Design Consultants, Inc.

120 Middlesex Avenue
Somerville, MA 02145
(617) 776-3350

MEMORANDUM

DCI JOB NO. 2015-116

TO: Anthony Fava
11 Elkins Street, #250, Boston, MA 02127

FROM: Tom Bertulis, P.E., PTOE
Design Consultants, Inc.

SUBJECT: **Trip Generation and Sight Distance Memorandum**
654 Mystic Avenue
Somerville, MA

DATE: September 30, 2016

Design Consultants, Inc. (DCI) has been retained by the client to evaluate the transportation and parking impacts of the Project located at 654 Mystic Avenue in Somerville, Massachusetts. Currently there is a one-floor building on-site. The proposed redevelopment calls for the demolition of the existing building and the construction of nine (9) 4-bedroom residential dwelling units. It proposed to have twenty-six (26) parking spaces at grade. Additonally, there will be three curb cuts to serve the at-grade parking spaces.

This memorandum serves to demonstrate that there will be minimal traffic impact expected from the proposed development on the surrounding roadway networks, and that the location of the proposed curb cuts do not present a safety concern.

Trip Generation

The base trip generation rates used were taken from the *Trip Generation Manual, 9th Edition* published by ITE in 2012. Land Use Code (LUC) 220, Apartment, was used for this Project, for nine (9) dwelling units. Table 1 shows the comparison between proposed site-generated trips estimate and existing site-generated trips estimate at the Project site. It should be noted that there is an existing building on-site that used to serve as a drive-up appraisal center for a car insurance company that generated trips during both the morning and evening peak hours. Although employees of this company may have taken alternative modes to get there, almost all other visitors

drove to the site, thus putting vehicular traffic on the adjacent roadway. These trips were not deducted from the proposed Project-generated trips, thus providing a more conservative report. Detailed trip-generation calculations are in the appendix attached to this memorandum.

Table 1: Preliminary Trip Generation Calculations

Land Use Code: 220			Apartment
	AM	PM	Daily
Dwelling Units (X)	9	9	9
Fitted Curve Equation	T = 0.49(X) +3.73	T = 0.55(X) + 17.65	T = 6.06(X) + 123.56
Total Trips (T)	**8**	**23**	**178**
Entering%	20%	65%	50%
Exiting%	80%	35%	50%
Entering Trips	2	15	89
Exiting Trips	6	8	89

These trip rates are unadjusted as they only account for motorized traffic trips. Non-vehicle trips were deducted from the base trips in the following steps.

Mode Share and Average Vehicle Occupancy

ITE's Trip Generation methods are typically based on data from suburban developments with no nearby transit service and no appreciable share of people walking or bicycling to or from the site. Commuting characteristics were analyzed from the 2010-2014 American Community Survey 5-Year Estimates. Census Tract 3501.04 in Somerville, which covers the Project site, was analyzed and used to estimate mode splits for journeys to work in the Project area. Table 2 displays estimated mode splits.

Table 2: Mode Split Data for Residents of Census Tract 3501.04

MEANS OF TRANSPORTATION TO WORK	
Car, truck, or van	69.0%
Drove alone	54.6%
Carpooled:	14.4%
In 2-person carpool	11.0%
In 3-person carpool	1.4%
In 4 person carpool	2.0%
Public transportation (excluding taxicab)	21.1%
Walked	6.8%
Bicycle	0.5%
Other means	0.9%
Worked at home	1.6%

Based on the modal split data above, an Average Vehicle Occupancy (AVO) rate of 1.3 persons per vehicle was calculated. According to the *Trip Generation Handbook,* Land Use Code (LUC)

220 already accounts for an AVO of 1.1 for all trips. Consequently, the base trips for this Project had to be adjusted to account for this. The base trips were adjusted for the AVO of 1.1, and then the AVO of 1.3 was applied, thus giving the number of person-trips during the morning and evening peak hours, and during a typical weekday. Then the number of non-vehicle trips was determined by multiplying the person-trips by the percentage expected to utilize transit, bicycling and walking to access the Project site. The US Census Tract 3501.04 Journey to Work data is attached in the Appendix.

Trip Generation Summary

The public transit, walking, and biking mode share from US Census Tract 3501.04 was taken and applied to the total person-trips. By applying this non-vehicular mode split to the Trip Generation calculations, the amount of expected vehicle traffic associated with the Project is reduced. The resulting adjusted vehicular traffic on the surrounding roadways were estimated and are summarized in Table 3.

Table 3: Adjusted Trip Generation

	AM	PM	Daily
Base Trips	8	23	178
Total Person-Trips	10	30	231
Total Vehicle Trips	6	16	122
Entering Vehicle-Trips	1	10	61
Exiting Vehicle-Trips	5	6	61
Total Public Transportation Trips	2	6	49
Total Bicycle Trips	0	0	1
Total Walking Trips	1	2	16

As indicated in Table 3, the Project is expected to generate **six (6) vehicle-trips** during the weekday morning peak hour, **sixteen (16) vehicle-trips** during the weekday evening peak hour and, **122 vehicle-trips** during a typical weekday. Generated transit trips are expected to be two (2) trips during the weekday morning peak hour and six (6) the weekday evening peak hour. The Project is expected to generate 49 transit trips on a daily weekday basis. Pedestrian trips are expected to be one (1) person-trip during the weekday morning peak hour, two (2) person-trips during the weekday evening peak hour, and 16 person-trips during a typical weekday. It is estimated that there will be no bicycle trips generated by the Project during both the morning and evening peak hours, and only one (1) bicycle trip on a typical weekday, based on the mode split from the Census Data.

Sight Distance Analysis

Stopping Sight Distance (SSD) is typically defined as the distance that a motorist on the major road can see a vehicle on the minor road and safely decelerate and stop. Intersection Sight Distance (ISD) is typically defined as the distance a motorist can see approaching vehicles before their line of sight is blocked by an obstruction near the intersection. The driver of a vehicle approaching or departing

from an intersection should have an unobstructed view of the intersection, including any traffic control devices, and sufficient lengths along the intersecting highway to allow the driver to anticipate and avoid potential collisions.

Minimum recommended SSD and ISD from the American Association of State Highway and Transportation Officials (AASHTO) are shown in Table 4 below. Note that the default speed limit on Mystic Avenue in the study area is 35 miles per hour (mph).

Table 4 – AASHTO Minimum Recommended SSD and ISD

Design Speed (mph)	Stopping Sight Distance (ft)	Intersection Sight Distance for Right-Turn Maneuvers (ft)
15	80	70
20	115	90
25	155	115
30	200	140
35	250	165
40	305	195
45	360	220
50	425	245

The right-turn maneuver must have sufficient sight distance to permit entrance onto the roadway and then accelerate to the posted speed limit without being overtaken by approaching vehicles. The SSD and ISD measured on-site is shown in Table 5. Figure 1 shows the proposed driveways relative to the roadway. Figures 2, 3, and 4 show the sight lines from the proposed western driveway, center driveway, and eastern driveway, respectively.

Table 5 – SSD and ISD Measured at Project Site

	Stopping Sight Distance (ft)	Intersection Sight Distance (ft)
Required at 35 mph	*250*	*165*
Measured (West Driveway)	650	600
Measured (Center Driveway)	700	650
Measured (East Driveway)	725	715

As seen in the table above, the sight distances for the right-turn maneuver out of the proposed sight driveways meet the AASHTO minimum recommended distances. Additionally, the measured stopping sight distances along Mystic Avenue exceed the AASHTO minimum recommended distance. Consequently, no mitigation is recommended or needed.

Figure 1: Proposed Site Driveways

Figure 2: Proposed West Driveway Sight Line

Figure 3: Proposed Center Driveway Sight Line

Figure 4: Proposed East Driveway Sight Line

Conclusion

The proposed trip generation for 654 Mystic Avenue in Somerville will have no adverse impact on surround traffic networks. The proposed site-generated trips are estimated to be six (6) vehicle-trips in the morning peak hour, sixteen (16) vehicle-trips during the afternoon peak hour, and 122 vehicle-trips on typical weekday daily basis. The sight distance analysis shows that all three of the proposed site driveways meet all the AASHTO sight distance requirements. No mitigation is recommended or needed.

Considering the results of the trip generation calculations and the sight distance analysis of the proposed site driveways, DCI concludes that the proposed redevelopment at 654 Mystic Avenue will not have an adverse impact on the traffic network in Somerville, Massachusetts.

APPENDIX

S0801 | COMMUTING CHARACTERISTICS BY SEX

2010-2014 American Community Survey 5-Year Estimates

Supporting documentation on code lists, subject definitions, data accuracy, and statistical testing can be found on the American Community Survey website in the Data and Documentation section.

Sample size and data quality measures (including coverage rates, allocation rates, and response rates) can be found on the American Community Survey website in the Methodology section.

Although the American Community Survey (ACS) produces population, demographic and housing unit estimates, it is the Census Bureau's Population Estimates Program that produces and disseminates the official estimates of the population for the nation, states, counties, cities and towns and estimates of housing units for states and counties.

Subject	Census Tract 3501.04, Middlesex County, Massachusetts				
	Total		Male		Female
	Estimate	Margin of Error	Estimate	Margin of Error	Estimate
Workers 16 years and over	3,460	+/-480	2,129	+/-329	1,331
MEANS OF TRANSPORTATION TO WORK					
Car, truck, or van	69.0%	+/-6.5	68.6%	+/-8.2	69.6%
Drove alone	54.6%	+/-8.6	58.1%	+/-10.4	49.0%
Carpooled	14.4%	+/-6.0	10.5%	+/-6.5	20.7%
In 2-person carpool	11.0%	+/-5.0	6.3%	+/-4.1	18.5%
In 3-person carpool	1.4%	+/-1.6	0.9%	+/-1.5	2.2%
In 4-or-more person carpool	2.0%	+/-3.2	3.3%	+/-5.2	0.0%
Workers per car, truck, or van	1.13	+/-0.07	1.11	+/-0.09	1.18
Public transportation (excluding taxicab)	21.1%	+/-6.5	20.7%	+/-8.3	21.7%
Walked	6.8%	+/-4.5	7.7%	+/-6.0	5.6%
Bicycle	0.5%	+/-0.8	0.8%	+/-1.3	0.0%
Taxicab, motorcycle, or other means	0.9%	+/-1.5	0.0%	+/-1.6	2.4%
Worked at home	1.6%	+/-1.5	2.2%	+/-2.3	0.7%
PLACE OF WORK					
Worked in state of residence	100.0%	+/-1.0	100.0%	+/-1.6	100.0%
Worked in county of residence	60.9%	+/-6.8	60.3%	+/-8.4	61.8%
Worked outside county of residence	39.1%	+/-6.8	39.7%	+/-8.4	38.2%
Worked outside state of residence	0.0%	+/-1.0	0.0%	+/-1.6	0.0%
Living in a place	100.0%	+/-1.0	100.0%	+/-1.6	100.0%
Worked in place of residence	17.4%	+/-5.6	17.9%	+/-7.0	16.6%
Worked outside place of residence	82.6%	+/-5.6	82.1%	+/-7.0	83.4%
Not living in a place	0.0%	+/-1.0	0.0%	+/-1.6	0.0%
Living in 12 selected states	100.0%	+/-1.0	100.0%	+/-1.6	100.0%
Worked in minor civil division of residence	17.4%	+/-5.6	17.9%	+/-7.0	16.6%
Worked outside minor civil division of residence	82.6%	+/-5.6	82.1%	+/-7.0	83.4%
Not living in 12 selected states	0.0%	+/-1.0	0.0%	+/-1.6	0.0%
Workers 16 years and over who did not work at home	3,405	+/-477	2,083	+/-330	1,322
TIME LEAVING HOME TO GO TO WORK					
12:00 a.m. to 4:59 a.m.	8.6%	+/-4.0	12.1%	+/-6.0	3.0%
5:00 a.m. to 5:29 a.m.	5.1%	+/-2.8	2.7%	+/-2.3	8.9%

Subject	Census Tract 3501.04, Middlesex County, Massachusetts				
	Total		Male		Female
	Estimate	Margin of Error	Estimate	Margin of Error	Estimate
5:30 a.m. to 5:59 a.m.	0.4%	+/-0.6	0.6%	+/-1.0	0.0%
6:00 a.m. to 6:29 a.m.	2.1%	+/-2.4	3.5%	+/-3.8	0.0%
6:30 a.m. to 6:59 a.m.	4.5%	+/-2.9	4.7%	+/-3.6	4.2%
7:00 a.m. to 7:29 a.m.	12.4%	+/-5.4	11.9%	+/-5.9	13.3%
7:30 a.m. to 7:59 a.m.	9.5%	+/-3.8	7.7%	+/-4.7	12.3%
8:00 a.m. to 8:29 a.m.	19.0%	+/-6.4	19.7%	+/-7.7	17.9%
8:30 a.m. to 8:59 a.m.	4.7%	+/-3.0	3.0%	+/-3.6	7.4%
9:00 a.m. to 11:59 p.m.	33.7%	+/-6.6	34.1%	+/-8.5	33.1%
TRAVEL TIME TO WORK					
Less than 10 minutes	10.7%	+/-5.0	9.5%	+/-5.3	12.8%
10 to 14 minutes	8.1%	+/-2.9	7.9%	+/-4.1	8.5%
15 to 19 minutes	14.0%	+/-4.7	17.6%	+/-6.9	8.3%
20 to 24 minutes	22.9%	+/-7.6	21.0%	+/-9.3	26.0%
25 to 29 minutes	1.3%	+/-1.1	1.4%	+/-1.6	1.2%
30 to 34 minutes	15.7%	+/-6.3	14.2%	+/-7.7	18.2%
35 to 44 minutes	10.8%	+/-4.3	12.4%	+/-6.3	8.4%
45 to 59 minutes	9.1%	+/-5.1	8.7%	+/-6.2	9.8%
60 or more minutes	7.2%	+/-4.4	7.3%	+/-5.4	6.9%
Mean travel time to work (minutes)	26.0	+/-2.6	26.1	+/-3.3	25.9
VEHICLES AVAILABLE					
Workers 16 years and over in households	3,460	+/-480	2,129	+/-329	1,331
No vehicle available	12.7%	+/-5.8	9.4%	+/-5.5	17.9%
1 vehicle available	49.7%	+/-10.1	50.0%	+/-11.1	49.3%
2 vehicles available	31.4%	+/-8.6	32.9%	+/-8.4	29.1%
3 or more vehicles available	6.2%	+/-3.8	7.7%	+/-5.1	3.8%
PERCENT IMPUTED					
Means of transportation to work	19.5%	(X)	(X)	(X)	(X)
Private vehicle occupancy	23.1%	(X)	(X)	(X)	(X)
Place of work	25.0%	(X)	(X)	(X)	(X)
Time leaving home to go to work	24.0%	(X)	(X)	(X)	(X)
Travel time to work	27.4%	(X)	(X)	(X)	(X)
Vehicles available	1.7%	(X)	(X)	(X)	(X)

Subject	Census Tract 3501.04, Middlesex County, Massachusetts
	Female
	Margin of Error
Workers 16 years and over	+/-266
MEANS OF TRANSPORTATION TO WORK	
Car, truck, or van	+/-8.9
Drove alone	+/-10.9
Carpooled	+/-8.7
In 2-person carpool	+/-8.5
In 3-person carpool	+/-3.3
In 4-or-more person carpool	+/-2.6
Workers per car, truck, or van	+/-0.09
Public transportation (excluding taxicab)	+/-8.0
Walked	+/-5.1
Bicycle	+/-2.6
Taxicab, motorcycle, or other means	+/-3.8
Worked at home	+/-1.1
PLACE OF WORK	
Worked in state of residence	+/-2.6
Worked in county of residence	+/-10.8
Worked outside county of residence	+/-10.8
Worked outside state of residence	+/-2.6
Living in a place	+/-2.6
Worked in place of residence	+/-7.6
Worked outside place of residence	+/-7.6
Not living in a place	+/-2.6
Living in 12 selected states	+/-2.6
Worked in minor civil division of residence	+/-7.6
Worked outside minor civil division of residence	+/-7.6
Not living in 12 selected states	+/-2.6
Workers 16 years and over who did not work at home	+/-267
TIME LEAVING HOME TO GO TO WORK	
12:00 a.m. to 4:59 a.m.	+/-4.8
5:00 a.m. to 5:29 a.m.	+/-6.6
5:30 a.m. to 5:59 a.m.	+/-2.6
6:00 a.m. to 6:29 a.m.	+/-2.6
6:30 a.m. to 6:59 a.m.	+/-3.7
7:00 a.m. to 7:29 a.m.	+/-7.7
7:30 a.m. to 7:59 a.m.	+/-6.0
8:00 a.m. to 8:29 a.m.	+/-9.3
8:30 a.m. to 8:59 a.m.	+/-5.7
9:00 a.m. to 11:59 p.m.	+/-10.1
TRAVEL TIME TO WORK	
Less than 10 minutes	+/-7.7
10 to 14 minutes	+/-5.3
15 to 19 minutes	+/-5.3
20 to 24 minutes	+/-8.9
25 to 29 minutes	+/-1.4
30 to 34 minutes	+/-9.1
35 to 44 minutes	+/-5.7
45 to 59 minutes	+/-6.4
60 or more minutes	+/-4.7
Mean travel time to work (minutes)	+/-3.1

Subject	Census Tract 3501.04, Middlesex County, Massachusetts
	Female
	Margin of Error
VEHICLES AVAILABLE	
Workers 16 years and over in households	+/-266
No vehicle available	+/-8.7
1 vehicle available	+/-12.1
2 vehicles available	+/-12.1
3 or more vehicles available	+/-2.9
PERCENT IMPUTED	
Means of transportation to work	(X)
Private vehicle occupancy	(X)
Place of work	(X)
Time leaving home to go to work	(X)
Travel time to work	(X)
Vehicles available	(X)

Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. The margin of error can be interpreted roughly as providing a 90 percent probability that the interval defined by the estimate minus the margin of error and the estimate plus the margin of error (the lower and upper confidence bounds) contains the true value. In addition to sampling variability, the ACS estimates are subject to nonsampling error (for a discussion of nonsampling variability, see Accuracy of the Data). The effect of nonsampling error is not represented in these tables.

The 12 selected states are Connecticut, Maine, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Wisconsin.

Workers include members of the Armed Forces and civilians who were at work last week.

While the 2010-2014 American Community Survey (ACS) data generally reflect the February 2013 Office of Management and Budget (OMB) definitions of metropolitan and micropolitan statistical areas; in certain instances the names, codes, and boundaries of the principal cities shown in ACS tables may differ from the OMB definitions due to differences in the effective dates of the geographic entities.

Estimates of urban and rural population, housing units, and characteristics reflect boundaries of urban areas defined based on Census 2010 data. As a result, data for urban and rural areas from the ACS do not necessarily reflect the results of ongoing urbanization.

Source: U.S. Census Bureau, 2010-2014 American Community Survey 5-Year Estimates

Explanation of Symbols:

1. An '**' entry in the margin of error column indicates that either no sample observations or too few sample observations were available to compute a standard error and thus the margin of error. A statistical test is not appropriate.
2. An '-' entry in the estimate column indicates that either no sample observations or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest interval or upper interval of an open-ended distribution.
3. An '-' following a median estimate means the median falls in the lowest interval of an open-ended distribution.
4. An '+' following a median estimate means the median falls in the upper interval of an open-ended distribution.
5. An '***' entry in the margin of error column indicates that the median falls in the lowest interval or upper interval of an open-ended distribution. A statistical test is not appropriate.
6. An '*****' entry in the margin of error column indicates that the estimate is controlled. A statistical test for sampling variability is not appropriate.
7. An 'N' entry in the estimate and margin of error columns indicates that data for this geographic area cannot be displayed because the number of sample cases is too small.
8. An '(X)' means that the estimate is not applicable or not available.