Traffic Impact, Access and Parking Study

Beharrell Street Redevelopment Project

Concord, Massachusetts

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Introduction

TEC, Inc. has prepared this Traffic Impact, Access, and Parking Study (TIAPS) in support of the proposed Beharrell Street Redevelopment located along Beharrell Street in West Concord, Massachusetts. The site is currently occupied by a 3,364 square foot (SF) post office building and approximately 45,697 SF of mixed-use commercial space contained in two separate buildings that consist of approximately 15,047 SF of light industrial space 10,915 SF of general office space, and 19,735 SF of what is characterized in the Town of Concord Zoning Bylaws as "Extensive Uses", and includes indoor amusement and health club space. The project proponents, Oaktree FX, LLC and the Boynton Company, are proposing to demolish the existing land uses on the site and construct a mixed-use development to contain 74 apartment units and 32,690 SF of light industrial / non-retail business space. For the purposes of this analysis, TEC has assumed the same percentages of space to be leased to the categories of uses that are currently in the existing buildings, or 33 percent (10,764 SF) light industrial, 24 percent (7,808 SF) general office, and 43 percent (14,118 SF) extensive use. A 6,750 SF building for specialty retail is also proposed to be built at 13B Commonwealth Avenue. In addition, the existing 3,364 SF post office will remain on the site. A total of 261 off-street parking spaces are proposed for the project. TEC evaluated the traffic operations for the immediate intersections surrounding the site under existing conditions (2012), future No-Build conditions (2017), as well as the conditions following the introduction of new traffic generated by the proposed development.

Study Area Intersections

The study area for this TIAS included the following intersections:

1. Laws Brook Road / Commonwealth Avenue (*3 intersections*)
2. Commonwealth Avenue / Proposed Beharrell Street Extension
3. Commonwealth Avenue / Beharrell Street
4. Commonwealth Avenue / MBTA T Station Driveway
5. Commonwealth Avenue / Church Street

Existing Traffic Volumes

Manual Turning Movement Counts (TMCs) were conducted at the study area intersections on Tuesday, March 29, 2011 during the weekday morning (7:00 AM – 9:00 AM) and weekday evening (4:00PM – 6:00 PM) peak periods. These TMCs were supplemented with an additional TMC at the intersection of Commonwealth Avenue / West Concord MBTA Station conducted on Thursday, September 13, 2012 to coincide with the weekday evening peak of traffic exiting the MBTA station

(5:00 PM – 7:00 PM). Based on historic traffic-volume counts provided by the Massachusetts Department of Transportation (MassDOT), traffic-volumes in the month of March are 0.6 percent lower than average-month conditions. Therefore, the March 2011 traffic counts were upwardly increased by 0.6 percent to reflect average-month conditions in accordance with Massachusetts Department of Transportation (MassDOT) standards for preparation of a traffic study.

Vehicle Collision History

Collision data for the study area intersections were compiled and analyzed for the most recent consecutive three year period (2008-2010) on file from MassDOT. The motor vehicle crash data was reviewed to determine if any collision trends exist within the study area. None of the intersections within the study area are listed on MassDOT's Top 200 Crash Locations, and none of the intersections are Highway Safety Improvement Program (HSIP) eligible. All intersections within the study area experienced, on average, three or fewer crashes per year over the three-year study period and crash rates significantly lower than statewide and district-wide averages, indicating that no safety trends exist at any of the study locations.

No-Build Traffic Volumes

The 2017 No-Build weekday morning and weekday evening peak-hour traffic-volumes were developed by applying the 1.0 percent per year compounded annual background growth rate to the 2012 Existing peak-hour traffic-volumes for 5 years and adding traffic to be generated by specific developments by others in the vicinity of the site. Based on coordination with the Town of Concord, the medical office building at 300 Baker Avenue was the only project identified that would increase traffic volumes in the study area.

Site-Generated Traffic

The No-Build condition includes a projection for the reoccupancy of the existing vacant space on the site. The trips generated by the proposed mixed-use development were estimated using standard trip rates published in the Institute of Transportation Engineers (ITE) publication, *Trip Generation, Eighth Edition* for Land Use Code (LUC) 110 (Light Industrial), LUC 220 (Apartments), LUC 495 (Recreational Community Center), LUC 710 (General Office Building), LUC 732 (United States Post Office), and LUC 814 (Specialty Retail) for each of the proposed uses.

The proposed project is estimated to generate approximately 2 additional primary vehicle trips (-13 entering and 15 exiting) during the weekday morning peak hour and 23 additional primary vehicle trips (21 entering and 2 exiting) during the weekday evening peak hour beyond those generated by the existing land uses on the site. The additional trips are considered as part of the Build condition and were added to the No-Build condition throughout the study area.

Trip Distribution

Directional distribution of trips to and from the proposed redevelopment was based on existing travel patterns along the study area roadways. Approximately 30 percent of the site-generated trips are expected to travel to/from the site via Commonwealth Avenue to the north, 30 percent via Commonwealth Avenue to the east, 30 percent via Laws Brook Road to the west, and 10 percent via Church Street to the south.

Redistributed Traffic Volumes

As part of the proposed mixed-use development project, a second connection to be known as the Beharrell Street Extension will connect the site to Commonwealth Avenue. This proposed Beharrell Street Extension will provide a full-access/egress connection to Commonwealth Avenue. As a result, existing traffic exiting the site will be partially redistributed from the existing Beharrell Street to the proposed Beharrell Street Extension to the west.

Build Traffic Volumes

The 2017 Build condition traffic volume networks consist of the 2017 No-Build traffic-volumes with the addition of the anticipated site-generated and the redistribution of trips from Beharrell Street to the proposed Beharrell Street.

Recommended Improvements / Mitigation

Traffic exiting Beharrell Street onto Commonwealth Avenue currently experiences long delays, particularly during the weekday evening peak hour, due to queues extending from the MBTA tracks beyond Beharrell Street that block exiting traffic. In addition, on-street parking along Commonwealth Avenue blocks visibility for vehicles exiting Beharrell Street. As part of the proposed mitigation for the mixed-use development project, TEC recommends that Town of Concord convert the existing Beharrell Street connection to Commonwealth Avenue from two-way to one-way flow entering the site. As a result, all traffic exiting the Beharrell Street development will be redistributed to the proposed Beharrell Street Extension to the west.

The Town of Concord's Master Plan recommends access management improvements for the West Concord area, which includes providing a connection between the Beharrell Street development and the West Concord MBTA Station. As mitigation for the project, the proponent will construct an extension of the site driveway to the property line with the MBTA station in order to allow for the Town to connect the Beharrell Street Extension to the MBTA Commuter Rail parking lot. Provision of this connection will significantly reduce delays and queues exiting the MBTA station onto Commonwealth Avenue.

Parking Analysis

Based on the Town of Concord Zoning By-laws, a total of 255 parking spaces are required on the Beharrell Street Redevelopment site to accommodate the proposed land uses. A total of 261 parking spaces are proposed to be provided on the site. Therefore, the available parking on site will exceed zoning requirements.

TEC estimated the parking demand of the proposed land uses on the site using parking demand generation rates contained in the ITE *Parking Generation* report. ITE data indicate that the proposed land uses are estimated to generate a peak parking demand of 160 parking spaces. Therefore, the peak parking demand can be accommodated by the proposed parking supply on the site.

Introduction

Purpose of Study

TEC, Inc. has prepared this Traffic Impact, Access, and Parking Study (TIAPS) in support of the proposed Beharrell Street Redevelopment located along Beharrell Street in West Concord, Massachusetts. The site is currently occupied by a 3,364 square foot (SF) post office and approximately 45,697 SF of mixed-use commercial space contained in two separate buildings that consist of approximately 15,047 SF of light industrial space 10,915 SF of general office space, and 19,735 SF of what is characterized in the Town of Concord Zoning Bylaws as "Extensive Uses", and includes indoor amusement and health club space. The project proponents, Oaktree FX, LLC and The Boynton Company, are proposing to demolish the existing land uses on the site and construct a mixed-use commercial development to contain 74 apartment units, and 32,690 SF of light industrial / non-retail business space. For purposes of this analysis, we have assumed the same percentage of space to be leased to the categories of uses that are currently in the existing buildings, or 33 percent (10,764 SF) light industrial, 24 percent (7,808 SF) general office, and 43 percent (14,118 SF) extensive use. A 6,750 SF specialty retail building is also proposed to be built at 13B Commonwealth Avenue. The existing 3,364 SF post office will remain on the site. A total of 261 off-street parking spaces are proposed for the project, of which 75 spaces will be within an underground parking structure designated for residential parking only. TEC evaluated the traffic operations for the immediate intersections surrounding the site under existing conditions (2012), future No-Build conditions (2017), as well as the conditions following the introduction of new traffic generated by the proposed development.

Access to the site is currently provided via a single full-access/egress connection of Beharrell Street to Commonwealth Avenue approximately 125 feet west of the Massachusetts Bay Transportation Authority (MBTA) commuter rail line. As part of the redevelopment project, Beharrell Street would be extended to provide a second full-access/egress connection to Commonwealth Avenue approximately 475 feet to the west of the existing Beharrell Street intersection. In addition, TEC recommends that the Town of Concord convert the existing Beharrell Street connection from two-way to one-way flow entering the site from Commonwealth Avenue. The extension of Beharrell Street will distribute traffic away from the congested existing intersection near the MBTA rail line.

This study reports existing traffic operating parameters on key roadways and intersections within the study area, as well as the anticipated future conditions as traffic-volumes increase due to background, specific nearby projects in the planning stages, the specific volumes generated by the site's redevelopment, and traffic-volumes redistributed as a result of the conversion of the existing Beharrell Street connection from two-way to one-way flow. To remain consistent with other traffic studies, TEC has coordinated with the Town of Concord to further identify future projects and plans relating to traffic increases.

Study Methodology

This TIAPS was prepared using standard guidelines for the preparation of traffic impact studies. It examines the existing conditions of the study area, including intersection geometry and traffic control. It examines a 5-year design horizon from the date of the initial project permitting (year 2012) for traffic volume projections, which include an evaluation of the no-build conditions (without the proposed project) and build conditions (with site traffic added). These conditions are compared to determine what, if any, off-site mitigation is necessary to provide reasonable traffic operations in the area after the development is complete.

I. Existing Conditions

A comprehensive field inventory of existing traffic conditions on the study area roadways was conducted by TEC staff in March 2011 and verified in September 2012. The field investigations consisted of an inventory of existing roadway geometrics, traffic-volumes, study area safety concerns, and intersection operating characteristics. The study area was selected to contain the major roadways providing local access to the project site. The study area intersections are listed below and shown graphically on Figure 1.

Study Area Intersections

The following intersections were included in the study area for this project:

1. Laws Brook Road / Commonwealth Avenue (*3 intersections*)
2. Commonwealth Avenue / Proposed Beharrell Street Extension
3. Commonwealth Avenue / Beharrell Street
4. Commonwealth Avenue / West Concord MBTA Station Driveway
5. Commonwealth Avenue / Church Street

Geometry

Intersection geometry and lane usage were obtained from a field inventory conducted by TEC, Inc. The field investigation consisted of an inventory of existing roadway geometrics and operating characteristics. A description of the existing roadways and intersection inventory is provided below.

Roadways

Commonwealth Avenue

Commonwealth Avenue generally runs in an east-west direction between Main Street (Route 62) to the east and the Concord Rotary (Route 2) to the west. The roadway is classified as a local roadway and operates under the jurisdiction of the Town of Concord. The roadway generally consists of one travel lane in each direction with directional flow separated by a marked centerline. Commonwealth Avenue has a posted speed limit of 20 miles per hour (mph) in the vicinity of the study area, however, vehicles were observed to travel at speeds of approximately 30 mph. The roadway primarily serves retail, office, and residential land uses. In addition, Commonwealth Avenue provides direct access to West Concord MBTA Commuter Rail Station.

Beharrell Street Redevelopment - Concord, Massachusetts

Study Area Intersections:

1-3. Commonwealth Avenue / Laws Brook Road
4. Commonwealth Avenue / Beharrell Street Ext. (Proposed)
5. Commonwealth Avenue / Beharrell Street
6. Commonwealth Avenue / MBTA Station Parking Lot
7. Commonwealth Avenue / Church Street

Figure 1

Project Location Map

TEC, Inc.

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Existing Intersections

Laws Brook Road / Commonwealth Avenue

Laws Brook Road intersects Commonwealth Avenue to form three T-type intersections with a large triangular green space in the center. All approaches to all three intersections each provide a single general-purpose travel lane. The Commonwealth Avenue southbound approach to Laws Brook Road South, the Laws Brook Road North eastbound approach to Commonwealth Avenue, and the Laws Brook Road North westbound approach to Laws Brook Road all operate under STOP control, while all other movements through the intersections are free-flowing. Sidewalks are provided along both sides of Laws Brook Road and Laws Brook Road South at the intersection. Sidewalks are provided along both sides of Commonwealth Avenue east of the intersection and along the easterly side of Commonwealth Avenue north of Laws Brook Road South. On-street parking is provided along both sides of Commonwealth Avenue east of the intersection.

Commonwealth Avenue / Beharrell Street

Beharrell Street intersects Commonwealth Avenue to form this T-type intersection. All approaches to the intersection each provide a single general-purpose travel lane. Although there is currently no STOP sign or STOP line on the Beharrell Street approach, there is an assumed stop condition. Traffic on Commonwealth Avenue is free-flowing. Sidewalks are provided along both sides of Commonwealth Avenue at the intersection. On-street parking is provided on both sides of Commonwealth Avenue in the vicinity of the intersection, which restricts sight distance for vehicles exiting Beharrell Street. In addition, vehicles parked on the street block visibility of pedestrians waiting to cross the roadway. The crosswalk on Commonwealth Avenue to the west of Beharrell Street crosses at a diagonal angle, creating an unnecessarily long pedestrian crossing. The handicap-accessible ramp along the westerly side of Beharrell Street leading to the Concord Outfitters store extends all the way to the roadway, providing no level landing area from Commonwealth Avenue.

Commonwealth Avenue / MBTA Station Driveway

The MBTA T-station driveway intersects Commonwealth Avenue from the north to form this T-type intersection. All approaches to the intersection provide a single general-purpose travel lane. The T-station driveway operates under STOP control, while traffic on Commonwealth Avenue is free-flowing. Sidewalks are provided along both sides of Commonwealth Avenue at the intersection. A paved walkway is provided along the easterly side of the T-station parking lot. A crosswalk is provided on Commonwealth Avenue to the east of the T-station driveway, which crosses the roadway at a diagonal angle and results in a long pedestrian crossing. On-street parking is provided along both sides of Commonwealth Avenue to the west of the T-station driveway.

Commonwealth Avenue / Church Street

Church Street intersects Commonwealth Avenue from the southwest to form this Y-type intersection. Each approach provides a single general-purpose travel lane. Church Street approaches Commonwealth Avenue at a skewed angle, which results in a wide approach. YIELD signs are posted on both sides of the Church Street approach; however, there is no STOP or YIELD line provided on Church Street. Sidewalks are provided along both sides of Commonwealth Avenue and Church Street at the intersection. There is a crosswalk provided on the Commonwealth Avenue easterly leg of the intersection, which crosses Commonwealth Avenue at a diagonal angle. The STOP line on the Commonwealth Avenue westbound approach is located after the crosswalk, resulting in vehicles stopped in the crosswalk. The location of the crosswalk and on-street parking on the southeast

corner of the intersection obscures pedestrians in the crosswalk from drivers turning right from Church Street onto Commonwealth Avenue.

Existing Traffic Volumes

In order to establish existing traffic-volume conditions at the study area intersection, manual Turning Movement Counts (TMCs) were conducted at the study area intersections on Tuesday, March 29, 2011 during the weekday morning (7:00 AM – 9:00 AM) and weekday evening (4:00PM – 6:00 PM) peak periods. Public schools were in session at the time that these counts were conducted. These TMCs were supplemented with an additional TMC at the intersection of Commonwealth Avenue / West Concord MBTA Station, which was conducted on Thursday, September 13, 2012 during the weekday evening peak period (5:00 PM – 7:00 PM) for traffic exiting the MBTA station. To provide a conservative (worst-case) analysis, the weekday evening peak hour traffic volumes entering and exiting the MBTA station were superimposed on weekday evening peak period traffic volumes for the adjacent street traffic.

A detailed summary of the TMCs partitioned into 15-minute intervals is provided in Appendix A.

Seasonal Adjustments

In accordance with MassDOT standards, traffic-volumes are typically adjusted to average-month conditions. To evaluate the potential for seasonal fluctuation of traffic volumes on roadways near the site, TEC reviewed historic traffic-volume counts collected by MassDOT at a permanent count station along Route 2 in Concord[1]. These counts indicated that traffic volumes in March are 0.6 percent lower than average-month conditions. Therefore, the March 2011 traffic counts were increased by 0.6 percent to reflect a conservative (worse case) analysis scenario. The compiled seasonal adjustment data is provided in Appendix B. The resulting 2012 Existing traffic-volumes are shown graphically in Figure 2.

[1] MassDOT Permanent Count Station 403 – Concord – Route 2 – East of Concord Rotary

Not to Scale

Beharrell Street Redevelopment - Concord, Massachusetts

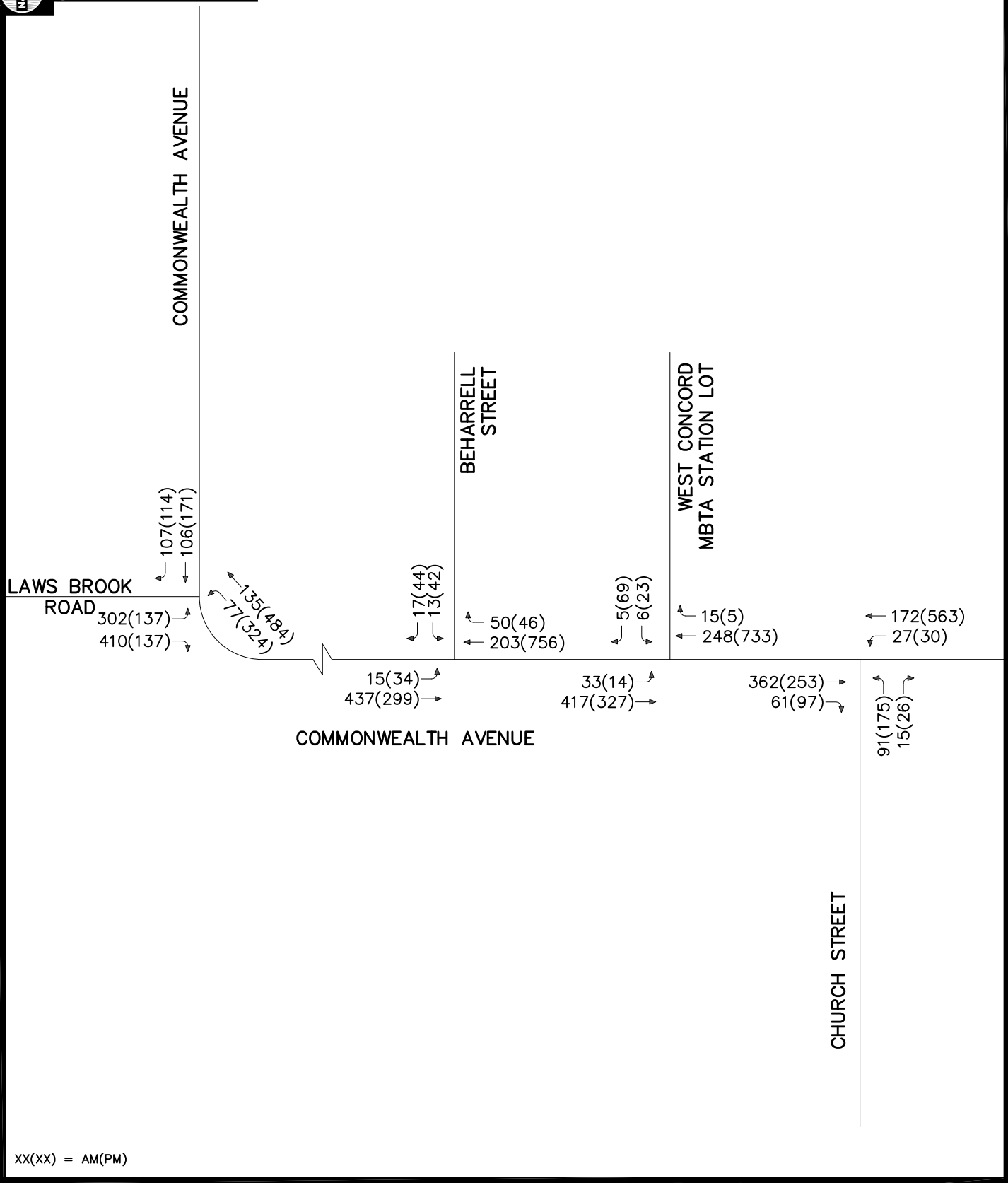

Figure 2

2012 Existing Conditions
Weekday Morning and
Weekday Evening
Peak Hour Traffic Volumes

TEC, Inc.

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Vehicle Collision History

Collision data for the study area intersections were compiled and analyzed for the most recent consecutive three year period (2008-2010) on file from MassDOT. The motor vehicle crash data was reviewed to determine if any collision trends exist within the study area. A summary of the vehicle collision data and intersection crash rates is provided in Table 1.

None of the intersections within the study area are listed on MassDOT's Top 200 Crash Locations, and none of the intersections are Highway Safety Improvement Program (HSIP) eligible.

Crash Rate Worksheets

In addition to examining the number of collisions at the intersections, a crash rate was calculated to compare occurrence of collisions to the volume of traffic passing through the intersection. The crash rate per million entering vehicles (MEV) was calculated using the evening peak hour volumes from the TMCs and a calculated K-factor obtained from ATR counts collected by MassDOT at a count station along Commonwealth Avenue north of Route 2. The crash rates at each of the study area intersections were compared to the statewide and district-wide averages published by MassDOT in July 2011 to determine the significance of the collision occurrence. The statewide average for signalized intersections is 0.81 and the District 4 average for signalized intersections is 0.78. The statewide average for unsignalized intersections is 0.61 and the District 4 average for unsignalized intersections is 0.59. A compilation of the MEV rate calculation worksheets and detailed crash data are provided in the Appendix C.

Collision Data Summary

All intersections within the study area experienced, on average, three or fewer crashes per year over the three-year study period and crash rates significantly lower than statewide and district-wide averages, indicating that no safety trends exist at any of the study locations. A compilation of the MEV rate calculation worksheets and crash data can be found in the Appendix C.

Table 1 - Crash Data Summary

		Commonwealth Avenue			
		Laws Brook Road	Beharrell Street	MBTA Station Driveway	Church Street
Crash Year:	2008	4	2	0	2
	2009	1	0	0	3
	2010	2	0	0	2
	TOTAL	**7**	**2**	**0**	**7**
Annual Average		*2.33*	*0.67*	*0.00*	*2.33*
Crash Rate (MEV):		*0.36*	*0.12*	*0.00*	*0.43*
Significant:		NO	NO	NO	NO
Type:	Rear-end	3	1	0	1
	Angle	2	0	0	1
	Sideswipe	2	0	0	2
	Single	0	0	0	3
	Ped / Bike	0	1	0	0
	Not Reported	0	0	0	0
	TOTAL	**7**	**2**	**0**	**7**
Surface Conditions:	Dry	5	1	0	6
	Wet	1	1	0	0
	Snow/Slush/Ice	1	0	0	1
	TOTAL	**7**	**2**	**0**	**7**
Severity:	PDO	5	1	0	6
	Non-Fatal Injury	2	1	0	0
	Not Reported	0	0	0	1
	TOTAL	**7**	**0**	**0**	**7**
Day Of Week:	Monday-Friday	4	2	0	5
	Saturday-Sunday	3	0	0	2
	TOTAL	**7**	**2**	**0**	**7**
Time Of Day:	6:00AM-9:00AM	3	0	0	1
	9:00AM-3:00PM	3	1	0	4
	3:00PM-6:00PM	1	0	0	2
	6:00PM-6:00AM	0	1	0	0
	TOTAL	**7**	**2**	**0**	**7**

Sight Distance Measurements

TEC, Inc. visited the site in September 2012 to measure the available sight distances at Beharrell Street and the proposed Beharrell Street Extension. The available sight distances were compared to minimum requirements established by the American Association of State Highway and Transportation Officials (AASHTO).

Sight distance represents the length of roadway that allows a driver to perceive an object within the roadway and safely slow or stop their vehicle. Two types of sight distance are typically evaluated for driveways and intersections: stopping sight distance (SSD) and intersection sight distance (ISD).

SSD is the minimum distance required for a driver traveling along a roadway to perceive an object in the roadway and stop safely in advance of the object when traveling on a wet pavement surface. SSD is measured from an eye height of 3.5-feet to an object height of 2-feet above the ground, which is equivalent to a driver viewing the taillight of a vehicle ahead. SSD is measured along the centerline of the travel lane approaching the driveway or intersection.

ISD represents the length of the roadway visible to a driver waiting to exit a driveway or minor street. Minimum ISD requirements are based on the distance required for a driver to exit a minor street onto a major street without requiring an approaching vehicle to reduce its speed from the design speed to less than 70 percent of the design speed. ISD is measured from an eye height of 3.5-feet to an object height of 3.5-feet, and is measured from a distance 15 feet off the edge of the travel-way of the major roadway to represent a driver waiting to exit a driveway or minor roadway.

SSD is typically considered the critical sight distance, as it represents the minimum distance required for safe stopping, while ISD represents an acceptable speed reduction for approaching vehicles. The ISD, however, must be at least equal to the minimum required SSD in order to prevent a driver from entering the roadway when an approaching vehicle is too close to safely stop. The guidance provided by AASHTO states:

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

The available SSD and ISD at the existing Beharrell Street and at the proposed Beharrell Street Extension intersections with Commonwealth Avenue were measured and compared to AASHTO's minimum requirements based on an observed speed of 30 miles per hour (mph) along Commonwealth Avenue. Table 2 summarizes the resulting sight distances.

Table 2 – Existing Sight Distance Measurements

Approach / Direction	Minimum Required	Measured: Stopping Sight Distance	Measured: Intersection Sight Distance
Commonwealth Ave / Beharrell Street*:*			
East of Beharrell Street	200 FT	270 FT	60 FT*
West of Beharrell Street	200 FT	>500 FT	70 FT*
Commonwealth Ave / Beharrell St Ext.*:*			
East of Beharrell St. Extension	200 FT	>500 FT	NA*
West of Beharrel St. Extension	200 FT	475 FT	NA*

*ISD limited by existing on-street parking spaces along the northerly edge of Commonwealth Avenue. This on-street is expected to conform to the MUTCD for regulatory offsets on the near and far side of the intersections.

Based on an observed speed of 30 mph on Commonwealth Avenue, AASHTO recommends a minimum SSD and ISD of 200 feet. As shown in Table 2, the available SSD at Beharrell Street and the proposed Beharrell Street Extension will exceed the minimum requirements for safe operations. ISD to both the east and west of Beharrell Street and the Beharrell Street Extension will be impeded by existing on-street parking stalls along the northerly edge of Commonwealth Avenue. As part of the proposed off-site roadway improvements, the existing Beharrell Street should be converted to one-way flow away from Commonwealth Avenue which will mitigate for deficiencies in sight distance. In addition, bump-outs (curb extensions) will be constructed at Beharrell Street Extension to eliminate

on-street parking immediately adjacent to the intersection, move the STOP line closer to the edge of the travel-way, and increase the sight distance for vehicles exiting Beharrell Street Extension onto Commonwealth Avenue. With these improvements, ISD exiting Beharrell Street Extension can be extended to meet AASHTO recommendations for safe operations.

Public Transportation

The MBTA currently provides commuter rail service to the project area along the Fitchburg Line with a train station (West Concord) located along Commonwealth Avenue immediately adjacent the site to the southeast. The Fitchburg Line Service provides connections between Fitchburg, North Leominster, Shirley, Ayer, Littleton, South Acton, West Concord, Concord, Lincoln, Silver Hill (Weston), Hastings (Weston), Kendal Green (Weston), Brandeis (Waltham), Waltham, Waverly (Belmont), Belmont, Porter Square (Cambridge), and North Station (Boston). This train operates from roughly 5:15 AM to 11:48 PM on weekdays with approximately 25-90 minute headways. Commuter rail route and schedule data are included in Appendix D.

II. Future Conditions

Traffic-volumes in the study area were projected to the year 2017, which reflects a five-year planning horizon from the date of project submission for permitting. The traffic conditions for the year 2017 under No-Build conditions were developed to document the operating conditions independent of the proposed project, including baseline traffic-volumes projected to year 2017 resulting from background growth and traffic related to specific developments by others expected to be completed by 2017. Anticipated site-generated traffic volumes for the proposed mixed-use development were superimposed upon the No-Build traffic network to reflect the Build conditions with the project.

Background Traffic Growth

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 ambient growth rate for the area roadways and applies that percentage to all mainline and side street traffic volumes. 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, the drawback of this procedure is that the potential growth in population and development external to the study area would not be accounted for in the traffic projections.

To provide a conservative analysis framework, both procedures were used.

General Background Growth

Traffic-volume data compiled by MassDOT from permanent count stations and historic traffic counts in the area were reviewed in order to determine traffic growth trends. Based on the MassDOT traffic volume data, traffic volumes in the area have been decreasing at a rate of 1.5 percent per year since 2000. In order to provide a conservative (worse case) analysis scenario, a 1.0 percent per year compounded annual background traffic growth rate was used to account for potential future traffic growth external to the study area and presently unforeseen development. This is consistent with other recent projects reviewed by MassDOT and the Town of Concord. Count station data have been included in Appendix E.

Specific Development by Others

TEC coordinated with the Town of Concord to identify nearby private / public development projects that are either in the planning process or were recently approved by the Planning Board. After discussions with Town officials and review of recently approved projects, TEC was informed of four (4) projects that are proposed or currently under construction in the area. These projects are described in detail below:

- *300 Baker Avenue Medical Office Building* – This project consists of development of 50,000 SF of new medical office space at 300 Baker Avenue near the intersection of Baker Avenue Extension / Route 2. Although a Traffic Impact and Access Study (TIAS)[2] was prepared in June 2000 by Rizzo Associates, Inc. for this project, this study assumed that the project would consist of 100,000 SF of general office space. No subsequent traffic study was conducted as a result of the change in land use and decrease in building footprint. Therefore, TEC estimated the weekday morning and weekday evening site-generated trips using standard trip rates from the Institute of Transportation Engineers (ITE) publication *Trip Generation, 8th Edition* for Land Use Code (LUC) 720 – Medical / Dental Office Building. With the proximity of the proposed buildings to Route 2, only 5 percent of total trips were estimated to arrive from / depart to Laws Brook Road through the study area intersections.
- *1112 Main Street TD Bank* – This project consists of the construction of a 3,000 SF TD Bank with ATM teller lanes on the northeast corner of the Baker Avenue / Main Street / Cottage Street intersection. The existing site is currently occupied by a Mobil Gas and Service Station with 6 fueling positions. A TIAS[3] was prepared in September 2011 by Ron Müller & Associates, and updated with subsequent peer reviews by Greenman-Pedersen, Inc. throughout 2011 and 2012. The redevelopment project is anticipated to result in a decrease in site-generated traffic volumes during the weekday morning peak period and will generate a negligible increase in traffic volumes during the weekday evening peak period at the study area intersections. Therefore, the trips generated by the TD Bank were assumed to be included within the conservative (over-estimated) annual background growth rate.
- *113 Commonwealth Avenue Project* – This project consists of demolishing the existing building at 113 Commonwealth Avenue (Tony and Tailor Property) and reconstructing a two-story 6,797 SF retail / office building with two tenants, one of which will be Concord Outfitters. Both the prior land use and the proposed uses are low traffic-generating retail business, and therefore, no traffic studies were conducted as a result of this project. As such, the trips generated by the retail / office building were assumed to be included within the conservative (over-estimated) annual background growth rate.
- *Bradford Mills Redevelopment* - This project consists of renovating the existing Bradford Mill Buildings on Bradford Street. A traffic study was not completed for this project as the project is anticipated to result in negligible increases in traffic volumes on area roadways. Therefore, the trips generated by the redevelopment were assumed to be included within the conservative (over-estimated) annual background growth rate.

[2] Traffic Impact and Access Study – 300 Baker Avenue Office Building, Baker Avenue, Concord, Massachusetts. Rizzo Associates, Inc; June 2000.

[3] Traffic Impact and Access Study – 1112 Main Street TD Bank, Main Street, Concord, Massachusetts. Ron Muller & Associates; September 2011.

The resulting "Other Development" traffic-volumes are illustrated in Figures F-1 for the weekday morning and weekday evening peak hours. Detailed trip generation worksheets and trip distribution models for the 300 Baker Avenue Medical Office Building have been provided in Appendix F.

Re-Occupancy of Vacant Space

At the time that the turning movement counts were collected, the existing mixed-use commercial development contained approximately 2,074 SF of vacant office space which could be re-occupied by a similar land use without further project permitting. To account for trips that could be generated by re-occupancy of the existing vacant space, TEC utilized trip rates obtained from the Institute of Transportation Engineers (ITE) publication *Trip Generation, 8th Edition* for Land Use Code (LUC) 710 – General Office Building to estimate the trips generated by the additional 2,074 SF of office space. These re-occupancy trips were superimposed on the No-Build traffic-volumes. The resulting trips generated by re-occupancy of the site are illustrated in Figures G-1 and G-2 for the weekday morning and weekday evening peak periods, respectively. Trip generation calculations for the re-occupancy of existing vacant space are provided in Attachment G.

No-Build Traffic Volumes

The 2017 No-Build weekday morning and weekday evening peak-hour traffic-volumes were developed by applying the 1.0 percent per year compounded annual background growth rate to the 2012 Existing peak-hour traffic-volumes for 5 years and adding traffic to be generated by specific developments by others in the vicinity of the site and traffic to be generated by the re-occupancy of existing vacant space on site. The resulting 2017 No-Build weekday morning and weekday evening peak-hour traffic-volume network is presented in Figure 3.

Not to Scale

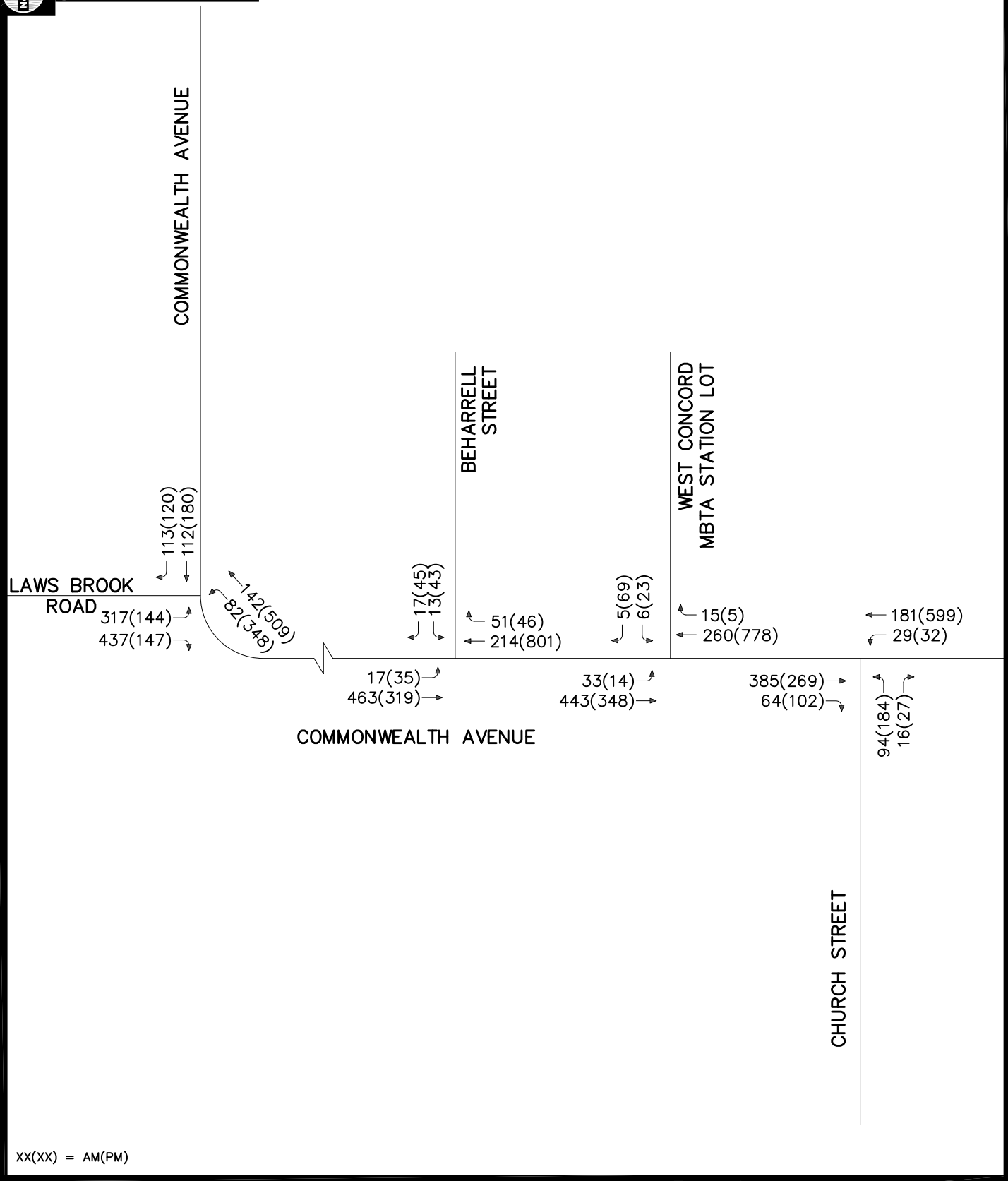

Figure 3

2017 No-Build Conditions
Weekday Morning and
Weekday Evening
Peak Hour Traffic Volumes

TEC, Inc.

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Site Generated Traffic

The site is currently occupied by a 3,364 SF post office and approximately 45,697 SF of mixed-use commercial space contained in two separate buildings that consist of approximately 15,047 SF of light industrial space 10,915 SF of general office space, and 19,735 SF of recreational uses. The project proponents, Oaktree FX, LLC and The Boynton Company, are proposing to demolish the existing land uses on the site and construct a mixed-use development to contain 74 apartment units, 10,764 SF of light industrial space, 7,808 SF of general office space, and 14,118 SF of recreational uses. In addition, a 6,750 SF of specialty retail building is proposed to be constructed at 13B Commonwealth Avenue. The existing 3,364 SF post office will remain on the site.

The trips generated by the proposed mixed-use development were estimated using standard trip rates published in the Institute of Transportation Engineers (ITE) publication, *Trip Generation, Eighth Edition* for Land Use Code (LUC) 110 (Light Industrial), LUC 220 (Apartments), LUC 495 (Recreational Community Center), LUC 710 (General Office Building), LUC 732 (United States Post Office), and LUC 814 (Specialty Retail) for each of the proposed uses, respectively. Table 3 provides a summary of the resulting trip generation.

Table 3 - Trip Generation Summary – Proposed Mixed-Use Commercial Development

Time Period	Light Industrial (LUC 110)	General Office (LUC 710)	Extensive Uses (LUC 495)	Specialty Retail (LUC 814)	Apartments (LUC 220)	Post Office (LUC 732)	Total Proposed Trips
Weekday Daily	75	86	323	299	572	364	**1,719**
Weekday Morning Peak Hour							
In	9	11	14	3	8	15	**60**
Out	1	1	9	2	32	13	**58**
Total	10	12	23	5	40	28	**118**
Weekday Evening Peak Hour							
In	1	2	16	17	38	19	**93**
Out	9	10	26	21	20	18	**104**
Total	10	12	42	38	58	37	**197**

[a]*ITE Trip Generation*, Eighth Edition, Institute of Transportation Engineers, 2008.

It is reasonable to expect that some trips to the site will be shared between multiple land uses. For example, someone living within the apartments may choose to visit one of the business locations on-site. Therefore, a reduction in the overall trips experienced on the adjacent roadways can be anticipated as a result of multi-use trips that include stops at more than one use within the mixed-use development. Based on information contained in the ITE publication *Trip Generation Handbook, 2nd Edition*, multi-use trips are anticipated to account for five (5) percent of the total Project-generated traffic during the weekday morning peak period, and twelve (12) percent of the total Project-generated traffic during the weekday evening peak period. The multi-use trip generation worksheets are included as in Appendix H.

Not all of the trips generated by the proposed mixed-use redevelopment will be new to the roadway network. The existing land uses on the site are currently generating trips that will be removed from the roadway network as part of the redevelopment of the site. Table 3 provides a summary of the trips generated by the existing land uses on the site.

In addition, many of the trips generated by the proposed development are already present in the existing traffic flow passing by the site. For example, some vehicles which are already on the roadways may decide to visit the mixed-use development on their way to another destination. These

vehicle trips are known as "pass-by" trips and are subtracted from the total trips to calculate the total primary (or "new") trips that affect the volume of traffic within the study area away from the project area. Based on information contained in the ITE publication *Trip Generation Handbook, 2nd Edition*, approximately 26 to 34 percent of the traffic generated by the proposed retail portion of the Project is expected to be pass-by traffic. To be consistent with MassDOT standards for preparation of a traffic study and in order to provide a conservative (worst case) analysis scenario, only 25 percent of the project-generated traffic from retail uses was assumed to be pass-by trips.

The proposed mixed-use project is located adjacent to the MBTA Commuter Rail Station (West Concord) located on Commonwealth Avenue. The availability of public transportation for access to the site will result in a reduction in the trips generated by passenger vehicles traveling to and from the site. Based on information contained in the ITE *Trip Generation Handbook, 2nd Edition* on trip reduction for developments located near transit centers, approximately 20 percent of the trips to/from the site will utilize public transportation.

Table 4 provides a summary of the resulting increase in trips generated by the proposed Beharrell Street Redevelopment project. The detailed trip generation calculations are provided as in Appendix H.

Table 4 - Trip Generation Summary

Time Period	Proposed Trips	Existing Trips	Net Increase	Multi-use Trips	Transit Trips	Pass-by Trips	New Primary Trips
Weekday Daily	1,719	1,041	**678**	154	256	52	**216**
Weekday Morning Peak Hour							
In	60	62	**-2**	3	7	1	**-13**
Out	58	29	**29**	3	10	1	**15**
Total	118	91	**27**	6	17	2	**2**
Weekday Evening Peak Hour							
In	93	43	**50**	11	15	3	**21**
Out	104	76	**28**	11	12	3	**2**
Total	197	119	**78**	22	27	6	**23**

[a]*ITE Trip Generation*, Eighth Edition, Institute of Transportation Engineers, 2008.

Site Access

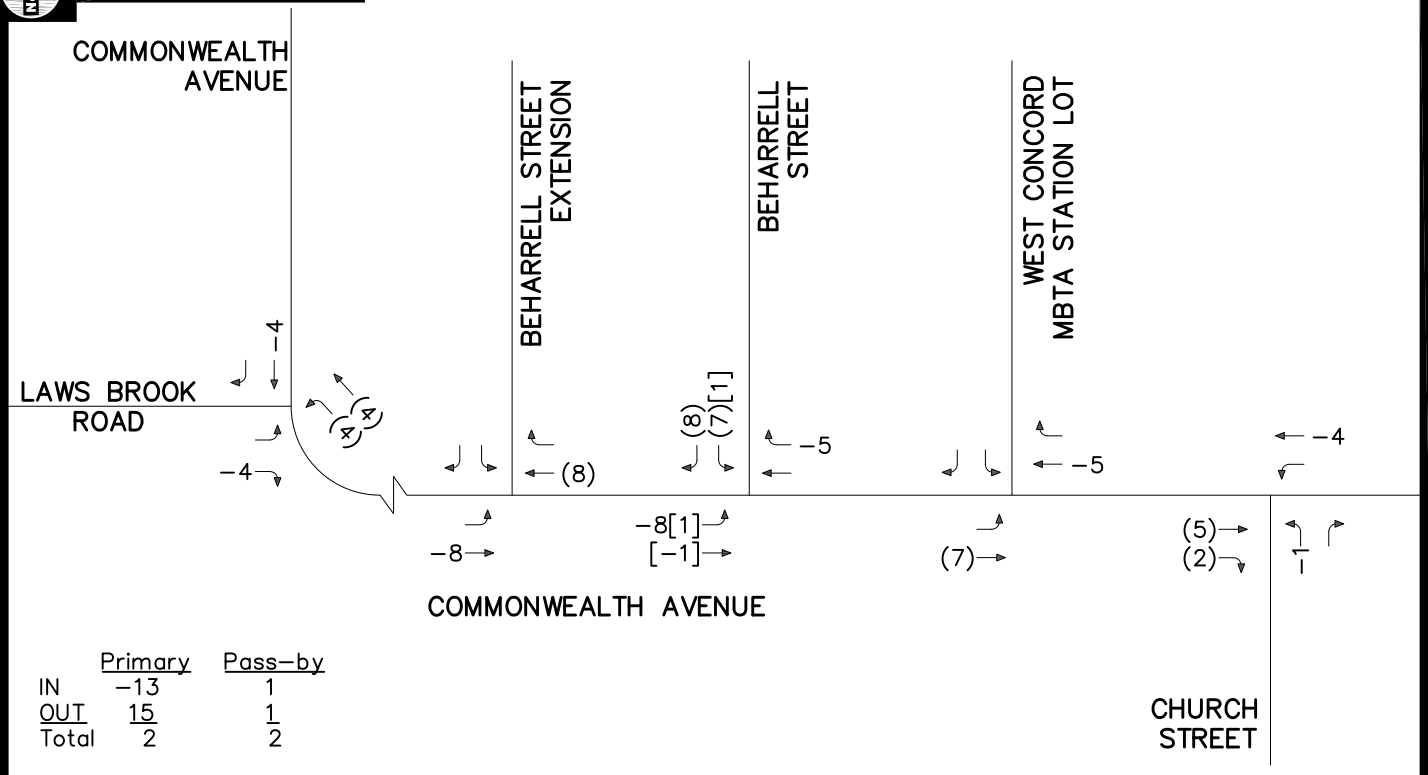
Access to the site is currently provided via a single full-access/egress connection of Beharrell Street to Commonwealth Avenue approximately 125 feet west of the MBTA commuter rail line. As part of the redevelopment project, Beharrell Street will be extended to provide a second full-access/egress connection to Commonwealth Avenue approximately 475 feet to the west of the existing Beharrell Street intersection. The extension of Beharrell Street will distribute traffic away from the congested exiting intersection near the West Concord MBTA Station.

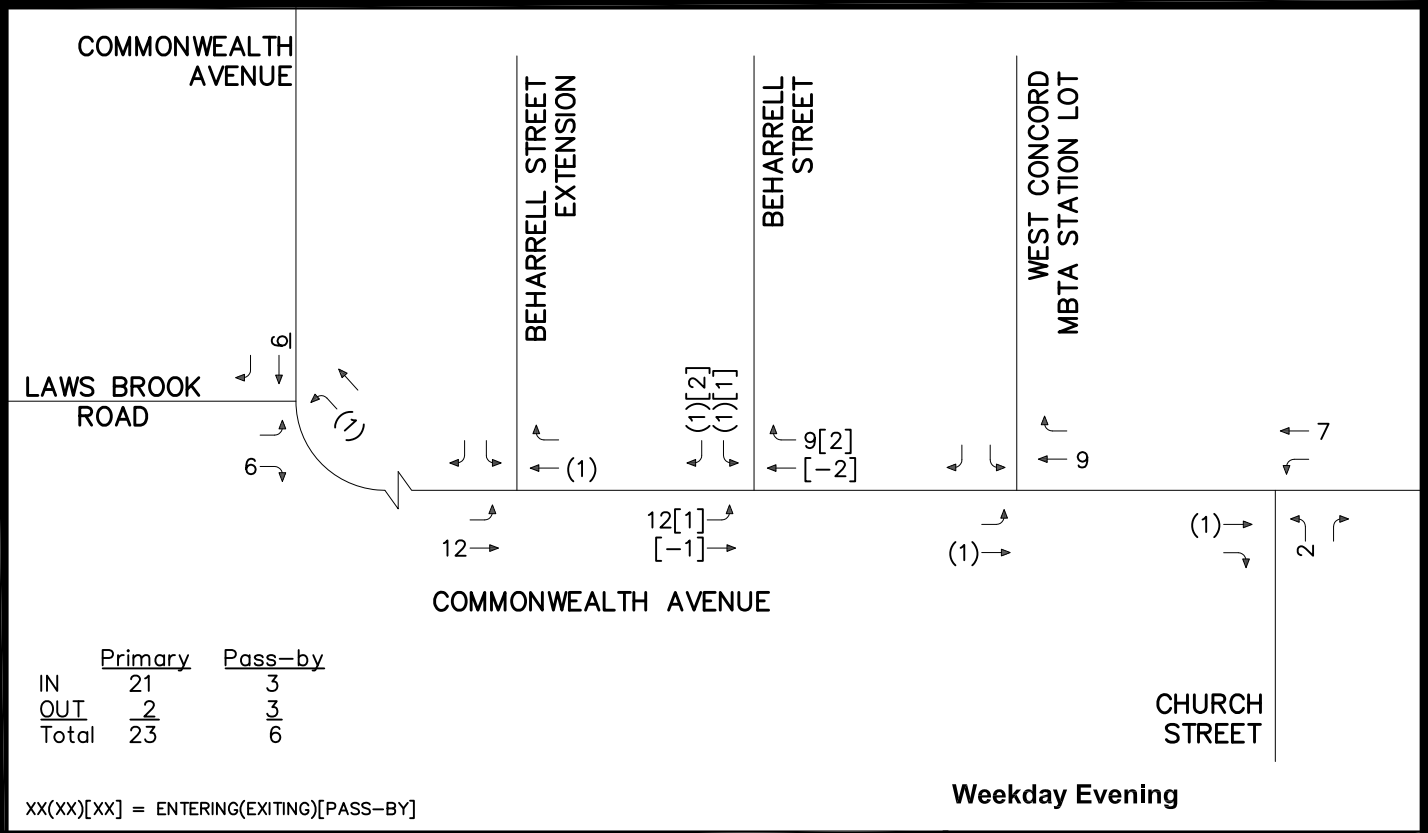
Trip Distribution & Assignment

Directional distribution of trips to and from the site was based on existing travel patterns along the study area roadways. Approximately 30 percent of the site-generated trips are expected to travel to/from the site via Commonwealth Avenue to the north, 30 percent via Commonwealth Avenue to the east, 30 percent via Laws Brook Road to the west, and 10 percent via Church Street to the south. The site-generated traffic-volumes are presented in Figure 4 for the weekday morning and the weekday evening peak hours. Distribution and assignment calculations based on existing traffic volumes can be found in Appendix H.

Not to Scale

Beharrell Street Redevelopment - Concord, Massachusetts





NOTE: ASSUMES ALL NEW SITE GENERATED TRIPS UTILIZED EXISTING BEHARRELL STREET TO ACCESS SITE. SITE TRIPS TO BE REDISTRIBUTED TO BEHARRELL STREET EXTENSION ARE SHOWN IN FIGURE 5.

Figure 4

Site Generated Trip Assignment
Weekday Morning and
Weekday Evening
Peak Hour Traffic Volumes

TEC, Inc.

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Redistributed Traffic Volumes

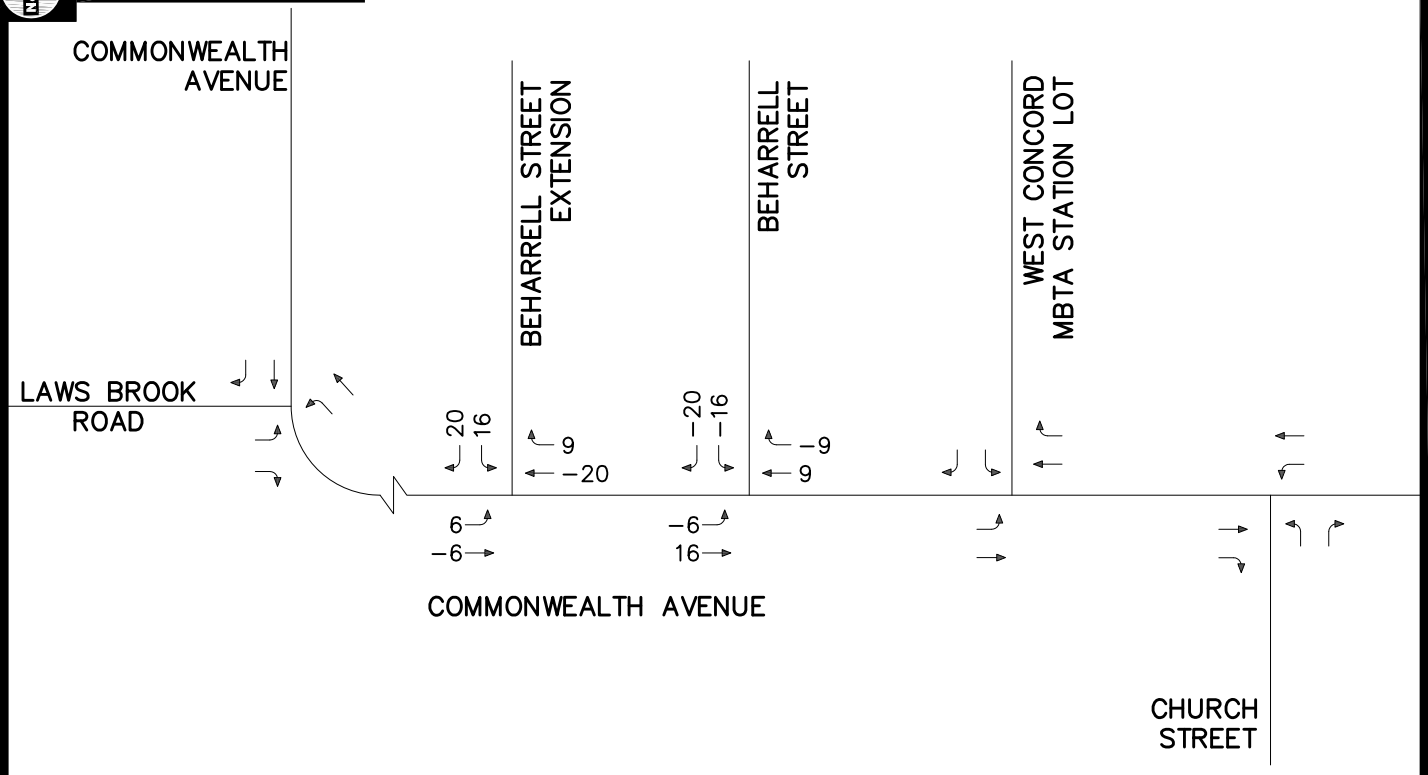
As part of the proposed mixed-use development project, a second connection to be known as the Beharrell Street Extension will connect the site to Commonwealth Avenue. This proposed Beharrell Street Extension will provide a full-access/egress connection to Commonwealth Avenue. As a result, some of the existing traffic exiting the site will be redistributed from the existing Beharrell Street to the proposed Beharrell Street Extension to the west. It is estimated that approximately 80 percent of the site-generated traffic to/from Commonwealth Avenue west of the site will be redistributed to the proposed Beharrell Street Extension. In addition, approximately 75 percent of the site-generated traffic exiting the existing Beharrell Street to Commonwealth Avenue east and 20 percent of the site-generated entering the existing Beharrell Street from Commonwealth Avenue east of the site will be redistributed to the proposed Beharrell Street Extension. The resultant redistribution of existing traffic to and from the Beharrell Street Extension is shown in Figure 5.

Build Traffic Volumes

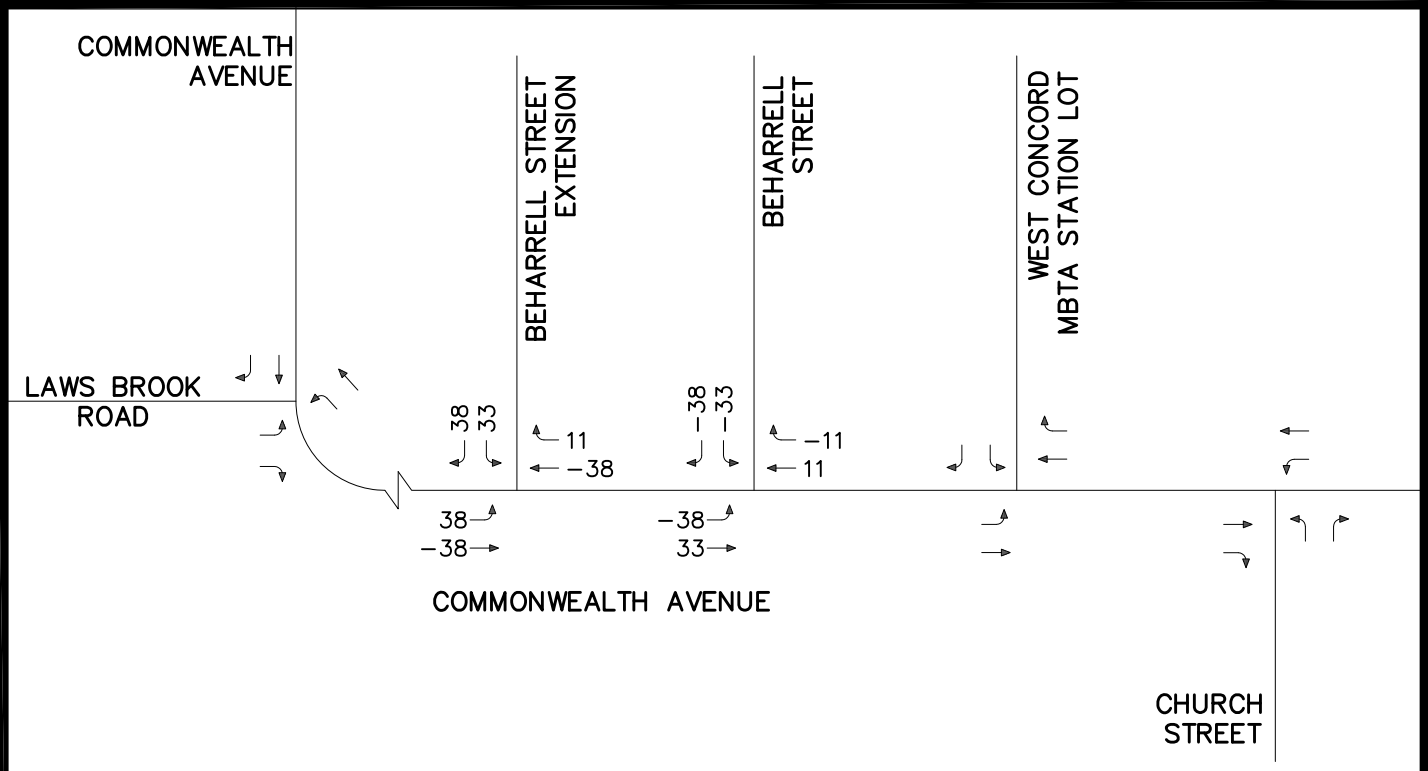
The 2017 Build condition traffic-volume networks consist of the 2017 No-Build traffic volumes with the addition of the anticipated site-generated trips and the redistribution of trips from Beharrell Street to the proposed Beharrell Street Extension. The 2017 Build traffic volumes for the weekday morning and weekday evening peak hours are graphically depicted in Figure 6.

Not to Scale

Beharrell Street Redevelopment - Concord, Massachusetts



Weekday Morning



Weekday Evening

Figure 5

Beharrell Street Ext. Redistribution
Weekday Morning and
Weekday Evening
Peak Hour Traffic Volumes

TEC, Inc.

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Not to Scale

Beharrell Street Redevelopment - Concord, Massachusetts

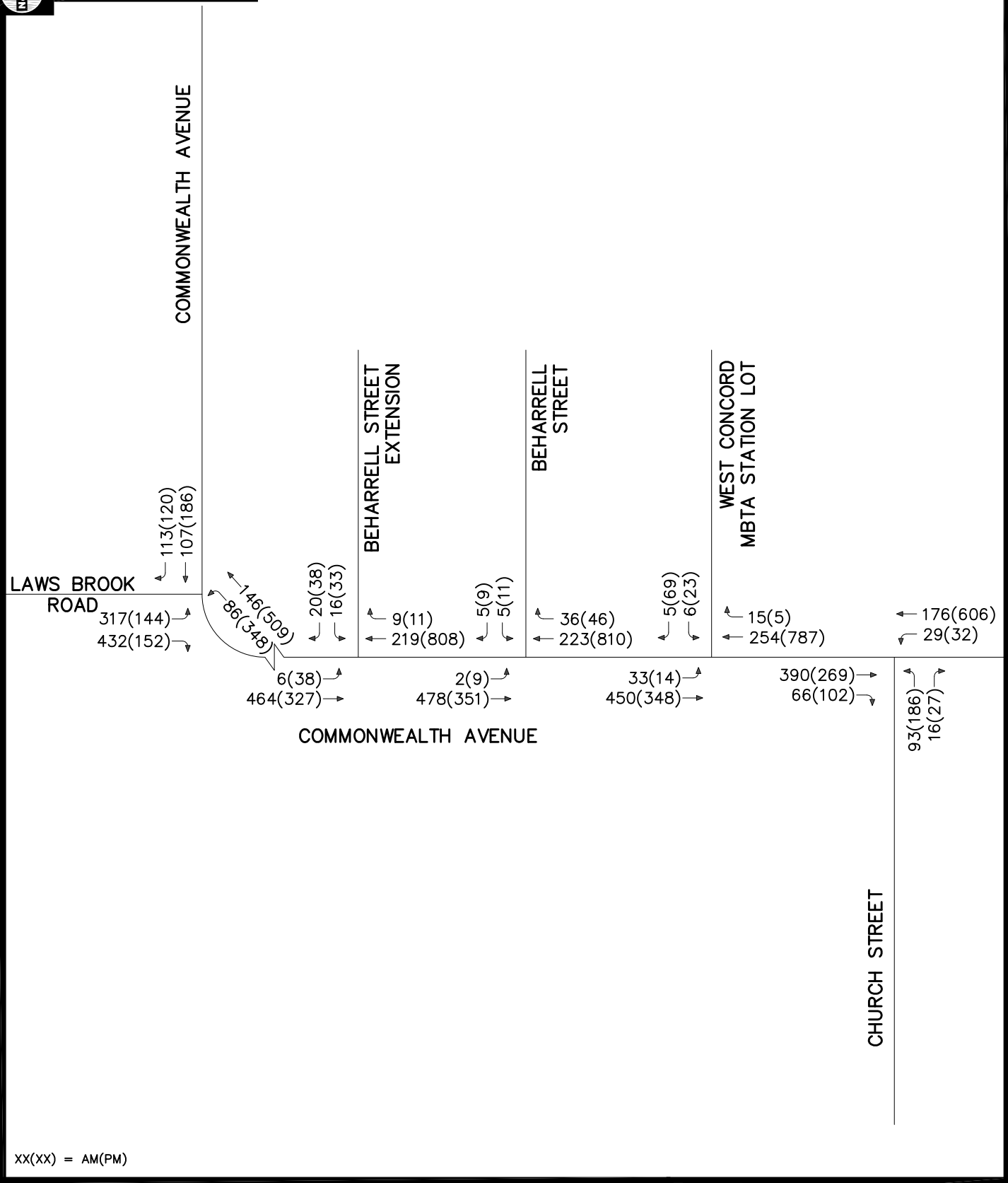

Figure 6

2017 Build Conditions
Weekday Morning and
Weekday Evening
Peak Hour Traffic Volumes

TEC, Inc.

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One-Way Flow Conversion

As part of the proposed mixed-use development project, the existing Beharrell Street connection to Commonwealth Avenue is proposed to be converted from two-way to one-way flow entering the site. As a result, traffic exiting the site from the existing Beharrell Street connection will be redistributed to the proposed Beharrell Street Extension to the west. The redistribution of trips resulting from the one-way conversion is shown in Figure 7.

MBTA Connections

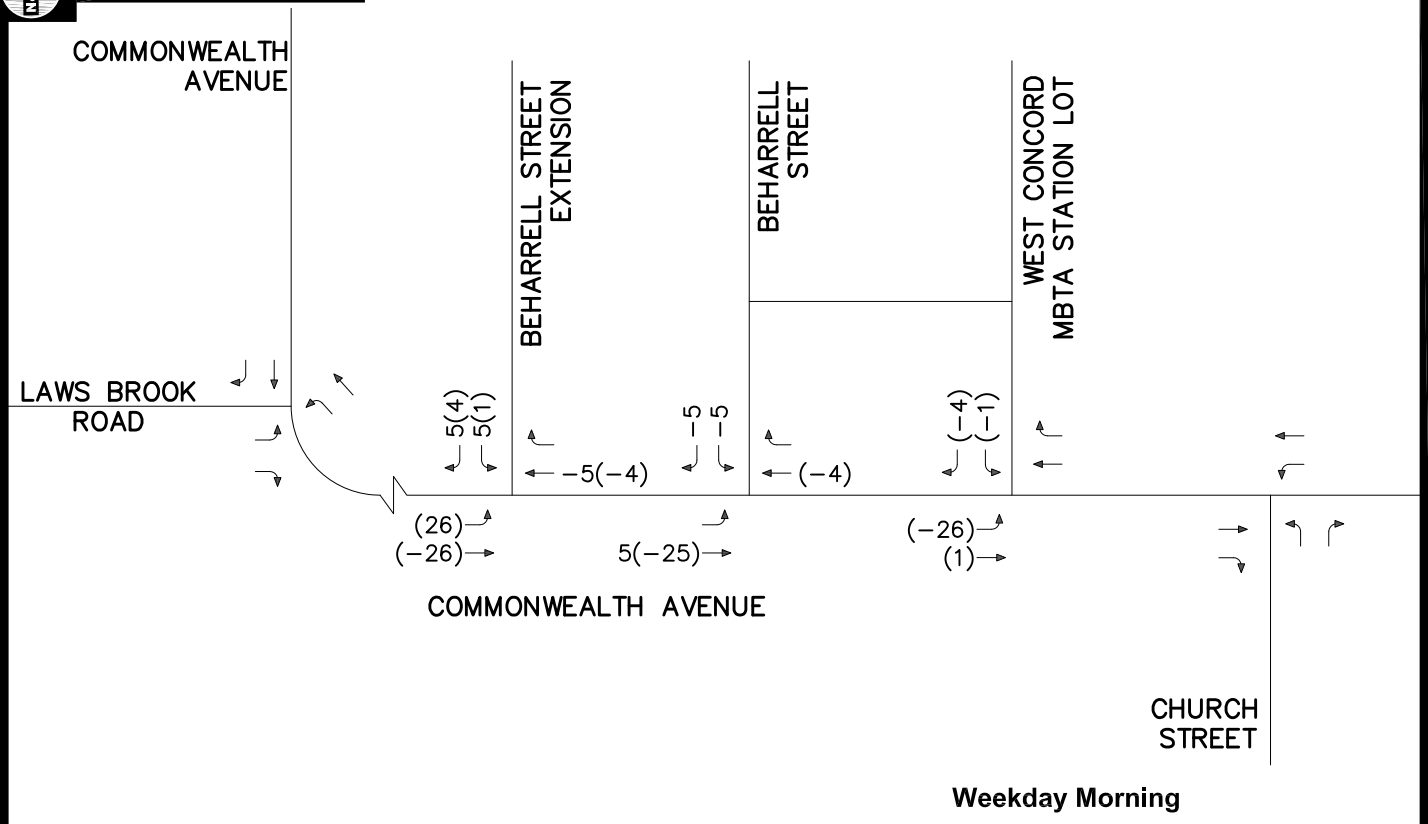
The Town of Concord's Master Plan recommends access management improvements for the West Concord area, which includes providing a connection between the Beharrell Street development and the West Concord MBTA Station. As mitigation for the project, the proponent will construct an extension of the site driveway to extend to the property line with the MBTA station in order to allow for a future connection to Beharrell Street Extension as part of a future Town of Concord and MBTA agreement. The redistribution of MBTA T-station trips resulting from the connection of the MBTA station to Beharrell Street Extension is shown in Figure 7.

Build with Mitigation Traffic Volumes

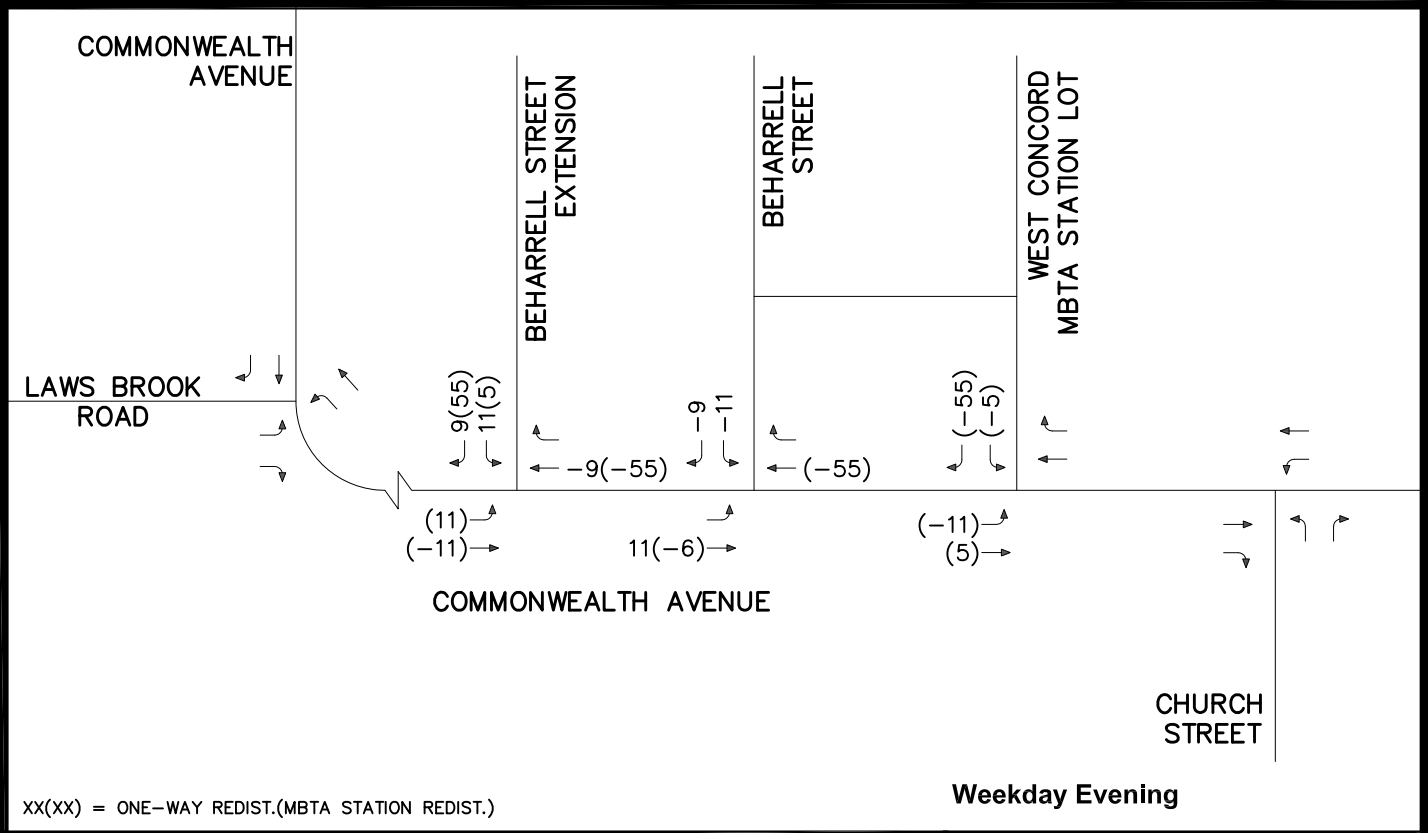
The 2017 Build with Mitigation condition traffic-volume networks consist of the 2017 Build traffic-volumes with the addition of the redistribution of resulting from the conversion Beharrell Street to one-way flow and the connection of Beharrell Street Extension to the MBTA station. The 2017 Build with Mitigation traffic volumes for the weekday morning and weekday evening peak hours are graphically depicted in Figure 8.

Not to Scale

Beharrell Street Redevelopment - Concord, Massachusetts



Weekday Morning



XX(XX) = ONE−WAY REDIST.(MBTA STATION REDIST.)

Weekday Evening

Figure 7

One-Way & T-Station Redistribution
Weekday Morning and
Weekday Evening
Peak Hour Traffic Volumes

TEC, Inc.

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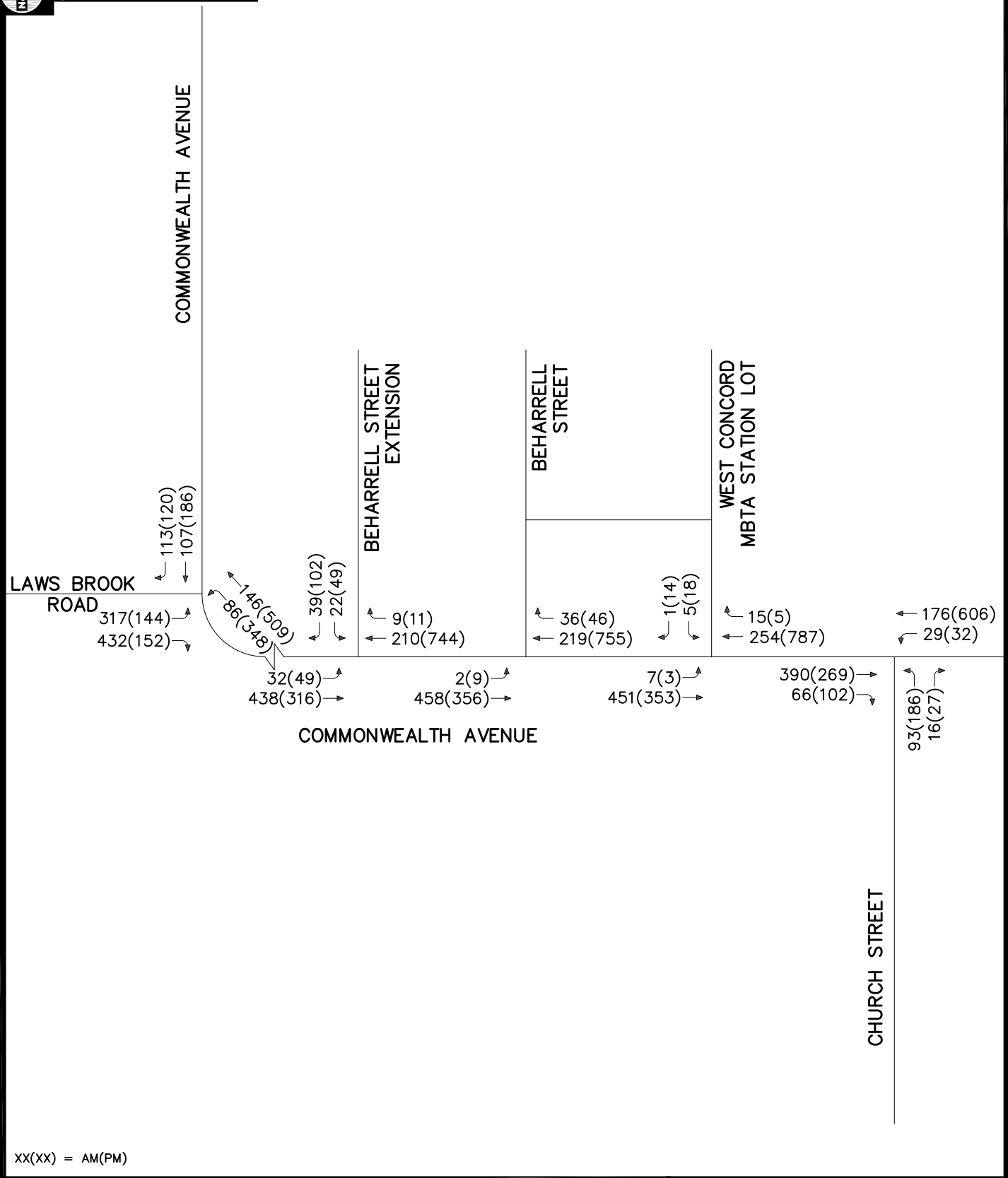

Figure 8

2017 Build with Mitigation Conditions
Weekday Morning and
Weekday Evening
Peak Hour Traffic Volumes

TEC, Inc.

III. 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 2012 Existing conditions, 2017 No-Build conditions, 2017 Build, and 2017 Build with Mitigation 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. The No-Build and Build conditions for the year 2017 are examined in order to determine the impacts associated with the redevelopment.

Methodology

Levels of Service

A primary result of capacity analyses is the assignment of level-of-service to traffic facilities under various traffic-flow conditions.[4] 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.

Six levels of service are defined for each type of facility. They are given letter designations from A to F, with level-of-service (LOS) A representing the best operating conditions and LOS F representing the worst.

Since the level of service of a traffic facility is a function of the traffic flows placed upon it, such a facility may operate at a wide range of levels of service, depending on the time of day, day of week, or period of year.

Queue Length Analysis

Vehicle queue analyses are a direct measurement of an intersections ability to process vehicles under various traffic control and volume scenarios and lane use arrangements.

The unsignalized intersection vehicle queue analysis was performed using the SimTraffic 7.0 intersection capacity analysis software which is also based upon the methodology and procedures

[4]The capacity analysis methodology is based on the concepts and procedures presented in the *Highway Capacity Manual 2000*; Transportation Research Board; Washington, DC; 2000.

presented in the 2000 HCM. SimTraffic reports both the 50th (average) and 95th percentile vehicle queues, which are based on the number of vehicles that experience a delay of six seconds or more at an intersection and is a function of the traffic signal timing; vehicle arrival patterns during the analysis period; and the saturation flow rate. The 50th percentile or average vehicle queue is the average number of vehicles that are projected to be delayed by six seconds or more at the intersection under study during the analysis period. The 95th 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 95th percentile queue length.

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 lane, with long control delays resulting. This may be a result of very high through traffic on the major street even with low volume on the side street.

The levels of service of unsignalized intersections are determined by application of a procedure described in the 2000 Highway Capacity Manual. 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 2000 Highway Capacity Manual. Table 5 summarizes the relationship between level of service and average control delay.

Table 5 – Level-of-Service Criteria for Unsignalized Intersections[a]

Level of Service	Average Control Delay (seconds per vehicle)
A	≤ 10.0
B	10.1 to 15.0
C	15.1 to 25.0
D	25.1 to 35.0
E	35.1 to 50.0
F	>50.0

[a]Source: *Highway Capacity Manual 2000*; Transportation Research Board; Washington, DC; 2000; page 17-2.

Unsignalized Intersection Capacity Analysis Summary

Level-of-service analyses were conducted for 2011 Existing, 2017 No-Build, 2017 Build, and 2017 Build with Mitigation conditions for the unsignalized intersections within the study area. The results of the unsignalized intersection capacity analyses are summarized in Table 6. The capacity analysis worksheets are provided in Appendix I.

Traffic exiting the Church Street, MBTA T-Station driveway, and Beharrell Street approaches onto Commonwealth Avenue currently experience long delays, particularly during the weekday evening peak hour. However, volume-to-capacity (v/c) ratios on these approaches will be well below 1.00, indicating there will be adequate capacity to accommodate the anticipated traffic volumes. The delay on these approaches is the result of queues extending from the railroad gates at the MBTA Commuter Rail tracks that block the intersections when an MBTA T train crosses Commonwealth Avenue. The proximity of the intersections to the commuter rail line exacerbates the delays as vehicles exiting Church Street, the MBTA station driveway, and Beharrell Street must wait for the long queue of vehicles on Commonwealth Avenue to clear after each train passes through before exiting onto Commonwealth Avenue.

As part of the proposed redevelopment project, a second connection to Commonwealth Avenue will be provided via Beharrell Street Extension, which will be located approximately 475 feet further west of the existing Beharrell Street connection to Commonwealth Avenue. In addition, the proponent will extend the proposed Beharrell Street Extension to the MBTA Station property line to allow for a future connection between the MBTA station and Beharrell Street Extension. With these improvements, delays exiting the Beharrell Street development area will be reduced by nearly 35 seconds below No-Build conditions, and delays exiting the MBTA station will be reduced by over 200 seconds below the No-Build conditions.

All movements at all other intersections within the study area are anticipated to operate at acceptable levels of service (LOS C or better) under all analysis scenarios.

Table 6 – Unsignalized Intersection Capacity and Queue Analysis Summary

	2012 Existing				2017 No-Build				2017 Build				2017 Build with Mitigation			
Intersection / Lane Group	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Commonwealth Avenue Spur / Laws Brook Road																
Weekday Morning																
Laws Brook Road EB approach	0.22	5.1	A	60/200	0.23	9.6	A	94/312	0.23	12.1	B	120/360	0.23	7.5	A	88/299
Commonwealth Avenue Spur SB approach	0.12	2.2	A	25/41	0.13	2.3	A	25/45	0.13	2.3	A	<25/40	0.13	2.3	A	<25/41
Weekday Evening																
Laws Brook Road EB approach	0.13	3.4	A	35/86	0.14	2.9	A	32/72	0.14	4.2	A	41/110	0.14	3.3	A	34/78
Commonwealth Avenue Spur SB approach	0.2	3.8	A	27/49	0.22	3.9	A	28/51	0.22	3.9	A	28/53	0.22	4.1	A	30/55
Commonwealth Avenue Spur / Commonwealth Avenue																
Weekday Morning																
Commonwealth Avenue Spur EB approach	0.52	5.6	A	56/78	0.55	5.9	A	58/82	0.56	6.2	A	59/82	0.56	5.5	A	57/80
Weekday Evening																
Commonwealth Avenue Spur EB approach	0.53	9.3	A	44/73	0.59	9.9	A	44/71	0.60	9.5	A	45/76	0.60	10.5	B	46/75
Commonwealth Avenue / Laws Brook Road																
Weekday Morning																
Commonwealth Avenue SB approach	0.24	13.3	B	35/71	0.27	18.5	C	39/83	0.26	19.6	C	42/89	0.26	7.6	A	36/75
Weekday Evening																
Commonwealth Avenue SB approach	0.37	12.3	B	51/91	0.41	15.8	C	58/104	0.43	20.5	C	66/118	0.43	20.7	C	62/115
Commonwealth Avenue / Beharrell Street Extension																
Weekday Morning																
Commonwealth Avenue EB approach	-	-	-	-	-	-	-	-	0.01	4.8	A	36/142	0.03	4.5	A	37/134
Beharrell Street Extension SB approach	-	-	-	-	-	-	-	-	0.08	5.0	A	<25/41	0.13	7.6	A	29/57
Weekday Evening																
Commonwealth Avenue EB approach	-	-	-	-	-	-	-	-	0.06	9.0	A	57/152	0.07	8.9	A	63/155
Beharrell Street Extension SB approach	-	-	-	-	-	-	-	-	0.36	25.4	D	38/78	0.62	47.3	E	99/221
Commonwealth Avenue / Beharrell Street																
Weekday Morning																
Commonwealth Avenue EB approach	0.01	27.2	D	168/541	0.02	28.5	D	196/587	0.00	24.7	C	142/404	0.00	24.4	C	127/411
Beharrell Street SB approach	0.11	7.2	A	<25/44	0.12	11.9	B	<25/47	0.04	10.0	A	<25/29	-	-	-	-
Weekday Evening																
Commonwealth Avenue EB approach	0.05	53.7	F	185/511	0.06	59.4	F	222/573	0.02	40.1	E	153/408	0.01	32.5	D	384/404
Beharrell Street SB approach	0.53	48.0	E	60/131	0.63	88.0	F	78/183	0.14	24.0	C	<25/44	-	-	-	-
Commonwealth Avenue / West Concord MBTA Station																
Weekday Morning																
Commonwealth Avenue EB approach	0.03	3.1	A	<25/51	0.03	2.9	A	25/53	0.03	3.0	A	<25/50	0.01	2.7	A	<25/51
MBTA Station SB approach	0.04	20.0	C	<25/<25	0.04	48.9	E	<25/<25	0.04	37.3	E	<25/<25	0.03	29.1	D	<25/<25
Weekday Evening																
Commonwealth Avenue EB approach	0.02	6.3	A	30/61	0.02	6.0	A	29/60	0.02	4.7	A	<25/51	0.00	3.9	A	<25/54
MBTA Station SB approach	0.61	221.3	F	149/340	0.69	464.1	F	242/510	0.70	239.5	F	136/354	0.31	76.5	F	<25/65

[a] Volume-to-capacity ratio, [b] Delay expressed in seconds per vehicle (average),[c] Level of service, [d] 95th Percentile Queue (in feet)

Table 6 – Unsignalized Intersection Capacity and Queue Analysis Summary (continued)

Intersection / Lane Group	2012 Existing				2017 No-Build				2017 Build				2017 Build with Mitigation			
	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Commonwealth Avenue / Church Street																
Weekday Morning																
Commonwealth Avenue WB approach	0.03	8.7	A	42/141	0.03	10.4	B	50/173	0.03	9.8	A	47/151	0.03	6.0	A	35/115
Church Street NB approach	0.36	16.7	C	44/96	0.40	17.1	C	28/84	0.40	16.7	C	31/94	0.40	16.1	C	30/88
Weekday Evening																
Commonwealth Avenue WB approach	0.03	40.8	D	218/487	0.03	35.5	E	226/508	0.03	31.4	D	238/521	0.03	34.3	D	214/508
Church Street NB approach	0.82	77.9	F	127/301	0.92	80.5	F	157/359	0.94	78.4	F	153/340	0.94	56.4	F	123/271

[a] Volume-to-capacity ratio, [b] Delay expressed in seconds per vehicle (average), [c] Level of service, [d] 95th Percentile Queue (in feet)

IV. Parking Analysis

The proposed Beharrell Street Redevelopment as depicted on the site plan prepared by Bohler Engineering dated September 27, 2012, consist of 74 apartment units, 10,764 SF of light industrial space, 7,808 SF of general office space, 6,750 SF of specialty retail, a 3,364 SF post office, and 14,118 SF of extensive uses. A total of 261 off-street parking spaces are proposed on the site to service the proposed redevelopment.

Parking Demand

TEC has estimated the potential parking demand generated by the proposed mixed-use development based on Town of Concord Zoning Regulations and published parking generation rates contained in the ITE publication *Parking Generation, 4th Edition*.

Town of Concord Zoning Regulations

The Town of Concord Zoning By-Laws contains off-street parking supply requirements for commercial, residential, and restaurant land uses. The following provides a summary of the parking requirements included in the Zoning By-Laws:

Residential	2.0 spaces per unit
Office	3 spaces per 1,000 SF
Government	4 spaces per 1,000 SF
Light industrial	2 spaces per 1,000 SF
Retail / Extensive Uses	1 space per 250 SF

As part of the Special Permit requirements, the proponents may request a waiver for a lesser provision of parking. While the Zoning By-Laws require that 2.0 parking spaces per residential unit be provided on the site, the proposed residential units will contain a mix of studio, one-bedroom, and two-bedroom units, resulting in a lower demand for residential parking spaces per unit. In addition, the proposed project will be a transit-oriented development, located adjacent to the MBTA station and within a walkable downtown setting, further reducing the need for residential parking. As such, the proponents intend to request a waiver to provide 1.5 parking spaces per unit for the residential uses.

The Town's zoning bylaws allow for sharing of parking spaces between land uses. Up to 50 percent of parking spaces used by retail, office and light industrial land uses may be used jointly by residential and educational land uses or other land uses that do not typically generate a high parking

demand during the same hours. The retail, office, and light industrial uses will generate the highest demand for parking during the day, while the recreational and residential uses will generate the highest parking demand at night. However, 75 of the 261 parking spaces provided on the site will be designated for residential parking only. Therefore, these parking spaces will not be available for shared use with the remaining uses on the site. The remaining 73 spaces (148 required – 75 designated residential spaces) required to meet zoning regulations for residential uses may be shared with other land uses on the site. Using the residential use as the critical land use and assuming 50 percent of the spaces may be shared with the retail, office, and light industrial uses, a reduction of parking of 37 spaces (73 x 0.5) may be allowed by the zoning bylaws.

Table 7 – Town Zoning Parking Requirements

	Required Rate	*Units*	*Required Spaces*
Residential	2.0 per unit	74 units	148
Office	3.0 per 1,000 SF	7,808 SF	24
Government	4.0 per 1,000 SF	3,364 SF	14
Recreational Center	1.0 per 250 SF	14,118 SF	57
Retail	1.0 per 250 SF	6,750 SF	27
Light Industrial	2.0 per 1,000 SF	10,764 SF	22
Subtotal			**292**
Reduction for Shared Parking			-37
Total Required Parking			**255**

As shown in Table 7, a total of 255 parking spaces are required by the zoning regulations to be provided on the site to accommodate the proposed land uses. However, the Town's zoning bylaws state that a waiver from the above requirements may be granted when a parking generation study indicates that the zoning regulations result in a parking supply far higher than the anticipated parking demand. Therefore, TEC has conducted a parking generation analysis to assess the adequacy of the proposed parking supply on the site.

ITE Parking Demand

The parking demand generated by the proposed mixed-use development was estimated based on parking demand generation rates contained in the ITE publication *Parking Generation, 4th Edition*. Table 8 summarizes the land use codes that were utilized to estimate the parking demand for the proposed uses. Detailed calculation sheets are included in Appendix J.

Table 8 - Parking Generation Land Use Summary

Proposed Use	ITE Land Use Code (LUC)	Supplemental ITE LUC
Light Industrial	110 (Light Industrial)	130 (Industrial Park)
Apartments	221 (Low/Mid-Rise Apartments)	None
Recreational Community Center	495 (Recreational Community Center)	492 (Health / Fitness Club)
Office	701 (Office Building)	None
Post Office	701 (Office Building)	130 (Industrial Park)
Retail	814 (Specialty Retail)	820 (Shopping Center)

The ITE parking demand data obtained for the above land uses was collected at rural or suburban sites, which did not account for nearby public transit. ITE estimates that for mixed-use commercial and light industrial developments with at least 30% of floor area dedicated to residential uses within 0.25 miles of a public transit station, a reduction in parking supply of 20 percent can be anticipated for commercial and residential land uses. Therefore, a reduction was accordingly applied to the parking demand generation estimates for each of these uses.

Of the 261 parking spaces to be provided on the site, a total of 75 spaces will be designated for residential parking only and will not be available for shared use with the remaining land uses on the site. As such, the parking demand for the residential land use was assumed to be at least 75 parking spaces for all hours of the day. For hours where the residential parking demand exceeded 75 parking spaces, these spaces were assumed to be shared with the remaining uses on the site.

Based on the ITE data for the proposed land uses, a peak parking demand of 160 parking spaces is estimated for the proposed mixed-use development on a weekday and a peak parking demand of 130 spaces is estimated for a Saturday. A total of 261 parking spaces will be provided on the site. Therefore, the peak parking demand can be accommodated by the proposed parking supply to be provided on the site.

V. Mitigation/Conclusion

After having evaluated the operations and safety of the study area roadways, the next step is to identify measures to improve the intersections based on existing and future deficiencies. The following sections provide a summary of measures that are recommended in order to improve the existing and future operations and safety of the study area intersections.

Commonwealth Avenue / Beharrell Street Extension

As part of the redevelopment project, a second connection of Beharrell Street to Commonwealth Avenue will be constructed, referred to as Beharrell Street Extension. This connection will alleviate long delays exiting the existing Beharrell Street connection onto Commonwealth Avenue. In addition, the applicant should implement the following improvements at the intersection of Commonwealth Avenue / Beharrell Street Extension:

- Construct a sidewalk along the northerly side of Beharrell Street Extension to provide a pedestrian connection between Commonwealth Avenue and the site
- Construct bump-outs on each corner to improve sight lines for vehicles exiting Beharrell Street Extension and provide a safe refuge for pedestrians waiting to cross the roadway.
- Install a crosswalk with ADA-compliant wheelchair ramps on Beharrell Street Extension.
- Eradicate the existing crosswalk on Commonwealth Avenue at the proposed Beharrell Street Extension and install a new crosswalk with ADA-compliant wheelchair ramps at the intersection.
- Install pedestrian crossing warning signs (W11-2) on Commonwealth Avenue in both directions at the relocated crosswalk.
- Remove the on-street parking along the southerly side of Commonwealth Avenue between the relocated crosswalk and the driveway to Concord Auto Sales.
- Install a STOP sign (R1-1) and STOP line on the Beharrell Street Extension approach to Commonwealth Avenue.

Commonwealth Avenue / Beharrell Street

The applicant should implement the following improvements at the intersection of Commonwealth Avenue / Beharrell Street:

- Convert Beharrell Street to one-way northbound (entering) flow between Commonwealth Avenue and the Post Office driveway.
- Install DO NOT ENTER (R5-1), NO RIGHT TURN (R3-1), and ONE WAY (R6-1) signs at the intersection of Beharrell Street and the Post Office driveway to indicate the one-way traffic flow pattern.

- Construct a sidewalk along the east side of Beharrell Street between Commonwealth Avenue and the Post Office driveway to reduce the roadway width, improve pedestrian safety, and provide traffic calming benefits.
- Construct bump-outs on each corner to improve visibility of pedestrians and provide a safe refuge for pedestrians waiting to cross the roadway.
- Eradicate the existing crosswalk on Commonwealth Avenue and restripe a new crosswalk perpendicular to the roadway.
- Construct new ADA-compliant wheelchair ramps on each approach to the crosswalks.
- Install pedestrian crossing warning signs (W11-2) on Commonwealth Avenue in both directions at crosswalk.

Figure 9 provides a graphical depiction of the proposed improvements along Commonwealth Avenue at the intersections of Beharrell Street and Beharrell Street Extension as mitigation for the proposed redevelopment project.

Conclusions

- The proposed Beharrell Street Redevelopment project contains a mix of complimentary land uses, which will reduce the total external vehicle trips and parking demand generated by the site by allowing for shared trips and parking between multiple uses.
- The project is anticipated to generate a total of 2 new primary trips during the weekday morning peak hour, and 23 new primary trips during the weekday evening peak hour.
- Traffic exiting the Church Street, MBTA T-Station driveway, and Beharrell Street approaches onto Commonwealth Avenue currently experience long delays, particularly during the weekday evening peak hour, as a result of queues extending from the railroad gates at the MBTA Commuter Rail tracks blocking the intersections when an MBTA T train crosses Commonwealth Avenue. The proximity of the intersections to the commuter rail line exacerbates the delays as vehicles exiting Church Street, the MBTA station driveway, and Beharrell Street must wait for the long queue of vehicles on Commonwealth Avenue to clear after each train passes through before exiting onto Commonwealth Avenue.
- As part of the proposed redevelopment project, a second connection to Commonwealth Avenue will be provided via Beharrell Street Extension, which will be located approximately 475 feet further west of the existing Beharrell Street connection to Commonwealth Avenue. In addition, the proponent will extend the proposed Beharrell Street Extension to the MBTA Station property line to allow the Town to connect the MBTA station and Beharrell Street Extension. With these improvements, delays exiting the Beharrell Street development area will be reduced by approximately 40 seconds below No-Build conditions, and delays exiting the MBTA station will be reduced by approximately 385 seconds below the No-Build conditions.
- All movements at all other intersections within the study area are anticipated to operate at acceptable levels of service (LOS C or better) under all analysis scenarios.

With implementation of the improvements identified in the previous section, the traffic associated with the Beharrell Street Redevelopment project can be safely and efficiently accommodated on the adjacent street system.

1" = 80'

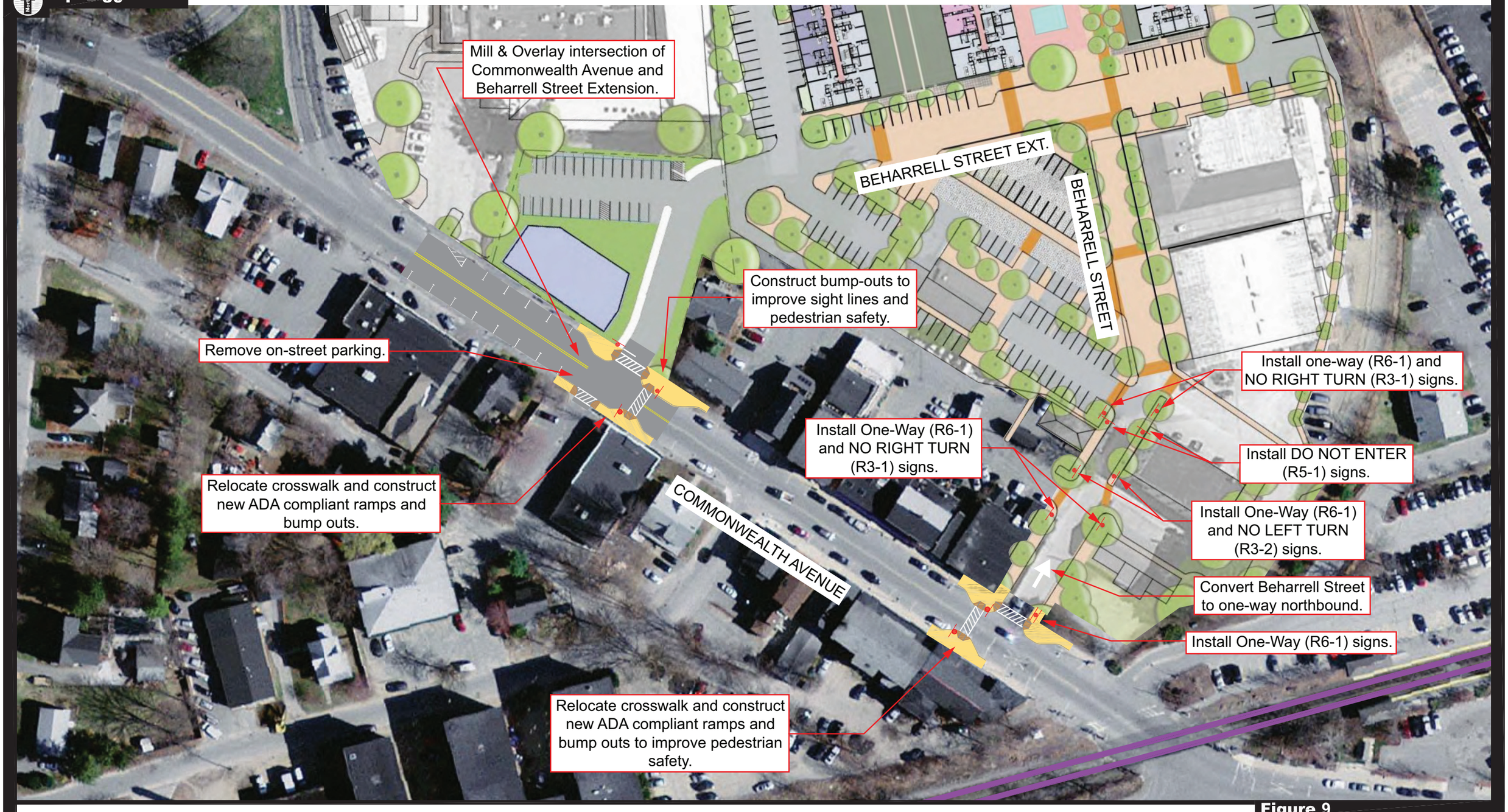

Figure 9

Conceptual Off-Site Improvement Plan for Commonwealth Avenue

TEC, Inc.

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