MEMORANDUM

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FROM: Scott W. Thornton, P.E. *and*
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DATE: October 21, 2020

RE: 8670

SUBJECT: Transportation Impact Assessment – Proposed Warehouse and Project Buildout
Hopping Brook Business Park, Holliston, Massachusetts

Vanasse & Associates, Inc. (VAI) has conducted a Transportation Impact Assessment (TIA) in order to determine the potential impacts on the transportation infrastructure associated with the proposed construction of 800,000 square feet (sf) of warehouse space to be located at 555 Hopping Brook Road in Holliston, Massachusetts (hereafter referred to as the "Project"). In addition, the traffic effects associated with an additional 700,000 sf of warehouse space representing the final build-out of the Hopping Brook Business Park, are also considered and included for purposes of design of the Hopping Brook Road and Washington Street (Route 16) intersection. This study evaluates the following specific areas as they relate to the Project: i) access requirements; ii) potential off-site improvements; and iii) safety considerations; and identifies and analyzes existing traffic conditions and future traffic conditions along Hopping Brook Road and the intersection of Hopping Brook Road at Washington Street. Further, the TIA reviews conditions at this intersection for purposes of developing a design capable of accommodating the future traffic demands assuming a complete build-out of the Hopping Brook Business Park.

PROJECT DESCRIPTION AND BACKGROUND

The Project site was originally reviewed through an Environmental Notification Form (ENF) with 3,000,000 square feet (sf) of development to include office space, research and development, high technology assembly uses, and approximately 9,684 parking spaces anticipating 36,900 vehicle trips per day in 1982 (EOEA No. 4411 Environmental Notification Form). The original program was defined as Phase I and Phase II and required to file Draft and Final Environmental Impact Reports (EIRs). After Massachusetts Environmental Policy Act (MEPA) review, the FEIR was issued on June 14, 1983. In 2002, a Notice of Project Change (NPC) was filed to modify the program to include 558,000 sf of office space, manufacturing, and warehouse space after construction of Phase I. In 2018, a 59,724-sf marijuana growing and processing facility (PharmaCann) was permitted as part of Phase II (this facility can expand up to an additional 55,000 sf.) and a 25,200-sf industrial building was recently permitted within part of the original Phase I project limits. These components are currently under construction. Currently, a total of 720,288 sf of development exists at the Park[1]. The proposed Project will entail the construction of an 800,000-sf warehouse building to be located at 555 Hopping Brook Road. The Phase II ultimate build program is defined to include the Project and the buildout of the remaining warehouse which will not

[1] This total development area is based on assessor's records provided by the Town of Holliston. The Applicant was operating under the assumption that the developed area at the Park totaled 558,000 sf, consistent with the MEPA documents filed for the site, until late 2019 when the updated total was requested and provided by the Town.

exceed an additional 700,000-sf; therefore, the final overall buildout of the Hopping Brook Business Park will not reach the 3Msf permitted through MEPA and instead a total buildout of 2.2Msf is anticipated.

The Project site is bounded by areas of open and wooded space to the north, south, and east, and commercial properties to the west. Access to the Project site will be provided via a new driveway that intersects the terminus of Hopping Brook Road. The location of the Project site, relative to the surrounding roadway network, is displayed in Figure 1.

EXISTING CONDITIONS

Roadways

Washington Street

Within the study area, Washington Street is a two-Road urban principal arterial roadway under jurisdiction of the Massachusetts Department of Transportation (MassDOT) that traverses the study area in a general northeast-southwest direction. Washington Street provides two 12-foot wide travel lanes separated by a centerline with marked shoulders. Illumination is provided on Washington Street by way of streetlights mounted on utility poles. The posted speed limit along Washington Street within the study area is 40 and 45 miles per hour (mph), with land use consisting of residential and commercial properties and areas of open and wooded space.

Hopping Brook Road

Hopping Brook Road is a two-Road local roadway under Town jurisdiction that traverses the study area in a general north-south direction. Hopping Brook Road provides two 12-foot wide travel lanes separated by a double-yellow centerline with marked shoulders. Illumination is provided intermittently on Hopping Brook Road by way of streetlights mounted on utility poles. There is no posted speed limit on Hopping Brook Road. Land use along Hopping Brook Road consists of commercial properties and areas of open and wooded space.

Intersection

Washington Street at Hopping Brook Road

Hopping Brook Road is intersected by Washington Street from the south to form this three-way intersection under STOP-sign control. Land use in the vicinity of this intersection consists of commercial properties and areas of open and wooded space. This intersection is under the jurisdiction of the MassDOT and Town of Holliston.

Traffic Volumes

Traffic-volume data for the study area intersections was collected in December 2019 as part of a prior TIA filed in January 2020. The automatic traffic recorder (ATR) counts, manual turning movement counts (TMCs), and vehicle classification counts were conducted on Washington Street and Hopping Brook Road over a continuous 96-hour period in order to record weekday traffic conditions over an extended period, with weekday morning (7:00 to 9:00 AM) and weekday evening (3:00 to 6:00 PM) peak-period manual TMCs performed at the study intersection in December 2019. These time periods were selected for analysis purposes as they are representative of the peak traffic-volume hours for both the Project and the adjacent roadway network.

Figure 1

Site Location Map

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In order to evaluate the potential for seasonal fluctuation of traffic volumes within the study area, traffic-volume data from MassDOT Continuous Count Station No. 3180 located on Interstate 495 (I-495) in Medway were reviewed.[2] Based on a review of this data, it was determined that traffic volumes for the month of December are approximately 8.0 percent below average-month conditions. As such, the raw traffic count data was adjusted upward accordingly.

Washington Street just east of Hopping Brook Road was found to accommodate approximately 16,160 vehicles on an average weekday (24-hour, two-way volume), with approximately 1,214 vehicles per hour (vph) during the weekday morning peak hour and 1,403 vph during the weekday evening peak hour. Hopping Brook Road south of Washington Street was found to accommodate approximately 3,310 vehicles on an average weekday (24-hour, two-way volume), with approximately 293 vph during the weekday morning peak hour and 298 vph during the weekday evening peak hour. The 2020 Existing weekday morning and weekday evening peak-hour traffic volumes are graphically depicted on Figure 2.

A review of the peak-period traffic counts indicate that the weekday morning peak hour generally occurs between 7:30 and 8:30 AM with the weekday evening peak hour generally occurring between 4:30 and 5:30 PM.

Public Transportation

Regularly scheduled public transportation services are not currently available in the vicinity of the Project site; however, the Metrowest Regional Transit Authority (MWRTA) does provide fixed-route bus services along Washington Street (Route 16) which also provides access to the Massachusetts Bay Transportation Authority (MBTA) commuter rail service via Framingham/Worcester Line.

Crash Data

Motor vehicle crash information for the study area intersection was provided by the MassDOT Highway Division Safety Management/Traffic Operations Unit for the most recent five-year period available (2013 through 2017, inclusive) in order to examine motor vehicle crash trends occurring within the study area. Based on a review of this data, 7 (seven) motor vehicle crashes were reported to have occurred at the intersection of Washington Street and Hopping Brook Road over the five-year review period. The study area intersection was found to have a motor vehicle crash rate below the MassDOT statewide and District 3 average crash rates for an unsignalized intersection in which the intersections are located. A review of the MassDOT statewide High Crash Location List indicated that the study area intersection is not included on MassDOT's Highway Safety Improvement Program (HSIP) listing as high crash locations.

The detailed MassDOT Crash Rate Worksheet is provided in the Appendix.

FUTURE CONDITIONS

Traffic volumes in the study area were projected to the year 2027, which reflects a seven-year planning horizon consistent with MassDOT's Guidelines. Independent of the Project, traffic volumes on the roadway network in the year 2027 under No-Build conditions include all existing traffic and new traffic resulting from background traffic growth. Anticipated Project-generated traffic volumes superimposed upon the 2027 No-Build traffic volumes reflect 2027 Build traffic-volume conditions with the Project.

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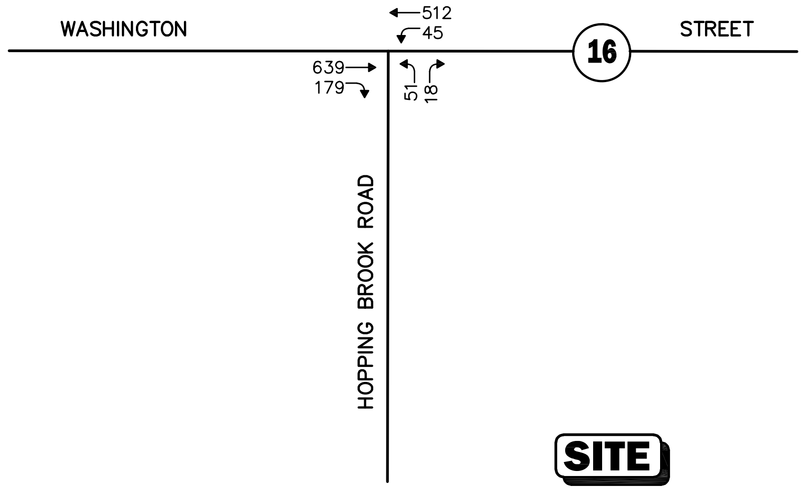
[2]MassDOT Traffic Volumes for the Commonwealth of Massachusetts; 2020.

WEEKDAY MORNING PEAK HOUR (7:30-8:30 AM)



WEEKDAY EVENING PEAK HOUR (4:30-5:30 PM)

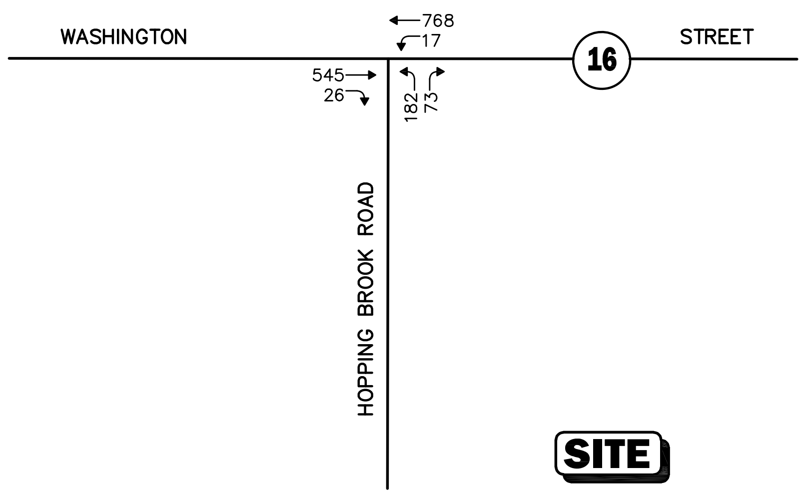


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Figure 2

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2020 Existing Peak Hour Traffic Volumes

Future Traffic Growth

Future traffic growth is a function of the expected land development in the immediate area and the surrounding region. Several methods can be used to estimate this growth. A procedure frequently employed estimates an annual percentage increase in traffic growth and applies that percentage to all traffic volumes under study. The drawback to such a procedure is that some turning volumes may actually grow at either a higher or a lower rate at particular intersections.

An alternative procedure identifies the location and type of planned development, estimates the traffic to be generated, and assigns it to the area roadway network. This procedure produces a more realistic estimate of growth for local traffic; however, potential population growth and development external to the study area would not be accounted for in the resulting traffic projections.

To provide a conservative analysis framework, both procedures were used, the salient components of which are described below.

Specific Development by Others

The Planning Department of the Town of Holliston was contacted in order to determine if there were any projects planned within the study area that would have an impact on future traffic volumes at the study intersections. Based on these discussions, the following projects were identified for inclusion in this assessment:

- ***Industrial Building, 56 Boynton Road, Holliston, Massachusetts.*** This project will entail the construction of a 25,200 sf of single-story industrial building to be located at 56 Boynton Road.

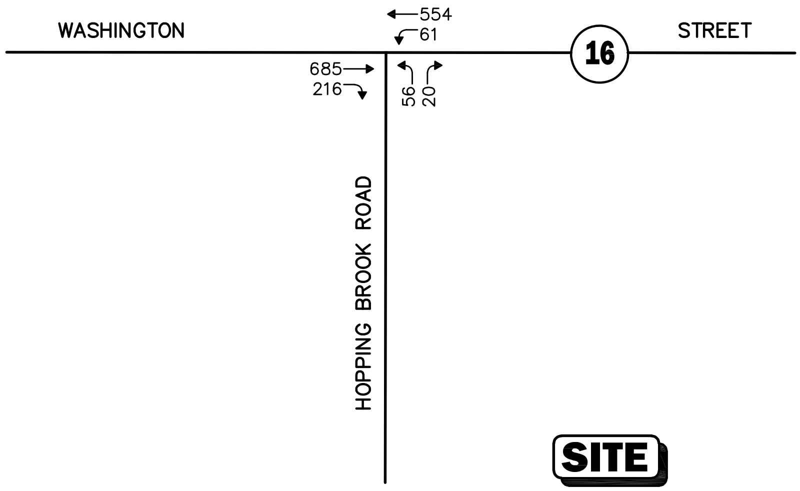
- ***PharmaCannis MA, 465 Hopping Brook Road, Holliston, Massachusetts.*** This project is currently under construction at 465 Hopping Brook Road and consists of 59,724 sf a single-story cannabis growth and processing center.

- ***Landscaping Company, 2016 Washington Street, Holliston, Massachusetts.*** This project will entail the construction of a 4,950 sf of landscaping company to be located at 2016 Washington Street. Traffic volumes associated with this project within the study area are expected to be relatively minor and would be reflected in the general background traffic growth rate (discussion follows).

Traffic volumes associated with the aforementioned specific development projects by others were obtained from trip-generation information available from the Institute of Transportation Engineers (ITE)[3] for the appropriate land use, and were assigned onto the study area roadway network based on existing traffic patterns where no other information was available. No other developments were identified at this time that are expected to result in an increase in traffic within the study area beyond the general background traffic growth rate.

[3] *Trip Generation,* Tenth Edition; Institute of Transportation Engineers; Washington, DC; 2017.

WEEKDAY MORNING PEAK HOUR (7:30-8:30 AM)



WEEKDAY EVENING PEAK HOUR (4:30-5:30 PM)

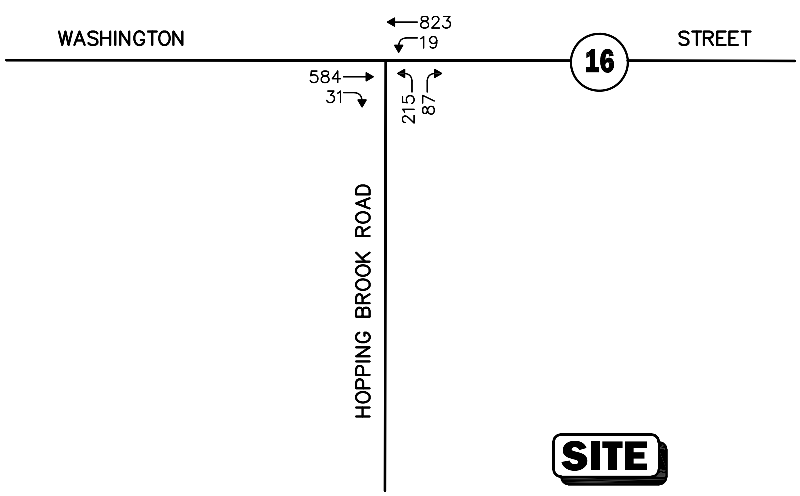


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Figure 3

2027 No-Build
Peak Hour Traffic Volumes

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General Background Traffic Growth

Traffic-volume data compiled by MassDOT in Holliston and Medfield were reviewed. Based on a review of this data, it was determined that traffic volumes within the study area have increased by an average of 0.81 percent per year over the past several years. In order to provide a conservative (high) analysis scenario and a prudent planning condition for the Project, a slightly higher (1.0 percent per year) compounded annual background traffic growth rate was used in order to account for future traffic growth and presently unforeseen development within the study area.

Roadway Improvement Projects

MassDOT and the Town of Holliston were consulted in order to determine if there were any planned future roadway improvement projects expected to be complete by 2027. Based on these discussions, no roadway improvement projects aside from routine maintenance activities were identified to be planned within the study area at this time.

No-Build Traffic Volumes

The 2027 No-Build condition peak-hour traffic volumes were developed by applying the 1.0 percent per year compounded annual background traffic growth rate to the 2020 Existing peak-hour traffic volumes and then adding the peak-hour traffic volumes associated with the identified specific development projects by others. The resulting 2027 No-Build weekday morning and evening peak-hour traffic volumes are shown on Figure 3.

PROJECT-GENERATED TRAFFIC

Design year (2027 Build and 2027 Ultimate-Build) traffic volumes for the study area roadways were determined by estimating Project-generated traffic volumes and the ultimate buildout of the remaining warehouse space and assigning those volumes on the study roadways. The following sections describe the methodology used to develop the anticipated traffic characteristics of the Project.

As proposed, the Project will entail the construction of an 800,000-sf warehouse building. In order to develop the traffic characteristics of the Project, trip-generation statistics published by the ITE for similar land uses as that proposed were used. ITE Land Use Code (LUC) 150, Warehousing, was used to develop the traffic characteristics of the Project.

The warehouse land use code was chosen as the most appropriate land use to project trips. This is based on information provided by the client that potential tenants for the site are proposing a building consistent with a standard warehouse use and not other warehouse uses such as High-Cube Transload, High-Cube Fulfillment Center (Sort and Non-Sort), and High-Cube Parcel Hub. Some of these are directly related to freight delivery facilities while others would require a high degree of automation not anticipated to be constructed with the Project. For these reasons, LUC 150 was chosen to estimate trips for the Project.

In order to account for truck trips generated by the Project, the base trip-generation calculations were converted to car trips and truck trips using truck percentage statistics provided for warehouse uses from the ITE Trip Generation Manual Supplement[4]. The vehicle trips for Project, with appropriate adjustments for truck and passenger vehicle trips, are summarized in Table 1.

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[4] Tenth Edition Trip Generation Manual Supplement; ITE; Washington, D.C.; 2020.

Table 1
PROJECT TRIP-GENERATION SUMMARY

Time Period/Direction	Vehicle Trips[a]	Trucks[b]	Cars
Weekday Daily	1,310	362	948
Weekday Morning Peak Hour:			
Entering	105	14	91
Exiting	31	4	27
Total	136	18	118
Weekday Evening Peak Hour:			
Entering	41	6	35
Exiting	111	17	94
Total	152	23	129

[a]Based on ITE LUC 150, *Warehousing* (800,000 sf).
[b]Percentage of truck trips: Weekday- 27 percent; weekday morning 13 percent; weekday evening 15 percent.

As can be seen in Table 1, the Project is expected to generate approximately 1,310 vehicle trips on an average weekday (two-way volume over the operational day of the Project or 655 vehicles entering and 655 exiting), with 136 vehicle trips (105 vehicles entering and 31 exiting) expected during the weekday morning peak hour and 152 vehicle trips (41 vehicles entering and 111 exiting) expected during the weekday evening peak hour. Furthermore, the Project is expected to generate approximately 362 truck trips on an average weekday, with 18 truck trips (14 trucks entering and 4 exiting) expected during the weekday morning peak hour and 23 truck trips (6 trucks entering and 17 exiting) expected during the weekday evening peak hour.

Remaining Buildout of Hopping Brook Business Park

While the previous MEPA approvals for the site permit the development of up to 3,000,000 sf of office/R&D space, it is unlikely that this level will be reached. Further, in response to changing market demands, additional development at the Park is expected to be of warehousing nature and not the office/R&D nature previously permitted. Therefore, the Ultimate-Build program includes only 700,000 sf of warehouse space intended to represent the remaining development of the Park. This results in a total buildout of 2,200,000 sf of mixed office/R&D/industrial/warehouse space. Therefore, vehicle trips associated with the remaining buildout of the Park were developed using ITE LUC 150, *Warehousing*. These trips are shown below in Table 2, with an estimated development size of 700,000 sf.

Table 2
TRIP-GENERATION SUMMARY

Time Period/Direction	Entering	Exiting	Total
Weekday Daily	576	576	1,152
Weekday Morning Peak Hour:	92	27	119
Weekday Evening Peak Hour:	36	97	133

[a]Based on ITE LUC 150, *Warehousing* (700,000 sf).

Following the development of the 800,000 sf warehouse, the full buildout of the remaining 700,000 sf of warehouse is expected to generate approximately 1,152 vehicle trips on an average weekday (two-way volume over the operational day of the Project or 576 vehicles entering and 576 exiting), with 119 vehicle trips (92 vehicles entering and 27 exiting) expected during the weekday morning peak hour and 133 vehicle trips (36 vehicles entering and 97 exiting) expected during the weekday evening peak hour. The same adjustments for truck trips that were applied to the Build conditions were also applied to the Ultimate Buildout conditions.

Based on the latest revisions to the Hopping Brook Business Park development program and the current and programmed development at the Park, the Park is expected to generate fewer vehicle trips than previously calculated in documents to MEPA. This is shown in Table 3, which identifies existing trips, programmed trips for developments under construction, the Project consisting of 800,000 sf, and the remaining buildout of 700,000 sf of warehouse.

Table 3
TRIP-GENERATION SUMMARY

Time Period/Direction	Existing Park[a]	Under Construction[b]	Proposed Project[c]	Ultimate Buildout[d]	Full Build Out	For Comparison – Initial MEPA Trip Estimates
Weekday Daily	3,034	422	1,310	1,152	5,918	17,904 (36,900)[e]
Weekday Morning Peak Hour:						
Entering	246	53	105	92	496	2,389
Exiting	50	7	31	27	115	442
Total	296	60	136	119	611	2,831
Weekday Evening Peak Hour:						
Entering	38	7	41	36	122	572
Exiting	222	47	111	97	477	2,288
Total	260	54	152	133	599	2,860

[a]Based on traffic counts of Hopping Brook Road conducted in 2019 and 720,288 sf of development.
[b]Includes PharmaCann cultivation facility and industrial building expansion; trips based on ITE LUC 110, Light Industrial and 84,924 sf.
[c]Based on ITE LUC 150, *Warehousing* (800,000 sf).
[d]Based on ITE LUC 150, *Warehousing* (700,000 sf).
[e]Vehicle trip total of the Project as reported in the April 3rd, 1982 ENF for Project (Page 3).

In comparison with the expected trip generation totals from the initial MEPA documents, the buildout of the Hopping Brook Business Park is expected to result in a total Park vehicle trip generation that is approximately 67 percent (84 percent in comparison with average daily trip of 36,900 vehicles), 78 percent, and 79 percent lower on an average weekday, weekday morning peak hour, and weekday evening peak hour, respectively.

TRIP DISTRIBUTION AND ASP8SIGNMENT

The directional distribution of generated trips to and from the Project site was determined based on a review of existing traffic patterns within the study area and the location of connections to the Interstate Highway System (IHS). The general trip distribution for the Project is graphically depicted on Figure 4, with separate distribution figures for the cars and trucks expected to travel to and from the site. The additional traffic expected to be generated by the Project and the ultimate buildout of the remaining 700,000-sf warehouse was assigned on the study area roadway network as shown on Figure 5-A and 5-B, respectively. The car and truck trips are shown separately on these figures, based on the truck restrictions agreed to by the Applicant, described in a later section of this report.

FUTURE TRAFFIC VOLUMES - BUILD AND ULTIMATE-BUILD CONDITIONS

The 2027 Build condition traffic volumes consist of the 2027 No-Build traffic volumes with the additional traffic expected to be generated by the Project added to them. The 2027 Build weekday morning and evening peak-hour traffic volumes are graphically depicted on Figure 6-A. The 2027 Ultimate-Build condition traffic volumes consist of the 2027 Build traffic volumes with the additional traffic expected to be generated by the ultimate buildout of 700,000-sf warehouse to them and are depicted on Figure 6-B.

A summary of peak-hour projected traffic-volume increases outside of the study area that is the subject of this assessment is shown in Table 4. These volumes are based on the expected increases from the Project.

Table 4
PEAK-HOUR TRAFFIC-VOLUME INCREASES

Location/Peak Hour	2020 Existing	2027 No-Build	2027 Build	Traffic Volume Increase Over No-Build	Percent Increase Over No-Build
Washington Street, east of Hopping Brook Road:					
Weekday Morning	1,214	1,320	1,355	35	2.6
Weekday Evening	1,403	1,513	1,551	38	2.5
Washington Street, west of Hopping Brook Road:					
Weekday Morning	1,381	1,511	1,612	101	6.7
Weekday Evening	1,521	1,653	1,767	114	6.9

As shown in Table 4, Project-related traffic-volume increases outside of the study area relative to 2027 No-Build conditions are anticipated to range from 2.5 to 6.9 percent during the peak periods, with vehicle

Legend:

XX	Cars
(XX)	Trucks

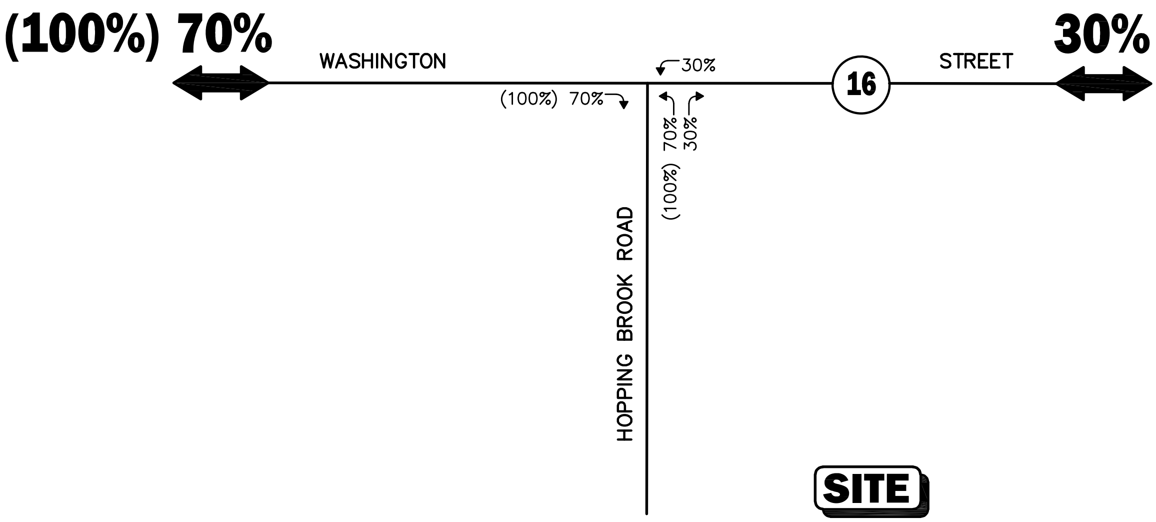

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Figure 4

Trip Distribution Map

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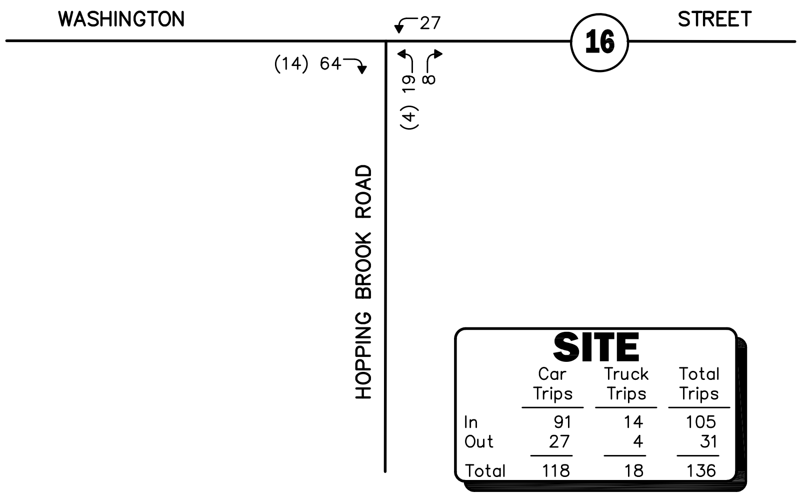
WEEKDAY MORNING PEAK HOUR

Legend:

XX	Car Trips
(XX)	Truck Trips



WEEKDAY EVENING PEAK HOUR

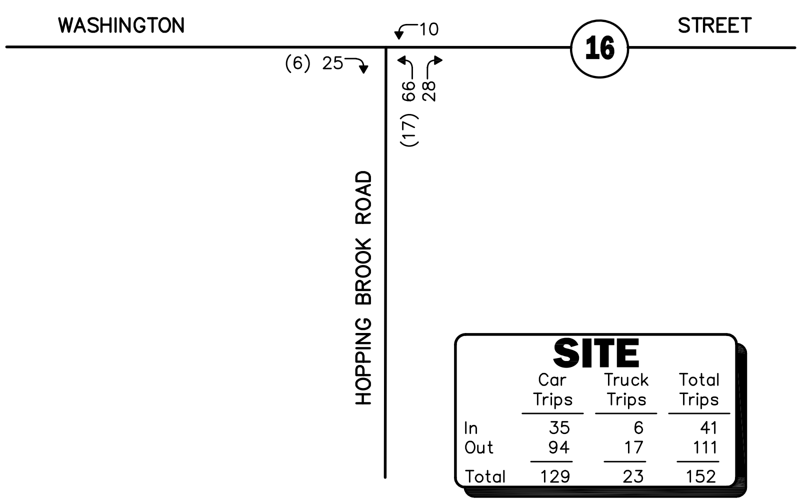


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Figure 5-A

Project-Generated Peak Hour Traffic Volumes

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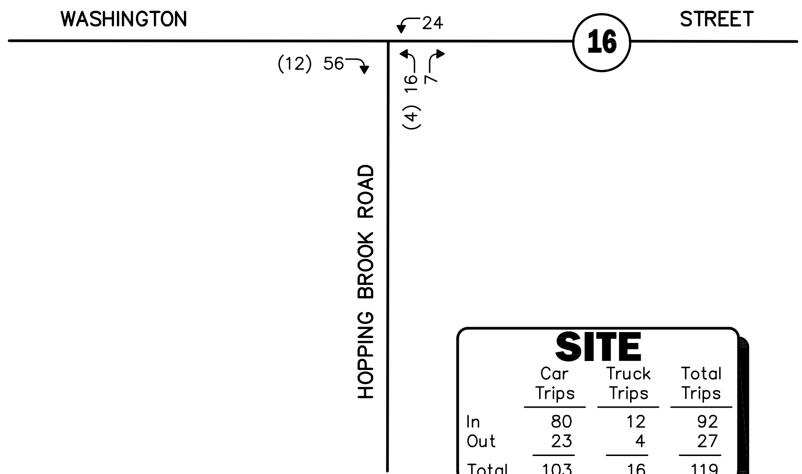
WEEKDAY MORNING PEAK HOUR

Legend:

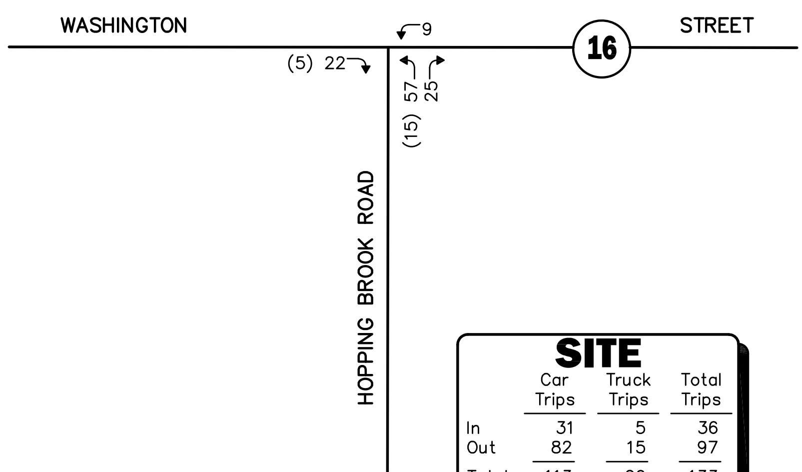
XX	Car Trips
(XX)	Truck Trips



SITE

	Car Trips	Truck Trips	Total Trips
In	80	12	92
Out	23	4	27
Total	103	16	119

WEEKDAY EVENING PEAK HOUR



SITE

	Car Trips	Truck Trips	Total Trips
In	31	5	36
Out	82	15	97
Total	113	20	133

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Figure 5-B

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Warehouse
Peak Hour Traffic Volumes

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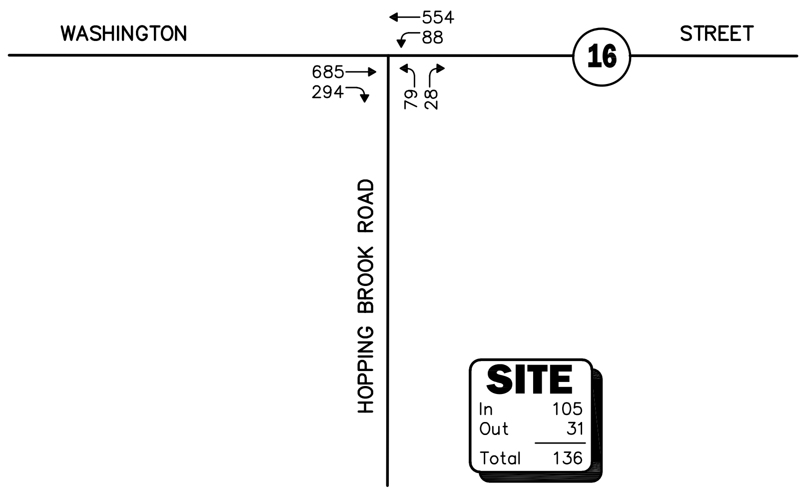
WEEKDAY MORNING PEAK HOUR (7:30-8:30 AM)



WEEKDAY EVENING PEAK HOUR (4:30-5:30 PM)

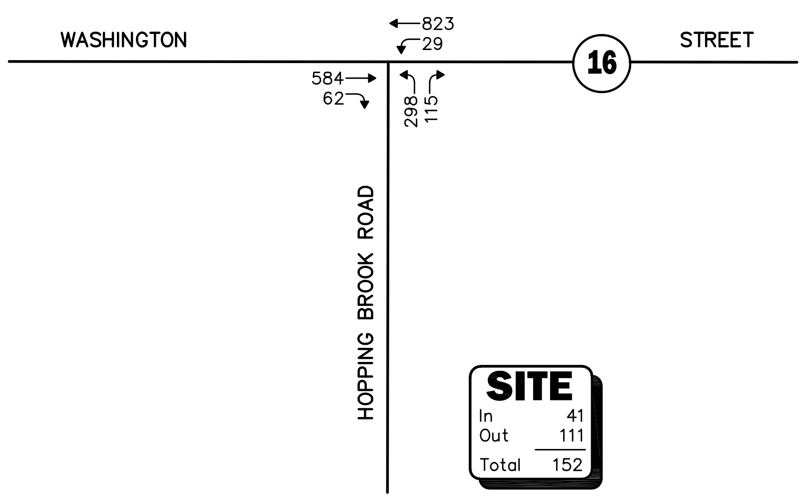


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Figure 6-A

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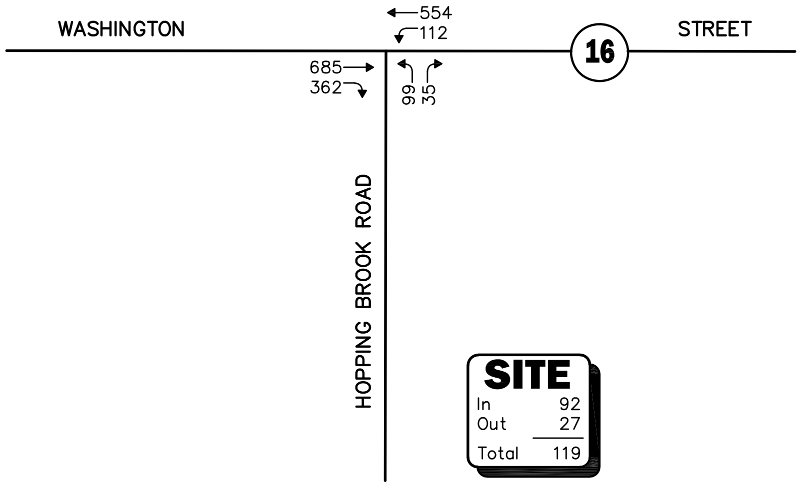
2027 Build
Peak Hour Traffic Volumes

WEEKDAY MORNING PEAK HOUR (7:30-8:30 AM)



WEEKDAY EVENING PEAK HOUR (4:30-5:30 PM)

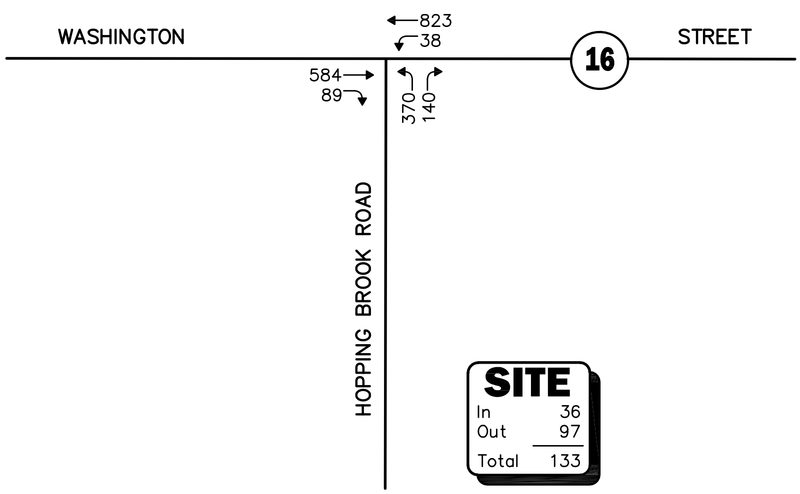


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Figure 6-B

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2027 Ultimate-Build Peak Hour Traffic Volumes

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increases shown to range from 35 to 114 vehicles. ***Outside of the Washington Street corridor, level of impact would not be readily apparent on the roadway network over existing conditions.***

TRAFFIC OPERATIONS ANALYSIS

Measuring existing and future traffic volumes quantifies traffic flow within the study area. To assess quality of flow, roadway capacity and vehicle queue analyses were conducted under Existing, No-Build, and Build traffic-volume conditions. Capacity analyses provide an indication of how well the roadway facilities serve the traffic demands placed upon them, with vehicle queue analyses providing a secondary measure of the operational characteristics of an intersection or section of roadway under study. A primary result of capacity analyses is the assignment of level of service to traffic facilities under various traffic-flow conditions.[5] The concept of level of service is defined as a qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers. A level-of-service definition provides an index to quality of traffic flow in terms of such factors as speed, travel time, freedom to maneuver, traffic interruptions, comfort, convenience, and safety.

Signalized Intersections

The six levels of service for signalized intersections may be described as follows:

- *LOS A* describes operations with very low control delay; most vehicles do not stop at all.

- *LOS B* describes operations with relatively low control delay. However, more vehicles stop than LOS A.

- *LOS C* describes operations with higher control delays. Individual cycle failures may begin to appear. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.

- *LOS D* describes operations with control delay in the range where the influence of congestion becomes more noticeable. Many vehicles stop, and individual cycle failures are noticeable.

- *LOS E* describes operations with high control delay values. Individual cycle failures is frequent occurrences.

- *LOS F* describes operations with high control delay values that often occur with over-saturation. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

Levels of service for signalized intersections were calculated using the Percentile Delay Method implemented as a part of the Synchro™ 10 software as required by MassDOT. The Percentile Delay Method assesses the effects of signal type, timing, phasing, and progression; vehicle mix; and geometrics on "percentile" delay. Level-of-service designations are based on the criterion of percentile delay per vehicle and is a measure of: i) driver discomfort; ii) motorist frustration; and iii) fuel consumption; and includes a uniform delay based on percentile volumes using a Poisson arrival pattern, an initial queue move-up time, and a queue interaction delay that accounts for delays resulting from queues extending from adjacent intersections. Table 5 summarizes the relationship between level-of-service and percentile

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[5]The capacity analysis methodology is based on the concepts and procedures presented in the *Highway Capacity Manual;* Transportation Research Board; Washington, DC; 2010.

delay and uses the same numerical delay thresholds as the 2010 *Highway Capacity Manual* (HCM) 6 method. The tabulated percentile delay criterion may be applied in assigning level-of-service designations to individual lane groups, to individual intersection approaches, or to entire intersections.

Table 5
LEVEL-OF-SERVICE CRITERIA
FOR SIGNALIZED INTERSECTIONS

Level of Service	Percentile Delay Per Vehicle (Seconds)
A	<10.0
B	10.1 to 20.0
C	20.1 to 35.0
D	35.1 to 55.0
E	55.1 to 80.0
F	>80.0

Unsignalized Intersections

The six levels of service for unsignalized intersections may be described as follows:

- *LOS A* represents a condition with little or no control delay to minor street traffic.
- *LOS B* represents a condition with short control delays to minor street traffic.
- *LOS C* represents a condition with average control delays to minor street traffic.
- *LOS D* represents a condition with long control delays to minor street traffic.
- *LOS E* represents operating conditions at or near capacity level, with very long control delays to minor street traffic.
- *LOS F* represents a condition where minor street demand volume exceeds capacity of an approach Road, with extreme control delays resulting.

The levels of service of unsignalized intersections are determined by application of a procedure described in the HCM. Level of service is measured in terms of average control delay. Mathematically, control delay is a function of the capacity and degree of saturation of the lane group and/or approach under study and is a quantification of motorist delay associated with traffic control devices such as traffic signals and STOP signs. Control delay includes the effects of initial deceleration delay approaching a STOP sign, stopped delay, queue move-up time, and final acceleration delay from a stopped condition. Definitions for level of service at unsignalized intersections are also given in the HCM. Table 6 summarizes the relationship between level of service and average control delay for two-way stop controlled and all-way stop controlled intersections.

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[6] *Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2010.

Table 6
LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS[a]

Level-of-Service by Volume-to-Capacity Ratio		Average Control Delay (Seconds Per Vehicle)
$v/c \leq 1.0$	$v/c > 1.0$	
A	F	≤10.0
B	F	10.1 to 15.0
C	F	15.1 to 25.0
D	F	25.1 to 35.0
E	F	35.1 to 50.0
F	F	>50.0

[a]Source: *Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2010; page 19-2.

Vehicle Queue Analysis

Vehicle queue analyses are a direct measurement of an intersection's ability to process vehicles under various traffic control and volume scenarios and lane use arrangements. The vehicle queue analysis was performed using the Synchro® intersection capacity analysis software which is based upon the methodology and procedures presented in the 2010 *Highway Capacity Manual*. The Synchro® vehicle queue analysis methodology is a simulation-based model which reports the number of vehicles that experience a delay of six seconds or more at an intersection. For signalized intersections, Synchro® reports both the average (50^{th} percentile) the 95^{th} percentile vehicle queue. The 95^{th} percentile vehicle queue is the vehicle queue length that will be exceeded only 5 percent of the time, or approximately three minutes out of sixty minutes during the peak one hour of the day (during the remaining fifty-seven minutes, the vehicle queue length will be less than the 95^{th} percentile queue length).

ANALYSIS RESULTS

Level-of-service and vehicle queue analyses were conducted for 2020 Existing, 2027 No-Build, 2027 Build, and 2027 Ultimate-Build conditions for the study area intersection. The results of the intersection capacity and vehicle queue analyses are summarized in Table 7. The detailed analysis results are presented in the Appendix.

Washington Street at Hopping Brook Road (Unsignalized)

Under 2020 Existing, left-turn movements exiting Hopping Brook Road were shown to operate at LOS F during both peak periods. Under 2027 No-Build, left-turn movements exiting Hopping Brook Road were shown to continue to operate at LOS F during morning and evening peak hours, and right-turn movements to degrade from LOS B to LOS C during weekday morning peak hour. Under 2027 Build, left-turn and right-turn movements were predicted to operate at LOS F and LOS C during peak periods with vehicle queues at the intersection were shown to increase by up to seven (7) vehicles with the addition of Project-related traffic. Under 2027 Ultimate-Build, no changes in LOS were shown to occur over 2027 Build conditions: however, vehicle queuing increases by up to 10 vehicles.

Table 7
UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

	2020 Existing				2027 No-Build				2027 Build				2027 Ultimate Build			
Unsignalized Intersection/Peak Hour/Movement	Demand[a]	Delay[b]	LOS[c]	Queue[d] 95th	Demand	Delay	LOS	Queue 95th	Demand	Delay	LOS	Queue 95th	Demand	Delay	LOS	Queue 95th
Washington Street at Hopping Brook Road																
Weekday Morning:																
Washington Street EB TH/RT	818	0.0	A	0	901	0.0	A	0	979	0.0	A	0	1,047	0.0	A	0
Washington Street WB LT/TH	557	0.8	A	0	615	1.0	A	0	642	1.6	A	1	666	2.0	A	1
Hopping Brook Road NB LT	51	>50.0	F	4	56	>50.0	F	6	79	>50.0	F	7	99	>50.0	F	9
Hopping Brook Road NB RT	18	14.8	B	0	20	15.9	C	0	28	16.6	C	0	35	17.5	C	0
Weekday Evening:																
Washington Street EB TH/RT	571	0.0	A	0	615	0.0	A	0	646	0.0	A	0	673	0.0	A	0
Washington Street WB LT/TH	785	0.2	A	0	842	0.2	A	0	852	0.3	A	0	861	0.4	A	0
Hopping Brook Road NB LT	182	>50.0	F	17	215	>50.0	F	24	298	>50.0	F	31	370	>50.0	F	41
Hopping Brook Road NB RT	73	13.7	B	1	87	14.8	B	1	115	15.4	C	1	140	16.8	C	1

[a]Demand in vehicles per hour.
[b]Average control delay per vehicle (in seconds).
[c]Level-of-Service.
[d]Queue length in vehicles.
NB = northbound; SB = southbound; EB = eastbound; WB = westbound; LT = left-turning movements; TH = through movements; RT = right-turning movements.

SIGNAL WARRANT ANALYSIS RESULTS

The MUTCD establishes nine warrants or criteria to evaluate a location for the installation (or retention) of a traffic signal; however, satisfaction of a warrant in and of itself does not necessarily indicate that the installation of a traffic signal is the best traffic control solution. An engineering evaluation of the location in question should indicate that the establishment of traffic signal control will improve the overall safety and/or operation of the intersection. As such, nine warrants used to evaluate an intersection for traffic signal control as presented in the MUTCD. Each of the nine traffic signal warrants were evaluated for the subject intersection under following conditions:

- ***Design Speed:*** >40 mph
- ***Traffic Volumes:*** 2020 Existing, 2027 Build, and 2027 Ultimate Build
- ***Geometry:***

  - **Washington Street Eastbound:** one shared through/right-turn travel lane
  - **Washington Street Westbound:** one left-turn lane and one through travel lane
  - **Hopping Brook Road:** one left-turn lane, one right-turn lane

Table 8 summarizes the results of the signal warrant analysis for the subject intersection using Highway Capacity Software (HCS7), with the detailed HCS7 worksheets attached.

Table 8
TRAFFIC SIGNAL WARRANTS ANALYSIS

		2020 Existing	2027 Build	2027 Ultimate Build
Warrant No.	Description	Satisfied?	Satisfied?	Satisfied?
1	Eight-Hour Vehicular Volume	No	No	No
2	Four-Hour Vehicular Volume	No	No	Yes
3	Peak Hour	Yes	Yes	Yes
4	Pedestrian Volume	No	No	No
5	School Crossing	No	No	No
6	Coordinated Signal System	No	No	No
7	Crash Experience	No	No	No
8	Roadway Network	No	No	No
9	Intersection Near a Grade Crossing	No	No	No

As can be seen in Table 8, the Hopping Brook Road intersection with Washington Street was found to satisfy Warrant 3 under 2020 Existing and 2027 Build traffic volume conditions, with Warrant 2 and Warrant 3 satisfied under 2027 Ultimate-Build traffic volume conditions. As such, it is recommended that a traffic control signal be installed at the intersection and that Washington Street approaching the intersection be widened to provide a left-turn lane in the westbound direction. The recommended improvements are shown on Figure 7 and will be completed in conjunction with the Project subject to receipt of all necessary rights, permits and approvals.

NOTES: 1. THIS PLAN IS FOR REVIEW PURPOSES ONLY AND IS NOT INTENDED FOR CONSTRUCTION.

FIGURE 7

CONCEPTUAL IMPROVEMENT PLAN HOPPING BROOK ROAD AT WASHINGTON STREET (ROUTE 16)

PROJECT:
PROPOSED WAREHOUSE
HOLLISTON, MASSACHUSETTS

PROPONENT:
ENVIRONMENTAL DESIGN CONSULTANTS, INC.
SOUTHBOROUGH, MASSACHUSETTS

NO.	REVISIONS	DATE

Vanasse & Associates inc
Transportation Engineers & Planners

DESIGNED BY:	TWO	DATE:	10/21/20
DRAWN BY:	TWO	SCALE:	1" = 40'
CHECKED BY:	SMB	SHEET	1 OF 1

PROJECT ACCESS

Access to the Project site will be provided via a new driveway that intersects the terminus of the Hopping Brook Road. The following recommendations are offered with respect to the design and operation of the Project site access and internal circulation:

- A review of the warrants specified in the Manual on Uniform Traffic Control Devices (MUTCD)[7] for the installation of a traffic control signal indicates that **the installation of a traffic control signal at the Hopping Brook Road intersection with Washington Street is warranted under 2020 Existing and 2027 Build conditions**. As such, it is recommended that a traffic control signal be installed at the intersection that would serve the Project and properties located along Hopping Brook Road, with the following intersection geometry:
  - ***Washington Street Eastbound:*** one shared through/right-turn travel lane
  - ***Washington Street Westbound:*** one left-turn lane and one through travel lane
  - ***Hopping Brook Road:*** one left-turn lane and one right-turn lane

With the installation of a traffic control signal at the intersection and the associated geometric improvements, all movements at the signalized intersection are predicted to operate at LOS D or better during the peak hours, as shown in Table 9. ***It is noteworthy that the vehicle queuing on Hopping Brook Road approach will be maintained along this roadway without impeding the movement of vehicles or bicyclists along Washington Street.***

Table 9
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

Signalized Intersection/ Critical Movement/Peak Hour	2027 Build V/C[a]	Delay	LOS	Queue Ave/95th	2027 Ultimate-Build V/C	Delay	LOS	Queue Ave/95th
Washington Street at Hopping Brook Road								
Weekday Morning:								
Washington Street EB TH/RT	0.87	20.0	B	13/21	0.90	23.0	C	16/29
Washington Street WB LT	0.36	6.7	A	1/1	0.49	13.0	B	1/2
Washington Street WB TH	0.45	5.0	A	3/5	0.44	4.9	A	3/5
Hopping Brook Road NB LT	0.42	38.8	D	2/3	0.54	45.0	D	2/5
Hopping Brook Road NB RT	0.13	14.2	B	0/1	0.17	13.5	B	0/1
Overall	--	**15.3**	**B**	--	--	**18.0**	**B**	--
Weekday Evening:								
Washington Street EB TH/RT	0.72	18.6	B	7/17	0.79	23.6	C	12/18
Washington Street WB LT	0.13	8.2	A	0/1	0.21	9.9	A	1/1
Washington Street WB TH	0.86	23.4	C	11/23	0.87	25.4	C	14/23
Hopping Brook Road NB LT	0.70	31.2	C	5/9	0.82	39.9	D	7/13
Hopping Brook Road NB RT	0.24	5.7	A	0/1	0.27	5.5	A	0/2
Overall	--	**21.7**	**C**	--	--	**25.8**	**C**	--

[a]Volume-to-capacity ratio.
[b]Delay in seconds per vehicle.
[c]Level of service.
[d]Queue length, in vehicle.
NB = northbound; SB = southbound; EB = eastbound; WB = westbound; LT = left-turning movements; TH = through movements; RT = right-turning movements.

[7]*Manual on Uniform Traffic Control Devices (MUTCD)*; Federal Highway Administration; Washington, D.C.; 2009.

CONCLUSIONS AND RECOMMENDATIONS

VAI has conducted a TIA in order to assess the potential impacts on the transportation infrastructure associated with the proposed construction of 1,500,000 sf warehouse space that will be comprised as the proposed 800,000 sf warehouse building to be located at 555 Hopping Brook Road in Holliston, Massachusetts and the remaining 700,000 sf build-out of warehouse space to be developed in the future. Based on this assessment, we have concluded the following with respect to the Project:

1. Using trip-generation statistics published by ITE, the Project is expected to generate approximately 1,310 vehicle trips on an average weekday (two-way volume over the operational day of the Project, or 655 vehicles entering and 655 exiting), with 136 vehicle trips (105 vehicles entering and 31 exiting) expected during the weekday morning peak hour and 152 vehicle trips (41 vehicles entering and 111 exiting) expected during the weekday evening peak hour.

2. The addition of 700,000 sf warehouse representing build-out of the remaining portion of the Hopping Brook Business Park is expected to generate an additional 1,152 vehicle trips on an average weekday (two-way volume over the operational day of the Project, or 576 vehicles entering and 576 exiting), with 119 vehicle trips (92 vehicles entering and 27 exiting) expected during the weekday morning peak hour and 133 vehicle trips (36 vehicles entering and 97 exiting) expected during the weekday evening peak hour.

3. Due to the expected revisions in development at the Hopping Brook Business Park, the Park is expected to generate approximately 67 percent (84 percent in comparison with average daily trip of 36,900 vehicles), 78 percent, and 79 percent fewer trips during the respective average weekday, weekday morning peak hour, and weekday evening peak hour time periods than was anticipated in earlier MEPA filings for the development.

4. The installation of a traffic control signal at the Hopping Brook Road intersection with Washington Street and the accompanying construction of a left-turn lane on the Washington Street westbound approach is recommended to accommodate the Project traffic increase at the intersection. With this improvement in place, all movements at the intersection were shown to operate at LOS D or better during the peak hours.

In consideration of the above, we have concluded that the Project can be accommodated within the confines of the existing transportation infrastructure in a safe and efficient manner with implementation of the recommendations that follow.

Recommendations

A detailed transportation improvement program has been developed that is designed to maintain safe and efficient access to the Project site and address any deficiencies identified at off-site locations evaluated in conjunction with this study. The improvements that have been recommended as a part of this evaluation, where applicable, will be completed in conjunction with the Project subject to receipt of all necessary rights, permits, and approvals.

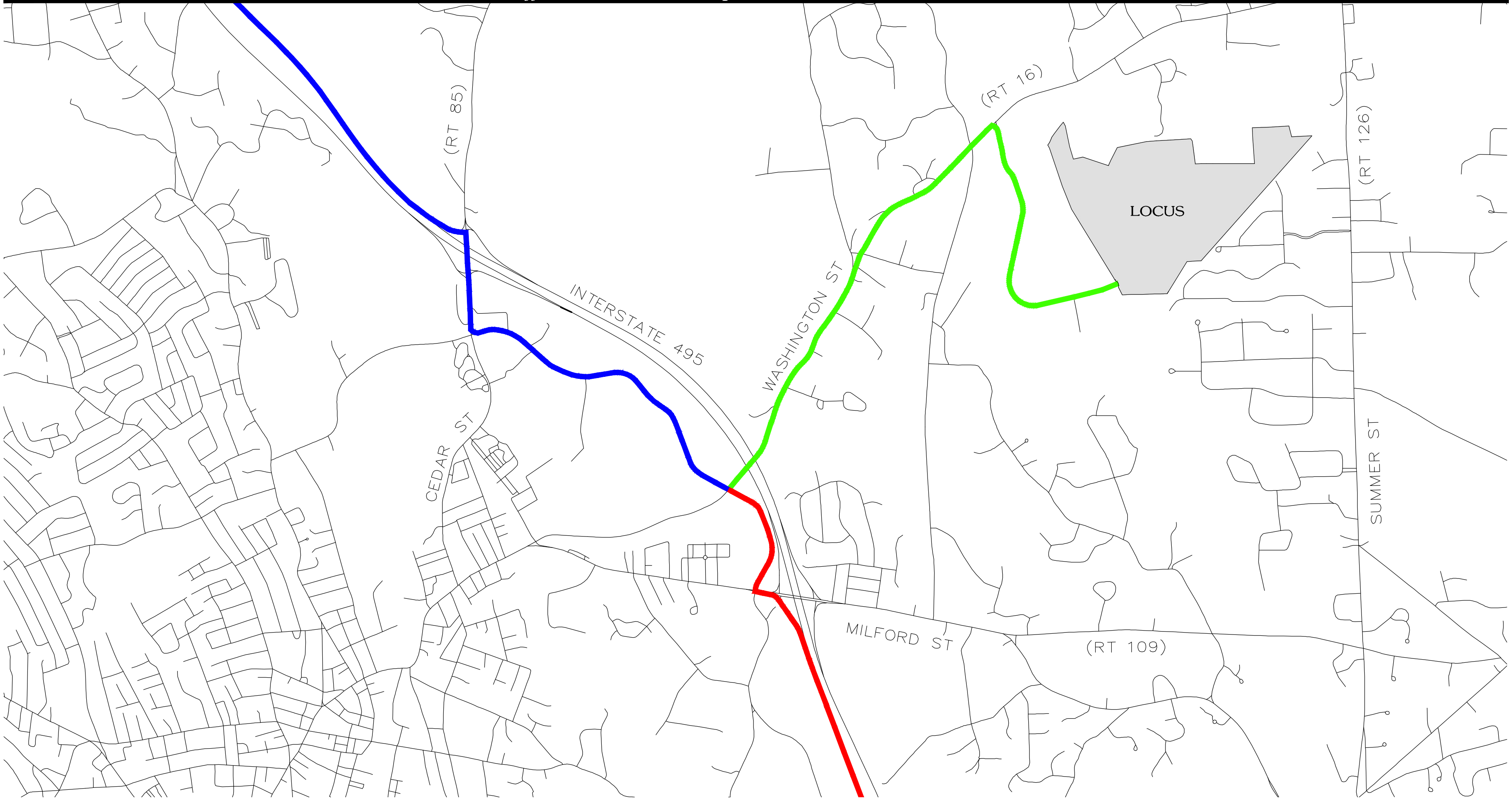
All signs and pavement markings to be installed within the Project shall conform to the applicable standards of the MUTCD.

Transportation Demand Management

Regularly scheduled public transportation services are not currently available in the vicinity of the Project site; however, the MWRTA does provide fixed-route bus services along Washington Street (Route 6) which also provides access to MBTA via Framingham/Worcester city line. In an effort to encourage the use of alternative modes of transportation to single-occupant vehicles, the following Transportation Demand Management (TDM) measures will be implemented as a part of the Project:

- A transportation coordinator will be assigned for the Project to coordinate the TDM program;
- Information regarding commuting options will be posted in a central location and/or otherwise made available to employees of the project;
- The transportation coordinator will facilitate a rideshare matching program for employees to encourage carpooling;
- A "welcome packet" will be provided to employees detailing available commuter options and will include the contact information for the transportation coordinator and information to enroll in the employee rideshare program;
- Specific amenities will be provided to discourage off-site trips, including providing a breakroom equipped with a microwave and refrigerator; offering direct deposit of paychecks; coordinating with a dry-cleaning service for on-site pick-up and delivery; allowing telecommuting or flexible work schedules; and other such measures to reduce overall traffic volumes and travel during peak traffic-volume periods;
- Pedestrian accommodations will be incorporated within the Project site; and
- The Applicant has committed to not rely on South Street for truck travel for either the 800,000-sf warehouse project or the remaining 700,000-sf development. This is unusual as the developer is not required under federal or state law to restrict where its traffic comes from nor can any town and no other user in the Hopping Brook Business Park has agreed to this and should the applicant be preplaced by another applicant this gracious commitment would go away by current applicant. The truck trip distribution map is detailed and depicted in Figure 8.

With implementation of the aforementioned recommendations, safe and efficient access will be provided to the Project site and the Project can be accommodated within the confines of the existing and improved transportation system.



NOTES

1. TRUCK TRAFFIC ASSOCIATED WITH THE LOCUS SITE IS REQUIRED TO FOLLOW THE ROUTES SHOWN HEREON AS DEFINED BY THE CERTIFICATE OF ACTION ISSUED BY THE TOWN OF HOLLISTON PLANNING BOARD DATED MARCH 11, 2020.

PLAN VIEW SCALE
1 inch = 3,000 ft.

LINE LEGEND

- ROUTE OF NORTH BOUND TRUCK TRAFFIC
- ROUTE OF SOUTH BOUND TRUCK TRAFFIC
- ROUTE SHARED BY NORTH & SOUTH BOUND TRUCK TRAFFIC

Source: Engineering Design Consultants, Inc.

N

Not To Scale

Figure 8

Truck Traffic Routing Exhibit For Access To Interstate 495

Vanasse & Associates inc

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