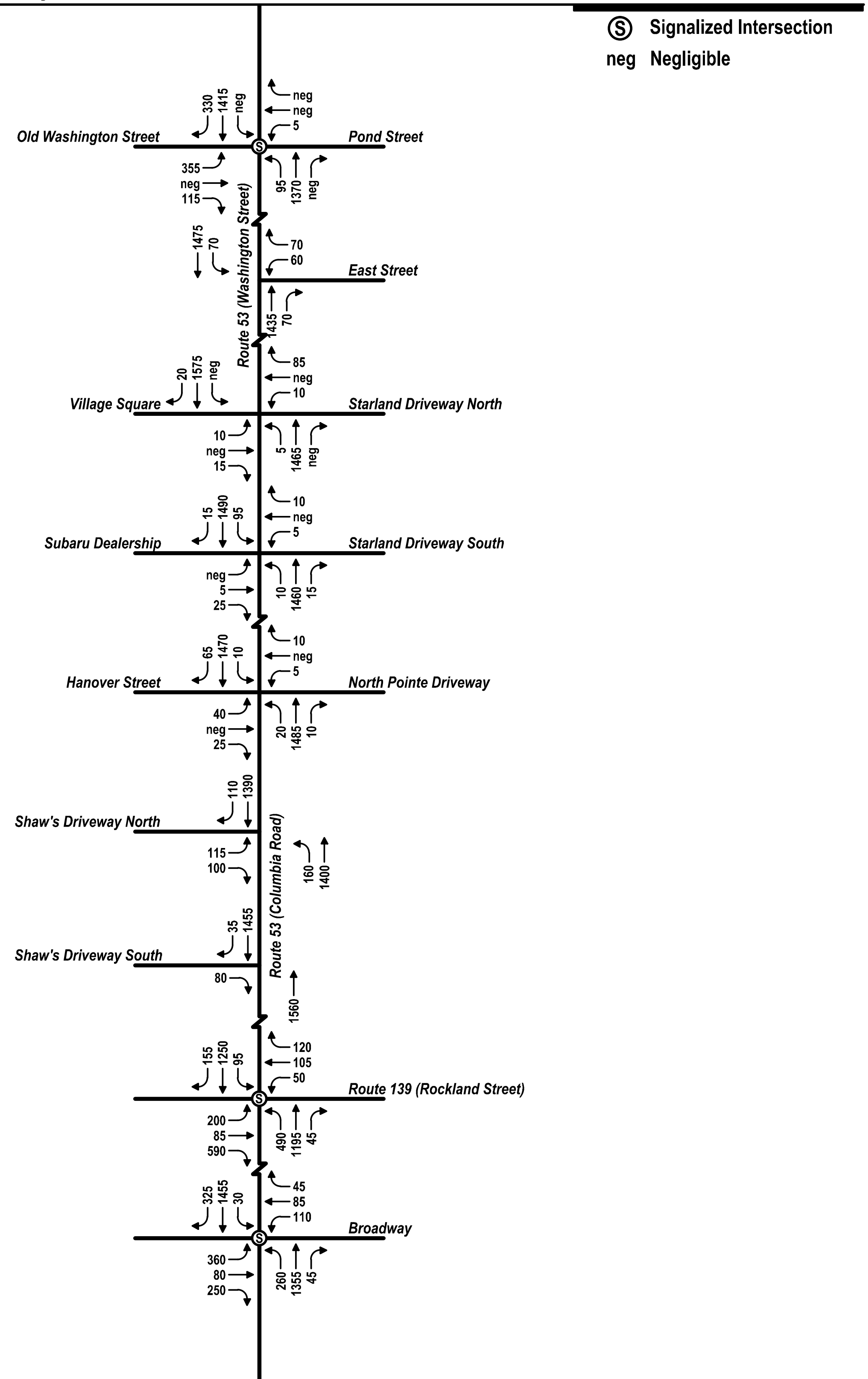


Vanasse Hangen Brustlin, Inc.

Not to Scale

Maximum Build-Out Conditions
Weekday Evening
Peak Hour Traffic Volumes
Route 53 Corridor Study
Hanover, Massachusetts

Figure 13



Vanasse Hangen Brustlin, Inc.

Not to Scale

Maximum Build-Out Conditions
Saturday Midday
Peak Hour Traffic Volumes
Route 53 Corridor Study
Hanover, Massachusetts

Figure 14

4

Traffic Operations

Understanding the relationship between the supply and demand on a roadway is a fundamental consideration in evaluating how well a transportation facility safely and efficiently accommodates the traveling public. Methods from the 2010 Highway Capacity Manual (HCM)[7] were used to evaluate how the unsignalized intersections accommodate the traffic demands and the percentile delay method (SYNCHRO outputs) was used to evaluate how the signalized intersections accommodate the traffic demands consistent with current MassDOT standards.

The term "level-of-service" (LOS) is used to denote the different operating conditions that occur under select traffic volume loads. It is a qualitative measure that considers a number of factors including traffic demands, roadway geometry, speed, signal operations, travel delay, and freedom to maneuver. Similar to a report card, the level-of-service designation is an index ranging from A to F, with LOS A representing the best operating conditions and LOS F representing the worst operating conditions. Typically, LOS D (as defined in the HCM) is considered to be the acceptable limit and LOS E or F conditions are indicative of excessive delays or queues where vehicles may wait through multiple signal cycles. The level-of-service ratings are based on delay for signalized and unsignalized intersections.

The computer software program, SYNCHRO 8.0, was used for the LOS evaluation of signalized and unsignalized intersections. This modeling software is widely used by traffic engineers and is consistent with procedures in the HCM. Levels-of-service analyses were conducted for the 2014 Existing, 2024 No-Build, and Maximum Build-out conditions for the signalized and unsignalized study area intersections.

[7] 2010 Highway Capacity Manual; Transportation Research Board, Washington, D.C.

Signalized Intersections

The capacity analysis results for the key signalized intersections in the study area are presented in Table 8 and are included in the Appendix. For each of the signalized intersections, the table summarizes the volume-to-capacity ratio, delay, level-of-service, 50th percentile queue, and 95th percentile queue for each lane group and for the intersection as a whole under 2014 Existing, 2024 No-Build, and Maximum Build-out conditions.

As summarized in Table 8, two of the three signalized study area intersections have operational issues during at least one peak period.

- **Route 53 (Columbia Road) at Route 139 (Rockland Street):** This intersection currently operates at LOS F during all three peak periods. The Route 139 eastbound left/ through movement operates over capacity. As traffic volumes grow under 2024 No-Build and Maximum Build-out conditions, the intersection is projected to continue to operate at LOS F. The Route 53 northbound left and southbound through/ right movements operate over capacity under Maximum Build-out conditions in the weekday evening and Saturday midday peak periods in addition to the Route 139 eastbound through/ left movement.
- **Route 53 (Columbia Road) at Broadway:** This intersection currently operates at LOS E during the Saturday midday peak period and the Broadway eastbound approach operates over capacity. Under 2024 No-Build conditions, the intersection is projected to degrade to LOS F during the Saturday midday peak period. With additional projected traffic under the Maximum Build-out conditions, the intersection is projected to operate at LOS F under all three peak periods. The Route 53 northbound approach would operate over capacity during the weekday evening and Saturday midday peak periods in addition to the Broadway eastbound approach.

Unsignalized Intersections

Levels-of-service at the study area unsignalized intersections were also analyzed; the results are summarized in Table 9 and are included in the Appendix.

As shown in Table 9, the minor street approaches of all six of the unsignalized study area intersections operate at or over capacity (LOS E/ F) during at least one peak period. These operations are typical of minor street/ driveway approaches along high volume mainline roadways with minimal gaps in traffic flow for entering motorists.

- **Route 53 (Washington Street) at East Street:** The East Street westbound left-turn movement currently operates at LOS E/ F during all three peak periods. Under

2024 No-Build and Maximum Build-out conditions, the movement is projected to continue to operate at LOS E/ F. Poor operations at this intersection may be partially attributed to sight distance issues associated with the horizontal alignment of Route 53.

- **Route 53 (Washington Street) at Village Square/Starland North Driveway:** The Village Square eastbound approach and Starland North Driveway westbound left movements currently operate at LOS E/ F during all three peak periods. Under 2024 No-Build and Maximum Build-out conditions, the approaches are projected to continue to operate at LOS E/ F with increased delay.
- **Route 53 (Washington Street) at Subaru Dealership/Starland South Driveway:** The Subaru Dealership eastbound approach and Starland South Driveway westbound approaches currently operate at LOS E/ F during the weekday evening and Saturday midday peak periods. Under 2024 No-Build and Maximum Build-out conditions, the approaches are projected to continue to operate at LOS E/ F. Additionally, the Starland South Driveway westbound approach is projected to operate at LOS E during the weekday morning peak period under Maximum Build-out conditions.
- **Route 53 (Washington Street) at Hanover Street/North Pointe:** The Hanover Street eastbound approach and North Pointe westbound approach currently operate at LOS E/ F during all three peak periods, with the exception of the North Pointe westbound approach during the weekday morning peak period. Under 2024 No-Build and Maximum Build-out conditions, the approaches are projected to continue to operate at LOS E/ F. Additionally, the North Pointe westbound approach is projected to operate at LOS F during the weekday morning peak period under Maximum Build-out conditions. Poor operations at this intersection may be partially attributed to sight distance issues due to the vertical alignment of Route 53 to the south.
- **Route 53 (Columbia Road) at Shaw's North Driveway:** The Shaw's North Driveway eastbound left movement currently operates at LOS F during the weekday evening and Saturday midday peak periods. Under 2024 No-Build and Maximum Build-out conditions, the movement is projected to continue to operate at LOS E/ F. Additionally, the movement is projected to degrade to LOS F during the weekday morning peak period under Maximum Build-out conditions. Poor operations at this intersection may be partially attributed to sight distance issues due to the vertical alignment of Route 53.
- **Route 53 (Columbia Road) at Shaw's South Driveway:** The Shaw's South Driveway currently operates at acceptable LOS B/ C during all three peak periods and is projected to continue to operate at LOS B/ C under 2024 No-Build conditions. However, with additional traffic projected along Route 53 under Maximum Build-out conditions, the Shaw's South Driveway eastbound right movement is projected to operate at LOS F during the weekday evening and Saturday midday peak periods.

Table 8 Signalized Intersection Capacity Analysis Summary

		2014 Existing					2024 No-Build					Maximum Build-out				
	Movement	**v/c[1]**	**Delay[2]**	**LOS[3]**	**50th Q[4]**	**95th Q[5]**	**v/c**	**Delay**	**LOS**	**50th Q**	**95th Q**	**v/c**	**Delay**	**LOS**	**50th Q**	**95th Q**
1. Route 53 (Washington Street) at Old Washington Street/Pond Street																
Weekday Morning																
Old Washington St	EB L/T	0.61	27	C	74	#294	0.66	30	C	86	#340	0.75	38	D	103	#360
	EB R	0.11	6	A	5	40	0.11	6	A	6	45	0.15	8	A	11	58
Pond St	WB L/T/R	0.02	18	B	2	9	0.02	20	B	2	9	0.02	22	C	3	10
Route 53	NB L	0.21	30	C	13	52	0.23	31	C	15	59	0.29	35	C	20	67
	NB T/R	0.62	16	B	107	263	0.66	17	B	123	298	0.62	15	B	135	325
Route 53	SB L	0.00	14	B	0	3	0.00	15	B	0	3	0.00	16	B	0	3
	SB T/R	0.59	21	C	82	144	0.60	21	C	91	156	0.72	23	C	137	222
	Overall		**19**	**B**				**20**	**B**				**21**	**C**		
Weekday Evening																
Old Washington St	EB L/T	0.75	54	D	123	#271	0.79	57	E	131	#289	0.79	58	E	133	#289
	EB R	0.15	10	B	11	48	0.17	11	B	15	55	0.20	12	B	23	69
Pond St	WB L/T/R	0.08	24	C	7	13	0.08	24	C	7	13	0.08	24	C	7	13
Route 53	NB L	0.51	54	D	45	100	0.53	55	E	48	104	0.66	61	E	68	#158
	NB T/R	0.31	9	A	77	186	0.33	9	A	86	205	0.49	11	B	145	339
Route 53	SB L	0.01	24	C	0	4	0.01	24	C	0	4	0.01	24	C	0	4
	SB T/R	0.77	22	C	319	517	0.84	25	C	373	#647	0.99	44	D	526	#851
	Overall		**22**	**C**				**24**	**C**				**33**	**C**		
Saturday Midday																
Old Washington St	EB L/T	1.13	>120	F	~250	#520	>1.20	>120	F	~302	#547	>1.20	>120	F	~315	#547
	EB R	0.12	9	A	6	41	0.14	10	A	9	44	0.21	14	B	27	75
Pond St	WB L/T/R	0.03	0	A	0	0	0.04	0	A	0	0	0.04	0	A	0	0
Route 53	NB L	0.37	48	D	31	79	0.44	52	D	36	84	0.60	58	E	59	#128
	NB T/R	0.48	11	B	126	296	0.48	11	B	141	330	0.63	13	B	216	497
Route 53	SB L	0.00	23	C	0	4	0.00	24	C	0	4	0.01	24	C	0	4
	SB T/R	0.76	21	C	287	482	0.79	22	C	331	547	1.01	47	D	~554	#885
	Overall		**31**	**C**				**41**	**D**				**50**	**D**		

1 volume to capacity ratio
2 average intersection delay, measured in seconds
3 level-of-service
4 50th Percentile queue, measured in feet
5 95th Percentile queue, measured in feet

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th Percentile volume exceeds capacity, queue may be longer
Shaded cells denote LOS E/F conditions

Table 8 Signalized Intersection Capacity Analysis Summary (cont.)

		2014 Existing					2024 No-Build					Maximum Build-out				
	Movement	v/c[1]	Delay[2]	LOS[3]	50th Q[4]	95th Q[5]	v/c	Delay	LOS	50th Q	95th Q	v/c	Delay	LOS	50th Q	95th Q
8. Route 53 (Columbia Road) at Route 139 (Rockland Street)																
Weekday Morning																
Route 139	EB L/T	>1.20	>120	F	~183	#315	>1.20	>120	F	~205	#352	>1.20	>120	F	~324	#551
	EB R	0.53	7	A	0	76	0.55	7	A	0	79	0.60	8	A	0	91
Route 139	WB L/T	0.63	58	E	81	133	0.64	59	E	86	140	0.68	65	E	99	158
	WB R	0.35	13	B	1	38	0.40	14	B	4	44	0.41	16	B	8	50
Route 53	NB L	0.74	44	D	219	#409	0.80	49	D	241	#458	0.89	64	E	287	#560
	NB T/R	0.53	27	C	194	288	0.55	28	C	210	312	0.66	30	C	305	438
Route 53	SB L	0.42	56	E	37	71	0.45	57	E	41	77	0.47	64	E	45	84
	SB T/R	0.71	48	D	118	150	0.73	49	D	131	163	0.80	50	D	206	240
	Overall		**99**	**F**				**>120**	**F**				**>120**	**F**		
Weekday Evening																
Route 139	EB L/T	>1.20	>120	F	~301	#465	>1.20	>120	F	~337	#494	>1.20	>120	F	~442	#636
	EB R	0.72	11	B	0	109	0.74	11	B	0	112	0.91	30	C	127	#372
Route 139	WB L/T	0.74	76	E	132	186	0.76	78	E	143	193	0.84	89	F	164	216
	WB R	0.32	13	B	0	33	0.35	17	B	9	45	0.38	19	B	19	58
Route 53	NB L	0.94	82	F	325	#599	1.01	99	F	~388	#644	>1.20	>120	F	~602	#856
	NB T/R	0.31	24	C	142	216	0.34	26	C	158	237	0.62	33	C	358	487
Route 53	SB L	0.54	75	E	60	119	0.59	77	E	77	138	0.65	81	F	93	155
	SB T/R	0.88	55	D	390	512	0.90	56	E	424	#554	>1.20	>120	F	~1010	#1199
	Overall		**>120**	**F**				**>120**	**F**				**>120**	**F**		
Saturday Midday																
Route 139	EB L/T	>1.20	>120	F	~313	#488	>1.20	>120	F	~344	#515	>1.20	>120	F	~507	#720
	EB R	0.69	10	A	0	110	0.71	10	B	0	115	0.91	30	C	125	#380
Route 139	WB L/T	0.71	75	E	113	193	0.72	77	E	122	201	0.84	90	F	155	#243
	WB R	0.39	17	B	8	63	0.41	18	B	12	69	0.43	22	C	29	93
Route 53	NB L	0.94	80	E	322	#601	1.01	98	F	~380	#651	>1.20	>120	F	~654	#915
	NB T/R	0.43	23	C	208	301	0.49	28	C	241	351	0.85	42	D	575	#816
Route 53	SB L	0.38	71	E	34	74	0.60	75	E	78	136	0.66	80	F	99	156
	SB T/R	0.87	53	D	374	459	0.89	55	D	407	496	>1.20	>120	F	~1065	#1175
	Overall		**>120**	**F**				**>120**	**F**				**>120**	**F**		

1 volume to capacity ratio
2 average intersection delay, measured in seconds
3 level-of-service
4 50th Percentile queue, measured in feet
5 95th Percentile queue, measured in feet

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th Percentile volume exceeds capacity, queue may be longer
Shaded cells denote LOS E/F conditions

Table 8 Signalized Intersection Capacity Analysis Summary (cont.)

		2014 Existing					2024 No-Build					Maximum Build-out				
	Movement	v/c[1]	Delay[2]	LOS[3]	50th Q[4]	95th Q[5]	v/c	Delay	LOS	50th Q	95th Q	v/c	Delay	LOS	50th Q	95th Q
9. Route 53 (Columbia Road) at Broadway																
Weekday Morning																
Broadway	EB L/T/R	0.97	58	E	269	#611	1.11	100	F	~379	#724	>1.20	>120	F	~791	#1094
Broadway	WB L/T/R	0.28	19	B	45	112	0.33	23	C	57	136	0.48	42	D	115	204
Route 53	NB L/T/R	0.78	23	C	205	275	0.78	22	C	226	300	0.80	20	C	344	439
Route 53	SB L/T/R	0.41	14	B	99	129	0.41	14	B	107	137	0.41	11	B	145	173
	Overall		**29**	**C**				**39**	**D**				**97**	**F**		
Weekday Evening																
Broadway	EB L/T/R	0.91	62	E	239	#565	1.03	93	F	~321	#614	>1.20	>120	F	~646	#872
Broadway	WB L/T/R	0.66	44	D	164	290	0.76	53	D	198	#331	0.99	96	F	271	#384
Route 53	NB L/T/R	>1.20dl	38	D	304	392	>1.20dl	42	D	351	456	>1.20	>120	F	~949	#1036
Route 53	SB L/T/R	0.69	16	B	298	360	0.70	16	B	328	396	0.96	31	C	771	#1045
	Overall		**32**	**C**				**38**	**D**				**>120**	**F**		
Saturday Midday																
Broadway	EB L/T/R	>1.20	>120	F	~720	#908	>1.20	>120	F	~785	#975	>1.20	>120	F	~1132	#1325
Broadway	WB L/T/R	0.73	55	D	212	258	0.81	63	E	226	271	0.91	77	E	258	#320
Route 53	NB L/T/R	1.02dl	31	C	350	493	1.15dl	36	D	413	#630	>1.20	>120	F	~1130	#1271
Route 53	SB L/T/R	0.62	14	B	287	321	0.64	14	B	318	353	1.14	92	F	~1103	#1145
	Overall		**78**	**E**				**97**	**F**				**>120**	**F**		

1 volume to capacity ratio
2 average intersection delay, measured in seconds
3 level-of-service
4 50th Percentile queue, measured in feet
5 95th Percentile queue, measured in feet

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th Percentile volume exceeds capacity, queue may be longer
dl defacto left lane
Shaded cells denote LOS E/F conditions

Table 9 Unsignalized Intersection Capacity Analysis Summary

	Critical Movement(s)	2014 Existing D[1]	v/c[2]	Delay[3]	LOS[4]	95th Q[5]	2024 No-Build D	v/c	Delay	LOS	95th Q	Maximum Build-out D	v/c	Delay	LOS	95th Q
2. Route 53 (Washington Street) at East Street																
Weekday Morning																
East St	WB L	20	0.17	38	E	1	20	0.21	48	E	1	35	0.69	>120	F	3
Route 53	SB L	60	0.09	10	B	1	65	0.11	11	B	1	65	0.13	12	B	1
Weekday Evening																
East St	WB L	30	0.95	>120	F	4	30	>1.20	>120	F	5	65	>1.20	>120	F	11
Route 53	SB L	115	0.14	10	A	1	120	0.15	10	A	1	120	0.21	13	B	1
Saturday Midday																
East St	WB L	20	0.60	>120	F	3	20	0.91	>120	F	3	70	>1.20	>120	F	12
Route 53	SB L	65	0.10	11	B	1	70	0.12	12	B	1	70	0.17	15	C	1
3. Route 53 (Washington Street) at Village Square/Starland North Driveway																
Weekday Morning																
Village Square	EB L/T/R	2	0.04	47	E	1	2	0.05	56	F	1	2	0.13	>120	F	1
Starland North Dwy	WB L	5	0.12	37	E	1	5	0.14	44	E	1	5	0.30	103	F	1
Route 53	NB L	1	0.00	10	A	0	1	0.00	10	B	0	1	0.00	11	B	0
Route 53	SB L	1	0.00	10	A	1	1	0.00	10	A	0	1	0.00	11	B	0
Weekday Evening																
Village Square	EB L/T/R	20	0.22	42	E	1	20	0.27	51	F	1	20	0.26	50	F	1
Starland North Dwy	WB L	5	0.13	89	F	1	5	0.17	115	F	1	5	>1.20*	>120*	F*	n/a*
Route 53	NB L	15	0.03	11	B	1	15	0.03	11	B	1	15	0.05	16	C	1
Route 53	SB L	10	0.01	9	A	0	10	0.01	9	A	0	10	0.02	11	B	1
Saturday Midday																
Village Square	EB L/T/R	25	0.60	>120	F	3	25	0.77	>120	F	3	25	>1.20*	>120*	F*	n/a*
Starland North Dwy	WB L	10	0.40	>120	F	2	10	0.52	>120	F	2	10	>1.20	>120	F	4
Route 53	NB L	5	0.01	10	B	0	5	0.01	11	B	0	5	0.02	14	B	0
Route 53	SB L	1	0.00	10	B	0	1	0.00	10	B	0	1	0.00	14	B	0

1 Demand in vehicles per hour
2 volume to capacity ratio
3 average intersection delay, measured in seconds
4 level-of-service
5 95th Percentile queue measured in vehicles
* Delay outside software calculable range
Shaded cells denote LOS E/F conditions

Table 9 Unsignalized Intersection Capacity Analysis Summary (cont'd)

	Critical Movement(s)	2014 Existing D[1]	v/c[2]	Delay[3]	LOS[4]	95th Q[5]	2024 No-Build D	v/c	Delay	LOS	95th Q	Maximum Build-out D	v/c	Delay	LOS	95th Q
4. Route 53 (Washington Street) at Subaru Dealership/Starland South Driveway																
Weekday Morning																
Subaru Dealership	EB L/T/R	neg	0.00	0	A	0	neg	0.00	0	A	0	neg	0.00	0	A	0
Starland South Dwy	WB L/T/R	12	0.08	20	C	1	12	0.09	21	C	1	12	0.16	35	E	1
Route 53	NB L	15	0.01	8	A	0	15	0.02	9	A	0	15	0.02	9	A	1
Route 53	SB L	neg	0.00	0	A	0	neg	0.00	0	A	0	neg	0.00	0	A	0
Weekday Evening																
Subaru Dealership	EB L/T/R	30	0.58	88	F	3	30	0.71	>120	F	4	30	>1.20	>120	F	8
Starland South Dwy	WB L/T/R	2	0.08	85	F	1	2	0.10	108	F	1	2	1.00	>120	F	2
Route 53	NB L	5	0.01	11	B	0	5	0.01	11	B	0	5	0.02	15	C	0
Route 53	SB L	5	0.01	9	A	0	5	0.01	9	A	0	5	0.01	11	B	0
Saturday Midday																
Subaru Dealership	EB L/T/R	30	0.29	44	E	2	30	0.36	59	F	2	30	>1.20	>120	F	5
Starland South Dwy	WB L/T/R	15	0.75	>120	F	4	15	1.04	>120	F	4	15	>1.20*	>120*	F*	n/a*
Route 53	NB L	10	0.02	10	A	0	10	0.02	10	B	0	10	0.03	14	B	1
Route 53	SB L	95	0.14	11	B	1	95	0.15	11	B	1	95	0.25	17	C	1
5. Route 53 (Washington Street) at Hanover Street/North Pointe																
Weekday Morning																
Hanover St	EB L/T/R	36	0.29	36	E	2	36	0.34	44	E	2	41	0.87	>120	F	4
North Pointe	WB L/T/R	15	0.09	28	D	1	15	0.11	32	D	1	15	0.21	65	F	1
Route 53	NB L	10	0.01	8	A	0	10	0.01	9	A	0	10	0.01	9	A	0
Route 53	SB L	1	0.00	10	A	0	1	0.00	10	A	0	1	0.00	11	B	0
Weekday Evening																
Hanover St	EB L/T/R	36	0.91	>120	F	5	41	>1.20	>120	F	7	51	>1.20	>120	F	13
North Pointe	WB L/T/R	16	0.24	46	E	1	16	0.29	59	F	2	16	>1.20	>120	F	5
Route 53	NB L	10	0.02	11	B	1	10	0.02	12	B	1	15	0.05	17	C	1
Route 53	SB L	5	0.01	9	A	0	5	0.01	9	A	0	5	0.01	11	B	0
Saturday Midday																
Hanover St	EB L/T/R	46	0.97	>120	F	5	51	>1.20	>120	F	7	66	>1.20	>120	F	13
North Pointe	WB L/T/R	16	0.25	57	F	1	16	0.30	72	F	2	16	>1.20	>120	F	5
Route 53	NB L	10	0.02	10	B	0	10	0.02	11	B	1	20	0.05	14	B	1
Route 53	SB L	10	0.02	10	B	0	10	0.02	11	B	0	10	0.03	14	B	1

1 Demand in vehicles per hour
2 volume to capacity ratio
3 average intersection delay, measured in seconds
4 level-of-service
5 95th Percentile queue measured in vehicles
* Delay outside software calculable range
Shaded cells denote LOS E/F conditions

Table 9 Unsignalized Intersection Capacity Analysis Summary (cont'd)

	Critical Movement(s)	2014 Existing					2024 No-Build					Maximum Build-out				
		D[1]	v/c[2]	Delay[3]	LOS[4]	95th Q[5]	D	v/c	Delay	LOS	95th Q	D	v/c	Delay	LOS	95th Q
6. Route 53 (Columbia Road) at Shaw's North Driveway																
Weekday Morning																
Shaw's North Dwy	EB L	10	0.08	29	D	1	10	0.09	34	D	1	25	0.57	>120	F	3
Route 53	NB L	10	0.01	8	A	0	10	0.01	8	A	0	45	0.05	9	A	1
Weekday Evening																
Shaw's North Dwy	EB L	30	0.50	84	F	3	30	0.60	115	F	3	90	>1.20	>120	F	19
Route 53	NB L	20	0.04	11	B	1	20	0.04	11	B	1	110	0.34	21	C	2
Saturday Midday																
Shaw's North Dwy	EB L	35	0.80	>120	F	4	35	0.98	>120	F	5	115	>1.20	>120	F	24
Route 53	NB L	25	0.04	10	B	1	25	0.04	11	B	1	160	0.44	21	C	3
7. Route 53 (Columbia Road) at Shaw's South Driveway																
Weekday Morning																
Shaw's South Dwy	EB R	10	0.03	11	B	1	10	0.03	11	B	1	1	0.05	13	B	1
Weekday Evening																
Shaw's South Dwy	EB R	40	0.20	21	C	1	40	0.22	23	C	1	85	1.08	>120	F	8
Saturday Midday																
Shaw's South Dwy	EB R	30	0.12	17	C	1	30	0.13	19	C	1	1	0.76	87	F	5

1 Demand in vehicles per hour
2 volume to capacity ratio
3 average intersection delay, measured in seconds
4 level-of-service
5 95th Percentile queue measured in vehicles

Shaded cells denote LOS E/F conditions

5

Conceptual Improvements

VHB identified short-term improvements and conceptual long-term improvements for the Route 53 corridor. The short-term improvements focus on low cost measures to the existing infrastructure that benefit operations and safety. The long-term corridor improvements look at additional geometric improvements along the Route 53 corridor to increase capacity and improve operations under the Maximum Build-out condition.

Short-Term Improvements

VHB, in association with the Town of Hanover, identified and analyzed short-term improvements at three intersections to improve corridor operations and safety:

- Route 53 (Washington Street) at East Street
- Route 53 (Columbia Road) at Route 139 (Rockland Street)
- Route 53 (Columbia Road) at Broadway

In addition, proposed improvements by others to the intersection of Route 53 at Park Drive were reviewed.

Route 53 (Washington Street) at East Street

At the request of the Town of Hanover, VHB evaluated the addition of a Route 53 southbound left-turn storage lane at the intersection to provide left-turning vehicles a place to queue and remove conflicts with southbound through traveling vehicles. Based on the queues expected under 2024 No-Build conditions, a storage length of 50 feet was determined to be adequate for the southbound left-turn storage lane. The improvement could be accomplished within the existing right-of-way and would require minor widening, paving, and re-striping along Route 53. Figure 15 conceptually illustrates this improvement to the Route 53 at East Street intersection. The preliminary lump sum cost estimate for a Route 53 southbound left-turn storage lane at East Street is approximately $226,500. This cost estimate does not include any property acquisitions or temporary or permanent easements.

To provide motorists traveling southbound on Route 53 an advanced warning of the East Street intersection, an intersection warning sign (W2-2) could be installed to the north of the intersection in accordance with the Manual on Uniform Traffic Control Devices (MUTCD)[8] guidance.

This improvement is anticipated to have negligible operational benefits at the intersection. However, mobility along Route 53 would be improved by providing storage for southbound vehicles waiting to turn left onto East Street and the possibility of vehicle crashes could be reduced by removing left-turning vehicles from the traffic flow. Sight distance issues noted in Chapter 2 would be neither improved nor worsened with this improvement, however the installation of an intersection warning sign would provide an advanced warning which does not currently exist.

Signal Warrant Analysis

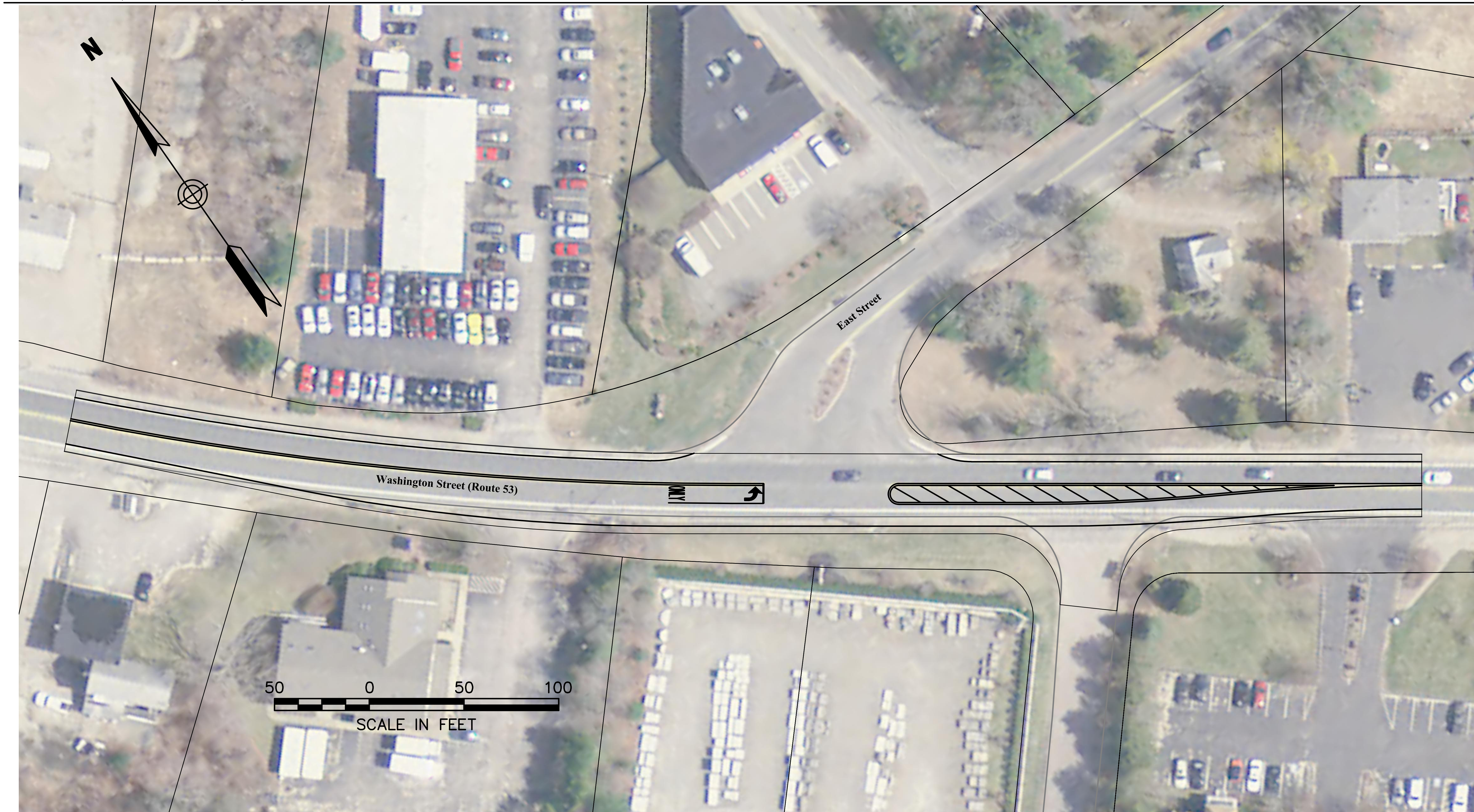
VHB performed a traffic signal warrant analysis at the unsignalized intersection of Route 53 at East Street using 2024 No-Build volumes. The Manual on Uniform Traffic Control Devices (MUTCD)[9] lists specific criteria, or warrants, for the consideration of installation of a traffic signal at an intersection. The MUTCD also notes that, "the satisfaction of a traffic signal warrant or warrants shall not, in itself, require the installation of a traffic control signal." The traffic signal warrant analysis provides guidance as to locations where signals would not be appropriate and locations where they could be considered further.

A traffic signal warrant analysis was performed for the volume-based peak hour warrant (Warrant 3) for the 2024 No-Build weekday morning, weekday evening, and Saturday midday peak periods. To be consistent with MUTCD guidance, East Street right-turning traffic was not included in warrant analysis. The MUTCD guidance indicates that at intersections with a minor street approach consisting of a shared left/ through lane and an exclusive right-turn lane and where right-turning traffic enters the major street with minimal conflict, only the volume in the through/ left-turn lane should be considered. The warrant is not

▼

[8] MUTCD, Part 2 – Signs, USDOT/FHWA, December 2009.

[9] MUTCD, Part 4 – Highway Traffic Signals, USDOT/FHWA, December 2009.



Vanasse Hangen Brustlin, Inc.

Figure 15

Short-Term Improvement Concept
Route 53 at East Street
Southbound Left-Turn Lane
Hanover, MA

met at the intersection of Route 53 at East Street for any of the peak hours. Additionally, the intersection does not meet the traffic signal warrants based on pedestrian volumes or history of vehicle crashes. The signal warrant analyses are included in the Appendix to this document.

Route 53 (Columbia Road) at Route 139 (Rockland Street)

VHB reviewed and updated the substandard yellow and all red clearance intervals and pedestrian clearance timings at the intersection of Route 53 and Route 139 to conform to current standards. The updated timings are expected to improve safety for both vehicles and pedestrians at the intersection by allowing for more appropriate reaction times to traffic signal phase changes. Additionally, the phasing at the intersection was modified to allow the Route 139 eastbound and westbound approaches to run concurrently. With the updated clearance timings and phase structure, the intersection cycle length and split times were also optimized based on time of day traffic demands.

Summary tables and capacity analysis results for the short-term improvements at the intersection of Route 53 (Columbia Road) and Route 139 (Rockland Street) are included in the Appendix. The overall operations at the intersection of Route 53 (Columbia Road) at Route 139 (Rockland Street) are expected to improve from LOS F during all three peak hours under 2024 No-Build conditions to LOS D or better with the short-term improvements applied.

The preliminary lump sum cost estimate for the signal timing and phasing improvements at the intersection of Route 53 at Route 139 is approximately $3,000.

Route 53 (Columbia Road) at Broadway

VHB reviewed and updated the substandard yellow and all red clearance intervals and pedestrian clearance timings at the intersection of Route 53 and Broadway to conform to current standards. The updated timings are expected to improve safety for both vehicles and pedestrians at the intersection by allowing for more appropriate reaction times to traffic signal phase changes. Additionally, the pedestrian phasing at the intersection was modified from exclusive to concurrent phasing to improve vehicle operations and reduce wait time for pedestrians. With the updated clearance timings and pedestrian phasing, the intersection cycle length and split times were also optimized based on time of day traffic demands.

Summary tables and capacity analysis results for the short-term improvements at the intersection of Route 53 (Columbia Road) and Broadway are included in the Appendix. The overall operations with the short-term improvements at the intersection of Route 53 (Columbia Road) at Broadway are expected to remain at the same level-of-service as under 2024 No-Build conditions, however a reduction in delay and queues is expected for the majority of movements.

The preliminary lump sum cost estimate for the signal timing and phasing improvements at the intersection of Route 53 at Broadway is approximately $3,000.

Route 53 (Washington Street) at Park Drive

At the request of the Town, VHB reviewed proposed improvements to the intersection of Route 53 at Park Drive. Park Drive intersects Route 53 just south of East Street and will provide access to the proposed Village at Seven Springs residential development. During a peer review of the traffic study for this project, a Route 53 northbound left-turn lane was recommended at the Park Drive intersection. The implementation of a northbound left-turn lane would provide left-turning vehicles a place to queue and remove conflicts with northbound through traveling vehicles. However, sight distance at the Route 53 and Park Drive intersection would need to be reviewed. Any proposed improvements should need to be coordinated with the proposed turn lanes at Starland to the south of Park Drive along Route 53.

Conceptual Corridor Improvements

VHB, in coordination with the Town of Hanover, identified and analyzed two conceptual improvement options for the Route 53 corridor:

- **Option 1:** Two-Way (center) Left-Turn Lane (TWLTL)
- **Option 2:** Four-Lane Cross-Section

In addition, both options also include the re-alignment and signalization of the Route 53 and East Street intersection described in detail below.

As discussed, Route 53 is under MassDOT jurisdiction and is an NHS roadway. As such, the roadway is subject to specific design standards. Considering these requirements, the following assumptions were made when evaluating both options in terms of the conceptual layout:

- Minimum 50-foot long turn lanes;

- Minimum 12-foot wide travel lanes. This is the minimum lane width allowed (without a design exception) on an NHS principal arterial roadway;
- Minimum 14-foot wide TWLTL;
- Minimum 5-foot wide shoulders. This shoulder would be of sufficient width to accommodate bicycles. No additional bicycle accommodations are assumed. It should be noted that the minimum shoulder width on an NHS principal arterial roadway is 8-feet. Review and approval by MassDOT of a design exception for shoulder widths less than this minimum would be required;
- Both options consider widening Route 53 from the center of the right-of-way. The widening would have impacts to parcels along both the eastern and western sides of Route 53; and
- Minimum 5-foot wide sidewalk along the western (southbound) side of Route 53. It should be noted that an Engineering Directive for Design Criteria for MassDOT Highway Division Projects [10] has been issued by MassDOT which introduces new controlling criteria for pedestrian accommodation. The directive states that "wherever adjacent land uses include commercial or residential development greater than 5 units per acre, a sidewalk shall be provided along the roadway adjacent to the use." A design exception request would need to be prepared and accepted by MassDOT for the exclusion of sidewalk along the eastern (northbound) side of Route 53.

Option 1: Two-Way (center) Left-Turn Lane (TWLTL)

Option 1 includes the following corridor improvements:

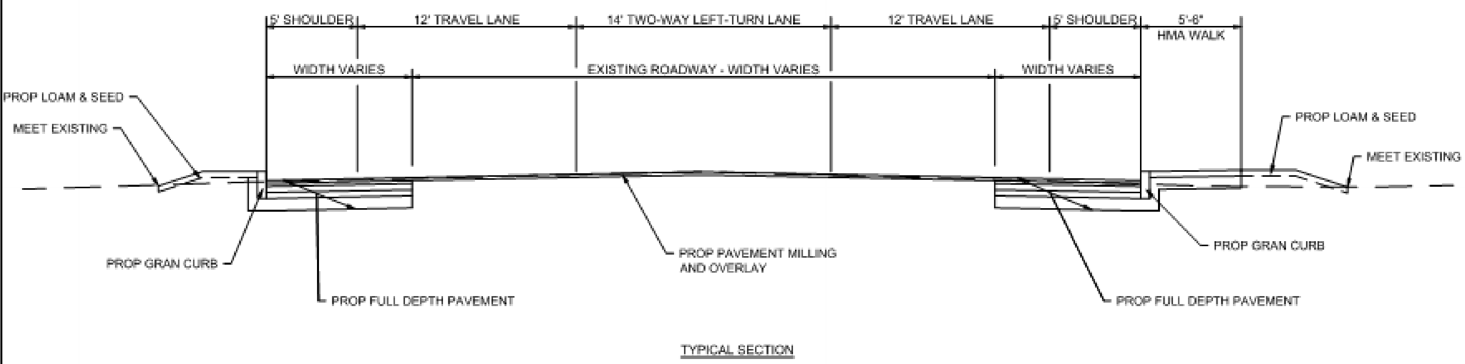
- A center TWLTL from Old Washington Street to Route 139 and from Broadway to the Pembroke Town Line, with one lane of travel in both the northbound and southbound directions. The TWLTL would provide left-turning vehicles along Route 53 a place to queue and remove conflicts with northbound and southbound through traveling vehicles.
- The re-alignment of East Street to intersect Route 53 directly across from Park Drive (Village at Seven Springs driveway). With the construction of Build-Out Parcel 1, the re-aligned intersection of Route 53 at East Street/ Park Drive (Village at Seven Springs driveway) would warrant installation of a traffic signal.
- Signal timing and phasing improvements to the intersections of Route 53 at Route 139 and Route 53 at Broadway, as described in the short-term

[10] Engineering Directive; Design Criteria for MassDOT Highway Division Projects; MassDOT; February 4, 2014.

improvements section. The signal timing and phasing were reviewed at the intersection of Route 53 and Old Washington Street and no potential improvements were identified.

Figure 16 shows the typical cross-section associated with Option 1. Conceptual improvement plans are included as an attachment to this report.

Figure 16 Option 1 Typical Cross-Section



The preliminary lump sum cost estimate for Option 1 is approximately $7,799,000. This cost estimate does not consider any property acquisitions or temporary or permanent easements. Preliminary cost estimates for utility relocation are included and are based on similar, recent projects in the area.

Option 1 Traffic Operations

Option 1 summary tables and capacity analysis results for the signalized and unsignalized study area intersections are included in the Appendix.

As shown in the Option 1 signalized capacity analysis results, operations at the intersection of Route 53 at Old Washington Street are expected to remain the same as under Maximum Build-out conditions (LOS D or better), as no improvements are proposed at this intersection. The re-alignment and signalization of the Route 53 at East Street intersection improves operations to LOS C or better between Maximum Build-out and Option 1 conditions. Overall operations at the intersections of Route 53 at Route 139 and Route 53 at Broadway are expected to improve under Option 1, with decreases in delays and queues for the majority of movements. Additionally, the updated clearance timings discussed in the short-term improvements section have the ability to enhance intersection safety.

As shown in the Option 1 unsignalized capacity analysis results, operations at the five unsignalized intersections are expected to remain the same as Maximum Build-out operations or improve. It should be noted that the TWLTL will provide storage for Route 53 left-turning vehicles to queue out of the way of through traveling vehicles, resulting in safety improvements along Route 53. Further, while it is anticipated that intersection operations would remain the same, the operation benefit of Option 1 is the potential reduction of through-traffic roadway delays as left-turning vehicles would be removed from the traffic flow.

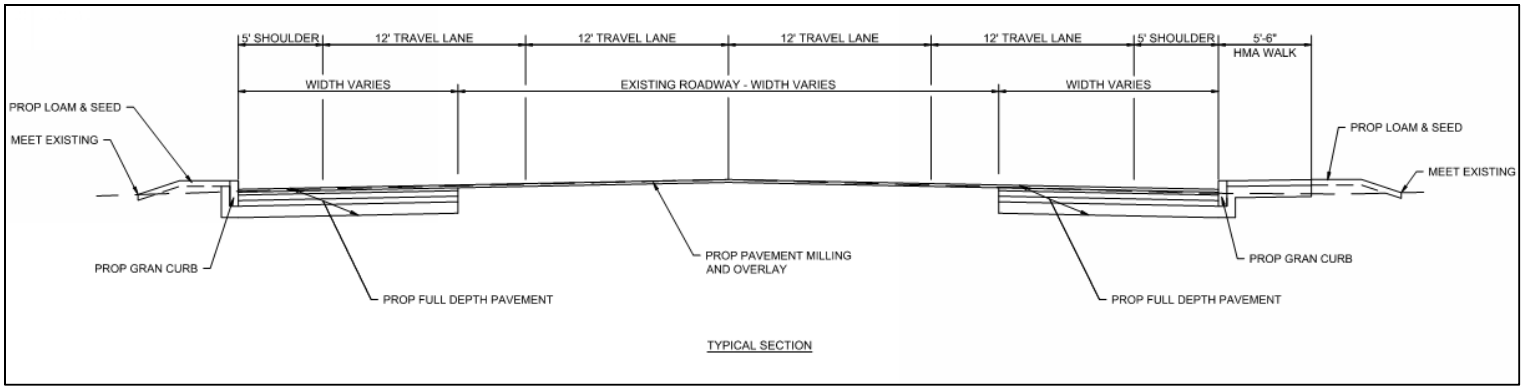
Option 2: Four-Lane Cross-Section

Option 2 includes the following corridor improvements:

- A four-lane cross-section from Old Washington Street to Route 139. The four-lane cross-section would provide additional capacity and increased mobility along Route 53.
- A TWLTL from Broadway to the Pembroke Town Line, with one lane of travel in both the northbound and southbound directions. The TWLTL would provide left-turning vehicles along Route 53 a place to queue and remove conflicts with northbound and southbound through traveling vehicles.
- The re-alignment of East Street to intersect Route 53 directly across from Park Drive (Village at Seven Springs driveway). With the construction of Build-Out Parcel 1, the re-aligned intersection of Route 53 at East Street/ Park Drive (Village at Seven Springs driveway) would warrant installation of a traffic signal.
- Signal timing and phasing improvements to the intersections of Route 53 at Route 139 and Route 53 at Broadway, as described in the short-term improvements section. The signal timing and phasing were reviewed at the intersection of Route 53 and Old Washington Street and no potential improvements were identified.

Figure 17 shows the typical cross-section associated with Option 2. Conceptual improvement plans are included as an attachment to this report.

Figure 17 Option 2 Typical Cross-Section



The preliminary lump sum cost estimate for Option 2 is approximately $8,351,000. This cost estimate does not consider any property acquisitions or temporary or permanent easements. Preliminary cost estimates for utility relocation are included and are based on similar, recent projects in the area.

Option 2 Traffic Operations

Option 2 summary tables and capacity analysis results for the signalized and unsignalized study area intersections are included in the Appendix.

As shown in the Option 2 signalized capacity results, operations at the intersection of Route 53 at Old Washington Street are expected to remain the same as under Maximum Build-out conditions (LOS D or better), as no improvements are proposed at this intersection. The re-alignment and signalization of the Route 53 at East Street intersection improves operations to LOS C or better between Maximum Build-out and Option 2 conditions. Overall operations at the intersections of Route 53 at Route 139 and Route 53 at Broadway are expected to improve under Option 2, with decreases in delays and queues for the majority of movements. Additionally, the updated clearance timings discussed in the short-term improvements section have the ability to enhance intersection safety.

As shown in the Option 2 unsignalized capacity results, the operations at the five unsignalized intersections are expected to remain the same as Maximum Build-out operations or improve. It should be noted that the four-lane cross-section will add capacity along Route 53, however minor street approaches to the unsignalized intersections are still expected to have the same operational deficiencies as under the Maximum Build-out condition.

6

Conclusions and Next Steps

VHB has evaluated the Route 53 corridor from Old Washington Street in the north to Broadway in the south. The evaluation focused on traffic operations, a safety review, and understanding the Maximum Build-out potential along the corridor within the limits of the study area. In coordination with the Town of Hanover, VHB identified and analyzed short-term improvements and two conceptual corridor improvement options that would address the impacts associated with the increased traffic demands if the corridor were to be developed.

Conclusions

Through field observations, signal inventories, and discussions with Town officials, several observations were noted regarding transportation conditions along Route 53. Three short-term improvements were considered to improve traffic flow and safety:

- **Route 53 (Washington Street) at East Street:** the addition of a southbound left-turn storage lane, which could improve safety by reducing vehicle conflicts with southbound through traveling vehicles at the intersection; potential advanced intersection warning signage;
- **Route 53 (Columbia Road) at Route 139 (Rockland Street):** signal timing and phasing improvements which are projected to result in improved intersection operations and could improve safety by allowing for more appropriate reaction times to the changing traffic signal; and
- **Route 53 (Columbia Road) at Broadway:** signal timing and phasing improvements which are projected to result in improved intersection operations and could improve safety by allowing for more appropriate reaction times to the changing traffic signal.

In addition, proposed improvements by others to the intersection of Route 53 at Park Drive were reviewed.

The following long-term improvements are presented for consideration:

- **Option 1:** Two-Way (center) Left-Turn Lane (TWLTL) which provides a place for left-turning vehicles to queue and removes conflicts with through traveling traffic resulting in improved traffic flow and the potential to decrease crashes along the Route 53 corridor; and
- **Option 2:** Four-Lane Cross-Section which provides additional capacity for vehicles traveling northbound and southbound along the Route 53 corridor.

VHB evaluated the traffic operations, potential safety impacts, and geometric impacts of the short-term improvements and conceptual corridor improvement options.

Overall, the short-term options result in safety/ mobility improvements at the Route 53 at East Street intersection with the addition of a southbound left-turn storage lane. Operational and safety improvements related to traffic signal clearance times at the two signalized intersections of Route 53 at Route 139 and Route 53 at Broadway are projected with the short-term improvements discussed. These short-term improvements can be implemented in the near-future at a relatively low cost.

The conceptual corridor improvement options result in different benefits and impacts to the Route 53 corridor:

- Option 1 requires approximately 53-feet of right-of-way (including curb-to-curb width and a sidewalk on the southbound side; Option 2 requires an additional ten feet of right-of-way to accommodate the wider cross-section;
- The preliminary lump sum cost estimate of $7,799,000 for Option 1 is approximately $552,000 less than Option 2; and
- Both options result in improved operations at signalized intersections along Route 53 when compared to the Maximum Build-out condition. However, Option 2 results in improved operations at one additional signalized intersection when compared to Option 1.

Next Steps

Chapters 5 identified potential short-term improvements at three locations along the Route 53 corridor. Since these improvements are relatively low-cost in nature and the signal improvements at two locations require little to no further engineering study, they could be implemented as soon as desirable through coordination with MassDOT.

To advance either of the conceptual corridor improvement options, the following steps would be recommended:

- Request a review of this study by MassDOT to determine general support and/or what potential changes would be required;
- Evaluate the benefits and impacts of each corridor option in light of the Town's priorities and funding availability;
- Determine whether the Town would pursue TIP funding for construction;
- Continue to monitor development proposals along the Route 53 corridor; and
- As discussed, Route 53 is under MassDOT jurisdiction and is an NHS roadway. As such, the roadway is subject to specific design standards. If the Town of Hanover advances either Option 1 or Option 2, design exception request(s) would need to be prepared and accepted by MassDOT and/or FHWA.

It should be noted that the re-alignment and potential signalization of East Street to intersect Route 53 directly across from Park Drive/Village at Seven Springs driveway could be advanced independently of the corridor-wide improvements. This intersection is projected to warrant a traffic signal with the construction and occupancy of Build-Out Parcel 1.