346 Somerville Avenue

Somerville, Massachusetts

Traffic Impact and Access Study

Prepared For:

346 Somerville LLC

Prepared by:

Design Consultants, Inc.

May 2019

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A. EXECUTIVE SUMMARY

A1. Introduction

Design Consultants, Inc. (DCI) has prepared this Traffic Impact and Access Study (TIAS) to analyze the potential impact that the proposed mixed-use development at 346 Somerville Avenue ("Project") will have on surrounding traffic operations in Somerville. Currently, the site is occupied by a commercial building and two separate parking areas. The site will be redeveloped to be a mixed-use building containing approximately 94 residential dwelling units and approximately 2,490 square feet of retail space. In addition, there will be a public park area on-site that will occupy approximately 7,490 square feet space. As part of the new development, a bike room containing space for 104 bicycles will be provided on the basement floor level. There is no on-site vehicle parking proposed for the development.

A2. Study Area

The following intersections, determined by DCI in conjunction with the City of Somerville, were examined. Figure A2.1 shows the study intersections and Figure A2.2 shows the study intersections relative to the larger transportation network:

- Somerville Avenue at Hawkins Street
- Somerville Avenue at Church Street
- Hawkins Street at Lake Street

A3. Safety Analysis

A safety analysis was carried out at each of the study intersections based on crash data from the Massachusetts Department of Transportation (MassDOT) from 2012 to 2016, the most recent five (5) years of data available. This analysis identifies possible existing safety issues that may need to be addressed as part of this Project.

The data was analyzed to determine trends in location, manner of collision, and other factors in order to point out high crash locations and analyze possible contributing factors. Of the three (3) intersections analyzed as part of this study, all of the intersections have crash rates that are below both the District 4 and Statewide averages. Additionally, there were no reported fatal crashes and 75% of crashes occurred outside of the peak periods (7am to 9am and 4pm to 6pm). Detailed safety analyses and crash data is contained in Section B4 of this report.

A4. Trip Generation

The proposed development is expected to generate approximately 18 vehicle-trips during the Weekday AM peak hour, 21 vehicle-trips during the Weekday PM peak, and 252 vehicle-trips during a typical weekday. This estimate of generated vehicle-trips provides a conservative analysis as it does not take credit for any existing trips. Further discussion and calculations are provided in Section D1.

A5. Intersection Capacity Analysis

Capacity analyses were performed at each of the study intersections to assess traffic operations under three scenarios: 2019 Existing, 2026 No-Build, and 2026 Build. The 2019 Existing Conditions analysis is based on current traffic counts carried out in the study area along with existing traffic control. The 2026 No-Build scenario reflects traffic adjustments due to the addition of background trips from other developments and a compounded annual growth rate to a seven year horizon to the year 2026. The 2026 Build scenario uses projected traffic volumes after the redevelopment, taking into account the additional traffic as a result of the Project. Detailed breakdowns of each of these scenarios are included later in this report. A comparison table showing the results of these capacity analyses is shown in Table A5-1.

Table A5-1: Level-of-Service Summary

ID	*Roadway*	*Movement*	2019 Existing Conditions		2026 No-Build Conditions		2026 Build Conditions	
			Weekday AM Peak Hour	Weekday PM Peak Hour	Weekday AM Peak Hour	Weekday PM Peak Hour	Weekday AM Peak Hour	Weekday PM Peak Hour
*1**	*Somerville Avenue at Hawkins Street and Driveway*	*EB LT*	A	A	A	A	A	A
		NB TR	B	B	B	B	B	B
		SB L	B	D	C	D	C	D
	Overall		--	--	--	--	--	--
*2**	*Somerville Avenue at Church Street*	*EB TR*	A	A	A	A	A	A
		WB LT	A	A	A	A	A	A
		SB LR	C	F	D	F	D	F
		NB LR	C	C	C	C	C	C
	Overall		--	--	--	--	--	--
*3**	*Lake Street at Hawkins Street*	*EB L*	B	B	B	B	B	B
		NB LT	A	A	A	A	A	A
	Overall		--	--	--	--	--	--

LEGEND *Unsignalized Intersection

	LOS F in Existing Conditions
	LOS Declined from Existing to No-Build

As shown in Table A5-1, the proposed mixed-use building is not expected to have a significant impact on the surrounding traffic network. There are zero (0) movements or overall intersections that decline in level of service going from the No-Build scenario to the Build scenario. Detailed analyses of each scenario are included later in this report.

A6. Conclusion

This Traffic Impact and Access Study was created to assess and analyze any potential impact of the proposed mixed-use building at 346 Somerville Avenue will have on surrounding traffic operations in Somerville.

From a safety perspective, recent data shows that all three (3) of the study intersections have crash rates that are below both the District 4 and Statewide averages. Additionally, there were zero (0)

reported fatal injuries and 75% of the reported crashes occurred outside of the peak hours. Capacity analyses were performed for each of the three (3) study intersections for the Weekday AM and Weekday PM peak hours. In order to determine the specific impact that the proposed Project may have on traffic operations, analyses were carried out for 2019 Existing, 2026 No-Build, and 2026 Build conditions. Zero (0) movements or overall intersections decline in Level of Service going from the No-Build to Build scenarios. As such, the Project is not expected to have a significant impact on the surrounding traffic network.

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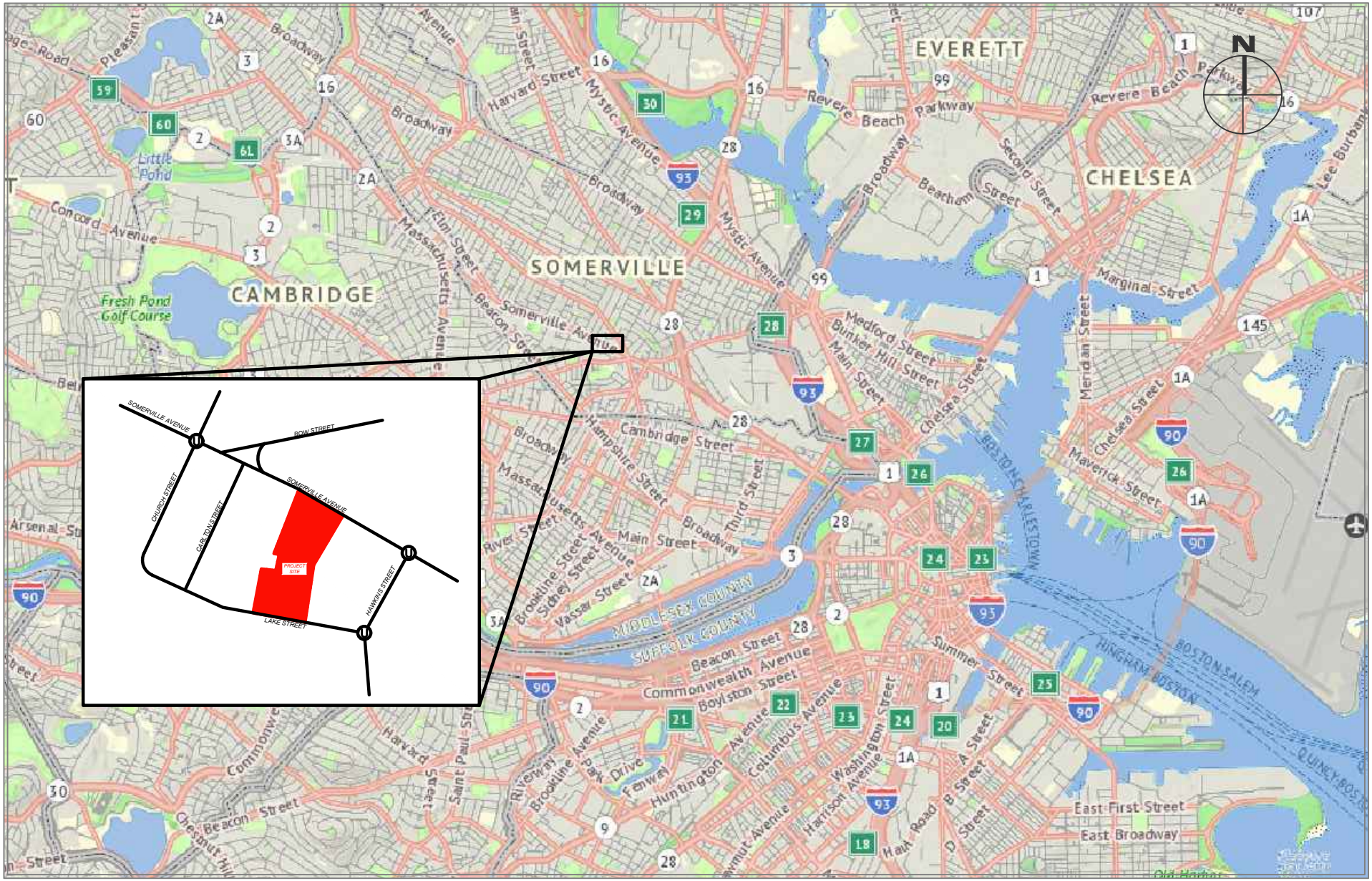
346 SOMERVILLE AVENUE
SOMERVILLE, MA

STUDY
INTERSECTIONS

PROJECT NO.: 2019-041

DATE: MAY 2019

SCALE: N.T.S. | FIGURE A2.1



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346 SOMERVILLE AVENUE
SOMERVILLE, MA

LOCUS MAP

PROJECT NO.: 2019-041

DATE: MAY 2019

SCALE: N.T.S.

FIGURE A2.2

B. EXISTING CONDITIONS

B1. Study Area

The following three (3) intersections, all located in Somerville, were examined in this traffic study:

- Somerville Avenue at Hawkins Street
- Somerville Avenue at Church Street
- Hawkins Street at Lake Street

This section describes the geometric elements of the intersections, including intersection alignments, lane widths, channelization islands and medians, sidewalk widths, curb treatments, pedestrian curb cut ramps and crosswalks, bicycle lane treatments, and locations of bus stops.

B1.1 Study Intersections

Somerville Avenue at Hawkins Street

The intersection of Somerville Avenue at Hawkins Street is a three-legged, unsignalized intersection. Somerville Avenue is a two-lane, one-way roadway in the southeasterly direction approaching from the northwest and Hawkins Street is a one-lane, one-way roadway approaching from the southwest. Somerville Avenue is functionally classified as an Urban Principal Arterial and Hawkins Street is classified a Local Road. Both roadways are under City of Somerville jurisdiction.

Source: ©2019 Google Earth

Approaching the intersection from the northwest and departing the intersection to the southeast, Somerville Avenue has an approximate curb-to-curb width of approximately 45 feet with parking permitted on both sides of the roadway. Travel lanes are approximately 11.5-feet wide and there is an approximately 5-foot wide green painted bike lane on the south side of the roadway between the travel and parking lane. Approaching the intersection from the southwest, Hawkins Street has an approximate curb-to-curb width of 26 feet with parking permitted on both sides of the roadway.

Sidewalks are provided on both sides of each of the roadways at the intersection. There are marked crosswalks with ADA ramps across the Somerville Avenue approach from the northwest and the Hawkins Street approach. Bump outs at the crosswalk across Somerville Avenue shortens the crossing distance to approximately 32-feet wide. In addition, pedestrian crossing signs with LED lights are provided for this crossing.

Somerville Avenue at Church Street

Source: ©2019 Google Earth

Somerville Avenue at Church Street is a four-legged, unsignalized intersection. Somerville Avenue is a two-lane, two-way roadway approaching the intersection from both the east and the west. Church Street is a two-lane, two-way roadway approaching from the south and a one-lane, one-way roadway in the southbound direction approaching the intersection from the north. Somerville Avenue is functionally classified as a Principal Arterial and Church Street is functionally classified as a Local Road. Both roadways are under City of Somerville jurisdiction.

Approaching the intersection from the west, Somerville Avenue has an approximate curb-to-curb width of 52 feet. Travel lanes are approximately 11.5-feet in width and five-foot bike lanes are painted on both sides of the roadway. Approaching from the east, Somerville Avenue has an approximate curb-to-curb width of 60 feet. A combination of a painted median and a raised cobblestone island separates the travel lanes along Somerville Avenue. Church Street has an approximate curb-to-curb width of 26 feet approaching the intersection from the north and south. Parking is permitted on both sides of Somerville Avenue, permitted on both sides of Church Street north of the intersection, and permitted on the east side of Church Street south of the intersection.

Sidewalks are provided on both sides of each of the roadways at the intersection. There are marked crosswalks with ADA ramps across both Church Street approaches and Somerville Avenue west of the intersection. Curb bump-outs shorten the crossing distance of all three crosswalks. The crossing distance across Somerville Avenue is approximately 40 feet, the crossing distance across Church Street from the south is approximately 24 feet, and the crossing distance across Church Street approaching the intersection from the north is approximately 17 feet. Painted green bike lanes with dashed white lines continue through the intersection on the north and south side of the intersection.

Hawkins Street at Lake Street

Source: ©2019 Google Earth

Hawkins Street at Lake Street is a three-legged, unsignalized intersection. Hawkins Street is a one-lane, one-way roadway in the northbound direction. Lake Street is a two-lane, two-way roadway approaching from the west. Both Hawkins Street and Lake Street are functionally classified as Local Roads and both are under City of Somerville jurisdiction.

Approaching the intersection from the south and departing the intersection to the north, Hawkins Street has an approximate curb-to-curb width of 26 feet. Approaching the intersection from the east, Lake Street has an approximate curb-to-curb width of 26. There is no striped center line. Lake Street operates as a yield street; when two vehicles traveling in opposite directions meet, one vehicle must yield to the other.

Sidewalks are provided on both sides of each of the roadways at the intersection. There are no marked crosswalks at the intersection. There are apex ramps at the northwest and southwest corners of the intersection.

B2. Accessibility and Multi-Modal Transportation

This section briefly describes the existing facilities at the study area intersections and within the entire study area. Schedules and routes are attached in Appendix A.

Pedestrian Facilities

Pedestrian connectivity in the area is facilitated by existing sidewalks and crosswalks. As part of the existing conditions analysis, an inventory of the existing sidewalks and crosswalks was taken. Marked crosswalks are provided at two (2) of the three (3) study intersections.

In the vicinity of the Somerville Avenue at Hawkins Street intersection, the sidewalks on the north and south side of Somerville Avenue are approximately 12 feet wide. The sidewalk on the west side of Hawkins Street is approximately 7.5 feet wide and the sidewalk on the east side of Hawkins Street is approximately 6 feet wide.

In the vicinity of the Somerville Avenue at Church Street intersection sidewalks on the south side of Somerville Avenue are approximately 8.5 feet wide west of the intersection and 10.5 feet wide east of the intersection. The sidewalk on the north side of Somerville Avenue west of the intersection is approximately 11 feet wide. The sidewalk on the north side of Somerville Avenue east of the intersection is approximately 10.5 feet wide. South of the intersection, the sidewalk on the west side of Church Street is approximately 5 feet wide and the sidewalk on the east side of the intersection is approximately 6.5 feet wide. North of the intersection, the sidewalk on the west

side of Church Street is approximately 6 feet wide and the sidewalk on the east side of the intersection is approximately 6.5 feet wide.

In the vicinity of the Hawkins Street at Lake Street intersection the sidewalk on the west side of Hawkins Street is approximately 7.5 feet wide north and south of the intersection. The sidewalk on the east side of Hawkins Street is approximately 6 feet wide north and south of the intersection. The sidewalk on the north side of Lake Street is approximately 7.5 feet wide and the sidewalk on the south side of Lake Street is approximately 6.5 feet wide.

Additional pedestrian amenities within the study area add to the pedestrian facilities along Somerville Avenue. Between the intersections with Church Street and Hawkins Street, there are two midblock crosswalks which are marked by pedestrian warning signs. Three (3) of the four (4) crosswalks across Somerville Avenue in the study area provide curb bump outs that shorten the crossing distance for pedestrians and prevent pedestrian visibility from being block by parked cars. Additionally, street trees and on-street parking create a barrier between pedestrians and vehicle traffic and the street is well lit at night.

Bicycle Facilities

In the study area there is a 5-foot wide bike lane painted on both sides of Somerville Avenue west of the intersection of Somerville Avenue at Church Street and on the south side of Somerville Avenue east of this intersection. Somerville Avenue functions as a major bicycle route with dedicated bicycle lanes for its entire length. This provides bicycle access to the MBTA Red Line stop at Porter Square 1.2 miles northwest of the Project site. Additionally, a BlueBikes Station is located in Union Square approximately 0.18 miles southeast of the Project site adjacent to the Somerville Avenue at Stone Avenue bus stop. BlueBikes is a public bike share with station facilities in Boston, Brookline, Cambridge, and Somerville.

Massachusetts Bay Transportation Authority (MBTA)

Subway Stops

The closest MBTA Subway stations are approximately 1.25 to 1.5 miles from the Project site. These include Sullivan Square on the MBTA Orange Line, Central Square and Porter Square on the MBTA Red Line, and Lechmere Station on the MBTA Green Line. Sullivan Square, Central Square, and Porter Square all have bicycle storage facilities, with both Sullivan and Central Square stations having covered bicycle parking. While these stops are all outside of walking distance from the Project site, bus stops within walking distance of the Project Site provide connections to these subway stops. Bus route connections to subway stops are discussed in the subsequent section.

The Green Line Extension Project (GLX) will provide additional light-rail transit service to both Somerville and Medford with connections to downtown Boston. Of the seven (7) additional stations along the GLX, the Union Square Station will be an approximate 0.3 mile walk from the

Project site. In addition, the station will provide approximately 86 covered bicycle parking spaces and 34 uncovered bicycle parking spaces.

Bus Stops and Routes within Study Area:

Somerville Avenue at Union Square (Routes 85, 87)
Somerville Avenue at Carlton Street (Routes 87)
Somerville Avenue at Church Street (Routes 87)
Bow Street at Warren Avenue (Routes 85, 87)
Washington Street at Kinston Road (Route 86)
Washington Street at Webster Avenue (Route 86)
Somerville Avenue at Stone Avenue (Route 86, 87, 91, CT2)
Somerville Avenue at Prospect Street (Routes 86, 87, 91)

Bus Route 85 runs between Kendall, a stop on the MBTA Red Line in Cambridge, and Avon Street at Central Street in Somerville. Approximately 8 (four inbound and four outbound) buses stop in the study area during the Weekday AM peak period and approximately 6 (three inbound and three outbound) buses stop in the study area during the Weekday PM Peak period.

Bus Route 86 runs between Sullivan Square and Reservoir, a stop on the MBTA Green Line. Bus Route 86 also stops at Harvard on the MBTA Red Line. Approximately 22 (eleven inbound and eleven outbound) buses stop in the study area during the Weekday AM peak period and approximately 17 (nine inbound and eight outbound) buses stop in the study area during the Weekday PM Peak period.

Bus Route 87 runs between Broadway at Massachusetts Avenue in Arlington and Lechmere station. Bus Route 87 also stops at Davis Square on the MBTA Red Line. Approximately 18 (nine inbound and nine outbound) buses stop in the study area during the Weekday AM peak period and approximately 14 (seven inbound and seven outbound) buses stop in the study area during the Weekday PM Peak period.

Bus Route 91 runs between Sullivan Square and Central Square. Approximately 10 (five inbound and five outbound) buses stop in the study area during the Weekday AM peak period and approximately 10 (five inbound and five outbound) buses stop in the study area during the Weekday PM Peak period.

Bus Route CT2 runs between Sullivan Square and Ruggles on the MBTA Orange Line, as well as the Needham and Providence/Stoughton Commuter Rail Lines. The CT2 Bus Route also stops at Longwood, a stop on the MBTA D Green Line. Approximately 13 (seven inbound and six outbound) buses stop in the study area during the Weekday AM peak period and approximately 9 (five inbound and four outbound) buses stop in the study area during the Weekday PM Peak period.

B3. Traffic Volumes

B3.1 Existing Traffic Counts

DCI contracted with Precision Data Industries, LLC (PDI) to collect turning movement counts in May 2019. In order to provide analysis for separate peak hours during the day, PDI collected data during the Weekday AM (7am to 9am) and Weekday PM (4pm to 6pm) peak periods for all study intersections on a typical Wednesday. These counts were taken when all area schools were in session and during a week not containing a holiday. With the presence of construction along Somerville Avenue between Warren Avenue and Washington Street, the traffic volumes are lower than those collected by Nelson Nygaard as part of the US2 Transportation Impact Study. Existing pedestrian volumes can be found in Figure B3.1 and existing bicycle volumes can be found in Figure B3.2.

PDI also collected Automatic Traffic Recorder (ATR) data through two consecutive days during a Wednesday to Thursday period in May 2019. The ATR data included traffic volume data, vehicular speed data, and vehicle classification data. The counts, summarized in 15-minute, hourly, and daily intervals, were collected at the following location:

- Somerville Avenue between Kilby Street and Hawkins Street

The collected ATR data is summarized in Table B3-1. As shown, the average weekday daily traffic along Somerville Avenue is approximately 5,226 vehicles. Complete traffic count data is provided in Appendix B.

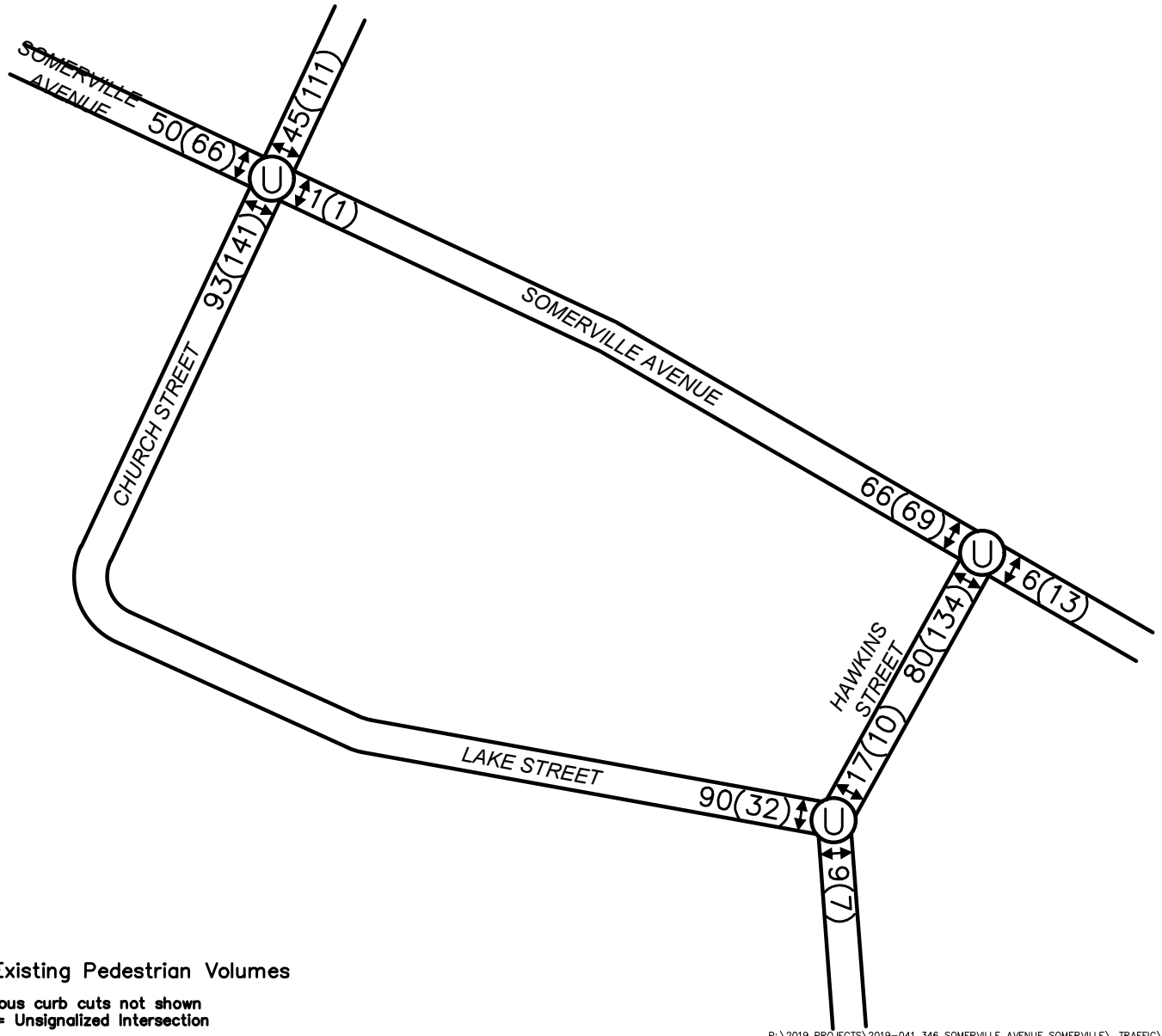
Table B3-1: ATR Volume Summary

Location	ADT[1]	Weekday AM Peak Hour			Weekday PM Peak Hour		
		Volume[2]	K[3]	Peak Direction	Volume[2]	K[3]	Peak Direction
Somerville Avenue between Kilby St and Hawkins St	5,226	424	8%	100% EB	337	6%	100% EB

ADT[1]: Average Daily Traffic (in vehicles); Volume[2]: Traffic during the peak hour (in vehicles); K[3]: The percent of Average Daily Traffic occurring during the peak hour

B3.2 Seasonal Adjustment

In order to reflect average annual daily traffic conditions, a seasonal factor was calculated to determine if the existing traffic counts should be adjusted. The 2017 Weekday Seasonal Axle Correction Factors from MassDOT were obtained. These seasonal correction factors are broken down by month and roadway classification. Somerville Avenue is classified as an Urban Principal Arterial and all other roadways in the study area are classified as Local Roads. The seasonal correction factor for these classifications of roadway in May is 0.92. In order to be provide a more conservative analysis, the existing traffic volumes remain unadjusted. The unadjusted existing peak hour traffic volumes are shown in Figure B3.3. The 2017 Weekday Seasonal Axle Correction Factors worksheet has been attached in Appendix B.



Legend

XX(YY) → AM(PM) 2019 Existing Pedestrian Volumes

Note: Imbalances due to numerous curb cuts not shown
S = Signalized Intersection; U = Unsignalized Intersection

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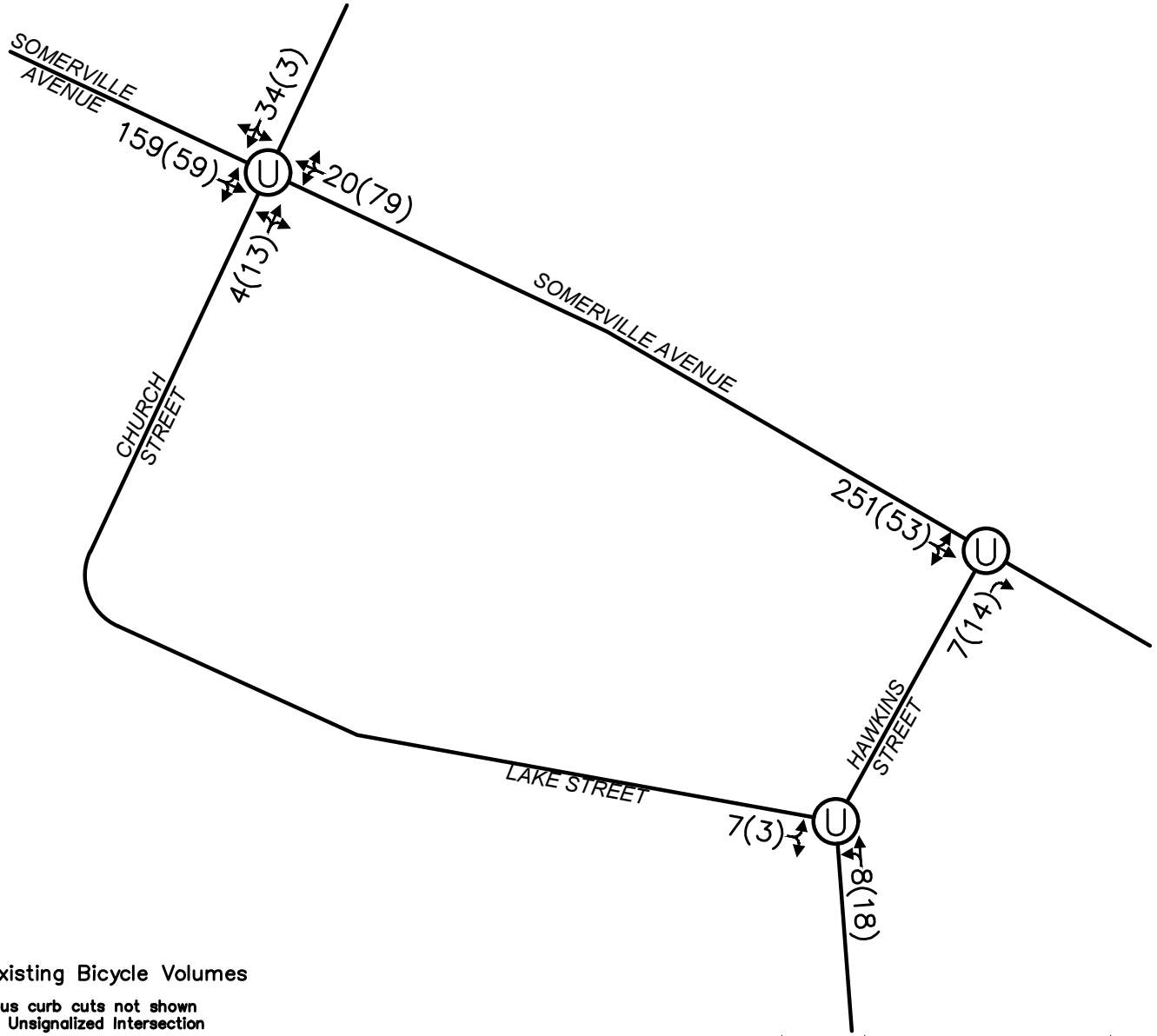
Design Consultants Inc. Somerville - Quincy - Newburyport www.dci-ma.com	346 SOMERVILLE AVENUE SOMERVILLE, MA	2019 EXISTING PEDESTRIAN VOLUMES	PROJECT NO.: 2019-041
			DATE: MAY 2019
			SCALE: N.T.S. FIGURE B3.1



Legend

XX(YY) → AM(PM) 2019 Existing Bicycle Volumes

Note: Imbalances due to numerous curb cuts not shown
S = Signalized Intersection; U = Unsignalized Intersection

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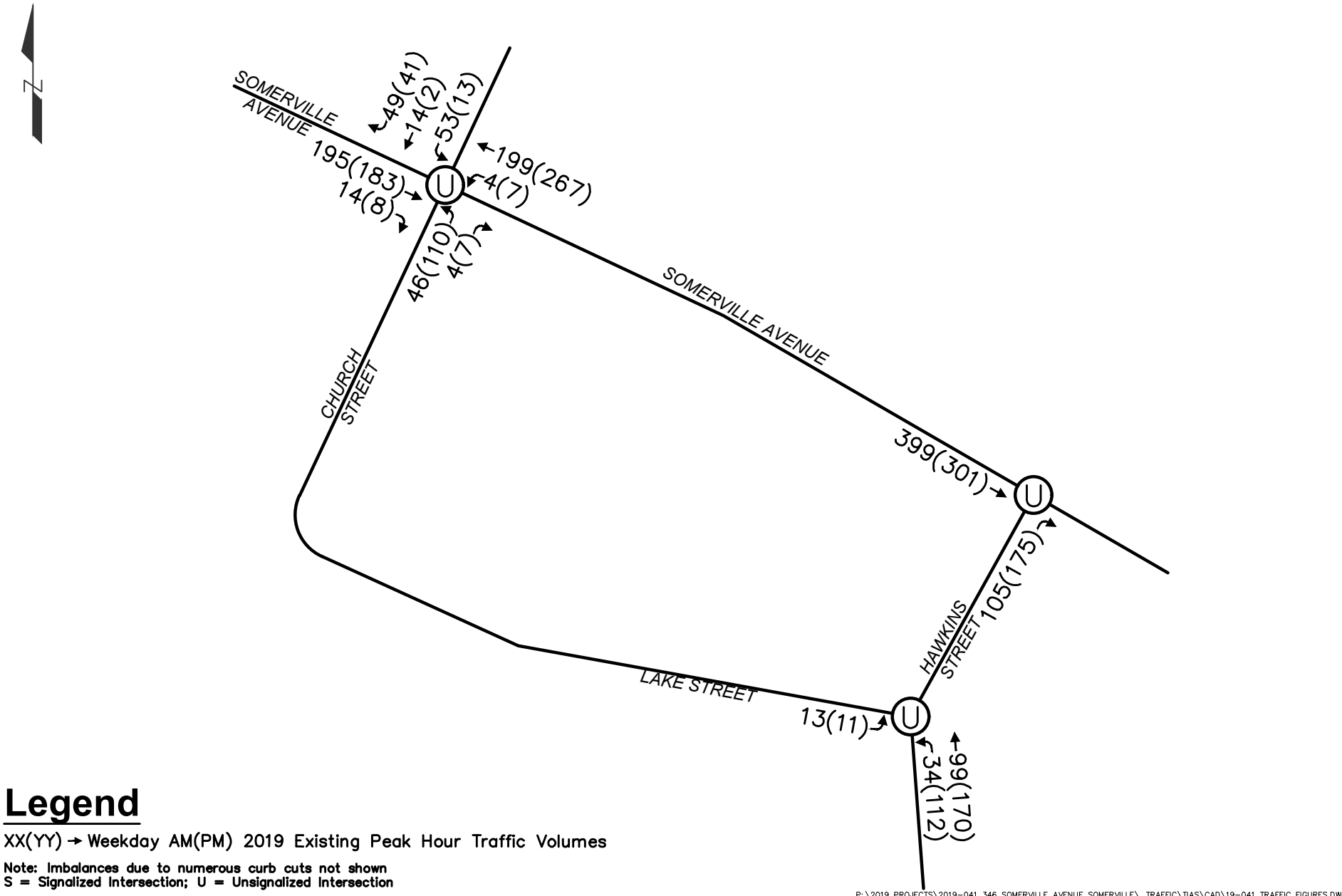
Design Consultants Inc. Somerville - Quincy - Newburyport www.dci-ma.com	346 SOMERVILLE AVENUE SOMERVILLE, MA	2019 EXISTING BICYCLE VOLUMES	PROJECT NO.: 2019-041
			DATE: MAY 2019
			SCALE: N.T.S. FIGURE B3.2



Legend

XX(YY) → Weekday AM(PM) 2019 Existing Peak Hour Traffic Volumes

Note: Imbalances due to numerous curb cuts not shown
S = Signalized Intersection; U = Unsignalized Intersection

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Design Consultants Inc. Somerville - Quincy - Newburyport www.dci-ma.com	346 SOMERVILLE AVENUE SOMERVILLE, MA	2019 EXISTING TRAFFIC VOLUMES	PROJECT NO.: 2019-041
			DATE: MAY 2019
			SCALE: N.T.S. FIGURE B3.3

B4. Safety Analysis

Intersection safety is one measure of assessing the performance of an intersection and can also have an impact on overall intersection operations. This section reviews historical crash data to identify any potential safety concerns.

B4.1 Existing Crash Data and Analysis

Crash data from MassDOT for years 2012 through 2016 was reviewed for each study intersection. This data represents the most recent five (5) years of data available through the MassDOT crash database. The MassDOT crash records offered the following information:

- Crash Location (General or Specific) / Direction of vehicle(s) involved
- Date / Time
- Roadway surface conditions / Light conditions / Weather conditions
- Crash Severity / Manner of Collision
- Type of non-motorist involved (if applicable)

The compiled data, in conjunction with engineering judgement, yielded a summary of crashes that may be used to identify general crash patterns and potential factors contributing to the predominant type of incidents at each location.

Crash rates can be a useful tool in measuring the safety for an intersection relative to Statewide and District averages for comparable intersection types. Crash rates for intersections are calculated based upon the number of crashes at an intersection and the volume of traffic traveling through an intersection on a daily basis, expressed as crashes per million entering vehicles (c/mev). MassDOT average intersection crash rates are published on a statewide basis and by district for signalized and unsignalized intersections.

Intersection crash rates were calculated for each of the study area intersections using available crash data for the 5-year period and the average daily traffic volumes for the May 2019 traffic counts. The average crash rates for unsignalized intersections are 0.57 c/mev for MassDOT District 4 and 0.57 c/mev Statewide. The summary results of the crash analysis are shown in Table B4-1. Detailed crash analysis worksheets for each intersection for years 2012 through 2016 are contained in Appendix C.

Table B4-1: MassDOT Intersection Crash Summary

	Somerville Avenue at Hawkins Street	***Somerville Avenue at Church Street***	***Hawkins Street at Lake Street***
Crash Severity			
Property Damage Only	1	0	1
Non-fatal Injury	1	3	0
Fatal Injury	0	0	0
Not Reported, Unknown	1	1	0
Total	*3*	*4*	*1*
Manner of Collision			
Sideswipe, Same Direction	1	0	0
Sideswipe, Opposite Direction	0	0	0
Angle	2	3	1
Rear-end	0	0	0
Head-on	0	0	0
Single Vehicle	0	1	0
Other, not reported	0	0	0
Total	*3*	*4*	*1*
Time of Day			
7:00am to 9:00am (AM Peak)	*0*	*1*	*0*
4:00pm to 6:00pm (PM Peak)	*0*	*0*	*1*
All Other Times	*3*	*3*	*0*
Total	3	4	1
Crash Averages			
Avg. Crashes per Year	0.60	0.80	0.20
Avg. Crash Rate (c/mev)	***0.27***	***0.31***	***0.17***
District 4 Avg. Crash Rate (c/mev)	0.73	0.57	0.57
Statewide Avg. Crash Rate (c/mev	0.78	0.57	0.57

The intersection of **Somerville Avenue at Hawkins Street** had three (3) reported crashes according to the MassDOT crash database during the five year period from 2012 to 2016. One (1) of the crashes resulted in property damage only, one (1) resulted in a non-fatal injury, and one (1) had an unknown/unreported crash severity. Of the three (3) crashes, one (1) was a sideswipe collision in the same direction and two (2) were angled collisions. The intersection averaged 0.60 crashes per year and had a crash rate of 0.27 c/mev, which is below both the District 4 and Statewide averages for unsignalized intersections.

The intersection of **Somerville Avenue at Church Street** had four (4) reported crashes according to the MassDOT crash database during the five year period from 2012 to 2016. Three (3) of the crashes resulted in non-fatal injuries and one (1) had an unknown/unreported crash severity. Of the four (4) crashes, three (3) were angled collisions and one (1) was a single vehicle collision. The intersection averaged 0.80 crashes per year and had a crash rate of 0.31 c/mev, which is below both the District 4 and Statewide averages for unsignalized intersections.

The intersection of **Hawkins Street at Lake Street** had one (1) reported crash according to the MassDOT crash database during the five year period from 2012 to 2016. The one (1) crash resulted in property damage only and was an angled collision. The intersection averaged 0.20 crashes per year and had a crash rate of 0.17 c/mev, which is below both the District 4 and Statewide averages for unsignalized intersections.

Of the three (3) intersections analyzed as part of this study, all three (3) have crash rates that are below both the District 4 and Statewide averages. Additionally, there were no reported fatal crashes and 75% of crashes occurred outside of the peak periods. As such, there are no salient safety issues that require mitigation as part of this Project.

B5. Existing Capacity Analysis

B5.1 Traffic Analysis Criteria

The Highway Capacity Manual (HCM), published by the Transportation Research Board, provides methodologies on how to calculate motor vehicle Level of Service (LOS), average delay, and volume-to-capacity (v/c) ratios. Those terms are commonly used to measure performance levels for freeway sections, ramp junctions, weave sections, and intersections, both signalized and unsignalized.

Level of Service (LOS) is a term used to denote different operating conditions that occur under various traffic volume loads. It is a qualitative measure of the effect of a number of factors including geometrics, speed, travel delay, freedom to maneuver, and safety. The LOS is divided into a range of six letter grades, ranging from A to F, with A being the best and F the worst. A LOS of F is generally considered to be inadequate traffic operation in suburban and urban areas. The delay ranges differ slightly between unsignalized and signalized intersections due to driver expectations and behavior for each LOS. Table B5-1 summarizes the LOS criteria.

Table B5-1: Intersection LOS Thresholds

LOS	Unsignalized Control Delay (sec/veh)
A	0-10
B	>10-15
C	>15-25
D	>25-35
E	>35-50
F	>50

Source: 2010 Highway Capacity Manual

In this study, intersection performance measures were calculated in the form of average intersection delay, 50th and 95th percentile queue lengths, level-of-service (LOS) for each approach/movement, and the LOS of the overall intersection operations. *Synchro 9.0 was the software used to execute the intersection analysis. Synchro 9.0,* a software program from

Trafficware, uses the methodologies and thresholds outlined within the HCM. This is the preferred/recommended software of MassDOT. Traffic volume represents the travel demand observed and capacity represents the amount of traffic the intersection can accommodate under prevailing conditions. Volume to capacity ratios that approach or exceed 1.0 indicate traffic congestion or poor operating conditions.

Three types of Synchro reports were created to analyze and compare intersection performance:

- Main report – "Int: Lanes, Volumes, Timings",
- Queuing Analysis Report
- HCM Signalized/Unsignalized Report.

For signalized intersections, LOS is defined in terms of delay, which is a measure of driver discomfort and frustration, fuel consumption, and lost travel time. The 50th and 95th percentile queue lengths are estimated.

B5.2 Capacity Analysis

The study intersections were analyzed using existing traffic conditions during the Weekday AM and Weekday PM peak hours. Existing intersection lane configurations, signal timing, and traffic control were modelled the same as the current traffic operations. The results of the 2019 Existing conditions analysis are shown in Table B5-2. Detailed capacity analysis worksheets are included in Appendix F.

As shown in Table B5-2, there is one movement that operates at a LOS F during both the Weekday AM and Weekday PM peak hours. This analysis serves as a basis for comparison for the No-Build scenario, detailed in the subsequent section.

Table B5-2: 2019 Existing Conditions LOS

ID	Roadway	Movement	2019 Existing Conditions							
			Weekday AM Peak Hour				Weekday PM Peak Hour			
			v/c [1]	Delay [2]	LOS [3]	Queue [4]	v/c [1]	Delay [2]	LOS [3]	Queue [4]
1*	Somerville Avenue at Hawkins Street and Driveway	EB LT	0.12	0.0	A	0 / 0	0.10	0.2	A	0 / 0
		NB TR	0.18	12.0	B	0 / 17	0.33	14.1	B	0 / 36
		SB L	0.01	14.9	B	0 / 1	0.02	26.7	D	0 / 2
	Overall			--	--			--	--	
2*	Somerville Avenue at Church Street	EB TR	0.14	0.0	A	0 / 0	0.15	0.0	A	0 / 0
		WB LT	0.01	0.3	A	0 / 1	0.02	0.6	A	0 / 1
		SB LR	0.24	23.5	C	0 / 22	0.72	59.6	F	0 / 114
		NB LR	0.34	16.5	C	0 / 37	0.14	16.4	C	0 / 17
	Overall			--	--			--	--	
3*	Lake Street at Hawkins Street	EB L	0.03	10.6	B	0 / 2	0.03	14.1	B	0 / 2
		NB LT	0.03	2.2	A	0 / 2	0.11	3.8	A	0 / 9
	Overall			--	--			--	--	

1 v/c = volume to capacity ratio; 2 Delay = average delay in seconds per vehicle; 3 LOS = Level of Service; 4 Queue = 50th/95th percentile queue length (if only one queue length is shown, it is the 95th percentile queue length), # = volume for 95th percentile cycle exceeds capacity. Queue shown is maximum after two cycles; R = right-turn movement, L = left-turn movement, T = through movement; WB = westbound, EB = eastbound, NB = northbound

C. FUTURE NO-BUILD CONDITIONS

C1. 2026 No-Build Traffic Volumes

Traffic volumes in the study area were projected to the year 2026, which reflects a seven-year planning horizon from the existing year 2019, consistent with MassDOT Guidelines. The traffic conditions for the year 2026 were examined under No-Build conditions independent of the proposed Project, including all existing traffic and new traffic.

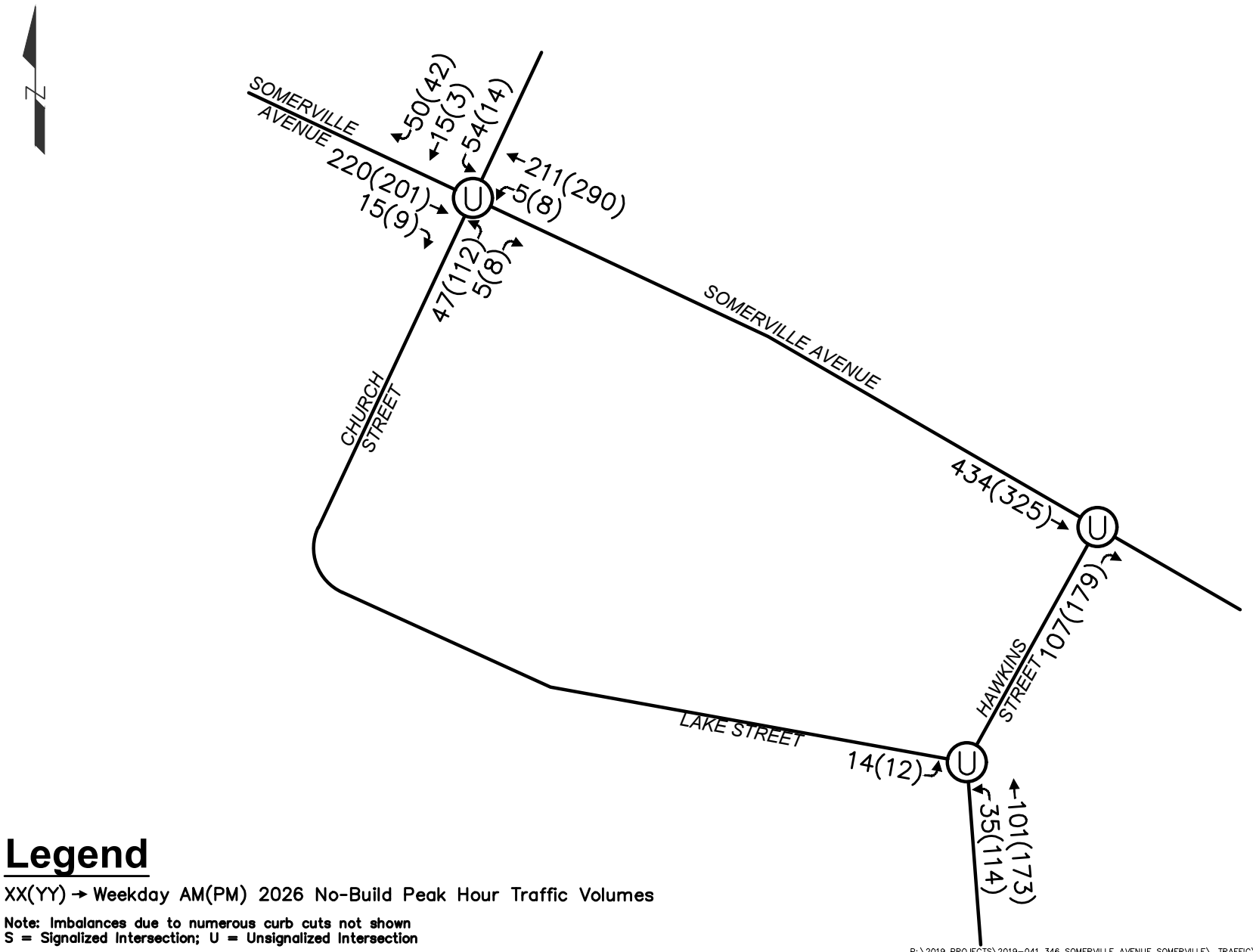
Traffic growth on the local roadway network results from multiple factors, most notably land development in the immediate area and growth in the surrounding region. Two techniques are typically used in combination to estimate this growth. The first technique identifies planned and permitted developments in the vicinity of the study area and assigns estimated traffic generated by the proposed developments to the study area network. The second technique applies an annual percentage increase in traffic growth to all traffic volumes under study. This practice accounts for traffic growth due to regional developments beyond the study area or developments that may be proposed but are not yet permitted. Both methods were used and summed together with the existing traffic counts to define the "No-Build" traffic volumes for this study. The "No-Build" traffic volumes for this study are shown in Figure C1.1

Background Developments

DCI has coordinated with the Transportation Planner for the City of Somerville to determine if there are any upcoming projects in the area that will have an impact on the traffic network. As part of the ongoing development in Union Square, Nelson Nygaard prepared a Transportation Impact Study to estimate the number of vehicle-trips that the developments will generate. As part of that study, vehicle-trips were distributed onto the surrounding traffic network to analyze their impact. It was determined that only Phase 1 of the project, which includes parcels D2 and D5, would be constructed within the 7-year planning horizon. As such, vehicle-trips associated with Phase 1 of the development in Union Square were included in the No-Build scenario. A figure of the proposed vehicle-trips is shown in Appendix D.

Background Growth Rate

Based on discussions with the City of Somerville, an annual traffic growth rate for the area of Somerville that the Project site is located was provided. In order to be consistent with the Union Square Project, US2, a 0.25 percent growth rate was provided by the city to account for general background traffic growth. The 0.25 percent annual growth rate was applied to project all existing volumes to a seven year design horizon, to the year 2026.



Legend

XX(YY) → Weekday AM(PM) 2026 No-Build Peak Hour Traffic Volumes

Note: Imbalances due to numerous curb cuts not shown
S = Signalized Intersection; U = Unsignalized Intersection

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			DATE: MAY 2019
			SCALE: N.T.S. / FIGURE C1.1

C2. 2026 No-Build Capacity Analysis

The study intersections were analyzed for 2026 No-Build peak hour traffic conditions during the Weekday AM and Weekday PM Peak hours. For this scenario, the existing lane configurations and existing traffic controls were maintained. The goal of this scenario is to provide a basis for comparison to analyze the potential effects of the proposed Project, as there are no site-specific vehicle-trips considered. As expected, given the increase in trips due to the background growth rate, most of the movements experience an increase in delay going from the Existing scenario to No-Build scenario. The results of this analysis are shown in Table C2-1. Detailed capacity analysis worksheets are included in Appendix F.

Table C2-1: 2026 No-Build Conditions LOS

ID	Roadway	Movement	2026 No-Build Conditions							
			Weekday AM Peak Hour				Weekday PM Peak Hour			
			v/c [1]	Delay [2]	LOS [3]	Queue [4]	v/c [1]	Delay [2]	LOS [3]	Queue [4]
1*	Somerville Avenue at Hawkins Street and Driveway	EB LT	0.14	0.0	A	0 / 0	0.11	0.2	A	0 / 0
		NB TR	0.19	12.3	B	0 / 18	0.35	14.4	B	0 / 38
		SB L	0.01	15.3	C	0 / 1	0.02	27.8	D	0 / 2
	Overall			--	--			--	--	
2*	Somerville Avenue at Church Street	EB TR	0.16	0.0	A	0 / 0	0.16	0.0	A	0 / 0
		WB LT	0.01	0.4	A	0 / 1	0.02	0.6	A	0 / 1
		SB LR	0.27	25.5	D	0 / 26	0.84	83.1	F	0 / 148
		NB LR	0.37	17.7	C	0 / 42	0.22	18.1	C	0 / 21
	Overall			--	--			--	--	
3*	Lake Street at Hawkins Street	EB L	0.03	10.7	B	0 / 3	0.03	14.3	B	0 / 3
		NB LT	0.03	2.2	A	0 / 2	0.11	3.8	A	0 / 9
	Overall			--	--			--	--	

1 v/c = volume to capacity ratio; 2 Delay = average delay in seconds per vehicle; 3 LOS = Level of Service; 4 Queue = 50^{th}/95^{th} percentile queue length (if only one queue length is shown, it is the 95^{th} percentile queue length), # = volume for 95^{th} percentile cycle exceeds capacity. Queue shown is maximum after two cycles; R = right-turn movement, L = left-turn movement, T = through movement; WB = westbound, EB = eastbound, NB = northbound

D. FUTURE BUILD CONDITIONS

D1. Preliminary Trip Generation

The base trip generation rates used for the proposed Project were taken from the *Trip Generation Manual (10th Edition)*, published by The Institute of Transportation Engineers (ITE) in 2017. The proposed mixed-use development will contain 94 residential units and 2,490 square feet of commercial space. Tables D1-1 and D1-2 show the calculated site-generated trips for the proposed land uses that will occupy the mixed-use development based on the ITE average trip rates.

Table D1-1: Residential Trip Generation Calculations (per ITE)

Land Use Code: 221			Multifamily Housing (Mid-Rise)
	Weekday AM Peak Hour	Weekday PM Peak Hour	Weekday Daily
Size per # of Dwelling Units (X)	94	94	94
Fitted Curve Equation	Ln(T) = 0.98* Ln(X) - 0.98	Ln(T) = 0.96* Ln(X) - 0.63	T = 5.45(X) - 1.75
Total Trips (T)	**32**	**42**	**510**
Entering%	26%	61%	50%
Exiting%	74%	39%	50%
Entering Trips	8	26	255
Exiting Trips	24	16	255

Table D1-2: Retail Trip Generation Calculations (per ITE)

Land Use Code: 932			High Turnover, Sit-down Restaurant
	Weekday AM Peak Hour	Weekday PM Peak Hour	Weekday Daily
Size per 1,000 Square Feet	2.490	2.490	2.490
Average Trip Rate	9.94	9.77	112.18
Total Trips	25	24	279
Pass-by %	43%	43%	43%
Adjusted Trips	**11**	**10**	**120**
Entering%	55%	62%	50%
Exiting%	45%	38%	50%
Entering Trips	6	6	60
Exiting Trips	5	4	60

The proposed dwelling units are expected to generate approximately 32 trips during the Weekday AM peak hour, 42 during the Weekday PM peak hour, and 510 trips during a typical weekday. The proposed retail space is expected to generate approximately 11 trips during the Weekday PM peak hour, 10 trips during the Weekday AM peak hour, and 120 trips during a typical weekday after accounting for pass-by trips.

Pass-by trips are expected to account for a portion of the generated trips by the restaurant. Pass-by trips are trips that are already in the traffic network, decide to stop at the location being studied, and then continue onto the traffic network. Pass-by trips are not new trips generated by the project, thus they are subtracted from the generated trips. One of the main reasons for deducting pass-by trips for the restaurant is its location in a high traffic area which will likely result in many generated trips originating from trips already in the network.

D1.1 Census Tract Data

As previously mentioned, the site is located in an area that has a high rate of pedestrian and bicycle traffic given the access to pedestrian, bicycle, and public transportation facilities. Additionally, with the Green Line Extension project, the site will be located less than ½-mile from a new transit stop. As such, it is expected that many of the trips will be made via non-vehicular modes of transportation. Census data from the four (4) census tracts surrounding the site were averaged to determine modal split for the proposed mixed-use site. Journey-to-Work data from the 2013 to 2017 Census shows that approximately 36.0 percent of people living in this area of Somerville get to work by way of car, truck, or van. The other 64 percent use public transportation, bicycles, walk to work, or work from home. A breakdown of the percentages for each census tract is shown in Table D1-3. These percentages were applied to the generated trips from the proposed residential units. Based on the census tract data, adjustments were made using engineering judgement, it is assumed that the restaurant space will generate a similar number of walking and public transportation trips. The biking and work-from-home trips are assumed to be converted to single-occupant vehicle-trips to provide a conservative analysis.

Table D1-3: Mode Share Data Comparison

MEANS OF TRANSPORTATION TO WORK	Census Tract 3512.03	Census Tract 3512.04	Census Tract 3513	Census Tract 3515	Census Tract Averages	**Percentage (Used for Residential)**	**Percentage (Used for Retail)**
Car, truck, or van	26.7%	37.5%	45.8%	35.2%	36.0%	**36.0%**	**53.9%**
Drove alone	24.7%	33.5%	42.1%	28.0%	32.3%	**32.3%**	**50.2%**
Carpooled:	1.9%	4.0%	3.7%	7.2%	3.7%	**3.7%**	**3.7%**
In 2-person carpool	1.6%	4.0%	1.0%	7.2%	2.9%	**2.9%**	**2.9%**
In 3-person carpool	0.0%	0.0%	0.8%	0.0%	0.2%	**0.2%**	**0.2%**
In 4 person carpool	0.3%	0.0%	2.0%	0.0%	0.6%	**0.6%**	**0.6%**
Public transportation	26.8%	20.6%	19.5%	29.3%	23.5%	**23.5%**	**23.5%**
Bicycle	14.7%	13.2%	11.8%	7.4%	12.5%	**12.5%**	**0.0%**
Walked	28.8%	21.1%	13.2%	19.0%	21.1%	**21.1%**	**21.1%**
Other means (including taxicab)	0.3%	0.3%	3.9%	2.0%	1.5%	**1.5%**	**1.5%**
Worked at home	2.7%	7.3%	5.8%	7.1%	5.4%	**5.4%**	**0.0%**

The *ITE Trip Generation Handbook, 3rd Edition* (2017) includes an Average Vehicle Occupancy (AVO) for both residential buildings and restaurants. Based on the modal split data above, an AVO rate of 1.142 persons per vehicle was calculated for the residential units and an AVO of 1.095 persons per vehicle was calculated for the retail space, both of which will be used for further calculations. The US Census Journey to Work data that was used is attached in Appendix E.

D1.2 Trip Generation Summary

As described above, adjustments were made to the base trips using US Census Tract data. By using the mode split data, the vehicle traffic associated with this Project is reduced. The resulting vehicular traffic on the surrounding roadways were estimated and are summarized in Table D1-4.

Table D1-4: Adjusted Trip Generation Summary

Mixed-Use Development	Weekday AM Peak Hour	Weekday PM Peak Hour	Weekday Daily
Base Trips (per ITE)	43	52	630
Total Person-Trips	49	59	717
Total Person-Vehicle-Trips	21	24	286
Total Vehicle-Trips	**18**	**21**	**252**
Entering Vehicle-Trips	7	13	126
Exiting Vehicle-Trips	11	8	126
Total Public Transportation Trips	11	14	169
Total Bicycle Trips	4	6	70
Total Walking Trips	10	12	151
Total "Other" Trips	3	3	41

As shown in Table D1-4, the Project is expected to generate 18 vehicle-trips during the Weekday AM peak hour, 21 vehicle-trips during the Weekday PM peak hour, and 252 vehicle-trips during a typical weekday. This equates to approximately one (1) vehicle-trip every three (3) minutes during each peak hour.

Additionally, the site is currently generating trips from the commercial property that exists on-site. However, due to the different nature of the existing and proposed uses it was decided to not take credit for the trips to the current space.

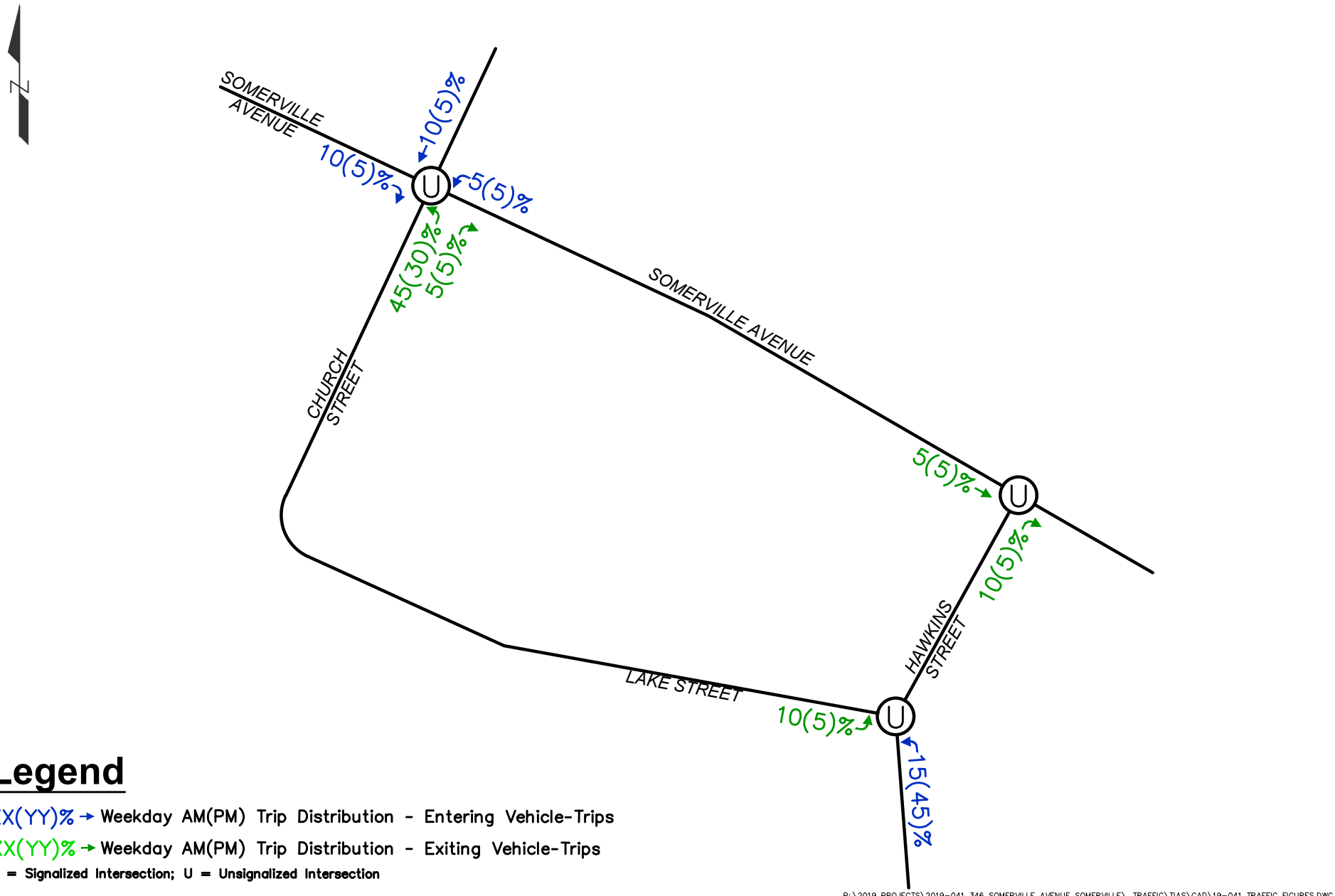
D2. Trip Distribution

Trip distribution patterns were estimated for site-generated trips both to and from the Project site. Given that there is no on-site parking, there are no site driveways as part of the Project. A majority of the on-street parking spaces are located along Lake Street, which is also a two-way

roadway which allows drivers to access Somerville Avenue in both directions. Due to this, it is assumed that all vehicle-trips will originate along Lake Street. The existing traffic data collected at the intersections of Somerville Avenue at Church Street and Lake Street at Hawkins Street were used to determine the trip distribution percentages. The projected trip distribution is shown in Figure D2.1 and the site-generated trips are shown in Figure D2.2. The site-generated trips were combined with the No-Build volumes in Figure C1.1 to calculate the Build traffic volumes used for future analysis and are shown in Figure D2.3.

D3. Pedestrian and Bicycle Analysis

As previously described, there are multiple pedestrian facilities throughout the study area, including ADA ramps, crosswalks, and wide sidewalks. As such, the pedestrian facilities are sufficient to handle any increase in trips that the site will generate after redevelopment. There will also be approximately 104 safe, secure bicycle parking spaces on-site as part of the Project. It is expected that a number of trips throughout the day will be made via bicycle. The surrounding bicycle infrastructure, as well as any planned bicycle infrastructure, will be sufficient to handle any increase in trips.



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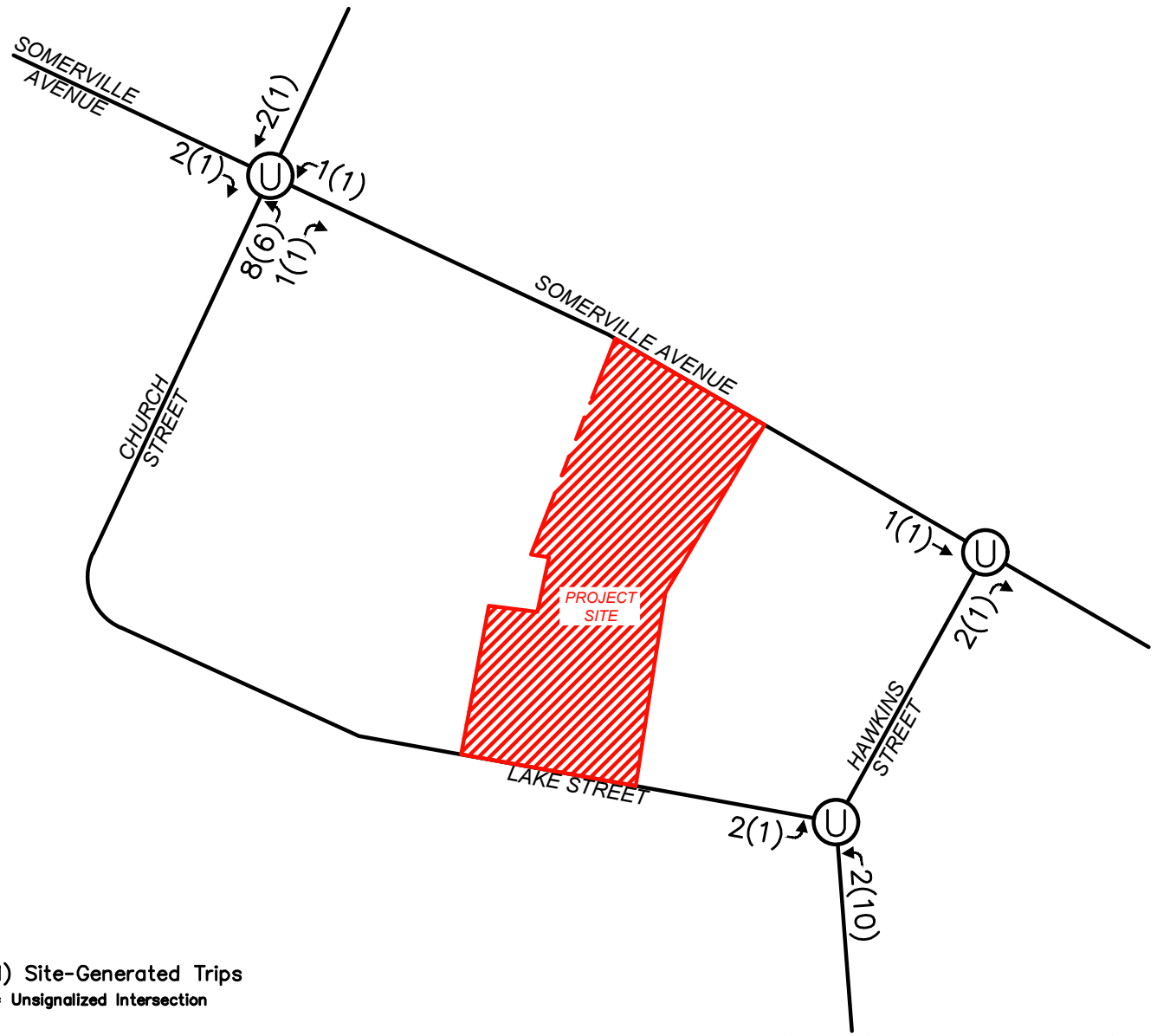
			DATE: MAY 2019
			SCALE: N.T.S. FIGURE D2.1



Legend

XX(YY) → Weekday AM(PM) Site-Generated Trips

S = Signalized Intersection; U = Unsignalized Intersection

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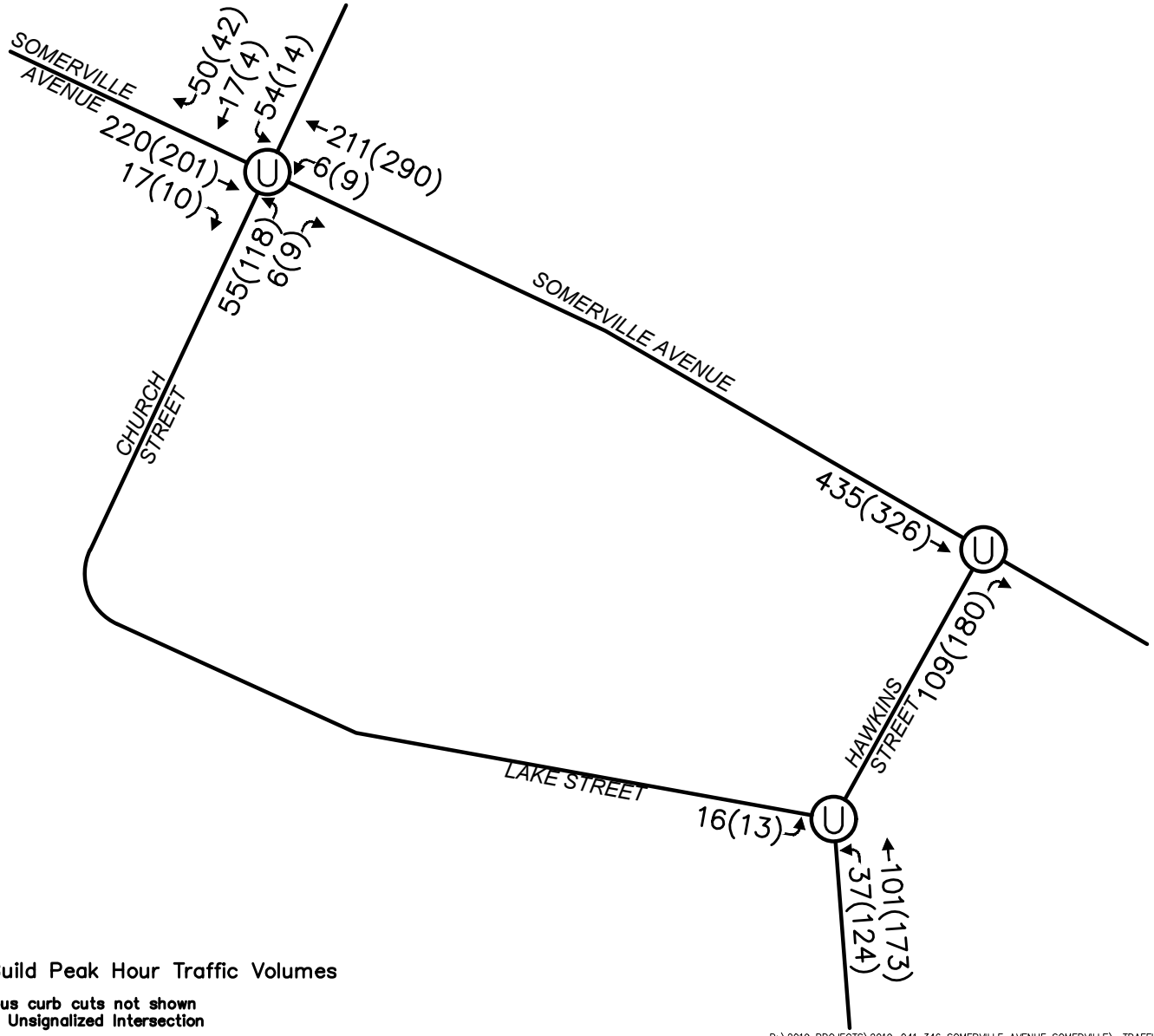
			DATE: MAY 2019
			SCALE: N.T.S. FIGURE D2.2



Legend

XX(YY) → AM(PM) 2026 Build Peak Hour Traffic Volumes

Note: Imbalances due to numerous curb cuts not shown
S = Signalized Intersection; U = Unsignalized Intersection

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			DATE: MAY 2019
			SCALE: N.T.S. FIGURE D2.3

D4. Intersection Capacity Analysis

The study intersections were analyzed for 2026 Build peak hour traffic conditions during the Weekday AM and Weekday PM peak hours. For each of the study intersections, existing traffic control and lane configuration was maintained during the 2026 Build analysis. The results of this analysis are shown in Table D2.3. Compared with Table C2-1 in Section C2, Table D2.3 illustrates minimal changes in delay from the No-Build to Build condition. There are zero (0) movements or overall intersections that decline in LOS.

The incremental increases of traffic at the study intersections due to the proposed mixed-use development will result in minimal impact to traffic operations. Additionally, as previously mentioned, the existing traffic counts, which were project to the year 2026, were lower than those collected during 2017 by Nelson Nygaard as part of the US2 development. This is due to the construction along Somerville Avenue between Warren Avenue and Washington Street. This means that the proposed Project trips represent a higher percentage of traffic along the roadway than normal. With higher existing traffic volumes expected after construction is finished, the impact that the proposed Project will have on the surround traffic network is expected to be less than what is shown in Table D4-1. As such, no additional mitigation is warranted to accommodate the proposed vehicle-trips. Detailed capacity analysis worksheets are included in Appendix F.

Table D4-1: 2026 Build Conditions LOS

ID	Roadway	Movement	2026 Build Conditions							
			Weekday AM Peak Hour				Weekday PM Peak Hour			
			v/c [1]	Delay [2]	LOS [3]	Queue [4]	v/c [1]	Delay [2]	LOS [3]	Queue [4]
1*	Somerville Avenue at Hawkins Street and Driveway	EB LT	0.14	0.0	A	0 / 0	0.11	0.2	A	0 / 0
		NB TR	0.20	12.3	B	0 / 17	0.35	14.5	B	0 / 39
		SB L	0.01	15.4	C	0 / 1	0.02	27.9	D	0 / 2
	Overall			--	--			--	--	
2*	Somerville Avenue at Church Street	EB TR	0.16	0.0	A	0 / 0	0.16	0.0	A	0 / 0
		WB LT	0.01	0.5	A	0 / 1	0.02	0.7	A	0 / 1
		SB LR	0.32	27.3	D	0 / 32	0.87	89.1	F	0 / 156
		NB LR	0.38	18.1	C	0 / 43	0.23	18.4	C	0 / 21
	Overall			--	--			--	--	
3*	Lake Street at Hawkins Street	EB L	0.04	10.8	B	0 / 3	0.04	14.8	B	0 / 3
		NB LT	0.03	2.3	A	0 / 2	0.12	4.0	A	0 / 10
	Overall			--	--			--	--	

1 v/c = volume to capacity ratio; 2 Delay = average delay in seconds per vehicle; 3 LOS = Level of Service; 4 Queue = 50th/95th percentile queue length (if only one queue length is shown, it is the 95th percentile queue length), # = volume for 95th percentile cycle exceeds capacity. Queue shown is maximum after two cycles; R = right-turn movement, L = left-turn movement, T = through movement; WB = westbound, EB = eastbound, NB = northbound

E. CONCLUSION

This Traffic Impact and Access Study was prepared to analyze the potential impact of the development Project at 346 Somerville Avenue in Somerville on vehicle, pedestrian, and transit operations in the area.

From a safety perspective, the intersections have been found to be safe. All three (3) of the intersections have crash rates that are below both the District 4 and Statewide averages. There were zero (0) reported fatal crashes and 75% of the reported crashes occurred outside of the peak periods.

Based on trip generation calculations per ITE trip generation rates, the site is expected to generate 43 trips during the Weekday AM peak hour, 52 trips during the Weekday PM peak hour, and 630 trips during a typical weekday. These trips were adjusted to take into account the availability of other modes of transportation (bicycle, pedestrian, and public transportation). After these adjustments, which were based on Census Tract data and engineering judgement, it is expected that the site will generate 18 vehicle-trips during the Weekday AM peak hour, 21 vehicle-trips during the Weekday PM peak hour, and 252 vehicle-trips during a typical weekday.

Capacity analyses were carried out for the three (3) study intersections for the Weekday AM and Weekday PM peak hours. Analyses were carried out for 2019 Existing, 2026 No-Build, and 2026 Build conditions. There are zero (0) movements or overall intersections that decline in LOS going from the No-Build to Build scenarios. Based on the results of these analyses, DCI believes that the proposed mixed-use development at 346 Somerville Avenue will not have significant impact on traffic operations in Somerville, Massachusetts.