Green Building Project Checklist

Green Building
Project Location: 600 MASSACHUSETTS AVENUE, CAMBRIDGE, MA 02139

Applicant

Name: CIFRINO MASS AVE REALTY LLC C/O C/O Attorney Kevin Crane
Address: 50 GALLIVAN BLVD, DORCHESTER, MA 02134
Contact Information
Email Address: kevin@cranelawoffice.com TMCIFRINO@SUPREMELIQUORS.NET
Telephone #: 617-876-8500

Project Information (select all that apply):

- ☐ New Construction – GFA: _____
- ☐ Addition – GFA of Addition: _____
- ☑ Rehabilitation of Existing Building – GFA of Rehabilitated Area: 78,990 SF W/ BSMT WAIVER
  - ☐ Existing Use(s) of Rehabilitated Area: EXIST. RETAIL SPACES TO REMAIN ON BSMT AND FIRST FLOORS
  - ☐ Proposed Use(s) of Rehabilitated Area: PROPOSED 46 DWELLING UNITS ON 5 STORIES ABOVE RETAIL LEVEL.
- ☑ Requires Planning Board Special Permit approval
- ☐ Subject to Section 19.50 Building and Site Plan Requirements
- ☐ Site was previously subject to Green Building Requirements

Green Building Rating Program/System:

- ☑ Leadership in Energy and Environmental Design (LEED) – Version: LEED Multifamily Mied-Rise v4
  - ☐ Building Design + Construction (BD+C) – Subcategory: _____
  - ☐ Residential BD+C – Subcategory: _____
  - ☐ Interior Design + Construction (ID+C) – Subcategory: _____
  - ☑ Other: ENERGY STAR MULTI-FAMILY NEW CONSTRUCTION v1.1
- ☐ Passive House – Version: _____
  - ☐ PHIUS+
  - ☐ Passivhaus Institut (PHI)
  - ☐ Other: _____
- ☐ Enterprise Green Communities – Version: _____

Project Phase

☑ **SPECIAL PERMIT**

Before applying for a building permit, submit this documentation to CDD for review and approval.

Required Submissions

All rating programs:

- ☑ Rating system checklist
- ☑ Rating system narrative
- ☑ Net zero narrative (see example template for guidance)
- ☑ Affidavit signed by Green Building Professional with attached credentials – use City form provided (Special Permit)

Affidavit Form for Green Building Professional
Certificate of Occupancy

Green Building Project Location: Phase 2 - Mixed-Use Six-Story building
600 Massachusetts avenue, Cambridge, MA

Green Building Professional

Name: Liam Deevy, AIA, LEED AP BD+C

☒ Architect

☐ Engineer

Mass. License Number: 50658

Company: Peter Quinn Architects LLC

Address: 259 Elm St. Suite 301, Somerville MA 02144

Contact Information

Email Address: ldeevy@pqarch.com

Telephone Number: 617-354-3989

I, Liam Deevy, as the Green Building Professional for this Green Building Project, have reviewed all relevant documents for this project and confirm to the best of my knowledge that those documents indicate that the project was built to achieve the requirements of Section 22.24 under Article 22.20 of the Cambridge Zoning Ordinance.

(Signature) 10/14/2020 (Date)

Attach either:

☒ Credential from the applicable Green Building Rating Program indicating advanced knowledge and experience in environmentally sustainable development in general as well as the applicable Green Building Rating System for this Green Building Project.

☐ If the Green Building Rating Program does not offer such a credential, evidence of experience as a project architect or engineer, or as a consultant providing third-party review, on at least three (3) projects that have been certified using the applicable Green Building Rating Program.

LEED AP BD+C

GREEN BUSINESS CERTIFICATION INC. CERTIFIES THAT

Liam Deevy

HAS ATTAINED THE DESIGNATION OF

LEED AP® Building Design + Construction

by demonstrating the knowledge and understanding of green building practices and principles needed to support the use of the LEED® green building program.

10067702-AP-BD+C

CREDENTIAL ID

26 OCT 2011

ISSUED

23 OCT 2021

VALID THROUGH

Mahesh Ramanujam

MAHESH RAMANUJAM
PRESIDENT & CEO, U.S. GREEN BUILDING COUNCIL
PRESIDENT & CEO, GREEN BUSINESS CERTIFICATION INC.

MaGrann ASSOCIATES
Building Science for a Better Environment
701 East Gate Drive • Mount Laurel, NJ 08054 • 1-888-MAGRANN • www.magrann.com
New Jersey • Pennsylvania • Washington, D.C. • New York • Kentucky • Ohio • Hawaii

600 Massachusetts Ave, Cambridge, MA
Sustainability Narrative and Strategies

City of Cambridge
Green Building Narrative
Preliminary Submission
March 30, 2020
Revised: August 26, 2020

Prepared For: Peter Quinn Architects
By: MaGrann Associates and Sustainable Energy Analytics

RESNET Residential Energy Services Network
ENERGY STAR AWARD 2018 PARTNER OF THE YEAR
LEED FOR HOMES
Enterprise green communities
Home Innovation NGBS GREEN VERIFIER

Contents

Executive Summary

This narrative is being submitted for review by the Green Building Department in Cambridge, MA by Superior Realty for the project at 600 Massachusetts Ave. This proposed project is primarily residential with two small retail spaces (14% of the total area) on the basement and first floors. The total lot size is 21,262 square feet. The proposed new building will accommodate 46 residential units, approximately 6,752 gross square feet of street level retail and a total of 87 bicycle parking spaces in a one-level, below-grade basement.

The project will replace single story commercial space to provide needed homes in a high demand, livable community. It will provide a convenient, affordable housing alternative for the neighborhood, serving existing residents and those wishing to return to the City of Cambridge. The site is conveniently located within walking distance of Lafayette Square, a center of extensive local activity, and will be part of the thriving Mass Ave corridor, known for many community resources such as restaurants, theaters, and stores.

Superior Realty is fully committed to the community's green building goals. The current plan will easily meet the minimum green building requirements of the "Gold" level (60 pts) with the team aggressively working to integrate more points. The current checklist shows compliance with 75 points for Gold level compliance, with 19 additional points being evaluated for inclusion as the project moves further with design and construction. The developer is considering whether to obtain official LEED for Homes certification from the USGBC and ENERGY STAR certifications from the EPA. Also under consideration is to make the building "solar ready" so that the option of adding an on-site solar system in the future with minimum investment is preserved. Superior Realty is intending to build a structure that is energy and water efficient, has minimal impact on the environment, and contributes to a healthy community for the surrounding neighbors and the City of Cambridge.

Superior Realty has hired Peter Quinn Architects, a Somerville MA-based Architecture and Planning firm to design the project with Sustainable Energy Analytics (SEA) and MaGrann Associates (MA) as the energy conservation and sustainability consultant team to ensure the project meets its sustainability goals.

The following sections will detail the specific green building strategies the team has selected that will be used in the design and construction of this project. Also included is the preliminary LEED for Homes v4 Workbook. The checklist demonstrates that the project, when complete, will meet the LEED Gold certification level.

Project Description

The Applicant proposes to construct 600 Mass Ave, a multifamily residential development sited on two adjoining parcels totaling 66,767 sf at 600 Massachusetts Ave (the "Site"). The site is currently completely covered by single story commercial building and an existing building which will remain, repurposed as part of phase one of the same development. As listed in the application the project is in the Central Square Overlay District with a base zoning district of Business B.

The Applicant proposes to demolish the existing building and construct forty six (46) residential dwelling units on five (5) levels above two levels of commercial and amenity space. Additionally there will be two small community oriented retail spaces on the first floor. As of the current plan, the Project will provide a variety of unit types: approximately 20% will be studios, 46% will be one bedrooms, 30% will be two bedrooms, and 4% will be three bedrooms.

The site is situated a few blocks from University Park Commons and Clement Morgan Park offering access to open space and public art. Abundant and diverse uses within a half mile will combine with easy access to a high-frequency, well-networked public transit service at Central Square T station to facilitate a car-free lifestyle for residents.

The primary entrance for the residential units will be located at the ground floor on Mass Ave along with a direct secondary entrance from Green Street. The Project will additionally include eighty-seven covered secure bike storage spaces. These areas offer a bike repair area, combined with a fitness center to residents in the basement of the building.

Sustainability Strategies

This Building is being designed to meet and exceed the prevailing environmental and energy efficiency standards in force in the City of Cambridge and will meet the following standards:

- LEED for Homes v4 "Gold" Level Certification
- Massachusetts Stretch Energy Code compliance
- ENERGY STAR Multifamily New Construction v 1.1
- IECC 2015

Superior Realty has hired Sustainable Energy Analytics (SEA), and MaGrann Associates (MA) two partner firms centered on sustainability, durability, and energy efficiency to ensure LEED for Homes, Massachusetts Stretch Energy Code, and Utility Program compliance.

This document summarizes the specific LEED for Homes strategies that are being targeted or investigated during the design phase of the project to meet the City of Cambridge green building requirements for buildings. Also included is the preliminary LEED for Homes Workbook. There is not sufficient information available at this time to determine modeled savings % for the building, but the project team will share the information when it is available.

As required by the City of Cambridge the project team is using the LEED for Homes v4 methodology and checklist to quantify the "level" of green building practices. The city requires that a level of "certified" be attained. Based on the attributes of this project, for a multi-family building, a minimum of 40 points must be documented to be considered "certifiable" as stipulated by Cambridge Green Building Review Guidance (Article. 22.20). Based on the preliminary rating the project team is expecting a point total of between 76 to 93 or 190% to 230% of the target. These targets are preliminary but do reflect the attention the team is giving to building green.

Minimum Green Building Requirements

The green building requirements include a set of practices that are mandatory in order to fulfill the requirements of certification. These requirements earn no points. The verification team from Sustainable Energy Analytics will verify that a plan is in place to meet these requirements by the time construction permits are issued and will verify that these requirements have been met by the project's conclusion (i.e. issuance of certificates of occupancy). There are times when the attainment of these requirements cannot be met by the project conclusion. If this situation arises, the project team will inform the City of Cambridge of the issue and provide a plan for compliance for the city to approve.

Mandatory Requirement	Status
Location & Transportation	
a. Floodplain Avoidance	Complete
Sustainable Sites	
b. Construction Activity Pollution Prevention	Documented on Civil Plans
c. No Invasive Plants	By Project Completion
Water Efficiency	
d. Water Metering	By Project Completion
Energy And Atmosphere	
e. Minimum Energy Performance – Simulation	By Permitting
f. Minimum Energy Performance – Verification	By Project Completion
g. Energy Metering	By Project Completion
h. Education of Tenant and Building Manager	By Project Completion
Materials and Resources	
i. Certified Topical Wood	By Project Completion
j. Durability Management	By Project Completion
Indoor Environment Quality	
k. Ventilation	By Project Completion
l. Combustion Venting	By Project Completion
m. Garage Pollution Prevention	By Project Completion
n. Radon Resistant Construction	By Project Completion
o. Air Filtering	By Project Completion
p. Environmental Tobacco Smoke	By Project Completion
q. Compartmentalization	By Project Completion
Innovation	
r. Preliminary Rating	Complete

Green Measures – Narrative

The following sections detail the specific green measures that will be implemented in this project. All targeted measures will be implemented and verified. Each point would be evaluated on a worst case basis so the final score would reflect the worst case scenario.

Integrative Process (IP)

Sustainable design strategies and measures are constantly evolving and improving. New technologies are continually introduced to the marketplace, and up-to-date scientific research influences building design strategies. Occasionally a strategy that has been implemented results in building performance that greatly exceeds that required by code or changes currently accepted building practices. The strategies in this section are being considered to ensure that the project team leverages the knowledge and experience of the entire team and the kinetic creativity that results from team interaction around complex problems. The project team includes an experienced LEED Green Rater, an experienced HERS Rater, a LEED for Homes Accredited Professional and Construction Project Managers practiced in energy-efficient construction techniques. Regular core-design team meetings will be held through the duration of design and construction to ensure that all opportunities to improve building performance are capitalized on, all LEED credit opportunities are met, and all building durability measures are employed. In this project 1 out of 3 points are expected, with 1 additional point under consideration.

Targeted Point Strategies:

Integrative Project Team: Option 1 will be pursued. A team has been assembled with a diverse array of skills. Regular meetings with members of project team will be held to manage the continuity between design and construction of green building measures. Current and upcoming work will be discussed to ensure the design meets all requirements and to identify additional opportunities to cost effectively implement additional measures.

The team is considering pursuing Option 3, Trades Training by expanding the SEA / MaGrann Associates standard practice of approximately 4 hours of project-specific trades training for a construction team to meet the requirements of this credit by providing 8 total hours of trades training. The standard includes an orientation meeting with the full team of Green Rater, HERS Rater, GC, Framing, Electrical, Insulation, Mechanical, and Plumbing subcontractors to review the project's prerequisites and credits as well as the process for on-site verification of those measures. This offers a forum for subcontractors to provide their insight about the project goals and ensure the details are best aligned with the desired outcomes. This decision will be made with input from the General Contractor.

Option 2 is not under consideration at this time because it does not fit into preferred design process of the current team, whose members prefer more frequent meetings from 1-2 hours than the longer 4-8 hour engagements required to earn the charrette credit.

Location and Transit (LT)

Location and Transit credits address the site-related environmental impacts, in terms of impact to the site itself, the impact of future occupants' travel options and the benefits of avoiding remote sites. The strategies in this category reward optimally situated sites for minimizing the environmental impact of the building, promoting sustainable land-use and lower-carbon transit practices. The project will earn 15 out of a possible 15 points, and meet the Prerequisite Floodplain Avoidance.

Targeted Point Strategies:

Site Selection: Option 1, Path 1, Previously Developed will be pursued, ruling out Path 2. Choosing a previously developed, infill site and developing it within an optimal range of density (40-100 units per acre) reduces pressure on the land that surrounds our urban areas. Compact Development will be pursued at the highest available point threshold of 3 with 93.9 units per acre planned. Additionally, Site Selection, Option 2, Infill Development will be pursued, because it requires far less new infrastructure, public or private, to serve the occupants within a fully developed network of utility services, transit and diverse community resources. Option 4 will be pursued because the street network in Cambridge is dense, offering over 110 intersections per square mile in the circle of land within .25 miles of 600 Mass Ave. This characteristic promotes walkability because walkers are able to take more direct routes as compared to those with longer block lengths characteristic of suburban development. Urban planners have long recognized that the efficiency of densely populated areas is important in many dimensions, but that it is also key to provide opportunities for a biophilic experience. Access to parks of sufficient size means that people are able to reconnect and access the calming rejuvenation of nature without owning a significant piece of it for themselves. Option 3, Open Space will be earned by virtue of the site's proximity to University Park Commons. Option 5, Bicycle Network is not currently included because it does not have the capability to add to the LEED score. The project will include bike storage, however in a way that makes the most sense for this development and their intended residents.

The project will earn both available points in Community Resources by using a LEED v 4.1 credit substitution which adjusted the maximum point threshold to 16 resources. Access to a diverse array of community resources that provide opportunity to complete errands and find entertainment within a short walk will reduce the carbon footprint of the occupants when they opt for these outlets instead of traveling to similar options at a greater distance. It also provides additional eyes-on-the-street, helping to make the community safer and more resilient.

The project will earn both available points in Access to Transit, also by using a LEED v 4.1 credit substitution. Public transit is by far the most efficient means of moving individuals about a city. Residents only choose it en-masse when service is frequent, safe, affordable and does not take significantly longer than other available means of transportation. With 202 weekday trips and

154 weekend trips available from within a half mile walk, the project earns two points in this credit.

LEED for Neighborhood Development was not considered because of the scope of control is limited to this two-phase project.

Sustainable Sites (SS)

Thoughtful site design and landscaping decisions can lead to low maintenance landscaping that protects native plant and animal species and contributes to the health of local and regional habitats.

The ways in which a building is, or is not, integrated into the site can have various effects: Rain that falls on a site can be either a detriment, causing soil erosion and runoff of chemicals and pesticides, or a benefit, offering an opportunity to offset potable water demand and recharge underground aquifers. The project is targeting 4 of the available 7 points in SS, with 2 more under consideration.

Targeted Point Strategies:

Construction Activity Pollution Prevention: The builder will follow DPW guidelines to prevent erosion, control runoff, and protect watersheds from silt and sediment damage. Erosion control fences will be installed as necessary to either side of the building site to protect the abutting properties from any unusual drainage caused by temporary or unanticipated runoff. New rainwater control systems will be installed and, during construction, protected by filter fabric to insure that they remained clean.

No Invasive Plants: All newly installed plants will be native to avoid the downside risk of invasive plants escaping into and damaging the local ecosystem, while taking advantage of the selected species capacity to thrive in the local microclimate.

Heat Island Reduction: Over 75% of the total hardscapes on the site will be roofing. High albedo materials, defined as having an SRI of 78 or higher, will be used to reduce heat absorption and mitigate the local urban heat island effect, earning 2 points under Option 2.

Nontoxic Pest Control: Traditional pest control methods often include pesticides detrimental to human health and the natural environment. This building will use a combination of pest control methods that reduce the need for these harmful chemicals. Strategies used will include a solid concrete foundation wall system, a 6-inch visible area of wall space above grade to allow for inspection for evidence of pest activity, diligent sealing of pest entry points in the exterior wall assembly, and pest-proof mesh screens on all openings greater than a ¼ inch (where permitted by code).

Strategies Under Consideration:

Rainwater Management: The project team is evaluating the feasibility of meeting the LEED targets for site permeability and rainwater management. This site is constrained by its available area for rainwater management but consideration is being given to how the area available can be utilized to reduce the impact on the municipal storm water system through increased onsite

infiltration. Given the relatively high cost of rainwater management systems with other strategies that may yield more benefits that will be experienced by the occupants or the ownership group, this credit is only likely to be pursued if it is aligned with local requirements for NPDES projects.

Water Efficiency (WE)

Historically, green building has focused mostly on energy efficiency, but sound water conservation measures are becoming an increasing more important focus of the green community. Water efficiency measures can easily reduce water usage by 30% or more. In a typical home, savings of 30,000 gallons of water a year can be achieved very cost-effectively. This results in average annual water utility savings of about $100 per year. On this project the focus is on installing measures that have the highest savings to investment ratio. Of the total 12 available points, the project is targeting 8 points. Local utility connections are required to have meters, meeting the prerequisite with a whole building water meter.

Targeted Point Strategies:

Indoor Water Use: All units at 600 Mass Ave will benefit from high efficiency faucets and fixtures. All fixtures will be WaterSense labeled to ensure not just their water efficiency but also their quality as verified by a government backed, third-party verified label. The lavatory faucets will have an average flow rate of 1 gallon per minute, the showerheads will average 1.75 gallons per minute. The clothes washer will also be ENERGY STAR certified to ensure it is both water and energy efficient. This suite of measures earns 4 points under the Prescriptive Path, Case 2. Toilets with flush rates of 1.1 Gallon per flush will also be considered for an added point.

Also under the prescriptive path, 600 Mass Ave will use native plants for 100% of its landscaped area, earning 4 points in Outdoor Water Use. This practice improves the integrity of the local ecosystem while also ensuring that the plants are hearty enough to survive in the local climate without additional watering needs. This practice reduces water consumption significantly as compared to the use of turf which is highly water intensive. This project has no turf on site.

Energy and Atmosphere (EA)

When building green homes, the most important aspect is to minimize the energy use and the associated environmental impacts. For this reason, the EA category has the most available points (37.) For the 600 Mass Ave project the performance path was chosen. The project is targeting an energy efficiency performance 25% better than ASHRAE 90.1-2010 which translates to 27 points toward certification. These points achieved also reflect the smaller size of the units on this project relative to an average size unit, as detailed in the "Multifamily HSA" sheet within the LEED Workbook. This lower square footage per bedroom is a proxy for higher density and correlates with reduced consumption per capita. This approach acknowledges that sheltering people has inherent value, and that metrics for homes must take into account people accommodated as well as consumption versus square footage.

Targeted Point Strategies:

Minimum Energy Performance: The energy targets modelled for 600 Mass Ave will be verified on site using the ENERGY STAR Multifamily New Construction Testing and Verification Protocols (T&V). This quality assurance process is critical to ensuring that the modelled and designed targets are implemented diligently onsite so that the efficiency outcomes are achieved once the building is occupied. The ENERGY STAR T&V Protocols include visual verification of 100% of units by a certified Home Energy Rater or Rating Field Inspector. Final testing and verification is completed according to RESNET protocols. Final testing includes envelope leakage and duct leakage tests to validate the air sealing of the units, ducts and ventilation systems.

Understanding that projects in Cambridge are required to pursue the Enhanced Commissioning Credit, even when that credit is not available within the rating system used, the project team for 600 Mass Ave presents the following comparison of Enhanced Commissioning credit from LEED NC with the requirements of LEED Multifamily Midrise.

Enhanced Commissioning requires that the Commissioning Authority (CxA) be experienced in similar projects, have that experience extend into the operational phase of those projects and be at least a disinterested subcontractor of the design team. The T&V requires that the modeling be overseen by an Energy Star Licensed Professional and that on-site verification and testing be carried out by a HERS Rater, trained in rough and final stage inspection and testing of the building envelope as well as HVAC systems intended for 600 Mass Ave.

Both Option 1 Enhanced Systems Commissioning, Path 1 Enhanced Commissioning AND Option 2 Envelope Commissioning requirements will be met by the requirements of the prerequisite of Multifamily Midrise T&V Protocols. Prescriptive requirements of the T&V that will influence how the Commissioning plan is developed and executed include blower door testing at the unit level and duct leakage testing of heat pump air handling systems in units. The T&V also requires

duct leakage testing on central ventilation systems, which is crucial and too rare in projects that are not pursuing the Energy Star label. One practice will be added to ensure full compliance with Enhanced Commissioning options above which is the review of building operations after 10 months of operation.

Annual Energy Use: 600 Mass Ave will be modelled using a whole building energy simulation to predict its annual energy consumption. This project is targeting a 25% reduction in energy consumption compared to ASHRAE 90.1-2010. This will earn the project 17 points in EA Annual Energy Use. The relatively smaller size of apartments earns the project an additional 10 points through LEED's Home Size Adjustment calculation, see HSA. A total of 27 out of 30 potential points are there for awarded in this critical energy efficiency category.

Strategies Under Consideration:

Efficient Hot Water Distribution: This project is considering the location of the hot water source and usage points when laying out the units. Centralized distribution systems offer some meaningful benefits, but do introduce complexity and add to ongoing maintenance and retro commissioning scope to avoid significant energy waste. Therefore the team is currently planning to specify individual water heaters for each unit which will reduce the total volume of hot water stored in piping throughout the building, as well as pump energy. As the design progresses, the plumbing engineers will be directed to layout the hot water distribution with a focus on keeping runs short and pipe diameters as small as possible. This is made more feasible by the using low flow fixtures. These measures are very likely to enable the project to take Option 2, Performance test. This credit is not yet in the confirmed column however, because the final results are not available until after construction, and the overall score does not require the points at this time.

Option 3 Pipe Insulation will be further investigated but is not intended at this time. If the LEED credit is a marginal increase in cost compared to the code requirement, it may be implemented. This credit is given lower priority because it is known to have a larger real-world impact on buildings in warmer climates.

Advanced Utility Tracking is not being pursued, primarily for cost reasons relative to the expected benefit to the occupants. The multifamily specialists on the project team have not found a user-friendly, cost-effective solution for an in-unit energy-consumption dashboard on the market.

Materials and Resources (MR)

Good design decisions on the selection, sourcing and installation of materials can significantly reduce demand for materials, as well as their associated waste, embedded energy, and eventual need for replacement. This project focused their efforts on durability and reducing construction waste. The primary culprit of building damage is water intrusion followed by interior moisture sources, like showers. Proper material selection and detailing can reduce the damage caused by water and the need for costly repairs. Out of the maximum 9 points, 4.5 points were earned in this category.

Targeted Point Strategies:

Durability Management & Verification: The ENERGY STAR for Homes program provides a checklist of durability measures that have been provided to the builder on this project to improve their quality assurance onsite. Additionally a third party verifier will confirm the items on the checklist and that the drywall installed in wet areas meets ASTM D 3273 standards for durability, water-resistant flooring is used in rooms that may regularly get wet, and proper drainage and exhaust is provided for the water heater, clothes washer and clothes dryer.

Certified Tropical Wood: All wood on this project is either non-tropical, reused, reclaimed or certified by the Forest Stewardship Council. This ensures that any forestry practices in tropical areas that are supported by this project are sustainable.

Environmentally Preferable Products: For this project, 100% of the aggregate in concrete will be sourced from a local facility less than 100 miles from the project site. Environmentally Preferable Products, Low Emission and Local Products will be used throughout this project wherever cost effective. The project team is anticipated gaining 3.5 credits in this category, but will periodically search for cost effective opportunities to achieve more. The following are considered possible avenues to increase points in credit: Insulation with recycled content – fiberglass is readily available with high recycled content, but the project is likely to use mineral wool which performs better thermally, Steel Studs and drywall with recycled content. The strategy for these items is to require the contractor to report on the origin and recycled content of their proposed products during the submittal phase, sending the signal to the market that these characteristics are important. This approach is selected because if mandated, requiring specific recycled content levels in certain products can cause delays or cost increases that could be detrimental to the project overall.

Omitting floor covering, flooring, sheathing, concrete, roofing and siding were all omitted because they are not considered feasible in the team's local multifamily construction experience.

Construction Waste Management: Construction Waste Management Planning includes finding local options for diversion and requirement for contractor to provide documentation of actual diversion rate of construction waste. The diversion rate for construction waste will be documented with 2 points anticipated for this credit, based on achieving at least 75%.

Indoor Environmental Quality (EQ)

Over the past 20 years, research and experience have improved our understanding of what is involved in attaining high indoor environmental quality and revealed manufacturing and construction best practices that can prevent future problems. Preventing indoor air quality problems is generally much less expensive than identifying and solving them after they occur. Generally, there are three types of strategies used to improve air quality: removal, source control, and dilution. Since the 1987 release of EPA reports that designated indoor air pollution as a top environmental risk to public health, assessing and managing indoor pollutants have become the focus of integrated governmental and private efforts.
The Indoor Environmental Quality category encourages builders to prevent air pollution and improve air quality and comfort in the homes they build. Of the 18 points available the team is targeting 9.5 points with 3.5 additional points under consideration.

Targeted Point Strategies:

Ventilation: The bathroom and kitchen exhaust fans and ducts on this project are designed to ASHRAE Standard 62.2-2010. Exhaust and supply will be balanced to provide pollution removal (local exhaust) with the same system as the whole house ventilation (fresh air supplied to units and common areas.) Commercial bath exhaust fans will be designed in accordance with ASHRAE Standard 62.1-2007 for the commercial spaces by the tenant.

Combustion Venting: There will be no unvented combustion appliances, a hard-wired, battery backed-up carbon monoxide monitor will be installed in each unit, there will be no fireplace or wood stove, and no combustion based space and water heating equipment will be installed.

Radon-Resistant Construction: This project is in Radon zone 1, a high risk area as defined by EPA. In response, the design will include all required features of EPA's radon resistant new construction: a gas permeable layer covered by a control layer of polyethylene, penetrated by air tight PVC piping. These runs will be routed up and through the roof, where an electrical junction box will be located to facilitate the installation of an inline fan should one be needed in the future.

Air Filtering: This project will install air filters with a MERV rating of 8 for recirculating space conditioning systems and a MERV rating of 6 for mechanically supplied outdoor air systems with 10 or more feet of supply ductwork.

Environmental Tobacco Smoke: Smoking is prohibited throughout this building and within 25 feet of entries. Signage will be provided to communicate this policy. This approach meets the prerequisite and the requirements of the credit for 1 point.

Compartmentalization: Multifamily buildings with good air control layers surrounding each unit are more comfortable, efficient and their occupants report greater satisfaction with the space. Compartmentalized units are less likely to share respiratory droplets, odors, pollutants and sound between units and other units, corridors or outside. The strategies to achieve this are varied and complex, which is part of why this team was assembled to create and execute a compartmentalization plan.

Enhanced Ventilation: Option 1 will be earned because a continuous flow rate makes the most sense when using an ERV to ventilate bathrooms. This qualifies as an enhanced strategy because it will manage any potential humidity build up in bathrooms regardless of occupant utilization. Option 2 is not selected because the second requirement stipulating that flow rates must be between 100-110% of the ASHRAE 62.2-2010 minimum is and aggressively tight threshold for small units, where outside air requirements are often in the 20-30 CFM range. Expecting a whole building system to deliver between 20-22 CFM at a given register is not realistic given the technology and variables in play. It is listed as a maybe as a reminder to check the final commissioning results and award the point in the unlikely event that it is met. All ventilation flow rates will be verified as meeting or exceeding the ASHRAE 62.2 minimum.

The Contaminant Control credit reminds us about several strategies for minimizing the presence of contaminants inside homes, some of which are applicable to this building type, while others are not. Walk-off mats are an often specified approach to automatically cleaning the soles of entrants' footwear as they walk into the building. The team plans to install a walk off mat at each entry point to the building. However the credit is not taken because the credit requires the mat be 10 feet in the direction of travel. That would not be possible without reconfiguring the lobby, which may happen, pending other entryway concerns. Shoe removal and storage is generally more reasonable in larger homes, and not considered an optimal use of space for smaller homes like those planned for 600 Mass Ave. Also in the maybe column is a pre-occupancy flush of the building to reduce VOCs and particulates that are inevitably present post construction. Research shows that the value of this practice is particularly short lived, so it will be encouraged, but not required that the builder conduct this flush to earn this half point. Option 4 Air Testing is unpredictable and relatively expensive and will not be pursued.

Balancing of Heating and Cooling Distribution Systems: Case 1, Option 1 Multiple Zones is awarded based on the size of the units, even though the intention is to install single zone heating and cooling systems. Smaller homes can deliver comfort similar to larger homes with multiple zones. Option 3, pressure balancing will be pursued because it increases the comfort level of occupants when the supply air needed to maintain the thermostat's set point is delivered regardless of an open or closed bedroom door. Option 2 Supply Air-Flow Testing will not be pursued. The project plans to offer balancing control at the face of each register, giving each occupant the opportunity to adjust the flow of air in each room. By providing this benefit, the design also practically negates the value of professionally balancing every unit's system, if

the occupant is encouraged to make adjustments to match their comfort preferences in each room once they move in.

Enhanced compartmentalization will not be pursued. This could be reconsidered if the general contractor selected has extensive experience and confidence with constructing multifamily units that have passed their blower door tests by significant margins across the board. Generally this credit is avoided by all but the most experienced Energy Star and LEED Multifamily builders due to the uncertainty it introduces to the envelope commissioning process.

Enhanced Garage Pollutant Protection: This project does not have a garage which eliminates the risk of pollutants from cars and other toxic materials often stored in garages from entering the home. Combustion Venting similarly rewards the project with 2 points for omitting a fireplace.

Low-Emitting Products: This project is significantly improving indoor air quality by using low-emitting products for its paints, flooring, insulation, adhesives, sealants and composite wood products. These will all be required to meet LEED v4.1 requirements via accepted credit substitution, aligning with the applicable South Coast Air Quality Management District rules.

Innovation (IN)

Green building is a dynamic landscape of new ideas. Concurrent design and construction of thousands of projects with data shared through green building rating systems has accelerated the transition to greener building practices, by allowing project teams a common language to share their successes, many of which have become standard practice, as well as their failures and other ideas they would be unlikely to repeat in the same manner. Of the total 5 available points, the project is targeting 3 points, with strategies to achieve the other two under consideration.

The Innovation category also offers teams the opportunity to take up to two credits for Exemplary Performance achieved elsewhere in the rating system.

Targeted Point Strategies:

Cambridge is an inherently green community based on the existing urban fabric. It is unsurprising then, that 600 Mass Ave achieved Exemplary Performance for doubling the highest available thresholds in both Community Resources and Access to Transit. An additional point is available for the intended HVAC Start up procedure that is aligned with Energy Star Multifamily New Construction and the City of Cambridge's commissioning requirements.

Up to two more points could be achieved and are under investigation. Housing Types and Affordability and Design for Accessibility may be met by the design as it evolves. If they aren't met, but could be with a modest adjustment to the plans, they may also be pursued.

Regional Priority (RP)

Every location has its own unique environmental challenges. While there are common themes of what can be done to mitigate environmental impact, the issue of how much emphasis to place on each is strongly impacted by the project's location on the Earth. To acknowledge this reality, USGBC created Regional Priority Credits for each location. If this credit is earned at the appropriate threshold, the project may claim an additional point, up to 4 in Regional Priority.

At 600 Mass Ave they are: Compact Development at 2 points which is met, Community Resources at 2 points which is met, Outdoor water use at 3 points which is met, and Annual Energy Use at 15 points which is also met. If the project had not filled all 4 of its available RP slots already, Rainwater management at 3 points or balancing of Heating and Cooling Systems at 3 points might offer points. As it stands, they do offer the team perspective on the priorities of the local USGBC volunteers who selected these credits as regional priorities.

Appendix A: LEED For Homes Scorecard

LEED BD+C: Multifamily Midrise v4 - LEED v4

600 Mass Ave Scorecard

Location: **600 Massachusetts Ave, Cambridge, MA 02139, USA**

Note: The information on this tab is READ-ONLY. To edit this information, see the Credit Category tabs.

Integrative Process		**Preliminary**	Y	1 of 2	M	*1*	**Verified**	1
IPc	**Integrative Process**			1 of 2		*1*		1
Location and Transportation		**Preliminary**	Y	15 of 15	M	*1*	**Verified**	15
LTp	Floodplain Avoidance			Required				Verified
Performance Path								
LTc	LEED for Neighborhood Development			0 of 15		*0*		
Prescriptive Path								
LTc	Site Selection			8 of 8		*1*		8
LTc	Compact Development			3 of 3		*0*		3
LTc	Community Resources			2 of 2		*0*		2
LTc	Access to Transit			2 of 2		*0*		2
Sustainable Sites		**Preliminary**	Y	4 of 7	M	*2*	**Verified**	4
SSp	Construction Activity Pollution Prevention			Required				Verified
SSp	No Invasive Plants			Required				Verified
SSc	Heat Island Reduction			2 of 2		*0*		2
SSc	Rainwater Management			0 of 3		*2*		
SSc	Nontoxic Pest Control			2 of 2		*0*		2
Water Efficiency		**Preliminary**	Y	8 of 12	M	*1*	**Verified**	8
WEp	Water Metering			Required				Verified
Performance Path								
WEc	Total Water Use			0 of 12		*0*		
Prescriptive Path								
WEc	Indoor Water Use			4 of 6		*1*		4
WEc	Outdoor Water Use			4 of 4		*0*		4
Energy and Atmosphere		**Preliminary**	Y	27 of 37	M	*5*	**Verified**	27
EAp	Minimum Energy Performance			Required				Not Verified
EAp	Energy Metering			Required				Verified
EAp	Education of the Homeowner, Tenant or Building Manager			Required				Verified
EAc	Annual Energy Use			27 of 30		*0*		27
EAc	Efficient Hot Water Distribution System			0 of 5		*5*		
EAc	Advanced Utility Tracking			0 of 2		*0*		

Materials and Resources		Preliminary	Y	3.5 of 9	M	*3.5*	Verified	3.5
MRp	Certified Tropical Wood			Required				Verified
MRp	Durability Management			Required				Verified
MRc	Durability Management Verification			1 of 1		*0*		1
MRc	Environmentally Preferable Products			0.5 of 5		*3.5*		0.5
MRc	Construction Waste Management			2 of 3		*0*		2

Indoor Environmental Quality		Preliminary	Y	9.5 of 18	M	*3.5*	Verified	9.5
EQp	Ventilation			Required				Verified
EQp	Combustion Venting			Required				Verified
EQp	Garage Pollutant Protection			Required				Not Verified
EQp	Radon-Resistant Construction			Required				Verified
EQp	Air Filtering			Required				Verified
EQp	Environmental Tobacco Smoke			Required				Verified
EQp	Compartmentalization			Required				Verified
EQc	Enhanced Ventilation			1 of 3		*2*		1
EQc	Contaminant Control			0 of 2		*1*		
EQc	Balancing of Heating and Cooling Distribution Systems			2 of 3		*0*		2
EQc	Enhanced Compartmentalization			0 of 3		*0*		
EQc	Combustion Venting			2 of 2		*0*		2
EQc	Enhanced Garage Pollutant Protection			1 of 1		*0*		1
EQc	Low-Emitting Products			2.5 of 3		*0.5*		2.5
EQc	No Environmental Tobacco Smoke			1 of 1		*0*		1

Innovation		Preliminary	Y	3 of 6	M	*2*	Verified	3
INp	Preliminary Rating			Required				Verified
INc	Innovation			3 of 5		*2*		3
INc	LEED Accredited Professional			0 of 1		*0*		

Regional Priority		Preliminary	Y	4 of 4	M	*0*	Verified	4
RPc	Regional Priority			4 of 4		*0*		4

Point Floors

The project earned at least 8 points total in Location and Transportation and Energy and Atmosphere	Yes
The project earned at least 3 points in Water Efficiency	Yes
The project earned at least 3 points in Indoor Environmental Quality	Yes

Total		Preliminary	Y	75 of 110	M	19	Verified	75

Certification Thresholds Certified: 40-49, Silver: 50-59, Gold: 60-79, Platinum: 80-110

MaGrann ASSOCIATES
Building Science for a Better Environment
701 East Gate Drive • Mount Laurel, NJ 08054 • 1-888-MAGRANN • www.magrann.com
New Jersey • Pennsylvania • Washington, D.C. • New York • Kentucky • Ohio • Hawaii

Net Zero Narrative for 600 Massachusetts Avenue, Cambridge, MA
Submitted by Peter Quinn Architects, Sustainable Energy Analytics & MaGrann Associates
August 21, 2020

Project Profile

Development Characteristics

Lot Area SF:	21,262
Existing Land Use(s) and Gross Floor Area SF, by Use:	Retail: 54,719
Proposed Land Use(s) and Gross Floor Area SF, by Use:	Retail: 33,355 with waiver; 46,053 without Residential: 47,884 with waiver; 45,918 without
Proposed Building Height(s) (ft. and stories):	70.2'; 6 stories
Proposed Dwelling Units:	46
Proposed Open Space SF:	3,319
Proposed Parking Spaces:	0
Proposed Bicycle Parking Spaces (Long-Term and Short-Term):	87

Green Building Rating System

Version:	LEED Multifamily Midrise v4
Level:	Gold
Seeking Certification?	TBD
Points:	75 Yes (over 60 required for Gold)

Net Zero Narrative for 600 Massachusetts Avenue, Cambridge, MA
Submitted by Peter Quinn Architects, Sustainable Energy Analytics & MaGrann Associates
August 21, 2020

Proposed Project Design Characteristics

Building Envelope

Descriptions:

Roof:	High Albedo (reflective, white) roof membrane, Polyisocyanurate insulation sufficient to create a drainage taper, roof sheathing supported by open web trusses, where the cavity is completely filled with fiberglass insulation, in contact with drywall below to prevent convective loops.
Foundation:	Existing foundation wall to remain, new concrete walls adjacent to existing foundation
Exterior Walls	Metal siding over 2" continuous insulation (type TBD – R-8.4-10) Gypsum wall sheathing on light gauge metal studs with 5.5" Mineral wool batt insulation providing an R-23 in the cavity, encapsulated by 5/8" gypsum wall board at the interior
Windows:	Fiberglass frame picture and casement windows
Window to wall ratio:	22%
Other components:	None

Envelope Performance:

	Proposed		Baseline	
	Area in sf	U-value	Area in sf	U-value
Window fixed/operable	6006	0.27	6006	0.38/0.45
Wall	21520	0.045	21520	0.052
Roof	8148	0.22 (or lower)	8148	0.035

Envelope Commissioning Process:

In accordance with Energy Star Multifamily New Construction requirements, a certified HERS Rater or Rating Field Inspector will verify that the insulation and air sealing have been installed according to the designed specifications, prior to covering with drywall. Air leakage will be verified as the building approaches completion by individual unit blower door testing. This provides assurance that both the exterior air barrier and the compartmentalization air barrier are properly sealed. All units must demonstrate no more than 0.30 CFM50 per square foot of enclosure area.

Net Zero Narrative for 600 Massachusetts Avenue, Cambridge, MA
Submitted by Peter Quinn Architects, Sustainable Energy Analytics & MaGrann Associates
August 21, 2020

Building Mechanical Systems

Descriptions:

Space Heating	Mini-split heat pump in each unit
Space cooling	Mini-split heat pump in each unit
Heat Rejection	N/A
Pumps	Water Booster pump to be NEMA premium efficiency
Ventilation	Local exhaust for bathrooms provided by continuous, outgoing air stream of two rooftop ERV units. Supply air stream of ERVs provides balanced whole house ventilation air directly to units per ASHRAE 62.2 and common areas per ASHRAE 62.1. Other local exhausts are intermittent from Kitchen and laundry and go directly outside the envelope.
Service Hot Water	Electric water heaters in each apartment
Interior lighting	100% LED fixtures, both semi-recessed and surface mounted
Exterior lighting	100% LED
Other systems	N/A

Commissioning Process:
The project will comply with Enhanced Commissioning requirements as laid out in LEED NC v4 by following the Energy Star Multifamily New Construction v1.1 requirements with the addition of a review of building performance and operation by the HERS Rater 10 months after occupancy. Several key components of that process include: duct leakage testing on central ventilation systems and heating and cooling systems, verification that all ventilation flow rates comply with applicable ASHRAE standards, as well as notification of the owner if tested values are out of alignment with the design intent.

Net Zero Narrative for 600 Massachusetts Avenue, Cambridge, MA
Submitted by Peter Quinn Architects, Sustainable Energy Analytics & MaGrann Associates
August 21, 2020

Anticipated Energy Loads and Greenhouse Gas Emissions

Assumptions

The initial energy study for 600 Mass Ave was conducted for the residential and residential-associated portions of the building only because it comprises the vast majority of the project. It is also important to consider those choices carefully because they will repeat their impact many times over though the building. ASHRAE 90.1 based energy modeling, using eQUEST software will begin once the project begins the Design Development phase.

The envelope and mechanical systems were reviewed and compared with both MaGrann Associates and Sustainable Energy Analytics' portfolio of high performance multifamily buildings with a priority on long term environmental performance. The first consideration was elimination of any gas combustion, a once unthinkable step in the area that is now achievable. This permits the building to become greener over time as the fuel mix of the grid lowers in carbon impact. It will create a building that has higher greenhouse gas emissions upon completion however, when compared to the presumed lower distribution losses of natural gas.

.

Annual Projected Energy Consumption and Greenhouse Gas (GHG) Emissions

Projected consumption results by end use will be provided in the next iteration of the Net Zero Narrative, once energy modeling has begun. At this stage we have set a target for EUI based on the building type, fuel sources and location.

	Baseline	Proposed	Future
Total projected energy use kWh/yr	5,718,546	4,084,676	4,046,452
Site EUI in kBtu/SF*yr	35	25	25
Source EUI in kBtu/SF*yr	0	70	0
On-site Renewable Energy Generation in kWh/yr	0	0	38,224
Off-site Renewable Energy Generation in kWh/yr	0	0	4,046,452
GHG Emissions total in tons CO2/yr	128	92	0
GHG Emissions total in lbs CO2/yr	256,538	183,241	0

Net Zero Narrative for 600 Massachusetts Avenue, Cambridge, MA
Submitted by Peter Quinn Architects, Sustainable Energy Analytics & MaGrann Associates
August 21, 2020

Building Energy Performance Measures

Overview

Land Uses	Mixed use building reserves street frontage for community supporting retail. Location within existing amenity rich community promotes walking and biking. No vehicle parking provided while significant bicycle parking is provided.
Building Orientation and Massing	Proposed building is locked between existing buildings and the street, glazing located efficiently where it can be included. Windows deployed in a responsible 22% window to wall ratio.
Envelope Systems	Walls and roof to have continuous exterior insulation in addition to cavity insulation limiting thermal bridging. High performance glazing included for dual benefit of Energy Efficiency and occupant comfort
Mechanical Systems	Mini-split heat pumps are the current top-tier system for efficiency in residential construction. They also offer individual control and superior dehumidification when compared to traditional heat pumps.
Renewable Energy Systems	None planned at this time, but 1,353 square feet of roof area has been identified as solar ready and appropriate conduit, roof configuration and electrical room space will be allocated to allow for future installation of on-site solar generation.
District Energy Systems	Not considered
Other Systems	High Efficiency plumbing systems save both water and energy used to pump and heat water.

Integrative Design Process

Architects manage regular meetings with the design team as the project progresses. Each meeting will include a reminder to revisit the strategies under consideration generated as part of the initial LEED preliminary rating. Each item needing further data collection or research is assigned to the appropriate team member to investigate and report back to the team at the next meeting.

Net Zero Narrative for 600 Massachusetts Avenue, Cambridge, MA
Submitted by Peter Quinn Architects, Sustainable Energy Analytics & MaGrann Associates
August 21, 2020

Solar-Ready Roof Assessment

Total Roof are in SF	8,148
Unshaded Roof Area in AF	1,353
Structural Support	All roof areas suitable for solar installation will be structurally designed to support PV panels when structural design commences.
Electrical Infrastructure	The electrical room layouts will include a future scenario showing the location of any inverters, disconnects and other equipment needed to install a grid connected solar system on the roof of the building at 600 Mass Ave.
Other Large Roof Appurtenances	Two large ERV units and approximately 44 condensing units, plumbing vent stacks have been optimized to increase the solar ready area, to some positive effect.
Solar Ready Roof Area	1,353 SF of roof area
Capacity of Solar Array	If we assume ultra-high efficiency panels at 22%, we can fit an approximately 29kW system with an annual generation capacity of 38,224 kWh/ year. Solar hot water was not considered because of the intention to use individual DHW systems per unit.
Financial Incentives	Financial incentive estimates will be investigated by the Solar specialist who will be engaged to diagram the layout of the system as the roof plan moves forward.
Cost feasibility	The solar specialist will also provide an estimate for the additional up-front cost to install the designed system at current rates, which will allow cost feasibility to be calculated prior to construction. At that point the decision of when to install the system will be made.

Green Building Incentive Program Assistance

The Project intends to pursue incentives through the Mass Save program with the assistance of SEA.

Net Zero Narrative for 600 Massachusetts Avenue, Cambridge, MA
Submitted by Peter Quinn Architects, Sustainable Energy Analytics & MaGrann Associates
August 21, 2020

Net Zero Scenario Transition

	Net-Zero Condition	Transition Process
Building Envelope	Similar to proposed	None required
HVAC Systems	Similar to proposed	At the end of each piece of equipment's life-cycle, replace with a more efficient modern (future) compatible system
Service Hot Water	Similar to proposed	At the end of the water heater lifecycle, consider if heat pump water heaters are available that will work well in apartments.
Lighting	Similar to proposed	At the end of each equipment's life cycle, replace with the most efficient option currently available.
Renewable Energy Systems	Installation of PV array described in the Solar Ready section	Installation will be relatively straightforward with design and all behind the walls infrastructure included in the original design
Other Strategies	None	None

By building within the urban fabric and excluding the use of fossil fuels on site at the outset the building is well positioned to make the transition to net zero emissions status as the grid becomes cleaner over time.

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

38,223 kWh/Year*

System output may range from 36,686 to 39,614 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	3.10	2,315	345
February	3.96	2,624	391
March	4.71	3,361	501
April	5.51	3,698	551
May	5.61	3,834	572
June	6.09	3,964	591
July	6.50	4,322	644
August	5.96	3,972	592
September	5.27	3,452	515
October	3.89	2,722	406
November	2.94	2,050	306
December	2.60	1,910	285
Annual	4.68	38,224	$ 5,699

Location and Station Identification

Requested Location	600 Massachusetts ave Cambridge MA 02139
Weather Data Source	Lat, Lon: 42.37, -71.1 0.4 mi
Latitude	42.37° N
Longitude	71.1° W

PV System Specifications *(Residential)*

DC System Size	29 kW
Module Type	Premium
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.149 $/kWh

Performance Metrics

Capacity Factor	15.0%

CITY OF CAMBRIDGE
TRAFFIC, PARKING, + TRANSPORTATION

Joseph E. Barr, Director
344 Broadway, Suite 202
Cambridge, MA 02139

December 9, 2019

Sean Manning
VHB Inc.
99 High Street, 10th Floor
Boston, MA 02110

Tom Cifrino
Superior Realty Co, Inc.
540 Gallivan Bou7levard #9
Dorchester Center, MA 02142

RE: 600 Massachusetts Avenue TIS Certification

Dear Sean and Tom:

The Cambridge Traffic, Parking, and Transportation Department (TP+T) received your Transportation Impact Study (TIS) dated November 7, 2019, and a revised TIS dated December 5, 2019, for a proposed development project located at 600 Massachusetts Avenue in Central Square by Superior Realty Co, Inc.

600 Massachusetts Avenue has an existing 26,700 square feet of commercial/retail space and 15,180 square feet of office space. The proposed project includes a net increase of 46 residential units and approximately 7,300 square feet of additional commercial/retail space. The project includes no vehicle parking spaces and approximately 98 long-term bicycle parking spaces

Based staff review the TIS is certified as complete and accurate.

We look forward to continuing to work with you on this project. Please contact Adam Shulman of my staff at 617-349-4745 if you have any questions or to set up a meeting.

Very truly yours,

Joseph E. Barr
Director

cc: Adam Shulman, Patrick Baxter, TP&T

600 Massachusetts Avenue

Cambridge, Massachusetts

PREPARED FOR

Superior Realty Co, Inc.
540 Gallivan Boulevard #9
Dorchester Center, MA 02142

PREPARED BY

vhb

99 High Street
Boston, MA 02110
617.728.7777

November 7, 2019
revised: December 5, 2019

UNDER THE DIRECTION OF

Sean Manning, P.E.

Table of Contents

List of Tables

List of Figures

Introduction & Project Overview

On behalf of Superior Realty Co, Inc. (the Owner), VHB, Inc. has conducted a Transportation Impact Study (TIS) for the proposed 600 Massachusetts Avenue Project (the Project Site). This project contemplates a mixed-use redevelopment of the existing office and commercial/retail building which includes the development of 46 residential units and an additional net increase of approximately 7,300 SF of commercial/retail in addition to the 15,180 SF of office and 26,700 SF of commercial/retail housed within the existing building (the Proposed Project).

The TIS responds to the scope dated May 20, 2019 defined by the City of Cambridge Traffic, Parking and Transportation (TP&T) Department in response to VHB's Request for Scoping dated April 19, 2019. Copies of the City's scoping letter and VHB's Request for Scoping are included in the Appendix. The TIS has been prepared in conformance with the current City of Cambridge Guidelines for Transportation Impact Studies, as required under the Article 19 Special Permit Project Review. This document is comprised of three components, as follows:

- Introduction and Project Overview – describing the framework in which the transportation component of this Project was evaluated;
- Transportation Impact Study (TIS) – presenting the technical information and analysis results as required under the guidelines; and,
- Planning Board Special Permit Criteria – summarizing the evaluation of the proposed Project as defined under the guidelines.

The required TIS Summary Sheets and Planning Board Criteria Performance Summary are included. Supplementary data and analysis worksheets are provided in the Appendix. Electronic files for Automatic Traffic Recorder (ATR) counts, Turning Movement Counts (TMC), and Synchro analyses are included on an accompanying CD.

Project Overview

The Proposed Project will include a net increase of 46 residential units and approximately 7,300 SF of commercial/retail in addition to existing 15,180 SF of office and 26,700 SF of commercial/retail in the existing building. No vehicle parking will be provided in association with the project. The building will be supported by approximately 98 long-term bicycle parking spaces.

- **Figure A** presents a site location map.
- **Figure B** presents a regional context map.
- **Figure C** presents the existing conditions site plan of the proposed site
- **Figures D.1-D.7** presents the proposed site plan.

- **Figure E** presents the study area intersections.
- **Figure G** presents the proposed bicycle parking layouts

As shown in Figures A and B, the Project site is centrally located in Central Square in the southeast corner of the intersection of Massachusetts Avenue at Prospect Street/River Street/Western Avenue. As shown in Figure C, the existing building currently contains several commercial/retail and office tenants fronting Massachusetts Avenue. Table A below summarizes the tenants that currently occupy the building space.

TABLE A EXISTING TENANT SUMMARY

Existing Tenant	Size (SF)	# of Employees
Supreme Liquors	6,300	9
CW Taekwondo	2,950	6
Chipotle	2,720	15
Total	**11,970**	**30**

Source: Superior Realty Co, Inc. as of August 2019

Figures D.1-D.7 presents the proposed 600 Massachusetts Avenue site plan for the Central Square site location. The site will include 46 residential units and approximately 34,000 SF of commercial/retail and 15,180 SF of office.

The Proposed Project program is summarized in Table B below.

TABLE B PROPOSED DEVELOPMENT PROGRAM

Project Component	Size/Quantity		
	Existing	Future (the Project)	Net-New
Commercial/Retail	26,700 SF	34,000 SF	+7,300 SF
Office	15,180 SF	15,180 SF	0 SF
Residential	0 units	46 units	46 units
Vehicle Parking	0 spaces	0 spaces	0 spaces
Bicycle Parking	0 long-term spaces 0 short-term spaces	98 long-term spaces 0 short-term spaces	98 long-term spaces 0 short-term spaces

SF – Gross Square Feet

The TIS study area for the Proposed Project, as defined by the City of Cambridge, is shown in Figure E. The study intersections include the following:

1. Massachusetts Avenue at Pearl Street
2. Massachusetts Avenue at Essex Street
3. Massachusetts Avenue at Prospect Street/River Street/Western Avenue

Planning Board Criteria Summary

Based on the TIS analysis, the Project has been evaluated within the context of the Planning Board Criteria to determine if the Project has any potential adverse transportation impacts. Exceeding one or more of the Criteria is indicative of a potentially adverse impact on the City's transportation network. However, the Planning Board will consider mitigation efforts, their anticipated effectiveness, and other information that identifies a reduction in adverse transportation impacts.

The Planning Board Criteria consider the Project's vehicular trip generation, impact to intersection level of service and queuing, as well as increase of volume on residential streets. In addition, pedestrian and bicycle conditions are considered. A discussion of the Criteria set forth by the Planning Board is presented in the final section of the TIS, and the Planning Board Criteria Performance Summary is presented below.

PROJECT

Project Name:	600 Massachusetts Avenue
Project Address:	600 Massachusetts Avenue Cambridge, MA 02139
Owner/Developer Name:	Superior Realty Co, Inc.
Contact Person:	Tom Cifrino
Contact Address:	540 Gallivan Boulevard #9 Dorchester Center, MA 02142
Contact Phone Number:	781-706-5931

SIZE

ITE quantity. :	+46 residential units; +7,300 SF of commercial/retail
Land Use Type:	Residential; Commercial/Retail

PARKING

Existing Parking Spaces:	0
Project Parking Spaces:	0
Net-New Parking Spaces:	0

TRIP GENERATION:

	AM Peak Hour	PM Peak Hour
Vehicle	33	30
Transit	46	44
Pedestrian	52	50
Bicycle	9	8
Other	3	3

MODE SPLIT (Person Trips)

	Residential	Commercial/Retail (employees)	Commercial/Retail (patrons)
Drive Alone	26%	11%	20%
Rideshare	2%	22%	3%
Transit	33%	56%	31%
Walk	23%	11%	38%
Bike	10%	0%	6%
Other	6%	0%	2%

TRANSPORATION CONSULTANT

Company Name:	VHB
Contact Name:	Sean Manning, PE, PTOE
Contact Phone Number:	617-607-2971

Date of Building Permit Approval: _____

Total Data Entries = 65 **Total Number of Criteria Exceedances = 4**

Criteria A –Project Vehicle Trip Generation

Time Period	Criteria (trips)	Build	Exceeds Criteria?
Weekday Daily	2,000	334	No
Week AM Peak Hour	240	33	No
Week PM Peak Hour	240	30	No

Criteria B – Vehicular LOS

	AM Peak Hour				PM Peak Hour			
Intersection	Existing Condition	Build Condition	Traffic Increase	Exceeds Criterion?	Existing Condition	Build Condition	Traffic Increase	Exceeds Criterion?
Massachusetts Ave at Pearl Street	C	C	0.4%	No	C	C	0.4%	No
Massachusetts Ave at Essex Street	B	B	0.4%	No	B	B	0.4%	No
Massachusetts Ave at Prospect Street/River Street/Western Ave	F	F	0.3%	No	E	E	0.3%	No

Criteria C – Traffic on Residential Streets

Roadway	Segment	Amount of Residential	AM Peak Hour			PM Peak Hour		
			Existing[1]	Project Trips	Exceeds Criteria?	Existing[1]	Project Trips	Exceeds Criteria?
Massachusetts Ave	west of Prospect Street/River Street	1/3 or less	563	3	No	575	4	No
	between Prospect Street/River Street and Essex Street	1/3 or less	741	3	No	736	3	No
	between Essex Street and Pearl Street	1/3 or less	741	2	No	711	3	No
	east of Pearl Street	1/3 or less	850	1	No	817	1	No
Pearl Street	south of Mass Ave	1/3 or less	249	2	No	274	2	No
Essex Street	north of Mass Ave	1/3 or less	4	1	No	153	1	No
Prospect Street	north of Mass Ave	1/3 or less	1023	3	No	1004	3	No
River Street and Western Ave	south of Mass Ave	1/3 or less	1019	3	No	1089	3	No

[1] Where driveways/on-street parking created a segment inflow/outflow volume imbalance, an average was calculated per direction and added

Criteria D – Lane Queue (for signalized intersections)

Intersection	Movement	AM Peak Hour			PM Peak Hour		
		Existing	Build	Exceeds Criteria?	Existing	Build	Exceeds Criteria?
Massachusetts Ave at Prospect Street/River Street/Western Ave	Northbound - Thru	6	5	No	5	5	No
	Northbound - Right	1	1	No	1	2	No
	Southbound – Thru/Right	1	1	No	1	1	No
	Eastbound – Thru	2	2	No	2	2	No
	Eastbound - Right	10	13	No	7	7	No
	Westbound – Thru	2	5	No	2	2	No
	Westbound – Right	7	7	No	8	8	No
Massachusetts Avenue at Essex Street	Eastbound – Left	0	1	No	2	2	No
	Eastbound – Thru	3	3	No	3	3	No
	Westbound – Thru/Right	5	5	No	5	6	No

Queue lengths are shown in number of vehicles. Synchro provides queue length in feet, which is converted to vehicles. (1 veh = 25 feet)

Due to the limitations of Syncho, modeled queues are all reported using SimTraffic.

Criteria E – Pedestrian Delay

Intersection	Crosswalk	AM Peak Hour			PM Peak Hour		
		Existing	Build	Exceeds Criteria?	Existing	Build	Exceeds Criteria?
Massachusetts Ave at Pearl Street	East	F	F	**Yes**	F	F	**Yes**
Massachusetts Ave at Essex Street	West	B	B	No	B	B	No
	North	B	B	No	B	B	No
Massachusetts Ave at Prospect Street/River Street/Western Ave	East	C	C	No	C	C	No
	West	C	C	No	C	C	No
	North	C	C	No	C	C	No
	South	C	C	No	C	C	No

Criteria F – Pedestrian and Bicycle Facilities

Adjacent Street	Link (between)	Sidewalk or Walkway Present	Exceeds Criteria?	Bicycle Facilities or Right of Ways Present	Exceeds Criteria?
Massachusetts Avenue	Essex Street and Pearl Street	Yes	No	Yes	No
Pearl Street	Massachusetts Avenue and Green Street	Yes	No	No	**Yes**
Green Street	Pearl Street and Magazine Street	Yes	No	No	**Yes**

Transportation Impact Study

This Transportation Impact Study for the proposed 600 Massachusetts Avenue mixed-use redevelopment (the Project) describes existing and future transportation conditions in the study area in accordance with the City of Cambridge Sixth Revision (November 28, 2011) of the Transportation Impact Study Guidelines. The study area for the TIS includes two signalized intersections and one unsignalized intersection as previously shown in Figure E.

This section includes inventories of physical and operational conditions in the study area including roadways, intersections, crosswalks, sidewalks, on-street parking, transit facilities, and land uses in the study area. Transportation data that were collected and compiled are presented, including automatic traffic recorder counts, intersection turning movement counts, pedestrian and bicycle counts, vehicle crash data, and transit service data.

1 Inventory of Existing Conditions

1.a Roadways

The Project site is located at the corner of Massachusetts Avenue and Prospect Street/River Street/Western Ave adjacent to the Central Square MBTA Station. The parcel is bordered by Mass Ave to the north, Pearl Street to the east, Green Street to the south and existing buildings to the west. Figure C, previously presented, shows the roadway network surrounding the Project site.

Massachusetts Avenue is an east-west roadway that extends from Uphams Corner in Dorchester to the east and Lexington to the west. Pearl Street is a north-south roadway that extends from Mass Ave in the north to Granite Street in the south. Green Street is an east-west roadway that extends from Landsdowne Street in the east to River Street in the west. Magazine Street is a north-south roadway that extends from River Street in the north to Memorial Drive in the south.

1.b Intersections

The Project study area included the following three study intersections which were presented previously in Figure E and illustrated in Figures 1.b.1 through 1.b.3.

1. Massachusetts Ave at Pearl Street
2. Massachusetts Ave at Essex Street
3. Massachusetts Ave at Prospect Street/River Street/Western Ave

1.c Parking

Parking Inventory

The Project site currently does not contain any existing vehicular or bicycle parking.

Figure 1.c.1 presents existing on-street parking within a quarter-mile (5-minute walk) of the Project site. Most of the on-street parking surrounding the study area is resident permit parking with areas of metered parking along Massachusetts Avenue, Bishop Allen Drive, and various other nearby locations.

1.d Transit Services

Figure 1.d.1 illustrates existing Massachusetts Bay Transportation Authority (MBTA) services within the study area.

Public Transit Services

The Project area is accessible by several MBTA bus lines as well as the subway. Services are summarized below.

Red Line – Central Square

The Central Square MBTA Station is located less than a tenth of a mile from the site along Massachusetts Avenue. The station provides access to the MBTA's Red Line providing service to Alewife to the northeast, downtown Boston and Braintree and Ashmont to the south. The Red Line connects with the Green Line at Park Street and the Orange and Silver Lines at Downtown Crossing. Connections to all southern commuter rail lines, the Red Line and Silver Line are made at South Station. In addition, the Fitchburg commuter rail line connects with the Red Line at Porter Square. The Red Line operates from 5:15 AM to 12:30 AM on weekdays with approximately 4.5-minute headways during peak hours. Saturday service is from 5:15 AM to 12:30 AM, and Sunday service is from 6:00 AM to 12:30 AM.

MBTA Route #1 – Harvard/Holyoke Gate – Dudley Station via Mass Ave.

MBTA Route #1 connects Harvard Square and Central Square in Cambridge to Dudley Square via Massachusetts Avenue. The nearest bus stops to the Project site are located at both the corners of Mass Ave and Prospect Street and Mass Ave at Pearl Street. Various stops along this route connect with other bus lines, the Red Line, Orange Line, and Green Line. The bus route runs on weekdays from 4:37 AM to 1:40 AM with 8 – 10-minute headways during peak hours. On Saturday, service runs from 4:40 AM to 1:40 AM, and Sunday services is from 6:00 AM to 1:32 AM.

MBTA Route #47 – Central Square, Cambridge – Broadway Station via B.U. Medical Center, Dudley Station & Longwood Medical Area

MBTA Route #47 connects Central Square in Cambridge to Broadway Station in South Boston via Fenway and the South End. The nearest bus stop to the Project site is located at the corner of Mass Ave at Pearl Street. Various stops along this route connect with other bus lines, the Red Line, Orange Line, and Green Line. The bus route runs on weekdays from 5:15 AM to 1:31 AM with 10 – 17-minute headways during peak hours. On Saturday, service runs from 5:00 AM to 1:40 AM, and Sunday service is from 7:30 AM to 1:04 AM.

MBTA Route #64 – Oak Square – University Park, Cambridge or Kendall/MIT via North Beacon St.

MBTA Route #64 connects Oak Square in Brighton and University Park and Kendall/MIT Station in Cambridge via North Beacon Street. The nearest bus stop to the Project site is located at the corner of Mass Ave at Pearl Street. Various stops along this route connect with other bus lines and the Red Line. The bus route runs on weekdays from 5:31 AM to 1:26 AM with 20 – 30-minute headways during peak hours. On Saturday, service runs from 5:20 AM to 1:29 AM, and Sunday services is from 8:18 AM to 7:02 PM.

MBTA Route #70/70A – Cedarwood, North Waltham or Watertown Square – University Park via Central Square, Cambridge, Arsenal St. & Western Ave.

MBTA Route #70/70A connects Waltham and Watertown to Central Square in Cambridge via Western Avenue Arsenal Street, and Main Street. The nearest bus stop to the Project site is located at the corner of Mass Ave at Pearl Street. Various stops along this route connect with other bus lines, the Red Line, and Fitchburg Commuter Rail. The bus route runs on weekdays from 4:31 AM to 1:19 AM with 10 – 20-minute headways during peak hours. On Saturday, service runs from 5:00 AM to 1:27 AM, and Sunday service is from 6:00 AM to 1:23 AM.

MBTA Route #83 – Rindge Ave. – Central Square, Cambridge via Porter Square Station

MBTA Route #83 connects Rindge Avenue near Alewife Station and Porter Square to Central Square via Massachusetts Avenue, Somerville Avenue, and Beacon Street. The nearest bus stop to the Project site is located at Magazine Street and Green Street. Various stops along this route connect with other bus lines, the Red Line, and Fitchburg Commuter Rail. The bus route runs on weekdays from 5:10 AM to 1:20 AM with 20 – 30-minute headways during peak hours. On Saturday, service runs from 5:10 AM to 1:29 AM, and Sunday service is from 7:25 AM to 1:22 AM.

MBTA Route #91 – Sullivan Square Station – Central Square, Cambridge via Washington Street

MBTA Route #91 connects Sullivan Square Station in Charlestown and Central Square in Cambridge via Washington Street and Union Square in Somerville. The nearest bus stop to the Project site is located at the corner of Magazine Street and Green Street. Various stops along this route connect with other bus lines, the Red Line, and Orange Line. The bus route runs on weekdays from 5:15 AM to 1:08 AM with 30-minute headways during peak hours. On

Saturday, service runs from 5:00 AM to 1:05 AM, and Sunday service is from 6:30 AM to 12:54 AM.

MBTA Route CT1 – Central Square, Cambridge – B.U. Medical Center/Boston Medical Center via M.I.T.

MBTA Route CT1 connects Central Square in Cambridge to the Boston University Medical Center via Massachusetts Avenue and MIT Campus. The nearest bus stop to the Project site is located at the corner of Mass Ave and Pearl Street. Various stops along this route connect with other bus lines, the Red Line, Orange Line, Green Line, and Silver Line. The bus route runs on weekdays from 6:00 AM to 7:42 PM with 20 – 30-minute headways during peak hours. There is no service on weekends and most holidays.

1.e Land Use

Figure 1.e.1 illustrates land uses in the area surrounding the Project site. The wider neighborhood is largely characterized by residential uses, while the immediate surrounding area incorporates ground floor commercial/retail, office and government/health land uses along Massachusetts Avenue and surrounding Central Square. These land uses continue in both directions on Massachusetts Ave. Southeast of the project site, the University Park development site contains predominantly office space.

2 Data Collection

2.a ATR Counts

Automatic Traffic Recorder (ATR) counts were conducted in June 2019 to capture existing daily vehicle volumes within the Project study area. ATR counts were collected at the following locations:

- Pearl Street, south of Massachusetts Avenue
- Green Street between Pearl Street and Magazine Street,

A traffic volume summary for the ATRs are presented in Tables 2.a.1 and 2.a.2. These data, representing the averages of data collected over two weekdays illustrate the daily variations of traffic demands and the directional flow of traffic over the course of an average weekday. The location on Pearl Street generally exhibits typical commuter peak traffic patterns while the Green Street location instead peaks in the midday around 2:00 PM. Detailed count data sheets are induced in the Appendix.

TABLE 2.A.1 EXISTING TRAFFIC VOLUME SUMMARY (JUNE 2019)

Location	Daily[a]	AM Peak Hour			PM Peak Hour		
		Volume[b]	K[c]	Peak Direction	Volume[b]	K[c]	Peak Direction
Pearl Street *South of Massachusetts Avenue*	3733	218	5.8%	100% SB	274	7.3%	100% SB
Green Street *between Pearl Street and Magazine Street*	3645	171	4.7%	100% WB	268	7.4%	100% WB

a vehicles per day
b vehicles per peak hour
c percentage of daily traffic that occurs during the peak hour

TABLE 2.A.2 EXISTING AVERAGE DAILY TRAFFIC SUMMARY (JUNE 2019)

	Pearl Street *South of Massachusetts Avenue*	Green Street *Between Pearl Street and Magazine Street*
Start Time	**SB**	**WB**
12:00 AM	47	39
1:00 AM	31	25
2:00 AM	16	14
3:00 AM	10	7
4:00 AM	17	16
5:00 AM	74	29
6:00 AM	135	59
7:00 AM	176	125
8:00 AM	218	159
9:00 AM	182	171
10:00 AM	193	156
11:00 AM	200	208
12:00 PM	214	230
1:00 PM	227	258
2:00 PM	228	268
3:00 PM	205	256
4:00 PM	207	252
5:00 PM	270	247
6:00 PM	274	205
7:00 PM	243	251
8:00 PM	195	220
9:00 PM	165	193
10:00 PM	123	162
11:00 PM	88	100
Total	**3733**	**3645**

2.b Pedestrian and Bicycle Counts

Peak hour bicycle and pedestrian counts were performed on June 19, 2019 and July 9, 2019 between 7:30 to 9:00 AM and 4:30 to 6:00 PM at the sidewalks and bike lanes adjacent to the intersection of Massachusetts Avenue at Pearl Street. The bicycle and pedestrian counts are summarized in Table 2.b.1.

Please note that bicycle and pedestrian counts discussed in Section 2.c below, differ from this table. Table 2.b.1 summarizes counts from June 19 and July 9, 2019 while Section 2.c discusses counts from December 4, 2019.

TABLE 2.B.1 EXISTING BICYCLE AND PEDESTRIAN VOLUMES

	Pedestrian Counts									Bike Counts	
	Mid-block crosswalk *across Massachusetts Avenue at Pearl Street*[1]			Massachusetts Avenue *Northern sidewalk*[1]			Massachusetts Avenue *Southern sidewalk*[2]			Massachusetts Avenue *Bike lane*[1]	
Start Time	**NB**	**SB**	**Total**	**EB**	**WB**	**Total**	**EB**	**WB**	**Total**	**EB**	**WB**
7:30 AM	67	171	238	226	102	328	401	126	527	62	24
8:00 AM	86	248	334	322	130	452	399	189	588	82	18
8:30 AM	122	218	340	294	123	417	458	135	593	126	24
9:00 AM	75	190	265	284	96	380	325	116	441	73	25
AM Peak Hour Total	**122**	**248**	**370**	**324**	**130**	**454**	**458**	**190**	**648**	**126**	**44**
4:30 PM	168	214	382	280	394	674	240	393	633	34	71
5:00 PM	271	228	499	333	544	877	293	485	778	44	134
5:30 PM	250	284	534	375	514	889	384	447	831	52	124
6:00 PM	221	272	493	406	547	953	331	406	737	62	118
PM Peak Hour Total	**271**	**284**	**555**	**406**	**552**	**958**	**384**	**485**	**869**	**62**	**135**

1 Counts conducted on Wednesday, June 19, 2019.
2 Counts conducted on Tuesday, July 9, 2019.

Peak hour pedestrian and bicycle turning movement counts at study area intersection were conducted along with vehicle intersection turning movement counts, as discussed in the following section.

2.c Intersection Turning Movement Counts

Manual turning movement counts were recently collected by TP&T, including vehicles, pedestrians, and bicycles, on Tuesday, December 4, 2018. The counts were collected at the following study area intersections:

1. Massachusetts Ave at Pearl Street
2. Massachusetts Ave at Essex Street
3. Massachusetts Ave at Prospect Street/River Street/Western Ave

The results of these counts indicated that the peak hours for vehicular traffic in the study area are:

- Morning Peak Hour – 8:15 AM to 9:15 AM
- Evening Peak Hour – 6:00 PM to 7:00 PM

The detailed turning movement counts are provided in the Appendix.

The morning and evening peak hour vehicle, pedestrian, and bicycle turning movement volumes are presented in Figures 2.c.1 through 2.c.6, respectively. The raw count data is included on the accompanying CD.

Please note that bicycle and pedestrian counts discussed in this section, differ from Table 2.b.1 above. Table 2.b.1 summarizes counts from June 19 and July 9, 2019 while this Section discusses counts from December 4, 2019.

VHB staff also conducted queue observations during the morning and evening peak hours at the signalized intersections on Wednesday, June 19, 2019, when the ATRs were being conducted. Since, the Scoping Letter indicated that previously conducted TMCs be used for the analysis, the queue observations were not able to be conducted on that day as recommended in the TIS Guidelines. Table 2.c.1 presents the existing queue observations for the signalized study area intersections. A detailed queue analysis in provided in Section 7 of this report.

TABLE 2.C.1 SIGNALIZED INTERSECTION AVERAGE QUEUE OBSERVATIONS

Intersection	Lane	**2019 Existing Observed** *Morning Peak Hour*	**2019 Existing Observed** *Evening Peak Hour*
Massachusetts Ave at Essex Street	Mass Ave Eastbound Left[1]	-	-
	Mass Ave Eastbound Thru	3	3
	Mass Ave Westbound Thru/Right	5	6
Massachusetts Ave at Prospect Street/River Street/Western Ave	Mass Ave Eastbound Thru	5	4
	Mass Ave Eastbound Right	1	1
	Mass Ave Westbound Thru	1	2
	Mass Ave Westbound Right	1	1
	River Street Northbound Thru	11	9
	River Street Northbound Right	5	5
	Prospect Street Southbound Thru/Right	12	12

Queue lengths are shown in number of vehicles.
Queue lengths were observed on Wednesday, June 19th, 2019.

[1]During queue observations, Essex Street was closed to through traffic. Eastbound left turns were restricted from Mass Ave onto Essex Street. Therefore, observed queues are not reported.

2.d Crash Analysis

Study area crash data was obtained from MassDOT records for the most recent three-year period available, January 2014 through December 2016. Analysis of the crash data is summarized in Table 2.d.1 and includes the calculated crash rates (number of reported crashes per million entering vehicles) based on the evening peak traffic volumes. A detailed summary by crash type is presented in the Appendix.

TABLE 2.D.1 MASSDOT CRASH ANALYSIS (JANUARY 2014 – DECEMBER 2016)

Location	Total Crashes (3-year period)	Crashes Involving Pedestrians	Crashes Involving Bicycles	Calculated Crash Rate
Massachusetts Ave at Pearl Street (unsignalized)	9	1	1	0.80
Massachusetts Ave at Essex Street (signalized)	14	2	1	1.46
Massachusetts Ave at Prospect Street/River Street/Western Ave (signalized)	21	0	2	1.01

Source: MassDOT data

MassDOT has 6 districts within Massachusetts, and Cambridge falls under the jurisdiction of District 6. The average crash rate per million entering vehicles for District 6 is 0.71 for signalized intersections and 0.52 for unsignalized intersections. All of the study area intersections have a calculated crash rate greater than the District 6 average for signalized/unsignalized intersections.

Massachusetts Avenue at Pearl Street is an unsignalized intersection above the average MassDOT crash rate in District 6. The following collision types appeared most frequently: angle (4), rear-end (3).

The intersection of Massachusetts Avenue at Essex Street was also above the MassDOT crash rate for signalized intersections in District 6. The following collision types appeared most frequently: rear-end (7) sideswipe same direction (2). Although this intersection has an exclusive pedestrian phase for Massachusetts Avenue and Essex Street, pedestrians commonly cross Essex Street during the vehicle phases.

Massachusetts Avenue at Prospect Street/River Street/Western Ave was above the MassDOT crash rate for signalized intersections in District 6. The intersection experienced a high number of the following collision types: rear-end (8), angle (4), sideswipe same direction (3). Approximately two-thirds of these crashes (13 out of 21) occurred during the weekday but none were during the morning or evening peak. Five of the crashes occurred on the weekend, but none during the Saturday midday peak. None of the crashes caused fatal injuries to the parties involved.

2.e Public Transit

Transit stops and stations closest to the site were shown previously in Figure 1.d.1. Operating hours, weekday daily ridership, and peak-hour headways for each service line are presented in Table 2.e.1.

TABLE 2.E.1 MBTA SERVICES

Route	Origin/Destination	Hours of Operation	Peak Hour Headways (minutes)	Weekday Ridership[1]
Red Line	Alewife/Ashmont or Braintree	Weekday: 5:15AM-12:30AM Saturday: 5:15AM-12:30AM Sunday: 6:00AM-12:30AM	4.5	240,178
MBTA Route #1	Harvard/Holyoke Street – Dudley Station	Weekday: 4:37AM-1:40AM Saturday: 4:40AM-1:40AM Sunday: 6:00AM-1:32AM	~8 – 10	11,802
MBTA Route #47	Central Square/ Broadway Station	Weekday: 5:15AM-1:31AM Saturday: 5:00AM-1:40AM Sunday: 7:30AM-1:04AM	~10 – 17	4,726
MBTA Route #64	Oak Square/ University Park or Kendall/MIT	Weekday: 5:31AM-1:26AM Saturday: 5:20AM-1:29AM Sunday: 8:18AM-7:02AM	~20 – 30	1,829
MBTA Route #70/70A	North Waltham or Cedarwood /University Park	Weekday: 4:31AM-1:19AM Saturday: 5:00AM-1:27AM Sunday: 6:00AM-1:23AM	~10 – 20	4,851 / 1,732
MBTA Route #83	Rindge Ave/Central Square	Weekday: 5:10AM-1:20AM Saturday: 5:10AM-1:29AM Sunday: 7:25AM-1:22AM	~20 – 30	1,848
MBTA Route #91	Sullivan Square Station/Central Square	Weekday: 5:15AM-1:08AM Saturday: 5:00AM-1:05AM Sunday: 6:30AM-12:54AM	~30	1,536
MBTA Route CT1	Central Square/BU Medical Center or Boston Medical Center	Weekday: 6:00AM-7:42PM Saturday: No Service Sunday: No Service	~20 – 30	1,619

Source: MBTA Summer 2019 Schedule

1 MBTA Ridership from 2018

2.f Bluebikes

Throughout Metro Boston there are 1,800 public bikes available as part of the Bluebikes bike share program. Several stations are located within the Central Square neighborhood. There are four Bluebike stations within a five-minute walk from the Project site summarized in Table 2.f.1. The Bluebikes stations and Zipcar locations are documented in **Figure 2.f.1.**

TABLE 2.F.1 BLUEBIKES IN CENTRAL SQUARE

Station Location	# of Docks
Central Sq Post Office/Cambridge City Hall at Mass Ave/Pleasant St	16
Central Square at Mass Ave/Essex St	19
Lafayette Square at Mass Ave/Main St/Columbia St	14
University Park	19

Source: Bluebikes.com – July 8, 2019

The Bluebikes website was used to monitor the utilization of the Bluebikes bicycles at these three locations over the course of a typical day on July 8, 2019. This data is presented in Table

2.f.2. The data shows that throughout the day there were almost always bikes and docks available at all stations. The four docks had varying patterns throughout the day. The dock at Central Square Post Office/Cambridge City Hall at Mass Ave/Pleasant Street was generally more full between 7:00 AM and 3:00 PM. The dock at Central Square at Mass Ave/Essex Street was consistently over 50% full throughout the entire observation period. The dock at Lafayette Square at Mass Ave/Main Street/Columbia Street reached a few time periods where no bikes were available in both the early morning and later evening. On average, otherwise around 4-6 bikes remained available through the midday. The dock at University Park had between 3-9 bikes available throughout most of the day.

TABLE 2.F.2 BLUEBIKES BICYCLE UTILIZATION DATA

Time	Central Sq Post Office/ Cambridge City Hall at Mass Ave/Pleasant St		Central Square at Mass Ave/Essex St		Lafayette Square at Mass Ave/Main St/ Columbia St		University Park	
	Bikes Available	Docks Available	Bikes Available	Docks Available	Bikes Available	Docks Available	Bikes Available	Docks Available
7:00 AM	12	4	16	3	0	14	3	16
8:00 AM	10	6	16	3	0	14	3	16
9:00 AM	15	1	11	8	1	13	6	13
10:00 AM	11	5	13	6	6	8	1	18
11:00 AM	9	7	19	0	5	9	1	18
12:00 PM	11	5	18	1	4	10	6	13
1:00 PM	11	5	10	9	0	14	9	10
2:00 PM	10	6	15	4	5	9	3	16
3:00 PM	14	2	15	4	0	14	9	10
4:00 PM	6	10	16	3	6	8	3	16
5:00 PM	5	11	14	5	1	13	6	13
6:00 PM	9	7	15	4	1	13	0	19
7:00 PM	9	7	16	3	0	14	1	18

Source: Bluebikes.com (July 8, 2019)

2.g Parking

Parking Inventory

Previously presented**, Figure 1.c.1 presents** existing on-street parking within a quarter-mile (5-minute walk) of the Project site.

Curbside Parking Utilization Study

As requested in the TIS Scoping letter, a curbside parking utilization study was conducted by VHB staff within ¼ mile radius from the project site to understand the parking occupancy and turnover. The weekday study was conducted on Thursday, June 27th from 6:00 AM to 12:00 AM (midnight) and the Saturday study was conducted on Saturday, June 22nd from 6:00 AM to 12:00 AM (midnight). Each of the studies were conducted in 1-hour increments.

The roadways shown in **Figure 1.c.1** were inventoried by VHB staff on the two study days. **Table 2.g.1** below summarizes the inventory of spaces within a ¼ mile radius by use. Note that the capacities reported in the table are approximated because on each individual observation day, slightly different capacities were approximated by VHB staff based on how close individuals park in unstriped spaces to other vehicles, sizes of vehicles, and construction activity that compromised on-street parking availability.

TABLE 2.G.1 SUMMARY OF CURB USES (1/4-MILE RADIUS)

Curb Use	Approximate Parking Capacity (parking spaces)
Parking by Permit Only (except Sunday)	830
Unregulated	20
30-min Metered	10
1-Hour Metered	50
2-Hour Metered	130
Handicapped	40
Loading	50
Total Spaces	**1,130**

A specific goal of this study was to identify if parking is available in the area as well as where the most available parking is located for residential parkers to influence their parking location decision making. The occupancy of each type of parking space is summarized in Figure 2.g.2 for Saturday, June 22, 2019 and Figure 2.g.3 for Thursday, June 27, 2019.

During the weekday curb study, residential parking (Parking by Permit Only) was observed to be readily available throughout the day. Available residential spaces ranged from approximately 115 to 200 spaces over the course of the day (6:00 AM to 12:00 AM). Residential parking was least available at 6:00 AM during which time about 115 spaces were observed to be available.

As expected, during the weekday, residential parkers tend to follow one of two patterns: leaving a parking space in the morning/arriving again in the evening or staying parked for most if not all of the day (non-drivers for daily commuting). Unregulated curb use areas tend to have similar patterns to the residential parkers. Metered parking spaces were frequently occupied beginning around 10:00 AM to 2:00 PM and peaking in occupancy between 6:00 and 8:00 PM. Metered spaces closest to Mass Ave and Central Square MBTA Station were the least available throughout the day.

During the Saturday study, many residential parkers depart parking spaces between 8:00 AM and 12 noon. Many metered parking spaces were frequently occupied beginning around 10:00 AM and generally continue to become more occupied throughout the day until about 10:00 PM. Metered spaces closest to Mass Ave and Central Square MBTA Station were the least available throughout the day.

2.h Existing Building Tenant Employee Survey

As requested in TP&T's Scoping Letter, existing building employees were surveyed by their tenant coordinators to understand how existing employees arrive and depart from work. The responses from the 30 employees (both full-time and part-time) that currently work at the Project site are summarized in **Table 2.h.1** below.

TABLE 2.H.1 EXISTING BUILDING TENANT EMPLOYEE SURVEY SUMMARY

Mode	Mode Share (%)
SOV	11%
HOV	22%
Transit	56%
Bike	0%
Walk	11%
Other	0%
Total	**100%**

Source: Superior Realty conducted Existing Building Tenant Employee Survey (August 2019)

The survey indicates that most employees arrive and depart from work by using public transportation. The few staff that travel by either SOV (11%) or HOV (22%), indicated they park in the Green Street garage (one-tenth of a mile away). Both mode shares and parking locations from the employee survey are applied to the following project-generated trip analysis.

2.i Existing Building Service and Loading

As requested in TP&T's Scoping Letter, existing building service and loading activity is documented below.

The delivery and trash removal schedule for the Existing site is as follows:

- Approximately 20 weekly deliveries on average
- 8:00 AM to 3:00 PM, Monday through Friday

3 Project Traffic

3.a Mode Share and Average Vehicle Occupancy

Mode share for residential and retail trips was based, in part, on the percentages outlined in the City's scoping letter. Another piece of information that was considered in the development of the mode shares was the existing travel patterns of the retail employees. These patterns were presented previously in Section 2.h. Table 3.a.1 summarizes all the mode share assumptions used to support the development of the TIS.

When mode shares were applied, it was assumed that employees account for 3% of the commercial/retail person trips during the peak hours and that 97% are made by patrons.

The 2017 National Household Travel Survey specifies the national average vehicle occupancy (AVO) of 1.18 for residential/work trips and 1.82 for shopping trips. Local HOV AVO for the area has been calculated to be 2.42 based on data from the 2013-2017 American Commuting Survey (ACS) 5-Year Estimates for local census tracts including 3530, 3531.01 and 3535, Middlesex County, MA.

TABLE 3.A.1 MODE SHARES BY LAND USE

Mode	Residential[1]	Commercial/ Retail (patrons)[2]	Commercial/ Retail (employees)[3]
SOV	26%	20%	11%
HOV	2%	3%	22%
Transit	33%	31%	56%
Bike	10%	6%	0%
Walk	23%	38%	11%
Other	6%	2%	0%
Total	**100%**	**100%**	**100%**

[1]Residential mode shares based on the Average of Area 4 and 5 from City of Cambridge 2019 Neighborhood Statistics Profile.
[2]Commercial/Retail mode share (patrons) based on the 2013 K2C2 Central Square Final Report for Retail Enhancement mode share

[3]Commercial/Retail mode share (employees) based on the existing employee survey conducted in August 2019 (Section 2.h)

3.b Trip Generation

In order to provide the most accurate trip generation estimates for the proposed project, each proposed land use was examined individually. Trip generation estimates were made starting with the Institute of Transportation Engineers (ITE) *Trip Generation Manual* (10th Edition) rates and as requested in the TIS scoping letter, some empirical components were developed to get the most realistic estimate of anticipated Project trip making.

Residential Land Use

For the residential component of the project, trip generation estimates were calculated starting with the Institute of Transportation Engineers (ITE) *Trip Generation Manual* (10th Edition) fitted curve rates for Mid-Rise Residential (LUC 221). These rates were compared to the driveway counts at the Northpoint residential buildings in Cambridge including Sierra & Tango and Twenty|20. In addition, vehicles were counted manually at the 49-unit 21 Brookline Street residential building in Central Square. These rates were also compared to ITE estimates Table 3.b.1 presents the peak driveway count data at each of these locations.

TABLE 3.B.1 NORTHPOINT RESIDENTIAL DRIVEWAY COUNTS

	Sierra + Tango *(329 occupied units)*[1]	**Twenty|20** *(326 occupied units)*[1]	**21 Brookline** *(49 occupied units)*[2]
Morning Peak Hour	**35**	**24**	**5**
In	8	3	1
Out	27	21	4
Evening Peak Hour	**42**	**31**	**3**
In	26	20	3
Out	16	11	0

Sources:

1 2018 TDM Traffic Monitoring Report – counts conducted on Monday, May 14, 2018; During the May 2018 reporting S + T had 329 units occupied and Twenty|20 had 326 units occupied

2 Counts conducted by VHB on Thursday, September 26, 2019 during adjacent street peak hours: 8:15-9:15 AM and 6-7 PM; During counts the 21 Brookline residential building was assumed to have 100% of its 49 units occupied

Empirical trip rates were then calculated using the occupancy of the residential units when counts were conducted. Table 3.b.2 summarizes the trip rate comparison of the buildings as compared to the ITE rates.

TABLE 3.B.2 VEHICLE TRIP RATE (VEHICLE TRIPS PER UNIT) COMPARISON

	Sierra + Tango *(329 occupied units)[1]*		Twenty|20 *(326 occupied units)[1]*		21 Brookline *(49 occupied units)[2]*		ITE 10th Edition *(LUC 221)[3]*
	Veh. Trips	**Vehicle Trip Rate** *(Vehicle trips per unit)*	**Veh. Trips**	**Vehicle Trip Rate** *(Vehicle trips per unit)*	**Veh. Trips**	**Vehicle Trip Rate** *(Vehicle trips per unit)*	**Vehicle Trip Rate** *(Vehicle trips per unit)*
Morning Peak Hour	**35**	**0.11**	**24**	**0.07**	**5**	**0.10**	**0.11**
In	8	0.02	3	0.01	1	0.02	0.03
Out	27	0.08	21	0.06	4	0.08	0.08
Evening Peak Hour	**42**	**0.13**	**31**	**0.09**	**3**	**0.06**	**0.14**
In	26	0.08	20	0.06	3	0.06	0.09
Out	16	0.05	11	0.03	0	0.00	0.06

1 2018 TDM Traffic Monitoring Report – counts conducted on Monday, May 14, 2018; During the May 2018 reporting S + T had 329 units occupied and Twenty|20 had 326 units occupied

2 Counts conducted by VHB on Thursday, September 26, 2019 during adjacent street peak hours: 8:15-9:15 AM and 6-7 PM; During counts the 21 Brookline residential building was assumed to have 100% of its 49 units occupied

3 *Trip Generation Manual*, 10th Edition, Institute of Transportation Engineers – (SOV + HOV)/# of units - where the SOV trips are HOV trips were developed using the mode share and VOR assumptions dictated in Section 3.a above

Sierra + Tango trip rates, aligned very closely to the ITE rates. Vehicle trip rates at Twenty|20 were moderately lower than the rates estimated by ITE. 21 Brookline trip rates aligned very closely to the ITE rates in the morning but were significantly lower than ITE estimates in the evening. Based on these findings, the trip generation analysis that follows is based 21 Brookline empirical trip rates presented previously in Table 3.b.2 to estimate the residential component of the project. This source is expected to provide the most realistic estimate of trip making characteristics of residents in Central Square.

Commercial/Retail Land Use

For the commercial/retail component of the project, trip generation estimates were developed starting with the Institute of Transportation Engineers (ITE) *Trip Generation Manual* (10th Edition) average rates High-Turnover Restaurant (LUC 932).

ITE vehicle trips were converted to person trips by application of the national AVO of 1.18 for residential/work trips and 1.82 for shopping trips. While local AVOs were used to convert person trips back to vehicle trips once mode shares were applied.

The resulting Project trip generation by mode for the Proposed Project is summarized in Table 3.b.3.

TABLE 3.B.3 PROJECT TRIP GENERATION BY MODE

			Vehicle		Transit		Bike		Walk		Other	
			AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
Residential		Entering	1	3	1	3	0	1	1	2	0	0
		Exiting	4	0	3	0	1	0	2	0	1	0
		Total	5	3	4	3	1	1	3	2	1	0
Commercial/ Retail	Patrons	Entering	15	17	22	24	4	5	27	30	1	2
		Exiting	12	10	18	15	3	3	22	18	1	1
		Total	27	27	40	39	7	8	49	48	2	3
	Employees	Entering	1	1	1	1	0	0	0	0	0	0
		Exiting	0	0	1	1	0	0	0	0	0	0
		Total	1	1	2	2	0	0	0	0	0	0
Total		Entering	17	21	24	28	4	5	28	32	2	2
		Exiting	16	10	22	16	5	3	25	18	2	1
		Total	33	30	46	44	9	8	53	50	4	3

Estimates based on ITE 10th Edition LUC 932 – High-Turnover Restaurant (commercial/retail) and 21 Brookline empirical trip rates (residential)
Daily trip generation in "trips per day"
Peak hour trip generation in "trips per hour"

3.c Site Access

The Project site will not provide dedicated parking on site. All vehicular trips arriving on site will need to either be parked on-street, in a local garage or lot, or be safely accommodated at the curb for transportation network company (TNC) or taxi pick-up or drop-off.

Accommodating TNC/Taxi Drop-off/Pick-up

The proponent understands that the increased use of Transportation Network Company providers can impact traffic flow, pedestrian conditions, and safe use of bicycle lanes along Massachusetts Avenue because of occasional double-parking and standing along the corridor. The Project proponent is interested in working with TP&T and the City to understand options that can be put in place to minimize this activity, including use of geo-fencing and other potential measures to better manage TNC activities.

Trip Distribution

Project generated traffic was distributed through the study area based on a number of factors. The 2013 Central Square Planning Study Residential Distribution for Sub-Area 6 (presented in Table 3.c.1) was used as a starting point to distribute the project generated traffic through the study area.

TABLE 3.C.1 RESIDENTIAL TRIP DISTRIBUTION – CENTRAL SQUARE PLANNING STUDY, SUB-AREA 6

Trip Distribution	Direction	Inbound Distribution	Outbound Distribution
Massachusetts Avenue	To/from Northwest	15%	16%
	To/from Southeast	59%	61%
Western Avenue/River Street	From West	26%	1%
Pearl Street	To/from South	0%	7%
Prospect Street	To/from North	0%	15%
Total		**100%**	**100%**

Source: K2C2 Study Residential/Employee Arrival & Departure Distribution for Sub-Area 6

For the residential trips, the parking inventory presented in Section 2.g was used to identify roadways that have availability for on-street residential (Permit Parking only) during the peak hours. Many of the residential roadways have some availability during peak hours. Figures 3.c.1 and 3.c.2 present the roadways within 1/4-mile radius of the site that had significant available spaces for residential parkers during peak hours. These figures do not depict all available residential parking but the roadways that had sufficient availability expected to influence a parking user's decision in their parking location. There was a total of approximately 150 and 190 available residential spaces during the morning and evening peak hours, respectively that could be used by future parkers. The highlighted areas depict approximately 52% and 46% of the total available residential spaces during the morning and evening peak hours, respectively. Future parkers could use any available spaces, but for the purposes of developing a

distribution, residential trips are assigned to the roadways to/from these primary areas with parking availability.

Employee surveys, as previously mentioned, indicated that employees who drive to and from work park in the Green Street Garage. It was assumed that future employees would choose similarly, though observations were conducted on Tuesday, October 1st of area off-street parking locations by VHB staff during the traffic peak hours to fully understand availability in the area. Parking vacancies on-street (in residential or metered spaces) that may be used by future patrons or employees are less predictable. For these reasons, patron and employee trips to the retail/commercial use were distributed to several garages/surface lots in the area based on availability, cost, and approximate walk time as presented below in Tables 3.c.2 and 3.c.3.

TABLE 3.C.2 AVAILABLE PUBLIC PARKING OPTIONS – MORNING PEAK HOUR

Parking Facility Location	Parking Cost: Hourly/ 12-hour	Capacity[1]	Occupied Spaces	Percent Occupancy	Available Spaces	Approximate Walk Time to 600 Mass Ave	Likelihood to Use Lot[2]
Green Street Garage	$2/$20	245	169	69%	76	2 minutes	75%
Municipal Lot 8	$1.25[3]	13	7	54%	6	4 minutes	
Municipal Lot 9	$1.25[3]	11	5	45%	6	4 minutes	
Central Square Parking Lot	$7/$19	80	60	75%	20	5 minutes	
Municipal Lot 5	$1.25[3]	65	26	40%	39	2 minutes	25%
Municipal Lot 6	$1.25[4]	33	33	100%	0	3 minutes	
Total		**447**	**300**		**147**		

1 Handicap, electric vehicle, and Zipcar reserved spaces are not included in facility capacity
2 Approximated based on lot capacities, distance from the project site, and approximate morning occupancy
3 Two-hour maximum parking between 8 AM and 6 PM
4 Four-hour maximum parking between 8 AM and 6 PM

TABLE 3.C.3 AVAILABLE PUBLIC PARKING OPTIONS – EVENING PEAK HOUR

Parking Facility Location	Parking Cost: Hourly/ 12-hour	Capacity[1]	Occupied Spaces	Percent Occupancy	Available Spaces	Approximate Walk Time to 600 Mass Ave	Likelihood to Use Lot[2]
Green Street Garage	$2/$9	245	102	42%	143	2 minutes	75%
Municipal Lot 8	$2[3]	13	13	100%	0	4 minutes	
Municipal Lot 9	$2[3]	11	11	100%	0	4 minutes	
Central Square Parking Lot	$10	80	22	28%	58	5 minutes	
Municipal Lot 5	$2[3]	65	51	78%	14	2 minutes	25%
Municipal Lot 6	$2[3]	33	8	24%	25	3 minutes	
Total		**447**	**207**		**240**		

1 Handicap, electric vehicle, and Zipcar reserved spaces are not included in facility capacity

2 Approximated based on lot capacities, distance from the project site, and approximate morning occupancy
3 Four-hour maximum parking between 6 PM and 10 PM

Many of the facilities have parking availability during peak hours. There was a total of 147 and 240 available spaces during the morning and evening peak hours, respectively that could be used by future parkers. The two closest facilities, the Green Street Garage and Municipal Lot 5, have under 70% and 80% occupancy during both the morning and evening peak hours, respectively. Based on its occupancy and proximity to the site, we expect most trips to try and utilize the Green Street Garage to reach the site. If users find Green Street garage is full (though observations suggest it will not be during peak hours), they are expected to travel westbound on Green Street where they can likely find availability in another of the parking facilities on Green Street. A smaller handful of users are expected to park in Municipal Lot #5. If trips are destined to this location and find no availability, they are expected to find parking in the nearby Municipal Lot #6. It is important to note that Municipal Lot #4 was closed for construction staging during the time of the study and has not been considered in this distribution.

The Project-generated trips were distributed to the roadway networks based on the assumptions above and the resulting Project-generated trips are shown for the morning and evening peak hours in Figures 3.c.3 and 3.c.4, respectively.

3.d Servicing and Deliveries

The Project will not provide a loading dock to serve the Project. Deliveries are expected to be wheeled through the courtyard and through the back of the building off Green Street.

The delivery and trash removal schedule for the Proposed Project is expected to be similar to the existing site with nominal increases do to the net increase of the proposed project.

4 Background Traffic

In accordance with the City's Scope, background traffic growth reflecting regional growth was assumed to occur at 0.5 percent per year for five years to the 2024 Future Condition. In addition, trips associated with specific planned projects in the area of the Project site have been incorporated into the 2024 Future condition analysis. These specific projects include:

- 10 Essex Street Residential Project – *This project is covered in the 0.5 percent background traffic growth.*
- MIT Kendall Square Redevelopment Project
- Mass + Main Development
- 907 Main Street Hotel - *This project is covered in the 0.5 percent background traffic growth.*
- 47 Bishop Allen Drive (Twining)
- Kendall Square Urban Renewal Area MXD Infill Development Concept Plan

- 541 Mass Ave Registered Marijuana Dispensary (RMD) - *This project is covered in the 0.5 percent background traffic growth.*

5 Traffic Analysis

Traffic networks were developed, in accordance with the TIS Guidelines, for the following scenarios:

5.a 2019 Existing Condition

The 2019 Existing Condition analysis is based on existing vehicle, pedestrian, and bicycle counts at the study area intersections (see Section 2 –Data Collection). The Existing Condition traffic networks are shown in Figures 2.c.1 and 2.c.2.

5.b 2019 Build Condition

The Build Condition analysis assumes full occupancy of the Project. Project generated traffic (see Section 3 – Project Traffic) was added to the study area to create the 2019 Build Condition networks shown in Figures 5.b.1 and 5.b.2.

5.c 2024 Future Condition

The 2024 Future Condition builds upon the 2019 Build Condition volumes to include general background growth and other specific development projects as previously described (see Section 4 – Background Traffic). The Future Condition traffic networks are shown in Figures 5.c.1 and 5.c.2.

6 Vehicle Capacity Analysis

Synchro 9 software was used to determine the vehicle level of service (VLOS) for the 3 study intersections. Synchro software is based on the 2000 Highway Capacity Manual.

Results for the 2019 Existing, 2019 Build, and 2024 Future Conditions for signalized intersections are shown in Tables 6.a.1 and 6.a.2 for the morning and evening peak hours, respectively. The results for unsignalized intersections are shown in Table 6.a.3 and 6.a.4 for the morning and evening peak hours, respectively. Visual representation of the changes in level of service are provided in Figures 6.a.1 and 6.a.2 for all conditions during the morning and evening peak hours. The tables also show the difference in delay between the Existing and Build delay and the Build and Future delay. Figures 6.a.3 and 6.a.4 show the incremental net change in vehicle delay at the study area intersections.

TABLE 6.A.1 SIGNALIZED INTERSECTION LOS – MORNING PEAK HOUR

Intersection	Approach	2019 Existing Condition			2019 Build Condition			Difference in Delay Existing to Build	2024 Future Condition			Difference in Delay Existing to Future
		V/C Ratio	Delay	VLOS	V/C Ratio	Delay	VLOS		V/C Ratio	Delay	VLOS	
Massachusetts Ave at Essex Street	Mass Ave Eastbound Left	0.01	2.1	A	0.01	2.0	A	-0.1	0.03	1.8	A	-0.3
	Mass Ave Eastbound Thru	0.52	4.1	A	0.52	4.1	A	0	0.58	4.3	A	0.2
	Mass Ave Westbound Thru/Right	0.63	23.3	C	0.63	23.3	C	0	0.68	24.9	C	1.6
	OVERALL	**0.41**	**13.4**	**B**	**0.41**	**13.4**	**B**	**0**	**0.45**	**14.0**	**B**	**0.6**
Massachusetts Ave at Prospect Street/River Street/Western Ave	Mass Ave Eastbound Thru	0.59	25.5	C	0.59	25.7	C	0.2	0.69	29.1	C	3.6
	Mass Ave Eastbound Right	0.06	27.9	C	0.06	27.9	C	0	0.06	27.9	C	0
	Mass Ave Westbound Thru	0.49	3.8	A	0.49	3.8	A	0	0.54	4.1	A	0.3
	Mass Ave Westbound Right	0.34	85.8	F	0.34	85.8	F	0	0.35	85.1	F	-0.7
	River Street Northbound Thru	1.40	217.2	F	1.41	221.6	F	4.4	1.45	239.3	F	22.1
	River Street Northbound Right	0.56	54.9	D	0.56	54.9	D	0	0.59	57.4	E	2.5
	Prospect Street Southbound Thru/Right	1.21	140.3	F	1.21	140.3	F	0	1.24	152.5	F	12.2
	OVERALL	**1.13**	**111.1**	**F**	**1.13**	**112.5**	**F**	**1.4**	**1.21**	**117.9**	**F**	**6.8**

V/C Ratio – Volume to Capacity Ratio
Delay – Average delay expressed in seconds per vehicle
VLOS – Vehicular level of service

TABLE 6.A.2 SIGNALIZED INTERSECTION LOS – EVENING PEAK HOUR

Intersection	Approach	2019 Existing Condition			2019 Build Condition			Difference in Delay Existing to Build	2024 Future Condition			Difference in Delay Existing to Future
		V/C Ratio	Delay	VLOS	V/C Ratio	Delay	VLOS		V/C Ratio	Delay	VLOS	
Massachusetts Ave at Essex Street	Mass Ave Eastbound Left	0.33	5.6	A	0.33	5.7	A	0.1	0.41	7.1	A	1.5
	Mass Ave Eastbound Thru	0.35	4.0	A	0.35	4.0	A	0	0.38	3.9	A	-0.1
	Mass Ave Westbound Thru/Right	0.65	22.0	C	0.65	22.1	C	0.1	0.73	24.9	C	2.9
	OVERALL	**0.40**	**13.6**	**B**	**0.40**	**13.7**	**B**	**0.1**	**0.45**	**15.5**	**B**	**1.9**
	Mass Ave Eastbound Thru	0.40	21.3	C	0.40	21.4	C	0.1	0.45	22.3	C	1.0

Intersection	Approach	2019 Existing Condition			2019 Build Condition			Difference in Delay Existing to Build	2024 Future Condition			Difference in Delay Existing to Future
		V/C Ratio	Delay	VLOS	V/C Ratio	Delay	VLOS		V/C Ratio	Delay	VLOS	
Massachusetts Ave at Prospect Street/River Street/Western Ave	Mass Ave Eastbound Right	0.10	29.2	C	0.10	29.2	C	0	0.10	29.3	C	0.1
	Mass Ave Westbound Thru	0.47	4.3	A	0.47	4.3	A	0	0.55	5.1	A	0.8
	Mass Ave Westbound Right	0.33	76.4	E	0.33	76.8	E	0.4	0.34	72.4	E	-4.0
	River Street Northbound Thru	0.63	20.8	C	0.64	21.0	C	0.2	0.66	21.8	C	1.0
	River Street Northbound Right	0.39	32.1	C	0.39	32.1	C	0	0.41	32.8	C	0.7
	Prospect Street Southbound Thru/Right	1.28	168.3	F	1.28	168.9	F	0.6	1.31	182.6	F	14.3
	OVERALL	**0.99**	**60.9**	**E**	**0.99**	**60.9**	**E**	**0**	**1.05**	**62.7**	**E**	**1.8**

V/C Ratio – Volume to Capacity Ratio
Delay – Average delay expressed in seconds per vehicle
VLOS – Vehicular level of service

TABLE 6.A.3 UNSIGNALIZED INTERSECTION LOS – MORNING PEAK HOUR

Intersection	Approach	2019 Existing Condition			2019 Build Condition			Difference in Delay Existing to Build	2024 Future Condition			Difference in Delay Existing to Future
		V/C Ratio	Delay	VLOS	V/C Ratio	Delay	VLOS		V/C Ratio	Delay	VLOS	
Massachusetts Ave at Pearl Street	Mass Ave Westbound	0.40	18.1	C	0.41	18.1	C	0	0.46	20.7	C	2.6

V/C Ratio – Volume to Capacity Ratio
Delay – Average delay expressed in seconds per vehicle
VLOS – Vehicular level of service

TABLE 6.A.4 UNSIGNALIZED INTERSECTION LOS – EVENING PEAK HOUR

Intersection	Approach	2019 Existing Condition			2019 Build Condition			Difference in Delay Existing to Build	2024 Future Condition			Difference in Delay Existing to Future
		V/C Ratio	Delay	VLOS	V/C Ratio	Delay	VLOS		V/C Ratio	Delay	VLOS	
Massachusetts Ave at Pearl Street	Mass Ave Westbound	0.44	18.9	C	0.44	19.0	C	0.1	0.48	20.3	C	1.4

V/C Ratio – Volume to Capacity Ratio
Delay – Average delay expressed in seconds per vehicle

VLOS – Vehicular level of service

All intersections remain operating at the same level-of-service from 2019 Existing to 2019 Build as well as 2019 Existing to 2024 Future. The analysis indicates that there were only minor impacts to the delay experienced at the intersections in the study area.

7 Queue Analysis

Queue analysis was performed in conjunction with the LOS analysis. Table 7.a.1 and 7.a.2 present the results for the observed and modeled average queues for each scenario for the morning and evening peak hour, respectively, for signalized intersections.

TABLE 7.A.1 SIGNALIZED INTERSECTION QUEUE ANALYSIS – MORNING PEAK HOUR

		Average Queue in Vehicles			
Intersection	**Lane**	**2019 Existing Observed**	**2019 Existing Modeled**	**2019 Build**	**2019 Future**
Massachusetts Ave at Essex Street	Mass Ave Eastbound Left[1]	-	0	1	1
	Mass Ave Eastbound Thru	3	3	3	3
	Mass Ave Westbound Thru/Right	5	5	5	6
Massachusetts Ave at Prospect Street/River Street/Western Ave	Mass Ave Eastbound Thru	5	6	5	6
	Mass Ave Eastbound Right	1	1	1	1
	Mass Ave Westbound Thru	1	1	1	1
	Mass Ave Westbound Right	1	2	2	2
	River Street Northbound Thru	11	10	13	13
	River Street Northbound Right	5	2	5	5
	Prospect Street Southbound Thru/Right	12	7	7	8

Queue lengths are shown in number of vehicles. Synchro provides queue length in feet, which is converted to vehicles. (1 veh = 25 feet)

Due to the limitations of Syncho, modeled queues are all reported using SimTraffic.
Queue lengths were observed on Wednesday, June 19th, 2019.

[1]During queue observations, Essex Street was closed to through traffic. Eastbound left turns were restricted from Mass Ave onto Essex Street. Therefore, observed queues are not reported.

TABLE 7.A.2 SIGNALIZED INTERSECTION QUEUE ANALYSIS – EVENING PEAK HOUR

		Average Queue in Vehicles			
Intersection	**Lane**	**2019 Existing Observed**	**2019 Existing Modeled**	**2019 Build**	**2019 Future**
Massachusetts Ave at Essex Street	Mass Ave Eastbound Left[1]	-	2	2	2
	Mass Ave Eastbound Thru	3	3	3	3
	Mass Ave Westbound Thru/Right	6	5	6	6
Massachusetts Ave at Prospect Street/River Street/Western Ave	Mass Ave Eastbound Thru	4	5	5	5
	Mass Ave Eastbound Right	1	1	2	2
	Mass Ave Westbound Thru	2	1	1	1
	Mass Ave Westbound Right	1	2	2	2
	River Street Northbound Thru	9	7	7	7
	River Street Northbound Right	5	2	2	2
	Prospect Street Southbound Thru/Right	12	8	8	8

Queue lengths are shown in number of vehicles. Synchro provides queue length in feet, which is converted to vehicles. (1 veh = 25 feet)

Due to the limitations of Syncho, modeled queues are all reported using SimTraffic.
Queue lengths were observed on Wednesday, June 19th, 2019.

[1]During queue observations, Essex Street was closed to through traffic. Eastbound left turns were restricted from Mass Ave onto Essex Street. Therefore, observed queues are not reported.

The queue analysis results presented in the above tables correlate to the LOS analyses conducted of the study area intersections. The 2019 Existing Synchro models were adjusted to obtain queues using SimTraffic that match those observed in the field.

8 Residential Street Volume Analysis

Roadway segments within the study area with residential street frontage were evaluated to understand Project impacts. The peak hour volumes (both directions) traveling the analyzed roadway segments are presented in Tables 8.a.1 and 8.a.2. For analyzed segments that are between study area intersections, the average volumes at these intersections were taken as the volume traveling along the segment. The analysis shows the percent increase in traffic along the residential roadway segments between Existing and Build volumes and Build and Future volumes.

Of all of the roadway segments in the study area, none of the eight segments identified are streets which have more than 1/3 of residential frontage, as determined by the existing first floor use. Segments that exceed 1/3 of residential frontage would be evaluated in the Planning Board Criteria for increased volume on residential streets.

TABLE 8.A.1 TRAFFIC ON STUDY AREA ROADWAYS – MORNING PEAK HOUR

Roadway	Segment	Amount of Residential	Existing[1]	Build	Increase	Percent Increase	Future[2]	Increase	Percent Increase
Massachusetts Ave	west of Prospect Street/River Street	1/3 or less	563	566	3	0.5%	637	74	13%
	between Prospect Street/River Street and Essex Street	1/3 or less	741	744	3	0.4%	820	79	11%
	between Essex Street and Pearl Street	1/3 or less	741	743	2	0.3%	815	74	10%
	east of Pearl Street	1/3 or less	850	851	1	0.1%	927	77	9.1%
Pearl Street	south of Mass Ave	1/3 or less	249	251	2	0.8%	260	11	4.4%
Essex Street	north of Mass Ave	1/3 or less	4	5	1	25%	9	5	125%
Prospect Street	north of Mass Ave	1/3 or less	1023	1026	3	0.3%	1055	32	3.1%
River Street and Western Ave	south of Mass Ave	1/3 or less	1019	1022	3	0.3%	1052	33	3.2%

[1] Where driveways/on-street parking created a segment inflow/outflow volume imbalance, an average was calculated per direction and added

[2] Future accounts for area background project volumes, Project generated volumes, and a background growth rate of 0.5%

TABLE 8.A.2 TRAFFIC ON STUDY AREA ROADWAYS – EVENING PEAK HOUR

Roadway	Segment	Amount of Residential	Existing[1]	Build	Increase	Percent Increase	Future[2]	Increase	Percent Increase
Massachusetts Ave	west of Prospect Street/River Street	1/3 or less	575	579	4	0.7%	658	83	14%
	between Prospect Street/River Street and Essex Street	1/3 or less	736	739	3	0.4%	825	89	12%
	between Essex Street and Pearl Street	1/3 or less	711	714	3	0.4%	787	76	11%
	east of Pearl Street	1/3 or less	817	818	1	0.1%	897	80	9.8%
Pearl Street	south of Mass Ave	1/3 or less	274	276	2	0.7%	286	12	4.4%
Essex Street	north of Mass Ave	1/3 or less	153	154	1	0.7%	169	16	10%
Prospect Street	north of Mass Ave	1/3 or less	1004	1007	3	0.3%	1040	36	3.6%
River Street and Western Ave	south of Mass Ave	1/3 or less	1089	1092	3	0.3%	1129	40	3.7%

[1] Where driveways/on-street parking created a segment inflow/outflow volume imbalance, an average was calculated per direction and added
[2] Future accounts for area background project volumes, Project generated volumes, and a background growth rate of 0.5%

9 Parking Analysis

9.a Vehicle Parking

Due to the proximity to Central Square Red Line Station and many bus routes, the Project will not provide parking on site. As identified in the Scoping Letter, both the expected parking needs and the parking locations of the building users are an important part of this TIS. This analysis was conducted separately from the peak hour needs of parking for the Project associated with the distribution of project generated trips in Section 3. Table 9.a.1 summarizes the parking demands that are expected as a result of the Project.

TABLE 9.A.1 PROJECT PARKING DEMAND

Project Component	Net-Net Program	Peak Parking Demand
Commercial/Retail – Employees	+7,300 SF	2
Commercial/Retail – Patrons		4
Residential	46 units	23 spaces *(0.5 spaces/unit)*[1]
Total		**29**

[1] Consistent with 10 Essex Street parking Utilization Study, Design Consultants, Inc. January 16, 2014.

As demonstrated in Section 2.g., where the on-street parking availability is summarized, there are sufficient available parking spaces in the area during both peak traffic hours as well as throughout the day to serve all residents, employees, and patrons that are expected to need parking in close proximity to the project. This analysis considers both active vehicle users during typical commutes as well as residential vehicle owners whose vehicles will need parking availability in the neighborhood.

9.b Bicycle Parking

Table 9.b.1 below summarizes the City of Cambridge's Bicycle Parking Zoning Ordinance requirements as determined by the proposed project size and use.

TABLE 9.B.1 BICYCLE PARKING REQUIREMENTS

Land Use	Rate	Spaces	Rate	Spaces
Residential	1.05 spaces per dwelling[1]	48	0.10 spaces per dwelling	5
Office	0.30 spaces per 1,000 sf	5	0.06 spaces per 1,000 sf	1
Commercial/Retail	0.10 spaces per 1,000 sf	4	0.60 spaces per 1,000 sf	21
Total		**57**		**27[2]**

Source: City of Cambridge Zoning Ordinance Section 6.100

[1]per city guide – 1.00 spaces per unit for the first 20 units for a residential building

[2]The proponent would like to seek approval from the City to make a contribution towards parking on public property in lieu of on-site bicycle parking (as permitted under Cambridge Zoning Ordinance Section 6.104.2b). The City of Cambridge Bicycle Parking Guidelines indicate that 27 short-term bicycle parking spaces would sufficiently support this Project Program.

Illustrated previously in Figure G, the 98 long-term bicycle parking locations provided within the Project site are in exceedance of the City of Cambridge's Bicycle Parking Zoning Ordinance for long-term bicycle spaces. As noted in the above table, the proponent would like to seek approval from the City to make a contribution towards parking on public property in lieu of on-site bicycle parking (as permitted under Cambridge Zoning Ordinance Section 6.104.2b). The City of Cambridge Bicycle Parking Guidelines indicate that 27 short-term bicycle parking spaces would sufficiently support this Project Program.

10 Transit Analysis

As requested by the City's Scoping Letter, a transit analysis has been conducted for the Project. The analysis reviewed existing Red Line and MBTA bus route operations and assessed the impacts of project-generated transit trips and future transit trips.

The following sections summarize existing transit services availability in the study area and provide an assessment of transit utilization and capacity for the Red Line and MBTA bus routes accessed nearby Central Square.

The transit analysis was based on the following 5-step methodology:

1. Quantify the existing transit system capacity (STEP 1)
2. Quantify the future Red Line capacity based on upcoming system improvements (STEP 1)
3. Quantify the existing system ridership (STEP 2)
4. Report on existing transit system utilization (ridership/capacity) – 2019 Existing Conditions (STEP 3)
5. Develop and assign project-generated transit trips to the existing transit system (STEP 4)
6. Report on project impacts to the transit system utilization - 2019 Build Conditions (STEP 4)
7. Grow 2019 existing transit system ridership to year 2024 (STEP 5)
8. Compile area background project transit trips and assign to transit system network (STEP 5)
9. Report on future transit system utilization (impacts from project as well as other background projects and general system growth) – 2024 Future Conditions (STEP 5)

The V/C ratio (Volume to Capacity) is the resulting metric that is used to reflect the level of utilization for each transit service line. The V/C ratios (or utilization rates) are presented for the Existing Condition (2019), Build Condition (Existing + Project trips), and Future Condition (Existing + Project trips + background growth).

10.a Existing Transit System Capacity – STEP 1

The capacity of a transit line depends the number of trains (or buses) operating during a specified time period (frequency), the number of people that can be accommodated on a vehicle (a train car or bus), and the number of individual cars in each train.

The study period for this analysis includes the morning and evening transit peak hours, defined as 8:00 AM to 9:00 AM and 5:00 PM to 6:00 PM respectively which is when peak ridership occurs at Central Station on the Red Line.

Train and bus frequencies were compiled from latest published MBTA schedules[1] and MBTA Bus Ridership Composite data from Fall 2018 and reported in Table 10.a.1.

For the purposes of this study the vehicle load standards (i.e. number of people safely and comfortably riding on a train car or bus) are based on MBTA's Service Delivery Policy[2] and MBTA Blue Book 14th edition data (Red Line policy capacity of 167 passengers per car, with a standard operation of 6-car trains; MBTA Bus policy capacity of 53 passengers per vehicle).

[1] MBTA schedules, Fall 2019
[2] MBTA Service Delivery Policy, approved by the Board of Directors in June 2010

The average Red Line on-time performance was adjusted based on the Red Line Average Reliability for the 30 days prior to Red Line derailment on June 11, 2019 obtained from the MBTA Performance Dashboard. The Dashboard noted that average on-time performance of the Red Line was at 89%. This number captures the percentage of passengers who wait on the platform no longer than the scheduled time between trains. For the purposes of this study, the on-time performance adjustment of 89% reduced the number of available trains during peak hour to account for schedule irregularities and resulting wait times experienced by the passengers. The MBTA Bus service capacity was not adjusted for on-time performance.

Table 10.a.1 below shows resulting system capacities for the Red Line and Bus Lines based on MBTA provided data.

TABLE 10.A.1 - SYSTEM PEAK HOUR CAPACITY (PER MBTA DATA)

Mode	Frequency[a]	OTP Factor[b]	# Passengers / Vehicle[c]	# Cars / Train	Resulting Capacity[d] (# Passengers / Peak Hour)
Red Line					
Southbound	13	0.89	167	6	11,593
Northbound	13	0.89	167	6	11,593
MBTA Bus					
Bus 1 Inbound	8	n/a	53	n/a	424
Bus 1 Outbound	8	n/a	53	n/a	424
Bus 47 Inbound	5	n/a	53	n/a	265
Bus 47 Outbound	4	n/a	53	n/a	212
Bus 64 Inbound	2.5	n/a	53	n/a	133
Bus 64 Outbound	2.5	n/a	53	n/a	133
Bus 70 Inbound	2	n/a	53	n/a	106
Bus 70 Outbound	3.5	n/a	53	n/a	186
Bus 70A Inbound	1	n/a	53	n/a	53
Bus 70A Outbound	2.5	n/a	53	n/a	133
Bus 83 Inbound	2.5	n/a	53	n/a	133
Bus 83 Outbound	2.5	n/a	53	n/a	133
Bus 91 Inbound	2	n/a	53	n/a	106
Bus 91 Outbound	2	n/a	53	n/a	106

Notes:
(a) Number of vehicles per hour, per MBTA published schedules Fall 2019; average number of buses assumed were not same during AM and PM period
(b) On Time Performance Factor from MBTA Performance Dashboard Prior to Derailment.
(c) Number of policy level capacity per MBTA Blue Book 14th Edition (Red Line and Buses) and EZ Ride Feasibility Study (March 2015)
(d) Calculated Capacity = #of Trains x OTP factor x # pax per vehicles x # cars – shown as number of passengers per peak hour

252 new Red line cars are scheduled to be delivered between 2019-2023 along with improvements in signal equipment which will significantly increase capacity and address

overcrowding at some stations along the Red Line. MBTA Red / Orange Line New Vehicle Technical Provisions (May 2014) report indicates that capacity increase will allow a decrease in the existing headway from 4.5 minutes to 3 minutes for an approximately additional 7,000 transit riders per hour.

Table 10.a.2 shows the resulting system capacities for the Red Line based on MBTA provided data and technical provisions. Step 5 is performed considering both existing Red Line capacity as well as this future condition.

TABLE 10.A.2 – FUTURE RED LINE PEAK HOUR CAPACITY (PER MBTA DATA)

Mode	Frequency[a]	OTP Factor[b]	# Passengers / Vehicle[c]	# Cars / Train	Resulting Capacity[d] (# Passengers / Peak Hour)
Red Line					
Southbound	20	0.89	175	6	18,690
Northbound	20	0.89	175	6	18,690

Notes:
(e) Number of vehicles per hour, per MBTA presentation to the Fiscal & Management Control Board (September 19, 2016)
(f) On Time Performance Factor from MBTA Performance Dashboard Prior to Derailment.
(g) MBTA technical provisions:
280 avg. pax/car (published crush capacity) – No available published policy capacity to existing crush-to-policy ratio of 1.6 used to estimate future policy capacity
(h) Calculated Capacity = #of Trains x OTP factor x # pax per vehicles x # cars – shown as number of passengers per peak hour

10.b Existing Transit System Ridership – STEP 2

Adjusted MBTA Ridership data from Spring and Fall 2018 was used to obtain peak hour passenger loads for transit routes in 2019 that are expected to be utilized by the future Project residents, retail employees, and patrons.

The resulting adjusted ridership numbers (which are representative of the 2019 Existing Conditions), as used for analyzing the utilization of services, are presented in Table 10.b.1, below.

TABLE 10.B.1 ADJUSTED RIDERSHIP LEVELS (YEAR 2019)

	AM Peak Hour				PM Peak Hour			
Mode	Pax Load Entering Station	# Pax Boarding	# Pax Alighting	Pax Load Exiting Station	Pax Load Entering Station	# Pax Boarding	# Pax Alighting	Pax Load Exiting Station
Red Line (a)								
Southbound	8,547	1,794	880	9,462	3,056	229	945	2,340
Northbound	3,200	999	372	3,827	8,398	801	1,767	7,432
MBTA Bus (b)								

Bus 1 Inbound	210	103	21	293	133	57	24	166
Bus 1 Outbound	145	18	34	129	311	36	103	243
Bus 47 Inbound	0	205	0	205	0	47	0	47
Bus 47 Outbound	20	0	19	1	68	0	64	3
Bus 64 Inbound	190	9	104	95	35	2	25	11
Bus 64 Outbound	31	1	0	32	53	18	1	71
Bus 70 Inbound	206	5	156	56	110	2	100	13
Bus 70 Outbound	34	63	0	96	89	69	2	156
Bus 70A Inbound	0	12	0	12	0	2	0	2
Bus 70A Outbound	13	0	13	0	52	0	48	4
Bus 83 Inbound	13	0	13	0	11	0	10	1
Bus 83 Outbound	0	22	0	22	0	35	0	35
Bus 91 Inbound	10	0	10	1	12	0	12	0
Bus 91 Outbound	0	13	0	13	0	22	0	22

Notes:
(a) Adjusted MBTA Spring 2018 Red Line ridership data
(b) Adjusted MBTA Fall 2018 Bus Stop Composite Data

10.c Existing Transit System Utilization (2019 Existing Conditions) – STEP 3

By combining system capacity developed in Step 1 and system ridership from Step 2, we obtain system utilization rates.

Table 10.c.1 presents existing utilization levels in terms of V/C (Volume to capacity) ratios using MBTA data and Table 10.c.2 presents resulting utilization.

Table 10.c.1 2019 Existing Transit Service Utilization (per MBTA Data)

Route and Direction	(a) Capacity Policy	(b) AM Peak Hour Ridership	(b) PM Peak Hour Ridership	(c) AM Peak Hour V/C	(c) PM Peak Hour V/C
Red Line					
Inbound Entering Central	11,593	8,547	3,056	0.74	0.26
Inbound Exiting Central	11,593	9,462	2,340	0.82	0.20
Outbound Entering Central	11,593	3,200	8,398	0.28	0.72
Outbound Exiting Central	11,593	3,827	7,432	0.32	0.64
Bus Routes					
Bus 1 Inbound Entering	424	210	133	0.50	0.31
Bus 1 Inbound Exiting	424	293	166	0.69	0.39
Bus 1 Outbound Entering	424	145	311	0.34	0.73
Bus 1 Outbound Exiting	424	129	243	0.30	0.57
Bus 47 Inbound Entering	265	0	0	0.00	0.00
Bus 47 Inbound Exiting	265	205	47	0.65	0.22
Bus 47 Outbound Entering	212	20	68	0.12	0.25
Bus 47 Outbound Exiting	212	1	3	0.01	0.01
Bus 64 Inbound Entering	133	190	35	1.20	0.33
Bus 64 Inbound Exiting	133	95	11	0.60	0.11
Bus 64 Outbound Entering	133	31	53	0.19	0.50
Bus 64 Outbound Exiting	133	32	71	0.20	0.67
Bus 70 Inbound Entering	106	206	110	1.30	2.08
Bus 70 Inbound Exiting	106	56	13	0.35	0.24
Bus 70 Outbound Entering	186	34	89	0.21	0.42
Bus 70 Outbound Exiting	186	96	156	0.61	0.74
Bus 70A Inbound Entering	53	0	0	0.00	0.00
Bus 70A Inbound Exiting	53	12	2	0.14	0.33
Bus 70A Outbound Entering	133	13	52	0.08	0.49
Bus 70A Outbound Exiting	133	0	4	0.00	0.04
Bus 83 Inbound Entering	133	13	11	0.12	0.07
Bus 83 Inbound Exiting	133	0	1	0.00	0.00
Bus 83 Outbound Entering	133	0	0	0.00	0.00
Bus 83 Outbound Exiting	133	22	35	0.14	0.33
Bus 91 Inbound Entering	106	10	12	0.10	0.12
Bus 91 Inbound Exiting	106	1	0	0.00	0.00
Bus 91 Outbound Entering	106	0	0	0.00	0.00
Bus 91 Outbound Exiting	106	13	22	0.12	0.21

Notes:
(a) Capacity from step 1, Table 10.a.1
(b) Peak hour ridership from step 2, Table 10.b.1
(c) Calculated V/C = ridership / capacity

As presented in Table 10.c.1, the Red Line and most existing Bus Routes are operating within MBTA policy capacity with V/C ratios below 1.0. The only exception to this is Route 64 Inbound which has a V/C ratio of 1.20 in the morning, Route 70 Inbound which has a V/C ratio of 1.30 in the morning and 2.08 in the evening.

10.d Transit System Utilization for Project Build Condition (2019 Build Conditions) – STEP 4

As discussed previously in this study, the transit mode share for the Project is 56% for residential land uses and 31% for Retail land uses, therefore the Project is expected to generate 46 new transit trips (24 entering, 22 exiting) during the morning peak hour and 44 new transit trips (28 entering, 16 exiting) during the evening peak hour as shown in Table 10.d.1.

TABLE 10.D.1 PROJECT-GENERATED TRANSIT TRIPS

	AM Peak Hour			PM Peak Hour		
Use	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Residential	1	3	4	2	0	2
Retail	23	19	42	26	16	42
Total	24	22	46	28	16	44

Project trip distribution was used to assign trips to transit routes. All distributions along Massachusetts Avenue were automatically assigned to the Red Line. Distributions along Western Avenue were evenly split amongst MBTA Route 64,70, and 70A, distributions along Pearl Street were assigned to MBTA Route 47, and trip distribution along Prospect Street were evenly split across MBTA Route 83 and 91.

A detailed transit distribution by line, direction and peak hour is presented in Table 10.d.2.

TABLE 10.D.2 TRANSIT TRIP DISTRIBUTION

Route and Direction	AM Peak Hour		PM Peak Hour	
	% OUT	%IN	% OUT	%IN
Red Line				
Inbound	61%	15%	61%	15%
Outbound	16%	59%	16%	59%
	77%	74%	77%	74%
Bus Routes				
Bus 1 Inbound	0%	0%	0%	0%
Bus 1 Outbound	0%	0%	0%	0%
Bus 47 Inbound	7%	0%	7%	0%
Bus 47 Outbound	0%	0%	0%	0%
Bus 64 Inbound	0%	8.6%	0%	8.6%
Bus 64 Outbound	0.3%	0%	0.3%	0%

Route and Direction	AM Peak Hour		PM Peak Hour	
	% OUT	%IN	% OUT	%IN
Bus 70 Inbound	0%	8.6%	0%	8.6%
Bus 70 Outbound	0.3%	0%	0.3%	0%
Bus 70A Inbound	0%	8.6%	0%	8.6%
Bus 70A Outbound	0.3%	0%	0.3%	0%
Bus 83 Inbound	0%	0%	0%	0%
Bus 83 Outbound	7.5%	0%	7.5%	0%
Bus 91 Inbound	0%	0%	0%	0%
Bus 91 Outbound	7.5%	0%	7.5%	0%
	23%	26%	23%	26%

Transit distribution is then applied to the Project generated transit trips presented previously in Table 10.d.1 in order to determine the Project-generated transit trips by line or route, as presented in Tables 10.d.3 and 10.d.4 below.

TABLE 10.D.3 AM PEAK HOUR PROJECT-GENERATED TRIPS BY LINE

Route and Direction	Trips OUT (Boardings)	Trips IN (Alightings)	Trips Total
Red Line			
Inbound	14	4	17
Outbound	4	14	18
Bus Routes			
Bus 1 Inbound	0	0	0
Bus 1 Outbound	0	0	0
Bus 47 Inbound	2	0	2
Bus 47 Outbound	0	0	0
Bus 64 Inbound	0	2	2
Bus 64 Outbound	0	0	0
Bus 70 Inbound	0	2	2
Bus 70 Outbound	0	0	0
Bus 70A Inbound	0	0	0
Bus 70A Outbound	2	0	2
Bus 83 Inbound	0	0	0
Bus 83 Outbound	2	0	2
Bus 91 Inbound	0	0	0
Bus 91 Outbound	0	0	0
Total	22	24	46

TABLE 10.D.4 PM PEAK HOUR PROJECT-GENERATED TRIPS BY LINE

Route and Direction	Trips OUT (Boardings)	Trips IN (Alightings)	Trips Total
Red Line			
Inbound	10	4	14
Outbound	3	17	19
Bus Routes			
Bus 1 Inbound	0	0	0
Bus 1 Outbound	0	0	0
Bus 47 Inbound	1	0	1
Bus 47 Outbound	0	0	0
Bus 64 Inbound	0	2	2
Bus 64 Outbound	0	0	0
Bus 70 Inbound	0	2	2
Bus 70 Outbound	0	0	0
Bus 70A Inbound	0	0	0
Bus 70A Outbound	1	0	1
Bus 83 Inbound	0	0	0
Bus 83 Outbound	1	0	1
Bus 91 Inbound	0	0	0
Bus 91 Outbound	0	0	0
Total	16	28	44

The Project-generated transit trips by line or route from detailed above were then added to existing route volumes to develop the "Build Condition" utilization scenario, where Existing + Project trips are assumed to be on the transit lines. Resulting v/c ratios are presented in Table 10.d.5

TABLE 10.D.5 2019 BUILD CONDITION TRANSIT SERVICE UTILIZATION

Route and Direction	Capacity Policy (from Step 1)	AM Peak Hour Ridership	PM Peak Hour Ridership	AM Peak Hour V/C (a)	PM Peak Hour V/C (a)
Red Line					
Inbound Entering Central	11,593	8,551	3,060	0.74	0.26
Inbound Exiting Central	11,593	9,476	2,350	0.82	0.20
Outbound Entering Central	11,593	3,214	8,415	0.28	0.73
Outbound Exiting Central	11,593	3,831	7,435	0.33	0.64
Bus Routes					
Bus 1 Inbound Entering	424	210	133	0.50	0.31
Bus 1 Inbound Exiting	424	293	166	0.69	0.39
Bus 1 Outbound Entering	424	145	311	0.34	0.73
Bus 1 Outbound Exiting	424	129	243	0.30	0.57
Bus 47 Inbound Entering	265	0	0	0.00	0.00
Bus 47 Inbound Exiting	265	207	49	0.65	0.23
Bus 47 Outbound Entering	212	20	68	0.12	0.25
Bus 47 Outbound Exiting	212	1	3	0.01	0.01
Bus 64 Inbound Entering	133	193	37	1.21	0.35
Bus 64 Inbound Exiting	133	95	11	0.60	0.11
Bus 64 Outbound Entering	133	31	53	0.19	0.50
Bus 64 Outbound Exiting	133	32	71	0.20	0.67
Bus 70 Inbound Entering	106	208	113	1.31	2.13
Bus 70 Inbound Exiting	106	56	13	0.35	0.24
Bus 70 Outbound Entering	186	34	89	0.21	0.42
Bus 70 Outbound Exiting	186	97	156	0.61	0.74
Bus 70A Inbound Entering	53	2	2	0.04	0.05
Bus 70A Inbound Exiting	53	12	2	0.23	0.03
Bus 70A Outbound Entering	133	13	52	0.08	0.49
Bus 70A Outbound Exiting	133	0	4	0.00	0.04
Bus 83 Inbound Entering	133	13	11	0.12	0.07
Bus 83 Inbound Exiting	133	0	1	0.00	0.00
Bus 83 Outbound Entering	133	0	0	0.00	0.00
Bus 83 Outbound Exiting	133	24	36	0.15	0.34
Bus 91 Inbound Entering	106	10	12	0.10	0.12
Bus 91 Inbound Exiting	106	1	0	0.00	0.00
Bus 91 Outbound Entering	106	0	0	0.00	0.00
Bus 91 Outbound Exiting	106	15	24	0.14	0.22

Notes:
(a) Calculated V/C = ridership / capacity

As presented in Table 10.d.1, the Red Line and almost all of the Bus Routes, are expected to operate within MBTA policy capacity (with V/C ratios below 1.0) in the Build Condition. The only exception to this is Route 64 Inbound which has a V/C ratio of 1.21 in the morning, Route 70 Inbound which has a V/C ratio of 1.31 in the morning and 2.13 in the evening.

A V/C ratio over 1.0 does not necessarily translate to passengers not able to board a bus, instead the ratio indicates the number of passengers riding above MBTA's policy level of 53 passengers per car. Note that MBTA's crush capacity ranges between 72 and 104 passengers per bus, depending on bus model. This crush capacity definition (source MBTA Blue Book 14th edition) assumes a 1.5 square foot area per passenger.

10.e Future Transit System Utilization with Project Impact (2024 Future Conditions) – STEP 5

To determine Future Build Conditions in year 2024 as detailed by the TIS Scope for this project, existing ridership calculated in Step 3 were forecasted out to 2024. Additional impacts from adjacent background projects, and project build conditions were summed to determine final 2024 future conditions.

Existing ridership for Step 3 was grown to 2024 forecasts based on a rate increase of 1.9% annually for rail [3]and 0.7% increase annually for bus[4].

In addition, per the scoping letter for 600 Massachusetts, 2024 conditions must also include background project impacts. Specifically, projects noted to impact routes serving 600 Massachusetts include:

- 10 Essex Street Residential Project – *This project is covered in the percent background growths by mode.*
- MIT Kendall Square Redevelopment Project
- Mass + Main Development
- 907 Main Street Hotel - *This project is covered in the percent background growths by mode.*
- 47 Bishop Allen Drive (Twining)
- Kendall Square Urban Renewal Area MXD Infill Development Concept Plan
- 541 Mass Ave Registered Marijuana Dispensary (RMD) - *This project is covered in the percent background growths by mode.*

Table 10.e.1 and 10.e.2 below include a summary of total transit trips that these developments will generate during the AM and PM Peak Hour as noted by their respective TISs. Please note

[3] Based on the Boston Metropolitan Planning Organization/Central Transportation Planning Staff study of the impact of planned large developments in the Boston metropolitan area: B. Kaplan, W. Kuttner, and S. Peterson, Core-Capacity Constraints: Accommodating Growth on Greater Boston's Congested Roads and Crowded Transit System, Central Transportation Planning Staff ("CTPS"), 2016.

[4] Boston MPO, Charting Progress to 2040, Annual Growth 2012-2040

that several of the projects are included as part of the percent background growth (as noted) since transit impacts were not noted in its project documents.

TABLE 10.E.1 AM PEAK HOUR BACKGROUND PROJECT-GENERATED TRIPS BY LINE

Route and Direction	Trips OUT (Boardings)	Trips IN (Alightings)	Trips Total
Red Line			
Inbound	188	285	473
Outbound	28	445	473
Bus Routes			
Bus 1 Inbound	4	8	12
Bus 1 Outbound	3	23	26
Bus 47 Inbound	10	0	10
Bus 47 Outbound	0	0	0
Bus 64 Inbound	3	2	5
Bus 64 Outbound	9	0	9
Bus 70 Inbound	0	0	0
Bus 70 Outbound	0	0	0
Bus 70A Inbound	0	0	0
Bus 70A Outbound	0	0	0
Bus 83 Inbound	0	1	1
Bus 83 Outbound	1	0	1
Bus 91 Inbound	0	0	0
Bus 91 Outbound	1	0	1
Total	247	764	1011

TABLE 10.E.2 PM PEAK HOUR BACKGROUND PROJECT-GENERATED TRIPS BY LINE

Route and Direction	Trips OUT (Boardings)	Trips IN (Alightings)	Trips Total
Red Line			
Inbound	318	227	545
Outbound	462	90	552
Bus Routes			
Bus 1 Inbound	33	5	38
Bus 1 Outbound	15	10	25
Bus 47 Inbound	2	0	2
Bus 47 Outbound	0	2	2
Bus 64 Inbound	1	5	6
Bus 64 Outbound	31	0	31
Bus 70 Inbound	0	0	0
Bus 70 Outbound	2	0	2
Bus 70A Inbound	0	0	0

Bus 70A Outbound	0	0	0
Bus 83 Inbound	0	4	4
Bus 83 Outbound	2	0	2
Bus 91 Inbound	0	2	2
Bus 91 Outbound	2	0	2
Total	868	345	1213

Aggregating the above tables with Existing 2019 Ridership, background growth and project-generated trips, provides final operating conditions in 2024. Final V/C rations are noted below Table 10.e.3. and 10.e.4.

TABLE 10.E.3 FINAL 2024 FUTURE TRANSIT SERVICE UTILIZATION

Route and Direction	Capacity Policy (from Step 1 – Table 10.a.1)	Forecasted AM Peak Hour Ridership	Forecasted PM Peak Hour Ridership	Forecasted AM Peak Hour V/C (a)	Forecasted PM Peak Hour V/C (a)
Red Line					
Inbound Entering Central	11,593	9,675	3,587	0.83	0.31
Inbound Exiting Central	11,593	10,592	2,898	0.91	0.25
Outbound Entering Central	11,593	3,973	9,329	0.34	0.80
Outbound Exiting Central	11,593	4,235	8,626	0.37	0.74
Bus Routes					
Bus 1 Inbound Entering	424	226	143	0.53	0.34
Bus 1 Inbound Exiting	424	308	205	0.73	0.48
Bus 1 Outbound Entering	424	173	332	0.41	0.78
Bus 1 Outbound Exiting	424	136	267	0.32	0.63
Bus 47 Inbound Entering	265	0	0	0.00	0.00
Bus 47 Inbound Exiting	265	225	52	0.71	0.25
Bus 47 Outbound Entering	212	20	72	0.13	0.27
Bus 47 Outbound Exiting	212	0	3	0.00	0.01
Bus 64 Inbound Entering	133	202	43	1.27	0.41
Bus 64 Inbound Exiting	133	102	13	0.64	0.12
Bus 64 Outbound Entering	133	32	55	0.20	0.52
Bus 64 Outbound Exiting	133	42	104	0.26	0.98
Bus 70 Inbound Entering	106	216	117	1.36	2.22
Bus 70 Inbound Exiting	106	57	14	0.36	0.26
Bus 70 Outbound Entering	186	35	92	0.22	0.43
Bus 70 Outbound Exiting	186	100	164	0.63	0.77
Bus 70A Inbound Entering	53	2	2	0.04	0.05
Bus 70A Inbound Exiting	53	13	2	0.25	0.04
Bus 70A Outbound Entering	133	13	54	0.08	0.51
Bus 70A Outbound Exiting	133	0	4	0.00	0.04
Bus 83 Inbound Entering	133	15	15	0.14	0.09
Bus 83 Inbound Exiting	133	1	0	0.01	0.00
Bus 83 Outbound Entering	133	0	0	0.00	0.00
Bus 83 Outbound Exiting	133	26	40	0.16	0.38
Bus 91 Inbound Entering	106	11	15	0.10	0.14
Bus 91 Inbound Exiting	106	1	1	0.01	0.01
Bus 91 Outbound Entering	106	0	0	0.00	0.00
Bus 91 Outbound Exiting	106	17	26	0.16	0.25

Notes:

(a) Calculated V/C = ridership / capacity

TABLE 10.E.4 FINAL 2024 FUTURE TRANSIT SERVICE UTILIZATION BASED ON FUTURE RED LINE PEAK HOUR CAPACITY (TABLE 10.A.2)

Route and Direction	Capacity Policy (from Step 1 – Table 10.a.2)	Forecasted AM Peak Hour Ridership	Forecasted PM Peak Hour Ridership	Forecasted AM Peak Hour V/C (a)	Forecasted PM Peak Hour V/C (a)
Red Line					
Inbound Entering Central	18,690	9,675	3,587	0.52	0.19
Inbound Exiting Central	18,690	10,592	2,898	0.57	0.16
Outbound Entering Central	18,690	3,973	9,329	0.21	0.50
Outbound Exiting Central	18,690	4,235	8,626	0.23	0.46

Notes:
(a) Calculated V/C = ridership / capacity

Based on 2024 final forecasts most transit routes continue to operate under MBTA Policy Threshold levels with the exception of the Route 64 Inbound which has a V/C ratio of 1.27 in the morning, Route 70 Inbound which has a V/C ratio of 1.36 in the morning and 2.22 in the evening.

11 Pedestrian Analysis

Pedestrian crossing volumes at study area intersections are presented in Figures 2.c.3 and 2.c.4.

The results of pedestrian level-of-service (PLOS) analysis at intersection crosswalks are presented in Table 11.a.1 for signalized intersections and Table 11.a.2 for unsignalized intersections.

Pedestrian level-of-service at signalized intersections is dictated by the portion of the signal cycle dedicated to the pedestrian crossings. Accordingly, increasing pedestrian volumes does not alter pedestrian level of service at signalized intersections, and no changes in PLOS are projected under build or future conditions. It is assumed that the walk time and cycle length at this intersection will not change from existing conditions and therefore PLOS will remain consistent.

For unsignalized intersections, the PLOS is calculated using the crosswalk length and the conflicting vehicle flow rates for AM and PM peak hours.

None of the study area intersections show any change in PLOS with the addition of projected trips. Figures 11.a.1 and 11.a.2 graphically show the PLOS in the morning and evening peak hours, respectively.

TABLE 11.A.1 SIGNALIZED INTERSECTION – PEDESTRIAN LOS SUMMARY

Intersection	Crosswalk	AM Peak Hour			PM Peak Hour		
		Existing 2019	Build 2019	Future 2024	Existing 2019	Build 2019	Future 2024
Massachusetts Ave at Essex Street	West	B	B	B	B	B	B
	North	B	B	B	B	B	B
Massachusetts Ave at Prospect Street/River Street/Western Ave	East	C	C	C	C	C	C
	West	C	C	C	C	C	C
	North	C	C	C	C	C	C
	South	C	C	C	C	C	C

TABLE 11.A.2 UNSIGNALIZED INTERSECTION – PEDESTRIAN LOS SUMMARY

Intersection	Crosswalk	AM Peak Hour			PM Peak Hour		
		Existing 2019	Build 2019	Future 2024	Existing 2019	Build 2019	Future 2024
Massachusetts Ave at Pearl Street	East	F	F	F	F	F	F

12 Bicycle Analysis

12.a Conflicting Movements

Conflicting vehicle turning movements at the study area intersections are presented in Figure 2.c.5 and 2.c.6, and summarized in Table 12.a.1 for Existing 2019, Build 2019, and Future 2024 conditions.

TABLE 12.A.1 CONFLICTING BICYCLE/VEHICLE MOVEMENTS AT STUDY INTERSECTIONS

Intersection	Time Period	Bicycle Direction	Existing Peak Hour	Conflicting Vehicle Movements					
				Existing 2019		Build 2019		Future 2024	
			Bicycle Volume	Right Turn[a]	Left Turn[b]	Right Turn[a]	Left Turn[b]	Right Turn[a]	Left Turn[b]
Massachusetts Ave at Prospect Street/River Street/Western Ave	AM	EB	110	25	NA	25	NA	26	NA
		WB	37	116	NA	116	NA	119	NA
		NB	18	117	NA	117	NA	121	NA
		SB	18	30	NA	30	NA	31	NA
	PM	EB	43	39	NA	39	NA	40	NA
		WB	107	77	NA	77	NA	79	NA
		NB	17	155	NA	155	NA	161	NA
		SB	17	32	NA	32	NA	33	NA
Massachusetts Ave at Essex Street	AM	EB	160	NA	NA	NA	NA	NA	NA
		WB	40	2	2	2	3	2	7
	PM	EB	47	NA	NA	NA	NA	NA	NA

				Conflicting Vehicle Movements					
			Existing Peak Hour	Existing 2019		Build 2019		Future 2024	
Intersection	Time Period	Bicycle Direction	Bicycle Volume	Right Turn[a]	Left Turn[b]	Right Turn[a]	Left Turn[b]	Right Turn[a]	Left Turn[b]
		WB	151	64	89	64	90	66	103
Massachusetts Ave at Pearl Street	AM	EB	171	70	179	72	179	74	186
		WB	49	NA	NA	NA	NA	NA	NA
	PM	EB	50	84	190	86	190	88	198
		WB	135	NA	NA	NA	NA	NA	NA

a Advancing volume
b Opposing volume
NA Movement not available

13 Transportation Demand Management

The Proponent will implement a program of transportation demand management (TDM) actions to reduce automobile trips generated by the Project. The goal of the Project's TDM plan is to reduce the use of single occupant vehicles (SOVs) by encouraging carpooling and vanpooling, bicycle commuting and walking, and increased use of the area's public transportation system by residents, employees and patrons.

The Proponent will consider the following TDM programs as part of the proposed Project to encourage residents to use alternatives to SOV travel:

- Subsidize MBTA passes for new building residents.
- Provide air pumps and other bike tools, such as a "fix-it" stand in the bicycle storage areas.
- Do not charge residents additional fees for regular bicycle parking.
- Join the Charles River Transportation Management Association (CRTMA).
- Designate a transportation coordinator (TC) for the site to manage the TDM program.
- Post information in a prominent location in the building and on the building's website, social media and property newsletters promoting the use of transportation options and service information.
- Provide packages for new residents providing information on transit and other alternative transportation modes.

14 Transportation Mitigation

The proposed Project exceeds 4 out of 65 possible data entries, resulting in an 6.1% exceedance rate. **Table 14.a.1** provides a listing of all Planning Board Special Permit Exceedances and indicates how transportation mitigation measures will or cannot mitigate the Project Exceedances.

TABLE 14.A.1 EXCEEDANCE MITIGATION SUMMARY

#	Location		Reason for Exceedance	Mitigation
	Criteria E-2 – Pedestrian LOS			
1 2	Massachusetts Avenue at Pearl Street	PLOS E or F on Massachusetts Ave east approach during the AM and PM Peak Hours	Increase in traffic volumes	Existing PLOS conditions are maintained under Build conditions
	Criteria E-3 – Pedestrian and Bicycle Facilities			
3	Pearl Street		Bicycle facilities or right of ways not present	None – N/A
4	Green Street		Bicycle facilities or right of ways not present	None – N/A

Planning Board Special Permit Criteria

Criterion A – Project Vehicle Trip Generation

Table A-1 presents the Project vehicle trip generation criterion. Project vehicle trip generation is based on ITE trip rates, adjusted for local mode split and vehicle occupancy rates as discussed previously.

TABLE A-1 PROJECT VEHICLE TRIP GENERATION

Time Period	Criteria (trips)	Build	Exceeds Criteria?
Weekday Daily	2,000	334	No
Week AM Peak Hour	240	33	No
Week PM Peak Hour	240	30	No

The Project is not expected to exceed the Planning Board criteria for daily, morning peak and evening peak Project vehicle trip generation under the Full Build program.

Criterion B – Vehicle LOS

The criteria for a Project's impact to traffic operations at signalized intersections are summarized in Table B-1 below. These criteria are evaluated for each signalized study-area intersection and presented in Table B-2.

TABLE B-1 CRITERION - VEHICULAR LEVEL OF SERVICE

Existing	With Project
VLOS A	VLOS C
VLOS B, C	VLOS D
VLOS D	VLOS D or 7% roadway volume increase
VLOS E	7% roadway volume increase
VLOS F	5% roadway volume increase

TABLE B-2 VEHICULAR LEVEL OF SERVICE

Intersection	AM Peak Hour				PM Peak Hour			
	Existing Condition	Build Condition	Traffic Increase	Exceeds Criterion?	Existing Condition	Build Condition	Traffic Increase	Exceeds Criterion?
Massachusetts Ave at Pearl Street	C	C	0.4%	No	C	C	0.4%	No
Massachusetts Ave at Essex Street	B	B	0.4%	No	B	B	0.4%	No
Massachusetts Ave at Prospect Street/River Street/Western Ave	F	F	0.3%	No	E	E	0.3%	No

Criterion C – Traffic on Residential Streets

This criterion considers the magnitude of Project vehicle trip generation during any peak hour that may reasonably be expected to arrive and/or depart by traveling on a residential street. The criteria, based on a Project-induced traffic volume increase on any two-block residential street segment in the study area, are summarized in Table C-1.

TABLE C-1 CRITERION – TRAFFIC ON RESIDENTIAL STREETS

Parameter 1: Amount of Residential[1]	Parameter 2: Current Peak Hour Street Volume (two-way vehicles)		
	< 150 VPH	150-400 VPH	> 400 VPH
1/2 or more	20 VPH[2]	30 VPH[2]	40 VPH[2]
>1/3 but <1/2	30 VPH[2]	45 VPH[2]	60 VPH[2]
1/3 or less	No Max.	No Max.	No Max

1 - Amount of residential for a two block segment as determined by first floor frontage
2 - Additional Project vehicle trip generation in vehicles per lane, both directions
VPH - Vehicles per hour

0 of the 8 roadway segments in the study area identified as street segments which have more than 1/3 of residential frontage and are therefore evaluated against the traffic volume criteria. The results are presented in Table C-2.

TABLE C-2 TRAFFIC ON RESIDENTIAL STREETS

Roadway	Segment	Amount of Residential	AM Peak Hour			PM Peak Hour		
			Existing[1]	Project Trips	Exceeds Criteria?	Existing[1]	Project Trips	Exceeds Criteria?
Massachusetts Ave	west of Prospect Street/River Street	1/3 or less	563	3	No	575	4	No
	between Prospect Street/River Street and Essex Street	1/3 or less	741	3	No	736	3	No
	between Essex Street and Pearl Street	1/3 or less	741	2	No	711	3	No
	east of Pearl Street	1/3 or less	850	1	No	817	1	No
Pearl Street	south of Mass Ave	1/3 or less	249	2	No	274	2	No
Essex Street	north of Mass Ave	1/3 or less	4	1	No	153	1	No
Prospect Street	north of Mass Ave	1/3 or less	1023	3	No	1004	3	No
River Street and Western Ave	south of Mass Ave	1/3 or less	1019	3	No	1089	3	No

[1] Where driveways/on-street parking created a segment inflow/outflow volume imbalance, an average was calculated per direction and added

Criterion D – Lane Queue

The criteria for a project's impact to queues at signalized intersections are summarized in Table D-1 below. These criteria are evaluated for each lane group at study-area signalized intersections and presented in Table D-2.

TABLE D-1 CRITERION – VEHICULAR QUEUES AT SIGNALIZED INTERSECTIONS

Existing	With Project
Under 15 vehicles	Under 15 vehicles, or 15+ vehicles with an increase of 6 vehicles
15 or more vehicles	Increase of 6 vehicles

TABLE D-2 LENGTH OF VEHICULAR QUEUES AT SIGNALIZED INTERSECTIONS

		AM Peak Hour			PM Peak Hour		
Intersection	**Movement**	**Existing**	**Build**	**Exceeds Criteria?**	**Existing**	**Build**	**Exceeds Criteria?**
Massachusetts Ave at Prospect Street/River Street/Western Ave	Northbound - Thru	6	5	No	5	5	No
	Northbound - Right	1	1	No	1	2	No
	Southbound – Thru/Right	1	1	No	1	1	No
	Eastbound – Thru	2	2	No	2	2	No
	Eastbound - Right	10	13	No	7	7	No
	Westbound – Thru	2	5	No	2	2	No
	Westbound – Right	7	7	No	8	8	No
Massachusetts Avenue at Essex Street	Eastbound – Left	0	1	No	2	2	No
	Eastbound – Thru	3	3	No	3	3	No
	Westbound – Thru/Right	5	5	No	5	6	No

Queue lengths are shown in number of vehicles. Synchro provides queue length in feet, which is converted to vehicles. (1 veh = 25 feet)

Due to the limitations of Syncho, modeled queues are all reported using SimTraffic.

Criterion E – Pedestrian and Bicycle Facilities

Criteria 1: Pedestrian Delay

Pedestrian delay is a measure of the pedestrian crossing delay on a crosswalk during the peak hour as determined by the pedestrian level of service analysis in the HCM 2000.

Table E-1 presents the indicators for this criterion. Tables E-2 present the evaluation of PLOS criteria for each crosswalk at study area intersections under existing and full build conditions.

TABLE E-1 CRITERION – PLOS INDICATORS

Existing	With Project
PLOS A	PLOS A
PLOS B	PLOS B
PLOS C	PLOS C
PLOS D	PLOS D or increase of 3 seconds
PLOS E, F	PLOS D

TABLE E-2 INTERSECTION PLOS SUMMARY

		AM Peak Hour			PM Peak Hour		
Intersection	**Crosswalk**	**Existing**	**Build**	**Exceeds Criteria?**	**Existing**	**Build**	**Exceeds Criteria?**
Massachusetts Ave at Pearl Street	East	F	F	**Yes**	F	F	**Yes**
Massachusetts Ave at Essex Street	West	B	B	No	B	B	No
	North	B	B	No	B	B	No
	East	C	C	No	C	C	No

Intersection	Crosswalk	AM Peak Hour			PM Peak Hour		
		Existing	Build	Exceeds Criteria?	Existing	Build	Exceeds Criteria?
Massachusetts Ave at Prospect Street/River Street/Western Ave	West	C	C	No	C	C	No
	North	C	C	No	C	C	No
	South	C	C	No	C	C	No

Criteria 2 & 3: Safe Pedestrian and Bicycle Facilities

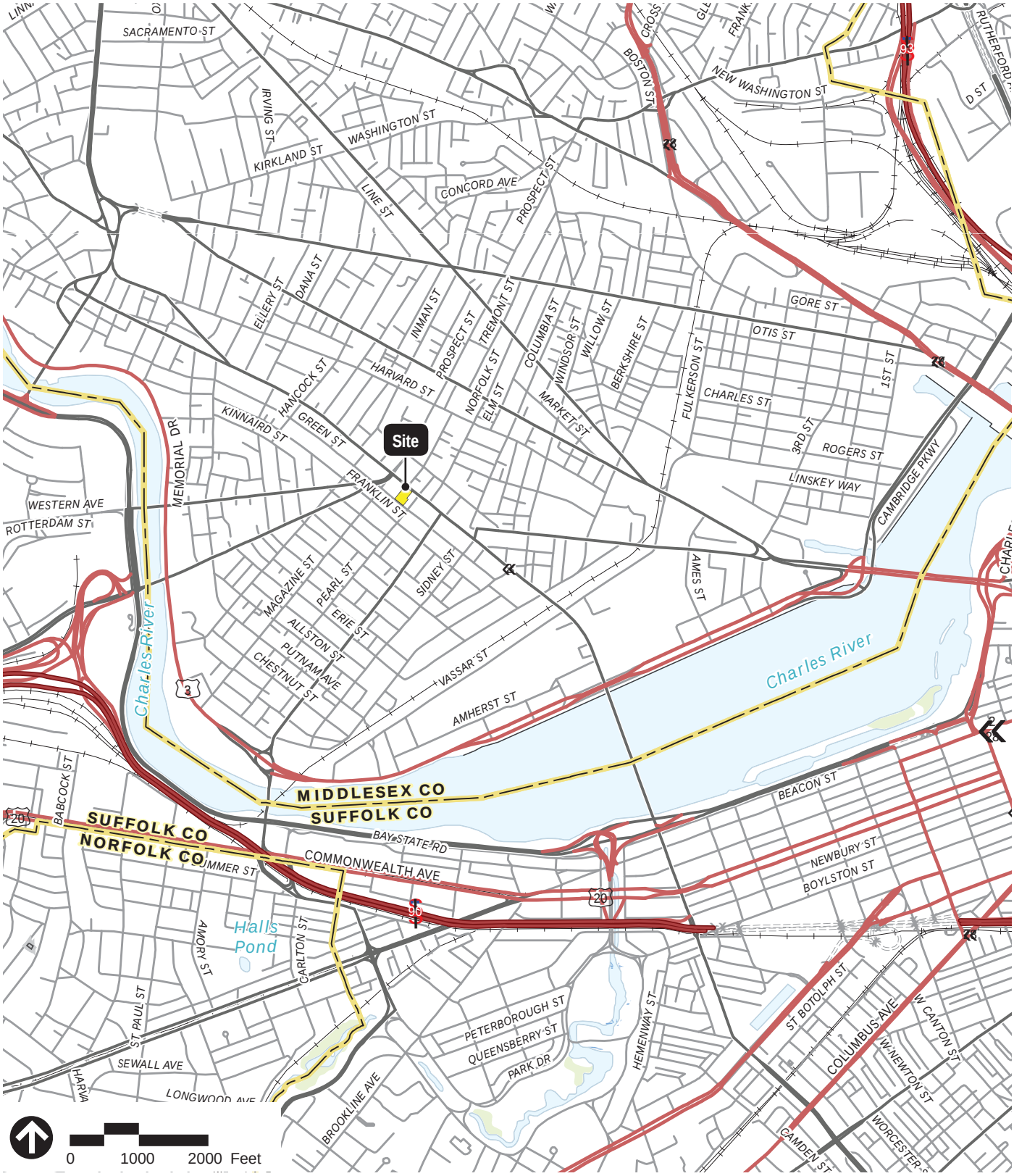
Safe pedestrian and bicycle facilities are off-road or on-street bicycle lanes and sidewalks that are along a publicly-accessible street.

Table E-3 presents the indicators for this criterion. The evaluation of sidewalks or walkways and bicycle facilities are displayed.

TABLE E-3 PEDESTRIAN AND BICYCLE FACILITIES

Adjacent Street	Link (between)	Sidewalk or Walkway Present	Exceeds Criteria?	Bicycle Facilities or Right of Ways Present	Exceeds Criteria?
Massachusetts Avenue	Essex Street and Pearl Street	Yes	No	Yes	No
Pearl Street	Massachusetts Avenue and Green Street	Yes	No	No	**Yes**
Green Street	Pearl Street and Magazine Street	Yes	No	No	**Yes**

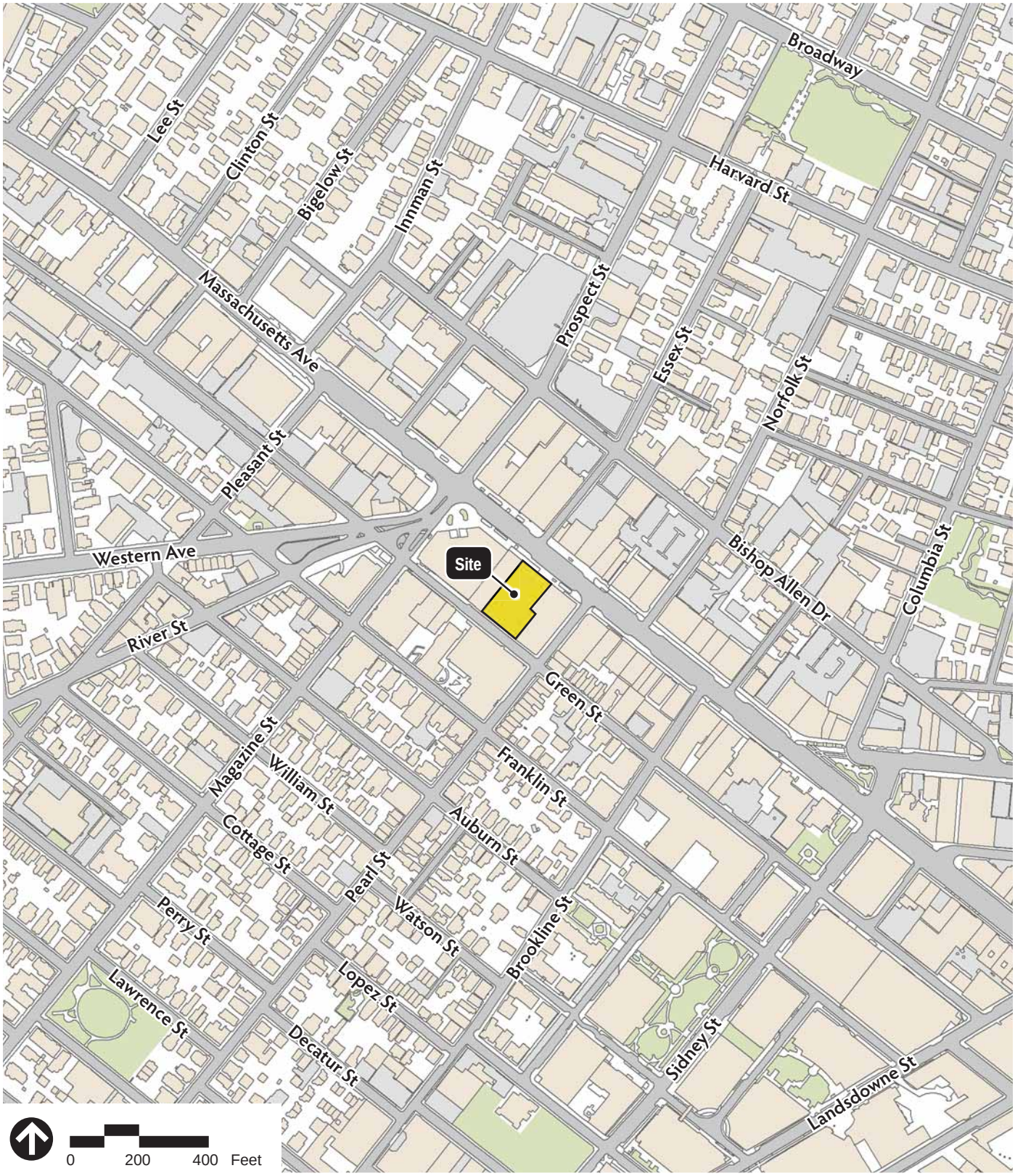
TIS Figures



Source: USGS US Topo

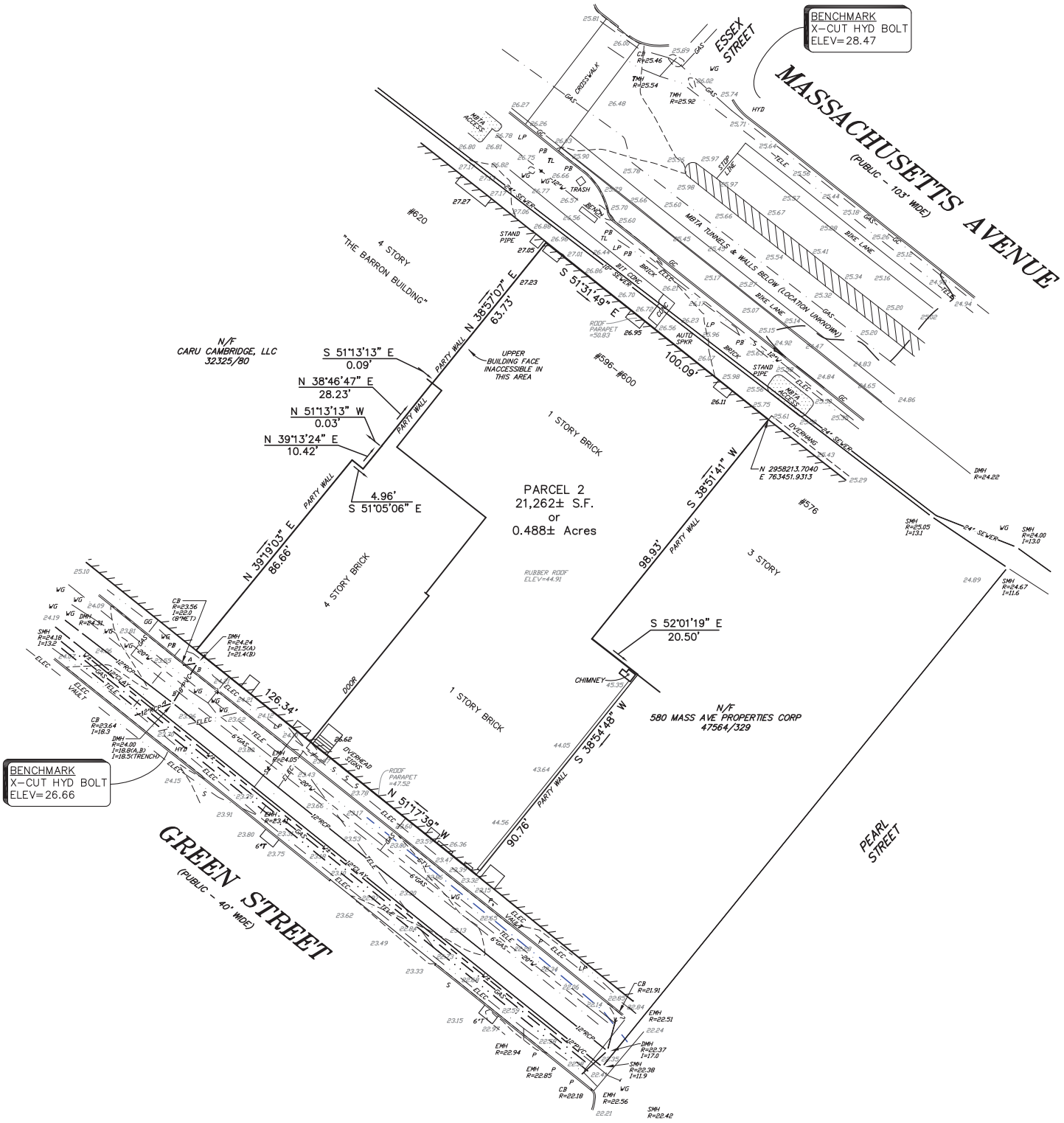
Figure A

Site Location Map



Source: City of Cambridge GIS

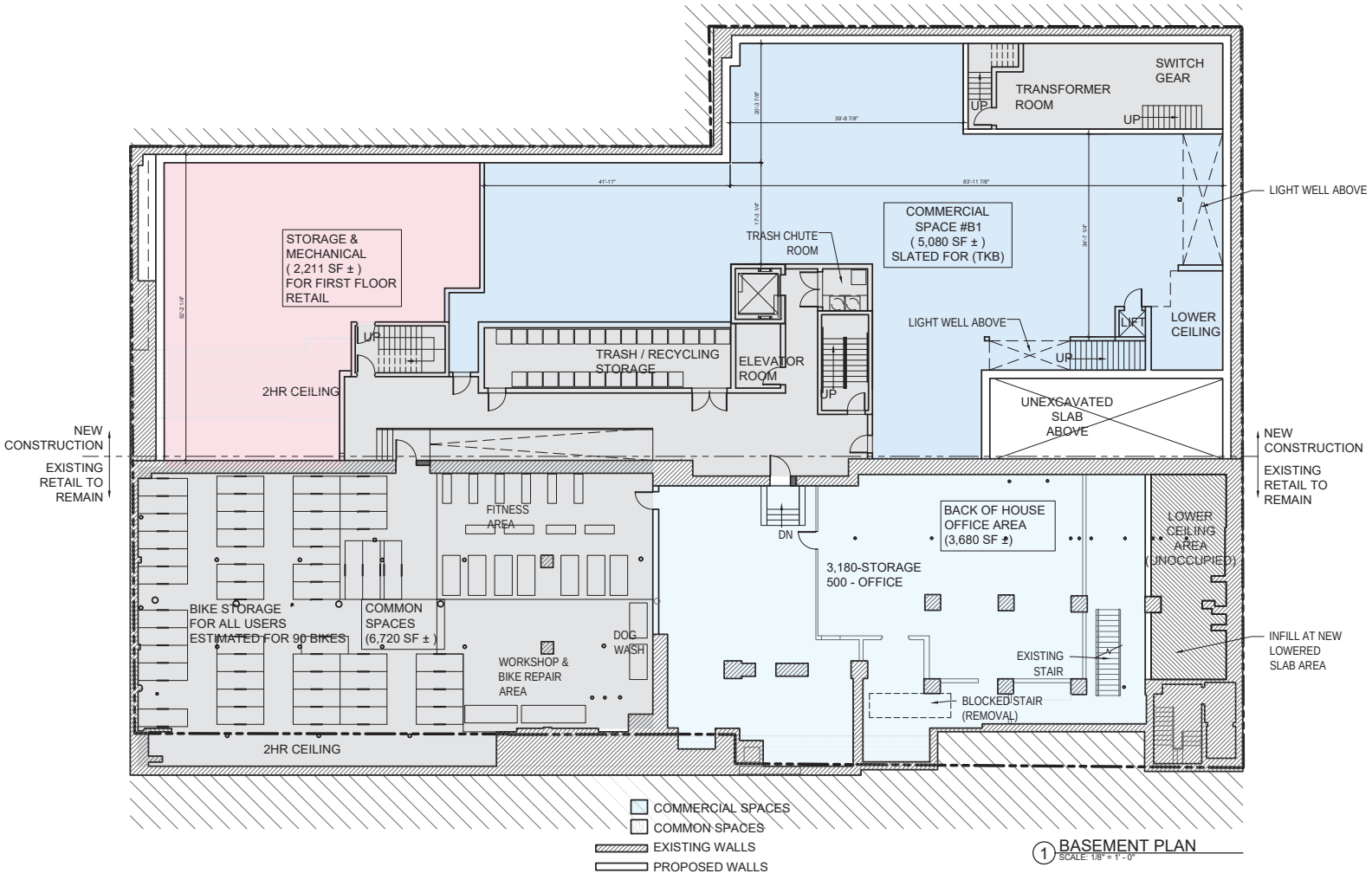
Figure B
Project Site



Source: Precision Land Surveying, Inc.

Figure C

Existing Conditions Site Plan

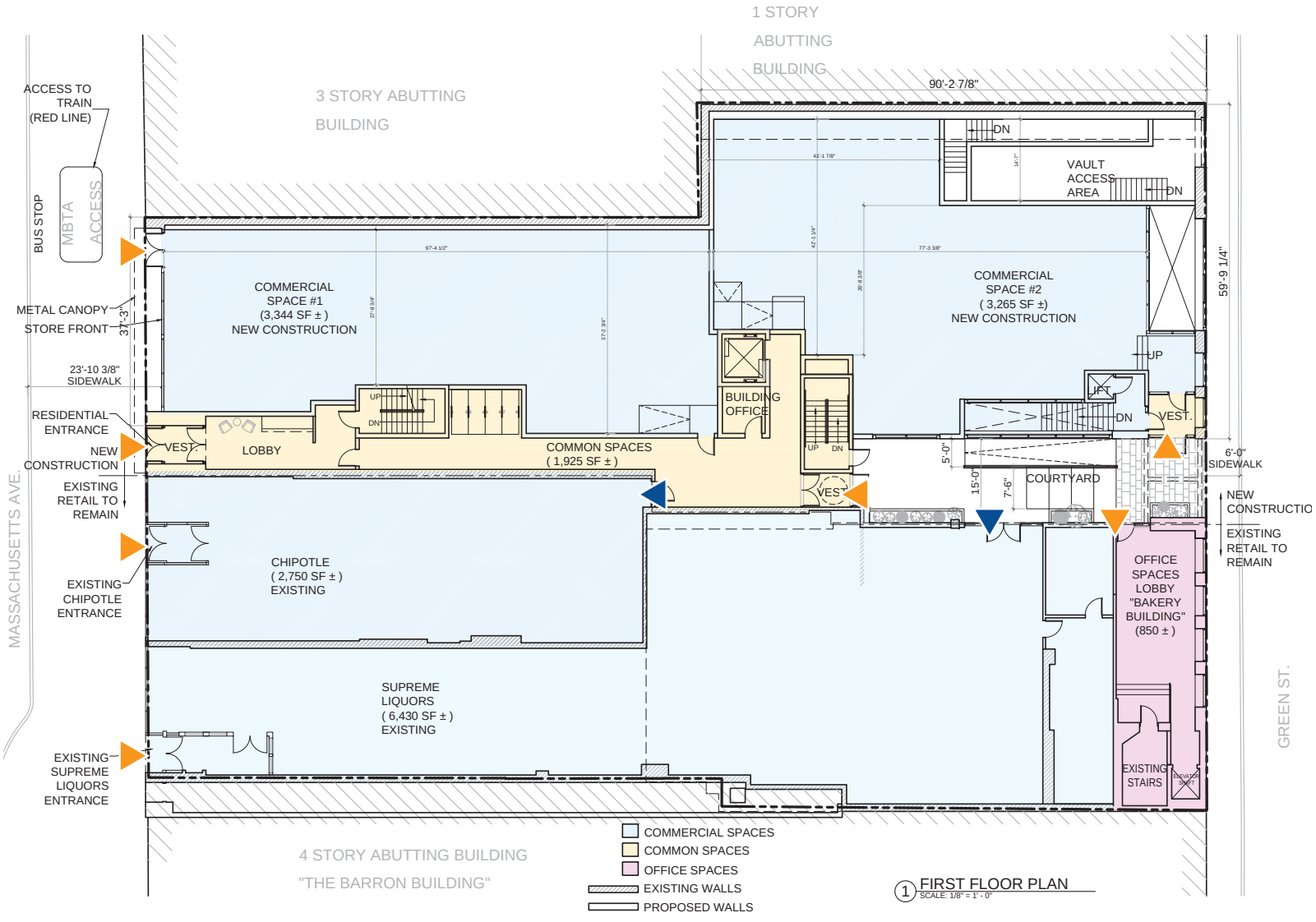


Source: Peter Quinn Architects

Figure D.1

Proposed Site Plan - Basement

600 Massachusetts Avenue TIS
Cambridge, Massachusetts



Source: Peter Quinn Architects

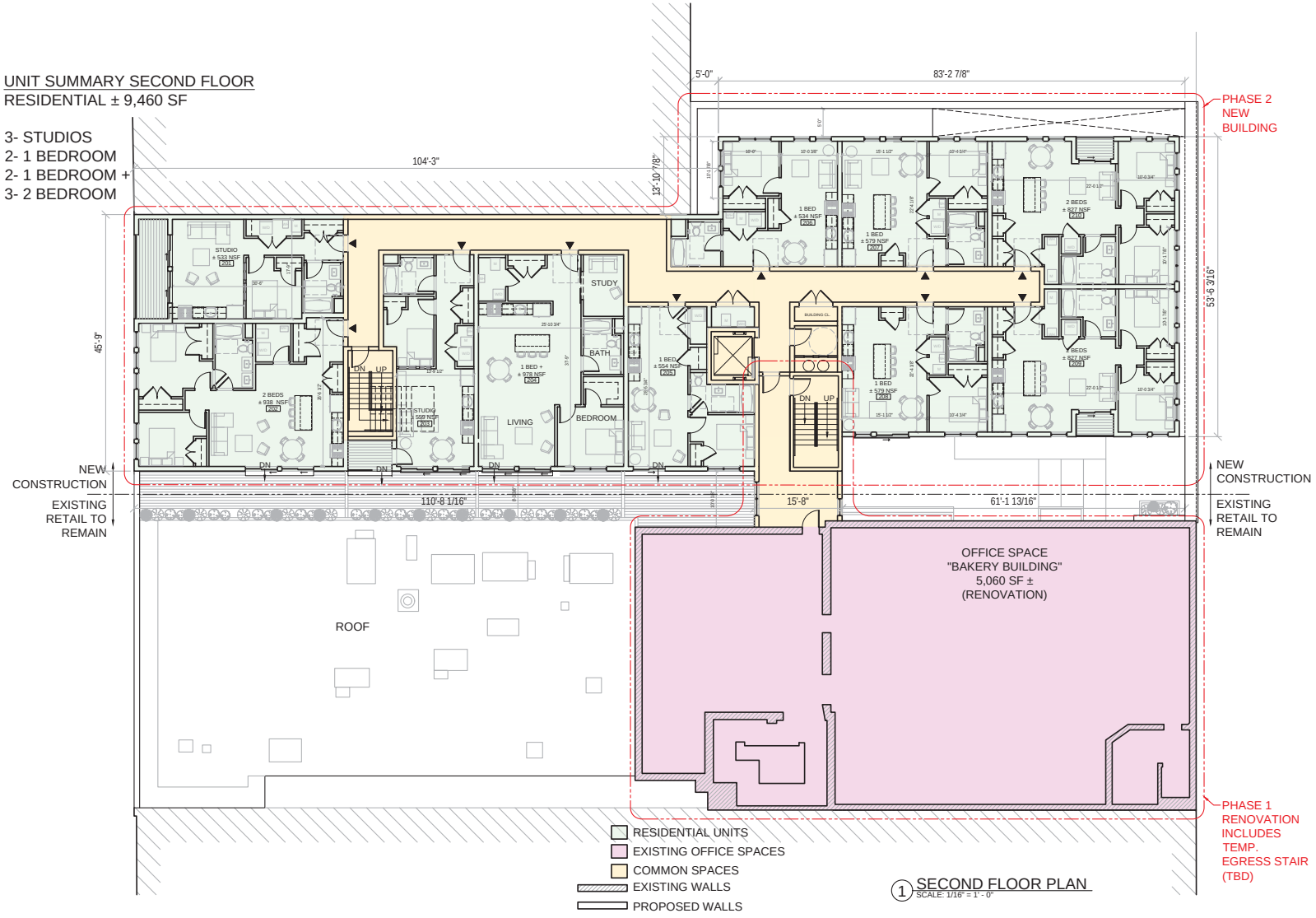
▲ Pedestrian Access

▲ Loading Access

Figure D.2

Proposed Site Plan - First Floor

600 Massachusetts Avenue TIS
Cambridge, Massachusetts

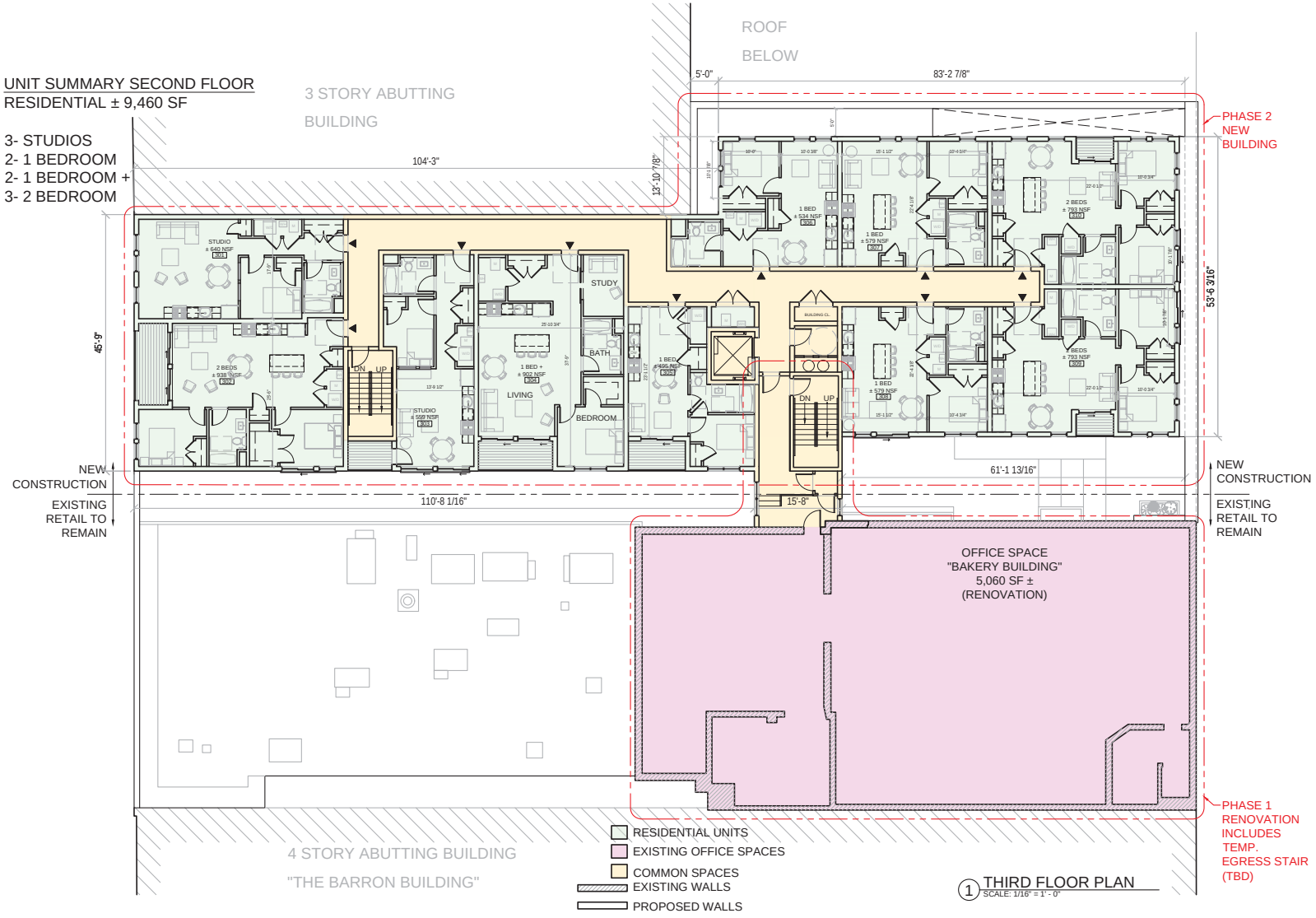


Source: Peter Quinn Architects

Figure D.3

Proposed Site Plan - Second Floor

600 Massachusetts Avenue TIS
Cambridge, Massachusetts



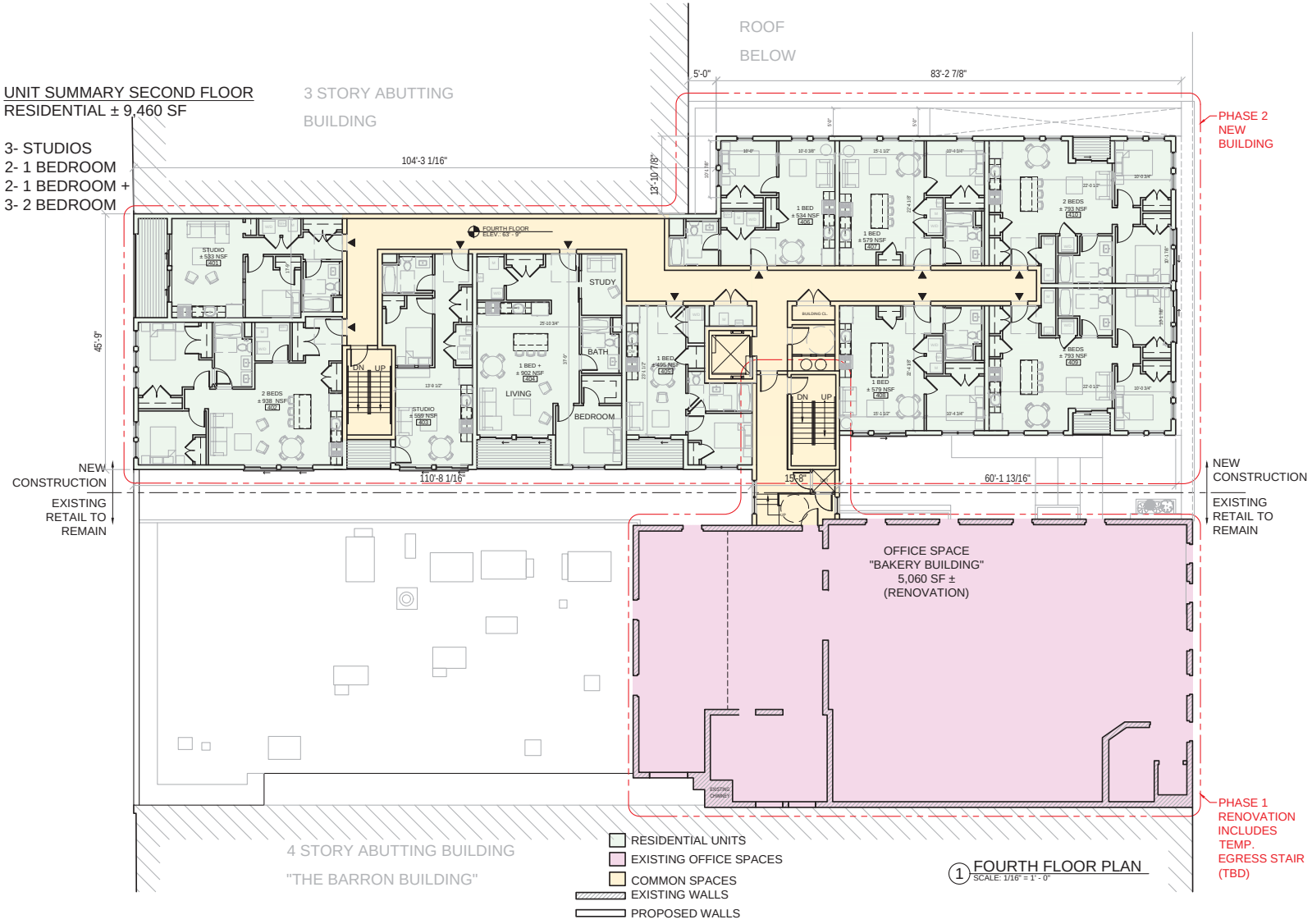
1 THIRD FLOOR PLAN
SCALE: 1/16" = 1' - 0"

Source: Peter Quinn Architects

Figure D.4

Proposed Site Plan - Third Floor

600 Massachusetts Avenue TIS
Cambridge, Massachusetts

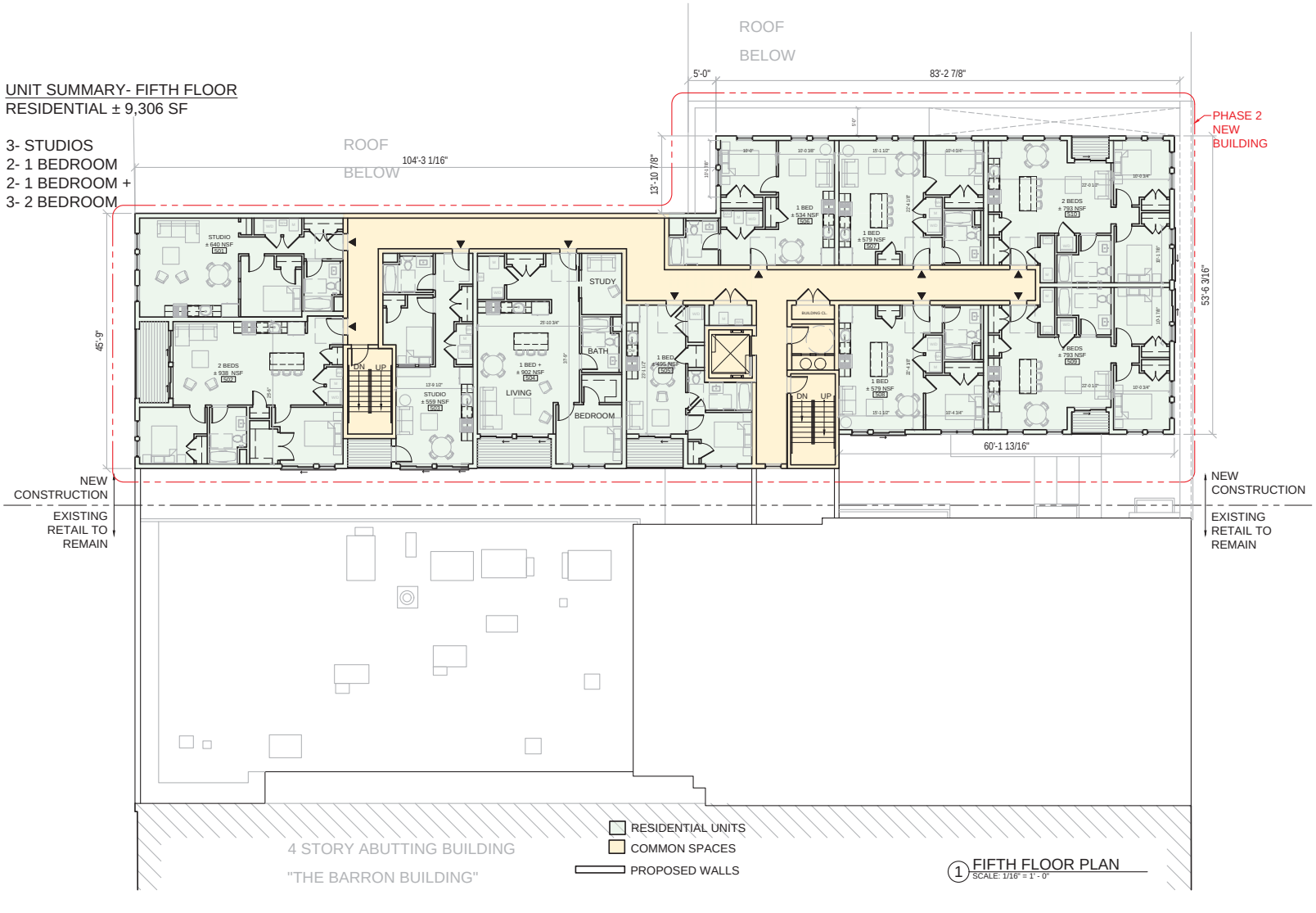


Source: Peter Quinn Architects

Figure D.5

Proposed Site Plan - Fourth Floor

600 Massachusetts Avenue TIS
Cambridge, Massachusetts

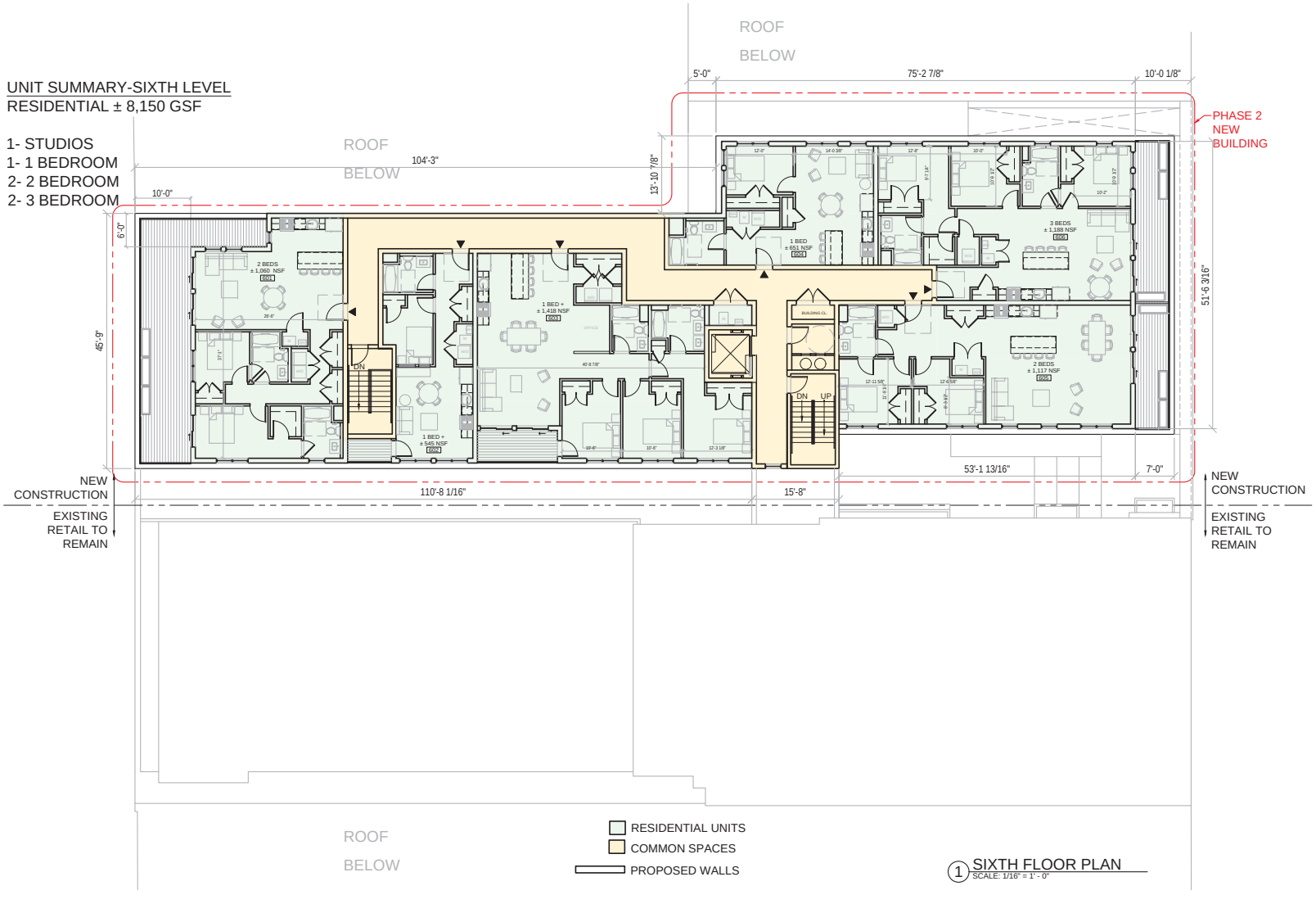


Source: Peter Quinn Architects

Figure D.6

Proposed Site Plan - Fifth Floor

600 Massachusetts Avenue TIS
Cambridge, Massachusetts

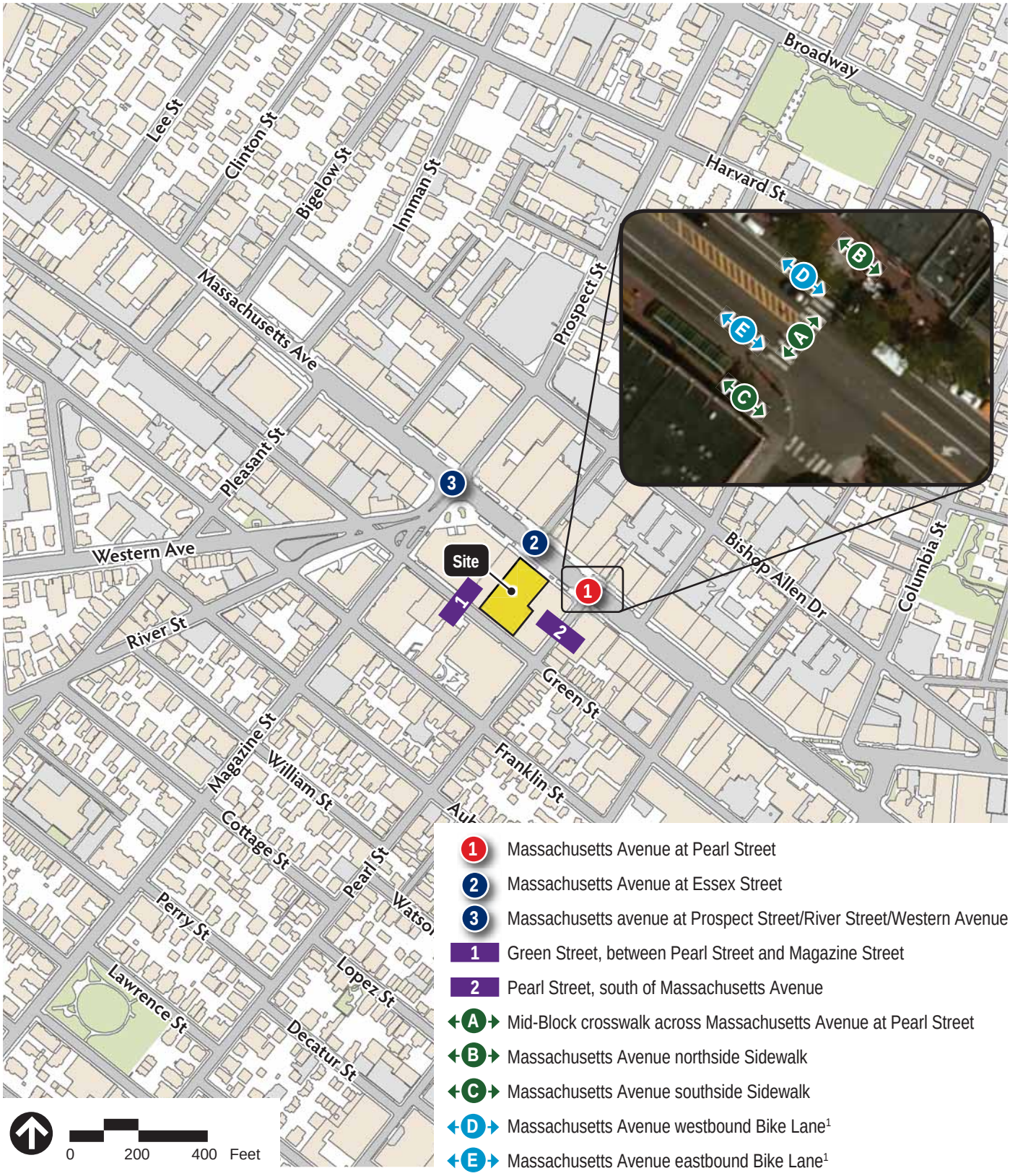


Source: Peter Quinn Architects

Figure D.7

Proposed Site Plan - Sixth Floor

600 Massachusetts Avenue TIS
Cambridge, Massachusetts



1 Massachusetts Avenue at Pearl Street
2 Massachusetts Avenue at Essex Street
3 Massachusetts avenue at Prospect Street/River Street/Western Avenue
1 Green Street, between Pearl Street and Magazine Street
2 Pearl Street, south of Massachusetts Avenue
A Mid-Block crosswalk across Massachusetts Avenue at Pearl Street
B Massachusetts Avenue northside Sidewalk
C Massachusetts Avenue southside Sidewalk
D Massachusetts Avenue westbound Bike Lane[1]
E Massachusetts Avenue eastbound Bike Lane[1]

Source: City of Cambridge GIS

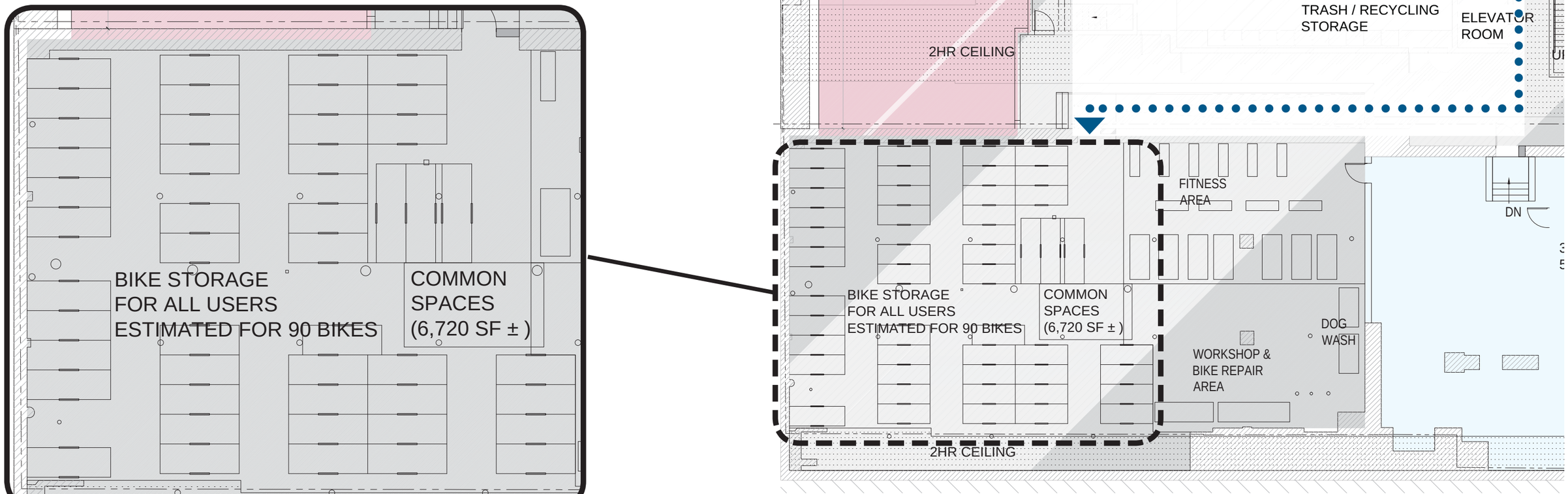
Signalized Intersection
Unsignalized Intersection
Vehicle ATR Location
X Pedestrian ATR Location
Y Bicycle ATR Location

[1] Bike lanes are directional, but volumes were counted in both directions

vhb

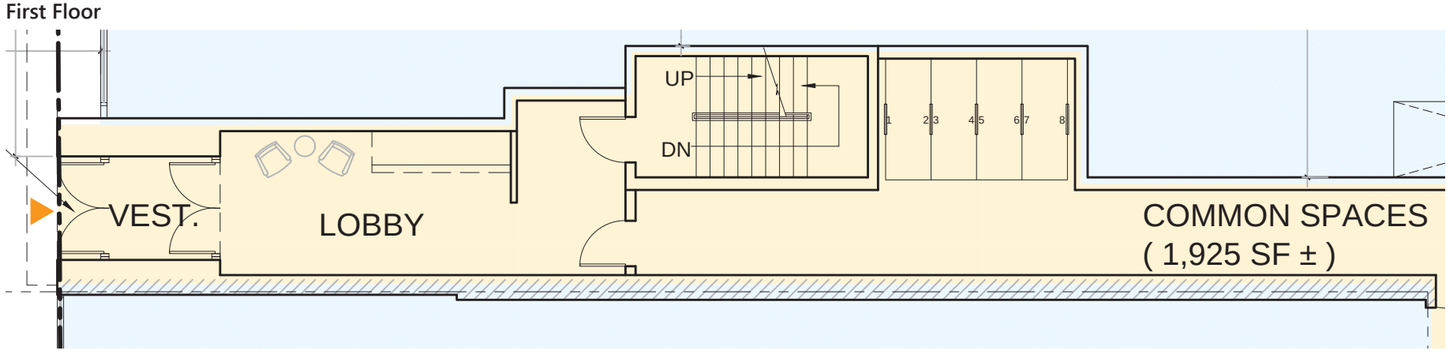
Figure E
Study Area Intersections

Basement Level



0 5 10 Feet

First Floor



0 5 10 Feet

Pedestrian Access

Bike Room Access

Figure G

Proposed Long-Term Bike Parking

600 Massachusetts Avenue TIS
Cambridge, Massachusetts

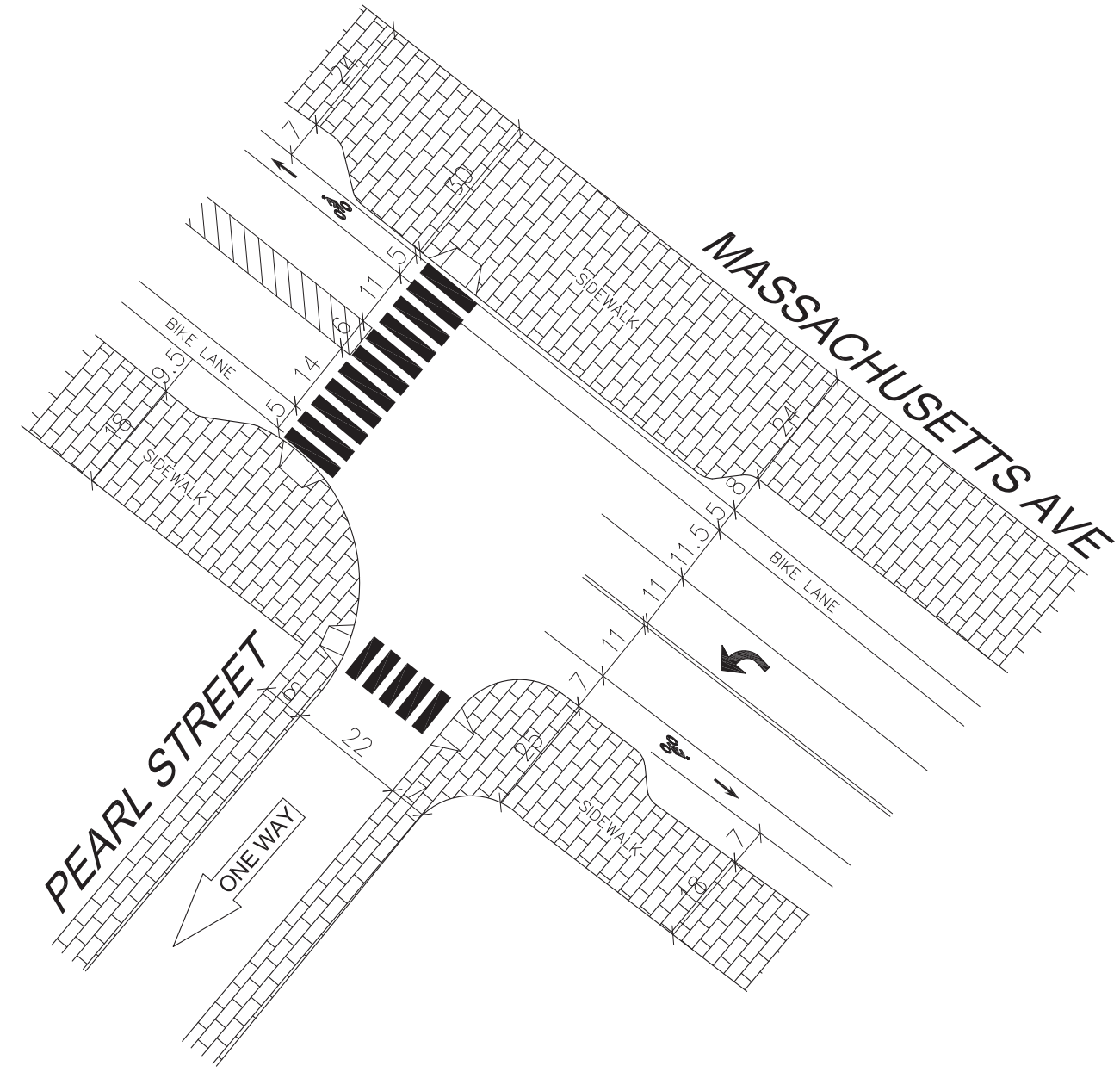
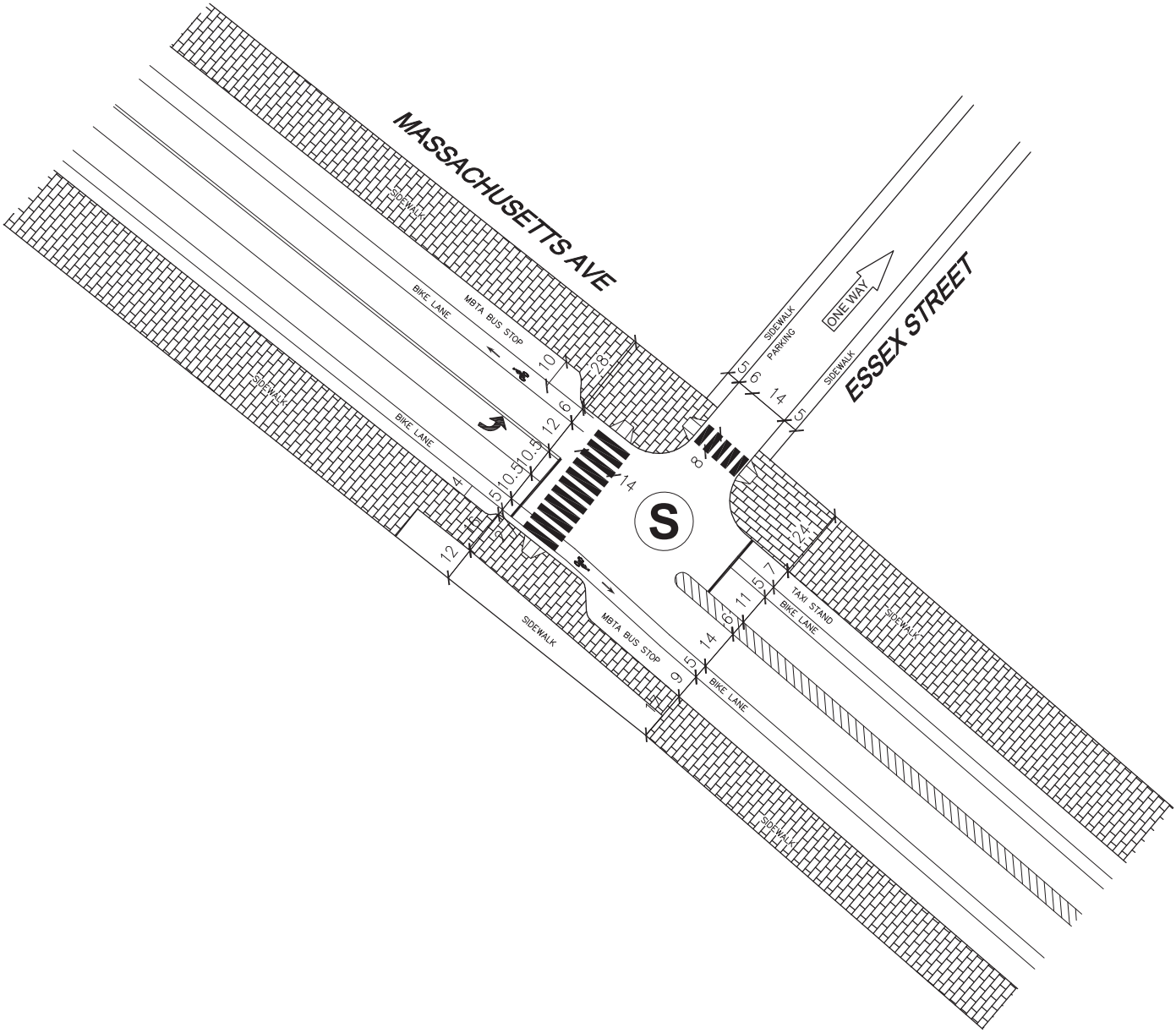


Figure 1.b.1
Massachusetts Ave at Pearl Street
600 Massachusetts Avenue TIS
Cambridge, Massachusetts



0 20 40 Feet

Figure 1.b.2
Massachusetts Ave at Essex St
600 Massachusetts Avenue TIS
Cambridge, Massachusetts

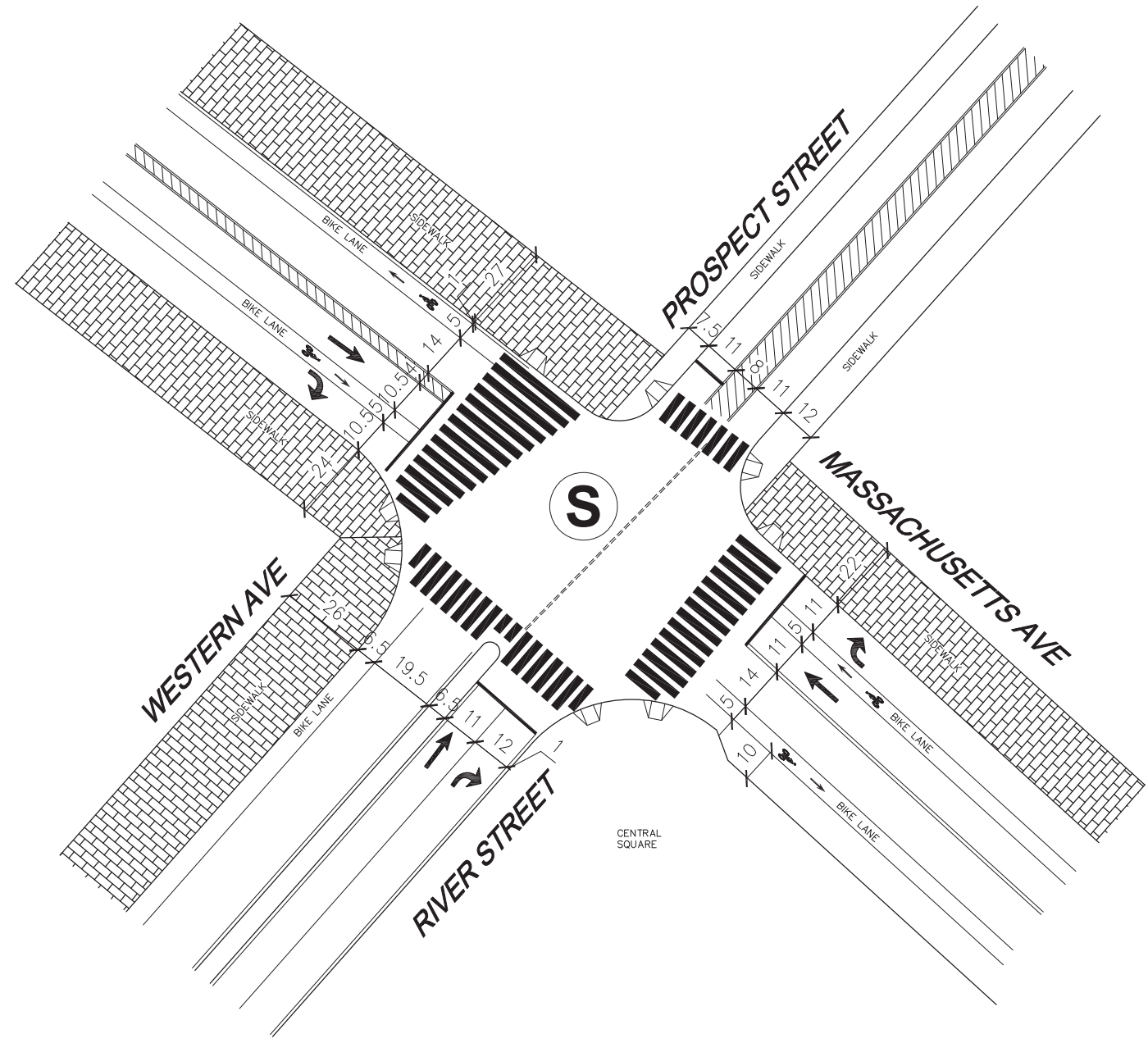
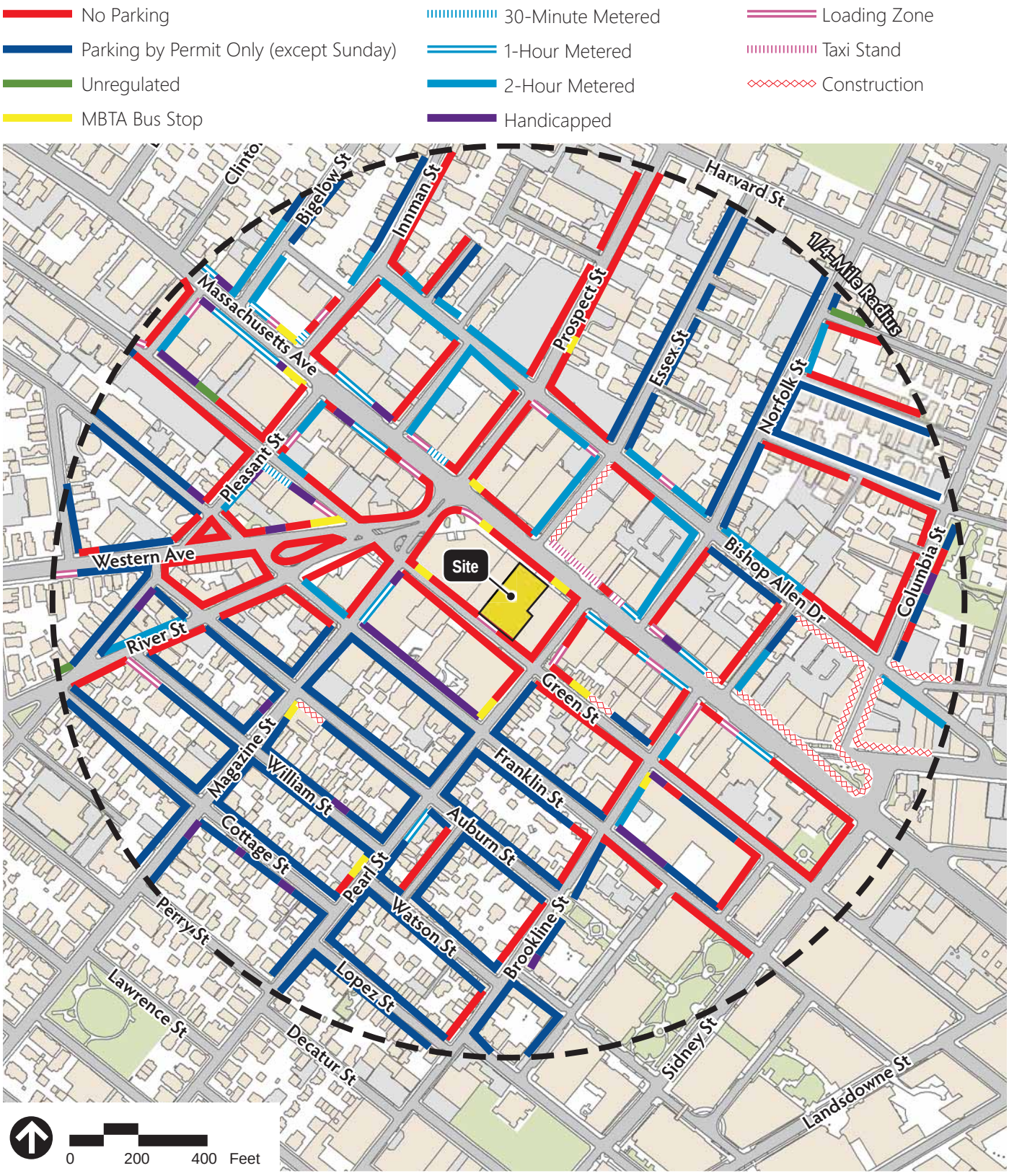
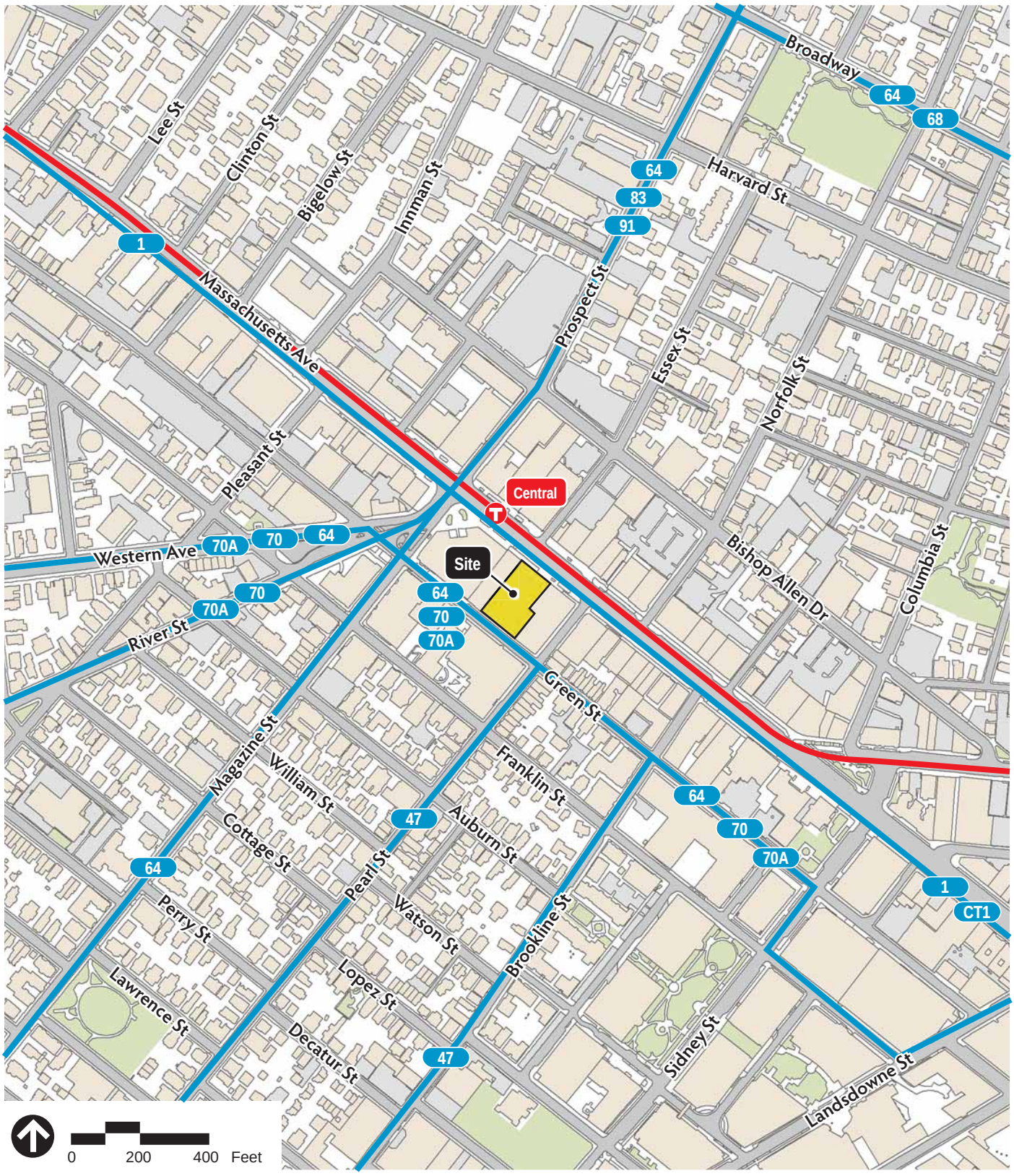


Figure 1.b.3
Massachusetts Ave at Prospect Street/River Street/
Western Ave



Source: City of Cambridge GIS

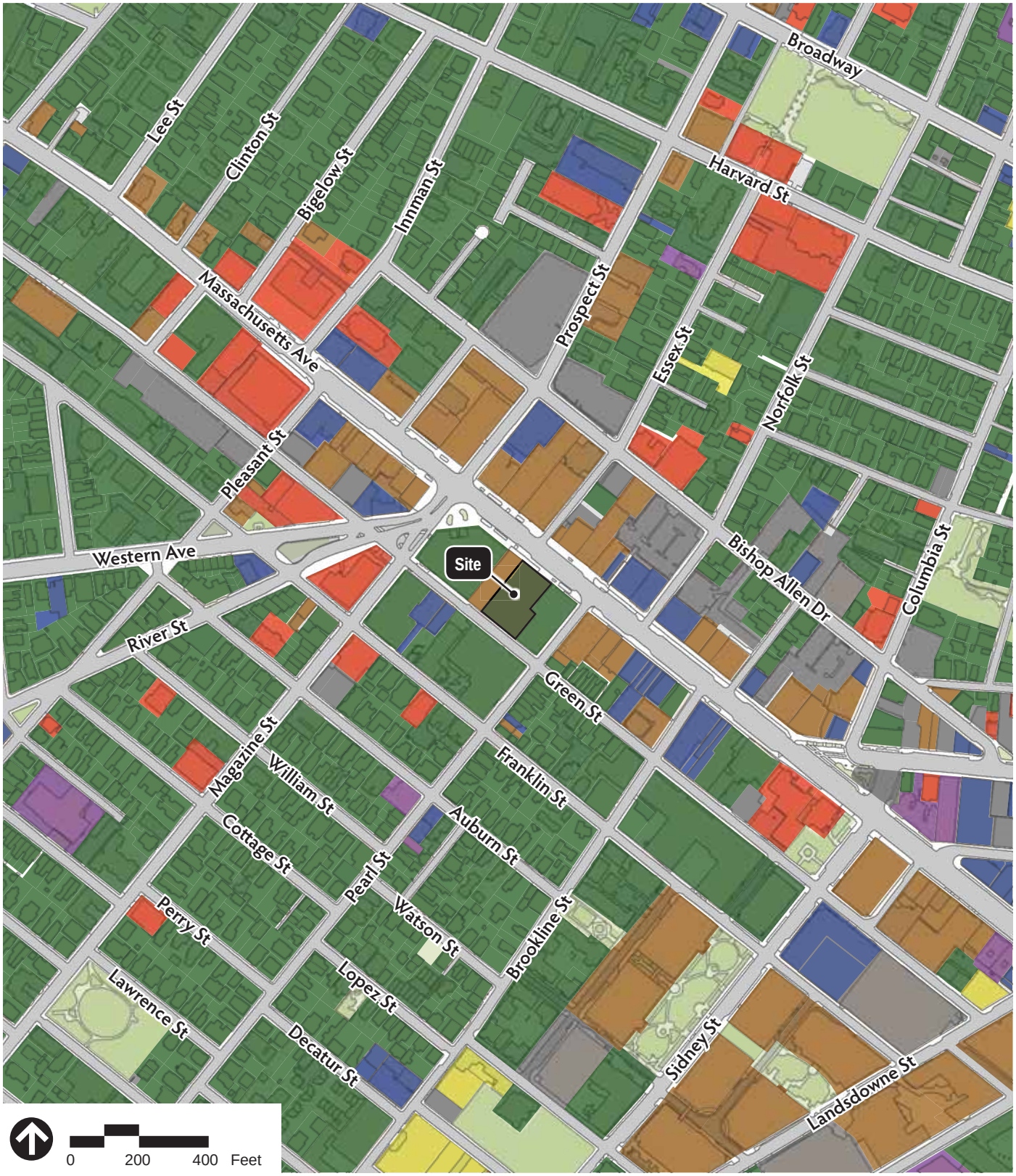
Figure 1.c.1
Existing Curb Use



Source: City of Cambridge GIS

Figure 1.d.1

Existing Public Transportation



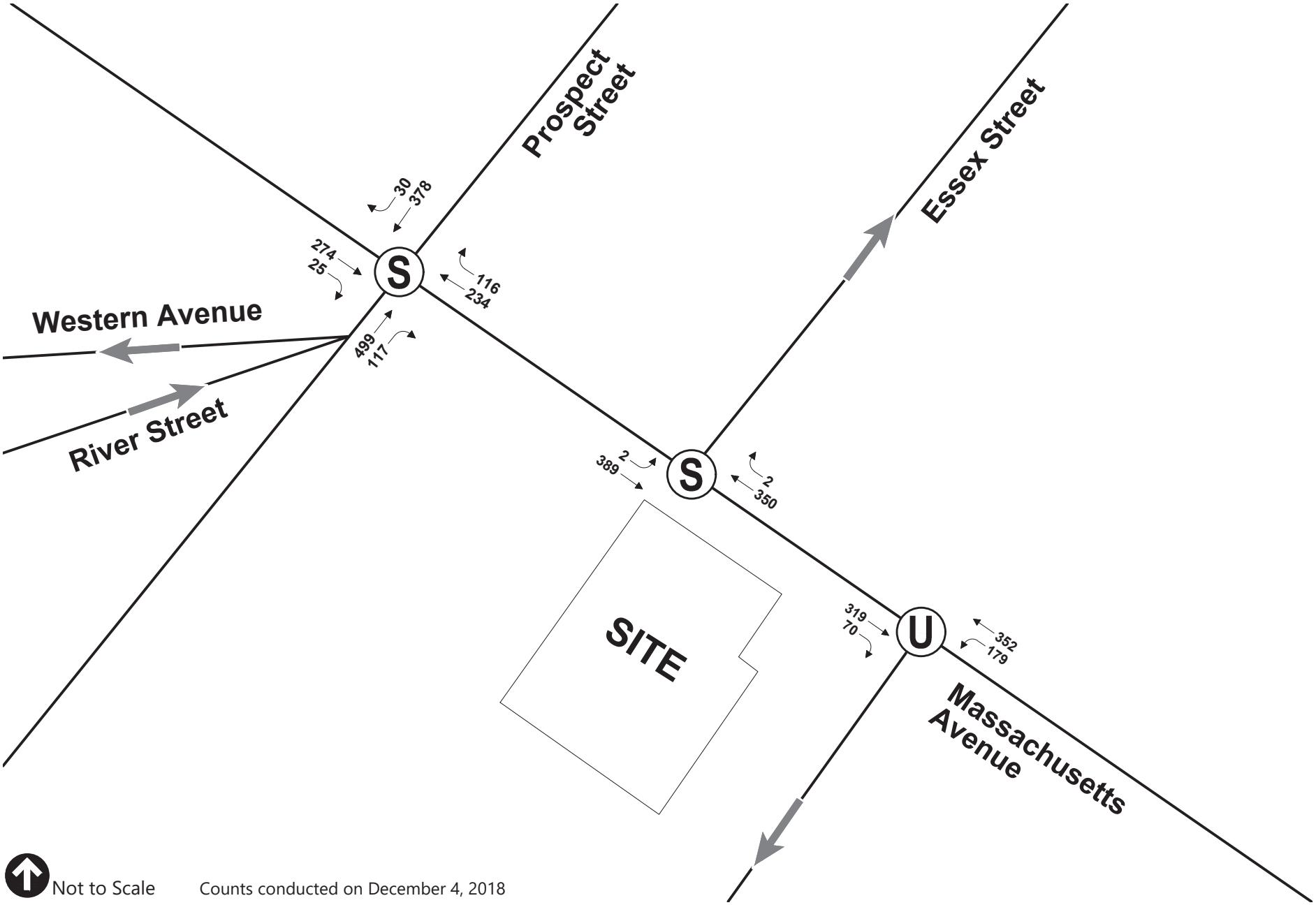
Source: City of Cambridge GIS

- Residential
- Commercial
- Office
- Industrial
- Education
- Government/Health
- Transportation/Utility
- Open Space

Figure 1.e.1

Land Use

600 Massachusetts Avenue TIS
Cambridge, Massachusetts

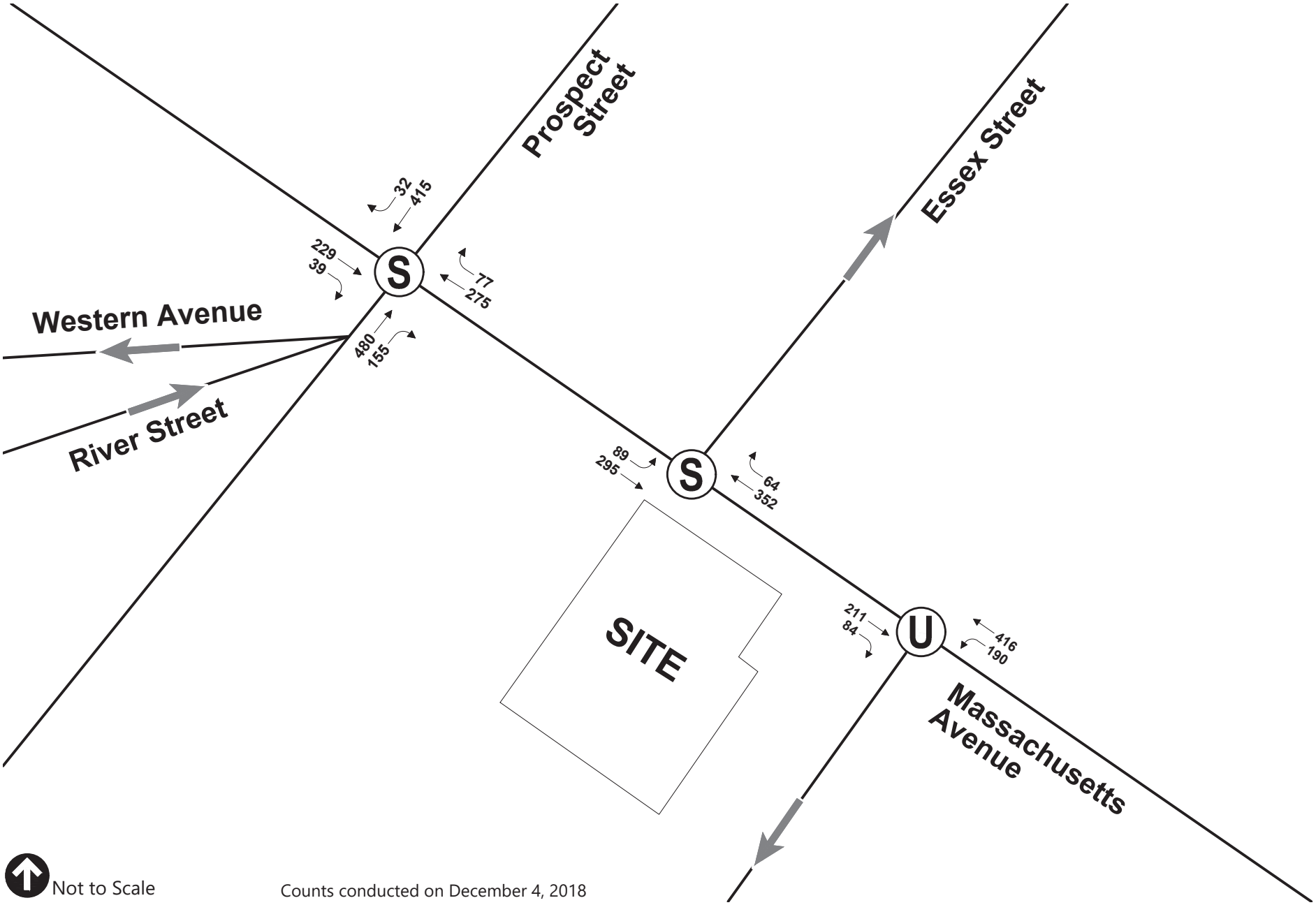


Not to Scale

Counts conducted on December 4, 2018

2019 Existing Condition
Vehicle Volume Morning Peak Hour
600 Massachusetts Avenue
Cambridge, MA

Figure 2.c.1

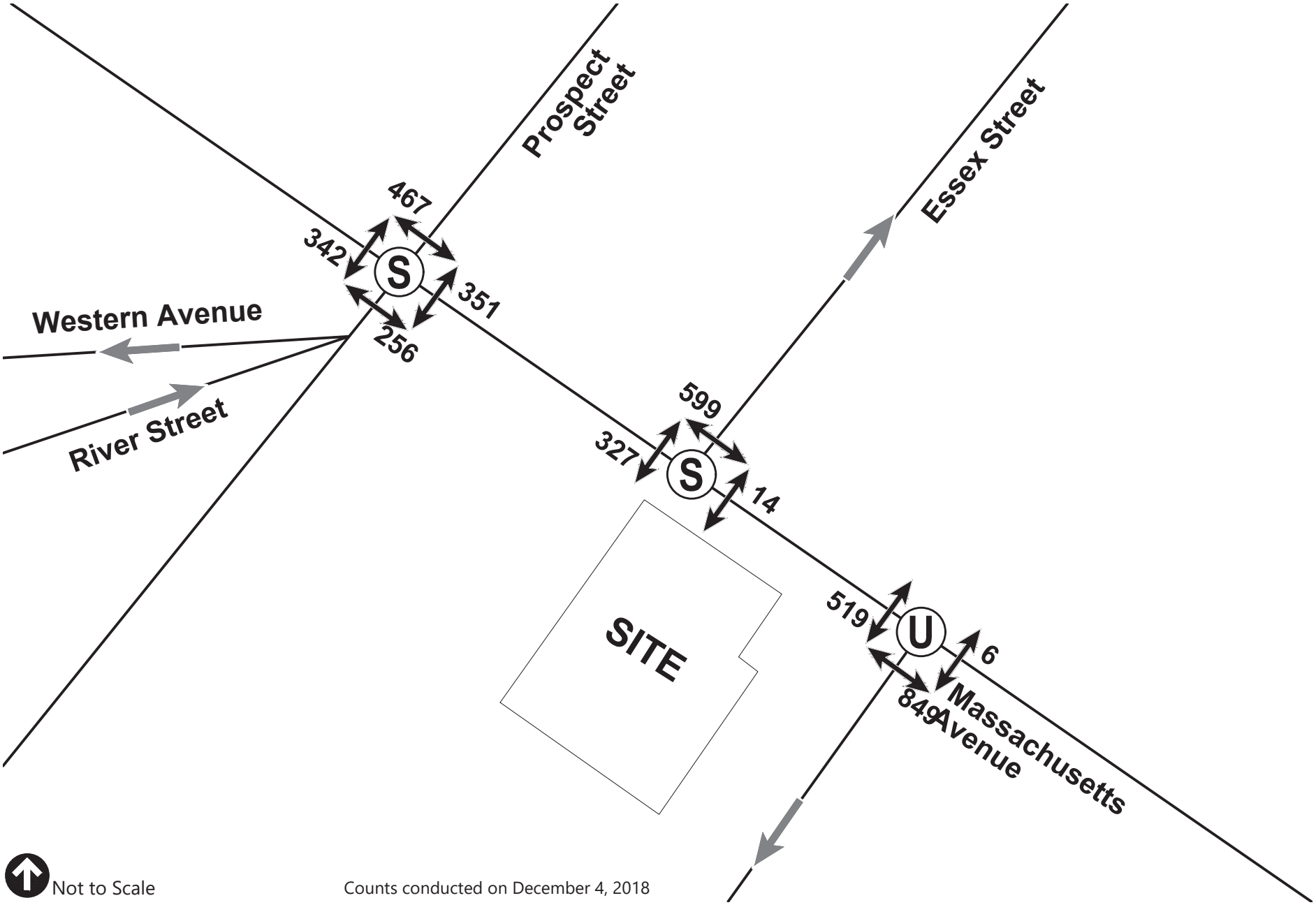


Not to Scale

Counts conducted on December 4, 2018

2019 Existing Condition
Vehicle Volume Evening Peak Hour
600 Massachusetts Avenue
Cambridge, MA

Figure 2.c.2

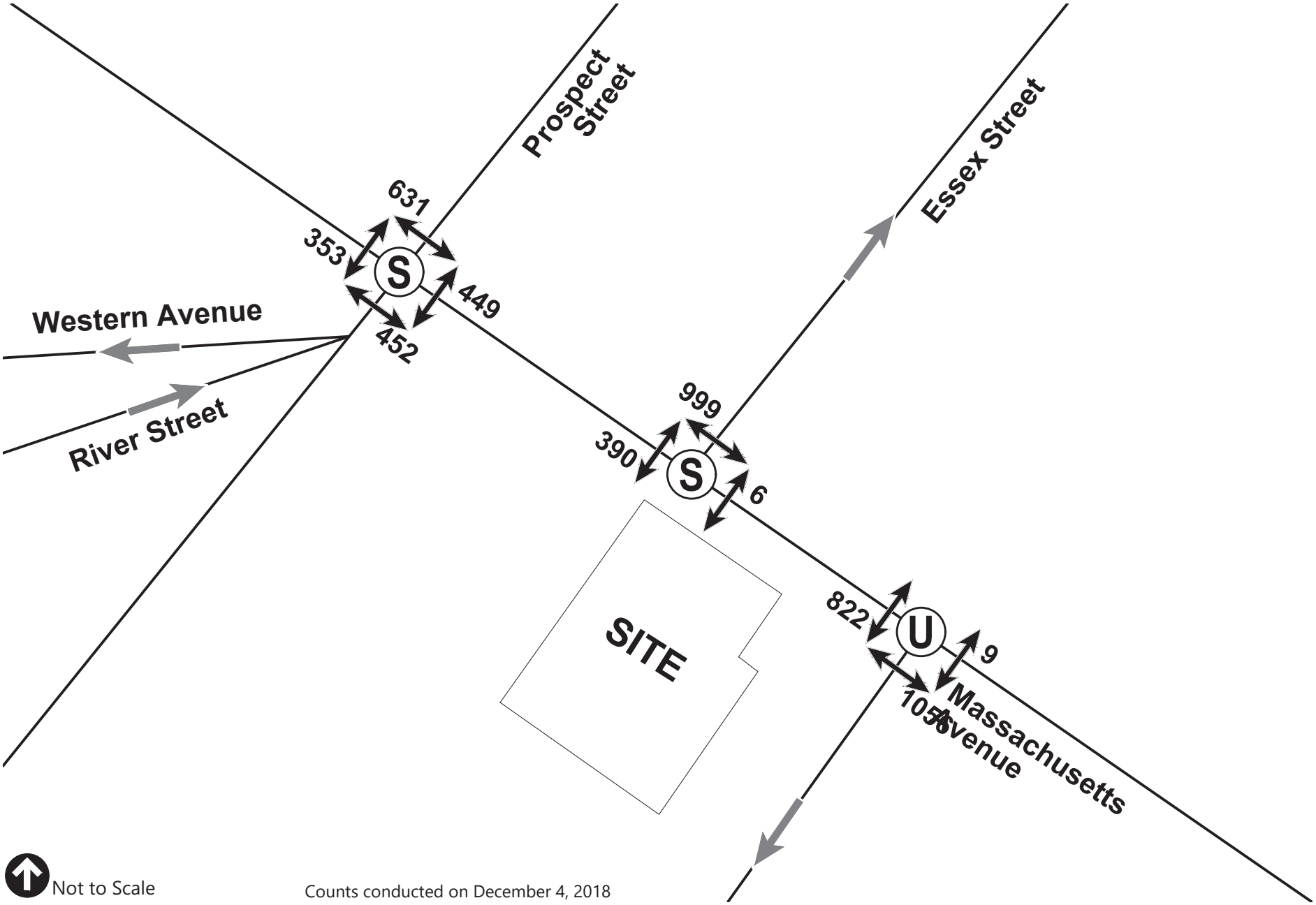


Not to Scale

Counts conducted on December 4, 2018

2019 Existing Condition
Pedestrian Volume Morning Peak Hour
600 Massachusetts Avenue
Cambridge, MA

Figure 2.c.3

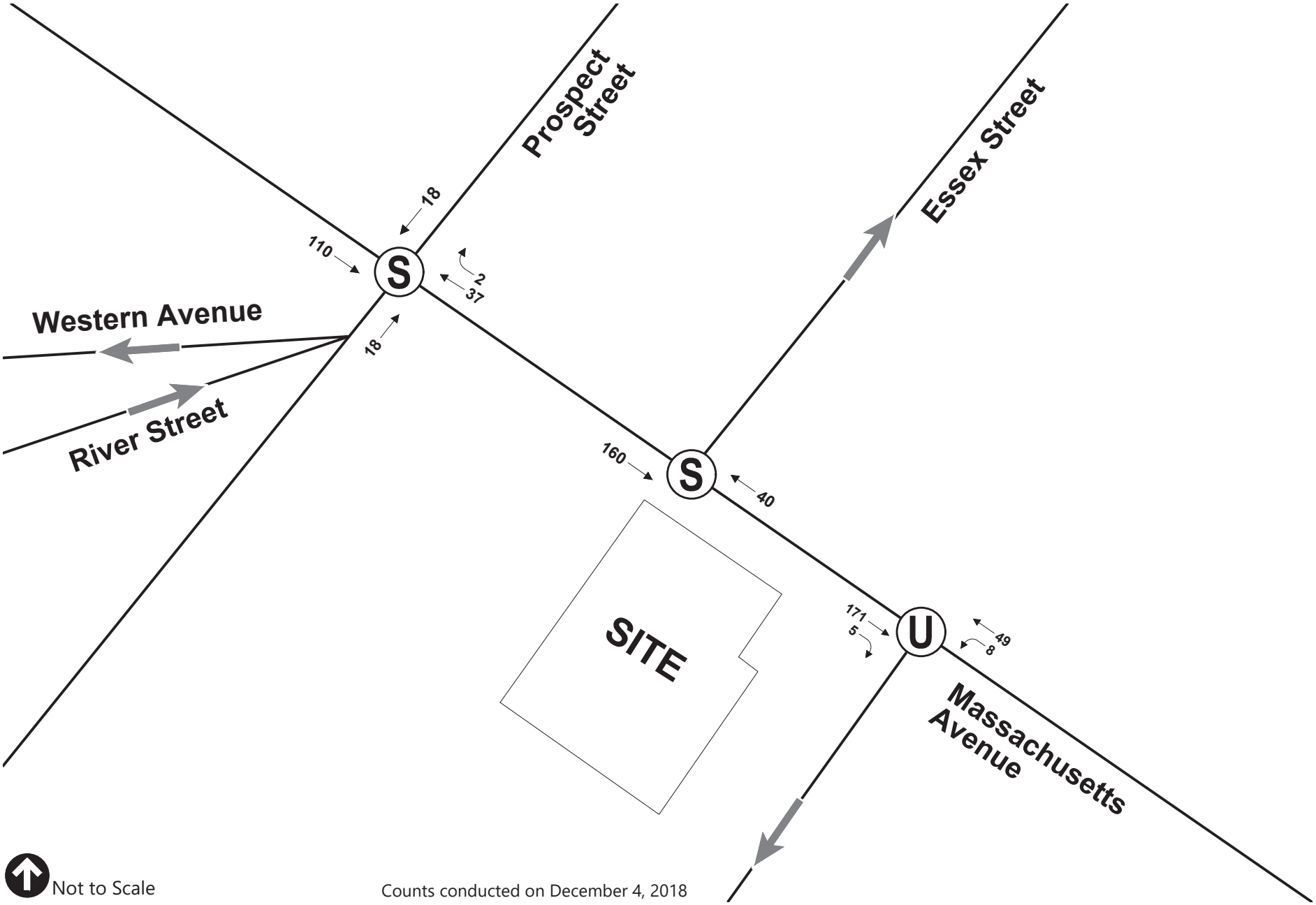


Not to Scale

Counts conducted on December 4, 2018

2019 Existing Condition
Pedestrian Volume Evening Peak Hour
600 Massachusetts Avenue
Cambridge, MA

Figure 2.c.4

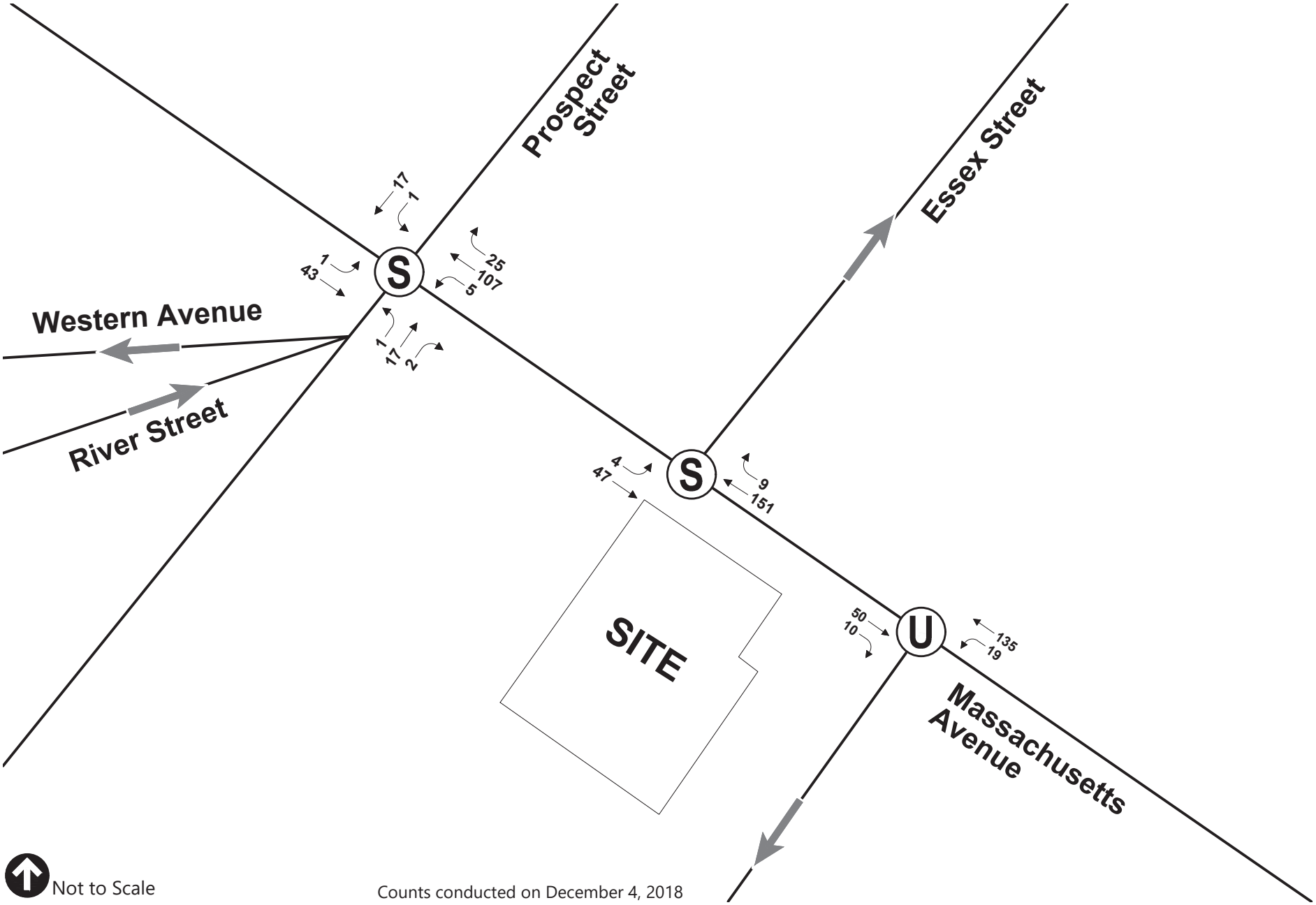


Not to Scale

Counts conducted on December 4, 2018

2019 Existing Condition
Bicycle Volume Morning Peak Hour
600 Massachusetts Avenue
Cambridge, MA

Figure 2.c.5

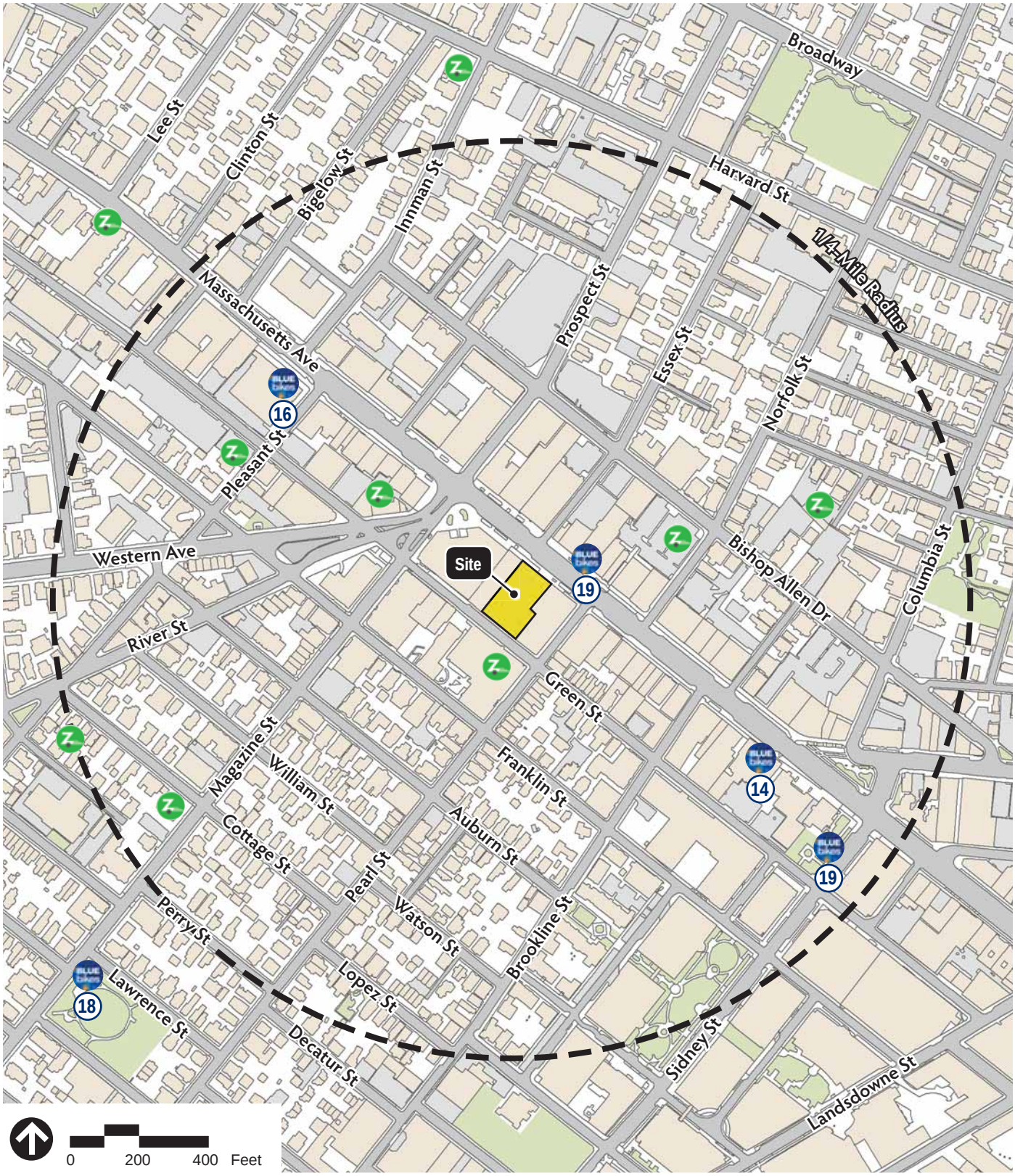


Not to Scale

Counts conducted on December 4, 2018

2019 Existing Condition
Bicycle Volume Evening Peak Hour
600 Massachusetts Avenue
Cambridge, MA

Figure 2.c.6



Source: City of Cambridge GIS, Bluebikes.com

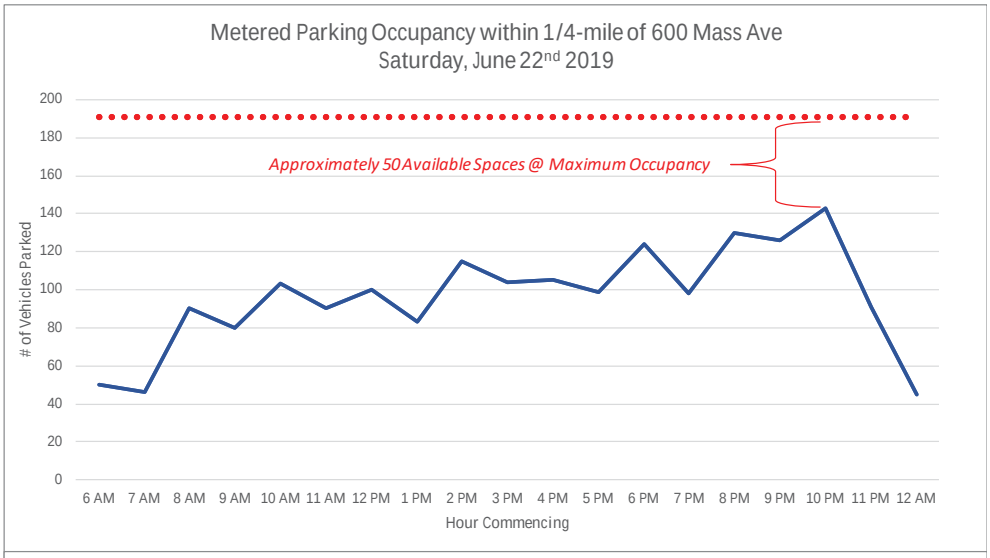
Bluebikes Station

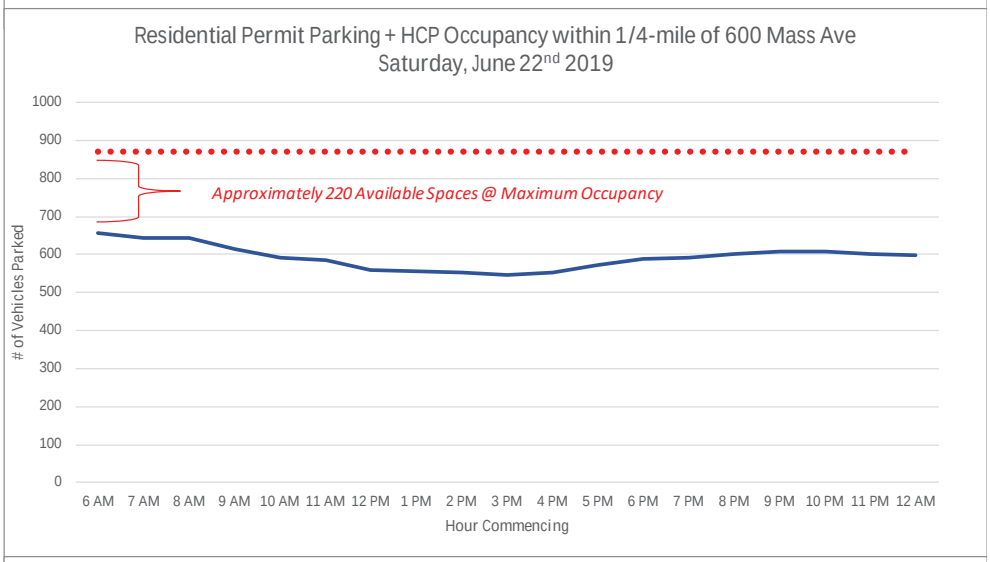
(#) Number of Docks

Zipcar Locations

Figure 2.f.1

Existing Bicycle & Car Sharing Services





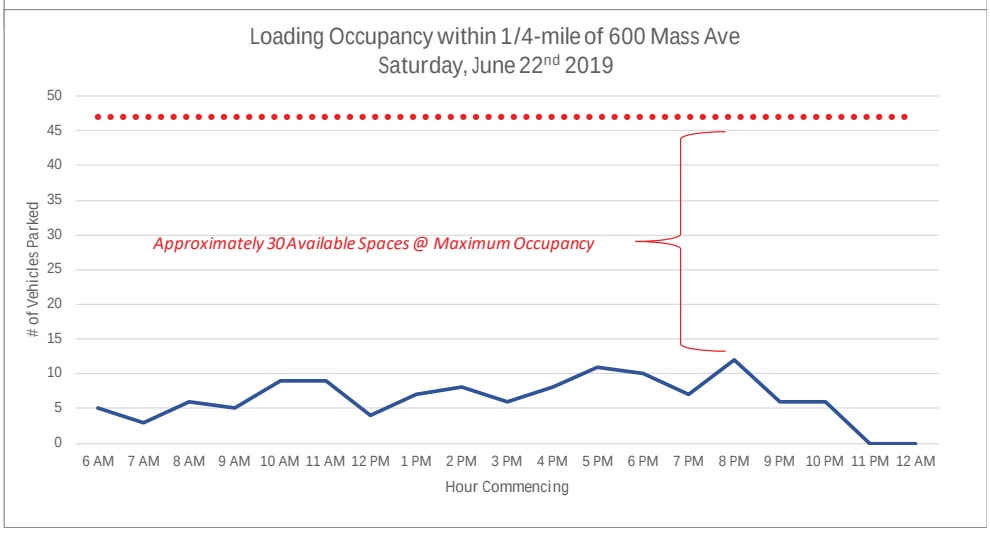
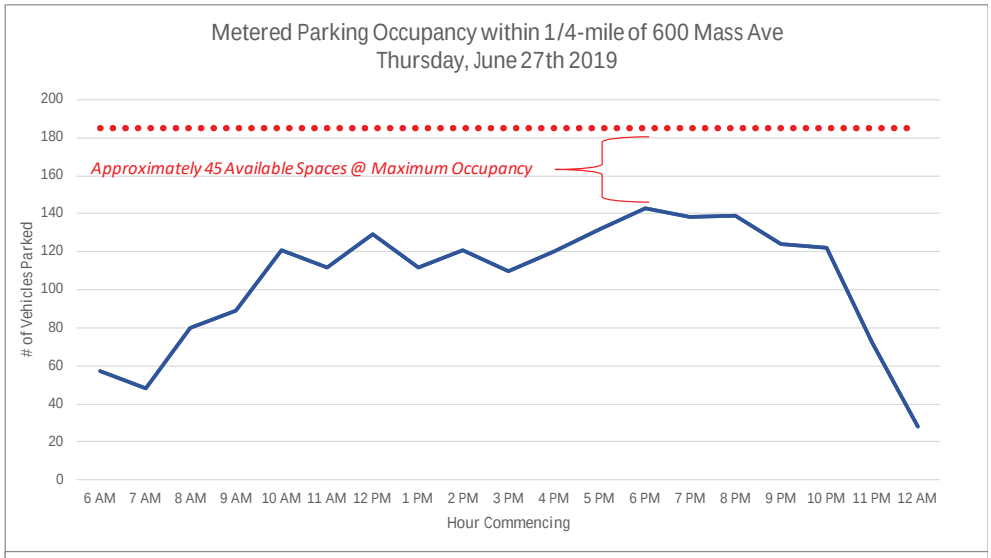
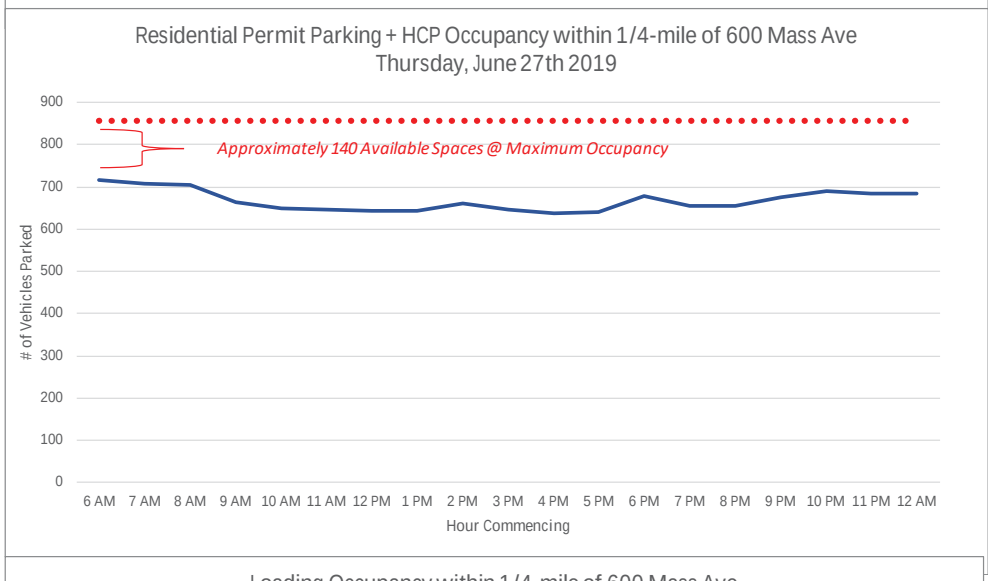


Figure 2.g.2

Saturday Parking Occupancy Summary

600 Massachusetts Avenue TIS
Cambridge, Massachusetts





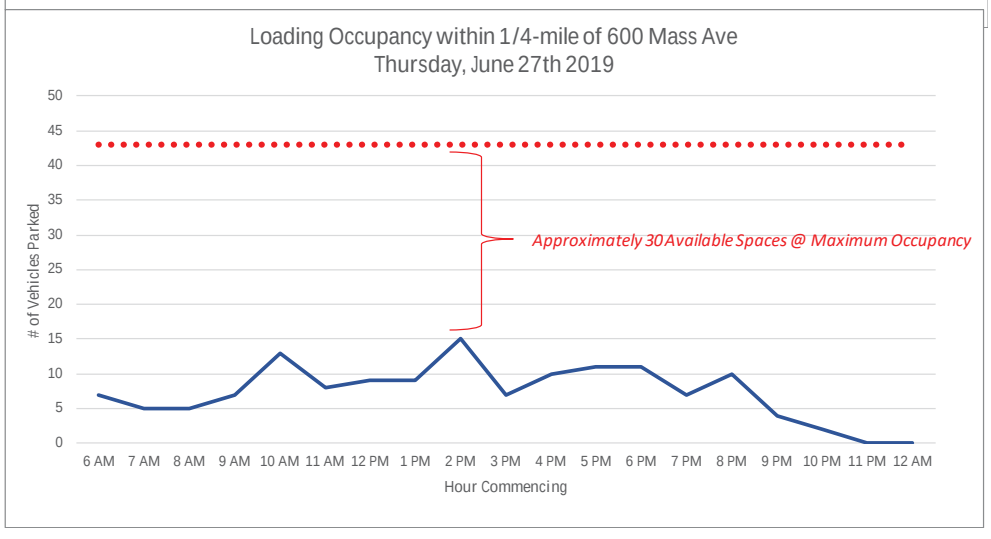
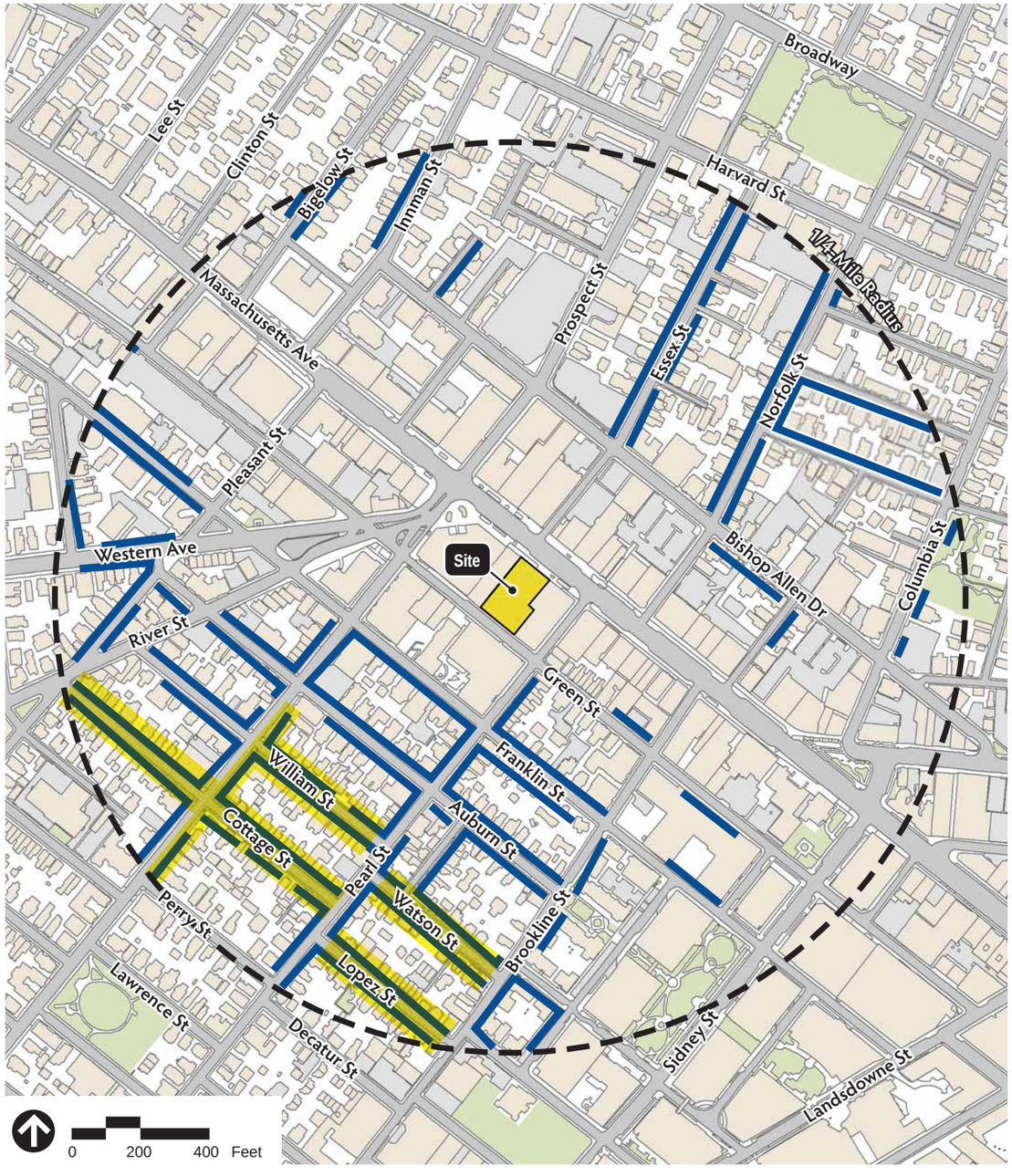


Figure 2.g.3

Weekday Parking Occupancy Summary

600 Massachusetts Avenue TIS
Cambridge, Massachusetts



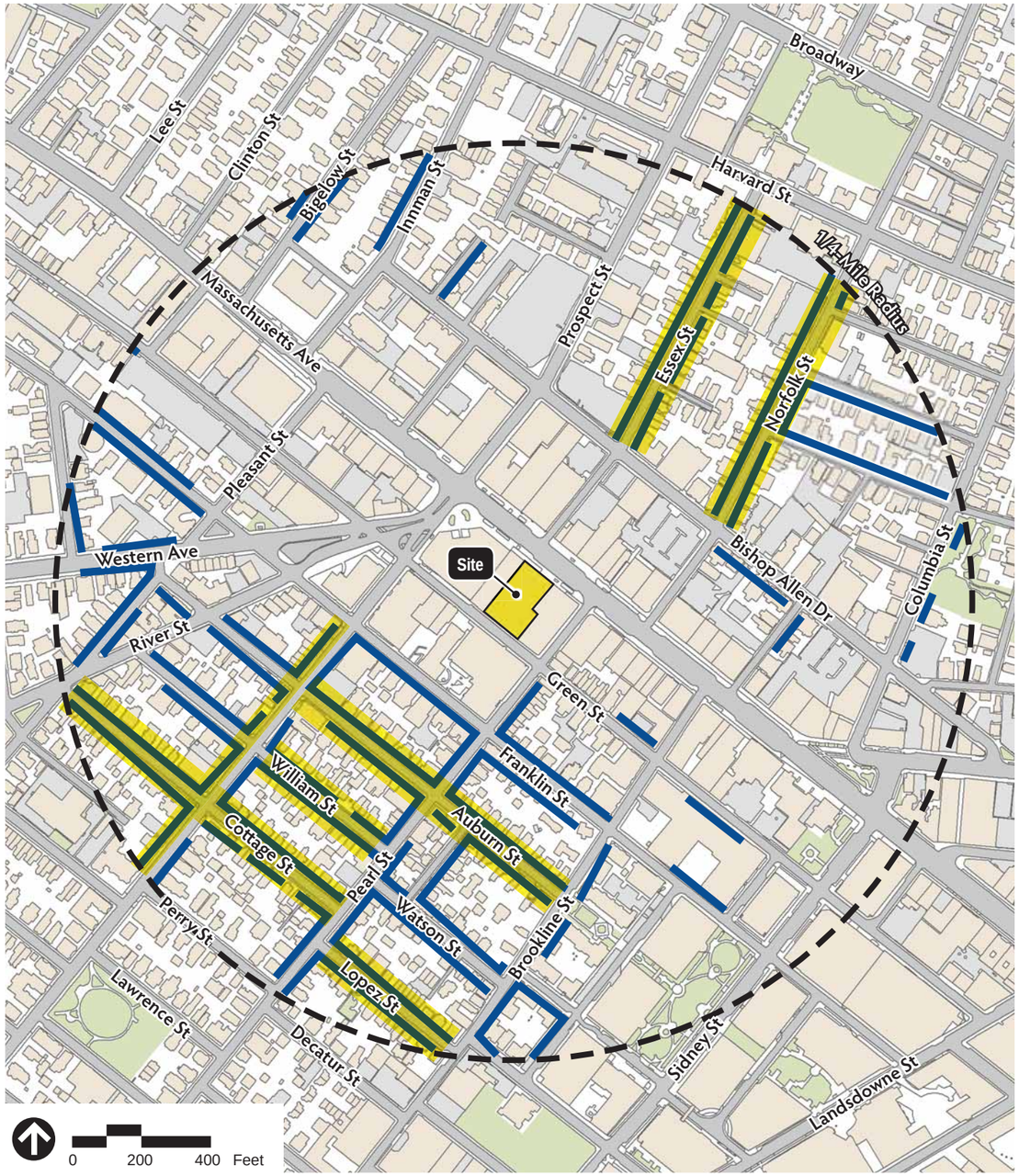
Location	# of Available Parking Spaces (8:15 – 9:15 AM)
Magazine Street – East Curb	12
Lopez Street – South Curb	9
Lopez Street – North Curb	7
Cottage Street – South Curb	13
Cottage Street – North Curb	14
William Street – South Curb	7
William Street – North Curb	7
Watson Street – South Curb	4
Watson Street – North Curb	5
TOTAL	**78**

Based on observations conducted on Thursday, June 27th 2019 from 6 AM to 12 AM (midnight)
Note: between 8:15 and 9:15 AM approximately 150 residential parking spaces are available within 1/4 mile radius of the Project Site. The table accounts for approximately 52% of these available spaces and is used to help predict which roadways residential parkers may park in the future.

Figure 3.c.1

Availability of Residential Parking Areas
Morning Peak Hour

600 Massachusetts Avenue TIS
Cambridge, Massachusetts



Parking by Permit Only (except Sunday)

Areas with Significant Availability of Residential Parking Spaces

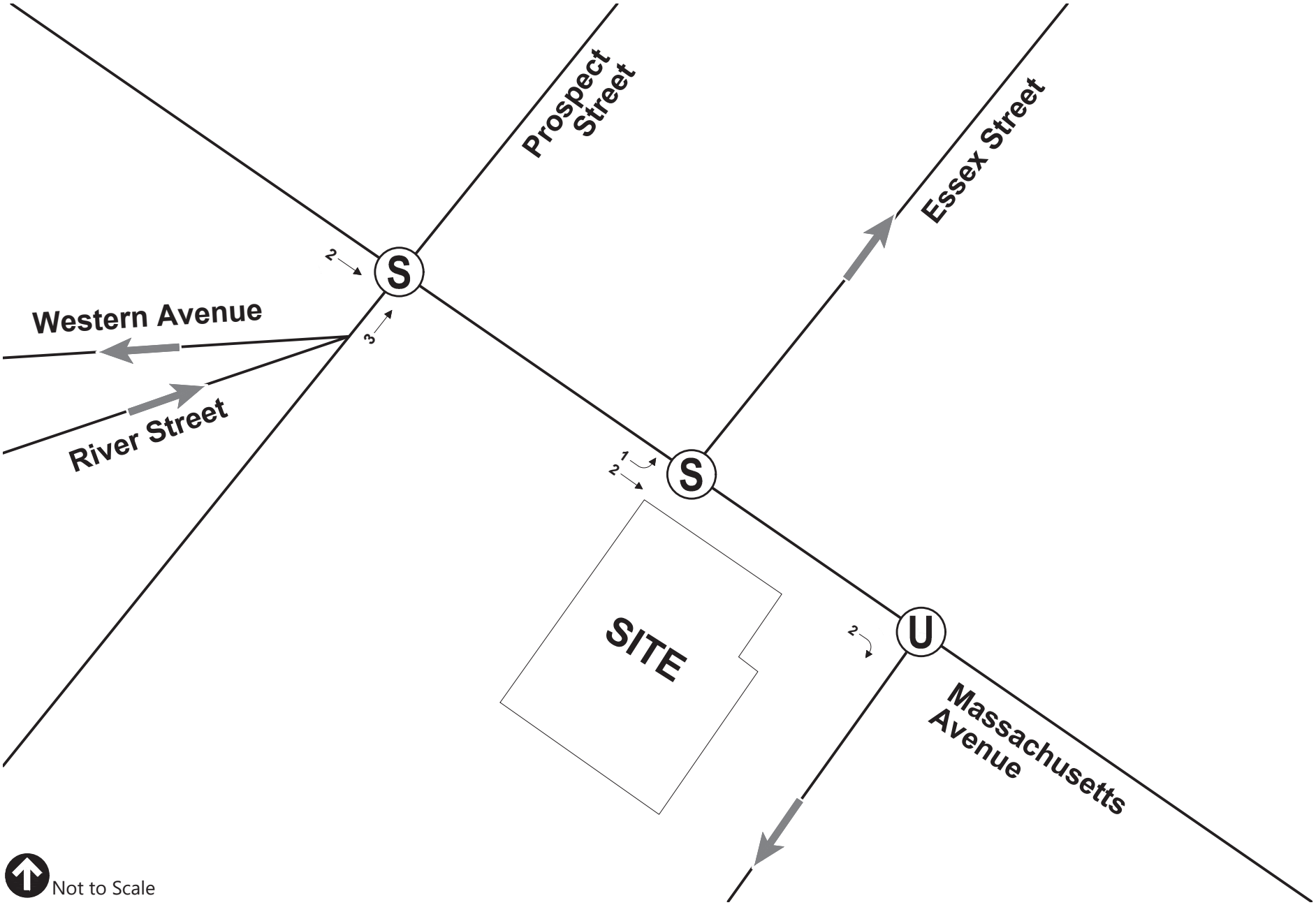
Location	# of Available Parking Spaces (6 – 7 PM)
Essex Street – West Curb	4
Essex Street - East Curb	5
Norfolk Street – West Curb	7
Magazine Street – West Curb	6
Magazine Street – East Curb	6
Lopez Street – South Curb	12
Lopez Street – North Curb	5
Cottage Street – South Curb	9
Cottage Street – North Curb	8
William Street – South Curb	4
William Street – North Curb	7
Franklin Street – South Curb	5
Franklin Street – North Curb	9
TOTAL	**87**

Based on observations conducted on Thursday, June 27th 2019 from 6 AM to 12 AM (midnight)
Note: between 6-7 PM approximately 190 residential parking spaces are available within 1/4 mile radius of the Project Site. The table accounts for approximately 46% of these available spaces and is used to help predict which roadways residential parkers may park in the future.

Figure 3.c.2

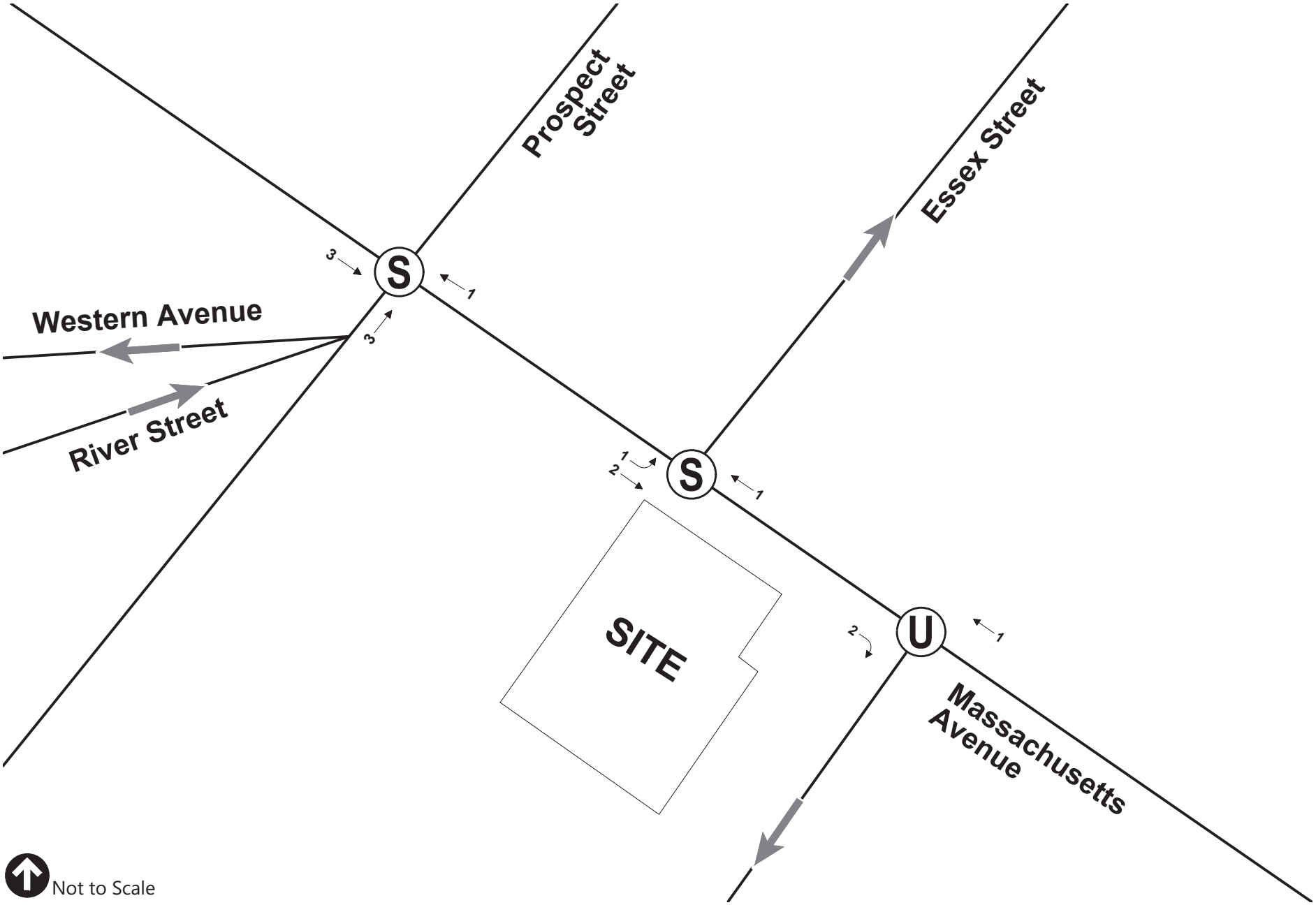
Availability of Residential Parking Areas
Evening Peak Hour

600 Massachusetts Avenue TIS
Cambridge, Massachusetts



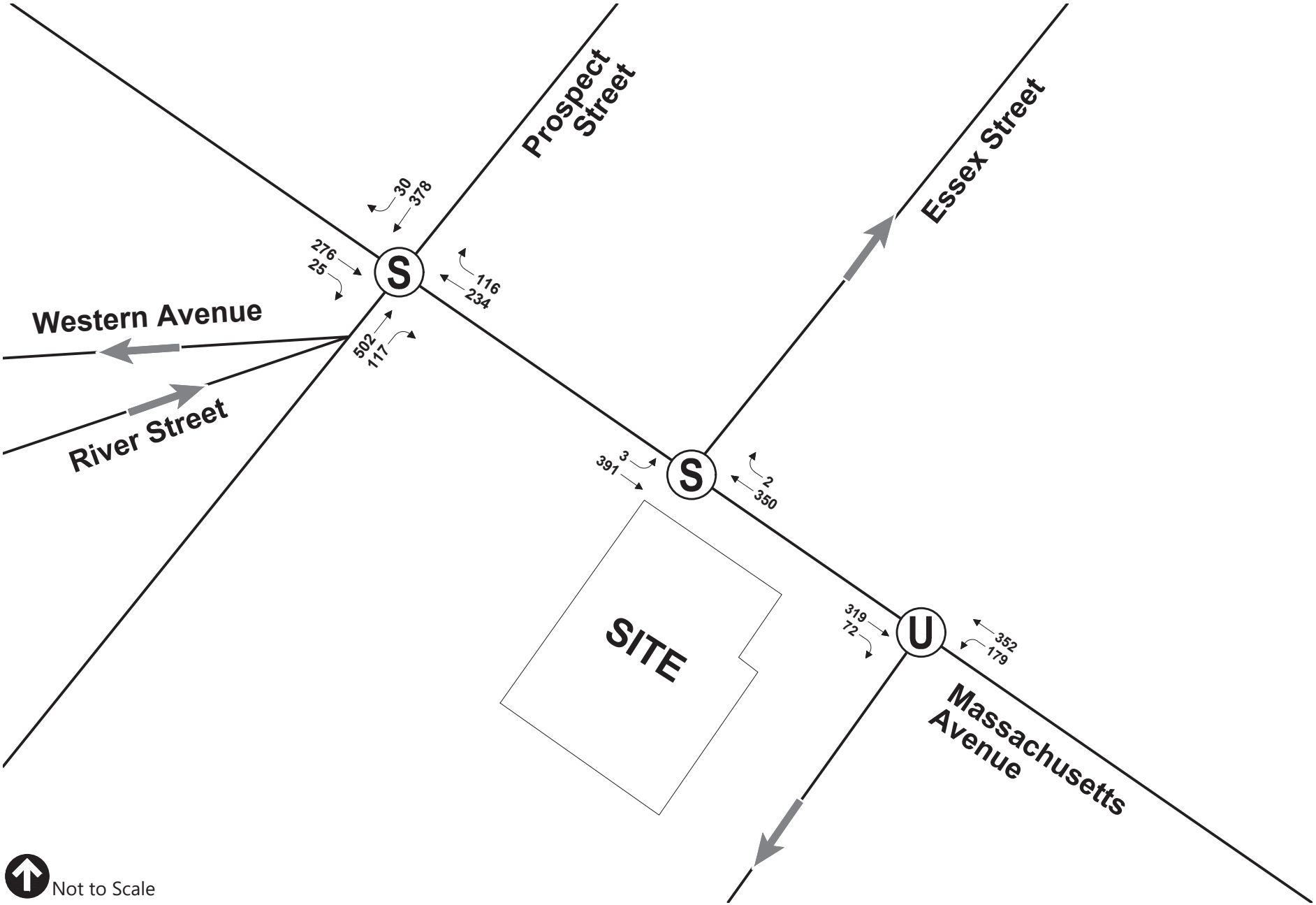
Project Generated Trips
Vehicle Volume Morning Peak Hour
600 Massachusetts Avenue
Cambridge, MA

Figure 3.c.3



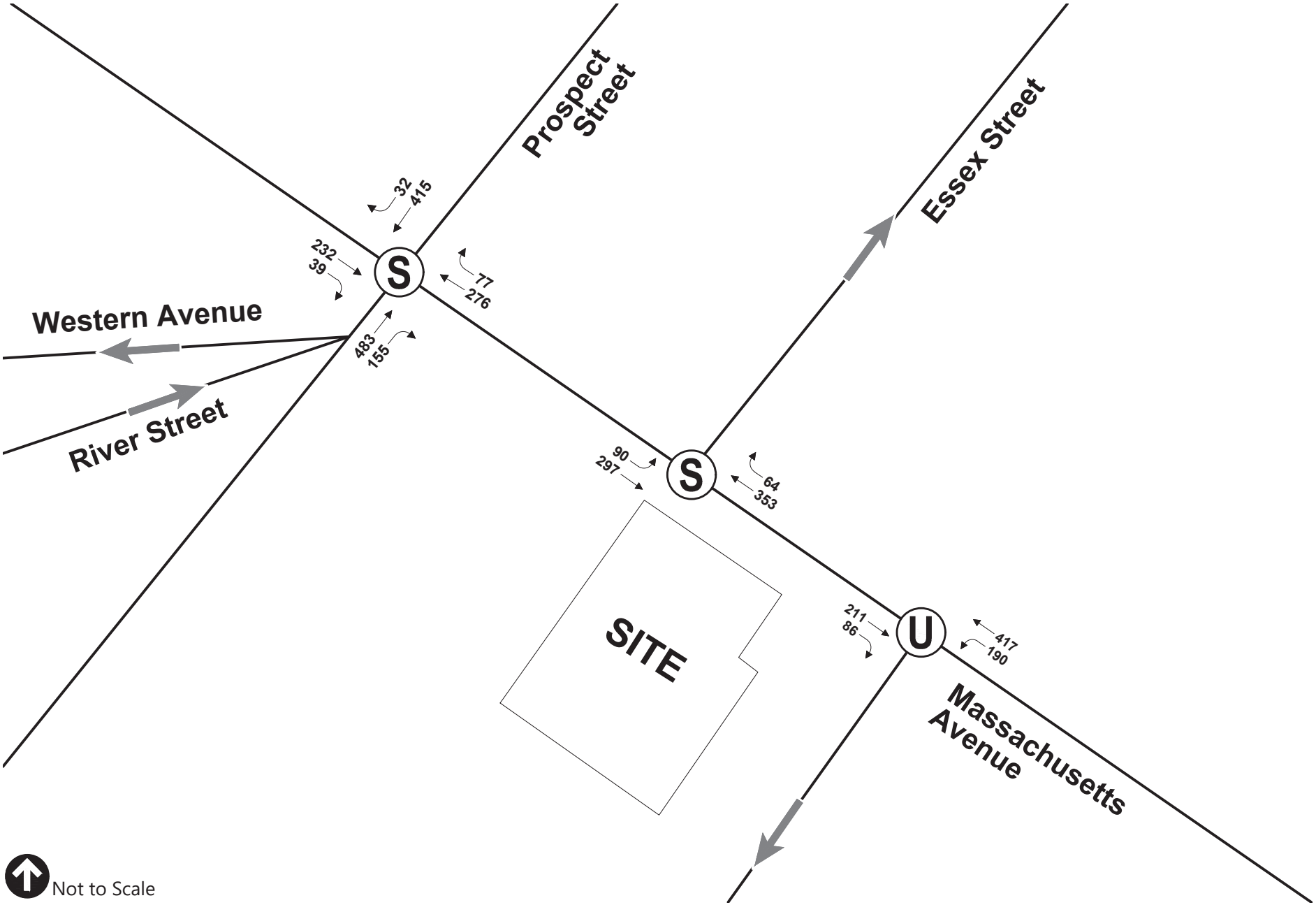
Project Generated Trips
Vehicle Volume Evening Peak Hour
600 Massachusetts Avenue
Cambridge, MA

Figure 3.c.4



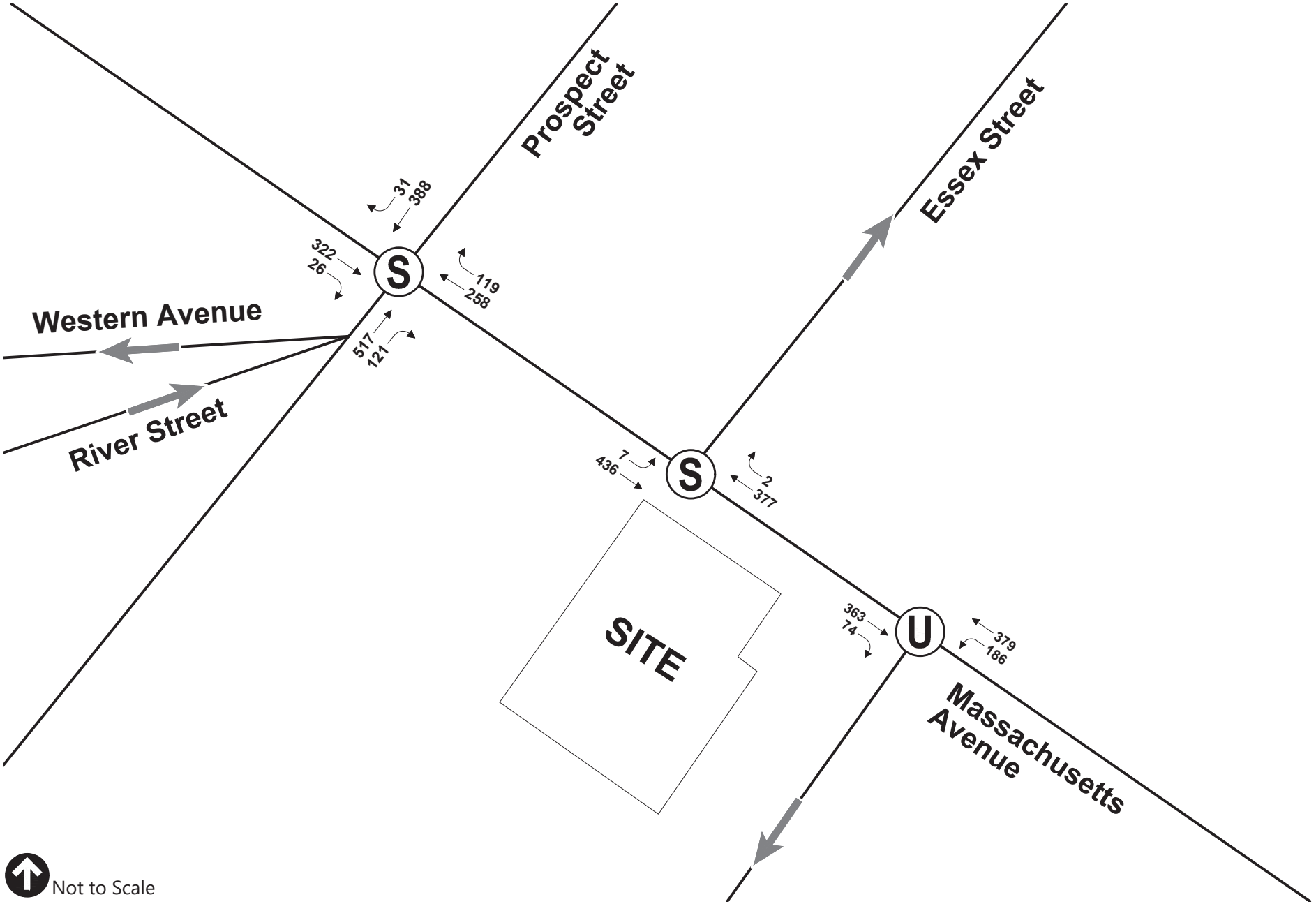
2019 Build Condition
Vehicle Volume Morning Peak Hour
600 Massachusetts Avenue
Cambridge, MA

Figure 5.b.1



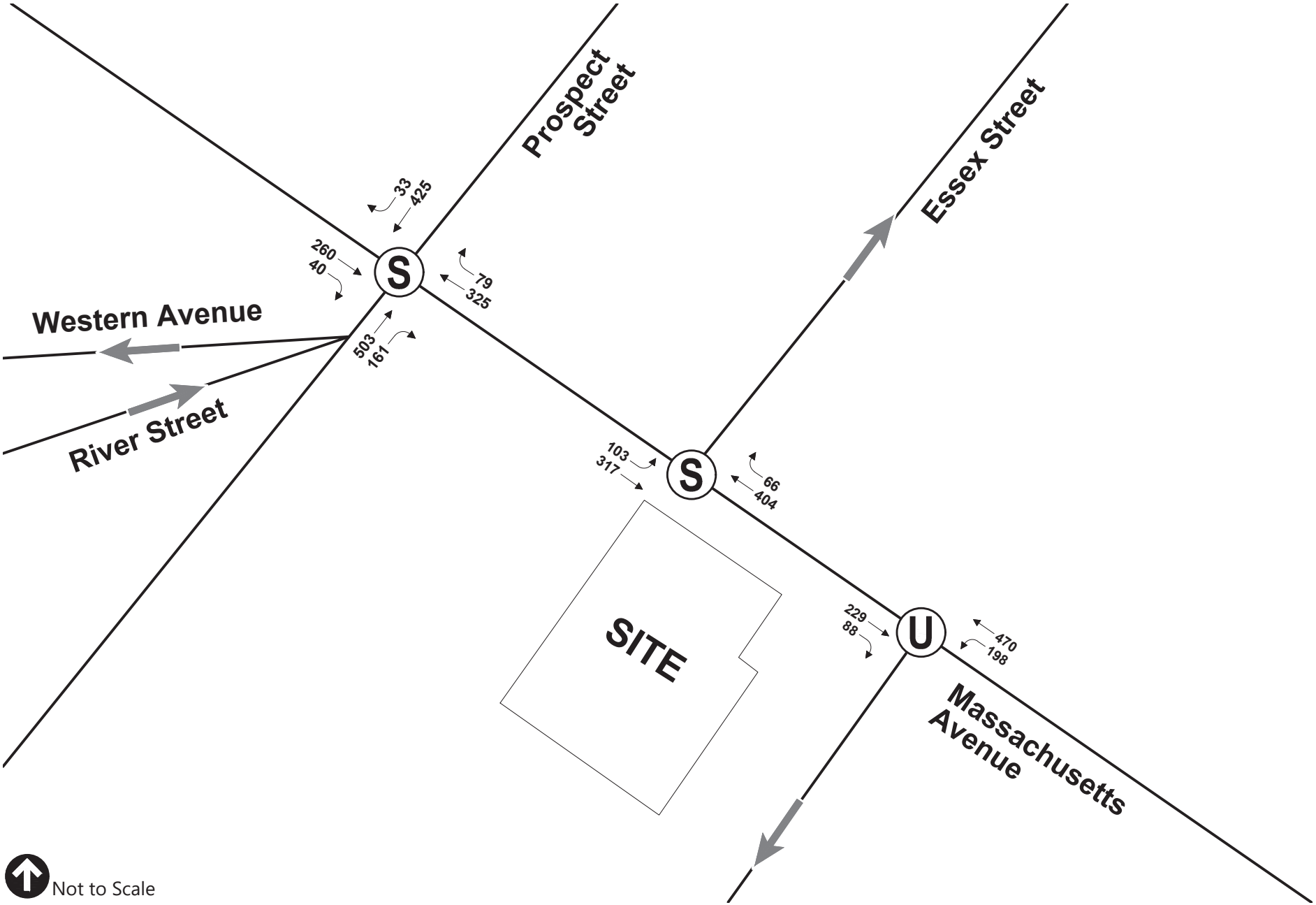
2019 Build Condition
Vehicle Volume Evening Peak Hour
600 Massachusetts Avenue
Cambridge, MA

Figure 5.b.2



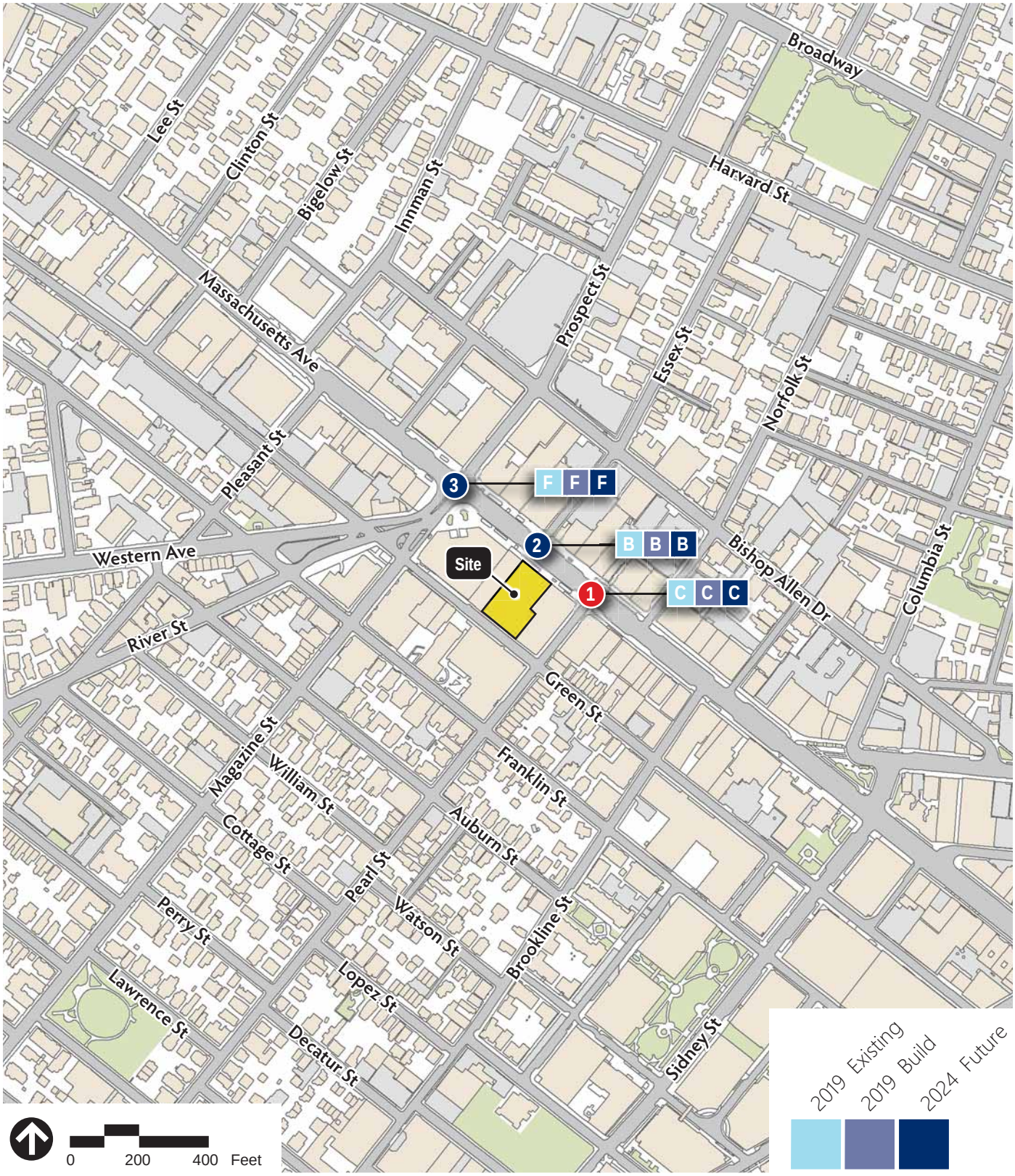
2024 Future Condition
Vehicle Volume Morning Peak Hour
600 Massachusetts Avenue
Cambridge, MA

Figure 5.c.1



2024 Future Condition
Vehicle Volume Evening Peak Hour
600 Massachusetts Avenue
Cambridge, MA

Figure 5.c.2



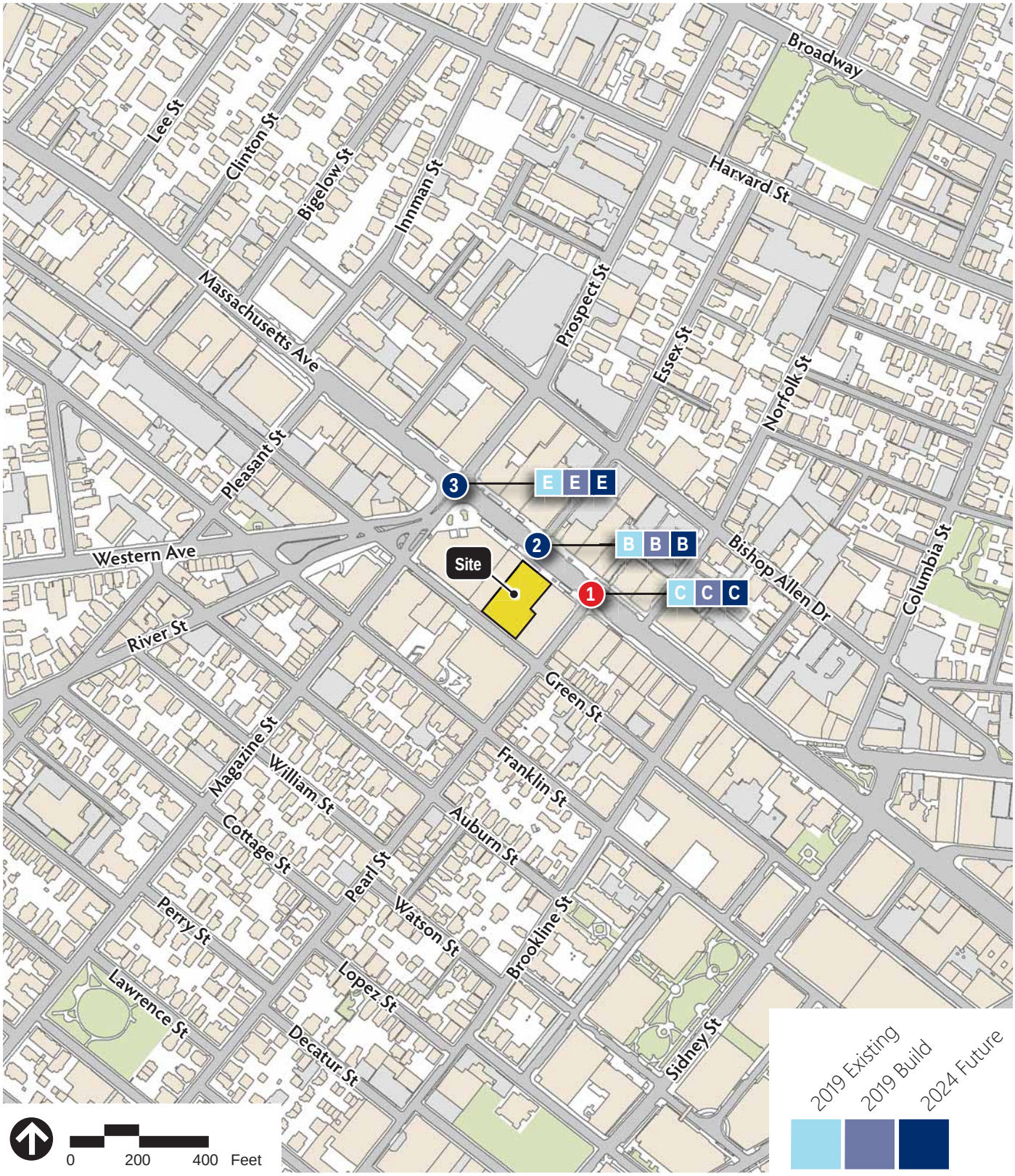
Source: City of Cambridge GIS

Signalized Intersection

Unsignalized Intersection

Figure 6.a.1

Vehicle Level of Service
Morning Peak Hour



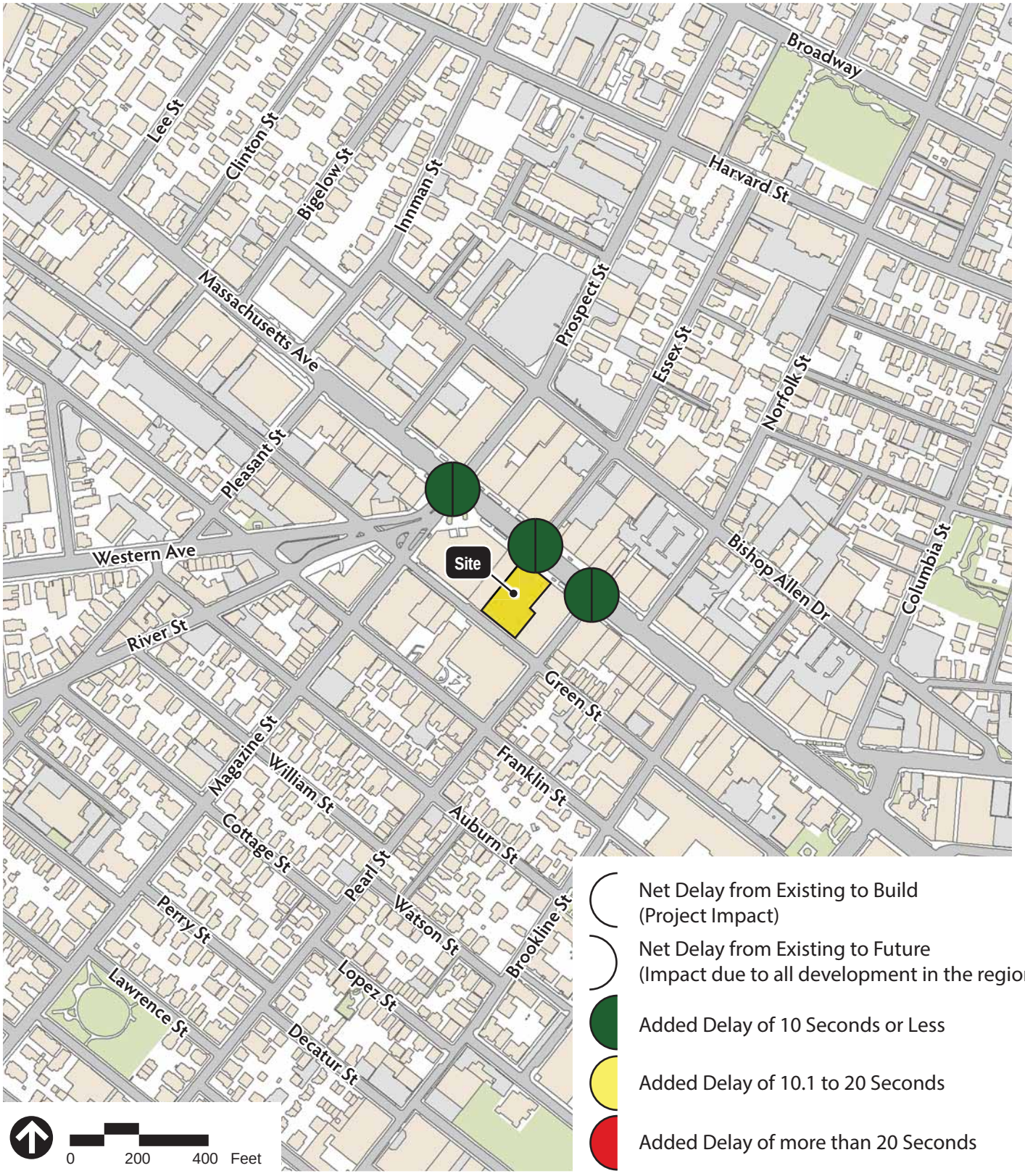
Source: City of Cambridge GIS

Signalized Intersection

Unsignalized Intersection

Figure 6.a.2

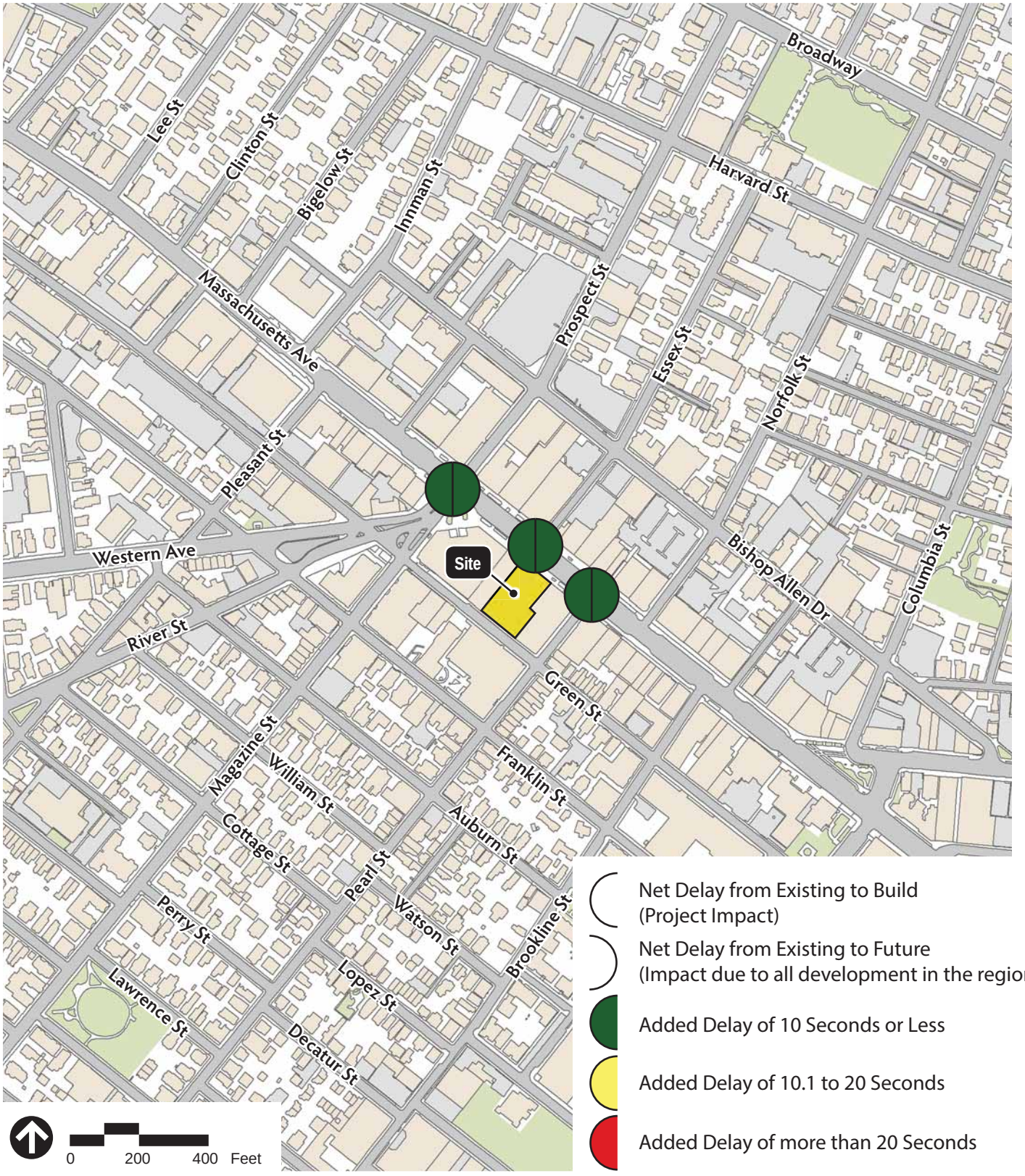
Vehicle Level of Service
Evening Peak Hour



Source: City of Cambridge GIS

Figure 6.a.3

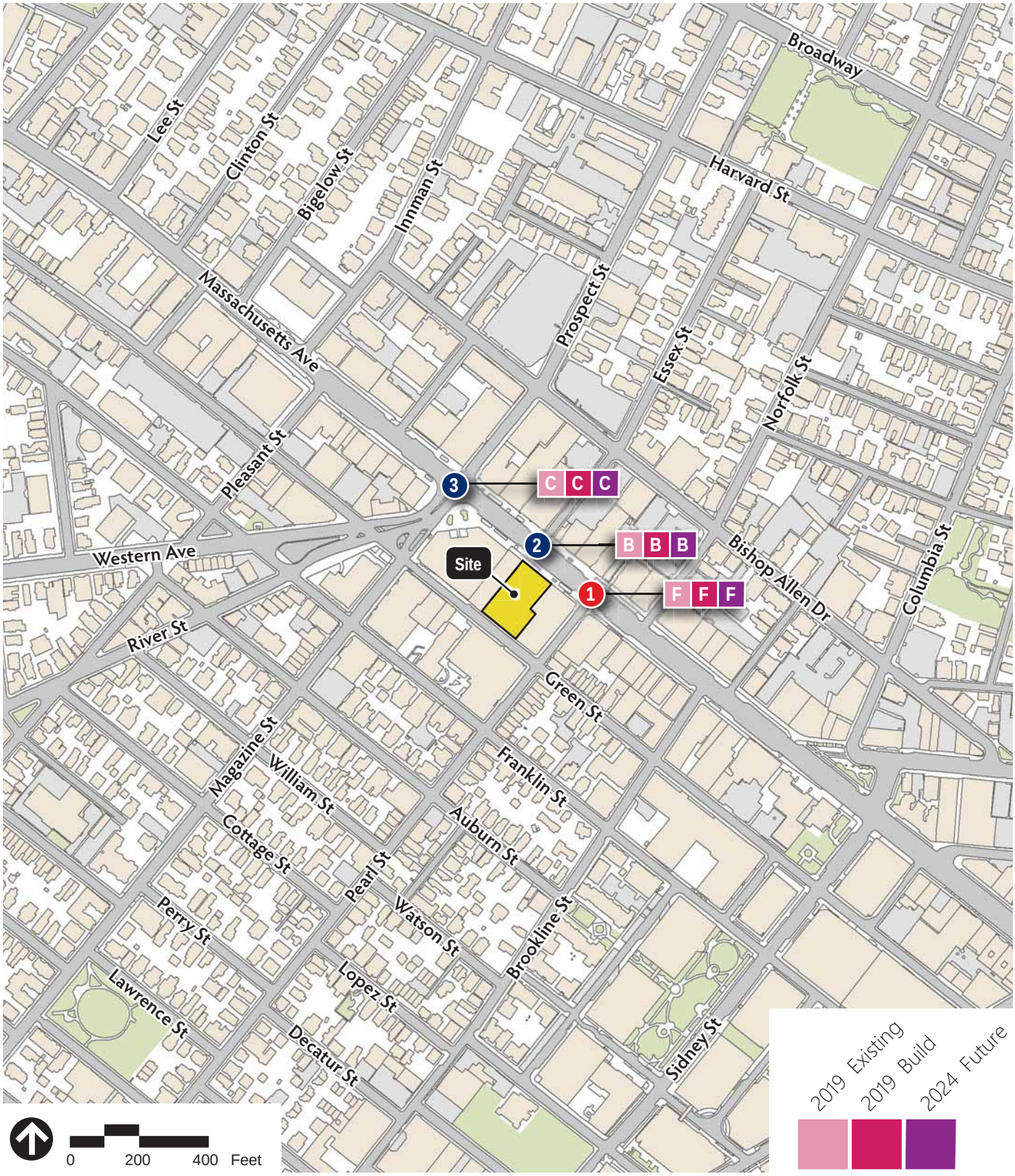
Net Change in Vehicular Delay
Morning Peak Hour



Source: City of Cambridge GIS

Figure 6.a.4

Net Change in Vehicular Delay
Evening Peak Hour



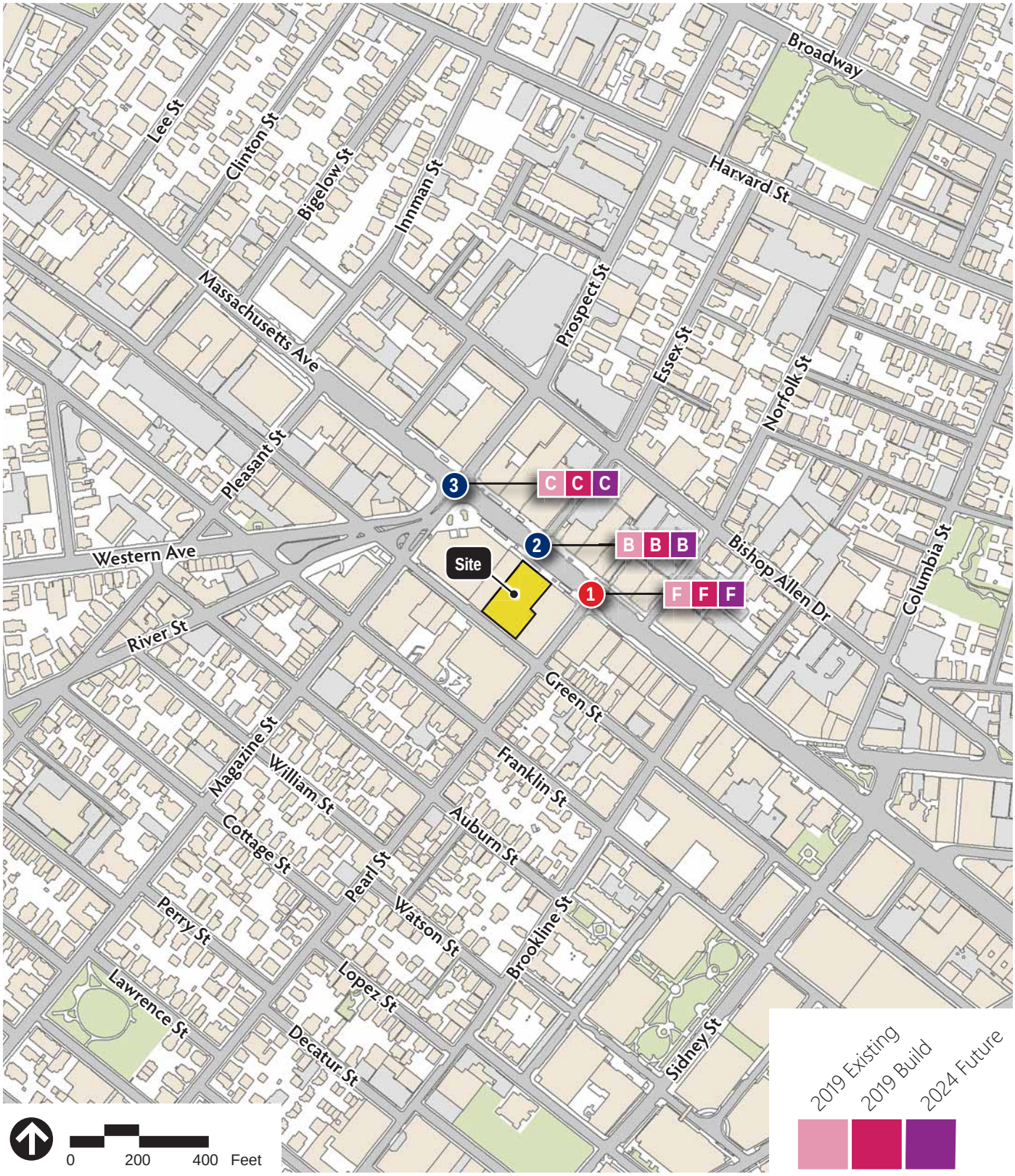
Source: City of Cambridge GIS

Signalized Intersection

Unsignalized Intersection

Figure 11.a.1

Pedestrian Level of Service
Morning Peak Hour



Source: City of Cambridge GIS

Signalized Intersection

Unsignalized Intersection

Figure 11.a.2

Pedestrian Level of Service
Evening Peak Hour