Public Notice

The Boston Redevelopment Authority ("BRA"), pursuant to Sections 80A-2 and 80B-5.4 of the Boston Zoning Code (“Code”), hereby gives notice that a Draft Project Impact Report (“Draft PIR”) was received by the BRA on March 6, 2012 from The Brigham and Women’s Hospital, Inc. (“BWH” or the “Proponent”).

The Proponent proposes an approximately 360,000 square foot (sf) building dedicated to hospital uses, including laboratory, research and support spaces, as well as 355 below-grade replacement parking spaces. The 2012 BWH IMP Amendment Project (the “Project”) is located at 45 Avenue Louis Pasteur on Parcel C of Emmanuel College’s Endowment Campus.

The Proponent has requested approval from the BRA pursuant to Article 80 of the Code for the issuance of a Preliminary Adequacy Determination Waiving Further Review pursuant to Section 80B-5.4(c)(iv) of the Code, finding that the Draft PIR adequately describes the Project’s impacts and waiving the requirement for the filing and review of a Final Project Impact Report, subject to BRA design review; the issuance of a Certification of Compliance by the Director of the BRA; and the execution of certain Project-related agreements called for under Article 80B of the Code.

The Draft PIR may be viewed at the following locations: Office of the Secretary of the BRA, Boston City Hall, One City Hall Square, Boston, MA 02201-1007 (Monday through Friday, 9am to 5pm). Public comments on the IMPNF/PNF should be transmitted to Ms. Sonal Gandhi, BRA, at the address stated above or at sonal.gandhi.bra@cityofboston.gov within 60 days of the date of this notice.

Boston Redevelopment Authority
Brian P. Golden, Executive Director/Secretary

Draft Project Impact Report

Submitted Pursuant to Article 80 of the Boston Zoning Code

Brigham and Women's Hospital 2012 IMP Amendment Project






Submitted to:
Boston Redevelopment Authority
One City Hall Square
Boston, MA 02201

Submitted by:
The Brigham and Women's Hospital, Inc.
75 Francis Street
Boston, MA 02115

Prepared by:
Epsilon Associates, Inc.
3 Clock Tower Place, Suite 250
Maynard, MA 01754

In Association with:
Chan Krieger NBBJ
Haley & Aldrich
Nutter McClennen & Fish LLP
Vanasse Hangen Brustlin, Inc.

March 6, 2012

Epsilon
ASSOCIATES INC.

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March 6, 2012

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Section 1.0

Introduction

1.0 INTRODUCTION

In 2000, the BRA approved an Institutional Master Plan ("IMP") for the Emmanuel College Campus. The IMP, as amended, included plans for development of a three-parcel "Endowment Campus", which was envisioned to be developed with uses that would support the development proposed on Emmanuel's Academic Campus. In conjunction with the Emmanuel 2000 IMP, Merck & Co., ("Merck") obtained approvals for an approximately 300,000 square foot research and development building with below grade parking, located on Endowment Campus Parcel B, which it ground leases from Emmanuel. The zoning for this building, which was completed and occupied in 2004, was established pursuant to the 2000 Emmanuel IMP. The 2000 IMP lapsed in 2010.

In 2012, Emmanuel filed a draft Institutional Master Plan for its Campus, which includes the Endowment Campus and Academic Campus ("Emmanuel 2012 IMP".) The proposed Emmanuel 2012 IMP seeks authorization of certain additional development on the Academic Campus as well as Parcel A of the Endowment Campus, all as more specifically described therein.

After consultation with the Boston Redevelopment Authority ("BRA"), the BRA and Merck have determined that, rather than have the underlying zoning for Parcel B established by an IMP which is subject to expiration or amendment, it is more appropriate for Parcel B to be designated as a Planned Development Area ("PDA") pursuant to Article 80C. Merck does not intend to make any changes to the permitted uses or dimensions of Parcel B. Rather, it is pursuing PDA approval as a technical means of ratifying the underlying zoning for Parcel B, which previously was established through Emmanuel's 2000 IMP.

In addition, Brigham and Women's Hospital ("BWH") now proposes to develop a new 360,000 square foot building for research/wet-laboratory purposes and 355 below-grade parking spaces on Parcel C of the Endowment Campus. To that end, BWH has filed an amendment to its existing BWH 2010 IMP to include its plans for Parcel C (the "BWH 2012 Amendment Project"). The BWH 2012 IMP Amendment Project which is being proposed by BWH will be approved by virtue of an IMP Amendment in accordance with Article 80D of the Code and Large Project Review in accordance with Article 80B of the Code.

Figure 1-1 shows the three parcels.

1.1 Project Summary

The Brigham and Women's Hospital, Inc. ("BWH" or the "Hospital") is pleased to submit this Draft Project Impact Report ("Draft PIR") for the BWH 2012 Institutional Master Plan Amendment Project (the "Project"). In order to maintain its leadership in medical research, BWH needs additional research space which it owns and controls instead of leases. This Draft PIR is being filed in accordance with the provisions of Article 80 of the Boston Zoning

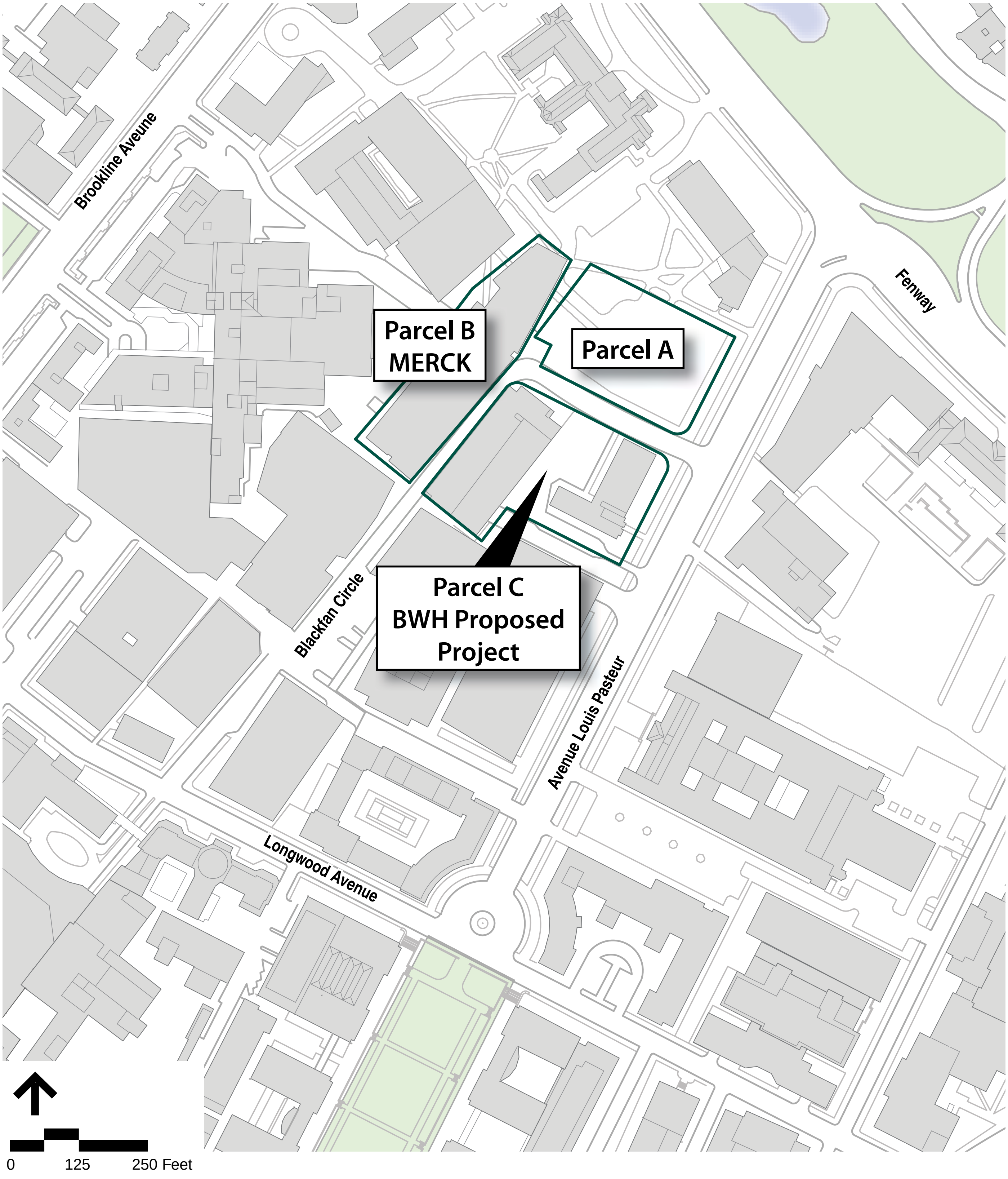

Figure 1-1
Parcel C Site Context

Code and Enabling Act (the "Code") to initiate approval of an approximately 360,000 square foot (sf) building dedicated to hospital uses, including laboratory, research and support spaces, as well as 355 below-grade replacement parking spaces. The 2012 BWH IMP Amendment is also being submitted simultaneously with the submission of this Draft PIR.

BWH, a founding member of Partners HealthCare System Inc., is a Harvard-affiliated, non-profit, teaching hospital located in the Longwood Medical and Academic Area ("LMA"). Figure 1-2 shows the location of the BWH Campus. BWH has an international reputation for the quality of its medical care and innovative research. In addition, its varied educational programs provide the highest quality training for medical nursing and other health professions.

The BWH 2012 IMP Amendment Project is located at 45 Avenue Louis Pasteur (the Project site) on Parcel C of Emmanuel College's Endowment Campus (see Figures 1-3 and 1-4). BWH currently occupies Parcel C pursuant to its lease with the Trustees of Emmanuel College ("Emmanuel") of Alumnae Hall, together with accessory parking, for hospital use, including office and dry research. BWH intends to enter into a long-term ground lease with Emmanuel for Parcel C in order to enable development of the proposed Project.

As described in detail in BWH's 2010 IMP, BWH is a major institutional employer in Boston. Currently, BWH employs just under 15,000 people, and approximately 30 percent of employees are Boston residents.

1.2 Project Identification and Team

Proposed Project:	BWH 2012 IMP Amendment Project
Address/Location:	45 Avenue Louis Pasteur, Emmanuel College Endowment Campus, Longwood Medical and Academic Area
Proponent:	The Brigham and Women's Hospital, Inc. 75 Francis Street Boston, MA 02115 (617) 355-6000 Arthur Mombourquette
Architect:	Chan Krieger NBBJ 8 Story Street Cambridge, MA 02138 (617) 354-5315 Alex Krieger Tom Sieniewicz

Environmental Permitting Consultants:	Epsilon Associates, Inc. 3 Clock Tower Place, Suite 250 Maynard, MA 01754 (978) 897-7100 Cindy Schlessinger Geoff Starsiak
Legal Counsel:	Nutter McClennen & Fish LLP Seaport West 155 Seaport Boulevard Boston, MA 02210 (617) 439-2000 Mary T. Marshall, Esq.
Transportation Consultants/Civil Engineers:	VHB/Vanasse Hangen Brustlin, Inc. 99 High Street Boston, MA 02110 (617) 728-7777 Sean Manning, PE, PTOE Howard Moshier
Geotechnical Consultant:	Haley & Aldrich 465 Medford Street Boston, MA 02129 (617) 886 7400 Lisa Turturro

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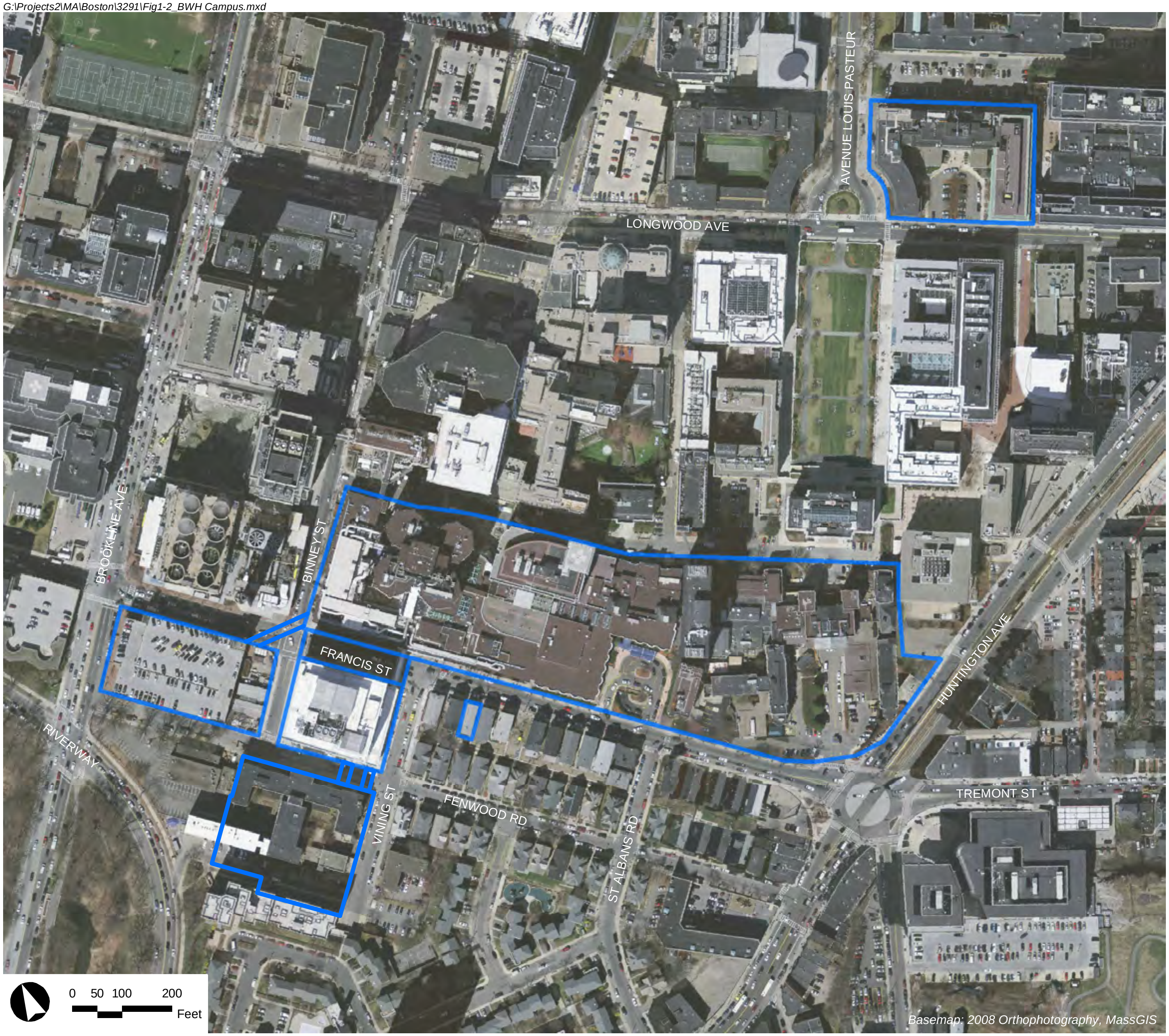

LEGEND

Existing BWH Campus

Source: BWH, BRA

BWH 2012 IMP Amendment Project Boston, MA

Epsilon ASSOCIATES INC.

Figure 1-2

BWH Campus

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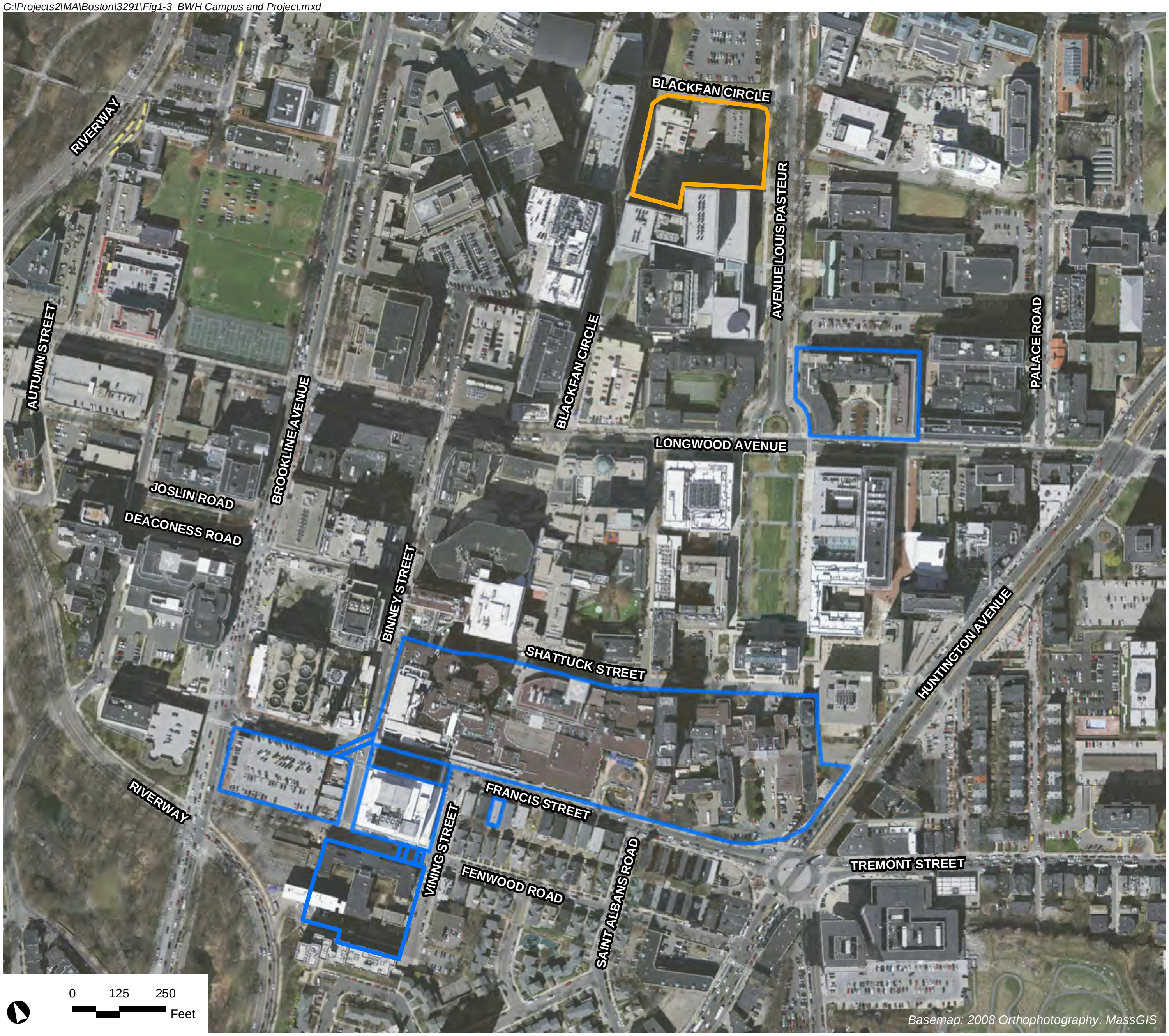

LEGEND

Existing BWH Campus

Project Site

Source: BWH, BRA

BWH 2012 IMP Amendment Project Boston, MA

Epsilon ASSOCIATES INC.

Figure 1-3

BWH Campus and Project Site

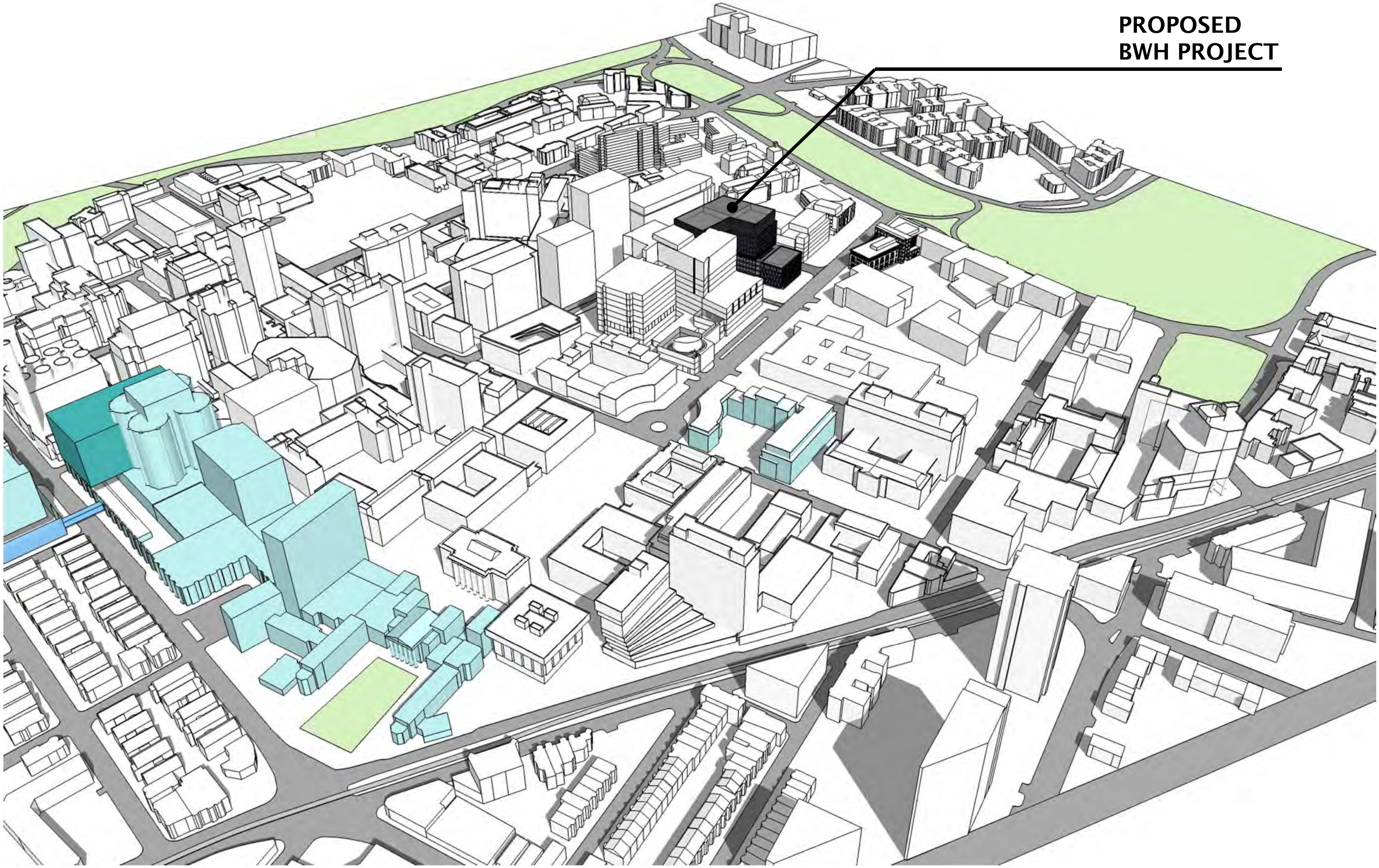

Figure 1-4

Aerial View Looking North

1.3 Review Process

The BWH 2010 IMP was approved by the BRA Board in February, 2010, adopted by Boston Zoning Commission on March 24, 2010, and became effective March 30, 2010. The term of the IMP was 10 years, from 2010 to 2020, and included two new IMP Projects, the Binney Street Building and the Brigham and Women's Building (now known as the Brigham Building for the Future), as well as minor campus additions and upgrades and the previously approved Brigham Green Enhancement and Parking Project. The Binney Street Building has been completed and is occupied, the Brigham Green Enhancement and Parking project is anticipated to begin construction in the Spring of 2012, and the Brigham and Women's Building is anticipated to begin construction in 2013.

BWH filed an Institutional Master Plan Notification Form/Project Notification Form ("IMPNF/PNF") on January 3, 2012 to initiate review of the BWH 2012 IMP Amendment Project. This Draft PIR is in response to the Scoping Determination issued by the BRA on February 17, 2012. A copy of the BRA's Scoping Determination and comments received on the IMPNF/PNF are included in Appendix A, as well as notations corresponding to the sections which address the comment.

By virtue of this filing in accordance with Article 80B of the Code and the simultaneous filing of the BWH 2012 IMP Amendment in accordance with Article 80D of the Code, BWH will establish the relevant zoning approvals to authorize the development of Parcel C through concurrent Article 80 processes for the Project.

1.4 Public Benefits

1.4.1 Community Benefits and Programs

Community Activities

BWH has a long-standing commitment to improving the health status of Boston residents, with a focus on Boston neighborhoods surrounding the Hospital with disproportionately poor health and social outcomes, and documented need for comprehensive health and social services. BWH makes a unique commitment to its residential neighbors. BWH takes a broad approach to community health which includes supporting neighborhood schools, youth serving organizations, anti-poverty programs, housing and public health initiatives, and employment and business development throughout Mission Hill. In FY 2011, over 2,000 people received support from the resources provided to Mission Hill organizations. The majority of people served were Mission Hill residents.

Residents of other Boston neighborhoods were also served by the Parker Hill/Fenway ABCD Emergency Food Pantry. BWH is also a long time supporter of activities of the Fenway CDC.

Birth Equity Initiative (BEI)

The Birth Equity Initiative is a comprehensive effort to address persistent disparities in infant mortality and low birthweight, particularly among infants born to Black women, through the engagement and empowerment of women, their families, and their communities. The BEI includes prevention and intervention efforts spanning the spectrum from research to community-based application. The concept of birth equity is grounded in the belief that a lifetime of health equity begins at birth. The guiding framework for the BEI is the lifecourse approach, which extends across the preconception, postnatal, and inter-conception periods, and is essential in order to help women achieve health before, during, and between pregnancies. This model links to and supports primary and pediatric care, safety in the home and community, nutritional assistance, and later risks to health such as teen pregnancy, interpersonal violence, and school drop-out in a dynamic and full-circle intervention. In FY 2011, the BEI continued community outreach efforts, developed a new Inter-conception Care (ICC) Model within the BWH Adolescent Reproductive Health clinic and expanded efforts related to Centering Pregnancy.

Brookside Community Health Center

Brookside's mission is to provide high quality, family-oriented, comprehensive health care, with a focus on serving the low income population of the community, regardless of ability to pay. Moreover, Brookside strives to:

1. Continue to be recognized as a leader in the delivery of high quality, integrated family-oriented health care, and as a model program for community-based primary care within the Brigham and Women's, Faulkner Hospital, and Partners Healthcare Systems.
2. Continue to offer successful programs training practitioners in the provision of community-based, culturally appropriate health care, while still maintaining a focus on the delivery of primary care.
3. Maintain a leadership role in developing programs designed to improve the health status of Jamaica Plain and the surrounding communities.

In FY 2011, Brookside provided care to 11,246 patients.

Cardiovascular Wellness Service

Cardiovascular Wellness Service is a multidisciplinary effort of BWH, dedicated to preventing heart disease and promoting heart health. BWH accomplishes this in a number of ways through the following programs:

- ♦ Community Outreach Program, providing free screenings and educational presentations throughout local Boston communities;
- ♦ Linda Joy Pollin Cardiovascular Wellness Program, dedicated to preventing heart disease in women;

- Online Cardiovascular Wellness Program, a comprehensive internet-based program that guides users in building a healthy heart;
- Employee Wellness Program, providing screenings, classes, and activities to help promote heart health among BWH employees;
- Heart Disease Prevention Research Program, conducting research studies to further knowledge of heart disease prevention and intervention; and
- Clinical Cardiology Program at the Watkins Cardiovascular Clinic, focusing on the primary and secondary prevention of heart disease.

In FY 2011, approximately 6,000 people were served.

Connecting Hope, Assistance, and Treatment Program (CHAT)

The Connecting Hope, Assistance, and Treatment (CHAT) program provides financial assistance to low income, uninsured and underinsured women with breast cancer to pay for necessary services related to their breast cancer diagnosis. In the absence of the CHAT program, many women are forced to sacrifice the items related to their breast cancer treatment in order to pay for rent, utilities, food, and other basic necessities. In the face of many competing survival priorities, the CHAT program is able to assist in providing the resources necessary to ensure the emotional and physical well-being of breast cancer patients. The majority of resources provided to women were breast prostheses/bras and transportation to treatment appointments. The CHAT program provided grocery cards to 20% of participating clients in an effort to address the issues of food insecurity. Since inception in 2002, the CHAT program has provided services to approximately 600 women. In FY 2011, there were 114 women served by the CHAT program with over 50% of participating women requesting more than one resource.

Elementary School Literacy Initiative

The Elementary School Literacy Initiative is designed to help strengthen reading, comprehension, listening and writing skills in kindergarten to fifth grade students in select Mission Hill schools. Literacy skills are vital for the healthy development of children and a crucial building block for future academic success. Educational attainment is a key determinant of health. The program provides an opportunity for BWH employees to volunteer directly in the schools as pen pals or Brigham Book Buddies. Pen pals develop a relationship with a child through the exchange of letters. Students are able to practice their literacy skills by receiving and responding to letters and increase their exposure to health care careers and BWH. Book Buddies read aloud to an entire classroom once a month for the school year, and then the book is donated to the classroom. In FY 2011, 104 Pen Pal students were served and 80 Brigham Book Buddy students were served. Since inception of the Book Buddy program in 1994, numerous students have been served, with 788 students served since 2006. Since inception of the Pen Pal program in 2006, 459 students have been served.

Health and Science Club Program

The Health and Science Club provides an informal learning environment in which elementary school students work together on science experiments in small groups led by Hospital employees and listen to presentations by BWH staff guest speakers. The relaxed, yet structured atmosphere of the Health and Science Club promotes teamwork and produces cooperative learning experiences that increase science knowledge. The Health and Science Club also exposes students to new health careers and introduces them to the types of education and training that are necessary to pursue specific health career paths. Since inception in 2006, 493 students have been served in the Health and Science Club Program.

Health Careers Ambassadors Program (HCAP)

The Health Careers Ambassadors Program (HCAP) is a partnership between the Hyde Square Task Force (HSTF) and Southern Jamaica Plain Health Center (SJPHC) that supports youth to develop community health leadership skills. This is done through engagement in peer-led community health improvement initiatives providing interactive, youth-led health education workshops, while also engaging in youth-led health equity organizing. The HCAP peer leaders are between the ages of 14 and 18 and attend Boston Public Schools. They receive extensive training on a number of topics such as sexual health, emotional wellness, nutrition, asthma, violence prevention techniques, environmental justice, and community organizing. The youth are trained using the lens of health equity and social justice to understand the social determinants of health in urban communities. In FY 2011, a total of 111 young people participated in training sessions provided by the 13 trained HCAP peer leaders. The peers have conducted over 95 workshops and trained over 667 youth since 2003.

Health Equity Research and Intervention (HERI)

The Health Equity Research and Intervention (HERI) team performs social determinants of health research and collaborates with individuals, institutions and communities to contribute the best science, evidence, and resources toward eliminating inequities in health status for diverse groups. HERI participates in dissemination of research findings to ensure that individuals, institutions, and communities have information resources that support their work in promoting health equity. HERI provides support and assistance to build the capacity of colleagues and collaborators in health equity research and practice. This includes collaborative fundraising, providing networking opportunities, and participating in training of interested parties in the conduct of health equity research.

Maurice J. Tobin School Partnership

For 20 years, BWH and the Maurice J. Tobin School in Mission Hill have partnered to support the school's academic mission by increasing parent, family, community, and Hospital involvement in students' learning. With the established link between educational attainment and health status, this partnership was created to support the Hospital's mission of improving the health status of the Mission Hill community. Family involvement has been shown to be a critical element in student achievement, therefore, the joint programming aims to reach out to families and assist them in becoming active participants in their children's education. Other elements of the program are designed to engage Hospital employees in students' education. Further, in FY 2011, new efforts were made to support students and teachers directly in the classroom in order to improve educational outcomes and achievement. In FY 2011, 460 children and their families participated. Since inception in 1991, approximately 8,000 students and their families have had access to services provided by the BWH-Maurice J. Tobin Partnership.

Perinatal Case Manager Program (PCMP)

The Perinatal Case Manager Program (PCMP) seeks to improve birth outcomes by addressing the social and medical needs of pregnant women. The Center for Community Health and Health Equity provides technical assistance and training for case managers at each of six of the Hospital's licensed or affiliated health centers. In FY 2011, there were 876 women served by case managers through the perinatal case management program. Since inception in 1991, over 16,000 women and families have been served by the case managers in the PCMP.

Open Doors to Health Colorectal Cancer Screening Initiative

The Dana-Farber/Brigham and Women's Cancer Center (DF/BWCC) Open Doors to Health (ODH) Cancer Screening Initiative is designed to bring together community based peer leaders/health educators and a patient navigator to:

- ♦ Increase awareness of the need for screening among patients who receive care at two community health centers;
- ♦ Increase physician recommendations for screening among patients aged 50 and older seeking care at BWH licensed and affiliated community health centers;
- ♦ Decrease no-show rates for screening colonoscopy; and
- ♦ Increase adequate test preparation and address barriers to screening through patient navigators and peer leaders.

In FY 2011, 423 patients were referred to patient navigator.

Project TEACH (Teen Education About Careers in Health)

Project TEACH (Teen Education About Careers in Health) is a summer program designed to stimulate interest in health, science and medical careers, targeted to rising 10th grade students attending BWH partnering public high schools in the surrounding Roxbury and Mission Hill neighborhoods. In FY 2011, 23 youth participated.

Racial Healing and Reconciliation Team

As an approach to improving community health, the Southern Jamaica Plain Health Center is working with a group of 15 youth—seven white youth and eight youth of color—in a racial healing and reconciliation (R&R) process. Through readings, affinity groups, workshops, speak outs and community teaching, youth are challenged and supported to understand the levels of the system of racism, explore racial identity development theory, and transform into racial justice activists, channeling their efforts to address the impact of racism on the social determinants of health with a focus on employment and workforce development and education.

South Huntington Avenue Medical Associates

In August 2011, BWH opened a new family centered practice, South Huntington Avenue Medical Associates, in Jamaica Plain. This practice, while still growing, is already serving 1,100 patients.

South Street Youth Center

BWH provides a financial contribution to the operation of the South Street Youth Center (SSYC) whose mission is to provide a safe, educational, and engaging space during out of school time for young residents of the South Street Development. Through its broad-based programs, participants learn a happy, healthy, resilient attitude toward life that will help sustain them through adulthood. In FY 2011, SSYC had 155 different youth access the Center. Since inception, approximately 550 youth have accessed SSYC.

Southern Jamaica Plain Health Center (SJPHC)

Southern Jamaica Plain Health Center (SJPHC) operates through the license of BWH and has been serving the community for 38 years. SJPHC's mission is to provide personal, high quality health care with compassion and respect to a diverse community. The health center now serves over 10,000 patients with its comprehensive services of adult medicine, pediatrics, women's health, mental health/substance abuse services, cardiology, dermatology, nutrition, and podiatry. The health center providers include nine internists, five pediatricians, an obstetrician/gynecologist, midwives and nurse practitioners in women's health, a podiatrist and cardiologist, dermatologists who are part of the BWH Dermatology staff, and social workers, psychologists and psychiatrists in the mental health/substance abuse department. A bilingual staff of nurses, medical assistants, secretaries, financial counselors, and other staff provide services and support the work of medical providers. The health center augments its medical and mental health services with health education, case management, screening programs (blood pressure, diabetes, mammography, cholesterol), a Mind/Body Center that includes T'ai Chi and yoga, and a child literacy program. In addition, the health center has a long history of providing substance abuse treatment services to patients, families, and the community. The health center staff also works collaboratively with residents of the local South Street public housing development to promote the health of public housing residents.

Student Success Jobs Program - High School

The Student Success Jobs Program (SSJP) is an intensive year-round employment and mentoring program for students of Boston public high schools. With the goal of addressing the underrepresentation of young people of color in health and science careers, SSJP targets 10th through 12th grade students providing the opportunity to build skills and a career pathway in the health and science field. BWH employees provide intensive mentoring to students in a dynamic and professional hospital environment. Tutoring support is provided to ensure the academic success of students in their science and mathematics subjects and individualized assistance is provided to students to identify their options for higher education and prepare college and financial aid applications. In FY 2011, 75 students participated.

Student Success Jobs Program Summer Internship for College Students (SSJP College)

The Student Success Jobs Program Summer Internship for College Students (SSJP College) is an intensive summer employment opportunity for students that have successfully graduated from the Student Success Jobs Program. SSJP College Summer Internship Program was created to support SSJP graduates, currently in college, majoring in a health related field. Summer internship opportunities are paid positions in a BWH department and are available to students for ten weeks, 40 hours per week, from June through August. SSJP creates pathways into science, health, or medicine careers for those who have traditionally been underrepresented in the field with 96 percent of students self-identified as people of color. In FY 2011, 23 students participated.

Summer Science Academy

BWH Summer Science Academy is a six-week summer program designed to stimulate interest in science, health, and medical careers, targeted to rising 9th grade students attending BWH partnering middle schools in the Mission Hill neighborhood in Roxbury. The goals of the Summer Science Academy are to:

- Engage rising ninth graders from Mission Hill schools in health and science topics through an interdisciplinary curriculum, scientific literature review, and scientific writing; and

- Expose rising 9th grade students to professions in the health and science field.

Since inception in 2009, Summer Science Academy has served 49 students. In FY 2011, Summer Science Academy served 20 students.

The Passageway Domestic Violence Program

The Passageway Domestic Violence Program provides free, voluntary, and confidential services to patients, employees and community members who are experiencing domestic violence. This intervention is based on a multidisciplinary and tailored response model that includes domestic violence advocates, nurses, physicians, social workers, mental health providers, security, and other health care providers. The team provides tailored interventions based on the needs of the individual. Passageway advocates come from diverse backgrounds reflecting the populations served. Advocates offer services in English and Spanish and use Hospital interpreters for all other languages. Advocates are on-site at the BWH Campus, Faulkner Hospital, Southern Jamaica Plain Health Center, Brookside Community Health Center, Whittier Street Health Center and the Mission Hill community. In FY 2011, Passageway provided services to 1,391 clients, and since inception, 10,218 people have been served.

Violence Intervention and Prevention Program

The Violence Intervention and Prevention Programs work to reduce intentional violence in local communities by providing comprehensive services to victims of intentional violence admitted to the BWH collaboratively with the Trauma, Burn and Surgical Critical Care Division. The Program's prevention efforts focus on increasing awareness and education on the adverse health effects of all intentional violence on both an individual and community level.

The Violence Recovery Program provides direct intervention to any patient admitted to BWH as a result of intentional violence. The Violence Recovery Specialist (VRS) meets with patients within 72 hours of admission, provides safety assessments, and helps tailor an individualized plan for ongoing advocacy after discharge. The VRS also provides supportive services to the patient's family and significant others as appropriate and provides ongoing support, case management and community linkages as needed for patients post discharge.

The Violence Prevention Program provides training, education and support to BWH and the local community on the health impacts of both community and domestic violence. The program works directly with youth in the community to provide education and support to local programs on violence prevention.

Indian Health Service

The BWH Physicians' Council, through its Brigham and Women's Outreach Programs (BWOP) is committed to supporting BWH physicians in contributing their skills and time through volunteerism. The goals of the Outreach Program include the development of a program that enables BWH physicians to directly support and enhance patient care delivered at a selected program site, while providing a sustainable, ongoing contribution to supporting an underserved community. In April of 2008, the BWH Physicians' Council selected the Indian Health Service (IHS) as the site for its outreach program. The program focuses on creating volunteer opportunities for BWH physicians at the IHS hospitals in Gallup and Shiprock, New Mexico. Both sites serve American Indian communities in remote rural locations. The hospital in Shiprock is physically located on the Navajo reservation. Both the 55-bed facility at Shiprock and the 99-bed hospital at Gallup have adequate equipment, medication and supplies, but they are challenged by a shortage of staffing. The IHS reports a nearly 15 percent vacancy rate in essential clinical positions, including access to specialty services and consultations. The BWOP physician volunteers are working to address this challenge. In 2011, there were 27 physician volunteers.

1.4.2 Additional Public Benefits

Employment

BWH employs just under 15,000 people, of which approximately 30 percent are Boston residents. Based on preliminary calculations, the Project is anticipated to include space for approximately 325 employees. BWH posts job opportunities through a variety of local employment programs including "Walk to Work".

Construction Employment

The construction of the Project will result in approximately 350 construction jobs. BWH will make reasonable good-faith efforts to have at least 50% of the total employee work hours be for Boston residents, at least 25% of total employee work hours be for minorities and at least 10% of the total employee work hours be for women. In addition, BWH will enter into a jobs agreement with the City of Boston.

Sustainable Design

BWH is committed to developing buildings that are sustainably designed, energy efficient, environmentally conscious and healthy for their researchers, staff, and visitors. The BWH 2012 IMP Amendment Project will be Leadership in Energy and Environmental Design (LEED) certifiable, consistent with the standards articulated in Article 37. The Project is targeting Gold Certification, which would far exceed the requirements of Article 37 of the Code and will set an example of environmental stewardship, responsible construction practices and energy conservation.

Some highlights of the Project's sustainability efforts include:

- Installation of a green roof on a portion of the building;
- Use of 20% less water than the water use baseline calculated for the building;
- Use of water conserving fixtures in the Project to reduce potable water use and waste conveyance by 50%;
- Anticipated reduction of building energy use by 20-30% from baseline performances;
- Engagement by the owner in a contract to provide Green Power for 35% of the building's energy use;
- Development of a waste management plan by the construction manager that keeps at least 75% of construction waste out of landfills;
- Provision of lighting controls throughout the building so that occupants can adjust the lighting within a space to meet their lighting needs; and
- Design of the building to have daylighting in at least 75% of regularly occupied spaces.

PILOT

BWH is a tax-exempt not for profit institution and currently has several Payment in Lieu of Taxes (PILOT) agreements in place with the City of Boston. Among medical institutions, BWH is the third largest contributor of PILOT funds. BWH will meet with the City of Boston Assessing Department and anticipates entering into a PILOT agreement.

Linkage

Under Section 80B-7 of the Boston Zoning Code, projects that require zoning relief and that will devote more than 100,000 sf of space to "development impact uses," must make contributions to the City of Boston's Neighborhood Housing Trust and Neighborhood Jobs Trust.

The majority of the 360,000 sf contemplated for the BWH 2012 Amendment Project will be dedicated for uses which would constitute Development Impact Project (DIP) uses. The Proponent will make a housing contribution grant of $7.87 per/1 sf of DIP use and a jobs contribution grant of $1.57 per/1 sf of DIP use to the Neighborhood Housing Trust and the Neighborhood Jobs Trust, respectively in accordance with the terms of a DIP Agreement to be entered into with respect to the Project.

Urban Design

The new research building will add logically to the LMA's innovation district whose research component is centered on Blackfan Circle. This builds on one of the City's major economic focuses, supporting Boston's internationally recognized leadership position in the innovation economy.

The Project will support and build a high quality pedestrian environment completing Blackfan Circle and reconstructing the surrounding walkways and curbs. A proper turning radius will be included on the property to facilitate the safe movement of cars and pedestrians across Blackfan Circle.

The Project, at the heart of its conception, will demolish an unsightly above grade 355 car parking garage replacing the parking below grade.

Avenue Louis Pasteur and the surrounding landscape will continue the quality and pattern of Emmanuel College grounds with well-maintained plantings, fencing, street furniture and open spaces.

1.5 Community Participation

BWH is committed to effective community outreach and will continue to engage the community to ensure public input on the Project. As part of this effort, BWH has met with a large number of community groups and elected officials as well as presented the Project at several area community meetings. BWH has met with the LMA Forum, the BWH Task Force, and the Emmanuel Task Force and will continue to undertake public review throughout the course of review of the Project.

Section 2.0

Project Description

2.0 PROJECT DESCRIPTION

2.1 Existing Site and Area Context

The Project site is an approximately 78,588 sf portion of Emmanuel College's current Endowment Campus (with a lot area of 76,444 sf as determined in accordance with the Code), known as Parcel C and as described in Emmanuel College's Institutional Master Plan, as approved in 2000 (see Appendix B for a survey of the Project site). Parcel C is also commonly referred to as 45 Avenue Louis Pasteur. The site, currently leased by BWH, includes a two-story concrete and brick parking garage with 328 parking spaces, 27 surface parking spaces and Alumnae Hall, an approximately 50,000 sf, three-story building. BWH intends to enter into a long-term ground lease with Emmanuel College for Parcel C. The existing structures on the site will be demolished in order to enable the development of the Project. See Figures 2-1 through 2-3 for the existing site conditions.

North of Blackfan Street and the Project site is Emmanuel College's Academic Campus. East of the Project site is the Simmons College campus. Both campuses include open spaces and pedestrian walkways between numerous academic and student residence buildings. The buildings on the campuses are generally less than five stories. Southeast of the site are other academic institutions, including Boston Latin School. These areas are more densely built and include buildings generally less than six stories. To the south, southwest and west of the Project site are hospitals, including Beth Israel Deaconess Medical Center, and buildings associated with medical research, including Harvard Medical School's New Research Building, Merck, and the Karp Family Research Laboratories (associated with Children's Hospital Boston). These immediately adjacent areas are more dense and include buildings more than 20 stories tall. In addition, the proposed buildings at Parcel A and Julie Hall as described in Emmanuel's 2012 IMP are also of similar density.

Throughout the LMA are a number of open spaces, including those found on the academic campuses, such as the Harvard Medical School Quadrangle, and those that are public spaces, such as the Back Bay Fens. The larger open spaces are generally on the edges of the LMA, while many of the major hospitals also include smaller open spaces on their campuses.

2.2 Program Need

Over the past several years, BWH-based research expenditures have been growing at 5 percent per year due to the burgeoning research activities. As one of the country's leading recipient's of NIH grants, BWH has a total research budget of more than $537 million. Mindful of future termination of leased research space and growth of research programs, BWH determined that new research space proximate to the BWH Campus is essential. BWH needs additional research space to maintain its leadership in medical research. In addition, BWH research facilities are aging and cannot keep up with state-of-the-art medical research.

nbbj

Figure 2-1

Existing Site Conditions

BWH 2012 IMP Amendment Project   Boston, MA

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Figure 2-2

Photos of Existing Site

Figure 2-3

Photos of Existing Site

Expanding research needs requires retaining and attracting new researchers to BWH. These researchers also serve as doctors and educators and prefer connectivity between research space and clinical centers. In addition to wet lab space, an essential part of successful research is the ability to provide adequate dry space in close proximity to research areas for faculty, fellows, research assistants, monitors, students, and associated dry research functions. With the expiration of several leases in buildings owned by Children's Hospital Boston and the Dana-Farber Cancer Institute, BWH recognizes the need for new research space proximate to its Campus and clinical areas which it owns as opposed to leases. BWH intends to enter into a long-term ground lease with Emmanuel College for Parcel C in order to enable development of the proposed Project. BWH's long-term lease ownership interest in Parcel C will be considered "owned" as opposed to "leased" property for the purposes of the BWH 2012 IMP Amendment.

2.3 Proposed Development Program

The BWH 2012 IMP Amendment Project is a new approximately 150-foot tall[1], 360,000 sf building for hospital use as that term is understood in Article 2A of the Code, including basic 'wet type' science labs for research. The proposed structure will have an associated underground parking garage for 355 replacement spaces. Research and imaging equipment will also be below grade. Figures 2-4 to 2-10 of the Draft PIR provide a site plan, sections, massing, perspective and a typical floor plan of the Project.

The Project will likely house research in support of the departments of Medicine and Surgery, particularly the divisions of pulmonary surgery and anesthesia. Advanced equipment will likely include a cyclotron facility to aid in nuclear pharmacology, a micro PET CT scanner and a research centered aquatics facility. The utility needs of the Project may be served in part by a modest cogeneration facility which will provide hot water as well as a source of redundant emergency power. Also in support of the laboratory facility will be laboratory administration, loading facilities, and a building management office. The Project will include a lecture auditorium for the purposes of medical research and teaching aiding in one of the Hospital's central missions to be a premier center for medical education. A small cafeteria is proposed to support the educational activities and researchers in the building.

The Project will allow for the continuation of a strong tradition of research in support of patient care offered historically at BWH. Recent advances in medicine portend a future of customized medicine, an unprecedented compression of the distance between bench and bedside, and a future of medicine that makes the individual patient the center of not only the care, but also the research enterprise. These labs will allow BWH to continue to be seen as a leader in research not only regionally, but also nationally; BWH currently attracts the

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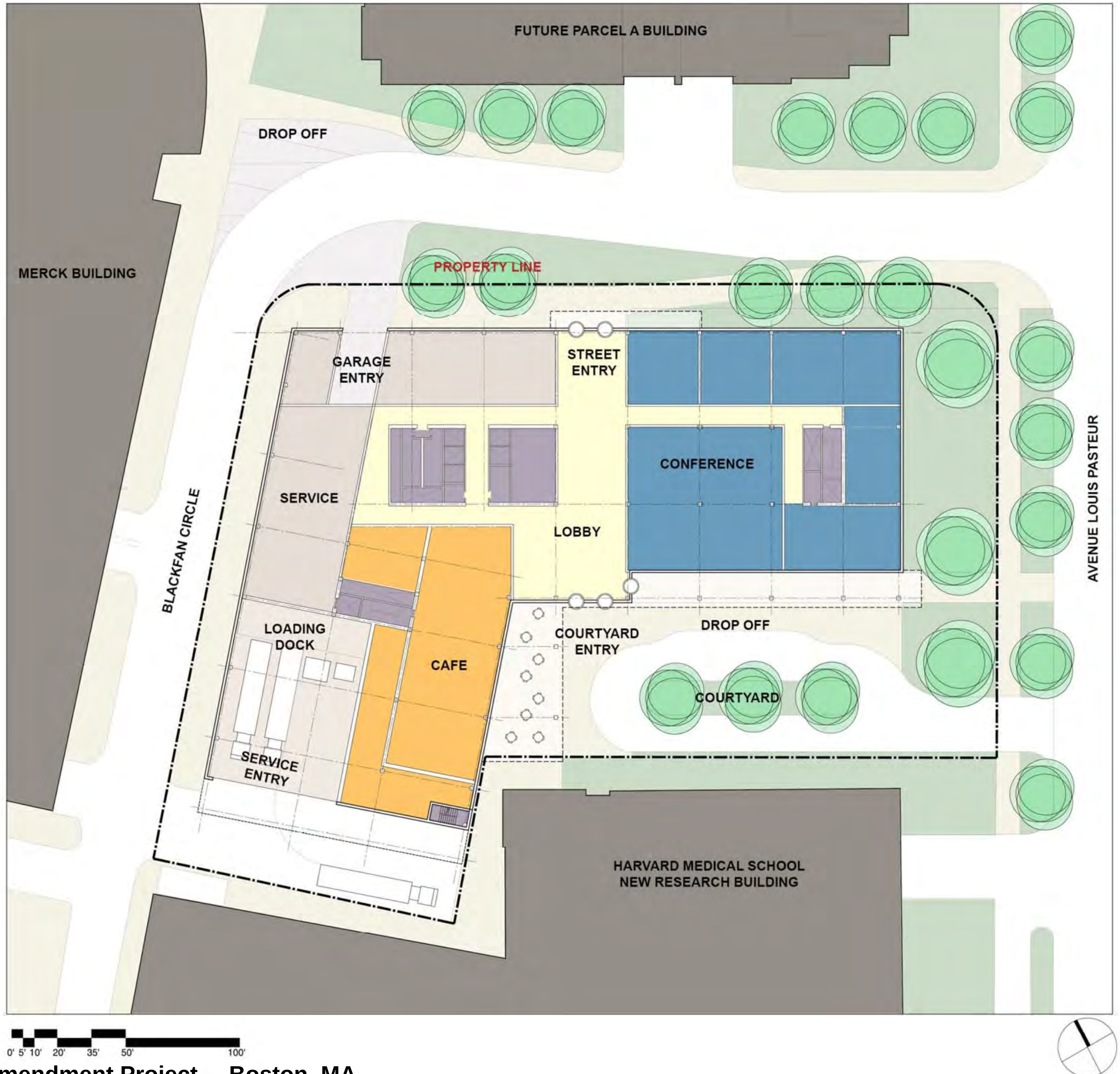
1 Height as measured in accordance with the Boston Zoning Code.



BWH 2012 IMP Amendment Project **Boston, MA**

Figure 2-4

Ground Flood Plan

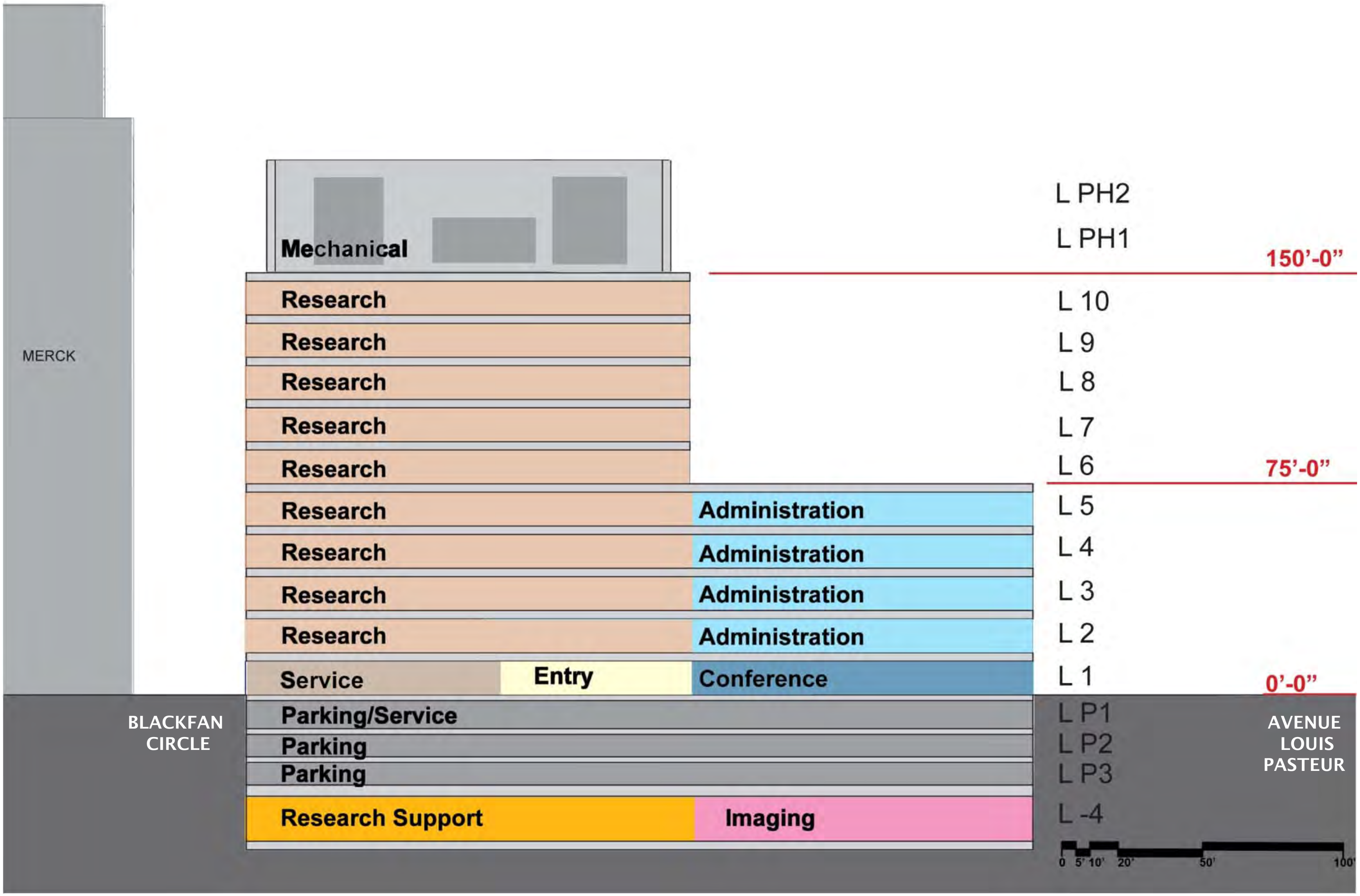


Figure 2-5

South Section

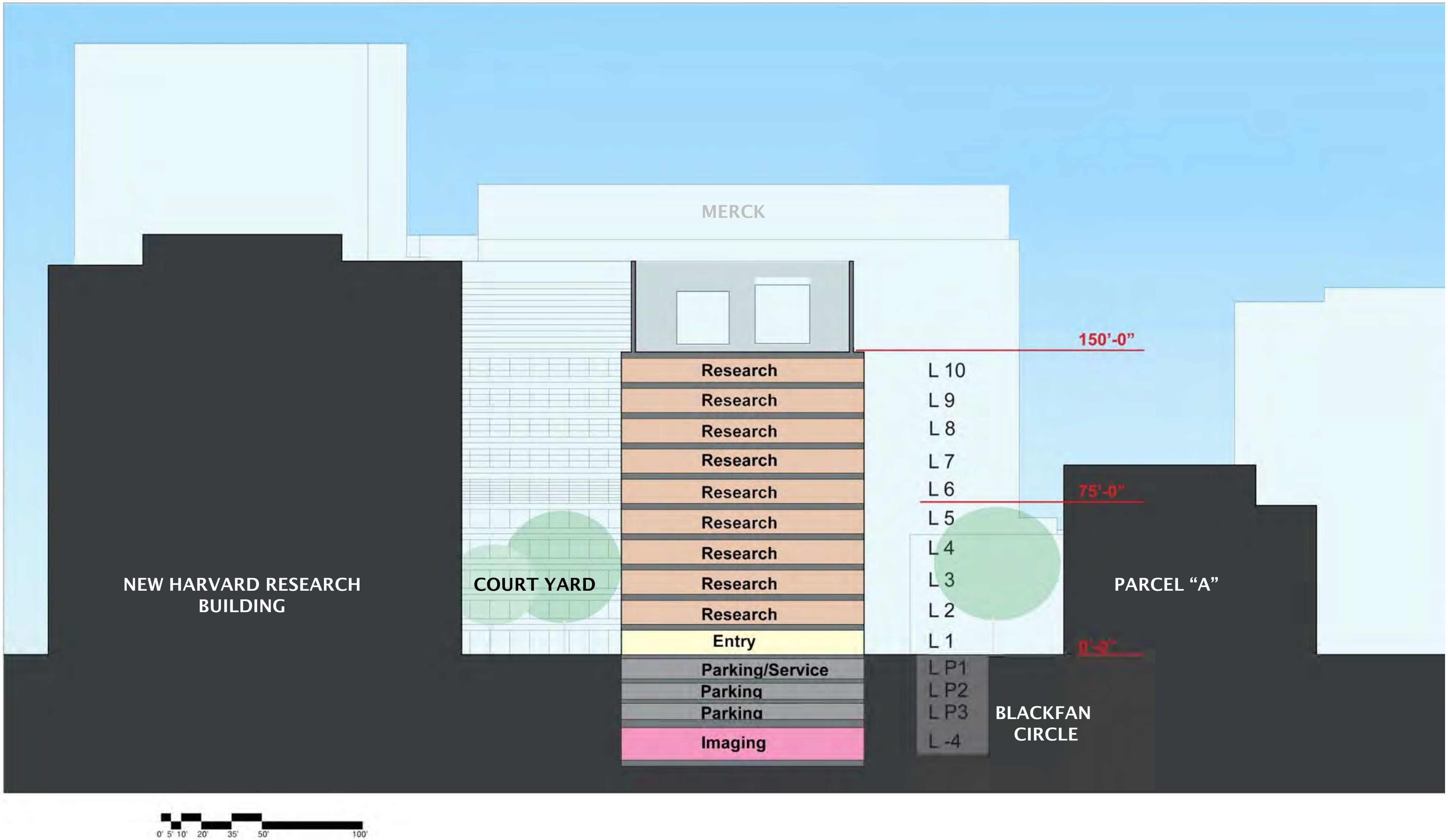


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Figure 2-6

Urban Section - East

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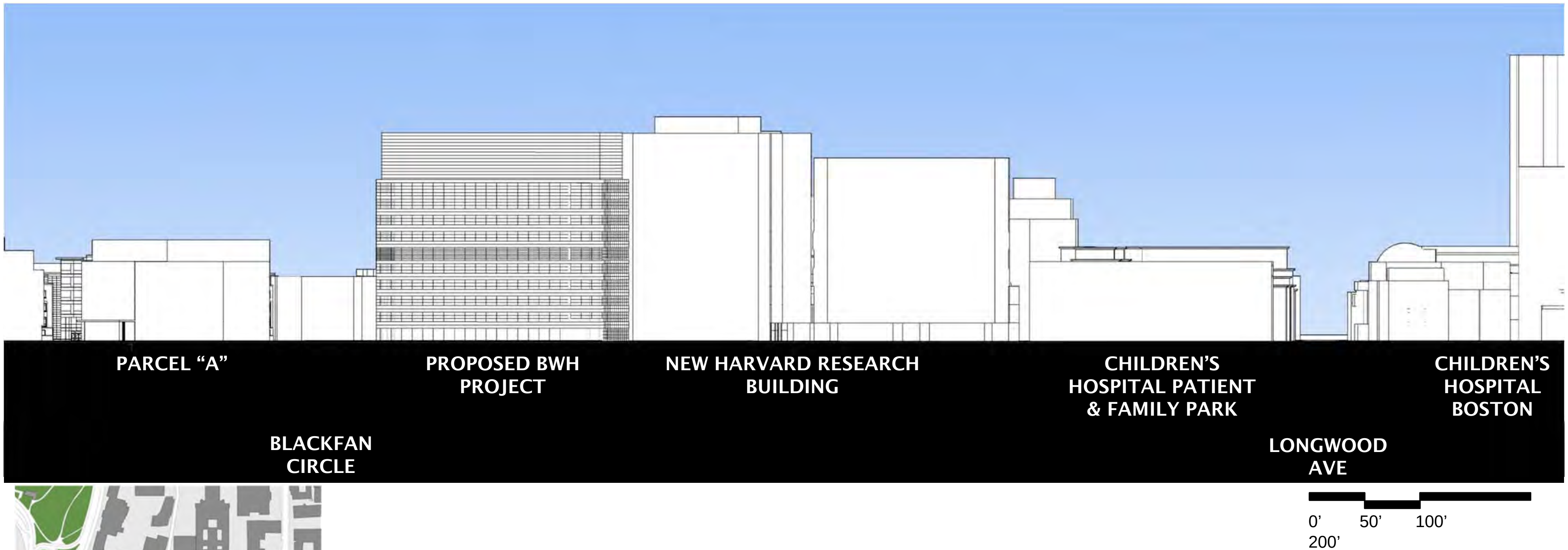
Figure 2-7

Aerial View Looking South



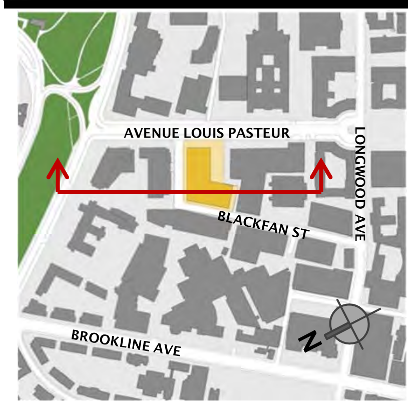
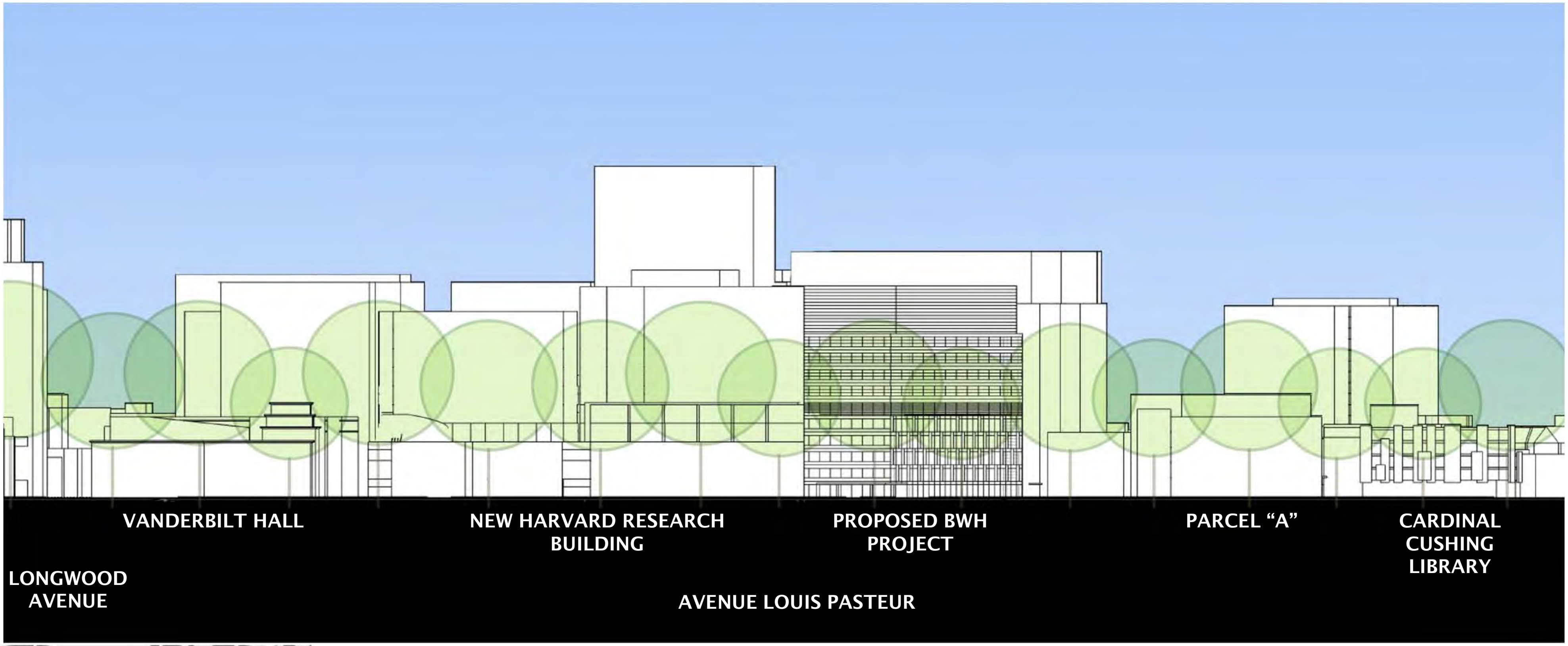
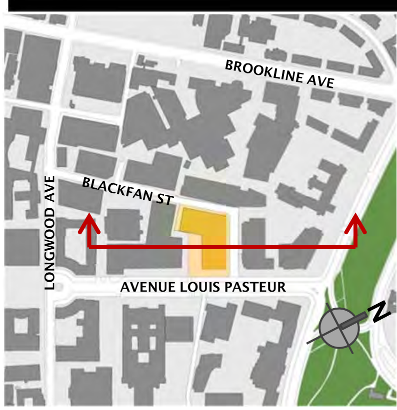


Figure 2-8

West Elevation





0’ 50’ 100’ 200’

Figure 2-9

East Elevation

BWH 2012 IMP Amendment Project Boston, MA

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Figure 2-10

Typical Floor Plan

second largest amount of NIH funding in the country, and the Project will allow BWH to continue this remarkable accomplishment. The Hospital's continued leadership in research and clinical care is dependent on the laboratory spaces it can offer its talented staff. The location of laboratories proximate to BWH's Campus is important, as well as BWH's assurance that it will be able to manage and control its laboratory space for the long-term.

The building's architecture will be consistent with the district in which it stands, set back from Avenue Louis Pasteur and enclosed in a combination of glass curtain wall and masonry. The architecture presents the short dimension of its mass to this main boulevard of the LMA.

Circulation

Three pedestrian entries to the building will be provided: one directly addressing Avenue Louis Pasteur, one on the north side of the structure; and one on the south facing side of the structure with a vehicle drop-off. (See Figure 2-11). All of these entryways will arrive at the same main lobby space in the building.

Vehicles will enter the underground garage on the north side of the Project site at the northwest corner of the building. Please see Chapter 3 for a more detailed discussion of transportation impacts.

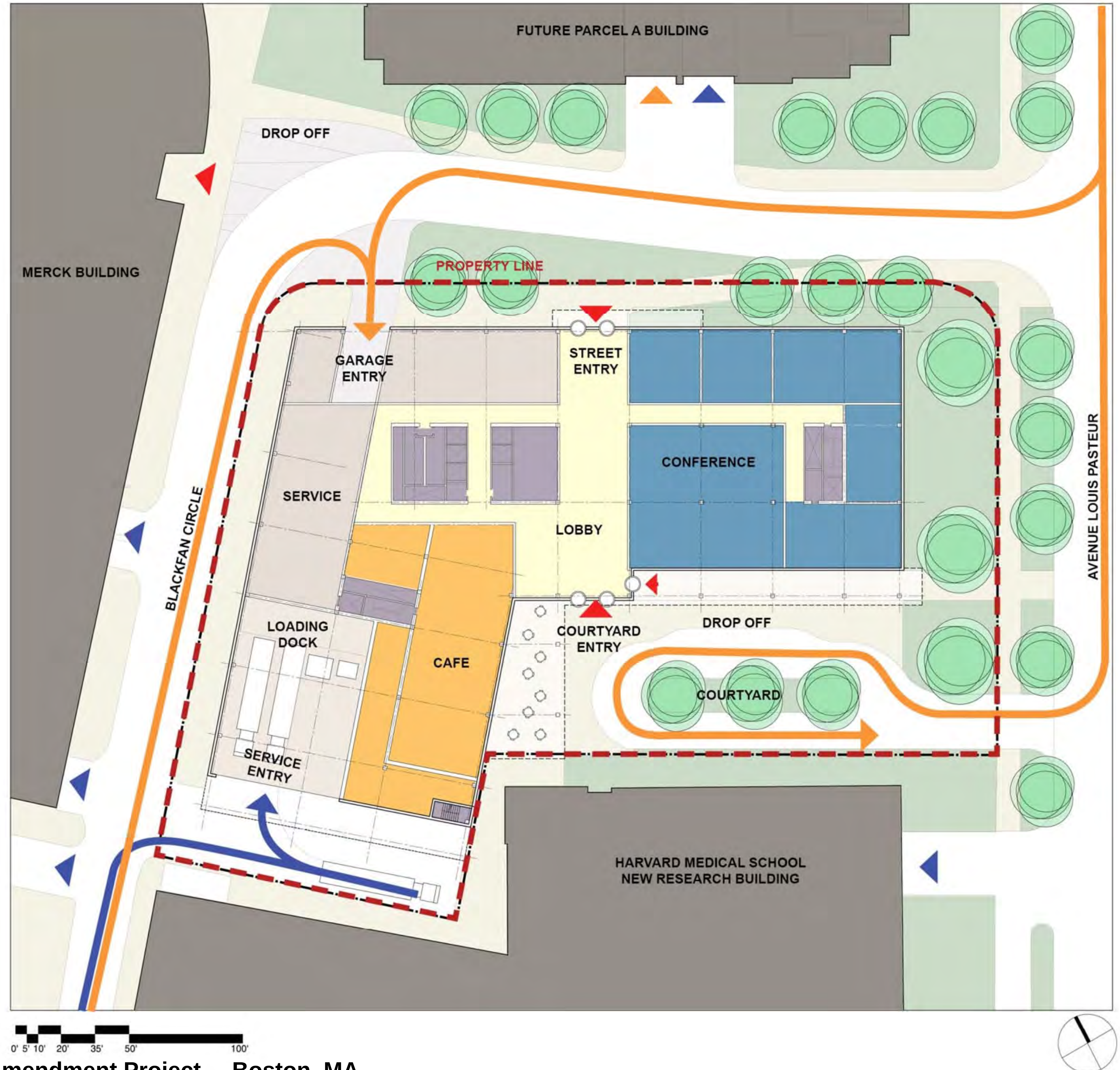
As the design of the building moves forward, emergency vehicle access to the site and adjacent buildings, impact on availability and accessibility of siamese connection locations, and other requirements associated with fire safety will be studied.

Loading

A loading and service area will be located off of one discrete curb-cut on the west side of the building on Blackfan Circle. Blackfan Circle will not be treated as a service street, rather all truck maneuvering will occur on the Project site. No truck loading or idling will occur on Blackfan Circle. Compressed gasses, which will be supplied and handled in smaller bottles servicing the building, will be supplied at the building's loading dock as bulk loading or storage of gasses at the site is not anticipated at this time based on the anticipated uses. See Figure 2-11.

Landscape

Spaces around the building will be landscaped consistent with the prevailing patterns in the vicinity, in particular the collegiate landscape of Emmanuel College and the axial promenade of Avenue Louis Pasteur. The rhythm of the tree canopies on the Avenue will be maintained and reinforced, where possible, with the addition of new trees. The sidewalks on Blackfan Circle will be extended and detailed consistent with the high quality associated with BWH facilities and in keeping with layout contemplated by Emmanuel College and the City for the Endowment Campus. See Figures 2-4 and 2-12.



BWH 2012 IMP Amendment Project **Boston, MA**

Figure 2-11

Ground Floor – Circulation Plan

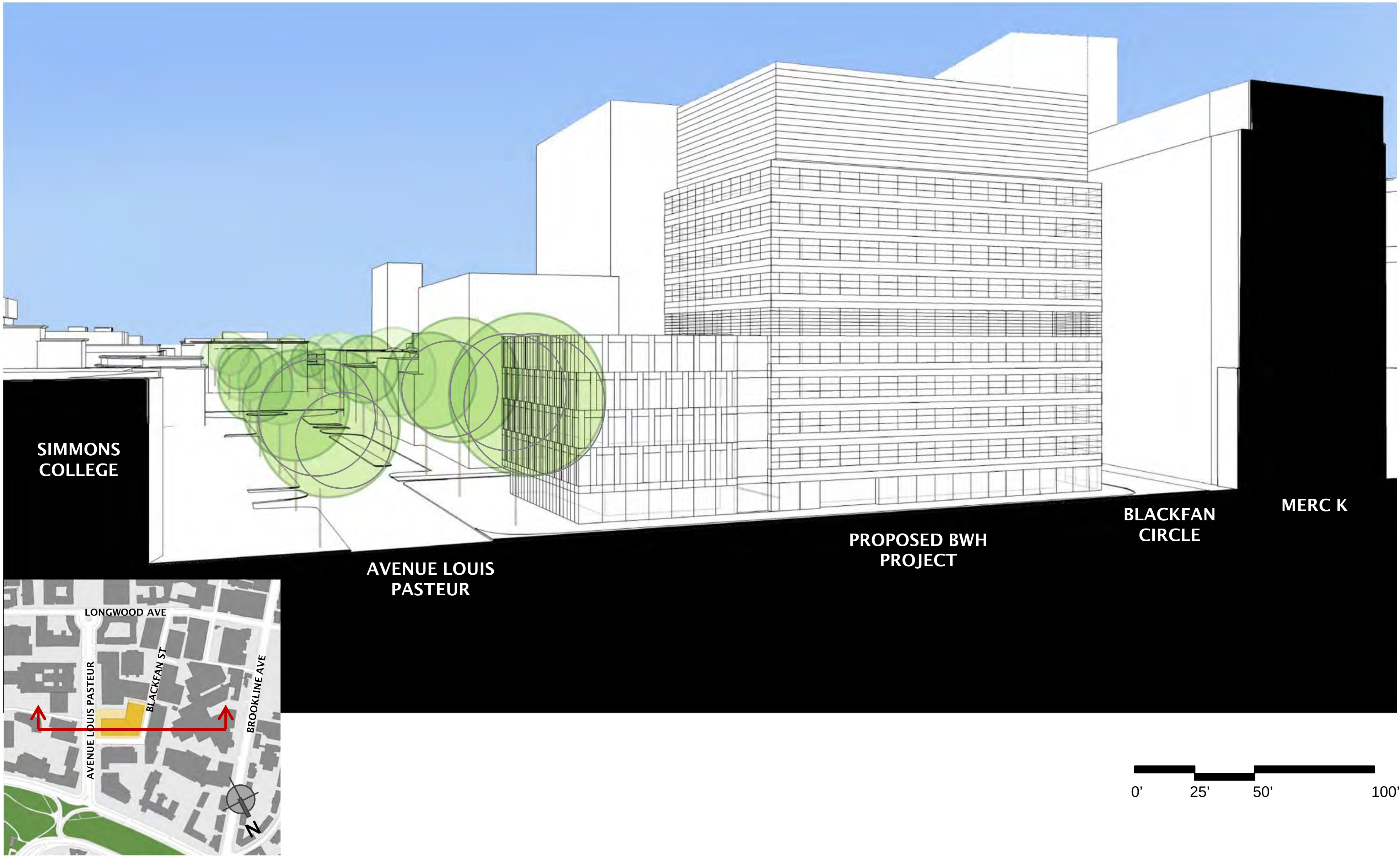


Figure 2-12
North Elevation

2.4 Legal Information

2.4.1 Legal Judgments Adverse to the Proposed Project

There are no legal judgments or actions pending with respect to the BWH 2012 IMP Amendment Project.

2.4.2 History of Tax Arrears on Property

There is no history of tax arrearages on property owned by BWH in the City of Boston.

2.4.3 Evidence of Site Control/Nature of Public Easements

As noted above, Parcel C is owned in fee by Emmanuel, currently leased to BWH and will be the subject of a long-term ground lease to BWH to enable the construction and development of the BWH 2012 IMP Amendment Project. The ground lease will be executed by Emmanuel and BWH prior to the commencement of construction of the BWH 2012 Amendment Project. BWH, as ground lessee of Parcel C, will be subject to the provisions and have the benefit of an easement agreement by and among Emmanuel and Merck which has been recorded with the Suffolk County Registry of Deed, as amended, which includes among other things, access, drainage and utility easements. Parcel C is also subject to a grant of easement to the Boston Water and Sewer Commission ("BWSC") to maintain a water line and prior takings by the City of Boston to install and maintain sewers. BWH, as ground lessee of Parcel C, will also be subject to the public's rights of travel over Blackfan Circle, which will remain a private way, although subject to public travel in and proximate to the Parcel C site. The construction and development of the BWH 2012 IMP Amendment Project will be undertaken in accordance with the terms and provisions of these easements and grants.

2.4.4 Disclosure of Beneficial Interests

The Disclosure of Beneficial Interests will be provided under separate cover.

2.5 Zoning

By virtue of the proposed BWH 2012 IMP Amendment, Parcel C will be included in the "BWH Campus" as that term is defined in the existing BWH 2010 IMP. The existing BWH 2010 IMP and BWH Institutional Overlay District will be amended to include Parcel C, which will be dedicated to BWH's use for the development and construction of the BWH 2012 IMP Amendment Project. The BWH Institutional Overlay District and BWH 2010 IMP as amended by the BWH 2012 IMP Amendment will be sufficient to authorize the office, laboratory, auditorium and research uses and construction of the proposed BWH 2012 IMP Amendment Project including the potential cogeneration facility and replacement parking spaces in the underground garage and loading accessory thereto. The development and use of the BWH 2012 IMP Amendment Project in accordance with the terms of the

BWH 2010 IMP as amended by the BWH 2012 IMP Amendment will be deemed to be allowed as of right and determined to be in compliance with all relevant provisions of the Code, including dimensional, parking, loading, and other special districts without the need for further relief.

2.6 Regulatory Controls and Permits

While the Project's design has not advanced sufficiently to definitively identify all Project approvals, Table 2-1 includes public permits and approvals likely to be required.

Table 2-1 Anticipated Permits and Approvals

Agency Name	Permit/Approval
City of Boston	
Boston Civic Design Commission	Review pursuant to Article 28 of General Massing and Site Strategy only
Boston Redevelopment Authority	Article 80B Large Project Review Article 80D Institutional Master Plan Review Other approvals as required
Boston Zoning Commission	Approval of the BWH Institutional Master Plan Amendment and corresponding changes to the boundaries of the BWH IMP Overlay District
Boston Water and Sewer Commission	Sewer Use Discharge Permits Site Plan Approvals Sewer Extension/Connection Permits Stormwater Connections
City of Boston Inspectional Services Department	Building and Occupancy Permit
City of Boston Public Improvement Commission	Streetscape Improvements and discontinuances (if required)
Boston Department of Public Works	Street Occupancy Permit (construction period) Curb Cut Approval (if required)
Boston Transportation Department	Transportation Access Plan Agreement Construction Management Plan
Boston Landmarks Commission	Article 85 Demolition Delay
Boston Parks and Recreation Commission	Approval of Construction within 100 feet of park or parkway (if required pending jurisdictional determination)
City of Boston Committee on Licenses	Permit to erect and maintain parking garage Flammable storage license
Boston Fire Department	Permits and review as necessary
Commonwealth of Massachusetts	
Department of Environmental Protection, Division of Air Quality Control	Environmental Results Program Review under Title V (if necessary) Abatement of hazardous materials permits (if required)
Massachusetts Water Resources Authority	Sewer Use Discharge Permit Construction Dewatering Permit Industrial Discharge Permit for Project (if required)
Massachusetts Historic Commission	State Register Review
Massachusetts Aeronautics Commission	Notice of Pre-Construction

2.6.1 Applicability of Massachusetts Environmental Policy Act Review

The Project does not require Massachusetts Environmental Policy Act Review. The only threshold met by the Project is related to Historic Resources. A Massachusetts Historical Commission ("MHC") Project Notification Form will be submitted to MHC to commence review. BWH will coordinate with MHC as design of the Project and review moves forward.

2.7 Consistency with LMA Guidelines

In late fall 2002, the BRA and the Office of Jobs and Community Services, in conjunction with the Boston Transportation Department initiated a master planning process for the LMA. In February 2003, the BRA adopted a set of Interim Guidelines to inform the BRA's considerations while reviewing proposed projects and Institutional Master Plans pursuant to Article 80 of the Code prior to completion of the LMA strategic plan.

The BWH 2012 IMP Amendment Project is within the boundaries of the area in which the LMA Interim Guidelines are applicable.

The proposed Project will be within the stated dimensions, will reinforce the character of the institution, have minimal impact to transportation infrastructure, and be a part of BWH's overall workforce development program. A detailed discussion of the Project's compliance with the LMA Interim Guidelines is provided in the BWH 2012 IMP Amendment.

BWH will continue to work with the city and its agencies, MASCO, and neighbors in the LMA to protect the assets of the area and create a better physical environment in the LMA.

2.8 Consistency with Other Plans

Fenway Community Development Corporation – Urban Village Plan

The Fenway Community Development Corporations' Urban Village Plan (2009) includes five components of an evolving vision with a goal of creating an urban village. These five components are:

1. A sufficient and varied housing supply.
2. Excellent access to public transportation and curbs on vehicular traffic.
3. Community-building facilities such as a community center.
4. A healthy business community serving local residents and visitors alike, while providing employment opportunities.
5. Easy access to open space and a responsible level of impact upon the environment.

The Project is consistent with the components most relevant to its mission and operations.

The Project will minimize its impact on transportation infrastructure, particularly roadways. The Project is located proximate to MBTA bus routes and the MBTA Green Line, as well as MASCO shuttle routes. The Project will not create any new parking, and provision of bicycle storage areas and showers for bicyclists will be included in the design. Employees of the Project will be offered the same transportation demand management ("TDM") incentives as currently offered to other BWH LMA employees as a means to reduce single occupant driving and increase use of alternative forms of transportation to access the workplace. Further detail of BWH's TDM incentives can be found in Section 3.1.2.6.

The Project will also be developed with an understanding for sustainable design and the Project's environmental impact. The Project is anticipated to reach the Gold level under the LEED rating system. Mechanical equipment will be as efficient as feasible, minimizing energy need and the resultant air quality impacts. The design will also emphasize natural lighting in the building. Additional measures related to energy efficiency are still being considered.

The Project contributes positively to the open space along Avenue Louis Pasteur connecting open spaces and pedestrians to the Back Bay Fens.

BWH has a community career liaison to help area residents identify open positions, provide assistance with applying for positions online, and referring individuals to the BWH community partner Project Hope for pre-employment preparation, referral for services, and career identification. In 2011, close to 200 new hires at BWH came from the adjacent neighborhood.

Consistency with the Emerald Necklace Master Plan

The Emerald Necklace Master Plan sets forth a vision for the Emerald Necklace for recovering Olmstead's original concept of a unified system of linked parks by reconnecting the watercourse; mitigating the adverse impact of physical barriers or, better, eventually eliminating them; removing "breaks" in the parks' circulation and function; improving and diversifying park landscapes; relocating or reorienting incongruous recreational activities; coordinating consistent management practices; and increasing and enhancing regular maintenance.

The proposed Project does not involve any construction within the boundaries of the Emerald Necklace parks system and there are a number of existing and proposed buildings between the Emerald Necklace and the Project site. As mentioned in the Master Plan however, many of the Emerald Necklace's most pressing problems, such as water pollution and stagnation, traffic and incompatible land uses, originate outside park boundaries. The Project will have a minimal impact on the Emerald Necklace, as it will improve stormwater runoff from the site, increased groundwater infiltration, improve pedestrian access to the site through the construction of a new sidewalk on Blackfan Circle, and does not include new parking.

The Project will improve the stormwater runoff that flows to the Muddy River from the site. The site currently includes a surface parking lot and an above-grade parking structure. The Project will place replacement parking below the new building and create new landscaped areas. A portion of the Project's roof will also be a green roof, which will improve the stormwater runoff from that section of the Project. In addition, the Project will infiltrate one inch of rain over all structures and impervious surfaces, which infiltration is consistent with the requirements of Article 32 of the Code.

The Project will also improve access to the Emerald Necklace. A new sidewalk will be constructed on the east side of Blackfan Circle where one currently does not exist. This will improve the pedestrian experience in this area, inviting pedestrians to walk by the Project site and to other areas in the LMA and to the Emerald Necklace. Street trees will also be planted or retained, where feasible, to provide for a pleasant pedestrian experience. The Project contributes positively to the open space along Avenue Louis Pasteur connecting open spaces and pedestrians to the Emerald Necklace.

Traffic at intersections proximate to the Project site is not anticipated to be impacted by the Project. In addition, the Project does not include new parking.

2.9 Development Schedule

The Project schedule anticipates 24 months of design and programming, and 40 months of construction. The Project design is anticipated to commence in 2016-2017.

Section 3.0

Transportation

3.0 TRANSPORTATION

3.1 Introduction

The transportation analysis presented in this chapter conforms to the Boston Transportation Department ("BTD") "Transportation Access Plans Guidelines" and is responsive to the scoping issues and concerns raised by the BRA and the BTD for the BWH 2012 IMP Amendment Project. This study is intended to identify transportation impacts that are expected over the term of BWH's Amended IMP, and to codify mitigation and improvement actions aimed at supporting access to BWH's 2012 IMP Amendment Project on Parcel C of the Emmanuel College Endowment Campus in the Longwood Medical and Academic Area ("LMA").

This chapter presents an evaluation and summary of existing and future transportation infrastructure and operations. This transportation study has been developed in order to understand and mitigate the transportation impacts of the BWH 2012 IMP Amendment Project, and to develop appropriate transportation infrastructure improvements.

The transportation study was conducted in three distinct stages. The first stage (Existing Conditions) involved a survey and compilation of existing transportation conditions within the study area (defined below) including:

- An inventory of the transportation infrastructure within the defined Project study area;
- Geometric and operational characteristics of study area roadways and intersections;
- Existing traffic control at study area intersections (i.e., traffic signalization, stop signs, one-way streets, etc.);
- Area off-street and on-street parking supply;
- Pedestrian activity at the Project site, along study area roadways, and at study area intersections;
- Bicycle activity and accommodations; and
- Public transportation options within the study area, including bus, subway, commuter rail, and private shuttle bus options.

In the second and third stages of the study (Evaluation of Long-Term Transportation Impacts), future transportation conditions were projected within the study area for the year 2022. The future 2022 No Build Condition includes an assessment of future transportation impacts, as well as background growth on area roadways, planned transportation infrastructure improvements, and growth related to other proposed projects within the study area. The future 2022 Build Condition assesses the No Build Condition plus the BWH 2012 IMP Amendment Project and supporting transportation infrastructure. This section also quantifies the proposed mitigation and improvement actions to address Project-related pedestrian, parking, traffic, and public transportation impacts that have been identified. The proposed improvement actions serve as the basis for the forthcoming preparation of a Transportation Access Plan Agreement ("TAPA") to be developed and executed by both the Hospital and the BTD.

This study includes detailed roadway capacity analyses for the morning and evening peak commuter periods for the following conditions:

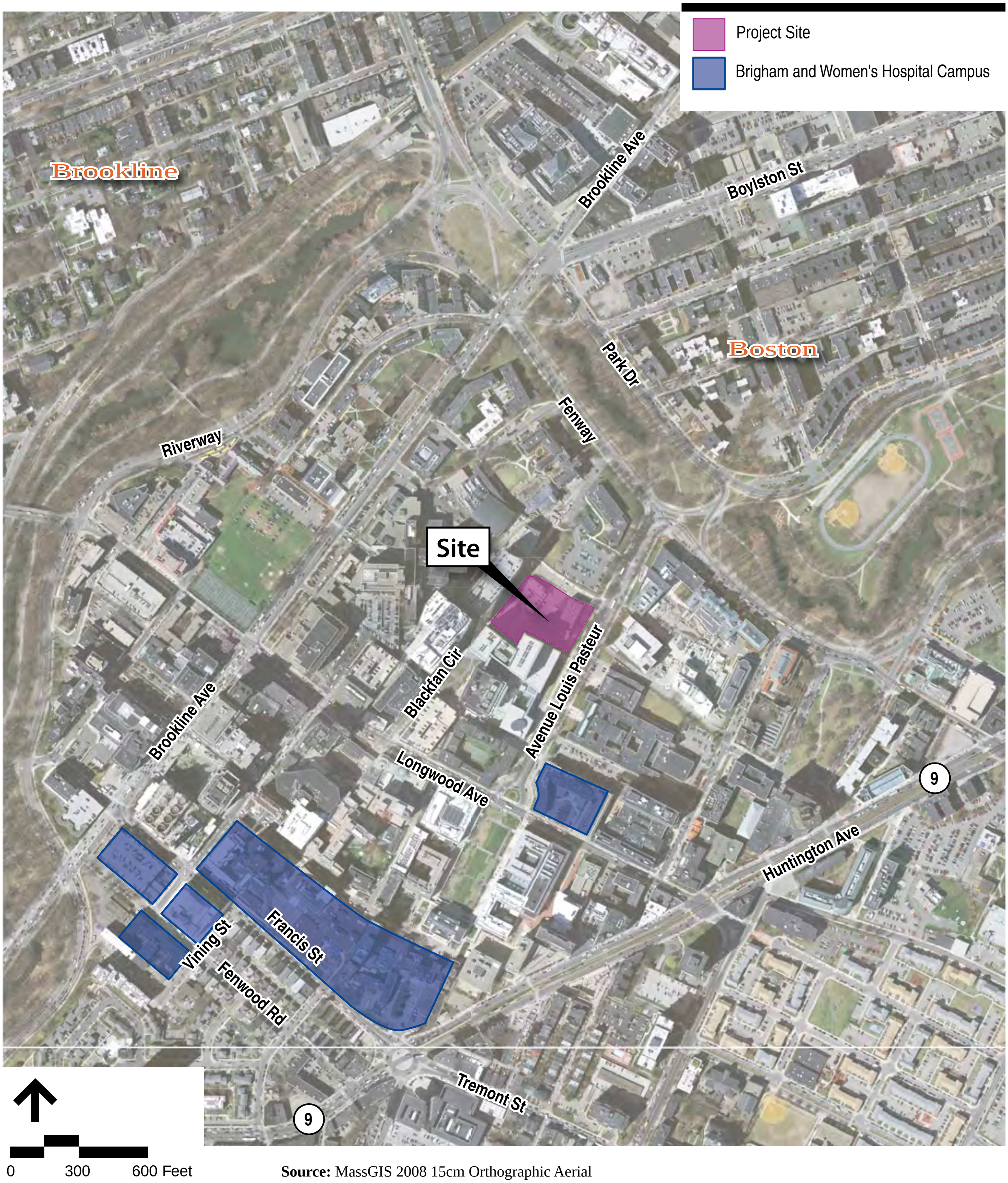
- 2012 Existing Condition
- 2022 No Build Condition
- 2022 Build Condition

The results of the analysis indicate that there will be no change in the LOS and minimal increases in queues and delays at the intersection of Longwood Avenue and Blackfan Circle as a result of the proposed Project.

3.1.1 Project Summary

The BWH Campus is located predominately in the LMA and includes a portion of the Mission Hill as shown in Figure 3-1. The existing BWH Campus is generally bounded by Francis Street, Shattuck Street, Brookline Avenue, and Huntington Avenue. BWH also owns the newly constructed Binney Street Building at 75 Fenwood Road, the Shapiro Cardiovascular Center at 70 Francis Street, the Servicenter Complex at 80 Francis Street and several buildings located at 221 Longwood Avenue. BWH controls portions of the Massachusetts Mental Health Center ("MMHC") site and plans to construct a new hospital building there in the next few years—as contemplated and approved the BWH 2010 IMP. Finally, BWH is also planning to begin construction of its approved Brigham Green Enhancement and Parking Project, a project to build 400 below-grade parking spaces in front of the existing Peter Bent Brigham Building. The parking facility will be fitted with green/open space at the surface—providing new public open space to the Hospital, Mission Hill, and Brigham Circle. All of these properties are described in BWH's existing 2010 IMP and located within the BWH IMP Overlay District.

The BWH 2012 IMP Amendment Project site is located at 45 Avenue Louis Pasteur on Parcel C of Emmanuel College's Endowment Campus. The Project includes construction of an approximately 360,000 square foot (sf) building dedicated to laboratory, research and support spaces, as well as 355 below-grade replacement parking spaces (no net new parking).



Source: MassGIS 2008 15cm Orthographic Aerial

2012 BWH IMP Amendment Project Boston, MA

VHB Vanasse Hangen Brustlin, Inc.

Figure 3-1

Site Location Map

The Hospital is proposing to enter into a long-term ground lease with Emmanuel College for Parcel C in order to enable development of the proposed Project. BWH currently leases Parcel C, which includes the 50,000 sf Alumnae Hall, 328 space parking deck, and 27 surface parking spaces, for hospital use, including office and dry research activities. The existing structures on the site will be demolished and a new building will be built with connecting below-grade parking and an off-street loading and service facility.

The proposed Project will be for hospital use, including basic 'wet type' science labs for research. The Project structure will have an associated underground parking garage for 355 replacement spaces. The Project will likely house research in support of the departments of Medicine and Surgery, particularly the divisions of pulmonary surgery and anesthesia. Advanced equipment will likely include a cyclotron facility to aid in nuclear pharmacology, a micro PET CT scanner and a research centered aquatics facility. The utility needs of the Project may be served in part by a modest cogeneration facility which will provide hot water as well as a source of redundant emergency power. Also in support of the laboratory facility will be laboratory administration, loading facilities, and a building management office. The Project will include a lecture auditorium for the purposes of medical research and teaching aiding in one of the Hospital's central missions to be a premier center for medical education. A small cafeteria is proposed to support the educational activities and researchers in the building.

Table 3-1 presents the proposed program for the Project.

Table 3-1 Project Building Program Summary

	Size (sf)	Parking
BWH Research Building	360,000	355
Demolition of Alumnae Hall and Parking Deck	(-50,000)	(-355)
Net New Total	310,000	0

3.1.2 Summary of Findings

The traffic generated by the Project is projected to be minimal and expected to have no measurable impacts on the area's transportation infrastructure. However, BWH is committed to providing transportation improvements and mitigation actions to improve transportation conditions for residents, patients, visitors, and employees traveling in the LMA.

3.1.2.1 Parking Summary

The Project will include the construction of 355 below-grade parking spaces on-site. The 355 parking spaces are equal to the amount of parking that is currently provided on the site and leased to BWH by Emmanuel College. Thus, the proposed parking spaces will be replacement spaces for the existing on-site parking supply (resulting in no net new parking spaces allocated to BWH on this site).

3.1.2.2 Pedestrian Access

BWH will provide a pedestrian friendly environment with improved pedestrian access, visibility and way-finding around the site. In addition, a new, wide sidewalk will be constructed abutting the Project site in order to provide better pedestrian circulation along the eastern side of Blackfan Circle where there is no sidewalk today. Chapter 5 provides some additional discussion and illustrations of anticipated pedestrian access improvements that are anticipated with the future construction of the Project.

3.1.2.3 Bicycle Storage

BWH will provide bicycle racks for visitor and employee use at the Project site. As the design advances, BWH will work with BTD to determine the appropriate number of bicycle spaces and location of these spaces at the site. At minimum, it is expected that covered, secured bicycle parking would be provided for 50 bicycles, which exceeds the BTD's Guidelines for bicycle accommodation for a project of this size.

3.1.2.4 Loading and Service

The building will include provision of dedicated, off-street loading docks so that area roadways will not be impacted. As currently planned, loading and service for the proposed Project will be accommodated from an off-street dock to be located along Blackfan Circle. The dock will be fitted with two loading bays and a third bay dedicated to trash removal (compactor). The dock's design will accommodate direct off-street access (i.e., trucks will not have to back into the dock from Blackfan Circle). Most deliveries are anticipated to be made by single-unit trucks or smaller vans—although there will be some deliveries made by larger WB-40 and/or WB-50 sized vehicles. The dock's design will be able to accommodate these larger vehicles off street as well. As the building design advances, BWH will work closely with BTD to ensure that loading and service needs are accommodated at the site and off-street limiting adverse impacts to traffic flow and pedestrian access on the adjacent sidewalk and street.

3.1.2.5 Traffic Impacts

The effects of the Project, including a detailed analysis of intersection level of service ("LOS"), were examined at five intersections including the future Project site driveway proposed on Blackfan Circle. This analysis was conducted for existing and future conditions. The future conditions analysis assumes the year 2022 for the Build Condition. These analyses consider background growth, growth attributable to other identified projects, and traffic estimates associated with the Project.

The 2022 Build Condition creates no substantial changes to the traffic demands on the streets surrounding the Project site. Traffic conditions are not expected to measurably change. The supply of parking is being held constant, and the users of those spaces (BWH staff/physicians/researchers) is not going to change. The results of the analysis indicate that there will be no measurable changes in the LOS on the study area roadways as a result of the Project.

3.1.2.6 Transportation Demand Management

The research and development employees will be offered the same TDM incentives as currently offered to other BWH LMA employees as a means to reduce single occupant driving and increase use of alternative forms of transportation to access the workplace. Current measures include the following:

- Employee Transportation Advisor – Provides alternative transportation information for employees. BWH promotes alternative transportation through a variety of newsletters, information kiosks, websites, e-mail, and special events.
- BWH provides bicycle racks throughout its Campus in several locations, including the Servicenter Garage, ASBII Garage, and Mission Park Garage. The future Brigham Green Garage will also be fitted with covered, secured bicycle parking. Additionally, the Project will also include its own, dedicated secured bicycle parking area on-site that exceeds the minimum requirements of the BTD's Bicycle Guidelines.
- 50 percent transit pass subsidy for employees – BWH provides a 50 percent subsidy in the cost of MBTA transit passes for employees. The cost of passes is deducted on a pre-tax basis, resulting in an additional cost savings to employees.
- Location-priced parking - Discouraging on-campus parking by offering market rate parking for employees on-campus while offering parking at a significantly lower rate in off-campus parking locations. Vanpool members are offered a 50 percent parking discount.
- Member of the CommuteWorks Transportation Management Association, which is operated by MASCO. CommuteWorks offers an array of ongoing programs (discussed further below) designed to encourage employees to choose alternative options for commuting.
- Emergency Ride Home - With CommuteWorks' Emergency Ride Home program, registered BWH employees can receive a guaranteed ride home in the event of a personal emergency during the work day.

- The Longwood T Party Program - Under this CommuteWorks program, BWH employees who currently drive to work alone can try using public transit risk free, and have CommuteWorks help pay for it.
- CommuteFit Program - Employees who incorporate biking, walking, or jogging into their daily commute are eligible to participate in the CommuteFit Program which offers employee incentives.
- Ridesharing: Carpools and Vanpools - CommuteWorks partners with MassRides, the Massachusetts statewide travel options program, to help match BWH employees into carpools and vanpools from their home town.
- MASCO Shuttle Services - MASCO operates several shuttles to and from the LMA providing connecting service to commuter rail and rapid transit and off-site parking facilities. With the exception of the M2 Shuttle, these shuttles are free of charge to BWH employees.
- Zipcar Discounts - BWH Employees are eligible to join CommuteWorks' Zipcar program at a reduced membership fee. Through the MASCO discount, Zipcar members also receive reduced hourly rates when using Zipcars during regular business hours.
- Personalized Commuting Assistance - CommuteWorks answers any general commuting questions employees have and provides them with various travel options to help maximize the efficiency of their commute. CommuteWorks' personalized itineraries identify employees' complete travel options with information on commuter rail, subway, bus, shuttles, ridesharing, biking and walking.
- Discounted regional bus services – BWH provides a 50 percent discount to employees who commute by non-MBTA bus services. This program includes private bus services to Cape Cod and New Hampshire.
- Secure bicycle storage – BWH offers bicycle storage throughout the Campus.
- Telecommuting and compressed workweeks – BWH has an informal policy of encouraging telecommuting and compressed workweeks for employees where reasonably feasible.

3.1.2.7 Public Transportation

The Project is projected to have only a modest incremental impact on transit operations in the area by 2022. The analysis assumed that future BWH employees, patients, and visitors will have access to the many public transportation services offered by the MBTA, as well as the array of private shuttle and transportation demand management services that are offered in the LMA through MASCO.

Because there are so many public transportation options that provide service to and from the LMA, no single service appears to be unduly affected by anticipated increases in activities because of the Project under future conditions. Consequently, transit trips are expected to affect the transit system only minimally under future conditions.

3.1.2.8 Proposed Mitigation

The proposed transportation mitigation plan includes several elements that will be codified in the forthcoming Amended TAPA with the BTD. Mitigation measures currently being considered include the following:

- Constructing new sidewalk along Blackfan Circle abutting the Project site to improve pedestrian circulation;
- Reconstructing the private way on the southern portion of the Project site and portions of Avenue Louis Pasteur abutting the Project site to create a friendlier pedestrian environment including better pedestrian access, visibility and way-funding around the site;
- Providing street trees and other landscape amenities along Avenue Louis Pasteur and Blackfan Circle consistent with the existing campus landscaping theme;
- Providing dedicated, off-street loading docks at the site;
- Providing secure bicycle storage racks at the Project site for BWH employees and visitors that conform to the BTD's Bicycle Guidelines;
- Preparing a detailed Construction Management Plan ("CMP") for the proposed construction; and
- Continuing participation in and funding support for system-wide transportation improvement studies for the LMA.

3.2 Existing Conditions

Existing transportation conditions in the study area, including roadway geometry, traffic controls, peak hour traffic and pedestrian flows, transit availability, parking supply, loading and service activities are all described within this section.

Initial sections specifically describe existing access characteristics of the BWH Campus, including the current use of the Project site. Subsequent sections describe and quantify transportation characteristics of the entire study area as required by the BRA and the BTD for the Draft PIR.

3.2.1 Summary of Existing BWH Transportation Infrastructure and Services

3.2.1.1 BWH Parking System

BWH currently controls approximately 5,873 total off-street parking spaces, with 1,525 parking spaces available for use by its patients and visitors, and 4,348 parking spaces available for staff. Approximately 44 percent of the employee parking supply (2,579 spaces) is located outside of the LMA in remote parking facilities. Most of the off-site parking is utilized by employees who either walk or use shuttle buses to travel between the Campus and these remote parking facilities. A summary of the existing parking supply is shown in Table 3-2.

Table 3-2 BWH Existing Parking Space Inventory (January 2012)

Parking Facility	Owned/ Leased	Number of BWH Spaces			Connecting Mode
On-Campus/LMA		Total	Patient/Visitor	Employee	
Mission Park Garage	Leased	1,315	160	1,155	Walk
Servicenter Complex	Owned	650	650	0	Walk
ASB-II Garage (45 Francis)	Owned	247	246	1	Valet
221 Longwood	Owned	15	15	0	Walk/Valet
Harvard Garage	Leased	3	0	3	Walk
15 Francis Street	Owned	57	47	10	Walk/Valet
One Brigham Circle	Leased	248	0	248	Walk
Harvard NRB Garage	Leased	311	0	311	Walk
Mass College of Pharmacy	Leased	40	0	40	Walk
Smith Building (Dana-Farber)	Leased	33	0	33	Walk
Children's Hospital Garage	Leased	20	0	20	Walk
Alumnae Hall (Emmanuel)	Leased	355	0	355	Walk
Total On-Campus/LMA		3,294	1,118	2,176	
Off-Campus outside of LMA					
20 Kent Street Lot*	Leased	24	0	24	Walk
850 Boylston Street*	Leased	681	407	274	Shuttle
Wentworth Lot	Leased	277	0	277	Shuttle
Lansdowne Garage	Leased	200	0	200	Shuttle
Red Sox Garage	Leased	107	0	107	Shuttle
116 Huntington Avenue	Leased	5	0	5	Walk
Colonnade Garage	Leased	15	0	15	Walk
Chestnut Hill Lot	Leased	146	0	146	Shuttle
Ipswich Garage	Leased	62	0	62	Shuttle
Atrium Mall	Leased	200	0	200	Shuttle
One Brookline Place	Leased	12	0	12	Shuttle
1249 Boylston Street Lot	Leased	40	0	40	Shuttle

Table 3-2 BWH Existing Parking Space Inventory (January 2012) (Continued)

Parking Facility	Owned/ Leased	Number of BWH Spaces			Connecting Mode
Off-Campus/LMA		Total	Patient/Visitor	Employee	
St. Lawrence Church	Leased	40	0	40	Walk
Crosstown Garage	Leased	616	0	616	Shuttle/Walk
65 Lansdowne Garage	Leased	122	0	122	Shuttle
Kenmore	Leased	32	0	32	Shuttle
Total Off-Campus		2,579	407	2,172	
Total BWH Parking Spaces		5,873	1,525	4,348	

**Spaces provided do not support space in the LMA.*

In addition to the parking spaces above, BWH has 400 (249 net-new) spaces permitted at the future Brigham Green Enhancement and Parking project site and 406 (300 net-new) spaces permitted at the MMHC site. BWH expects to begin construction of the new Brigham Green parking facility in the spring of 2012. Below grade parking on the approved MMHC site is not anticipated for several years, as discussed in greater detail within BWH's 2010 IMP.

The Project site currently provides 355 parking spaces in a combination of 328 structured spaces and 27 surface spaces.

3.2.1.2 BWH Employee Transportation Demand Management Program

BWH actively supports efforts to reduce auto use for employees traveling to the Hospital campus. Many actions to support this goal are actively employed by BWH, including the following:

- Employee Transportation Advisor – Provides alternative transportation information for employees. BWH promotes alternative transportation through a variety of newsletters, information kiosks, websites, e-mail, and special events. Bicycle racks are provided throughout the Campus.
- 50 percent transit pass subsidy for employees - Provides a 50 percent subsidy in the cost of MBTA transit passes for employees. The cost of passes is deducted on a pre-tax basis, resulting in an additional cost savings to employees.
- Location-priced parking - Discouraging on-campus parking by offering market rate parking for employees on-campus while offering parking at a significantly lower rate in off-campus parking locations. Vanpool members are offered a 50 percent parking discount.

- Member of the CommuteWorks Transportation Management Association, which is operated by MASCO. CommuteWorks offers an array of ongoing programs (discussed further below) designed to encourage employees to choose alternative options for commuting.
- Emergency Ride Home - With CommuteWorks' Emergency Ride Home program, registered BWH employees can receive a guaranteed ride home in the event of a personal emergency during the work day. Up to five times a year, CommuteWorks will pay for a taxi cab or rental car to get employees home quickly. All employees who participate in their employers' transit subsidy program are eligible for the Emergency Ride Home Program. Employees who carpool, vanpool, or walk/bike to work through the CommuteFit Program (see below) are also eligible to register for Emergency Ride Home.
- The Longwood T Party Program - Under this CommuteWorks program, BWH employees who currently drive to work alone can try using public transit risk free, and have CommuteWorks help pay for it. The Longwood T Party Program allows drive-alone commuters to put their parking spaces on hold for three months to try public transportation and receive up to $333 in incentives. Eligible employees receive $65 per month in commuter checks to use towards the purchase of transit passes and reimbursement for up to $46 per month for parking costs at transit stations. While employees' parking spaces are on hold, they do not pay for or lose the space and can opt out of the program at any time if they decide to go back to parking. This program is also available for commuters who recently moved to a new home location resulting in an increased cost of their monthly MBTA pass.
- CommuteFit Program - Employees who incorporate biking, walking, or jogging into their daily commute are eligible to participate in the CommuteFit Program. By signing up for the CommuteFit program, employees can keep track of the miles commuted by foot and earn points for free prizes. Rewards include water bottles, coffee mugs, lunch totes, pedometers, first aid kits, and many others. All participants who log 500 miles in the CommuteFit program will receive a $30 gift certificate to REI.
- Ridesharing: Carpools and Vanpools - CommuteWorks partners with MassRides, the Massachusetts statewide travel options program, to help match BWH employees into carpools and vanpools from their home town. By completing CommuteWorks' online Ridematching Registration Form, CommuteWorks will work with the State using their 13,000+ member database to help find BWH employees potential carpool partners who share their commutes and working hour and/or vanpool options from their home areas. MassRides currently manages a fleet of aver 40 vanpools including two (Rockland and Sagamore/Kingston) that come directly into the LMA. BWH offers a 50 percent discount for vanpool members.

- MASCO Shuttle Services - MASCO operates several shuttles to and from the LMA providing connecting service to commuter rail, rapid transit and off-site parking facilities. With the exception of the M2 Shuttle, these shuttles are free of charge to BWH employees.
- Zipcar Discounts - BWH employees are eligible to join CommuteWorks' Zipcar program at a reduced membership fee of only $25 per year and no application fee. Ordinarily, people joining Zipcar pay $75 in initial set up fees and $50 per year in membership fees. Through the MASCO discount, Zipcar members also receive reduced hourly rates when using Zipcars during regular business hours.
- Personalized Commuting Assistance - CommuteWorks answers any general commuting questions employees have and provides them with various travel options to help maximize the efficiency of their commute. CommuteWorks' personalized itineraries identify employees complete travel options with information on commuter rail, subway, bus, shuttles, ridesharing, biking and walking.
- MBTA Service Feedback Options - MASCO continually advocates for improved MBTA services to the LMA, and rider feedback regarding MBTA experiences helps us work with the MBTA for such improvements. BWH employees who use MBTA services such as bus, boat, subway, or commuter rail and want to offer feedback on their experiences or share ideas for new or improved MBTA services can do so by completing the online MBTA Service Feedback Form. This information is relayed by MASCO at regularly scheduled meetings with MBTA staff to discuss LMA service improvement needs.
- Discounted regional bus services – BWH provides a 50 percent discount to employees who commute by non-MBTA bus services. This program includes private bus services to Cape Cod and New Hampshire.
- Secure bicycle storage – BWH offers bicycle storage throughout the Campus (discussed later in more detail).
- In 2012, BWH committed to paying for any employee who chooses to participate in the Boston Bikeshare Program, which would give those employees access to the network of bikes in the New Balance Hubway system of bicycles that are stationed around the City.
- Telecommuting and compressed workweeks – BWH has an informal policy of encouraging telecommuting and compressed workweeks for employees where reasonably feasible.

3.2.1.3 BWH/Partners Shuttle Bus System

The Partners Passenger Transportation Service is a free shuttle bus service for employees, patients and visitors to BWH. There are six distinct shuttle routes that serve the main BWH Campus. These routes connect BWH to surrounding Partners HealthCare facilities, local transit hubs, and parking garages.

- **MGH, Prudential Center, BWH**: Operating Mondays through Fridays, except holidays, this route stops at MGH, Prudential Center and BWH. The shuttles arrive at the Prudential Center approximately five minutes after leaving BWH and 10 minutes after leaving MGH. The shuttles run between 6:00 am and 8:30 pm with 15 minute headways during peak hours.
- **BWH to 850 Boylston Street**: Four shuttles run a continuous loop between 5:45 am and 8:30 pm. The loop picks up at BWH, Brookline Village T Stop, 850 Boylston Street, Atrium, and Chestnut Hill Parking Lot (mid-day only). During peak hours, the headway is 15 minutes.
- **BWH to 10 Brookline and 111 Cypress Street**: Monday thru Friday, this shuttle operates between 5:15 am and 7:40 pm. The shuttles travel from BWH to 10 Brookline Place, to 111 Cypress Street to the Brookline Village T Station.

  BWH to Faulkner Hospital: Two shuttles travel between BWH and Faulkner Hospital with five trips including stops at Trinity Lot and West Roxbury VA Medical Center. The stops are at BWH Francis Street Shelter, Main Entrance to Faulkner Hospital (Center Street-Side), Trinity Parking Lot and West Roxbury VA Medical Center's MBTA bust stop near the Main Entrance. The shuttles operate Monday through Friday, except holidays, between 6:00 am and 7:30 pm.
- **BWH/MIT Shuttle**: Operating Monday through Friday, except holidays, this shuttle travels between BWH and MIT. The shuttle stops at BWH at the corner of Binney and Francis Street, 65 Lansdowne Street main entrance, and 84 Massachusetts Avenue – Julie Adams Stratton Building. With a 30 minute headway, the shuttle operates between 7:00 am and 7:00 pm.
- **BWH to Wellesley Gateway (HPHC)**: The shuttle stops at BWH and at the Harvard Pilgrim Health Care facility located at 93 Worcester Street in Wellesley. The shuttle runs between the hours of 7:30 am and 6:30 pm with a one hour headway.
- **BWH to Crosstown**: The shuttle operates Monday through Friday, except on holidays, between the hours of 6:15 am and 6:15 pm. The stops include BWH, 221 Longwood Avenue, and 801 Massachusetts Avenue. The 221 Longwood stop is a "rolling stop" which occurs five minutes after departing BWH and seven minutes after departing 801 Massachusetts Avenue.

3.2.1.4 BWH Loading and Service Activities

The main BWH loading and service area is located in the Servicenter Loading Dock at 89 Fenwood Road, underneath the Servicenter Parking Garage and connected to the main BWH Campus by an underground tunnel beneath Francis Street. Additional loading and service areas are located at the West Plaza Loading Dock (20 Shattuck Street) and the Thorn Building (50 Shattuck Street). Small deliveries such as flowers occasionally arrive at the 75 Francis Street entrance. No changes are anticipated at the existing loading facilities servicing the Campus as a result of the proposed Project.

3.2.2 Transportation Study Area

The Project study area as required by the BRA/BTD includes the analysis of five intersections including the future Project site driveway proposed on Blackfan Circle. These intersections are described below and illustrated in Figure 3-2. The descriptions of the intersections include physical characteristics, geometric conditions, pedestrian facilities, and traffic control measures.

<u>1. Longwood Avenue/Avenue Louis Pasteur</u>

The intersection of Longwood Avenue and Avenue Louis Pasteur is a three-legged unsignalized intersection (also known as Oscar Tugo Circle) controlled by a stop sign on the Avenue Louis Pasteur southbound approach. The Longwood Avenue eastbound approach provides two general-purpose travel lanes and the westbound approach provides a single lane. The Avenue Louis Pasteur southbound approach provides an exclusive left-turn and right-turn lane. On-street parking is not permitted at any of the approaches; however, a considerable amount of MASCO bus parking, pick-up/drop-off and double parking were observed on the southbound approach during a weekday evening peak hour. There is an MBTA bus stop located on Avenue Louis Pasteur in the vicinity of the intersection, which services bus routes CT3, 8, 19 and 47. Sidewalks and crosswalks are provided at all three intersection approaches.

<u>2. Longwood Avenue/Blackfan Circle</u>

The intersection of Longwood Avenue and Blackfan Circle is a four-legged, signalized intersection that operates under a four-phase traffic signal control, including an exclusive pedestrian phase. The Longwood Avenue eastbound and westbound approaches provide two general-purpose travel lanes. The Blackfan Circle northbound approach has a single general-purpose lane, while the southbound approach provides a shared left-turn/through lane and an exclusive right-turn lane. Sidewalks and crosswalks are provided at all four intersection approaches. On-street parking is not permitted at any of the approaches; however, there is an MBTA bus stop located in front of 333 Longwood Avenue which services bus routes 8, 47, CT2, CT3, and 19.

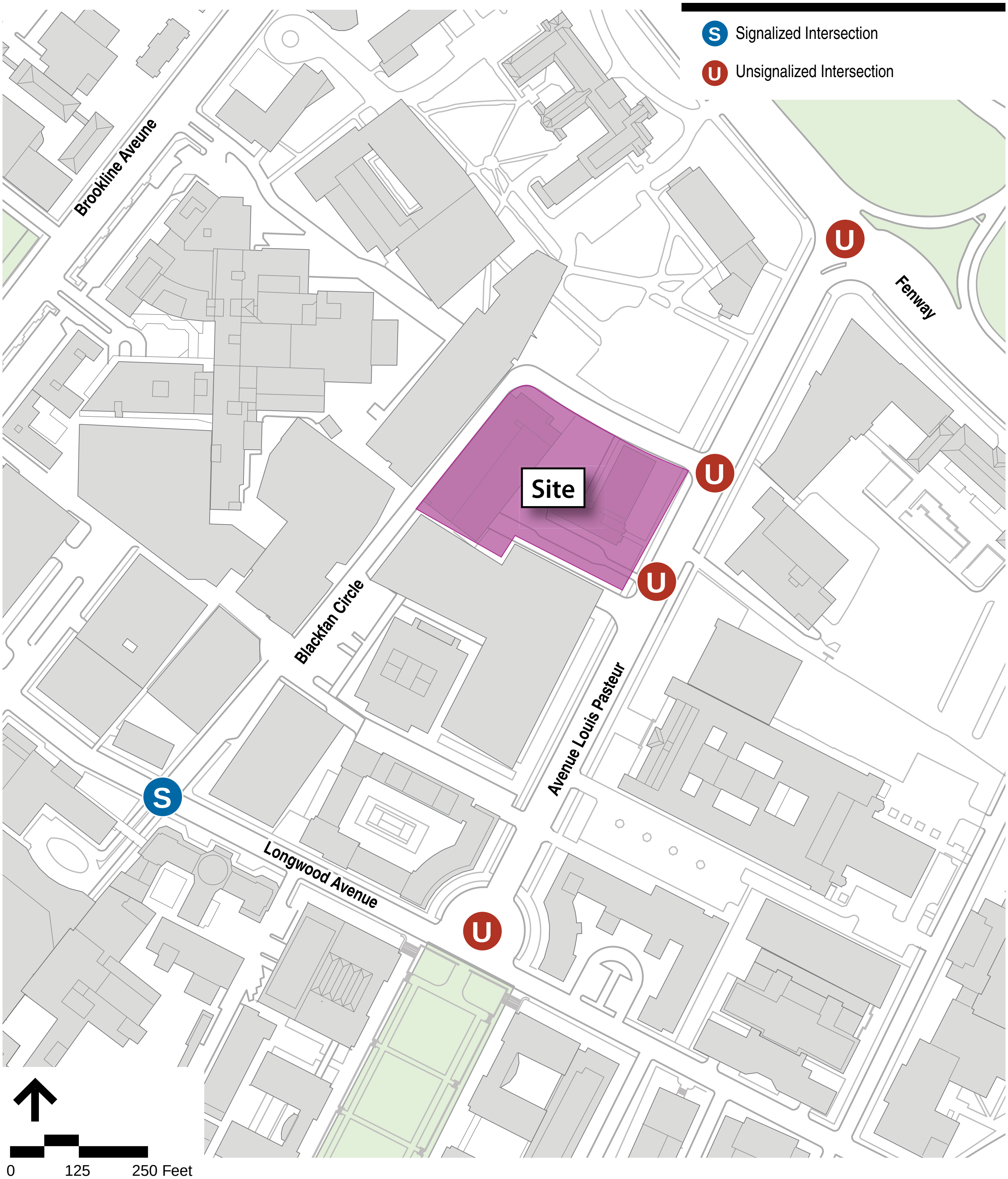


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Figure 3-2

Study Area Intersections

3. Avenue Louis Pasteur/Blackfan Circle

The intersection of Avenue Louis Pasteur and Blackfan Circle is a three-legged, unsignalized intersection, with stop control on the Blackfan Circle eastbound approach. The Avenue Louis Pasteur northbound and southbound approaches provide two general-purpose travel lanes. The Blackfan Circle eastbound approach has a single general-purpose lane. Sidewalks are provided at all intersection approaches. On-street parking is not permitted at any of the approaches; however, there is an MBTA bus stop located in the vicinity of the intersection, which services MBTA bus routes CT3, 8, 19 and 47 and several shuttle bus routes

4. Avenue Louis Pasteur/The Fenway

The intersection of Avenue Louis Pasteur and The Fenway is a four-legged, unsignalized intersection. Prior to the intersection, there is a channelized exclusive right-turn lane on The Fenway westbound. At the intersection, The Fenway westbound has a channelized, exclusive left-turn lane under stop control. The Fenway eastbound is one-way with an exclusive left-turn lane, exclusive through lane, and an exclusive right-turn lane. The Fenway also has a one lane jug handle departure which merges with the westbound Fenway exclusive right-turn before entering Park Drive. Avenue Louis Pasteur northbound has an exclusive right-turn lane.

A bus stop is located on the northbound approach of Avenue Louis Pasteur Street, just south of The Fenway which services MBTA bus routes CT3, 8, 19, and 47. On-street parking is not permitted in the vicinity of the intersection, except on a short segment of The Fenway, as illustrated later in this chapter in Figure 3-7. Crosswalks and sidewalks are provided at all approaches.

5. Site Driveway/Avenue Louis Pasteur

The intersection of Avenue Louis Pasteur and the existing site driveway is a three-legged unsignalized intersection. The site driveway is gated and the sole access/egress point for the existing facility including the parking garage on the site. The driveway provides one general purpose eastbound lane. Avenue Louis Pasteur has two travel lanes in each direction. On-street parking occurs during certain hours on Avenue Louis Pasteur (although signed as no parking). Sidewalks are provided on all intersection approaches, as well as a crosswalk on the south side of the intersection.

3.2.3 Study Area Intersection Conditions

Existing traffic counts from nearby projects, supplemented by field observation from January 24, 2012, were utilized for this analysis. Counts that were not conducted in 2012 were adjusted by a 0.5 percent growth rate to year 2012, to be conservative, despite the fact that historical traffic count data for the LMA does show a trend of declining volumes. Section 3.3.1.1 of this chapter describes in more detail the historical data trend.

In addition, counts were adjusted to account for all recently constructed projects in the Project study area, thereby further increasing volumes and making the analysis more conservative. All counts included passenger vehicles, heavy vehicles, pedestrian and bicycle volumes.

As substitute to an automatic traffic recorders (ATRs) count, a 12-hour turning movement count (TMP) was conducted at the intersection of Avenue Louis Pasteur and Blackfan Circle in March, 2009. The traffic data was adjusted to year 2012 by applying a growth rate of 0.5 percent per year. Volumes are included in Appendix C and are summarized below.

3.2.3.1 12-Hour Daily Traffic Count

Avenue Louis Pasteur at Blackfan Circle

A 12-hour turning movement count was conducted at Avenue Louis Pasteur and Blackfan Circle, near the Project site. At this location, Avenue Louis Pasteur carries approximately 5,731 vehicles on an average weekday from 6:00 am to 6:00 pm. Over the course of the day, 3,742 vehicles travel southbound and 1,989 travel northbound. That is a 65 percent to 35 percent directional split.

Historic data shows that daily volumes in this vicinity have dropped in the past several years. Hourly traffic volumes have also decreased. Hourly volumes for Avenue Louis Pasteur and Blackfan Circle are summarized in Table 3-3 below.

Table 3-3 Existing Adjusted* Hourly Traffic Volumes

Time	Avenue Louis Pasteur (entering volumes from north)	Avenue Louis Pasteur (entering volumes from south)	Blackfan Circle (entering volumes from west)
6:00 - 7:00 am	246	73	29
7:00 – 8:00 am	698	387	56
8:00 – 9:00 am	466	103	45
9:00 – 10:00 am	383	105	49
10:00 – 11:00 am	324	105	33
11:00 – 12:00 pm	200	132	51
12:00 – 1: 00 pm	198	132	63
1:00 – 2:00 pm	205	117	49
2:00 – 3:00 pm	257	201	76
3:00 – 4:00 pm	266	243	79
4:00 – 5:00 pm	255	197	89
5:00 – 6:00 pm	244	194	95

* 2010 hourly volumes grown by 0.5% per year to 2012

3.2.3.2 Peak Hour Volumes

The intersection turning movement counts were used to establish traffic networks for the 2012 Existing Condition for the morning and evening peak hours. The study area's overall morning peak hour was determined to occur between 7:00 am and 8:00 am, and the study area's overall evening peak hour was determined to occur between 4:45 pm and 5:45 pm. These peak hours are predominately governed by traffic volumes on Longwood Avenue and The Fenway when commuter volumes are the heaviest. Existing Condition (2012) weekday morning and evening peak hour traffic volumes are shown in Figure 3-3.

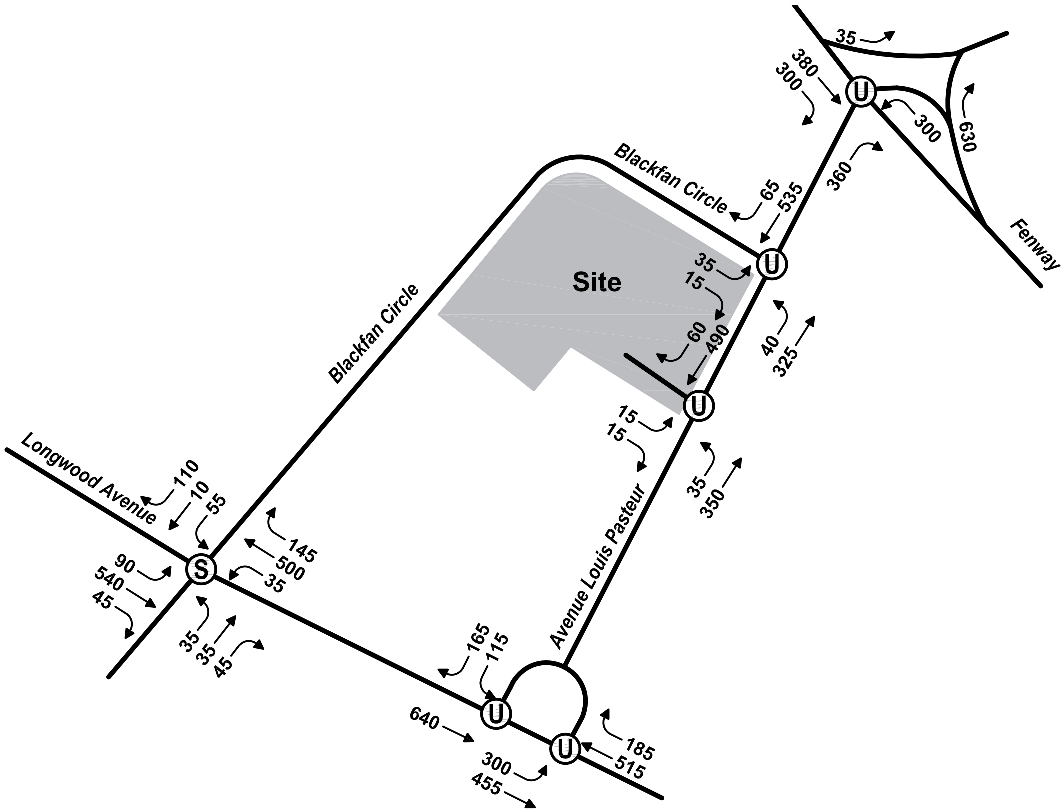
3.2.4 Crash Analysis

Accident data was investigated for the study area. Data was obtained from the Massachusetts Department of Transportation ("MassDOT") for the most recent three-year period available (2007 through 2009) for the intersections within the study area. Crash results are summarized in Table 3-4.

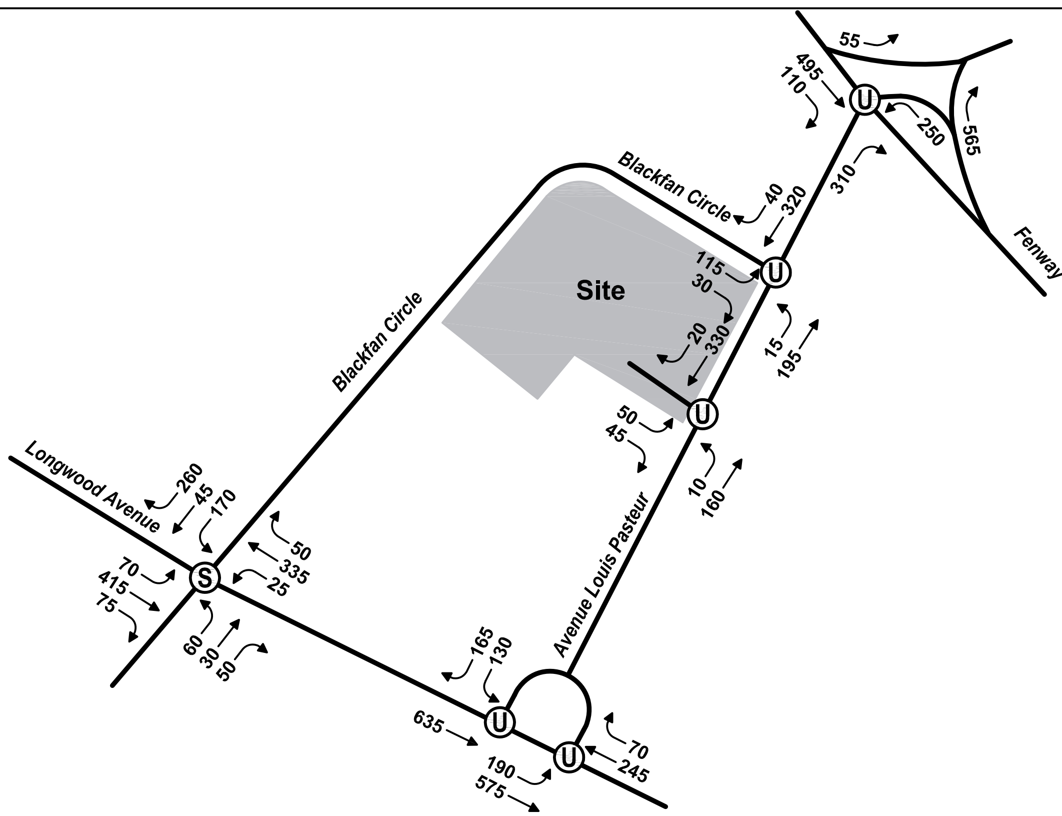
Of the reported accidents, most (50 percent) occurred during a weekday outside of the typical peak travel periods of 7:00-9:00 am and 4:00-6:00 pm. The majority of the reported incidents occurred during dry pavement conditions. The severity ranged from personal injury to property-damage. No fatalities were indicated by the data.

The City of Boston falls into the MassDOT Highway Division District 6 which includes the northeast region of the state. The 2009 average intersection crash rate for District 4 signalized intersections is 0.78 crashes per million entering vehicles ("MEV"). The average for unsignalized intersections in District 4 is 0.59 crashes per MEV. District 4 has a slightly lower average than the Statewide Average of 0.81 crashes per MEV for signalized intersections and 0.61 crashes per MEV for unsignalized intersections. Over the three year period, the study area intersections had crash rates lower than the district and statewide averages.

The study area intersections adjacent to the site had very few crashes reported. Over the three year period, the two intersections on Longwood Avenue next to the Project site (intersections with Blackfan Circle and Avenue Louis Pasteur) had a total of seven crashes, averaging less than one crash per year. The intersection of Blackfan Circle and Avenue Louis Pasteur had no reported crashes during the last three year period.



Morning



Evening

2012 BWH IMP Amendment Project Boston, MA

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Figure 3-3

2012 Existing Condition Peak Hour Traffic Volumes

Table 3-4 Vehicular Crash Summary (2007 - 2009)

	Longwood Ave at Avenue Louis Pasteur	Longwood Ave at Blackfan Circle	Avenue Louis Pasteur at The Fenway	Total
Year				
2007	1	1	0	2
2008	3	1	1	5
2009	0	1	0	1
Total	4	3	1	8
Average	1.33	1.00	0.33	2.67
Collision Type				
Angle	3	0	0	3
Head-on	0	0	0	0
Rear-end	1	1	1	3
Rear-to-Rear	0	0	0	0
Sideswipe, opposite direction	0	0	0	0
Sideswipe, same direction	0	0	0	0
Single vehicle crash	0	0	0	0
Unknown	0	1	0	1
Not reported	0	1	0	1
Total	4	3	1	8
Crash Severity				
Fatal injury	0	0	0	0
Non-fatal injury	1	2	1	4
Property damage only (none injured)	3	1	0	4
Not Reported	0	0	0	0
Unknown	0	0	0	0
Total	4	3	1	8
Time of Day				
Weekday, 7:00 am - 9:00 am	1	1	0	2
Weekday, 4:00 pm - 6:00 pm	1	0	0	1
Saturday, 11:00 am - 2:00 pm	0	0	0	0
Weekday, other time	2	1	1	4
Weekend, other time	0	1	0	1
Total	4	3	1	8
Pavement Conditions				
Dry	4	2	1	7
Wet	0	1	0	1
Snow	0	0	0	0
Ice	0	0	0	0
Sand, mud, dirt, oil, gravel	0	0	0	0
Water (standing, moving)	0	0	0	0
Slush	0	0	0	0

Table 3-4 Vehicular Crash Summary (2007 - 2009) (Continued)

	Longwood Ave at Avenue Louis Pasteur	Longwood Ave at Blackfan Circle	Avenue Louis Pasteur at The Fenway	Total
Pavement Conditions (continued)				
Other	0	0	0	0
Unknown	0	0	0	0
Not reported	0	0	0	0
Total	4	3	1	8
Non Motorist (Bike, Pedestrian)				
Total	1	0	0	1
MassDOT Crash Rates	0.2	0.17	0.04	

Source: MassDOT Crash Database

3.2.5 Pedestrians and Bicycles

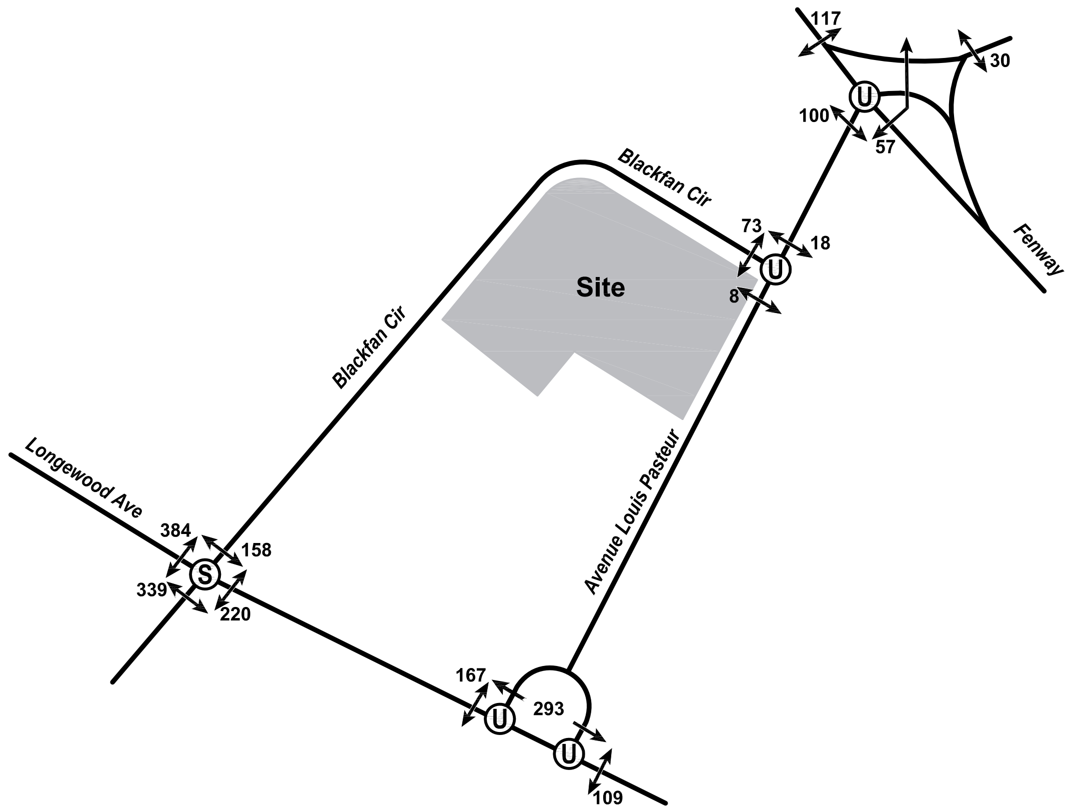
The following section discusses pedestrian and bicycle accommodations in the Project study area.

3.2.5.1 Existing Pedestrian Accommodations

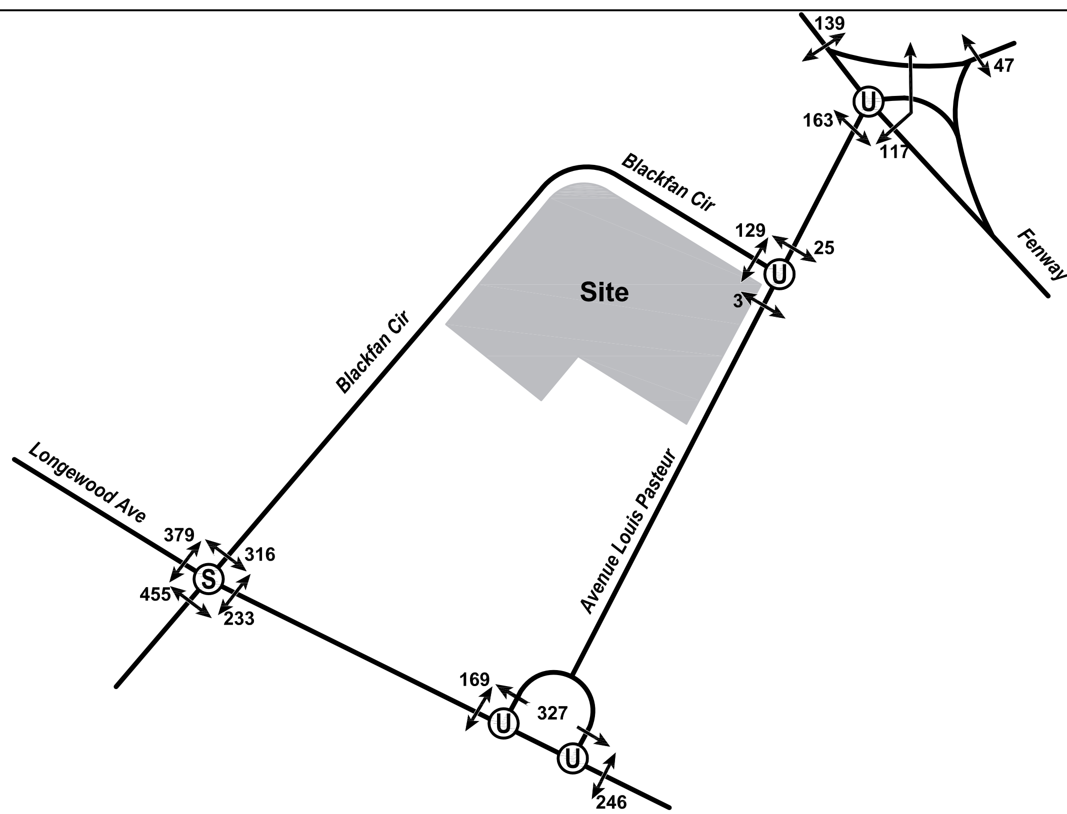
MASCO and its member institutions, including BWH, recognize the importance of providing safe and efficient pedestrian facilities, and continue to study and re-evaluate pedestrian needs in the area. The high level of pedestrian activity in the area has prompted changes in traffic signal design and operation in recent years to include exclusive pedestrian phasing, and area signalized intersections now are equipped with pedestrian push-buttons.

At the study area intersections, the crossing volumes are most concentrated on Longwood Avenue at Blackfan Circle during the morning peak hour with approximately 380 pedestrians per hour on the west side of Longwood Avenue. During the evening, peak hour volumes crossing Longwood Avenue on the western crosswalk are in a similar range of 380, however the Blackfan Circle south crosswalk pedestrian volumes are at approximately 450 pedestrians per hour.

Pedestrian volumes adjacent to the Project site on Avenue Louis Pasteur and Blackfan Circle are the lowest in the study area due to the limited activity at this location. Pedestrian activity crossing Blackfan Circle is about 70 pedestrians in the morning and 130 pedestrians in the evening peak hour. Avenue Louis Pasteur sees only about 30 pedestrian crossings during the morning and evening peak hours. Existing Condition (2012) weekday morning and evening peak hour pedestrian volumes are shown in Figure 3-4, and weekday morning and evening peak hour cyclist volumes are shown in Figure 3-5.



Morning

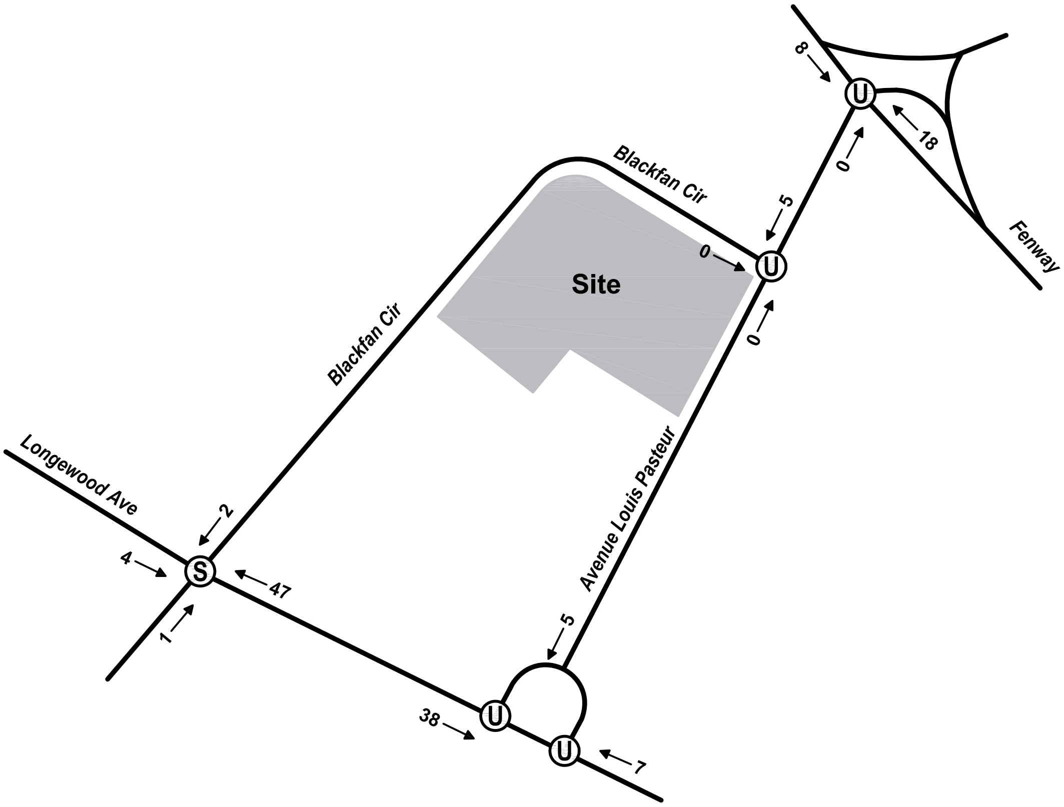


Evening

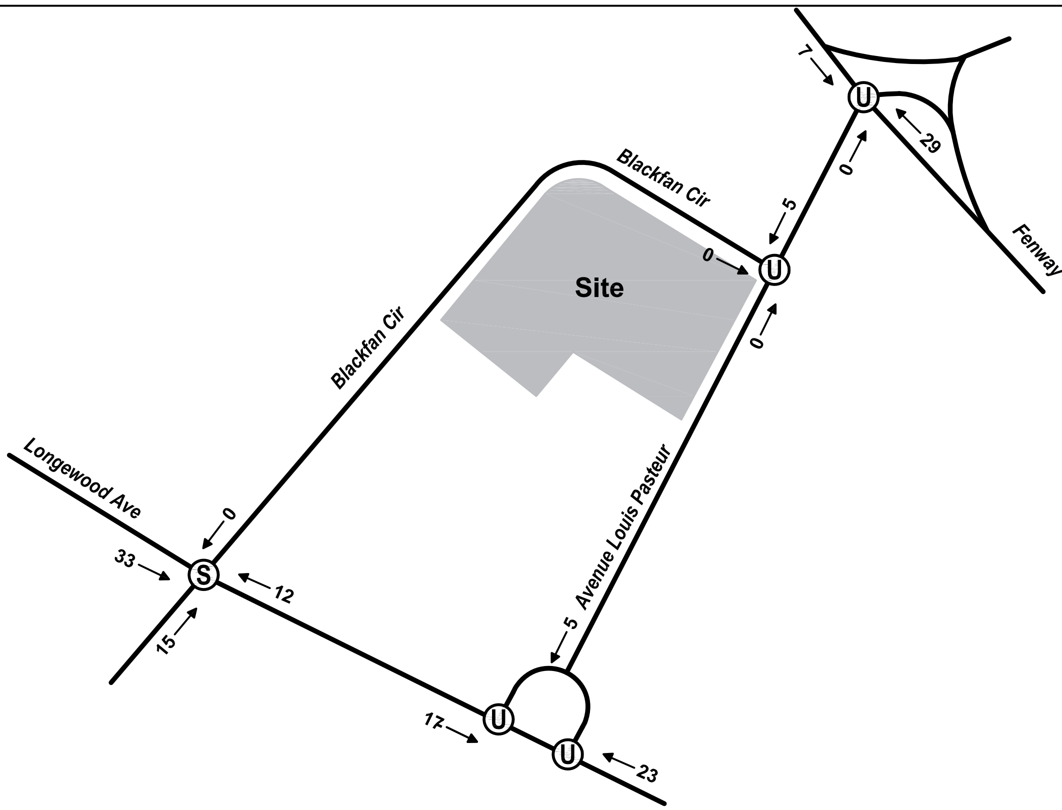
2012 BWH IMP Amendment Project Boston, MA

Figure 3-4

2012 Existing Condition Peak Hour Pedestrian Volumes



Morning



Evening

Figure 3-5

2012 Existing Condition Peak Hour Bicycle Volumes

3.2.5.2 Existing Bicycle Amenities

BWH encourages employees to commute by bicycle, and there are 26 bicycle storage racks located throughout the Campus. These racks are available to both employees and visitors.

Seasonal Hubway bicycle sharing stations are also available to patients, visitors and employees. There are several stations located throughout the LMA. The closest Hubway station to the Project site is located on Emmanuel College's campus adjacent to the Project site on The Fenway. A Hubway system map for the LMA area is presented as Figure 3-6.

3.2.6 Public Transportation and Shuttle Services

The Project site is well served by public transportation. The site is located between the Arborway (E Line) Branch and the Riverside Branch (D Line) of the MBTA Green Line. The Green Line connects to the North Station Commuter Rail Station. The Project is also close to the Orange Line which provides connections to Back Bay's Commuter Rail Station. MBTA services are described in more detail below, and a system map is presented in Figure 3-7.

- **Green Line D Branch** – The D (or Riverside) Branch of the Green Line light rail subway line runs on five-minute headways during peak hours. The line runs above ground on a dedicated right-of-way from Riverside Station in Newton through multiple stations in Newton, Brookline, and Boston before turning north along the Riverway and joining the main below-grade Green Line east of Fenway Station. The main line continues through the Back Bay, Government Center, and North Station to its terminus at Lechmere Station. The D Line stops closest to the site are the Fenway and Longwood stops, located to the northwest and west of the Project site, respectively.

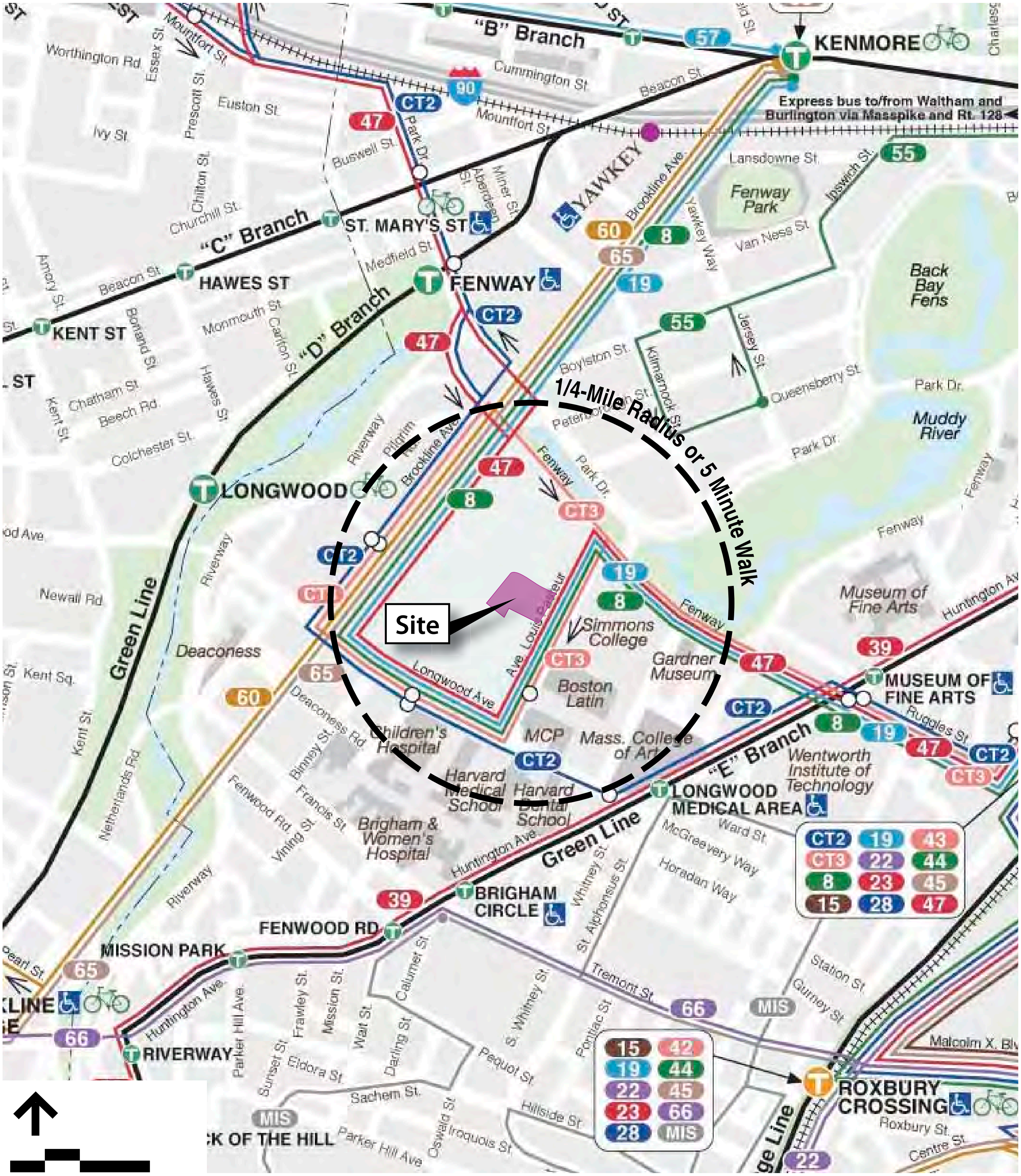
- **Green Line E Branch** – The E (or Heath Street) Branch of the Green Line light rail subway line runs on nine-minute headways during peak hours. The line originates at Heath Street Station and runs east at grade within the median of Huntington Avenue. Southwest of Massachusetts Avenue, the line descends below grade to serve Symphony and Prudential stations before joining the main Green Line (described previously in the D Branch section) at Copley. The site is served by the line's Longwood stop, which is about a quarter-mile (or five minute) walk from the site.

- **Orange Line** – The Orange Line heavy rail subway line runs on five-minute headways during peak hours, using six-car trains. From north to south, the line runs from Oak Grove Station in Malden through Medford, Charlestown, downtown Boston, the South End, and Roxbury, before reaching Forest Hills Station in Jamaica Plain. The Orange Line connects with the Green Line at North Station and

Source: Hubway.com

Figure 3-6

Hubway Bikeshare Stations



Source: MBTA.com (2009)

Figure 3-7

Public Transportation

Haymarket, with the Blue Line at State Street, and with the Red Line at Downtown Crossing. It connects with all northern commuter rail lines at North Station. Orange Line passengers traveling to the site would either walk approximately one mile from Roxbury Crossing Station or take the MASCO Ruggles Express shuttle service from Ruggles Station to the LMA.

The MBTA also operates several bus routes that provide service within one-half mile of the Project site:

- **Crosstown 2 (CT2)** bus route operates on 20-minute headways between Kendall Square Station on the Red Line and Ruggles Station on the Orange Line.

- **Crosstown 3 (CT3)** bus route operates on 20-minute headways between the LMA and Andrew Square Station on the Red Line in Dorchester.

- **Route 8** operates on 20-minute headways between Kenmore Square and Harbor Point in Dorchester, with high-frequency service between Kenmore Square and the Ruggles MBTA Orange Line/Commuter Rail Station during peak commuter periods.

- **Route 19** runs between Fields Corner Station on the Red Line and Kenmore Station on the Green Line. During peak hours, this route stops at Ruggles Station on the Orange Line. During the midday, this route only provides service between Fields Corner and Ruggles Station.

- **Route 39** provides service between the Forest Hills Station and Back Bay Station, both of which are on the MBTA Orange Line. It operates on four-minute headways during peak periods and seven-minute headways during off-peak periods.

- **Route 47** provides service between Central Square and Broadway Stations on the MBTA Red Line via Ruggles Station on the MBTA Orange Line. It runs on 25-minute headways during peak hours and 45-minute headways during off-peak hours.

- **Route 60** provides service between Chestnut Hill in Newton and Kenmore Square via Brookline Village Station on the MBTA Green Line – D Branch. The route operates on 18-minute headways during peak periods and on 30-minute headways during off-peak periods.

- **Route 65** provides service between Harvard Square in Cambridge and Dudley Square, and operates on 10-minute headways during peak periods and 15-minute headways during off-peak periods.

In addition to MBTA bus routes, MASCO operates several shuttle routes that provide service within one-half mile of the Project site:

- **Fenway Shuttle** connects the LMA to the Kenmore lot. The route connects to the Landmark Center and Harvard Vanguard along Brookline Avenue. The shuttle operates on approximately 10-minute headways in the morning peak hours and eight-minute headways during the afternoon/early evening hours.

- **Wentworth Shuttle** provides access from the LMA to the Wentworth parking lot in the morning and to and from the Ruggles MBTA Station during the evening. The shuttle operates on approximately 6- to 12-minute headways in the morning peak hours and 10-minute headways during the afternoon/early evening hours.

- **Crosstown Shuttle** connects the Crosstown Parking facility to the LMA. The morning peak period shuttle runs on 7- to 12-minute headways, while the evening peak period operates on 10- to 12-minute headways.

- **M6 Chestnut Hill** connects Hammond Pond Park to the LMA while operating on 10- to 15-minute headways during both the morning and evening peak hours.

- **M2 Cambridge-Harvard Shuttle** connects Harvard and MIT in Cambridge to the LMA. The shuttle operates from 6:40 am to 11:30 pm on 10- to 15-minute headways during peak times.

- **Ruggles Express Shuttle** connects the LMA to the Ruggles MBTA Station which provides access to the Orange Line, as well as multiple bus and commuter rail lines. The shuttle runs on 5- to 10-minute headways during the morning peak and 6- to 10-minute headways during the evening peak.

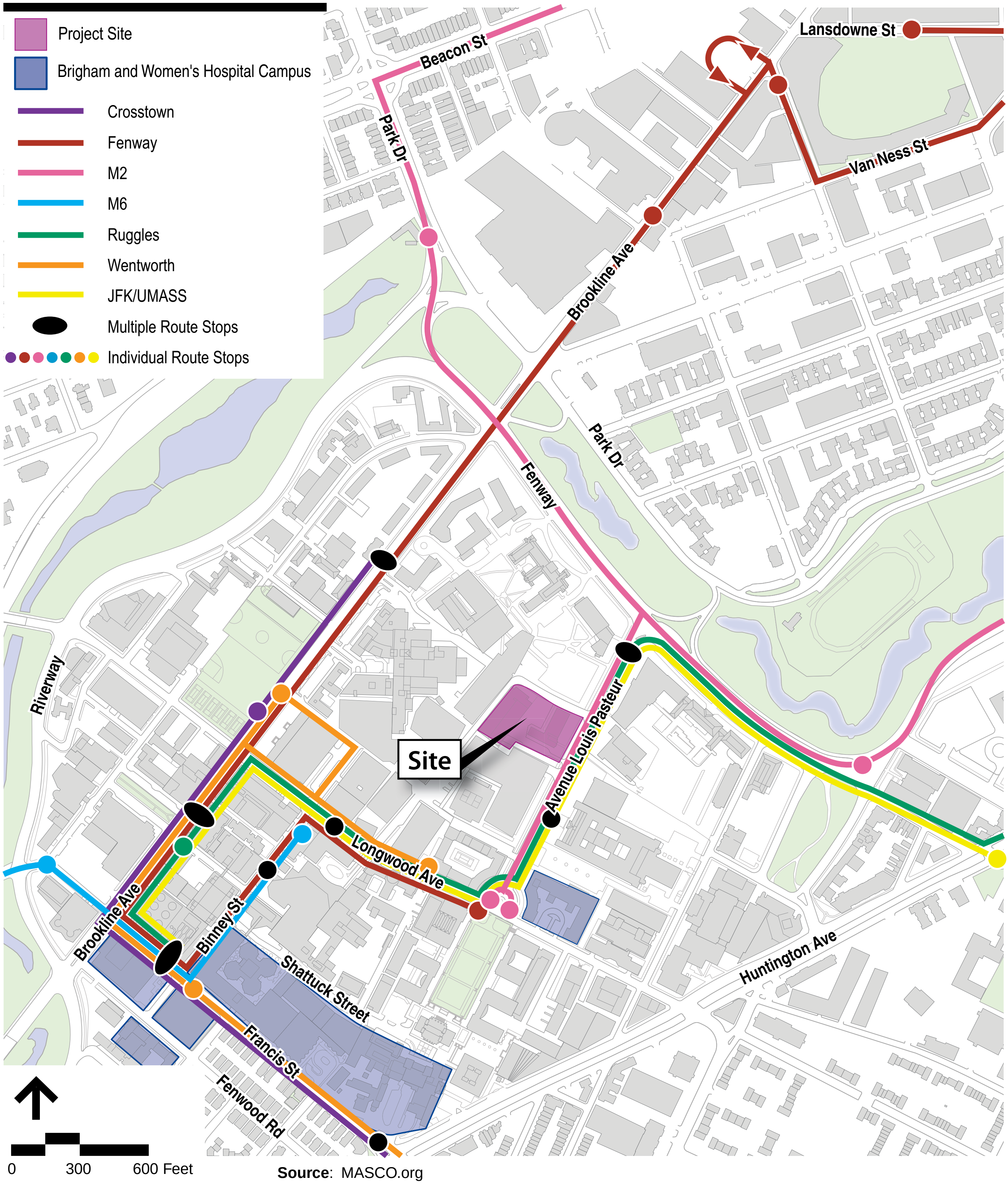
- **JFK/UMass Shuttle** provides access to and from the JFK/UMass MBTA Red Line station in South Boston and the LMA. The shuttle operates on 10-minute headways during the morning and 15- to 20- minute headways during the afternoon.

- **Landmark Shuttle** provides service between the Landmark Center and the Harvard School of Public Health. The service runs on 25-minute headways from 8:00 am to 6:30 pm.

BWH employees, patients and visitors are also eligible to ride the free shuttles offered by Partners Passenger Transportation Service. Shuttle routes for the morning and evening hours are presented as Figures 3-8 and 3-9.

3.2.7 Area-wide Parking

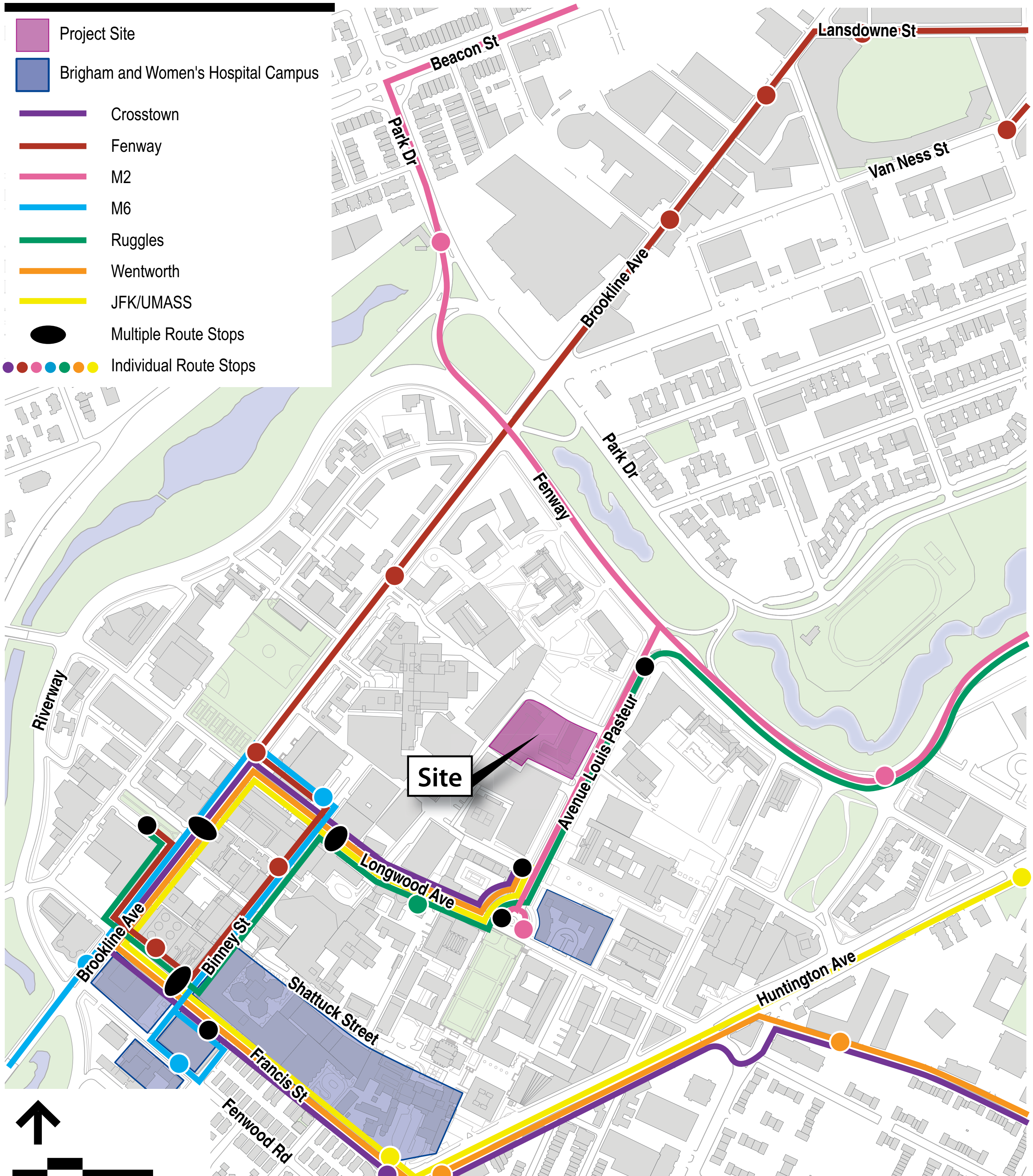
This section identifies the parking supply for the study area, including off-street and on-street parking. Several off-street public parking facilities and a relatively small number of on-street parking spaces are located in close proximity of the Project site.



Source: MASCO.org

Figure 3-8

MASCO Shuttle - Morning Routes



Source: MASCO.org

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Figure 3-9

MASCO Shuttle - Afternoon Routes

On-street parking located in the area around the Project site is illustrated in Figure 3-10. Although no counts were taken, informal observations of on-street parking revealed that non-resident spaces were generally fully utilized during the day.

As shown in Figure 3-11, there are several publicly available off-street parking areas in close proximity to the Project site. At midday, there is relatively little available parking in any of these facilities. The apparent supply is further reduced by the number of spaces reserved for specific institutions or specific users within those institutions. Most of the Hospital-controlled spaces are primarily for each institution's patients and visitors. Many LMA institutions maintain long waiting lists of employees seeking reserved off-street parking.

3.3 Evaluation of Long-Term Transportation Impacts

This section describes the future transportation infrastructure in the LMA including the impacts of the proposed Project. This section includes a detailed summary of the development of 2022 future traffic conditions with and without the Project. The development and evaluation of the 2022 No Build and Build Conditions has been conducted to help identify additional improvements that may be appropriate to mitigate identified transportation impacts generated by the Project.

3.3.1 2022 No Build Condition

The 2022 No Build Condition was developed and analyzed to evaluate future transportation conditions in the study area, such as background traffic growth and site-specific traffic growth, without taking into consideration the Project construction.

A two-step process has been utilized to estimate the increases in traffic activity in the Project study area under the No Build Condition as discussed below.

3.3.1.1 Step 1 - Background Growth

An annual growth rate of 0.5 percent per year was applied to the 2012 Existing Condition traffic volumes to increase background traffic to the 2022 forecast year. The 0.5 percent is consistent with the rate used for several other recently approved LMA development projects.

Traffic counts in the area show that traffic volumes in the LMA have actually been generally stable or decreasing during the peak hours in recent years. A summary of historic traffic volumes in the area are shown in Table 3-5. However, to be conservative, a general background growth rate 0.5 percent per year was applied to the baseline traffic volumes.

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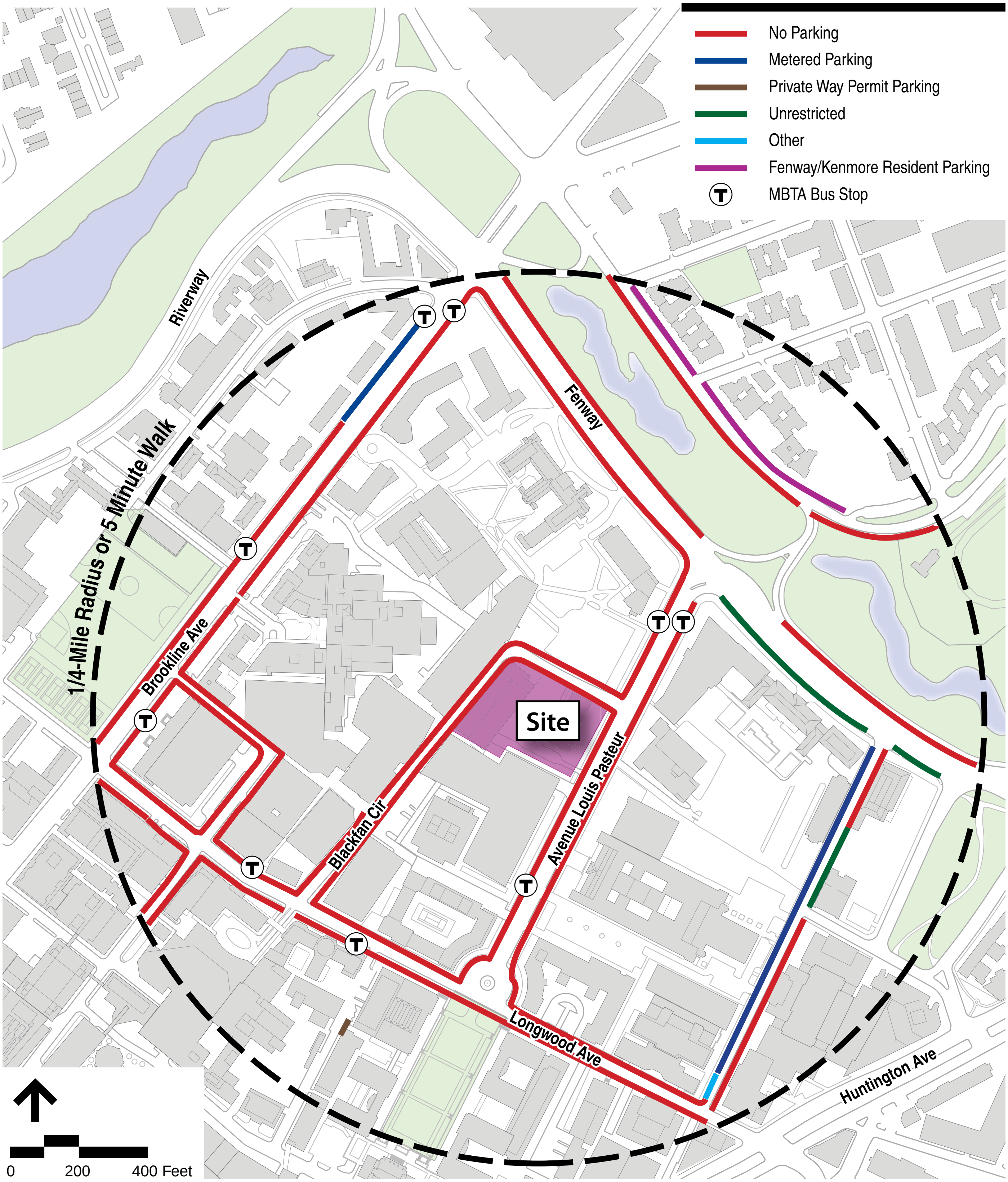

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Figure 3-10

Summary of Nearby On-Street Parking Regulations

1. Longwood Research Institute Garage / 340 Brookline Avenue Garage
2. Emmanuel College Deck
3. HMS / New Research Building
4. Boston Latin School Lots
5. BIDMC / Carl J. Shapiro Clinical Center Garage
6. 333 Longwood Avenue Garage
7. BWH 221 Longwood Lot
8. MCPHS Fennell Garage
9. Longwood Galleria Garage
10. HMS / Quad Garage
11. Children's Hospital Boston-Patient & Family Garage
12. MERCK
13. Simmons College-School of Management Parking
14. Emmanuel Campus Parking-Parcel A
15. Emmanuel Campus Parking-Jean Yawkey Center
16. BIDMC East Campus
17. Center for Life Sciences Boston Garage
18. Karp Research Facility Garage
19. DFCI / Dana Building Garage

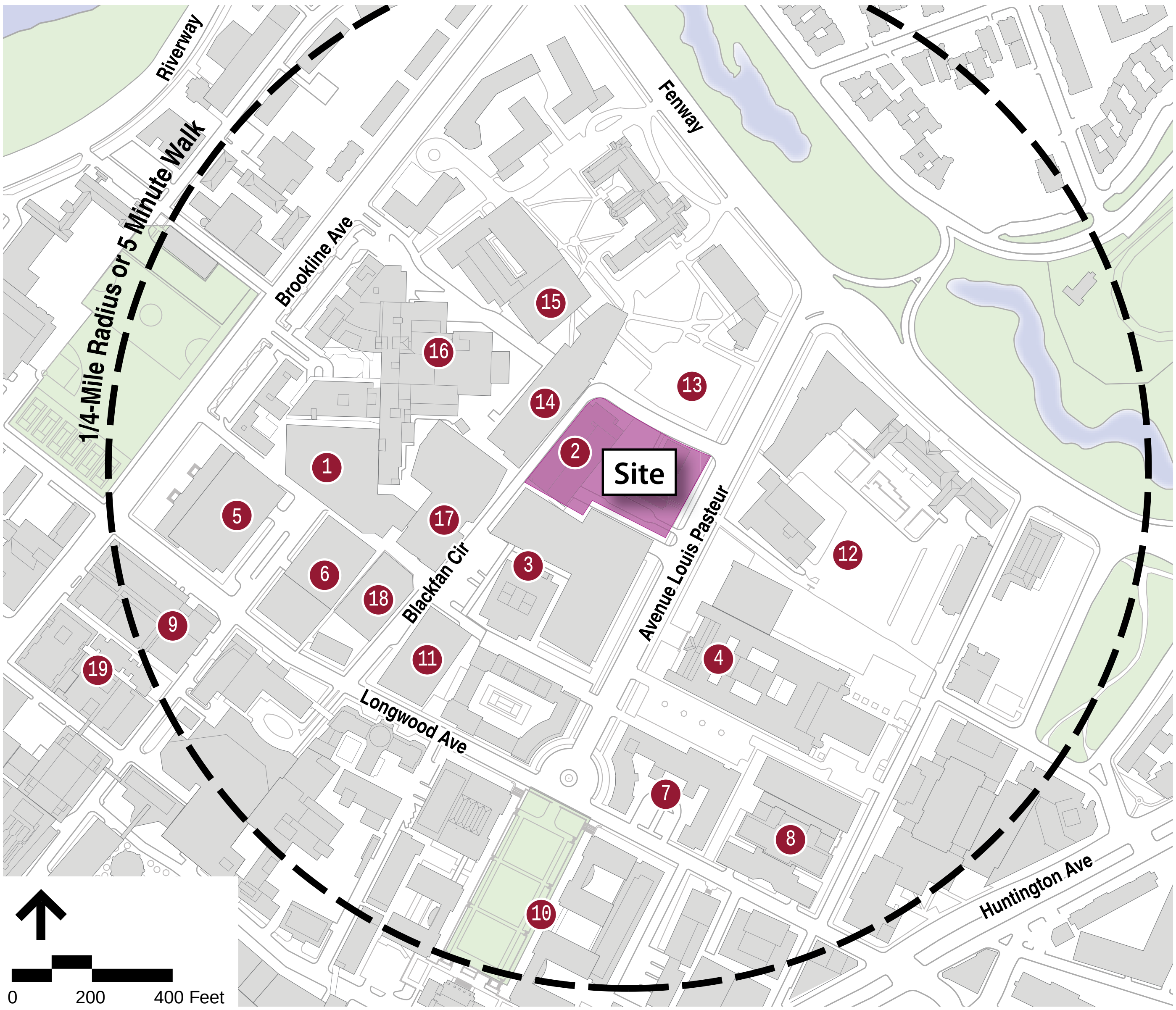


Figure 3-11

Summary of Nearby Off-Street Parking Facilities

Table 3-5 Peak Hour Intersection Volume Comparison (Entering Vehicles)

Intersection	AM Peak 2002	AM Peak 2006/2007	AM Peak 2011	PM Peak 2002	PM Peak 2006/2007	PM Peak 2011
Brookline Ave/Francis St	2,550	2,310	2,153	2,820	2,273	2,075
Francis Street/Vining St	805	892	827	980	836	793
Brigham Circle	2,280	1,785	2,044	2,800	2,278	2,268

3.3.1.2 Step 2 - Site-Specific Growth

The following projects have been included in the 2022 No Build Condition due to anticipated site-specific background traffic growth:

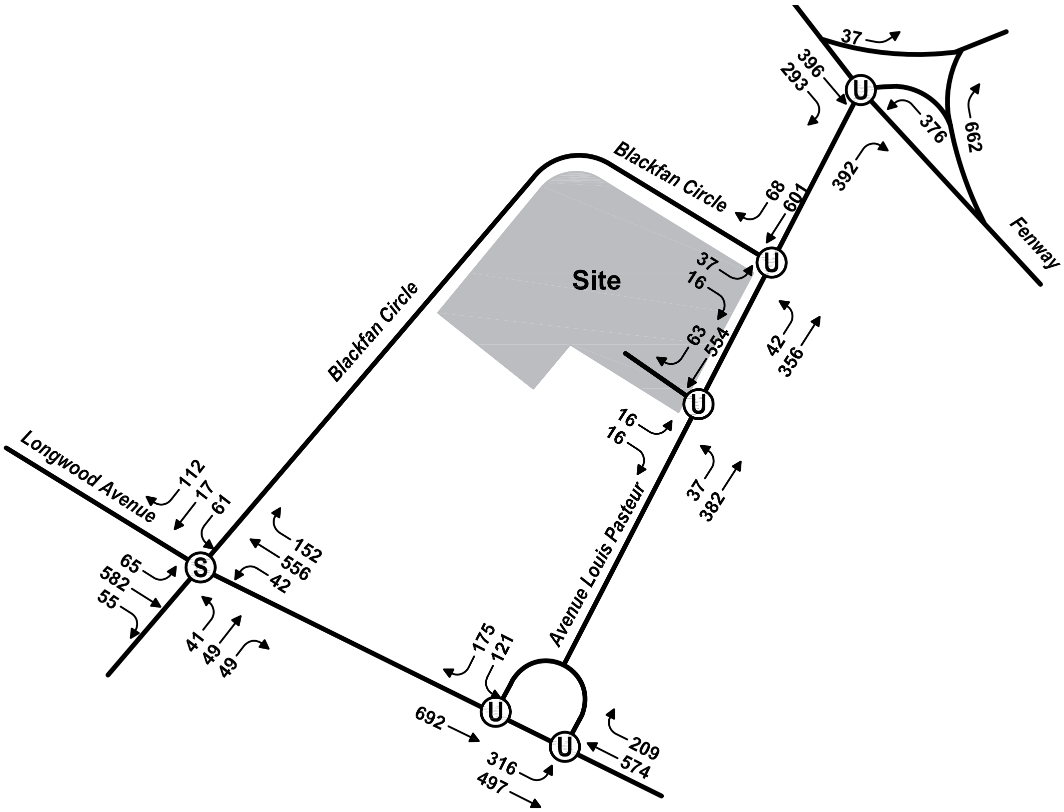
- Children's Hospital Boston Main Building Expansion
- Longwood Center (previously the Joslin Diabetes Center Expansion)
- The Winsor School Campus Projects
- BWH/Massachusetts Mental Health Center Project
- CHB/Longwood Research Institute (formerly Longwood North Research Center)
- BWH/Brigham Green Parking and Enhancement Project

Figure 3-12 illustrates the morning and evening peak hour traffic volume networks for the 2022 No Build Condition.

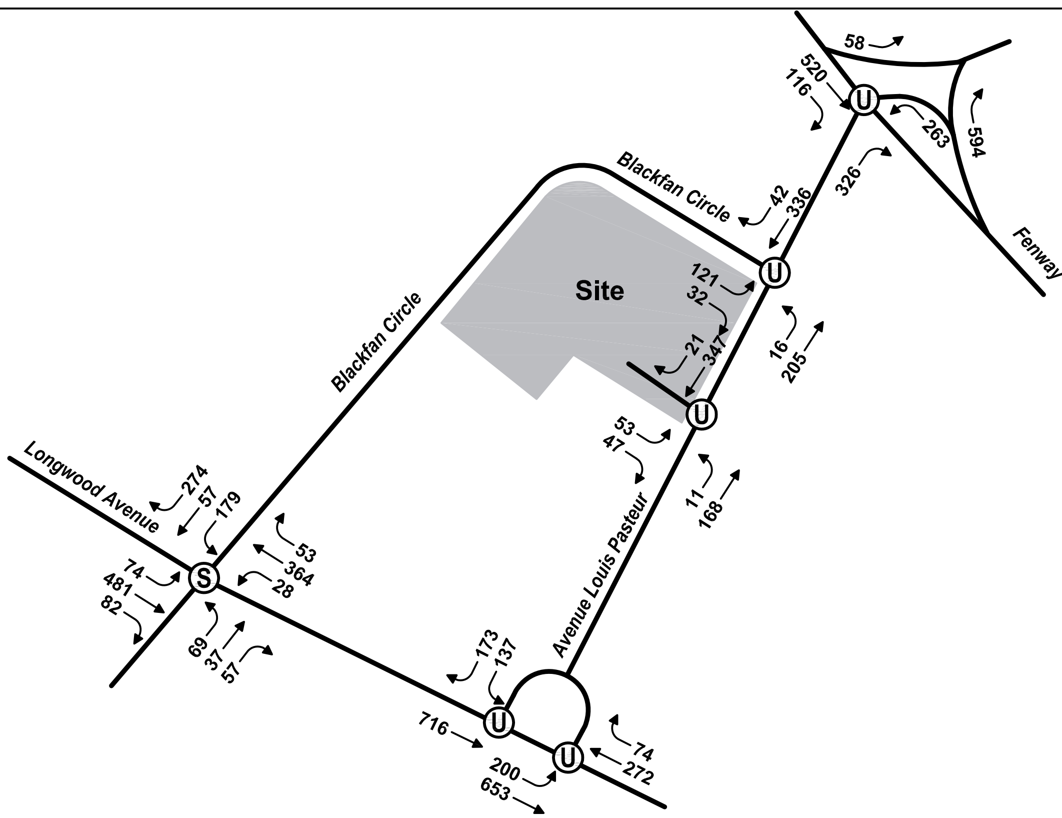
3.3.2 2022 Build Condition

The 2022 Build Condition will include the construction of an approximately 360,000 sf building dedicated to hospital uses, including laboratory, research and support spaces. The building will provide 355 below-grade replacement parking spaces that will be accessed via the private driveway proposed on Blackfan Circle. BWH currently occupies the Project site including a 50,000 sf Alumnae Hall, 328 space parking garage, and 27 surface parking spaces, pursuant to its lease with Emmanuel College.

The 2022 Build program is summarized in Table 3-6 below.



Morning



Evening

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Figure 3-12

2022 No-Build Condition Peak Hour Traffic Volumes

Table 3-6 Project Building Program Summary

	Size (sf)	Parking
BWH Research Building	360,000	355
Demolition of Alumnae Hall and Parking Deck	(-50,000)	(-355)
Net New Total	310,000	0

3.3.2.1 Trip Generation

This section provides a summary of the trip generation estimates for the Project.

3.3.2.1.1 Unadjusted Vehicle Trip Generation

Consistent with BTD guidelines, trips were estimated using the Institute of Transportation Engineers ("ITE") Trip Generation Manual. The ITE manual yields 'unadjusted' vehicle trips meaning that these trips do not reflect alternative modes of transportation such as walking and public transportation. The most appropriate ITE land code was used:

- **LUC 760 (Research and Development Center)** – was used to estimate the BWH research and development space planned at the Project.

Table 3-7 summarizes net new unadjusted ITE trips once existing trips are accounted for.

Table 3-7 Net-New Unadjusted Trip Generation*

Land Use	Land Use Code	Size	ITE Unadjusted Vehicle Trip Generation						
			AM Peak Hour			PM Peak Hour			Daily
			Enter	Exit	Total	Enter	Exit	Total	Total
Research and Development	R&D	360,000 sf	401	87	488	68	360	428	3,220
Less Alumnae Hall Demolition	R&D	50,000 sf	(-51)	(-11)	(-62)	(-8)	(-46)	(-54)	(-406)
Less Existing Parking Deck	N/A	355 Spaces**	(-95)	(-32)	(-127)	(-32)	(-95)	(-127)	(-952)
Net-New Trips			255	44	299	28	219	247	1,862

**Trips are not adjusted for local mode share.*

***Does not include any parking trips directly associated with Alumnae Hall activities.*

3.3.2.1.2 Adjusted Vehicle Trip Generation

To account for alternative modes of transportation, mode splits were applied to the trip results presented in Table 3-8. The auto mode split includes all vehicle based trips including taxis. Mode splits for the area are based on BTD Guidelines and are shown in Table 3-8 below.

Table 3-8 Peak Hour Mode Splits

Mode	Work Trips
Automobile	47 %
Public Transit	33 %
Walk/Bike/Other	20 %

Source: BTD Guidelines, Zone 5

As shown in Table 3-8, according to BTD mode split guidelines, only 47 percent of work trips to the site will be by personal automobile. The remaining trips will be walk, bike, or transit trips.

Table 3-9 provides a summary of vehicle trips adjusted for the local mode share for the Project.

Table 3-9 Build Condition Project Trip Generation (Adjusted)

Time Period/Direction	Walk/Bike/Other	Transit	R&D Vehicle Trips	Less Existing Trips*	Net-New Vehicle Trips
Daily Total	**385**	**1,752**	**1,138**	**(-1,110)**	**28**
AM Peak Hour					
Inbound	49	222	144	(-115)	29
Outbound	10	46	30	(-36)	(-6)
AM Total	**59**	**268**	**174**	**(-151)**	**23**
PM Peak Hour					
Inbound	8	35	23	(-35)	(-12)
Outbound	44	198	129	(-113)	16
PM Total	**52**	**233**	**152**	**(-148)**	**4**

*Includes demolition of 50,000 sf of office space and 355 parking spaces.

As shown in Table 3-9, the Project is expected to generate approximately 23 net-new vehicle trips (29 in, -6 out) during the weekday morning peak hour, and 4 new vehicle trips (-12 in, 16 out) during the weekday evening peak hour, once the proposed Project is completed and fully occupied. On a daily basis, the Project is expected to generate approximately 28 new vehicle trips. It should be noted that the difference in tripmaking as denoted in this study is based upon the calculation of new Project trips making use of ITE Trip Generation, and then subtracting from that estimate the amount of actual trips that are generated by the Project site under current conditions. As a practical matter, the site will continue to accommodate 355 off-street parking spaces that are used entirely by LMA employees with a similar turnover characteristic as how they are used currently (i.e., there should really be no measurable change in traffic conditions from what occurs under current conditions).

3.3.2.2 Trip Distribution

2022 Build Condition peak hour traffic volumes for the study area roadways were based on the vehicle-trip generation estimates summarized previously in Table 3-9. Having estimated the vehicle trips, the next step is to determine the trip distribution for the different users. The anticipated trip distribution patterns were based on BTD distributions to/from Area 5 (LMA/Mission Hill). Employees were distributed according to 'trips ending' in Area 5.

The majority of the employee trips by auto travel on Storrow Drive, Route 9, and Melnea Cass Boulevard to reach the site. Table 3-10 indicates the percentage of vehicle trips using each route. Figure 3-13 illustrates distribution assignment to roadway network near the Project site.

Table 3-10 Peak Hour Auto Trip Distribution

Origin/Destination	Patients/ Employees
North	19%
South	40%
East	34%
West	3%
Local	4%
Total	**100%**

Source: BTD Guidelines Area 5

3.3.2.3 Build Condition Peak Hour Traffic Volumes

The 2022 Build Condition weekday morning and evening peak hour traffic volumes were developed by adding the Project-generated trips and BWH redistributed trips to the 2022 No Build Condition traffic networks. Figure 3-14 presents Project-generated trips for the proposed Project for the morning and evening peak hours. Figure 3-15 presents the resulting 2022 Build Condition traffic volume networks for the morning and evening peak hours.

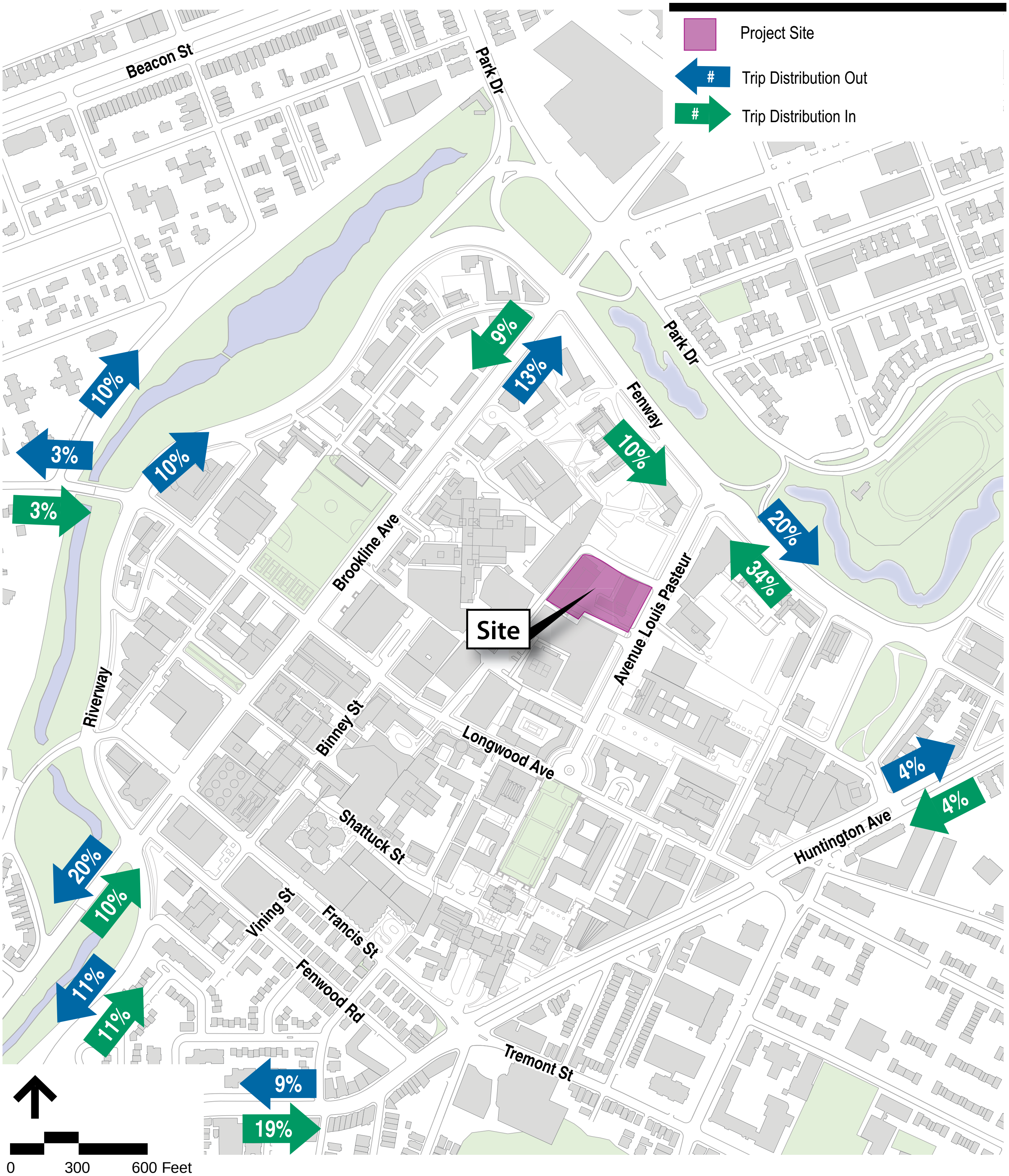

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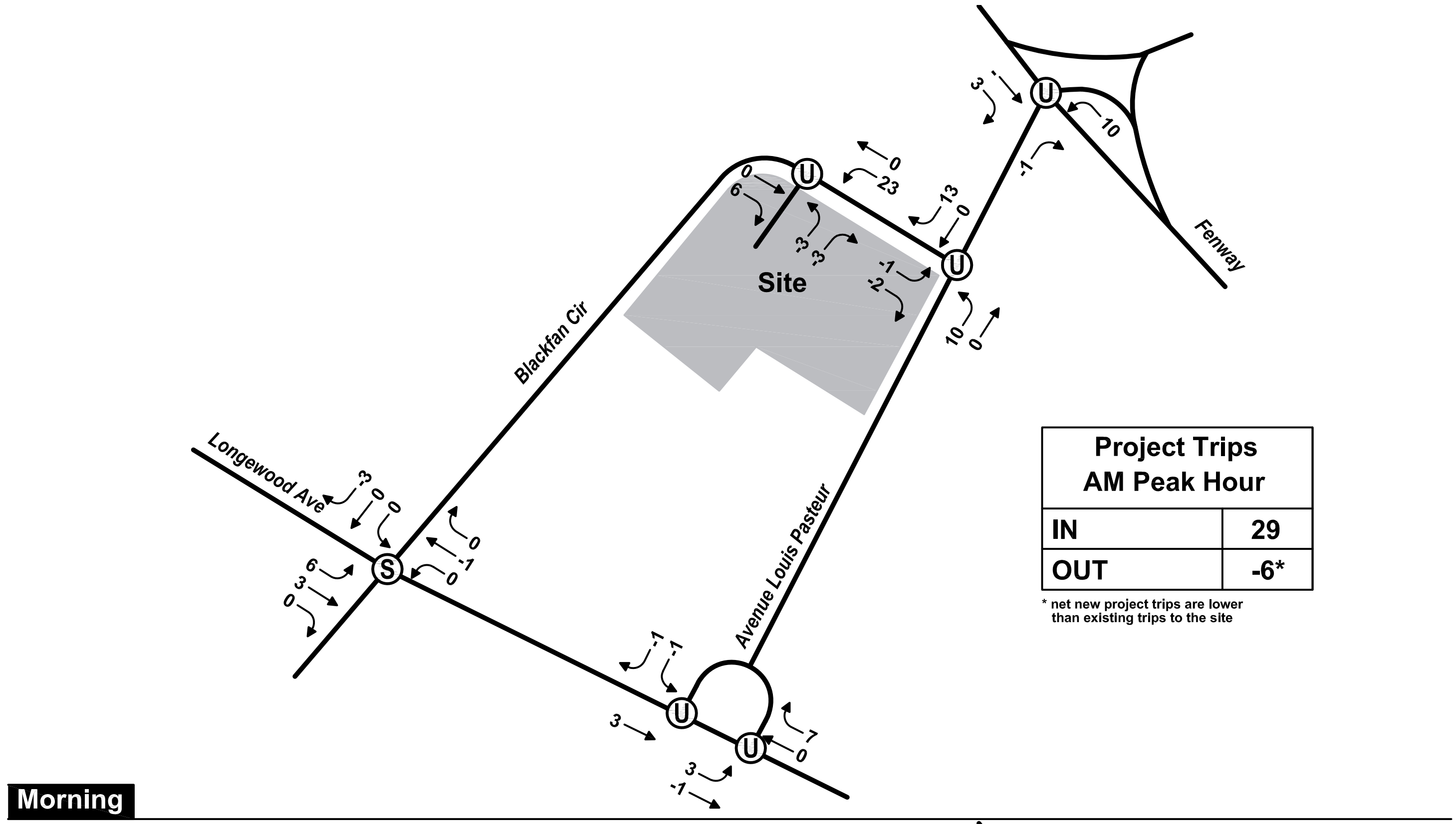
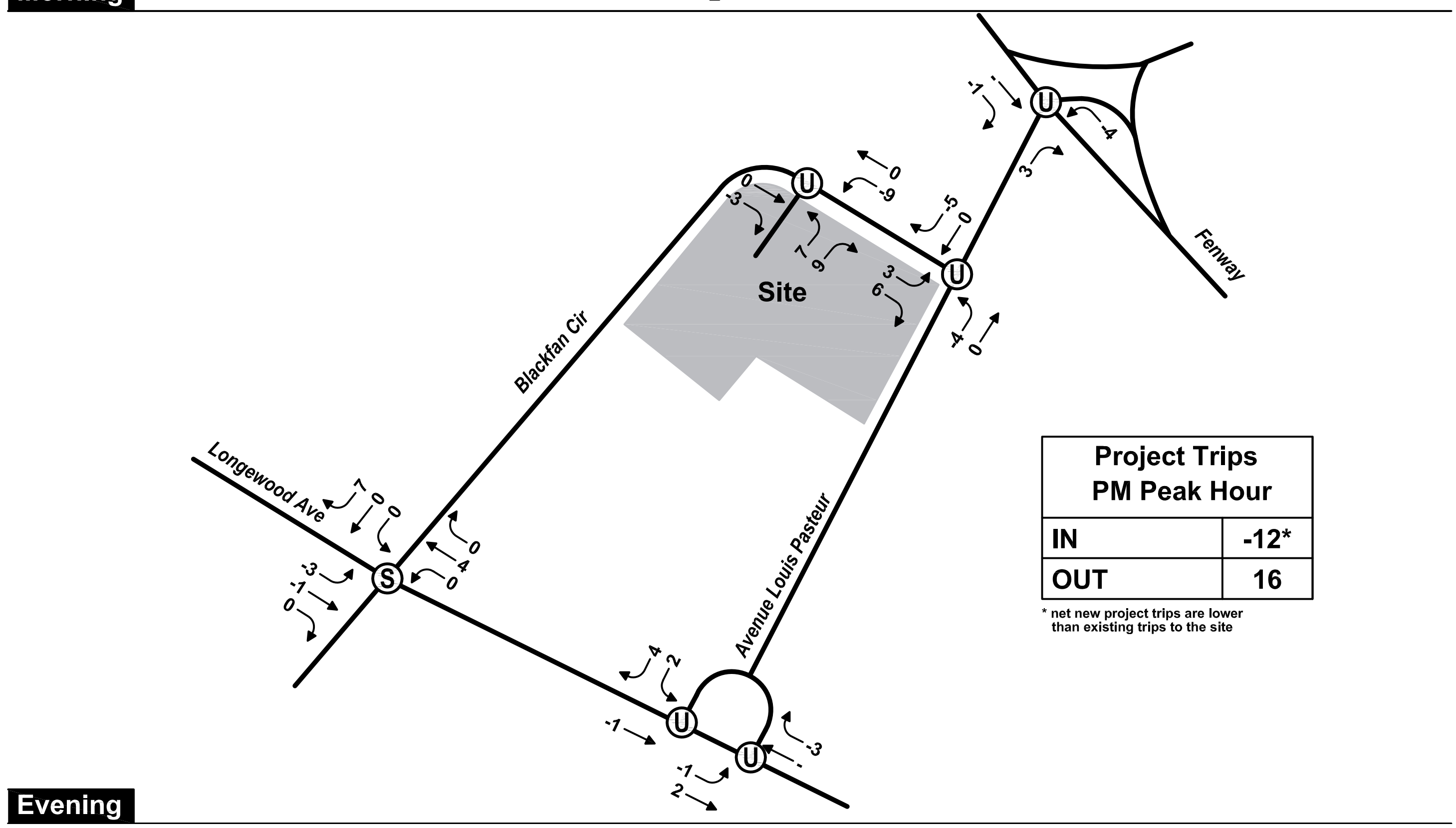
Figure 3-13

Project Trip Distribution



Project Trips AM Peak Hour	
IN	29
OUT	-6*

* net new project trips are lower than existing trips to the site



Project Trips PM Peak Hour	
IN	-12*
OUT	16

* net new project trips are lower than existing trips to the site

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Figure 3-14

2022 Build Condition Project Generated Vehicle Trips

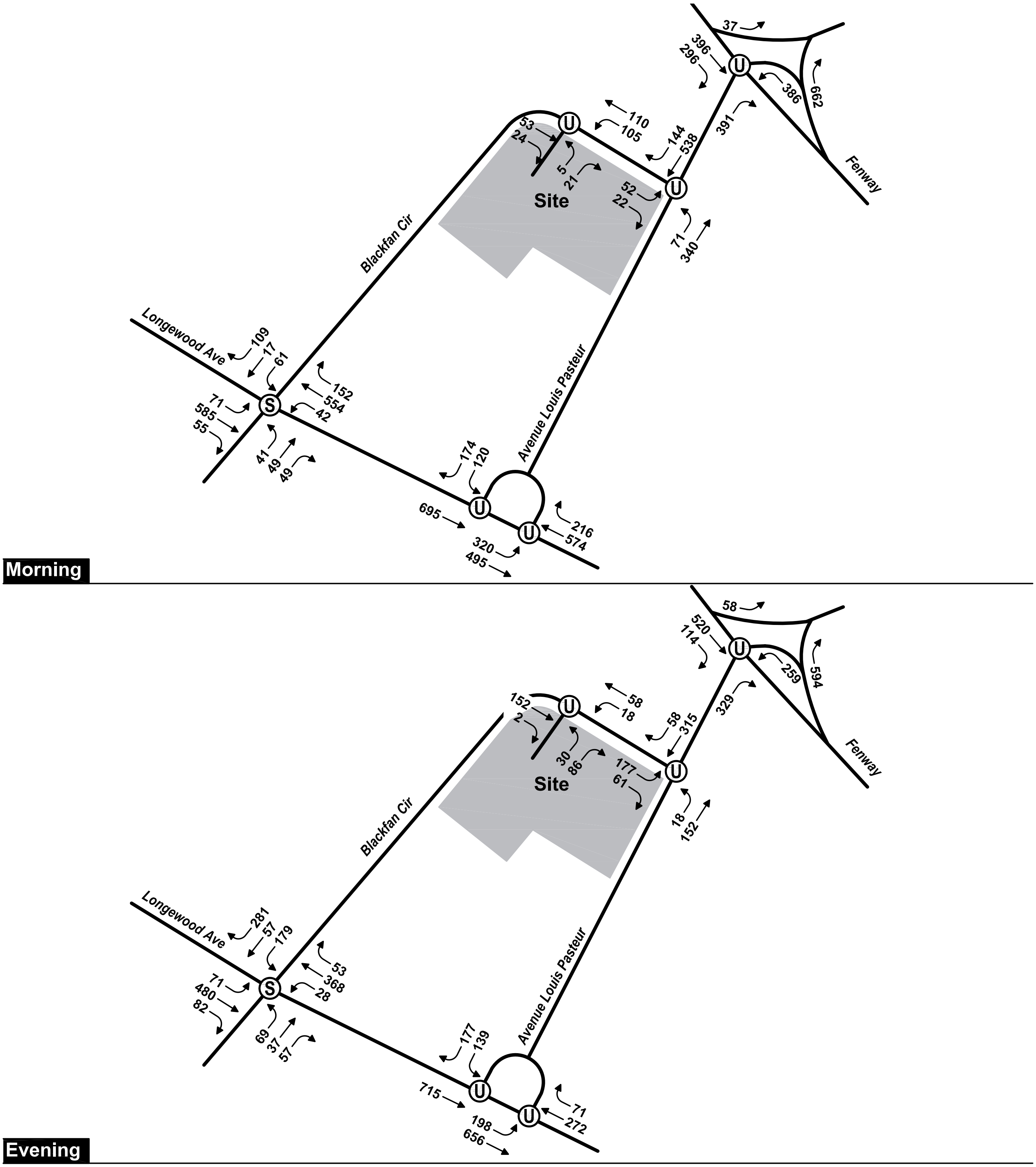

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Figure 3-15

2022 Build Condition Peak Hour Traffic Volumes

3.3.3 Public Transportation

The Project will generate a total of 268 and 233 transit trips during the morning and evening peak hours, respectively. These trips include the transit trips that are occurring at the Project site under existing conditions. These trips will be distributed amongst the numerous transit and bus lines in the area.

Because there are so many public transportation options that provide service to and from the LMA, no single service appears to be unduly affected by anticipated increases in activities under future conditions because of the Project.

3.3.4 Pedestrians & Bicycles

To encourage walking and bicycling, BWH will reconstruct sidewalks around the Project site along Avenue Louis Pasteur, and create a new wide sidewalk along the east side of Blackfan Circle adjacent to the Project site. Additionally, BWH will provide secure bicycle storage at the Project building in conformance with the BTD's Bicycle Guidelines. In addition, shower facilities and lockers will be installed for employees at the Project.

3.3.5 Parking

Upon completion, the Project will include 355 replacement below-grade parking spaces on-site. Access to and egress from these spaces will be provided from the proposed driveway on Blackfan Circle.

The amount of parking provided is identical to the supply that is currently leased to BWH by Emmanuel. Thus, no net new parking spaces will be allocated to BWH on this site.

3.3.6 Loading & Service

As currently planned, loading and service for the proposed Project will be accommodated from an off-street dock to be located along Blackfan Circle. The dock will be fitted with two loading bays and a third bay dedicated to trash removal (compactor). The dock's design will accommodate direct off-street access (i.e., trucks will not have to back into the dock from Blackfan Circle). Most deliveries are anticipated to be made by single-unit trucks or smaller vans—although there will be some deliveries made by larger WB-40 and/or WB-50 sized vehicles. The dock's design will be able to accommodate these larger vehicles off street as well.

It is anticipated that the Build Conditions will generate approximately six to eight new daily truck trips.

3.3.7 Construction Management

BWH will develop and submit a CMP to the BTD once a design has been finalized and they are prepared to construct the Project. This plan will provide a detailed evaluation of potential short-term construction-related transportation impacts, including construction vehicle traffic, parking supply and demand, and pedestrian access to the Project site.

3.3.7.1 Construction Vehicle Traffic

Construction vehicles will be necessary to move construction materials to and from the Project site. Every reasonable effort will be made to reduce the noise, control dust, and minimize other disturbances associated with construction traffic. While not specifically planned at this time, BWH will likely use Avenue Louis Pasteur via Louis Prang Street and Huntington Avenue as the principal construction traffic route to the Project site. The CMP will attempt to minimize the disruption of the traffic. All construction traffic routes are subject to BTD approval. The primary lay-down area is expected to be located on the Project site, therefore reducing the impacts to adjacent properties. BWH will work closely with abutting institutions and MASCO to ensure that adjacent operations are not negatively impacted during the construction phase of the Project.

3.3.7.2 Construction Parking

Contractors will be required to develop access plans for their personnel that de-emphasize auto use (such as seeking off-site parking, provide transit subsidies, on-site lockers, etc.) Construction workers will also be encouraged to use public transportation to access the Project site because no new parking will be provided for them. The Proponent will work with the BTD, MASCO, and the Boston Police Department to ensure that parking regulations in the area and in designated residential parking areas are enforced.

3.3.7.3 Pedestrian Access during Construction

During the construction period, pedestrian access around the Project site may need to be re-routed. A variety of measures will be considered and implemented to protect the safety of pedestrians around the site that are affected by construction. Temporary walkways, appropriate lighting, and new directional and informational signage to direct pedestrians around the construction site will be provided. After construction is complete, finished pedestrian sidewalks will be reconstructed around the new building.

3.4 Transportation Operations

This section presents the transportation operations analyses including a summary of transportation capacities and overall operations as they relate to delay and congestion for peak hour operations at the study area intersections.

The results of the analysis indicate that there will be no change in the LOS and minimal increases in queues and delays at the intersection of Longwood Avenue and Blackfan Circle as a result of the proposed Project.

3.4.1 Intersection Level of Service Operations

Vehicle Level of Service is a qualitative measure of control delay at an intersection providing an index to the operational qualities of a roadway or intersection. LOS designations range from A to F, with LOS A representing the best operating conditions and LOS F representing the worst operating conditions. LOS A through D are considered acceptable, while LOS E indicates vehicles endure significant delay, and LOS F suggests a level of delay that exceeds the intended capacity of that respective intersection. LOS thresholds differ for signalized and unsignalized intersections with longer delays at signalized intersections perceived as being acceptable.

Table 3-11 below presents the LOS delay threshold criteria as defined in the 2000 Highway Capacity Manual ("HCM").

Table 3-11 Level of Service Criteria

Level of Service (LOS)	Unsignalized Intersection Control Delay (sec/veh)	Signalized Intersection Control Delay (sec/veh)
A	$\leq$ 10	$\leq$10
B	> 10 - $\leq$ 15	> 10 - $\leq$20
C	> 15 - $\leq$25	> 20 - $\leq$35
D	> 25 - $\leq$35	> 35 - $\leq$55
E	> 35 - $\leq$50	> 55- $\leq$ 80
F	> 50	> 80

Source: HCM 2000

Consistent with BTD's Guidelines, Synchro 6 software was used to model LOS operations at the study area intersections. Adjustments were made to the Synchro model to include characteristics of the study area such as heavy vehicles, bus operations, parking activity, and pedestrian crossings. "Defacto turns" were coded into the Synchro model when the traffic model recognized that a shared-lane had a high enough turning volume that the lane is used for turns only even though there may not be striping or signs posted at the intersection to designate such operations. Often this condition only occurs during one peak hour.

A summary of the results for each analysis scenario that was studied is presented in Tables 3-12 thru 3-23. Overall, intersection LOS and delay are only provided for signalized intersections by Synchro. In addition, 50th percentile queues are not reported by Synchro for unsignalized intersections. Synchro calculation sheets are presented in Appendix C.

Table 3-12 Existing Condition (2012) Intersection LOS Summary – AM Peak Hour

Intersection	LOS	Delay (sec.)	V/C Ratio	Average Queue	95th % Queue (feet)
Signalized Intersections					
Longwood Avenue at Blackfan Circle	C	30.9	0.89	-	-
EB Longwood Left	B	14.8	0.45	41	#130
EB Longwood Thru/Right	B	19.0	0.78	345	#569
WB Longwood Left	A	7.7	0.15	12	30
WB Longwood Thru/Right	C	29.0	0.90	~495	#665
NB Blackfan Left/Thru/Right	E	64.2	0.81	82	#158
SB Blackfan Left/Thru	D	47.6	0.63	42	77
SB Blackfan Right	E	72.6	0.86	96	#158

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

Table 3-13 Existing Condition (2012) Intersection LOS Summary – AM Peak Hour

Intersection	LOS	Delay (sec.)	V/C Ratio	95th % Queue (feet)
Unsignalized Intersections				
Longwood Avenue at Avenue Louis Pasteur (Exit)				
EB Longwood Thru	A	0.0	0.21	0
WB Longwood Thru	A	0.0	0.34	0
SB Avenue Louis Pasteur Left	E	39.0	0.63	97
SB Avenue Louis Pasteur Right	E	45.4	0.76	147
Longwood Avenue At Avenue Louis Pasteur (Enter)				
EB Longwood Left/Thru	B	14.6	0.52	75
WB Longwood Thru/Right	A	0.0	0.47	0
Avenue Louis Pasteur at Blackfan Circle				
EB Blackfan Left/Right	D	33.2	0.35	38
NB Avenue Louis Pasteur Left/Thru	A	1.8	0.06	5
SB Avenue Louis Pasteur Thru/Right	A	0.0	0.42	0
Avenue Louis Pasteur at The Fenway				
EB The Fenway Left	A	7.5	0.03	2
EB The Fenway Thru	A	0.0	0.28	0
EB The Fenway Right	A	0.0	0.22	0
WB The Fenway Left	C	17.8	0.57	89
NB Avenue Louis Pasteur Right	F	>120	>1.0	478
Avenue Louis Pasteur at Site Driveway				
EB Site Driveway Left/Right	C	18.7	0.14	12
NB Avenue Louis Pasteur Left/Thru	A	1.3	0.05	4
SB Avenue Louis Pasteur Thru/Right	A	0.0	0.39	0

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

Table 3-14 Existing Condition (2012) Intersection LOS Summary – PM Peak Hour

Intersection	LOS	Delay (sec.)	V/C Ratio	Average Queue	95th % Queue (feet)
Signalized Intersections					
Longwood Avenue at Blackfan Circle	F	>120	>1.0	-	-
EB Longwood Left	B	11.2	0.21	31	57
EB Longwood Thru/Right	C	21.7	0.73	350	437
WB Longwood Left	A	10.0	0.10	9	25
WB Longwood Thru/Right	B	15.7	0.54	195	299
NB Blackfan Left/Thru/Right	F	>120	>1.0	~211	#314
SB Blackfan Left/Thru	F	>120	>1.0	~180	#312
SB Blackfan Right	F	>120	>1.0	~357	#514

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

Table 3-15 Existing Condition (2012) Intersection LOS Summary – PM Peak Hour

Intersection	LOS	Delay (sec.)	V/C Ratio	95th % Queue (feet)
Unsignalized Intersections				
Longwood Avenue at Avenue Louis Pasteur (Exit)				
EB Longwood Thru	A	0.0	0.19	0
WB Longwood Thru	A	0.0	0.16	0
SB Avenue Louis Pasteur Left	C	17.2	0.32	35
SB Avenue Louis Pasteur Right	C	16.2	0.36	40
Longwood Avenue At Avenue Louis Pasteur (Enter)				
EB Longwood Left/Thru	A	6.7	0.22	20
WB Longwood Thru/Right	A	0.0	0.21	0
Avenue Louis Pasteur at Blackfan Circle				
EB Blackfan Left/Right	D	25.6	0.49	65
NB Avenue Louis Pasteur Left/Thru	A	0.8	0.02	1
SB Avenue Louis Pasteur Thru/Right	A	0.0	0.24	0
Avenue Louis Pasteur at The Fenway				
EB The Fenway Left	A	7.6	0.04	3
EB The Fenway Thru	A	0.0	0.32	0
EB The Fenway Right	A	0.0	0.07	0
WB The Fenway Left	B	14.9	0.45	58
NB Avenue Louis Pasteur Right	F	>120	>1.0	374
Avenue Louis Pasteur at Site Driveway				
EB Site Driveway Left/Right	B	13.2	0.2	19
NB Avenue Louis Pasteur Left/Thru	A	0.6	0.01	1
SB Avenue Louis Pasteur Thru/Right	A	0.0	0.24	0

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

3.4.1.1 Existing (2012) AM Peak Hour LOS Summary

Longwood Avenue at Blackfan Circle is the only signalized intersection within the study area. Overall, the intersection operates at LOS C during the weekday morning peak hours with delays for traffic on Blackfan Circle. The queues on Longwood Avenue are metered/ blocked by the upstream signal located at the intersection of Longwood Avenue and Binney Street. The pedestrian activity at this intersection is heavy with pedestrians activating the exclusive pedestrian phase almost at every cycle and/or crossing without waiting for the pedestrian signal, causing conflicting movements with turning vehicles.

The other four study area intersections along Avenue Louis Pasteur, including the existing Site Driveway, are unsignalized. The Avenue Louis Pasteur/ Longwood Avenue intersection was modeled using two nodes adjacent to each other to reflect existing conditions. The Avenue Louis Pasteur Southbound (SB) approach is under stop control and operates at LOS E with long vehicle queues. The unsignalized intersections at Blackfan Circle, The Fenway, and Site Driveway operate at acceptable LOS C or D for the stop-controlled movements except at The Fenway. The Fenway Northbound (NB) movement operates at LOS F due to the heavy pedestrian volumes crossing The Fenway.

3.4.1.2 Existing (2012) Intersection LOS Summary PM Peak Hour

During the evening peak period, Longwood Avenue at Blackfan Circle operates at an overall LOS F with significant delays and queues for traffic on Blackfan Circle. The queues on Longwood Avenue are metered/blocked by the upstream signal located at the intersection of Longwood Avenue and Binney Street. The pedestrian activity at this intersection is heavy with pedestrians activating the exclusive pedestrian phase almost at every cycle and/or crossing without waiting for the pedestrian signal, causing conflicting movements with turning vehicles.

The other four unsignalized intersections along Avenue Louis Pasteur, i.e., at Longwood Avenue, Blackfan Circle, The Fenway, and Site Driveway, operate at an acceptable LOS C or D for the stop-controlled movements except at The Fenway. The Fenway NB movement operates at LOS F due to the heavy pedestrian volumes crossing The Fenway.

Table 3-16 No Build Condition (2022) Intersection LOS Summary – AM Peak Hour

Intersection	LOS	Delay (sec.)	V/C Ratio	Average Queue	95th % Queue (feet)
Signalized Intersections					
Longwood Avenue at Blackfan Circle	D	44.7	0.99	-	-
EB Longwood Left	B	15.4	0.41	29	#105
EB Longwood Thru/Right	C	25.4	0.86	414	#651
WB Longwood Left	A	9.2	0.21	15	37
WB Longwood Thru/Right	D	49.6	1.0	~621	#763
NB Blackfan Left/Thru/Right	F	97.8	0.96	103	#216
SB Blackfan Left/Thru	E	56.9	0.72	48	#98
SB Blackfan Right	E	71.1	0.86	104	#176

~ Volume exceeds capacity, queue is theoretically infinite.
\# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal

Table 3-17 No Build Condition (2022) Intersection LOS Summary – AM Peak Hour

Intersection	LOS	Delay (sec.)	V/C Ratio	95th % Queue (feet)
Unsignalized Intersections				
Longwood Avenue at Avenue Louis Pasteur (Exit)				
EB Longwood Thru	A	0.0	0.22	0
WB Longwood Thru	A	0.0	0.38	0
SB Avenue Louis Pasteur Left	F	57.8	0.76	135
SB Avenue Louis Pasteur Right	F	69.4	0.90	202
Longwood Avenue At Avenue Louis Pasteur (Enter)				
EB Longwood Left/Thru	C	17.7	0.59	97
WB Longwood Thru/Right	A	0.0	0.52	0
Avenue Louis Pasteur at Blackfan Circle				
EB Blackfan Left/Right	E	43.0	0.44	51
NB Avenue Louis Pasteur Left/Thru	A	2.0	0.07	6
SB Avenue Louis Pasteur Thru/Right	A	0.0	0.47	0
Avenue Louis Pasteur at The Fenway				
EB The Fenway Left	A	7.5	0.03	2
EB The Fenway Thru	A	0.0	0.29	0
EB The Fenway Right	A	0.0	0.21	0
WB The Fenway Left	C	23.8	0.72	150
NB Avenue Louis Pasteur Right	F	>120	>1.0	608
Avenue Louis Pasteur at Site Driveway				
EB Site Driveway Left/Right	C	21.5	0.17	15
NB Avenue Louis Pasteur Left/Thru	A	1.4	0.05	4
SB Avenue Louis Pasteur Thru/Right	A	0.0	0.43	0

~ Volume exceeds capacity, queue is theoretically infinite.
\# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

Table 3-18 No Build Condition (2022) Intersection LOS Summary – PM Peak Hour

Intersection	LOS	Delay (sec.)	V/C Ratio	Average Queue	95th % Queue (feet)
Signalized Intersections					
Longwood Avenue at Blackfan Circle	F	>120	>1.0	-	-
EB Longwood Left	B	11.6	0.24	34	61
EB Longwood Thru/Right	C	28.5	0.84	460	#594
WB Longwood Left	B	10.7	0.13	10	29
WB Longwood Thru/Right	B	16.7	0.58	219	336
NB Blackfan Left/Thru/Right	F	>120	>1.0	~283	#357
SB Blackfan Left/Thru	F	>120	>1.0	~203	#337
SB Blackfan Right	F	>120	>1.0	~406	#564

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal

Table 3-19 No Build Condition (2022) Intersection LOS Summary – PM Peak Hour

Intersection	LOS	Delay (sec.)	V/C Ratio	95th % Queue (feet)
Unsignalized Intersections				
Longwood Avenue at Avenue Louis Pasteur (Exit)				
EB Longwood Thru	A	0.0	0.22	0
WB Longwood Thru	A	0.0	0.18	0
SB Avenue Louis Pasteur Left	C	19.7	0.38	43
SB Avenue Louis Pasteur Right	C	17.3	0.39	46
Longwood Avenue At Avenue Louis Pasteur (Enter)				
EB Longwood Left/Thru	A	6.8	0.23	23
WB Longwood Thru/Right	A	0.0	0.23	0
Avenue Louis Pasteur at Blackfan Circle				
EB Blackfan Left/Right	D	28.6	0.54	76
NB Avenue Louis Pasteur Left/Thru	A	0.9	0.02	1
SB Avenue Louis Pasteur Thru/Right	A	0.0	0.26	0
Avenue Louis Pasteur at The Fenway				
EB The Fenway Left	A	7.6	0.04	3
EB The Fenway Thru	A	0.0	0.33	0
EB The Fenway Right	A	0.0	0.07	0
WB The Fenway Left	C	15.9	0.48	66
NB Avenue Louis Pasteur Right	F	>120	>1.0	436
Avenue Louis Pasteur at Site Driveway				
EB Site Driveway Left/Right	B	13.8	0.22	21
NB Avenue Louis Pasteur Left/Thru	A	0.6	0.01	1
SB Avenue Louis Pasteur Thru/Right	A	0.0	0.25	0

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal

3.4.1.3 No Build Condition (2022) AM Peak Hour LOS Summary

During the No Build Condition morning peak period, the intersection of Longwood Avenue and Blackfan Circle operates at LOS D, lower than the LOS C under 2012 Existing Condition. The increase in delay and queues is seen mostly for the side street traffic on Blackfan Circle. The unsignalized intersections at Longwood Avenue, Blackfan Circle, The Fenway, and Site Driveway along Avenue Louis Pasteur operate at a LOS similar to the Existing Condition in most cases, and only slightly lower in other cases than the 2012 Existing Condition.

3.4.1.4 No Build Condition (2022) Intersection LOS Summary PM Peak Hour

During the evening peak period, the intersection of Longwood Avenue and Blackfan Circle continue to operate at LOS F but with further increase in delays and queues for traffic on Blackfan Circle over Existing Conditions. The unsignalized intersections at Longwood Avenue, Blackfan Circle, The Fenway, and Site Driveway along Avenue Louis Pasteur also operate at a similar LOS as the 2012 Existing Condition but with increased delays and queues for the stop-controlled approaches.

Table 3-20 2022 Build Intersection LOS Summary – AM Peak Hour

Intersection	LOS	Delay (sec.)	V/C Ratio	Average Queue	95th % Queue (feet)
Signalized Intersections					
Longwood Avenue at Blackfan Circle	D	44.1	0.99	-	-
EB Longwood Left	B	16.5	0.45	29	79
EB Longwood Thru/Right	C	25.5	0.86	418	#656
WB Longwood Left	A	9.2	0.21	14	35
WB Longwood Thru/Right	D	48.3	1.0	~619	#760
NB Blackfan Left/Thru/Right	F	96.3	0.95	103	#215
SB Blackfan Left/Thru	E	58.2	0.72	48	#98
SB Blackfan Right	E	67.9	0.85	101	#170

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

Table 3-21 2022 Build Intersection LOS Summary – AM Peak Hour

Intersection	LOS	Delay (sec.)	V/C Ratio	95th % Queue (feet)
Unsignalized Intersections				
Longwood Avenue at Avenue Louis Pasteur (Exit)				
EB Longwood Thru	A	0.0	0.22	0
WB Longwood Thru	A	0.0	0.38	0
SB Avenue Louis Pasteur Left	F	57.4	0.76	133
SB Avenue Louis Pasteur Right	F	68.4	0.89	199
Longwood Avenue At Avenue Louis Pasteur (Enter)				
EB Longwood Left/Thru	C	17.9	0.60	100
WB Longwood Thru/Right	A	0.0	0.53	0
Avenue Louis Pasteur at Blackfan Circle				
EB Blackfan Left	F	66.8	0.58	71
EB Blackfan Right	C	16.4	0.09	7
NB Avenue Louis Pasteur Left/Thru	A	3.3	0.12	10
SB Avenue Louis Pasteur Thru/Right	A	0.0	0.48	0
Avenue Louis Pasteur at The Fenway				
EB The Fenway Left	A	7.5	0.03	2
EB The Fenway Thru	A	0.0	0.29	0
EB The Fenway Right	A	0.0	0.21	0
WB The Fenway Left	D	25.1	0.74	161
NB Avenue Louis Pasteur Right	F	>120	>1.0	605
Blackfan Circle at Site Driveway				
EB Blackfan Circle Thru/Right	A	0.0	0.06	0
WB Blackfan Circle Left/Thru	A	4.1	0.08	7
NB Site Driveway Left/Right	A	9.5	0.03	3

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

Table 3-22 2022 Build Intersection LOS Summary – PM Peak Hour

Intersection	LOS	Delay (sec.)	V/C Ratio	Average Queue	95th % Queue (feet)
Signalized Intersections					
Longwood Avenue at Blackfan Circle	F	>120	>1.0	-	-
EB Longwood Left	B	11.6	0.23	32	58
EB Longwood Thru/Right	C	28.3	0.84	457	#587
WB Longwood Left	B	10.7	0.13	10	28
WB Longwood Thru/Right	B	16.9	0.58	222	341
NB Blackfan Left/Thru/Right	F	>120	>1.0	~288	#367
SB Blackfan Left/Thru	F	>120	>1.0	~203	#337
SB Blackfan Right	F	>120	>1.0	~420	#579

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

Table 3-23 2022 Build Intersection LOS Summary – PM Peak Hour

Intersection	LOS	Delay (sec.)	V/C Ratio	95th % Queue (feet)
Unsignalized Intersections				
Longwood Avenue at Avenue Louis Pasteur (Exit)				
EB Longwood Thru	A	0.0	0.22	0
WB Longwood Thru	A	0.0	0.18	0
SB Avenue Louis Pasteur Left	C	19.8	0.39	44
SB Avenue Louis Pasteur Right	C	17.5	0.40	48
Longwood Avenue At Avenue Louis Pasteur (Enter)				
EB Longwood Left/Thru	A	6.3	0.23	22
WB Longwood Thru/Right	A	0.0	0.22	0
Avenue Louis Pasteur at Blackfan Circle				
EB Blackfan Left	D	32.9	0.63	99
EB Blackfan Right	B	13.5	0.14	12
NB Avenue Louis Pasteur Left/Thru	A	1.2	0.02	2
SB Avenue Louis Pasteur Thru/Right	A	0.0	0.25	0
Avenue Louis Pasteur at The Fenway				
EB The Fenway Left	A	7.6	0.04	3
EB The Fenway Thru	A	0.0	0.33	0
EB The Fenway Right	A	0.0	0.07	0
WB The Fenway Left	C	15.7	0.48	64
NB Avenue Louis Pasteur Right	F	>120	>1.0	445
Blackfan Circle at Site Driveway				
EB Blackfan Circle Thru/Right	A	0.0	0.11	0
WB Blackfan Circle Left/Thru	A	1.9	0.02	1
NB Site Driveway Left/Right	B	10.3	0.16	14

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

3.4.1.5 2022 Build AM Peak Hour LOS Summary

During the 2022 Build morning peak hour, the intersection of Longwood Avenue and Blackfan Circle operates at the same LOS as compared to the 2022 No Build condition. The unsignalized intersections at Longwood Avenue, Blackfan Circle and The Fenway also operate at similar LOS as the No Build condition, except for the eastbound left movement which operates at LOS F and eastbound right movement operates at LOS C. The unsignalized intersection at Site Driveway along Blackfan Circle operates at LOS A. Due to the minimal traffic generated by the Project, there is no substantial change in delays and queues at the study area intersections.

3.4.1.6 2022 Build Intersection LOS Summary PM Peak Hour

During the evening peak hour, the intersection of Longwood Avenue and Blackfan Circle operates at the same LOS as compared to the 2022 No Build Condition. The unsignalized intersections at Longwood Avenue, Blackfan Circle and The Fenway also operate at the same LOS as the No Build Condition. The unsignalized intersection at Site Driveway along Blackfan Circle operates at LOS A in the eastbound and westbound directions, and LOS B in the northbound direction. Due to the minimal traffic generated by the Project, there is no substantial change in delays and queues at the study area intersections.

3.4.1.7 Intersection LOS Summary

The results of the analysis indicate that there will be no change in the LOS and minimal increases in queues and delays at the intersection of Longwood Avenue and Blackfan Circle as a result of the proposed Project.

All mitigation measures will be formalized with the BTD in the forthcoming TAPA for the Project.

3.5 Mitigation and Improvement Actions

This section delineates the transportation improvements and mitigation plan developed by BWH. The purpose of this transportation mitigation plan is to:

- Provide transportation infrastructure enhancements to the LMA, including improved pedestrian corridors, and public space amenities; and
- Exceed the requirements of the BRA's LMA Interim Guidelines relative to transportation improvements and mitigation.

BWH has also made important mitigation commitments in the form of policies and management actions. Key commitments are to continue to establish and maintain a proactive TDM program, parking management strategies and carefully coordinate construction management actions related to the forthcoming Project.

The transportation impact generated by the Project is anticipated to be minimal and have no substantial impacts on the area's transportation infrastructure. However, BWH is committed to providing transportation improvements and mitigation actions to improve transportation conditions for residents, patients, visitors, and employees traveling in the area. BWH believes that these transportation mitigation actions improve the LMA's existing transportation infrastructure.

This transportation mitigation plan includes several elements:

- Roadway and traffic operations improvements;
- Parking consolidation and management strategies;
- Transportation demand management enhancements;
- Pedestrian access and open space improvements; and
- Construction management.

Table 3-24 lists each transportation mitigation element that is proposed by the Proponent and provides a summary of the following:

- Description of the proposed action;
- Interim Guideline criterion that is met by that action;
- Summary of the purpose and benefit of that action; and
- Implementation responsibility.

3.6 Conclusion

The results of the traffic analysis indicate that there will be no change in the LOS and minimal increase in queues and delays at the study area intersections as a result of the Project. In addition, the Project will not add any net new parking spaces. Also, BWH will continue and expand its TDM measures to its employees to encourage the use of transit and other alternative forms of transportation.

The purpose of this transportation mitigation plan is to:

- Provide transportation infrastructure enhancements to the LMA, including intersection improvements and open space amenities and streetscape improvements; and

- Exceed the requirements of the BRA's LMA Interim Guidelines relative to transportation improvements and mitigation.

The Proponent believes that the transportation mitigation actions will lessen the impacts of the proposed development plans and, when complete, will help improve the LMA's existing transportation infrastructure.

Table 3-24 Mitigation Action Plan

	Mitigation Element	Description	Purpose/Benefit	Implementation Timing
Local Street Network / System-wide Transportation Improvements				
1	Area Sidewalk Improvements	Construct wide sidewalks along portions of Blackfan Circle adjacent to the Project site.	Improve pedestrian access, safety, and urban design of the area.	Certificate of Occupancy BWH 2012 IMP Amendment Project site
2	Area Street Improvements	Resurface roadways and implement refreshed pavement markings around the surrounding site (as necessary).	Improve operations and safety.	Certificate of Occupancy BWH 2012 IMP Amendment Project site
Urban Design				
3	Urban Design Improvements	Provide street trees and other hardscape amenities along Avenue Louis Pasteur and Blackfan Circle adjacent to the Project site.	Provide open space enhancement that complements open space in the area.	Certificate of Occupancy BWH 2012 IMP Amendment Project site
Parking				
4	Limit new parking to be constructed	Project will include construction of 355 replacement below-grade spaces that will replace the existing parking on-site.	The proposed spaces are identical to the amount of existing on-site parking that is leased to BWH by Emmanuel College. No net new parking spaces will be provided.	Certificate of Occupancy BWH 2012 IMP Amendment Project site
5	Employee Parking Pricing	Evaluate and charge market rates for monthly employee parking.	Encourage shifting employee mode share from auto to transit. Will help to reduce parking demands.	Ongoing
BWH Transportation Demand Management Plan				
6	Maintain proactive in MASCO's TMA	Maintain access to wide array of TDM programs and amenities that seek to encourage the use of transit as a regular means of commuting.	Encourage shift in employee mode share from auto to transit.	Ongoing

Table 3-24 Mitigation Action Plan (Continued)

	Mitigation Element	Description	Purpose/Benefit	Implementation Timing
BWH Transportation Demand Management Plan				
7	Maintain high percentage employee transit subsidy	Maintain employee/tenant transit subsidy at 50 percent.	Encourage shift in employee mode share from auto to transit.	Ongoing
8	Zipcar Provision	Coordinate with Zipcar representatives to investigate provision of this shared-car service at the BWH 2012 IMP Amendment Project site.	Encourage shift in employee mode share from auto to transit.	Certificate of Occupancy BWH 2012 IMP Amendment Project site
9	Loading Dock Manager	Oversee loading operations.	Oversee delivery scheduling to maintain dock efficiency and reduce truck queuing at BWH 2012 IMP Amendment Project site and other BWH materials management locations in the LMA.	Ongoing
10	Support Alternatively-Fueled Vehicles	Equip vehicle charge stations within the new garage	Encourage increased use of environmentally-friendly vehicles	Part of future Project design/construction
Traffic Management Plan				
11	Loading and Service Improvements	Include three loading bays to serve the BWH 2012 IMP Amendment Project site.	Improve off-street loading conditions along Blackfan Circle.	Certificate of Occupancy BWH 2012 IMP Amendment Project site
12	Materials Management Operations Plan	Continue to employ a proactive materials management plan at BWH Servicenter and West Plaza Loading docks.	Allows for "just in time" delivery techniques, which will reduce trucks trip frequency and dock utilization times at these locations.	Ongoing
Construction Management Plan				
13	Prepare Construction Management Plan	Prepare and submit a detailed Construction Management Plan (CMP) for the BWH 2012 IMP Amendment Project	Minimize construction impacts.	Part of future Project design/construction

Section 4.0

Environmental Protection Component

4.0 ENVIRONMENTAL PROTECTION COMPONENT

4.1 Pedestrian Level Winds

4.1.1 Introduction

Rowan Williams Davies & Irwin Inc. (RWDI) conducted a pedestrian wind study for the proposed Project. The purpose of the study is to assess the effect of the Project on the wind conditions on pedestrian areas around the Project in terms of pedestrian comfort and safety. The study involved wind tunnel testing of a 1:400 scale model of the proposed Project and surroundings.

Wind tunnel modeling is considered to be the most accurate method of replicating airflow patterns around buildings and of quantifying their effects on pedestrian comfort and safety. As requested by the BRA, the Existing condition includes proposed massing on Parcel A of Emmanuel College's Endowment Campus (immediately north of the Project site) as included in their 2000 Institutional Master Plan, proposed massing for the redevelopment of the Julie Hall site, and the renovation and addition to the Cardinal Cushing Library as described in their IMP. In general, all of the wind conditions with the proposed Project were comfortable for walking, sitting or standing. The effective gust criterion limits (for safety) were not exceeded seasonally or annually at any location.

4.1.2 Overview

Major buildings, especially those that protrude above their surroundings, often cause increased local wind speeds at the pedestrian level. Typically, wind speeds increase with elevation above the ground surface, and taller buildings intercept these faster winds and deflect them down to the pedestrian level. The funneling of wind through gaps between buildings and the acceleration of wind around corners of buildings may also cause increases in wind speed. Conversely, if a building is surrounded by others of equivalent height, it may be protected from the prevailing upper-level winds, resulting in no significant changes to the local pedestrian-level wind environment. The most effective way to assess potential pedestrian-level wind impacts around a proposed new building is to conduct scale model tests in a wind tunnel.

The consideration of a project's impact on wind in areas with pedestrian activity is important since high winds in an area tend to deter pedestrian use. For example, winds should be light or relatively light in areas where people would be sitting, such as outdoor cafes or playgrounds. For bus stops and other locations where people would be standing, somewhat higher winds can be tolerated. For frequently used sidewalks, where people are primarily walking, stronger winds are acceptable. For infrequently used areas, the wind comfort criteria can be relaxed even further. The actual effects of wind can range from pedestrian inconvenience, due to the blowing of dust and other loose material in a moderate breeze, to severe difficulty with walking due to the wind forces on the pedestrian.

4.1.3 Methodology

Information concerning the site and surroundings was derived from: site photographs; information on surrounding buildings and terrain; and site plans and elevations of the proposed Project provided by the design team. The following site configurations were simulated:

Existing Configuration: includes all existing surrounding buildings;

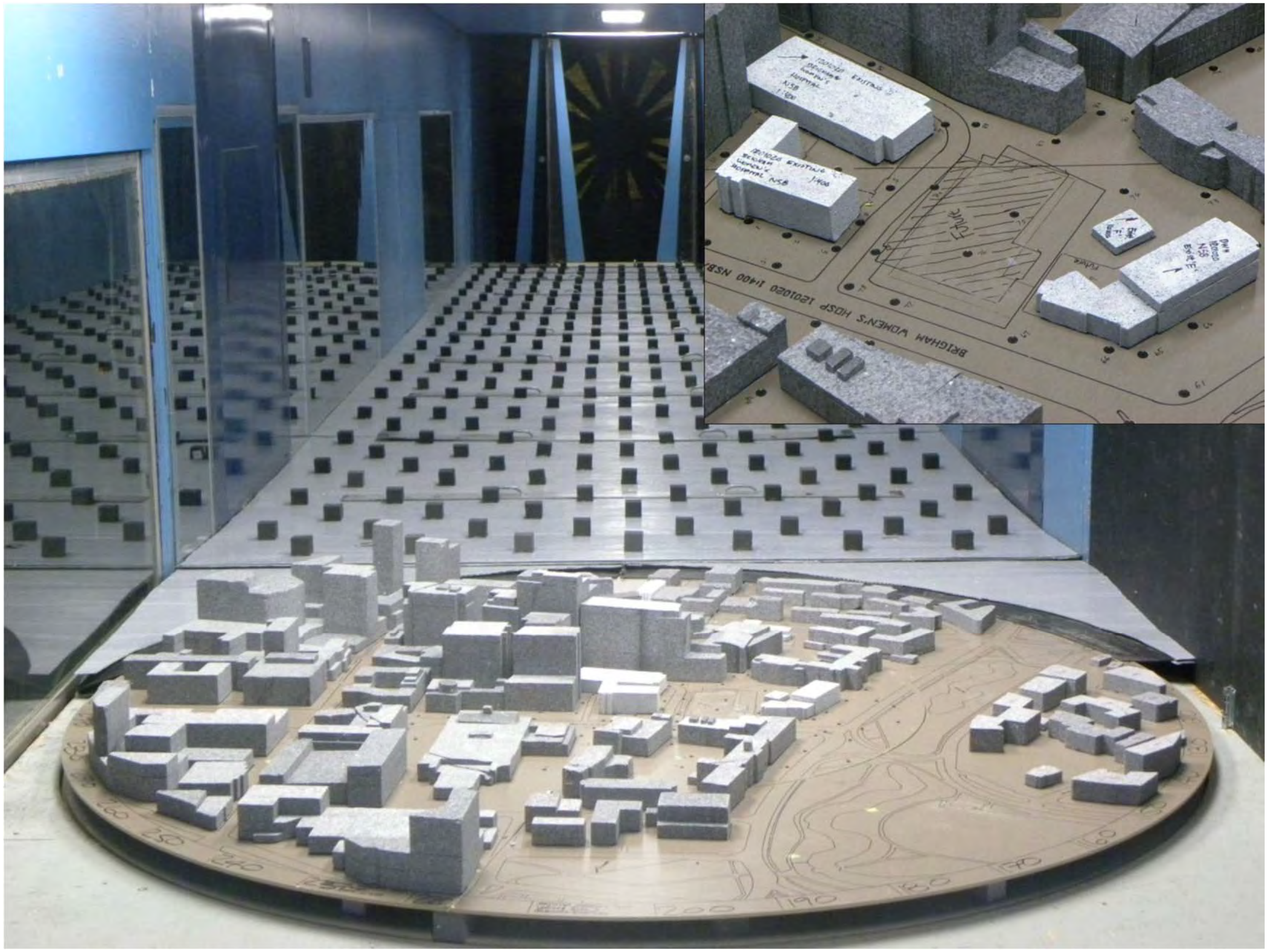
Build Configuration: includes the proposed Project, all existing surroundings and proposed future developments.

As shown in Figures 4.1-1 and 4.1-2, the wind tunnel model included the proposed Project and all relevant surrounding buildings and topography within a 1,600-foot radius of the study site. A list of the drawings used for construction of the physical model is presented in Appendix D. The mean speed profile and turbulence of the natural wind approaching the modeled area were also simulated in RWDI's boundary layer wind tunnel. The scale model was equipped with 108 specially designed wind speed sensors that were connected to the wind tunnel's data acquisition system to record the mean and fluctuating components of wind speed at a full-scale height of five feet above grade in pedestrian areas throughout the study site. The sensor layout was based on experience and understanding of the pedestrian usage of this site. It was reviewed with the BRA prior to testing. Wind speeds were measured for 36 wind directions, in 10 degree increments, starting from true north. The measurements at each sensor location were recorded in the form of ratios of local mean and gust speeds to the reference wind speed in the free stream above the model. The results were then combined with long-term meteorological data, recorded during the years 1982 to 2011 at the Boston Logan International Airport, in order to predict full scale wind conditions. The analysis was performed separately for each of the four seasons and for the entire year.

Figures 4.1-3 through 4.1-5 present "wind roses", summarizing the annual and seasonal wind climates in the Boston area. The left-hand wind rose in Figure 4.1-3, for example, summarizes the spring (March, April, and May) wind data. In general, the prevailing winds originate from the west-northwest year-round, especially in the spring and winter seasons. Easterly winds are also frequent. In the summer and fall, the prevailing winds are from the southwest directions, but of lower speeds in general.

On an annual basis, the most common wind directions are those that originate from the southwest through northwest. Winds from the east are also relatively common. In the case of strong winds, west-northwest and northeast are the dominant wind directions.

This study involved state-of-the-art measurement and analysis techniques to predict wind conditions at the study site. Nevertheless, some uncertainty remains in predicting wind comfort. For example, the sensation of comfort among individuals can be quite variable.



BWH 2012 IMP Amendment Project   Boston, MA

RWDI

Figure 4.1-1

Wind Tunnel Study - Existing

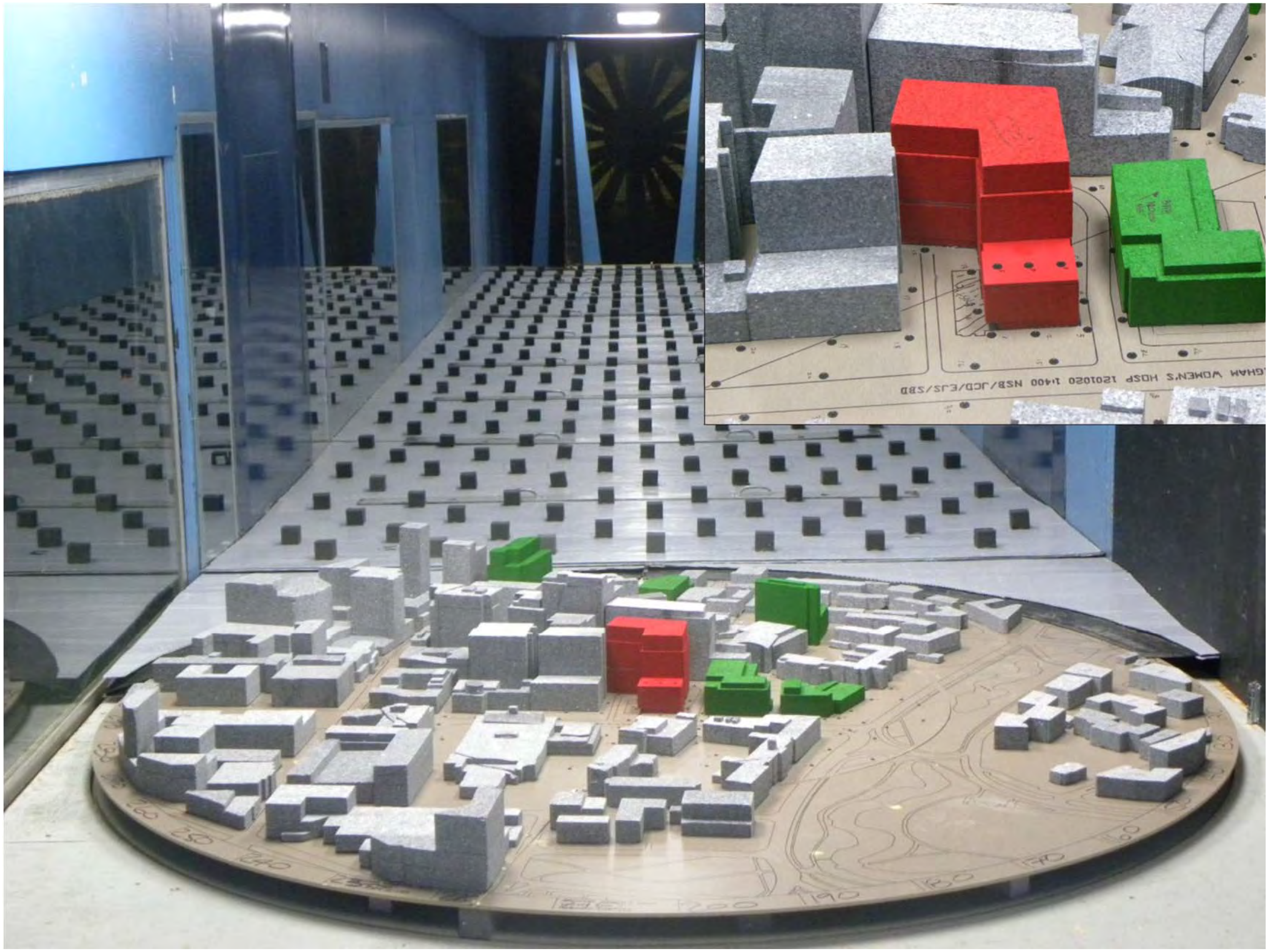
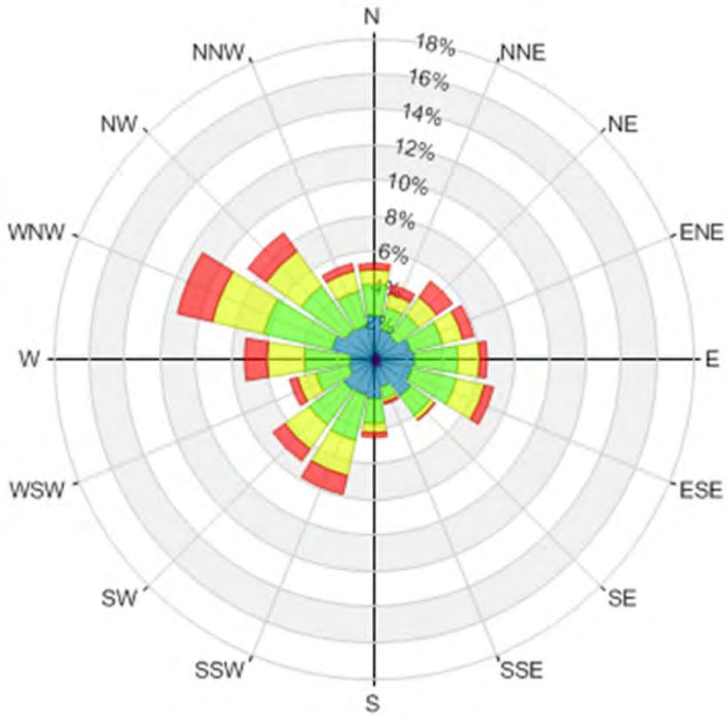
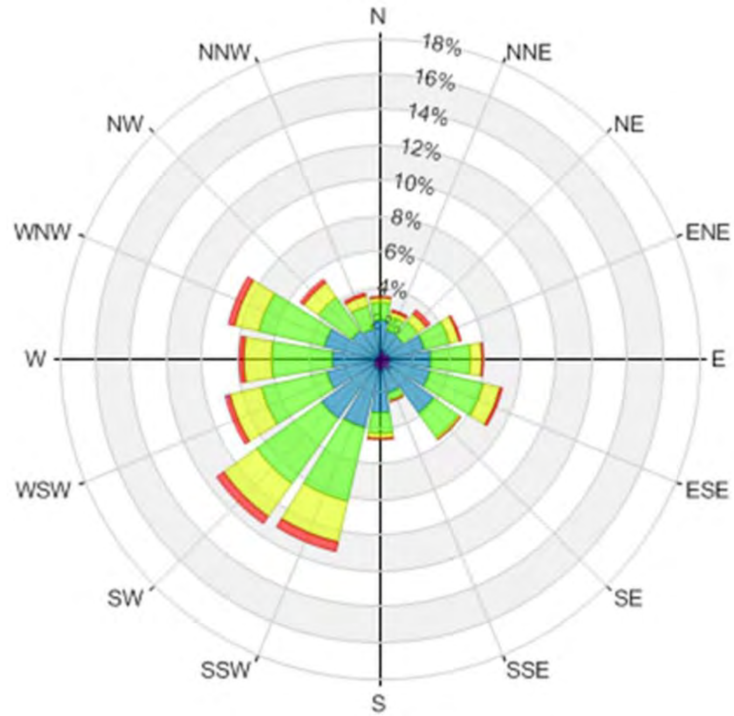


Figure 4.1-2

Wind Tunnel Study - Build



Spring Winds
(March - May)

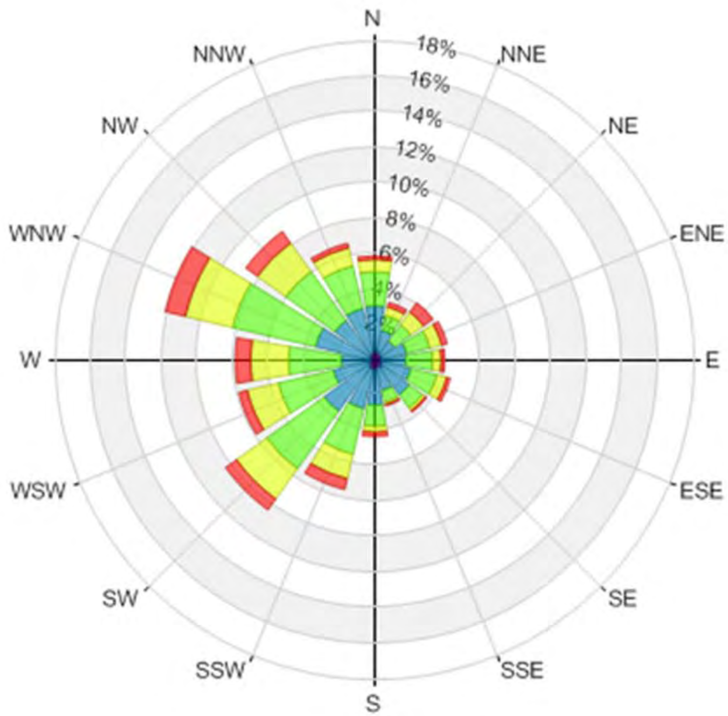


Summer Winds
(June - August)

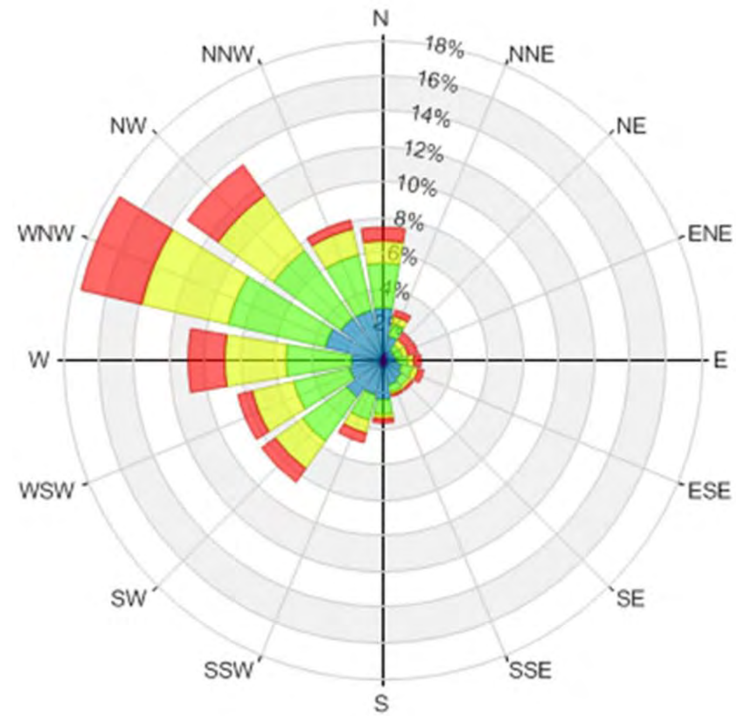
(mph)	Probability (%) Spring	Probability (%) Summer
Calm	1.4	1.5
1-5	5.8	8.3
6-10	26.9	36.1
11-15	33.4	36.2
16-20	21.3	14.9
>20	11.2	2.9

Figure 4.1-3

Directional Distribution (%) of Winds (Blowing from) Boston Logan International Airport (1982 – 2011)



Fall Winds
(September -
November)

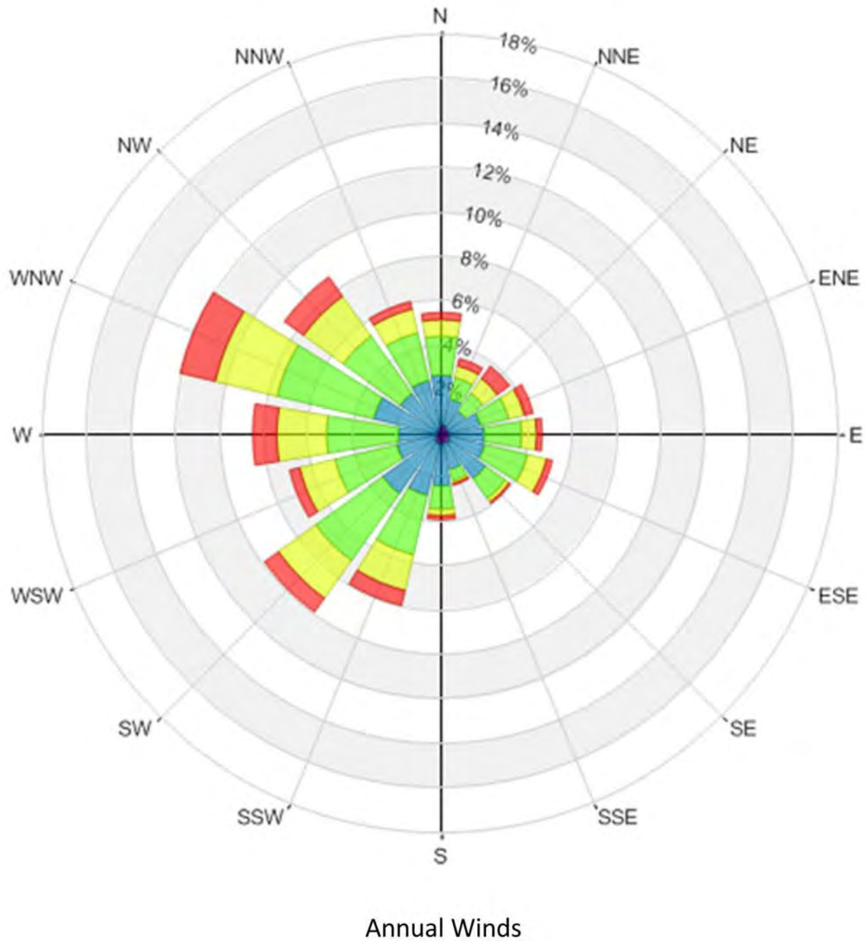


Winter Winds
(December - February)

(mph)	Probability (%) Fall	Winter
Calm	1.6	1.2
1-5	7.0	5.3
6-10	32.0	25.1
11-15	34.6	32.1
16-20	17.6	22.6
>20	7.2	13.7

Figure 4.1-4

Directional Distribution (%) of Winds (Blowing from) Boston Logan International Airport (1982 – 2011)



Wind Speed (mph)	Probability (%)
Calm	1.8
1-5	6.3
6-10	30.4
11-15	34.0
16-20	18.8
>20	8.7

Figure 4.1-5

Directional Distribution (%) of Winds (Blowing from) Boston Logan International Airport (1982 – 2011)

Variations in age, individual health, clothing, and other human factors can change a particular response of an individual. The comfort limits used in this study represent an average for the total population. Also, unforeseen changes in the Project area, such as the construction or removal of buildings, can affect the conditions experienced at the site. Finally, the prediction of wind speeds is necessarily a statistical procedure. The wind speeds reported are for the frequency of occurrence stated (one percent of the time). Higher wind speeds will occur, but on a less frequent basis.

Wind criteria recommended by the BRA were used in this study.

4.1.4 Pedestrian Wind Comfort Criteria

The BRA has adopted two standards for assessing the relative wind comfort of pedestrians. First, the BRA wind design guidance criterion states that an effective gust velocity (hourly mean wind speed +1.5 times the root-mean-square wind speed) of 31 miles per hour (mph) should not be exceeded more than one percent of the time. The second set of criteria used by the BRA to determine the acceptability of specific locations is based on the work of Melbourne[1]. This set of criteria is used to determine the relative level of pedestrian wind comfort for activities such as sitting, standing, or walking as shown on Table 4.1-1. The criteria are expressed in terms of benchmarks for the one-hour mean wind speed exceeded 1% of the time (i.e., the 99-percentile mean wind speed).

Table 4.1-1 BRA Mean Wind Criteria*

Dangerous	> 27 mph
Uncomfortable for Walking	> 19 and ≤ 27 mph
Comfortable for Walking	> 15 and ≤ 19 mph
Comfortable for Standing	> 12 and ≤ 15 mph
Comfortable for Sitting	< 12 mph

* Applicable to the hourly mean wind speed exceeded one percent of the time.

The wind climate found in a typical downtown location in Boston is generally comfortable for the pedestrian use of sidewalks and thoroughfares and meets the BRA effective gust velocity criterion of 31 mph. However, without any mitigation measures, this wind climate is likely to be frequently uncomfortable for more passive activities such as sitting.

1 Melbourne, W.H., 1978, "Criteria for Environmental Wind Conditions", Journal of Industrial Aerodynamics, 3 (1978) 241 - 249.

4.1.5 Test Results

Appendix D presents the mean and effective gust wind speeds for each season, as well as those averaged annually. Figures 4.1-6 and 4.1-7 graphically depict the wind comfort conditions at each wind measurement location based on the annual winds. The sensor layout upon which the study is based is presented in Figures 4.1-6 and 4.1-7. The placement of wind measurement locations was based on RWDI's experience and understanding of the pedestrian usage for this site. It was reviewed by the BRA prior to testing. Wind criteria recommended by the BRA were used in this study. Typically the summer and fall winds tend to be more comfortable than the annual winds, while the winter and spring winds are less comfortable than the annual winds. The following summary of pedestrian wind comfort is based on the annual winds for each configuration tested, except where noted below in the text.

4.1.5.1 Existing Configuration

A wind comfort categorization of walking is considered appropriate for sidewalks. Lower wind speeds conducive to standing are preferred at building entrances. As shown in Figure 4.1-6, with the exception of the northwest corner of the Merck Research Laboratories (Location 83), wind conditions in the vicinity were suitable for walking or better annually. At the northwest corner of the Merck Research Laboratories, wind conditions were estimated to be currently uncomfortable for pedestrians.

Similarly, the effective gust criterion (for safety) was met seasonally and annually at all locations except at the northwest corner of the Merck Research Laboratories (Location 83), where the gust wind conditions marginally exceeded the effective gust criterion limit, particularly in the winter months.

4.1.5.2 Build Configuration

Wind conditions suitable for walking are acceptable for sidewalks seasonally and annually. In the winter and spring, walking conditions are also considered acceptable in courtyard areas. The preferred wind climate during the summer should be comfortable for standing in the vicinity of building entrances and courtyards.

Wind conditions in the vicinity were suitable for walking or better on an annual basis (see Figure 4.1-7). In general, wind conditions suitable for standing or sitting were observed near building entrances, while increased wind speeds suitable for walking were observed near building corners and along the roadways.

In general all of the wind conditions were comfortable for walking, sitting or standing as shown on Figure 4.1-7. In addition, the high wind speeds causing the uncomfortable areas observed in the Existing Configuration (Location 83) were improved to being suitable for walking in the Build condition. The effective gust criterion limits (for safety) were not exceeded seasonally or annually at any location.

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RWDI

Figure 4.1-6

Pedestrian Wind Conditions (Annual) - Existing

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RWDI

Figure 4.1-7

Pedestrian Wind Conditions (Annual) - Build

4.2 Shadow Impacts

4.2.1 Introduction and Methodology

A shadow impact analysis was conducted to investigate shadow impacts from the Project during three time periods (9:00 am, 12:00 noon, and 3:00 pm) during the summer solstice (June 21), autumnal equinox (September 21), vernal equinox (March 21), and the winter solstice (December 21). In addition, shadow studies were conducted for the 6:00 pm time period during the summer solstice and autumnal equinox.

The shadow analysis presents the existing shadow and new shadow that would be created by the proposed Project, illustrating the incremental impact of the Project. As requested by the BRA, the existing condition includes proposed massing on Parcel A of Emmanuel College's Endowment Campus (immediately north of the Project site) as included in their 2000 Institutional Master Plan, proposed massing for the redevelopment of the Julie Hall site, and the renovation and addition to the Cardinal Cushing Library as described in their IMP. The analysis focuses on nearby open spaces and the sidewalks adjacent to and in the vicinity of the Project site. Shadows have been determined using the applicable Altitude and Azimuth data for Boston. Figures showing the net new shadow from the Project are provided in Figures 4.2-1 to 4.2-11.

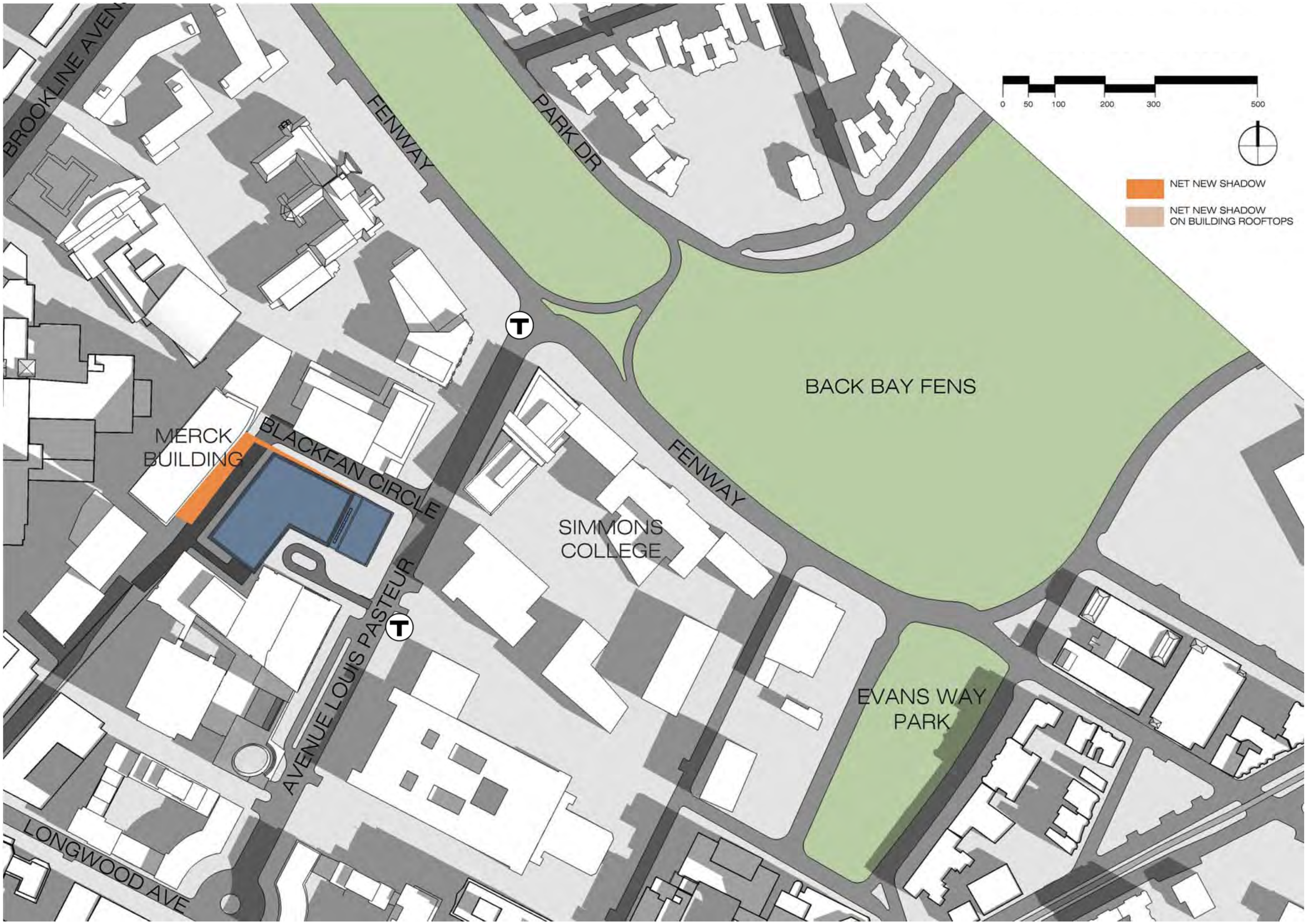
New shadow will generally be limited to the immediately surrounding streets and sidewalks. Nearby bus stops, The Fenway and Park Drive will not be impacted by new shadow from the Project during any of the time periods studied. During 10 of the 11 time periods studied, no new shadow will be cast onto the Back Bay Fens.

4.2.2 Vernal and Autumnal Equinoxes (March and September 21)

No new shadow will be cast onto nearby bus stops, the Back Bay Fens, The Fenway or Park Drive during the time periods studied for the vernal and autumnal equinoxes.

At 9:00 am during the vernal and autumnal equinoxes, new shadow from the Project will be cast to the northwest and is limited to only a small portion of the western sidewalk of Blackfan Circle.

At 12:00 pm, new shadow will be cast to the north onto Blackfan Circle and its sidewalks to the north and northwest. New shadow will be cast onto a small portion of open space on Emmanuel College's campus between the Merck building and Parcel A.



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nbbj

Figure 4.2-1

March/September 21st, 9:00 AM

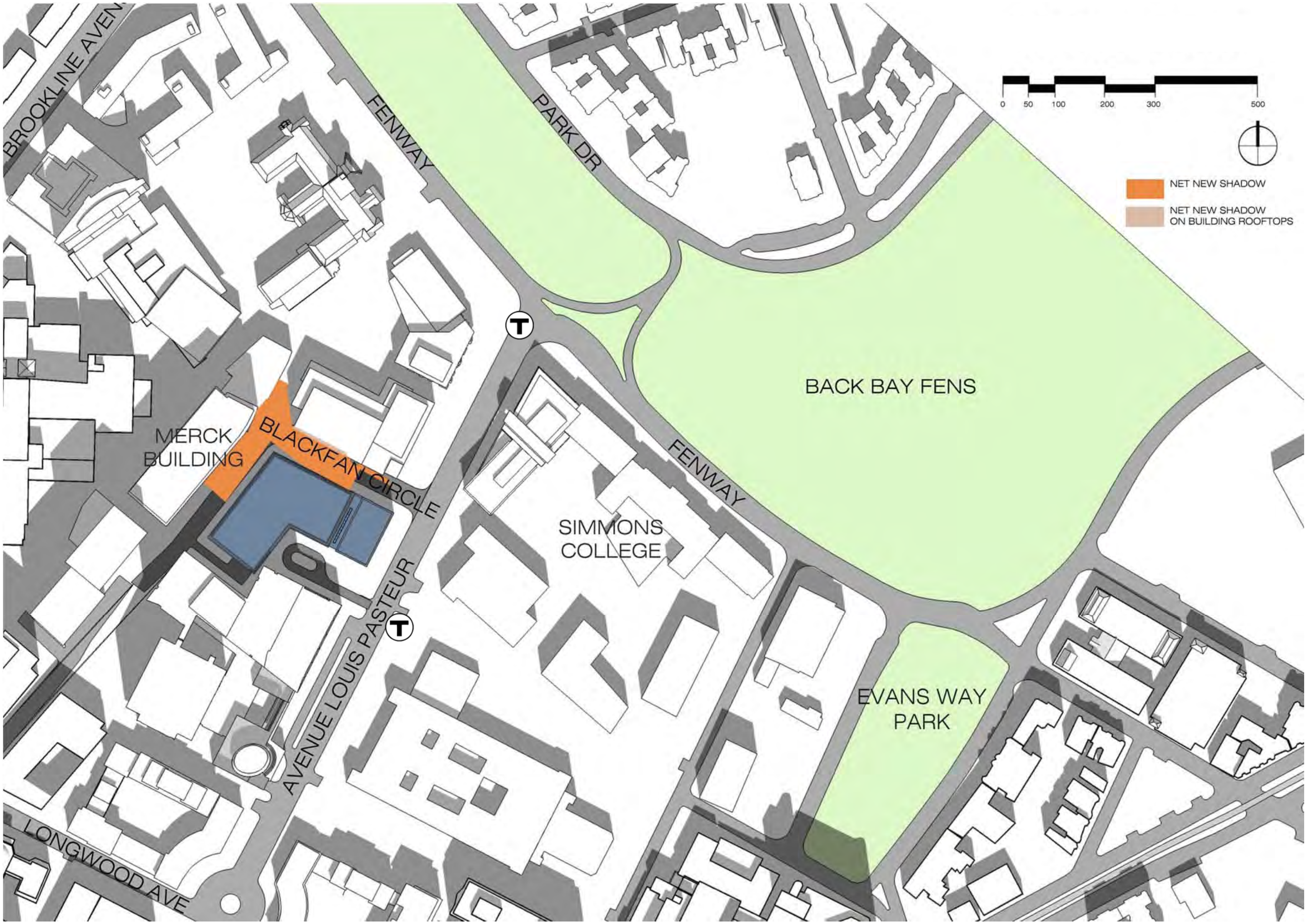

Figure 4.2-2

March/September 21st, 12:00 PM

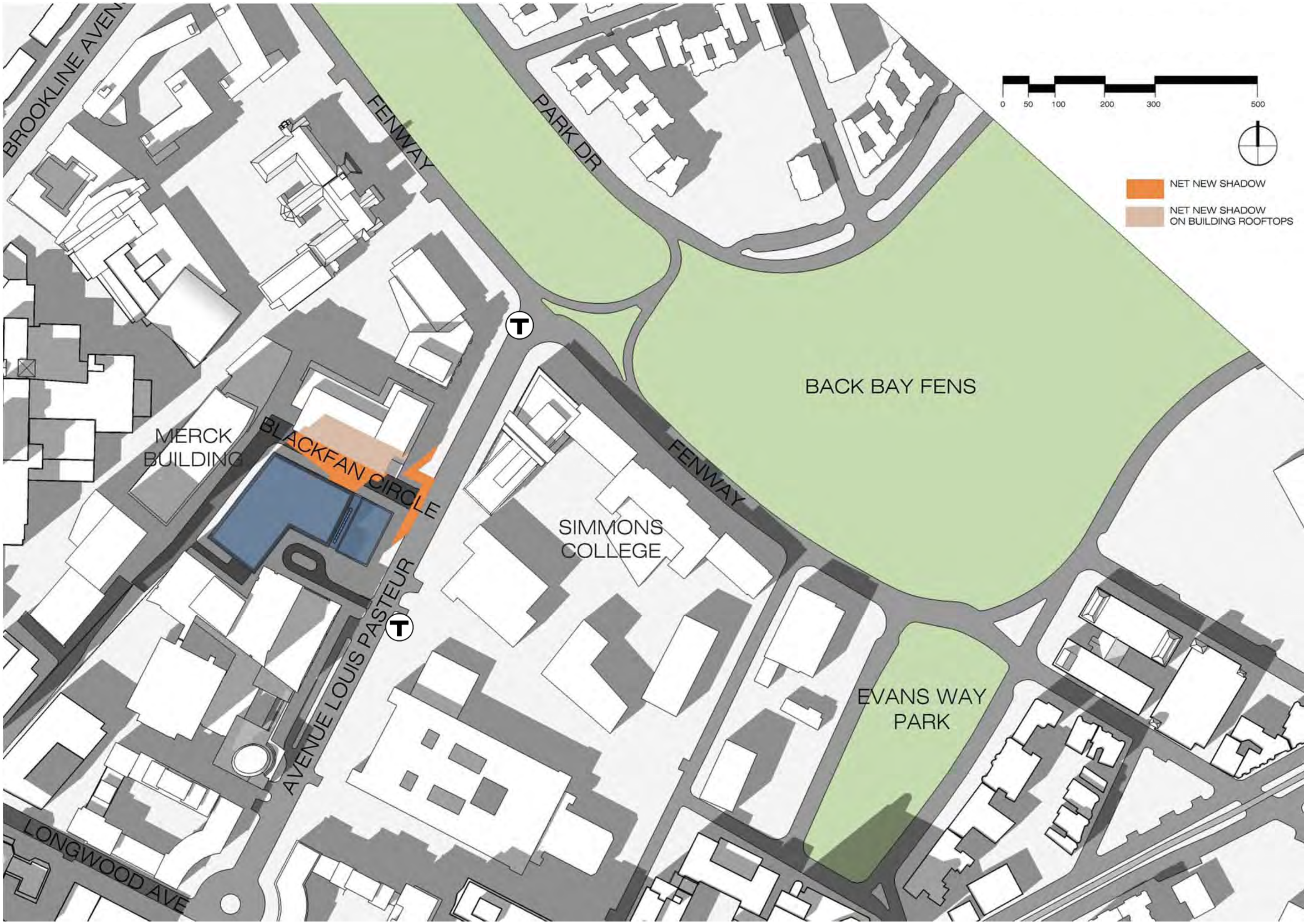

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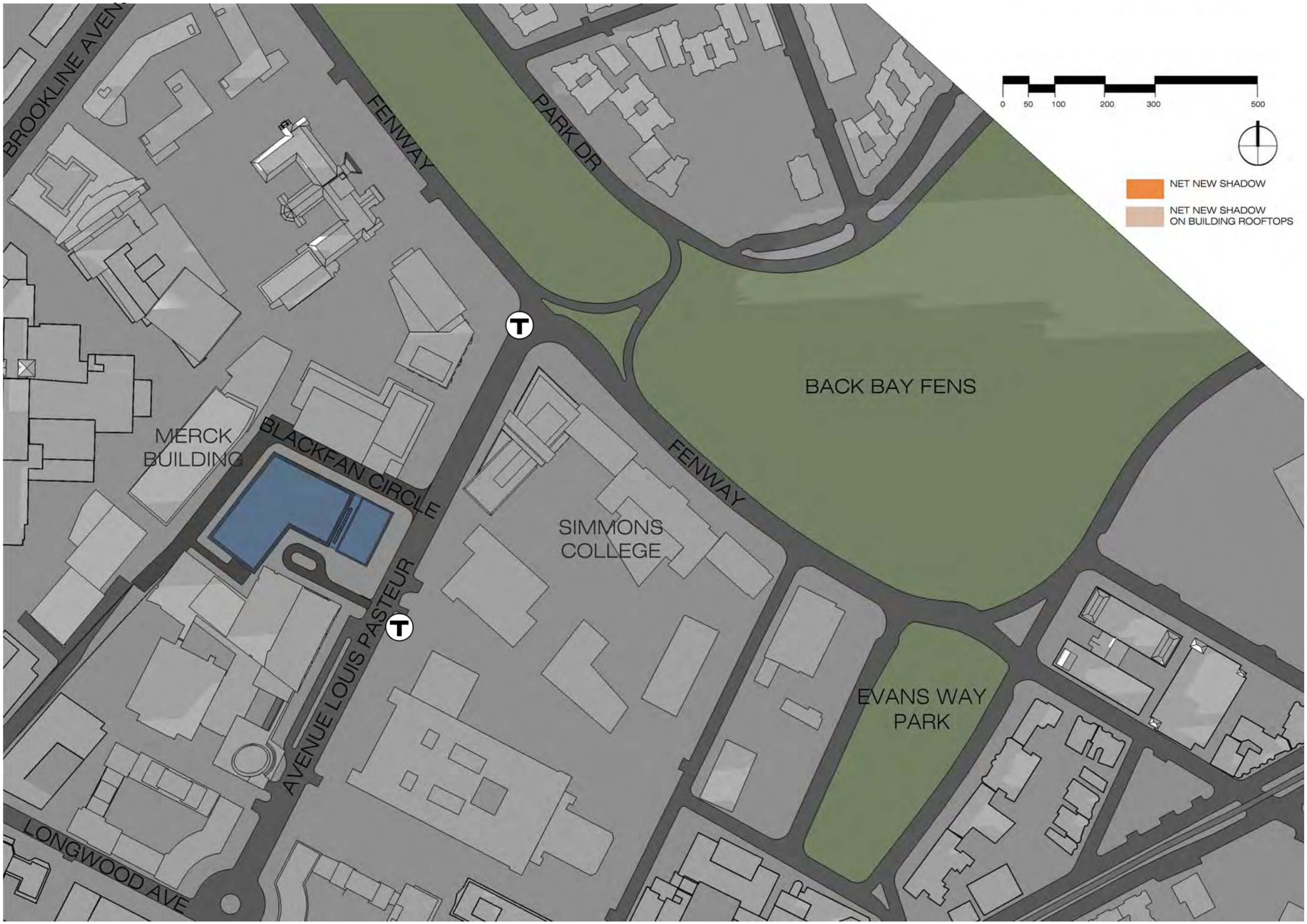
Figure 4.2-3

March/September 21st, 3:00 PM

nbbj



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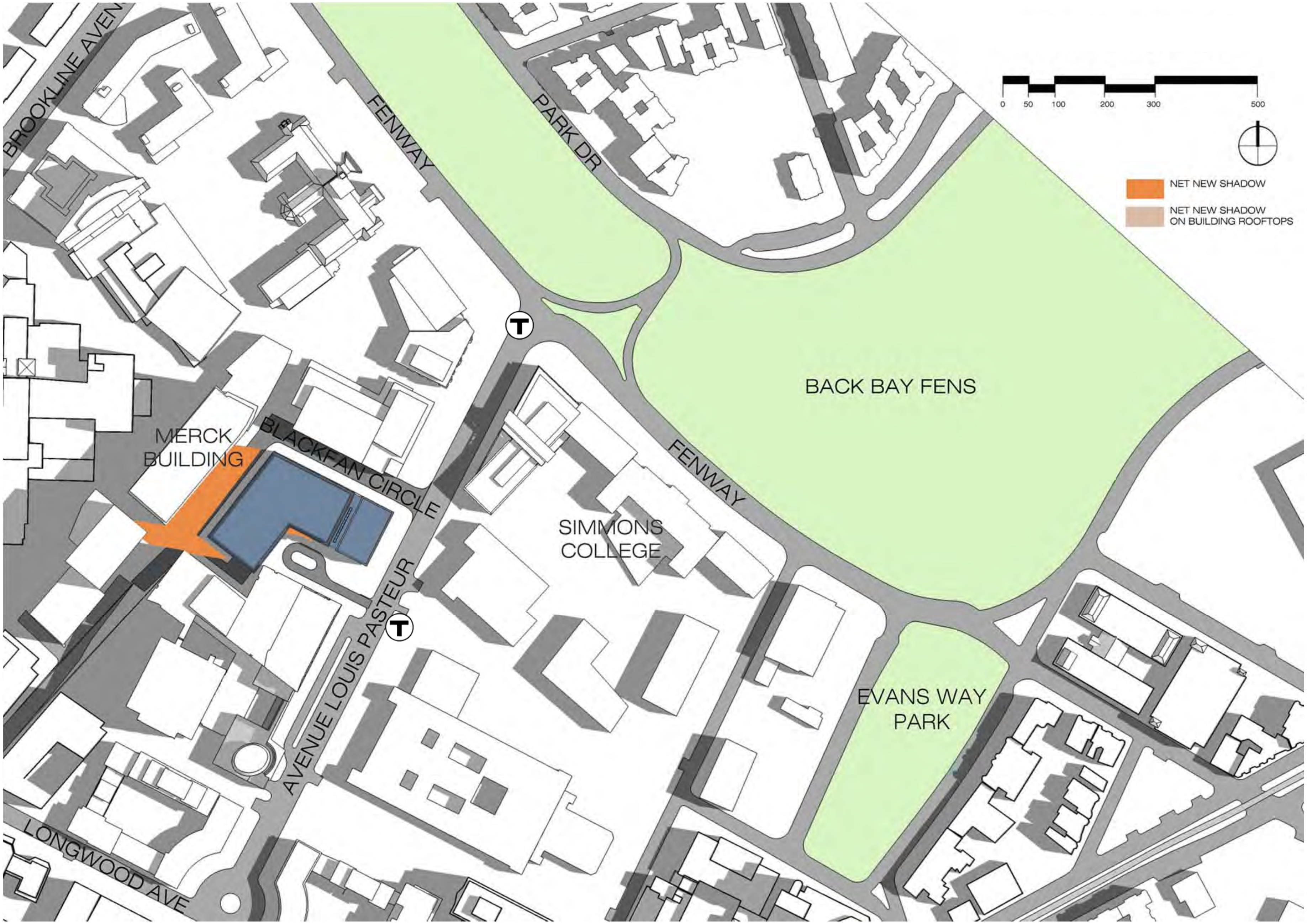
nbbj

Figure 4.2-4

March/September 21st, 6:00 PM



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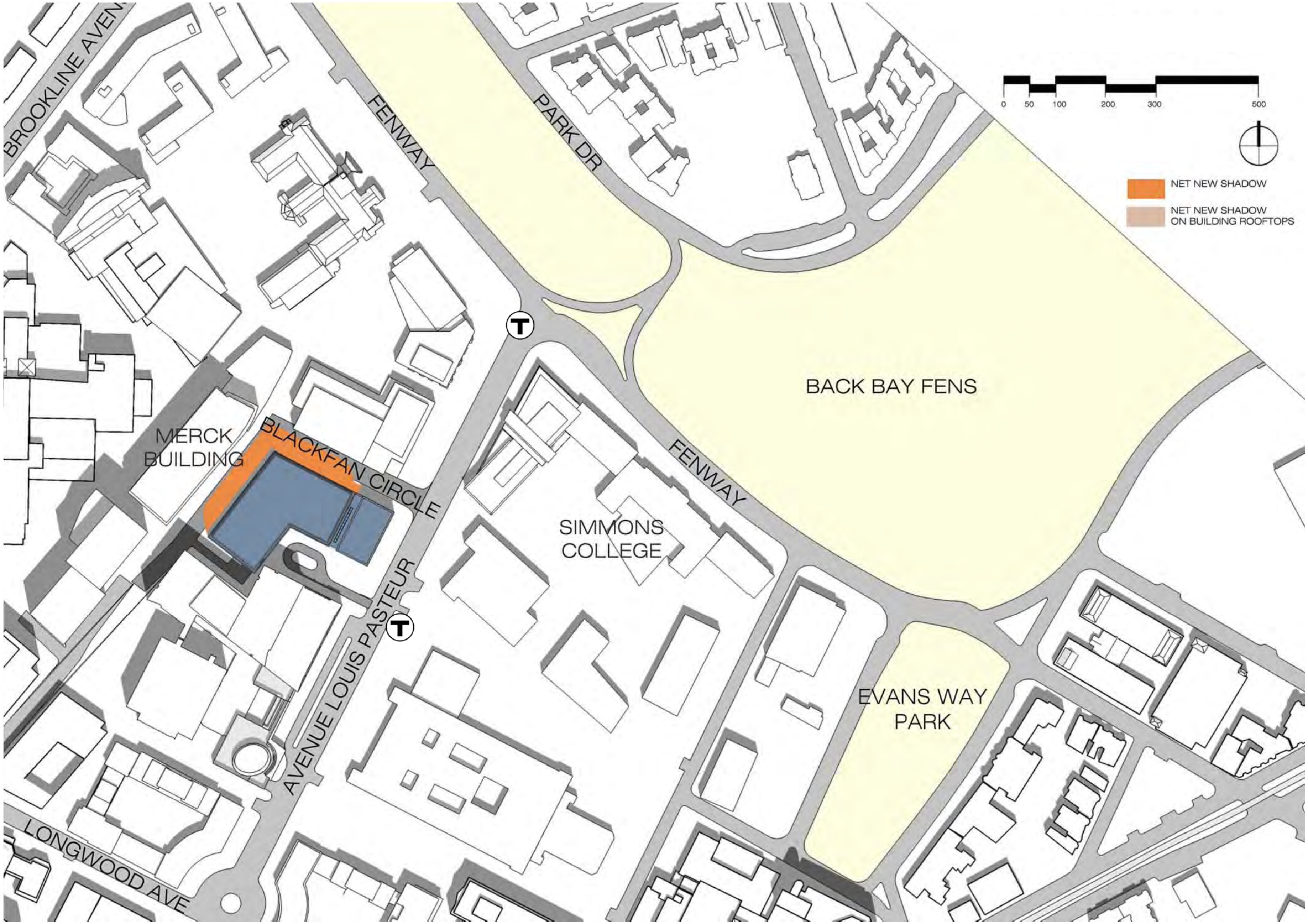
nbbj

Figure 4.2-5

June 21st, 9:00 AM



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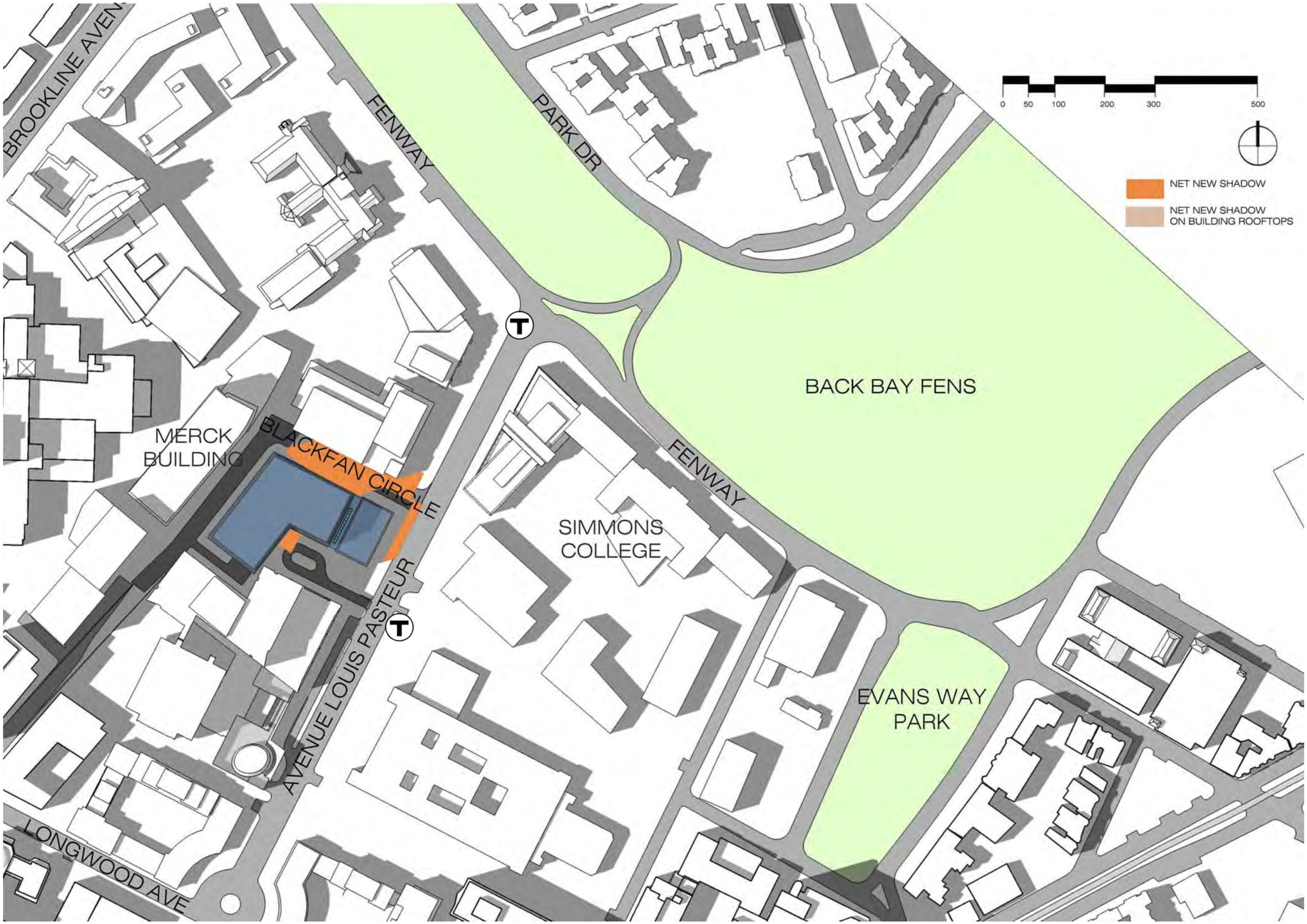
nbbj

Figure 4.2-6

June 21st, 12:00 PM



BWH 2012 IMP Amendment Project Boston, MA

nbbj

Figure 4.2-7

June 21st, 3:00 PM

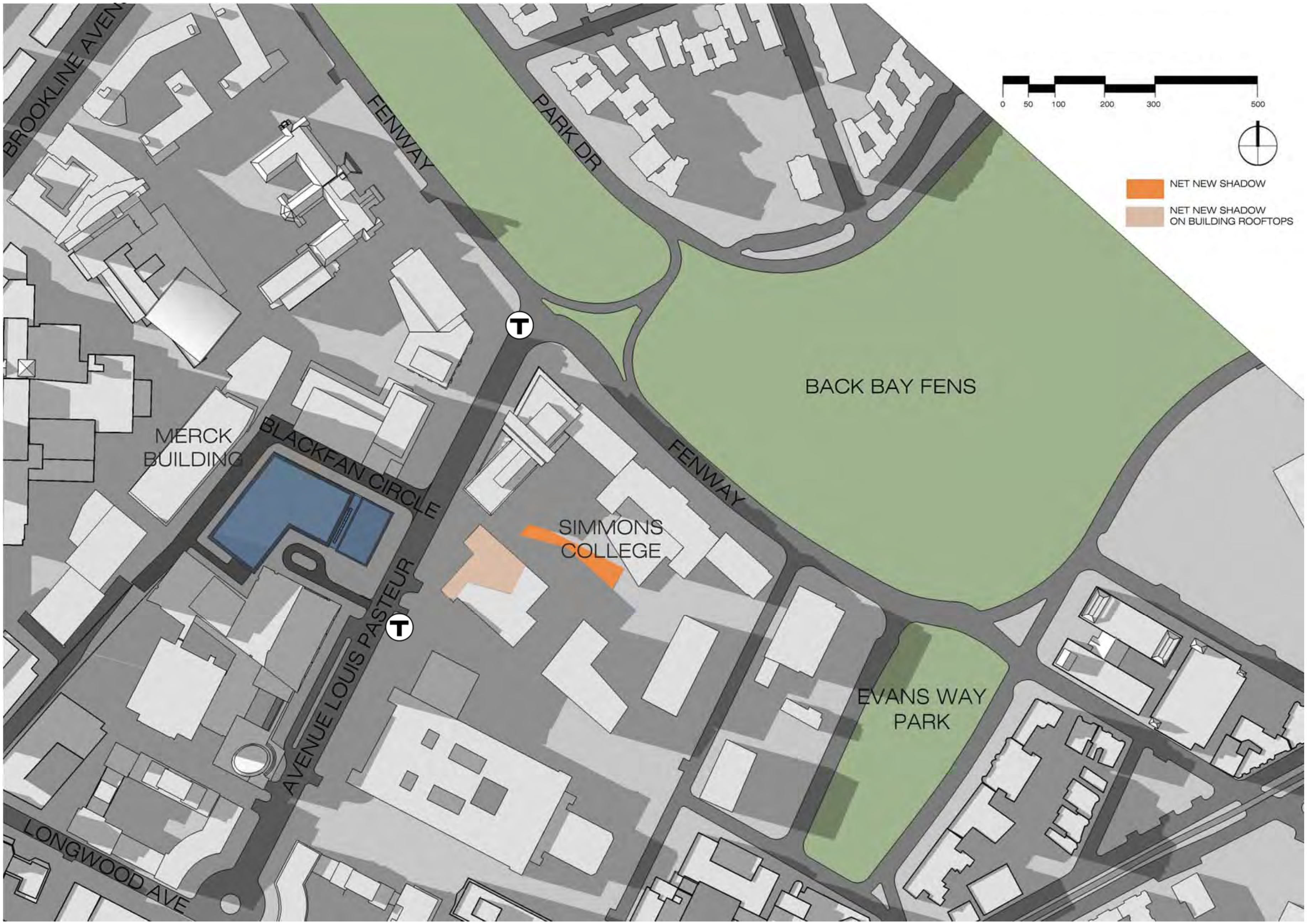
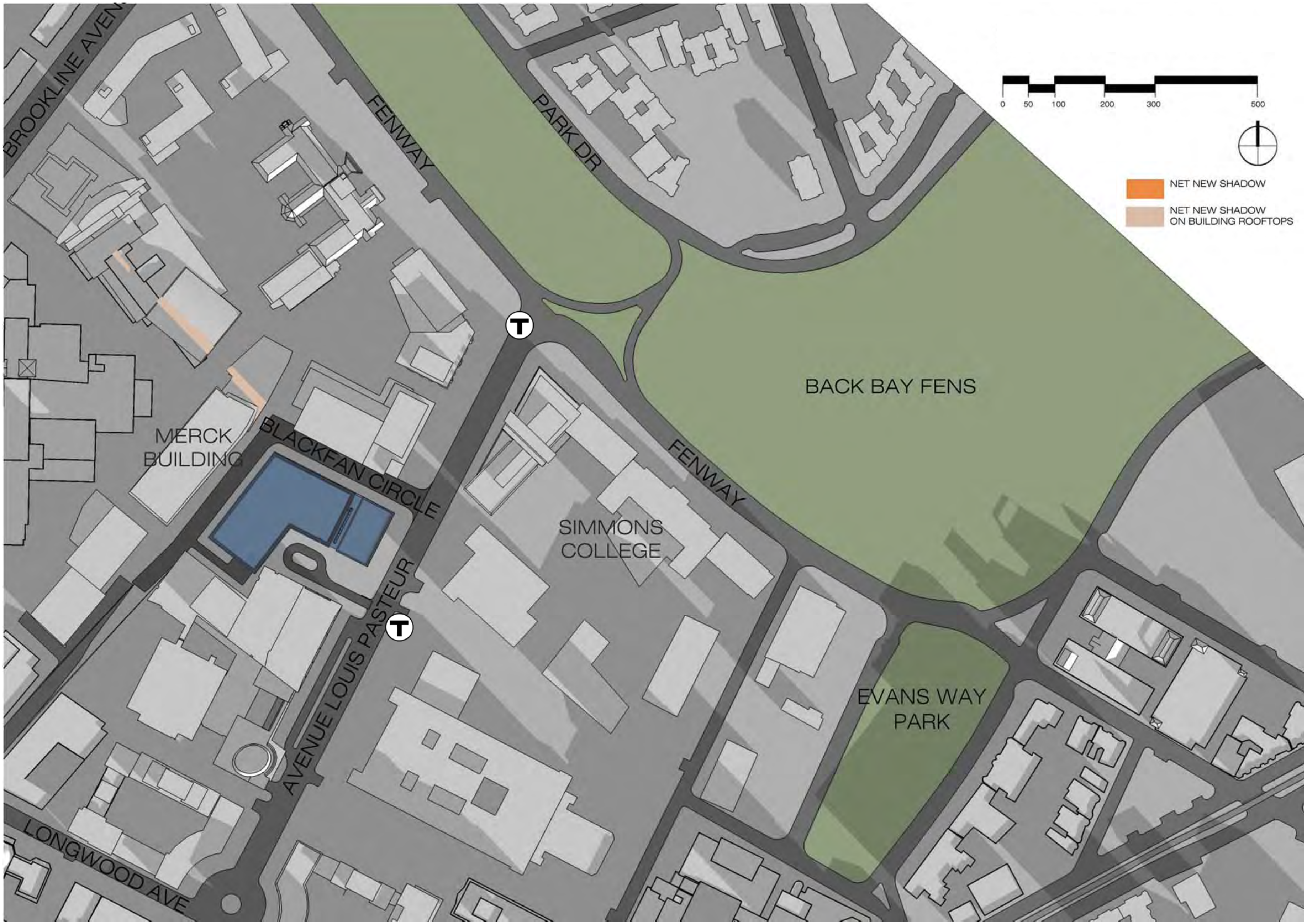


Figure 4.2-8

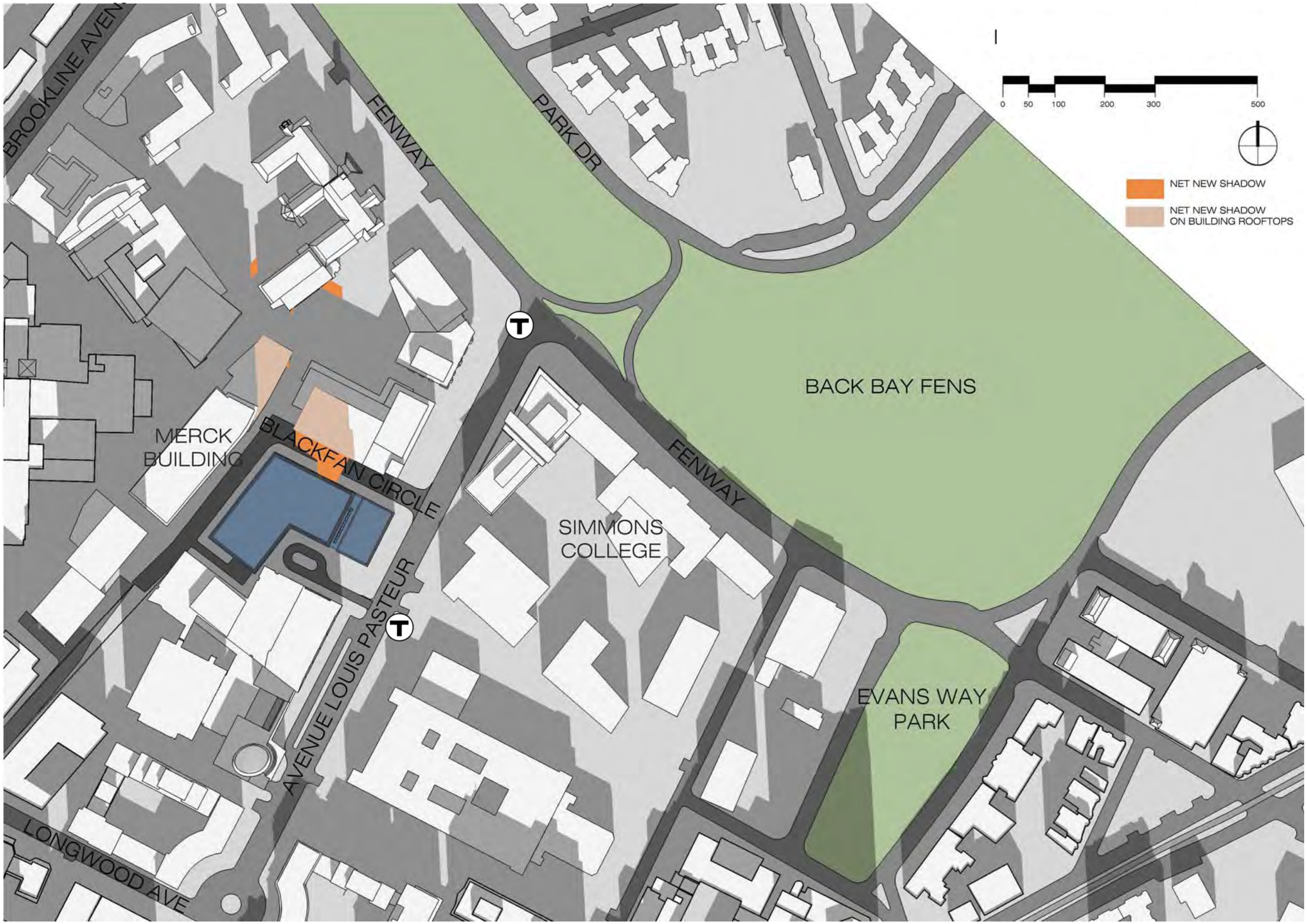
June 21st, 6:00 PM



BWH 2012 IMP Amendment Project   Boston, MA

Figure 4.2-9

December 21st, 9:00 AM



BWH 2012 IMP Amendment Project **Boston, MA**

nbbj

Figure 4.2-10

December 21st, 12:00 PM

Figure 4.2-11

December 21st, 3:00 PM

At 3:00 pm, new shadow will be cast to the northeast across Blackfan Circle and its sidewalks, a small portion of Avenue Louis Pasteur and its western sidewalk, and onto a small portion of the Emmanuel College campus east of Parcel A.

At 6:00 pm, much of the area is under existing shadow. No new shadow will be created by the Project on the surrounding area.

4.2.3 Summer Solstice (June 21)

No new shadow will be cast onto nearby bus stops, the Back Bay Fens, The Fenway or Park Drive during the summer solstice time periods studied.

At 9:00 am during the summer solstice, new shadow is cast in a westerly direction and will be cast onto a portion of Blackfan Circle and its sidewalks, as well as an area just south of the Merck building.

At 12:00 pm, new shadow will be cast to the north and is limited to Blackfan Circle and its sidewalk to the northwest of the Project site and its southern sidewalk to the north of the Project site.

At 3:00 pm, new shadow will be cast to the northeast on Blackfan Circle and its sidewalks, and Avenue Louis Pasteur's western sidewalk.

At 6:00 pm, new shadow from the Project will be cast in the easterly direction and will be limited to a small portion of open space on the Simmons College campus.

4.2.4 Winter Solstice (December 21)

The winter solstice creates the least favorable conditions for sunlight in New England. The sun angle during the winter is lower than in any other season, causing the shadows in urban areas to elongate and be cast onto large portions of the surrounding area. No new shadow will be cast onto nearby bus stops, The Fenway or Park Drive during the winter solstice time periods studied.

At 9:00 am, new shadow will be cast to the northwest and will be limited to rooftops.

At 12:00 pm, new shadow is cast to the north. New shadow is cast onto a portion of Blackfan Circle and its sidewalks, as well as minor portions of the open space on the Emmanuel College campus.

At 3:00 pm, new shadow is cast to the northeast onto a small portion of Avenue Louis Pasteur. New shadow is also cast onto a the Back Bay Fens.

4.2.5 Conclusions

The shadow impact analysis looked at net new shadow created by the Project during 11 time periods. New shadow will generally be limited to the immediately surrounding streets and sidewalks and in some cases, new shadow will be cast onto small portions of open space on the Emmanuel College campus. New shadow will also be cast onto a small portion of Simmons College campus during one time period studied. Nearby bus stops, The Fenway and Park Drive will not be impacted by new shadow from the Project during any of the time periods studied. During 10 of the 11 time periods studied, no new shadow will be cast onto the Back Bay Fens.

4.3 Daylight Analysis

4.3.1 Introduction

The purpose of the daylight analysis is to estimate the extent to which a proposed project will affect the amount of daylight reaching the streets and the sidewalks in the immediate vicinity of a project site. The daylight analysis for the Project considers the daylight conditions for existing and proposed scenarios, as well as those of the surrounding area.

The Project site is currently occupied by two structures, an approximately 50,000 sf building and a parking garage. Although the development of the Project will result in increased daylight obstruction at the site over existing conditions, the resulting conditions are typical of a densely developed area and are similar to daylight obstruction values associated with other existing buildings in the vicinity of the Project site.

4.3.2 Methodology

The daylight analysis was performed using the Boston Redevelopment Authority Daylight Analysis (BRADA) computer program. This program measures the percentage of skydome that is obstructed by a project, and is a useful tool in evaluating the net change in obstruction from existing to build conditions at a specific site.

Using BRADA, a silhouette view of the building is taken at ground level from the middle of the adjacent city streets centered on the proposed building. The façade of the building facing the viewpoint, including heights, setbacks, corners and other features, is plotted onto a base map using lateral and elevation angles. The two-dimensional base map generated by BRADA represents a figure of the building in the "sky dome" from the viewpoint chosen. Due to the constraints of the BRADA program, the setbacks of the building may be simplified or the building may be divided into sections in some cases. The BRADA program calculates the percentage of daylight that will be obstructed on a scale of 0% to 100% based on the width of the view, the distance between the viewpoint and the building, and the massing and setbacks incorporated into the design of the building; the lower the number, the lower the percentage of obstruction of daylight from a given viewpoint.

The analysis treats the following elements as controls for data comparison:

- Existing Conditions;
- Proposed Conditions; and
- The Context of the Area.

The as-of-right build-out of the site will be determined through the Article 80D process and is presumed to be similar to the proposed condition; therefore, an as-of-right condition was not analyzed.

Viewpoints were chosen along Avenue Louis Pasteur (Viewpoint 1), Blackfan Circle north of the site (Viewpoint 2), and Blackfan Circle west of the site (Viewpoint 3). The daylight analysis examined daylight obstruction from the three locations for the existing and proposed conditions. Additionally, this study considered area context points to provide a basis of comparison to existing conditions in the surrounding area. These area context viewpoints were taken along Avenue Louis looking at Harvard Medical School's New Research Building (AC1) and Blackfan Circle looking towards the Merck building (AC2). The viewpoints are illustrated on Figure 4.3-1.

4.3.3 Results of Daylight Analysis

The results for each viewpoint under each alternative condition are described in Table 4.3-1. Figures 4.3-2 through 4.3-4 illustrate the BRADA results for each analysis and are located at the end of this section.

Table 4.3-1 Viewpoint Locations

Viewpoint Locations		Existing Conditions	Proposed Conditions
Viewpoint 1	Avenue Louis Pasteur looking west at the site	20.7%	20.7%
Viewpoint 2	Blackfan Circle looking south at the site	15.4%	76.2%
Viewpoint 3	Blackfan Circle looking east at the site	59.6%	84.9%
Area Context Points			
AC1	Avenue Louis Pasteur looking west at Harvard Medical School's New Research Building	59.1%	
AC2	Blackfan Circle looking west at Merck Building	89.5%	

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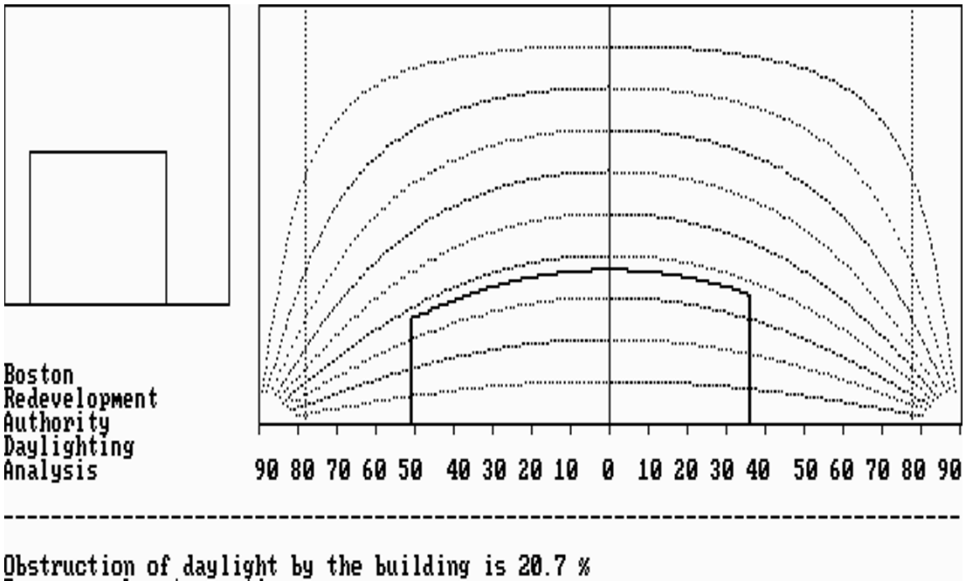
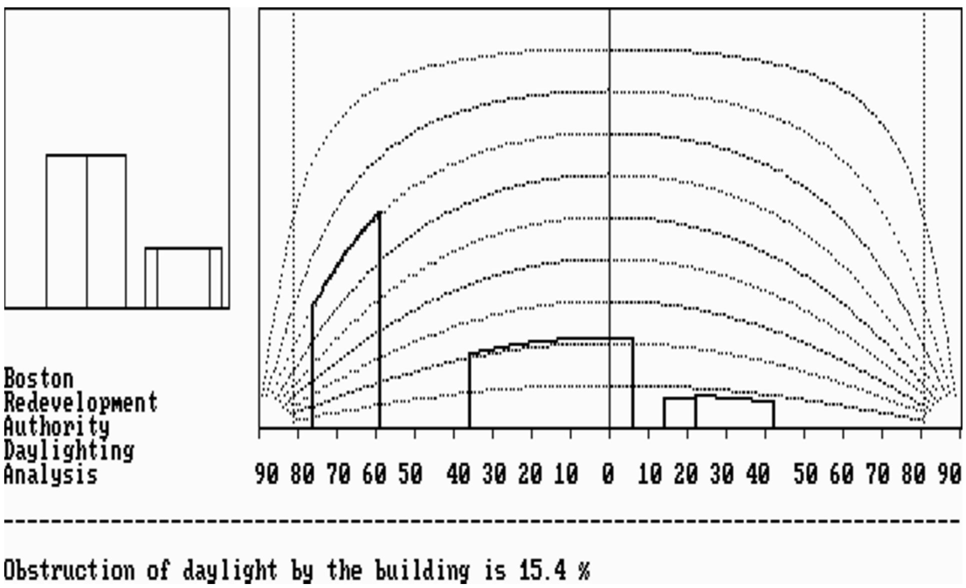
Figure 4.3-1

Daylight Analysis - Viewpoints



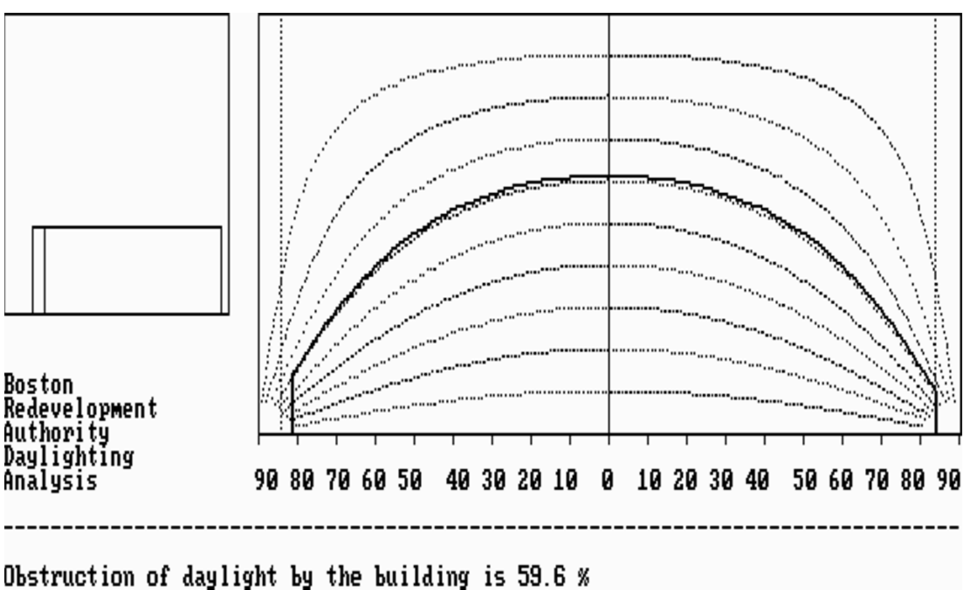
Viewpoint 1

Avenue Louis Pasteur Looking West at the Site



Viewpoint 2

Blackfan Circle Looking South at the Site

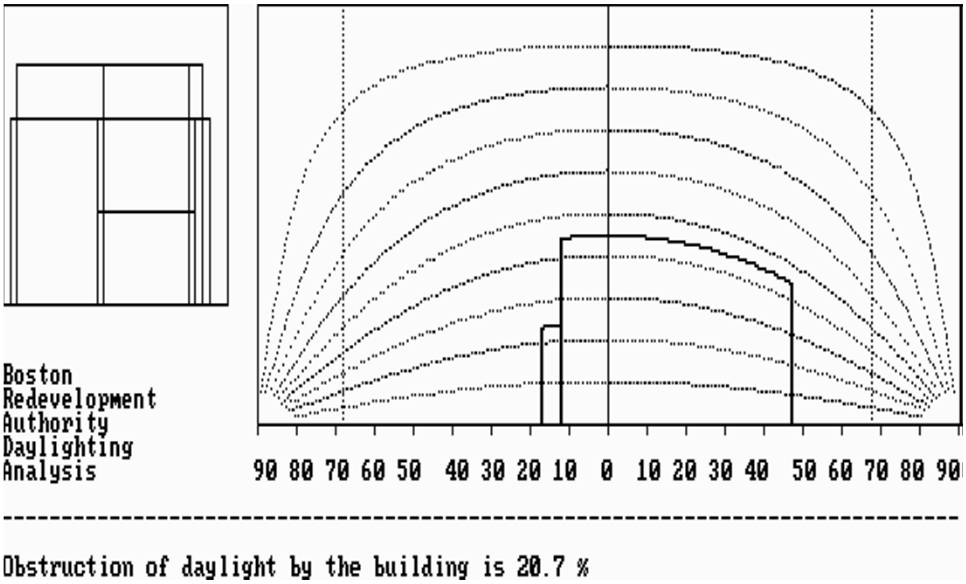


Viewpoint 3

Blackfan Circle Looking East at the Site

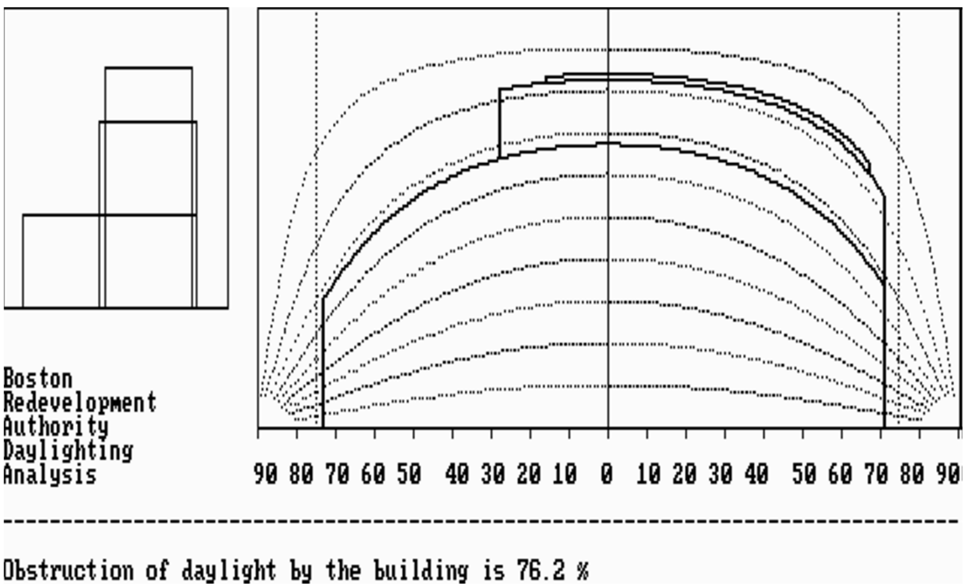
Figure 4.3-2

Existing Condition Viewpoints



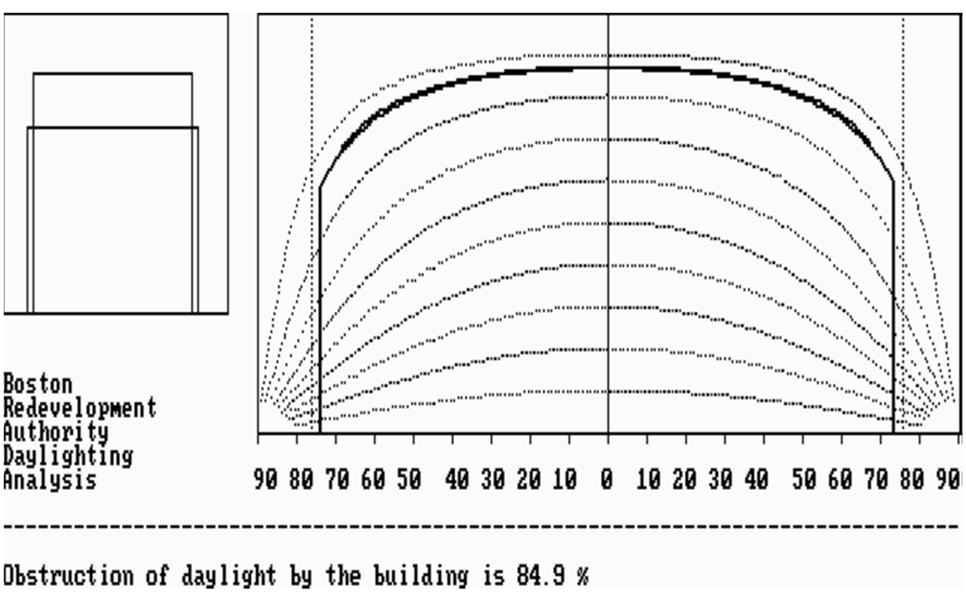
<u>Viewpoint 1</u>

Avenue Louis Pasteur Looking West at the Site



<u>Viewpoint 2</u>

Blackfan Circle Looking South at the Site

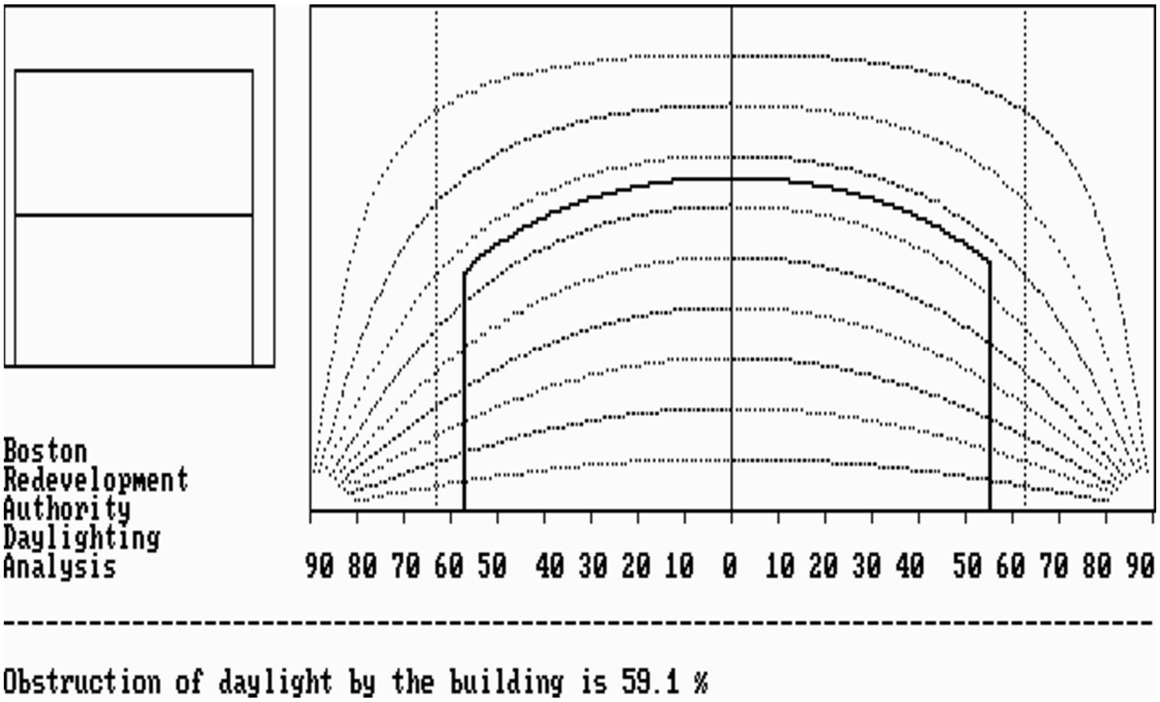


<u>Viewpoint 3</u>

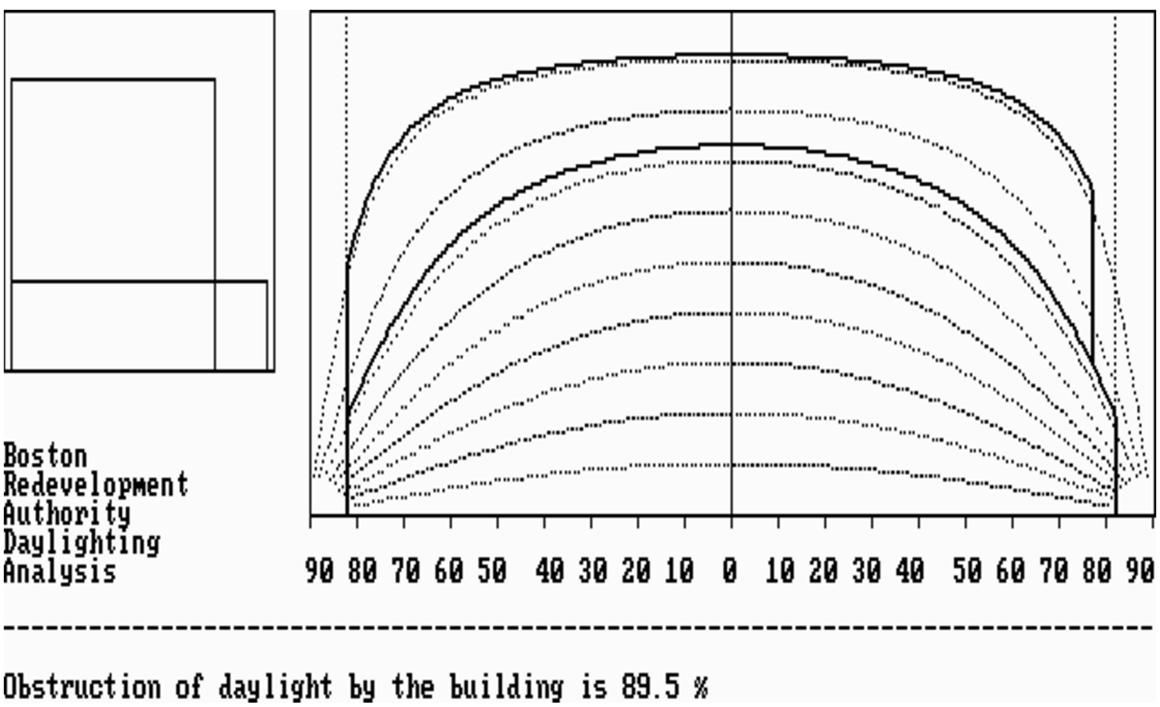
Blackfan Circle Looking East at the Site

Figure 4.3-3

Proposed Condition Viewpoints



AC1: Avenue Louis Pasteur Looking West at Harvard Medical School's New Research Building



AC2: Blackfan Circle Looking West at Merck Building

4.3.3.1 Viewpoint 1

Viewpoint 1 was taken from Avenue Louis Pasteur looking west towards the Project site. The existing site includes Alumnae Hall, which has the same approximate setback from the street as the proposed building. Although Alumnae Hall is shorter than the proposed Project, the portion of the proposed Project adjacent to Avenue Louis Pasteur is similar in height to the existing building. The daylight obstruction value from this viewpoint is identical in the existing and proposed conditions at 20.7%.

4.3.3.2 Viewpoint 2

Viewpoint 2 was taken from Blackfan Circle looking south at the Project site. The existing buildings on the Project site are on the east and west side of this view, leaving a large space in the middle. Therefore, the daylight obstruction value is low at 15.4%. The proposed Project covers more of the site from this viewpoint, especially the tallest portions of the proposed building. The daylight obstruction value, therefore, is higher at 76.2% and is more typical of urban areas and other locations on Blackfan Circle.

4.3.3.3 Viewpoint 3

Viewpoint 3 was taken from Blackfan Circle looking east at the Project site. The view includes the length of the existing parking garage on the site, which has a minimal setback from the street. The daylight obstruction value for the existing condition is 59.6%. The tallest portion of the proposed Project will be located along this portion of the site, with some set back from the street. The daylight obstruction value is 84.9%. This daylight obstruction value, however, is similar to those found along Blackfan Circle south of the site and other locations in the LMA.

4.3.3.4 Area Context Viewpoints

The areas immediately adjacent to the Project site on the south and west are dense and include tall buildings, while areas to the north and east are less dense, generally academic campuses, and include shorter buildings. Similar buildings immediately adjacent to the Project site have similar daylight obstruction values. Harvard Medical School's New Research Building has a daylight obstruction value of 59.1% from Avenue Louis Pasteur. The Merck building across Blackfan Circle from the Project site has a daylight obstruction value of 89.5%.

4.3.4 Conclusion

The daylight analysis conducted for the Project shows existing and proposed daylight obstruction conditions at the Project site and in the surrounding area. The Project design sets the taller portion of the building back from Avenue Louis Pasteur, and matches the existing streetwall along this street. The taller portions are placed along Blackfan Circle, similar to other taller buildings on sites adjacent to the Project. The results of the BRADA analysis indicate that while the development of the Project will result in increased daylight obstruction at the site over existing conditions, the resulting conditions generally will be consistent with the area context.

4.4 Air Quality

4.4.1 Introduction

An air quality analysis was conducted to determine the impact of pollutant emissions from combustion and mobile source emissions generated by the Project. A microscale analysis is typically performed to evaluate the potential air quality impacts of carbon monoxide due to traffic flow around the Project area. In addition, for stationary sources (i.e., combustion source stacks and garage vents), United States Environmental Protection Agency (EPA) approved air dispersion models were used to estimate Project-generated ambient concentrations of NOx, PM-10 and PM-2.5, and sulfur dioxide SO_2, in addition to CO.

The impacts were added to monitored background values and compared to the Federal NAAQS. The standards were developed by EPA to protect the human health against adverse health effects with a margin of safety.

The modeling methodology was developed in accordance with the latest Massachusetts Department of Environmental Protection (MassDEP) modeling policies and Federal modeling guidelines.[2]

Modeling assumptions and backup data for results presented in this section are provided in Appendix E.

The air quality analysis results show that carbon monoxide (CO), nitrogen oxides (NOx), particulate matter (PM-10, PM-2.5), and SO_2 (sulfur dioxide) concentrations at all receptors studied are well under the National Ambient Air Quality Standards (NAAQS) thresholds.

4.4.2 Microscale Analysis

A microscale analysis is used to determine the effect on air quality of the increase in traffic generated by the Project. A proponent is required to analyze local effects of the potential increase in traffic on ambient air quality near specific intersections. A microscale analysis is required for the Project at intersections where 1) Project traffic would impact intersections or roadway links currently operating at Level of Service (LOS) D, E, or F or would cause LOS to decline to D, E, or F; 2) Project traffic would increase traffic volumes on nearby roadways by 10% or more (unless the increase in traffic volume is less than 100 vehicles per hour); or, 3) the Project will generate 3,000 or more new average daily trips on roadways providing access to a single location.[3] The microscale analysis involves modeling

2 40 CFR 51 Appendix W, Guideline on Air Quality Models, 70 FR 68228, Nov. 9, 2005

3 BRA, Development Review Guidelines, 2006.

CO emissions from vehicles idling at and traveling through both signaled and unsignalized intersections. Predicted ambient concentrations of CO for the Build and No-Build cases are compared with federal and state ambient air quality standards for CO.

The microscale analysis typically examines ground-level CO impacts due to traffic queues in the immediate vicinity of a project. CO is used in microscale studies to indicate roadway pollutant levels since it is the most abundant pollutant emitted by motor vehicles and can result in so-called "hot spot" (high concentration) locations around congested intersections. NAAQS have been established by the EPA for CO to protect the public health (known as primary standards). These standards do not allow ambient CO concentrations to exceed 35 parts per million (ppm) for a one-hour averaging period and 9 ppm for an eight-hour averaging period, more than once per year at any location. The widespread use of CO catalysts on late-model vehicles has reduced the occurrences of CO hotspots. Air quality modeling techniques (computer simulation programs) are typically used to predict CO levels for both existing and future conditions to evaluate compliance of the roadways with the standards. The analysis followed the procedure outlined in U.S. EPA's intersection modeling guidance.[4]

The microscale analysis has been conducted using the latest versions of EPA MOBILE6.2, CAL3QHC, and AERMOD to estimate CO concentrations at sidewalk receptor locations.

Baseline (2012) and future year (2022) emission factor data calculated from the MOBILE6.2 model, along with traffic data, were input into the CAL3QHC program to determine CO concentrations due to traffic flowing through the selected intersections. AERMOD was used to estimate potential ground-level impacts due to emissions from the parking garage and combustion sources.

Existing background values of CO at the nearest monitor location in Kenmore Square were obtained from MassDEP. CAL3QHC and AERMOD results were then added to background CO values of 1.9 ppm (one-hour) and 1.5 ppm (eight-hour), as provided by MassDEP, to determine total air quality impacts due to the Project. This value was compared to the NAAQS for CO of 35 ppm (one-hour) and 9 ppm (eight-hour).

4.4.2.1 Intersection Selection

An analysis of the seven intersections from the traffic study was conducted (see Chapter 3). Microscale modeling was performed for the four intersections that met the aforementioned criteria for microscale analyses:

- the intersection of Longwood Avenue and Blackfan Circle;
- the intersection of Avenue Louis Pasteur and Blackfan Circle;

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4 U.S. EPA, Guideline for Modeling Carbon Monoxide from Roadway Intersections; EPA-454/R-92-005, November 1992.

- the intersection of Avenue Louis Pasteur and The Fenway; and
- the intersection of Longwood Avenue and Avenue Louis Pasteur.

The traffic volumes and LOS calculations provided in Chapter 3 form the basis of evaluating the traffic data versus the microscale thresholds.

4.4.2.2 Emissions Calculations (MOBILE6.2)

The EPA MOBILE6.2 computer program was used to estimate motor vehicle emission factors on the roadway network. Emission factors calculated by the MOBILE6.2 model are based on motor vehicle operations typical of daily periods. The Commonwealth's statewide annual Inspection and Maintenance (I&M) program was included, as well as the state specific vehicle age registration distribution. The input files for MOBILE6.2 for the existing (2012) and build year (2022) are provided by MassDEP. As is typical, minor edits to the files were necessary to allow the program to output emission factors for the various speeds used in the analysis.

The current version of MOBILE6.2 does not explicitly calculate idle emissions. However, idle emissions can be obtained from a vehicle speed of 2.5 miles per hour (mph) (the lowest speed MOBILE6.2 will model). The resulting emission rate given in grams/mile is then multiplied by 2.5 mph to estimate idle emissions (in grams/hour). Moving emissions are calculated based on actual speeds at which free-flowing vehicles travel through the intersections. A speed of 30 mph is used for all free-flow traffic. Speeds of 10 and 15 mph were used for right (and U-turns, if necessary) and left turns, respectively.

Winter CO emission factors are typically higher than summer. Therefore, winter vehicular emission factors were conservatively used in the microscale analysis.

4.4.2.3 Receptors and Meteorology Inputs

Sets of up to 150 receptors were placed in the vicinity of each of the modeled intersections. Receptors extended approximately 100 to 300 feet on the sidewalks along the roadways approaching the intersection. The roadway links and receptor locations of the modeled intersections are presented in Figures 4.4-1 to 4.4-4.

For the CAL3QHC model, limited meteorological inputs are required.[5, 6]

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5 Following EPA guidance, a wind speed of one m/s, stability class D (4), and a mixing height of 1,000 meters was used. To account for the intersection geometry, wind directions from 0° to 350°, every 10°, were selected. A surface roughness length of 321 cm corresponding to "City Land Use – Central Business District" was selected for the intersection of Blackfan Circle and Longwood Avenue and the intersection of Blackfan Circle and Avenue Louis Pasteur. A roughness length of 127 cm ("city park") was chosen for the intersection of Avenue Louis Pasteur and The Fenway due to the proximity to the Emerald Necklace.

6 U.S. EPA, *User's Guide for CAL3QHC Version 2: A Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections*. EPA –454/R-92-006 (Revised), September 1995

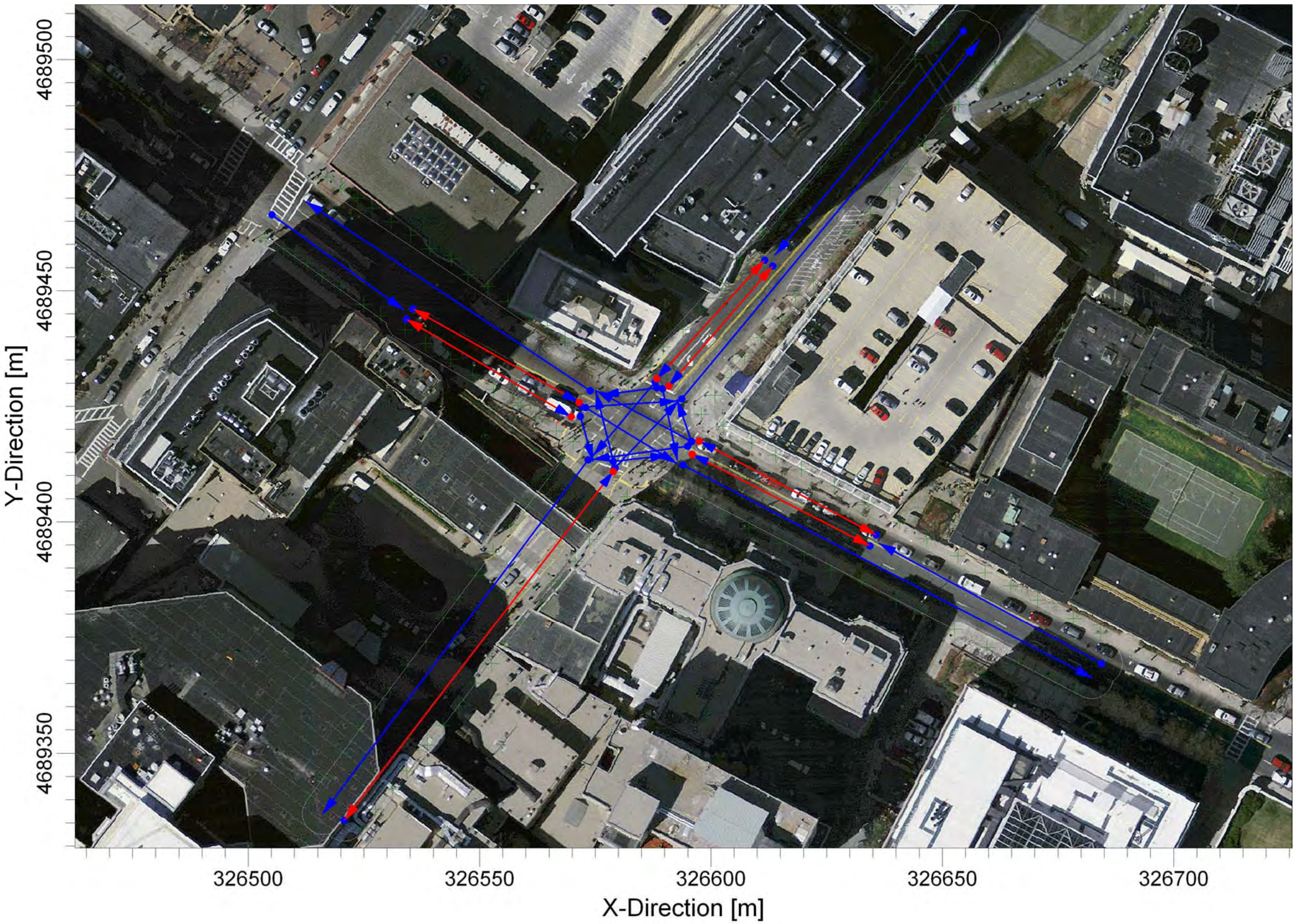

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Figure 4.4-1

Link and Receptor Locations for CAL3QHC modeling of Intersection 1: the intersection of Longwood Avenue and Blackfan Circle

Figure 4.4-2

Link and Receptor Locations for CAL3QHC modeling of Intersection 2: the intersection of Avenue Louis Pasteur and Blackfan Circle

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Figure 4.4-3

Link and Receptor Locations for CAL3QHC modeling of Intersection 1: the intersection of Ave. Louis Pasteur and The Fenway

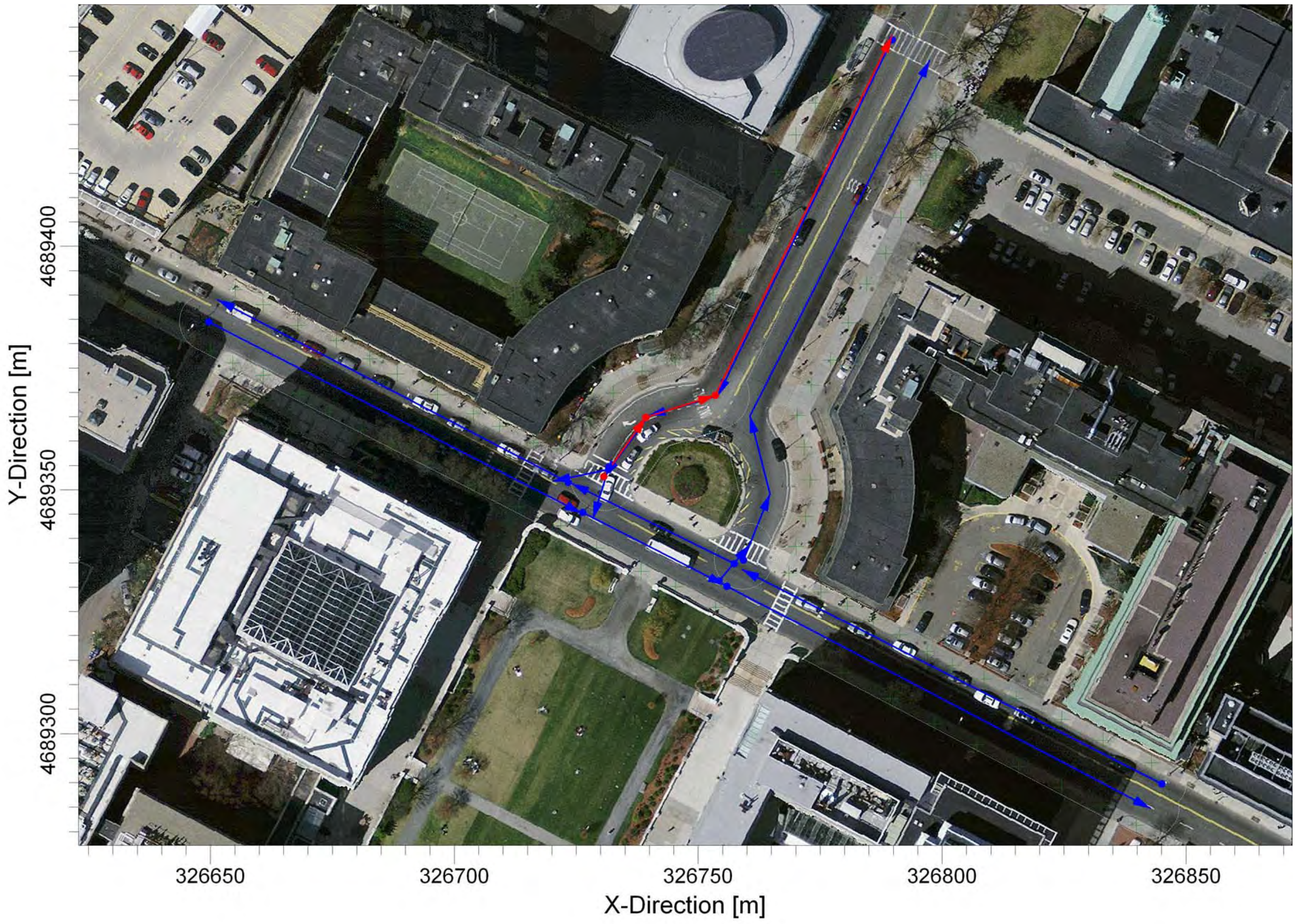

Figure 4.4-4

Link and Receptor Locations for CAL3QHC modeling of Intersection 1: the intersection of Longwood Avenue and Avenue Louis Pasteur

4.4.2.4 Impact Calculations (CAL3QHC)

The CAL3QHC model predicts one-hour concentrations using queue-links at intersections, worst-case meteorological conditions, and traffic input data. The one-hour concentrations were scaled by a factor of 0.7 to estimate eight-hour concentrations.[7] The CAL3QHC methodology was based on EPA CO modeling guidance. Signal timings were provided directly from the traffic modeling runs. For unsignalized intersections, a cycle length of 60 seconds and a red time of 45 seconds were assumed. The CAL3QHC input parameters are also described in Appendix E.

4.4.3 Stationary Source Analysis

4.4.3.1 AERMOD Modeling Methodology

The most recent version of the EPA AERMOD refined dispersion model (Version 11353) was selected to predict concentrations from the stationary sources related to the Project. AERMOD is the EPA's preferred model for regulatory applications. The use of AERMOD provides the benefits of using the most current algorithms available for steady state dispersion modeling.

The ISC-AERMOD View graphical user interface (GUI) Version 7.4, created by Lakes Environmental, was used to facilitate model setup and post-processing of data. The AERMOD model was selected for this analysis as described below:

- the model is the required EPA model for all refined regulatory analyses for receptors within 50 km of a source;
- the model is a refined model for facilities with multiple sources, source types, and building-induced downwash;
- the model uses actual representative hourly meteorological data;
- the model incorporates direction-specific building parameters which can be used to predict impacts within the wake region of nearby structures;
- the model allows the modeling of multiple sources together to predict cumulative downwind impacts;
- the model provides for variable emission rates;

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[7] U.S. EPA, Screening Procedures for Estimating the Air Quality Impact of Stationary Sources; EPA-454/R-92-019, October 1992

- the model provides options to select multiple averaging periods between one-hour and one year (scaling factors can be applied to adjust the one-hour impact to a peak impact less than one-hour); and

- the model allows the use of large Cartesian and polar receptor grids, as well as discrete receptor locations.

Regulatory default options adopted for the model include:

- *Use stack-tip downwash (except for building downwash).* Stack-tip downwash is an adjustment of the actual stack release height for conditions when the gas exit velocity is less than 1.5 times the wind speed. For these conditions, the effective release height is reduced a bit, based on the diameter of the stack and the wind and gas exit velocity. This option applies to point sources only, such as emergency generators, cooling towers, boiler units and garage vents.

- *Use the missing data and calms processing routines*. The model treats missing meteorological data in the same way as the calms processing routine—i.e., it sets the concentration values to zero for that hour, and calculates the short term averages according to EPA's calms policy, as set forth in the Guideline.

The AERMOD model is able to assign sources to a rural or urban category to allow specified urban sources to use the effects of increased surface heating under stable atmospheric conditions. The urban dispersion classification was selected based on a visual inspection of the area within a three kilometer radius of the Project site. A population estimate of 650,000 was obtained from the U.S. Census website (www.census.gov) and is used in the AERMOD model to estimate the urban boundary layer height.

The regional meteorology in Boston is best approximated with meteorological data collected by the nearby Logan International Airport in East Boston, MA. The station is located approximately 4.9 miles (7.9 km) to the east-northeast of the Project site at an elevation of 15 feet (4.57 m) above mean sea level. This station is the closest site for which extensive meteorological data are available which are representative of similar topographic influences that affect the proposed site. Five years (2005-2009) of hourly surface data collected at the station include wind speed and direction, temperature, cloud cover and ceiling height. As standard procedure, upper air data from Gray, Maine was processed along with the surface data. The processed meteorological files for use in AERMOD were provided by MassDEP. These files have been used on other AERMOD applications in the area for review by MassDEP and are presumed to be of sufficient quality for regulatory applications.

A network of 2,087 receptors was used for the refined AERMOD modeling analysis. A nested grid of Cartesian receptors centered on the Project was used. The entire modeling domain encompassed 17.6 square kilometers. The spacing of the receptors was as follows:

- a 600 meter by 600 meter area bounding the Project with receptors spaced every 20 meters;

- an area extending 300 meters from the 20 meter grid with receptors spaced every 50 meters;

- an area extending 500 meters from the 50 meter grid with receptors spaced every 100 meters; and

- an area extending 1,000 meters north and south from the 100 meter grid with receptors spaced every 200 meters.

Terrain data were obtained from the U.S.G.S National Map Seamless Server (www.seamless.usgs.gov) according to guidance set forth by EPA.[8] Source, building, and receptor elevations were processed using the AERMAP processor by way of the Lakes AERMOD View interface.

4.4.3.2 Stationary Sources

Stationary sources of air pollution are typically units that combust fuel. In this case, these sources consist of heating units, electrical generating units, etc.

Boilers

The design anticipates twenty 3 MMBTU/hr domestic hot water units. All units will be natural gas-fired and located in a penthouse mechanical area on the roof of the building. The units are expected to be exhausted through individual stacks.

The boilers will be outside the requirements of the MassDEP's Environmental Results Program (ERP) since individual estimated heat inputs are expected to be below the 10 to 40 mmBtu/hour ERP range. However, emissions were conservatively estimated for each boiler based on MassDEP Boiler ERP program emission limits. Dispersion modeled impacts from the heating units were estimated from exhaust stacks 10 feet above the building roof heights above ground level. For all impacts, the heating equipment is assumed to be in operation 24 hours per day, seven days per week.

Since all boilers are expected to be below the ERP limits of 10 MMBTU/hour, registration with MassDEP would not be required.

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8 U.S. EPA, AERMOD Implementation Guide, March 19, 2009.

Cogeneration

A cogeneration (combined heat and power, CHP) plant is being studied for inclusion in the Project. The units would provide additional hot water to be distributed to the heating loop, as well as additional standby power in the event of a power outage. A cogeneration unit is one of the most efficient ways of producing electricity and heat from a given amount of fuel, since the heat of combustion that would otherwise be lost, is used to address other facility needs. Additionally, it provides a reliable source of power and reduces the dependency on the existing power grid and its emissions from less clean sources of energy (oil and coal).

The units would be located on the roof of the proposed building and are assumed to be designed such that their exhaust stack extends at least 10 feet above the individual building roof height above ground level.

It is assumed that the units would run 24/7 for air quality impact analysis purposes and no aftermarket controls are assumed to be installed.

It is expected that the cogeneration units would be subject to the MassDEP's ERP program for non-emergency engines and turbines if included in the final design.

Emergency Generator

Current design plans are for one 1,250-kilowatt emergency generator to be installed on the building to be constructed. The unit will provide life safety and standby emergency power to the building. The unit will be diesel-fired and located in a mechanical area on the roof of the building. The generator is assumed to be designed such that its exhaust stack extends at least 10 feet above the individual building roof height above ground level.

Typically, the generator will operate for approximately one hour each month for testing and general maintenance. The ERP regulation applies to new emergency generators greater than 37 kW. The regulation is similar to the boiler ERP in that new engines are subject to emission standards, recordkeeping, certification, and compliance with the MassDEP noise policy. Since the generator maximum rating capacity is greater than the ERP limit of 37 kW, it will be subject to the new ERP program. Per the ERP, the generator owner will limit operation of the generator to less than 300 hours per year and submit a certification form to MassDEP within 60 days of installation.

Emissions were estimated for the emergency generator based on vendor supplied data. Comparable equipment was assumed where not provided by the architect or design engineers. The generator is assumed to operate 300 of 8,760 hours per year in the modeling for annual averaging times.

Cooling Towers

Small industrial cooling towers are typically installed on medium to large high rise residential and office buildings to remove the excess heat generated by the building's mechanical equipment. The design is for a three-cell cooling tower, capable of providing approximately 3,600 tons of cooling, to be installed on the proposed building. All units will be located on the roof of the building.

Only emissions of particulate matter are assumed to be produced by the cooling tower cells. The cooling towers are assumed to operate at 100% capacity for 8,760 hours per year. Emissions of all other pollutants from the cooling towers are expected to be negligible.

Emissions and exhaust parameters were based on vendor supplied data and/or engineering judgment.

Loading Dock Exhaust

A loading dock with mechanical ventilation will be part of the proposed building. Carbon monoxide monitors are typically installed within enclosed areas where idling vehicles reside to insure that levels of CO do not exceed health standards.

Emissions from the loading dock were calculated using MOBILE6.2 and an estimate of the total idling time permitted under Massachusetts law (90 MGL Section 16A). It was conservatively assumed that the dock would be 100% utilized from 7:00 am to 4:00 pm and that trucks would idle for five minutes per hour, the Massachusetts legal limit.

To provide a conservative assumption for emissions from the loading dock, an emission rate from MOBILE6.2 of 2.5 mph was conservatively assumed for a midpoint year of 2013. As is accepted, the 2.5 mph emission rate in g/mile is multiplied by 2.5 mph to get an idling emission rate in mass/time. The higher of the summer or winter factors were used, depending on pollutant. Additionally, emission factors were weighted such that only factors for heavy duty gasoline and heavy duty diesel vehicle classes (MOBILE6.2 designations Heavy Duty Gas Vehicles (HDGV) and Heavy Duty Diesel Vehicles (HDDV) were used for dock emissions.

High velocity air intake louvers and the dock entry will supply make-up air for the dock's ventilation systems. Based on mechanical estimates, a total ventilation air requirement of 3,900 cubic feet per minute was used. A single vent is expected to be exiting vertically at 20 feet above the sidewalk grade and is assumed to be three square feet in area.

Parking Garage Exhaust

A below grade parking garage including 355 replacement spaces is proposed as part of the Project. Carbon monoxide monitors will be installed within the garage to ensure that levels of CO do not exceed health standards and will be used to control abatement ventilation when necessary.

Emissions from the parking garage were calculated using MOBILE6.2 and an estimate of the total miles traveled within the garages during the am and pm peak hours. Estimates of vehicle turnover by usage were provided by the transportation consultant. The total vehicle miles traveled (VMT) are calculated by multiplying the average distance a car would travel in the garage by the number of cars entering and leaving the garage.

To provide a conservative assumption for emissions from the garages, an emission rate from MOBILE6.2 of 10 mph was assumed for the 2022 conditions. The higher of the summer or winter factors were used, depending on pollutant. Additionally, emission factors were weighted such that only factors for light duty gasoline and diesel vehicle classes (MOBILE6.2 designations Light Duty Gas Vehicle (LDGV), Light Duty Gas Truck (LDGT), Light Duty Diesel Vehicle (LDDV), and Motrocycles (MCY)) were used for garage emissions.

Therefore, the emission rates from the garage vents can be calculated as follows:

Mobile 6.2 emission factor in grams/mile
x garage VMT/hour
x 1 hour/3600 seconds
= grams/second

High velocity air intake louvers and the main garage entry will supply make-up air for the garage's ventilation systems. A total ventilation air requirement of 1.5 cubic feet per minute per square foot was used. Four vents are assumed to be exiting vertically at 20 feet above sidewalk grade. Each vent is assumed to be 50 square feet in area.

Detailed calculations, assumptions, and exhaust parameters for all stationary sources are presented in Appendix E.

4.4.3.3 GEP Stack Height Analysis

The Good Engineering Practice (GEP) stack height evaluation of the facility has been conducted in accordance with the EPA revised Guidelines for Determination of Good Engineering Practice Stack Height (EPA, 1985). A GEP stack is sufficiently high to avoid aerodynamic downwash effects from nearby buildings or structures. As defined by the EPA guidelines, the formula for computing GEP stack height is the greater of:

1. 65 meters, or

2. for stacks constructed after January 12, 1979,

$$H_{GEP} = H_b + 1.5L$$

where H_{GEP} = GEP stack height,

H_b = Height of adjacent or nearby structures,

L = Lesser of height or maximum projected width of adjacent or nearby building (*i.e.*, the critical dimension), and nearby is within 5L of the stack from downwind (trailing edge) of the building.

The GEP formula was applied to the Project. The EPA's Building Profile Input Program Prime Version (BPIP-Prime) was run to confirm the GEP height and to calculate direction-specific building dimensions for use in AERMOD.

The point sources subject to building influences are the boiler stacks, dock vents, the cooling towers, and the emergency generator stacks.

The proposed boiler stacks, the cooling towers, dock vents, and emergency generator stacks are all below GEP height; therefore, building downwash effects were considered in the air quality modeling. The AERMOD model determines when and if to include downwash in its calculations. In addition, if downwash applies, the AERMOD downwash algorithm will be used to estimate concentrations in the building cavity areas.

4.4.3.4 Background Concentrations

To estimate background pollutant levels representative of the area, the most recent air quality monitor data reported by the MassDEP in their Annual Air Quality Reports, was obtained for 2008 to 2010. MassDEP guidance specifies the use of the latest three years of available monitoring data from within 10 km of the Project site.

The Clean Air Act allows for one exceedance per year of the CO and SO_2 short-term NAAQS per year. The highest second-high accounts for the one exceedance. Annual NAAQS are never to be exceeded. The 24-hour PM-10 standard is not to be exceeded more than once per year on average over three years. To attain the 24-hour PM-2.5 standard, the three-year average of the 98th percentile of 24-hour concentrations must not exceed 35 $\mu g/m^3$. For annual PM-2.5 averages, the average of the highest yearly observations was used as the background concentration. A new one-hour NO_2 standard was recently promulgated. To attain this standard, the three-year average of the 98th percentile of the maximum daily one-hour concentrations must not exceed 188 $\mu g/m^3$.

Background concentrations were determined from the closest available monitoring stations to the proposed Project. The closest monitor is located at Kenmore Square in Boston. A summary of the background air quality concentrations are presented in Table 4.4-1.

Table 4.4-1 Observed Ambient Air Quality Concentrations and Selected Background Levels

Pollutant	Averaging Time	2008	2009	2010	Background Concentration ($\mu g/m^3$)	Location
SO_2 [4]	1 HOUR	75.4	65	69.94	75.4	Kenmore Sq., Boston
	3 HOUR	62.4	49.4	N/A	62.4	Kenmore Sq., Boston
	24 HOUR	46.8	23.4	21.84	46.8	Kenmore Sq., Boston
	ANNUAL	10.4	6.5	5.824	10.4	Kenmore Sq., Boston
PM-10	24 HOUR	53	69	40	69	One City Sq., Boston
	ANNUAL	23	20.6	15.5	23	One City Sq., Boston
PM-2.5	24 HOUR [1]	26	19.1	21.9	22.33	174 North St., Boston
	ANNUAL [2]	11.14	8.98	9.31	9.81	174 North St., Boston
NO_2	1 HOUR [3]	133.48	114.68	119.38	133.48	Kenmore Sq., Boston
	ANNUAL	41.36	37.788	35.908	41.36	Kenmore Sq., Boston
CO	1 HOUR	1938	1596	2166	2166	Kenmore Sq., Boston
	8 HOUR	1482	1254	1710	1710	Kenmore Sq., Boston

From 2008-2010 MassDEP Annual Data Summaries

[1] Average of the 98th percentile 24-hour values.

[2] Average of the annual values.

[3] Maximum annual one-hour concentrations (EPA "first tier" method).

[4] The 24-hour and Annual standards were revoked by EPA on June 22, 2010, Federal Register 75-119, p. 35520.
The 2010 three-hour value is not reported in the 2010 Annual Data Summary

For use in the microscale analysis, background concentrations of CO in ppm were required. The corresponding maximum background concentrations in ppm were 1.9 ppm for one-hour and 1.5 ppm for eight-hour CO.

4.4.4 Results

4.4.4.1 Microscale Analysis

The results of the maximum one-hour predicted CO concentrations from CAL3QHC are provided in Tables 4.4-2 through 4.4-4 for the 2012 and 2022 scenarios at the end of this section. Eight-hour average concentrations are calculated by multiplying the maximum one-hour concentrations by a factor of 0.7.[9]

[9] U.S. EPA, Screening Procedures for Estimating the Air Quality Impact of Stationary Sources; EPA-454/R-92-019, October 1992

The results of the one-hour and eight-hour maximum modeled CO ground-level concentrations from CAL3QHC were added to EPA supplied background levels for comparison to the NAAQS. These values represent the highest potential concentrations at the intersection as they are predicted during the simultaneous occurrence of "defined" worst case meteorology. The highest one-hour traffic-related concentration predicted in the area of the Project, for the modeled conditions (1.3 ppm) plus background (1.9 ppm) is 3.2 ppm for both existing and future afternoon peak hour cases (at Blackfan Circle and Longwood Avenue). As indicated on Tables 4.4-2 and 4.4-4, the highest eight-hour traffic-related concentration predicted in the area of the Project for the modeled conditions (0.9 ppm) plus background (1.5 ppm) is 2.4 ppm for both existing and future cases also at Blackfan Circle and Longwood Avenue as indicated in Tables 4.4-2 and 4.4-4. Both concentrations are well below the one-hour NAAQS of 35 ppm and the eight-hour NAAQS of 9 ppm.

It would be expected that any other mitigation measures implemented to improve traffic flow at any of the modeled intersections would result in further improved air quality conditions.

4.4.4.2 Stationary Source Analysis

In addition to the microscale analysis, a cumulative impact analysis was also conducted for comparison to the NAAQS for SO_2, NOx, PM-10 and PM-2.5. This analysis addresses emissions from the Project's heating boilers, emergency generators, cooling towers, and the loading dock vent.

Worst case maximum predicted impacts from these source groups were added to monitored background values obtained from MassDEP and compared to the NAAQS.

Table 4.4-5 presents the cumulative modeling results for the stationary sources plus monitored background values. The total impacts when combined with background are below the NAAQS for all pollutants and averaging periods.

When adding the high-second highest AERMOD-predicted one-hour CO concentrations from the stationary sources (129.2 $\mu g/m^3$, 0.11 ppm) to the traffic-generated impacts for the future build case, the one-hour modeled concentration from moving vehicles (1.3 ppm) plus background (1.9 ppm) is 3.3 ppm. The total future build concentration includes the highest second-high predicted concentrations from AERMOD for the parking and loading dock exhaust vents, the heating boilers, the cogeneration units, and the emergency generator. This combined value is also well below the one-hour NAAQS standard of 35 ppm.

Similarly, when adding the high-second highest AERMOD-predicted eight-hour CO concentrations from the stationary sources (66.9 $\mu g/m^3$, 0.06 ppm) to the traffic-generated impacts for the future build case, the eight-hour modeled concentration from moving vehicles (0.9 ppm) plus background (1.5 ppm) is 2.5 ppm. These values are also below the eight-hour NAAQS standard of 9 ppm.

This is a highly conservative estimate, since the added values are irrespective of time and space (i.e., the modeled and background concentrations occur at different times and at different locations).

4.4.5 Conclusions

Using conservative estimates, the CO concentrations at the nearest receptors for impacts from the intersection, the heating boilers, and emergency generator units, plus monitored background values, are well under the CO NAAQS thresholds. In addition, maximum cumulative impacts from the heating boilers, garage vents, cooling towers, and emergency generators plus monitored background values are also below the NAAQS thresholds for SO_2, NOx, PM-10, and PM-2.5.

Table 4.4-2 Summary of Microscale Modeling Analysis (Existing 2012)

Intersection	Peak	CAL3QHC Modeled CO Impacts (ppm)	Monitored Background Concentration (ppm)	Total CO Impacts (ppm)	NAAQS (ppm)
One-Hour					
Blackfan Circle & Longwood Avenue	AM	1.1	1.9	3.0	35
	PM	1.3	1.9	3.2	35
Avenue Louis Pasteur & The Fenway	AM	0.6	1.9	2.5	35
	PM	0.5	1.9	2.4	35
Avenue Louis Pasteur & Blackfan Circle	AM	0.4	1.9	2.3	35
	PM	0.4	1.9	2.3	35
Avenue Louis Pasteur & Longwood Avenue	AM	0.9	1.9	2.8	35
	PM	0.8	1.9	2.7	35
Eight-Hour					
Blackfan Circle & Longwood Avenue	AM	0.8	1.5	2.3	9
	PM	0.9	1.5	2.4	9
Avenue Louis Pasteur & The Fenway	AM	0.4	1.5	1.9	9
	PM	0.4	1.5	1.9	9
Avenue Louis Pasteur & Blackfan Circle	AM	0.3	1.5	1.8	9
	PM	0.3	1.5	1.8	9
Avenue Louis Pasteur & Longwood Avenue	AM	0.6	1.5	2.1	9
	PM	0.6	1.5	2.1	9

Notes:
CAL3QHC eight-hour impacts were conservatively obtained by multiplying one-hour impacts by a screening factor of 0.7.

Table 4.4-3 Summary of Microscale Modeling Analysis (No-Build 2022)

Intersection	Peak	CAL3QHC Modeled CO Impacts (ppm)	Monitored Background Concentration (ppm)	Total CO Impacts (ppm)	NAAQS (ppm)
One-Hour					
Blackfan Circle & Longwood Avenue	AM	1.1	1.9	3.0	35
	PM	1.3	1.9	3.2	35
Avenue Louis Pasteur & The Fenway	AM	0.7	1.9	2.6	35
	PM	0.6	1.9	2.5	35
Avenue Louis Pasteur & Blackfan Circle	AM	0.4	1.9	2.3	35
	PM	0.4	1.9	2.3	35
Avenue Louis Pasteur & Longwood Avenue	AM	0.9	1.9	2.8	35
	PM	0.7	1.9	2.6	35
Eight-Hour					
Blackfan Circle & Longwood Avenue	AM	0.8	1.5	2.3	9
	PM	0.9	1.5	2.4	9
Avenue Louis Pasteur & The Fenway	AM	0.5	1.5	2.0	9
	PM	0.4	1.5	1.9	9
Avenue Louis Pasteur & Blackfan Circle	AM	0.3	1.5	1.8	9
	PM	0.3	1.5	1.8	9
Avenue Louis Pasteur & Longwood Avenue	AM	0.6	1.5	2.1	9
	PM	0.5	1.5	2.0	9

Notes:
CAL3QHC eight-hour impacts were conservatively obtained by multiplying one-hour impacts by a screening factor of 0.7.

Table 4.4-4 Summary of Microscale Modeling Analysis (Build 2022)

Intersection	Peak	CAL3QHC Modeled CO Impacts (ppm)	Monitored Background Concentration (ppm)	Total CO Impacts (ppm)	NAAQS (ppm)
One-Hour					
Blackfan Circle & Longwood Avenue	AM	1.0	1.9	2.9	35
	PM	1.3	1.9	3.2	35
Avenue Louis Pasteur & The Fenway	AM	0.7	1.9	2.6	35
	PM	0.6	1.9	2.5	35
Avenue Louis Pasteur & Blackfan Circle	AM	0.4	1.9	2.3	35
	PM	0.4	1.9	2.3	35
Avenue Louis Pasteur & Longwood Avenue	AM	0.9	1.9	2.8	35
	PM	0.7	1.9	2.6	35
Eight-Hour					
Blackfan Circle & Longwood Avenue	AM	0.7	1.5	2.2	9
	PM	0.9	1.5	2.4	9
Avenue Louis Pasteur & The Fenway	AM	0.5	1.5	2.0	9
	PM	0.4	1.5	1.9	9
Avenue Louis Pasteur & Blackfan Circle	AM	0.3	1.5	1.8	9
	PM	0.3	1.5	1.8	9
Avenue Louis Pasteur & Longwood Avenue	AM	0.6	1.5	2.1	9
	PM	0.5	1.5	2.0	9

Notes:
CAL3QHC eight-hour impacts were conservatively obtained by multiplying one-hour impacts by a screening factor of 0.7.

Table 4.4-5 Summary of NAAQS Stationary Source Modeling Analysis

Pollutant	Averaging Time	Max Modeled Conc. ($\mu g/m^3$)	Year	Background Concentration ($\mu g/m^3$)	Total Conc. ($\mu g/m^3$)	Standard ($\mu g/m^3$)	% Of Standard
SO_2	1 HR (1)	2.71	2005-2009	75.4	78.1	195	40%
	3 HR (2)	2.61	2009	62.4	65.0	1300	5%
	24 HR (2)	1.71	2009	46.8	48.5	365	13%
	ANN. (3)	0.07	2008	10.4	10.5	80	13%
PM-10	24 HR (4)	2.89	2007	69.0	71.9	150	48%
	ANN. (3)	0.95	2008	23.0	24.0	50	48%
PM-2.5	24 HR (5)	2.99	2005-2009	22.3	25.3	35	72%
	ANN. (6)	0.93	2005-2009	9.8	10.7	15	72%
NO_2	1 HR (7,8)	44.13	2005-2009	133.5	177.6	188	94%
	ANN. (3,8))	6.06	2009	41.4	47.4	100	47%
CO	1 HR (2)	129.17	2006	2166.0	2295.2	40000	6%
	8 HR (2)	66.90	2009	1710.0	1776.9	10000	18%

Notes:
(1) Maximum 4th-Highest Maximum Daily One-hour Concentration Averaged Over Five Years
(2) Highest 2nd-High Concentration Over Five Years
(3) Highest Annual Concentration Over Five Years
(4) Highest 6th-High Concentration Over Five Years
(5) Maximum 1st-Highest 24-Hour Concentration Averaged Over Five Years
(6) Maximum Annual Concentration Averaged Over Five Years
(7) Maximum 8th Highest Maximum Daily one-hour Concentrations Averaged Over Five Years.
(8) Ambient Ratio Method used to incorporate conversion of modeled NOx to NO_2. Factor of 0.8 used for one-hour and 0.75 used for annual.

4.5 Solid and Hazardous Waste

4.5.1 Hazardous Waste

Historically, the site consisted of filled land reclaimed from the former Back Bay tidal flat in the 1860s. Alumnae Hall has been utilized as a science building for educational and research purposes since its development by Emmanuel College and later by Beth Israel Deaconess Medical Center. BWH currently leases the site for general office and dry research use and associated parking.

The results of a preliminary testing program conducted in January 2012 indicate that metals were detected in fill material at concentrations consistent with what is typical for urban fill soils. Additional characterization of soil and groundwater will be conducted at the appropriate stage of the design process to further evaluate site environmental conditions and soil management requirements. During future redevelopment, soil and groundwater will be managed in accordance with applicable local, state, and federal laws and regulations.

The Project involves the demolition of existing buildings. The demolition debris will be disposed of at a properly licensed solid waste disposal facility. Asbestos-containing materials or other hazardous materials will be addressed and disposed of according to applicable local, state and federal laws and regulations.

4.5.2 Operation Solid Waste and Recycling

Solid waste generated by the Project is expected to include wastepaper, styrofoam, cardboard, and food. Labeled site collection containers for solid waste will be located at designated collection points throughout the building, and waste will be collected daily and transported by BWH's Environmental Services Department.

BWH has long been a leader in healthcare recycling efforts. BWH's aggressive recycling program includes paper, cardboard, styrofoam, fluorescent bulbs, batteries, monitors and televisions, toner cartridges, cans, cafeteria cooking oils, and old furniture and medical equipment. BWH will extend its existing policy to the proposed Project and will recycle as much solid waste as is feasible from this Project.

The Project will include easily-accessible areas designated for recycling collection. Prior to final programmatic design, BWH will perform an evaluation to identify the most effective locations and space requirements for recycling areas. An area for storage and pick-up will be available.

Paper will be collected in secure confidential data bins and subsequently removed by a vendor who will shred the paper before recycling the pulp. Labeled paper recycling collection containers will be located throughout the building at collection points.

4.5.3 Hazardous Waste Generation and Disposal

Regulated Medical Waste Generation and Disposal

Regulated medical waste (excluding pathological/antineoplastic) will be segregated in leak-proof labeled waste carts staged in designated waste rooms. Medical waste is rendered non-infectious in BWH's on-site autoclave, shredded, and disposed of as solid waste. BWH performs twice-weekly Biological Monitoring to ensure that hazardous infectious waste is decontaminated through autoclaving. Any pathological/antineoplastic-contaminated waste will be contained in cartons labeled "Regulated Medical Waste." These cartons will be lined, sealed, and marked for incineration.

Sharp waste is segregated from other wastes immediately at the point of use and placed in rigid, puncture-resistant, leak-proof and shatter-proof biohazard sharps containers. Sharps containers are sealed and treated to be rendered non-infectious by steam sterilization. Treated waste is shredded on-site prior to disposal as solid waste.

All waste will be handled, transported, and disposed of in accordance with local, state and federal regulations.

Chemical Waste

BWH has an active program to reduce and eliminate toxic materials (e.g., mercury, dioxins, lead and cadmium) from products that are used within the facility. All chemical waste will be characterized for chemical composition, packaged, transported and disposed of in accordance with federal and state requirements, utilizing a Massachusetts Licensed Hazardous Waste Contractor.

Low-level Radioactive Waste

Low-level radioactive waste material could potentially be generated from biomedical laboratory research. Waste materials will be handled in accordance with federal and state waste regulations, which will include personnel training, monitoring and disposal by trained radiation safety personnel. Any waste that requires off-site management will be serviced through a licensed contractor in accordance with applicable local, state and federal regulations.

Spill Control Measures

BWH has a detailed Spill Prevention Control and Countermeasure (SPCC) Plan that includes the following measures:

- detailed written procedures for handling and storage of chemicals on-site;
- 24-hour on-call staff;
- detailed responder training in control procedures;
- on-site storage of supplies and equipment to handle small to moderate spills; and
- an on-call contingency plan with a licensed contractor to respond to larger spills if they occur.

4.6 Noise Impacts

4.6.1 Introduction

This section describes a noise analysis conducted for the Project, including a noise-monitoring program to determine existing background levels and an estimate of future sound levels when the Project is in operation. The scope of the analysis is consistent with BRA requirements for noise studies.

Baseline noise levels were measured in the vicinity of the proposed building and were compared to predicted noise levels based on reference sound data for mechanical equipment identified by the client. These predicted noise levels were compared to the City of Boston Zoning District Noise Standards and the MassDEP Noise Policy. The analysis indicates that predicted noise levels from Project mechanical equipment with appropriate noise mitigation will comply with both state and local regulations at all modeled locations.

4.6.2 Noise Terminology

There are several ways in which sound (noise) levels are measured and quantified. All of them use the logarithmic decibel (dB) scale. The following information defines the noise measurement terminology used in this analysis.

The decibel scale is logarithmic to accommodate the wide range of sound intensities found in the environment. A property of the decibel scale is that the sound pressure levels of two separate sounds are not directly additive. For example, if a sound of 50 dB is added to another sound of 50 dB, the total is only a three-decibel increase (to 53 dB), not a doubling to 100 dB. Thus, every three dB change in sound levels represents a doubling or halving of sound energy. Related to this is the fact that a change in sound levels of less than three dB is imperceptible to the human ear.

Another property of decibels is that if one source of noise is 10 dB (or more) louder than another source, then the total sound level is simply the sound level of the higher source. For example, a source of sound at 60 dB plus another source of sound at 47 dB is 60 dB.

The sound level meter used to measure noise is a standardized instrument. It contains "weighting networks" to adjust the frequency response of the instrument to approximate that of the human ear under various circumstances. One network is the A-weighting network (there are also B- and C-weighting networks). The A-weighted scale (dBA) most closely approximates how the human ear responds to sound at various frequencies. Sounds are frequently reported as detected with the A-weighting network of the sound level meter. A-weighted sound levels emphasize the middle frequency (i.e., middle pitched—around 1,000 Hertz sounds), and de-emphasize lower and higher frequency sounds.

Because the sounds in our environment vary with time, they cannot simply be described with a single number. Two methods are used for describing variable sounds. These are exceedance levels and the equivalent level, both of which are derived from a large number of moment-to-moment A-weighted sound level measurements. Exceedance levels are values from the cumulative amplitude distribution of all of the sound levels observed during a measurement period. Exceedance levels are designated L_n, where n can have a value of 0 to 100 percent. For example:

- L_{90} is the sound level in dBA exceeded 90 percent of the time during the measurement period. The L_{90} is close to the lowest sound level observed. It is essentially the same as the residual sound level, which is the sound level observed when there are no obvious nearby intermittent noise sources.

- L_{50} is the median sound level, the sound level in dBA exceeded 50 percent of the time during the measurement period.

- L_{10} is the sound level in dBA exceeded only 10 percent of the time. It is close to the maximum level observed during the measurement period. The L_{10} is sometimes called the intrusive sound level because it is caused by occasional louder noises like those from passing motor vehicles.

- L_{max} is the maximum instantaneous sound level observed over a given period.

L_{eq}, the equivalent level, is the level of a hypothetical steady sound that would have the same energy (*i.e.,* the same time-averaged mean square sound pressure) as the actual fluctuating sound observed. The equivalent level is designated L_{eq} and is also A-weighted. The equivalent level represents the time average of the fluctuating sound pressure, but because sound is represented on a logarithmic scale and the averaging is done with linear mean square sound pressure values, the L_{eq} is mostly determined by occasional loud, intrusive noises.

By using various noise metrics it is possible to separate prevailing, steady sounds (the L_{90}) from occasional, louder sounds (L_{10}) in the noise environment or combined average levels (L_{eq}). This analysis of sounds expected from the Project treats all noises as though they will be steady and continuous, and hence the L_{90} exceedance level was used. In the design of noise control treatments, it is essential to know something about the frequency spectrum of the noise of interest. Noise control treatments do not function like the human ear, so simple A-weighted levels are not useful for noise-control design. The spectra of noises are usually stated in terms of octave band sound pressure levels, in dB, with the octave frequency bands being those established by standard. To facilitate the noise-control design process, the estimates of noise levels in this analysis are also presented in terms of octave band sound pressure levels.

4.6.3 Noise Regulations and Criteria

The primary set of regulations relating to the potential increase in noise levels is the City of Boston Zoning District Noise Standards (City of Boston Code – Ordinances: Section 16–26 Unreasonable Noise and City of Boston Air Pollution Control Commission Regulations for the Control of Noise in the City of Boston). Results of the baseline ambient noise level survey and the modeled noise levels were compared to the City of Boston Zoning District Noise Standards. Separate regulations within the Standards provide criteria to control different types of noise. Regulation 2 is applicable to the effects of the proposed buildings, as completed, and was considered in this noise study. Table 4.6-1 includes the Zoning District Standards.

Additionally, MassDEP regulates community noise by its Noise Policy: DAQC policy 90-001. The MassDEP policy limits source sound levels to a 10-dBA increase in the ambient measured noise level (L_{90}) at the Project property line and at the nearest residences. The policy further prohibits pure tone conditions—when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by three decibels or more.

Table 4.6-1 City of Boston Zoning District Noise Standards, Maximum Allowable Sound Pressure Levels

Octave Band Center	Residential Zoning District		Residential-Industrial Zoning District		Business Zoning District	Industrial Zoning District
Frequency (Hz)	Daytime (dB)	All Other Times (dB)	Daytime (dB)	All Other Times (dB)	Anytime (dB)	Anytime (dB)
32	76	68	79	72	79	83
63	75	67	78	71	78	82
125	69	61	73	65	73	77
250	62	52	68	57	68	73
500	56	46	62	51	62	67
1000	50	40	56	45	56	61
2000	45	33	51	39	51	57
4000	40	28	47	34	47	53
8000	38	26	44	32	44	50
A-Weighted (dBA)	60	50	65	55	65	70

Notes:
- Noise standards are extracted from Regulation 2.5, City of Boston Air Pollution Control Commission, "Regulations for the Control of Noise in the City of Boston", adopted December 17, 1976.
- All standards apply at the property line of the receiving property.
- dB and dBA based on a reference pressure of 20 micropascals.
- Daytime refers to the period between 7:00 am and 6:00 pm daily except Sunday.

The U.S. Department of Housing and Urban Development (HUD) Environmental Criteria and Standards (24 CFR Part 51), Subpart B – "Noise Abatement and Control" specifies noise criteria for HUD-funded housing developments. This Project is not a HUD-funded development, therefore, the HUD noise criteria do not apply. However, the HUD criteria are presented for informational purposes. The HUD exterior noise goal for residential construction is a day-night average sound level (Ldn) of 65 dBA or less. This is considered Acceptable. Ldn sound levels above 65 dBA but not exceeding 75 dBA are considered Normally Unacceptable, and Ldn levels above 75 dBA are considered Unacceptable.

Funding for HUD approvals in Normally Unacceptable areas require a minimum of 10 dB of additional sound attenuation for buildings having noise-sensitive uses. The HUD interior noise goals require a day-night average sound level of 45 dBA or less through the employment of "feasible" attenuation measures.

4.6.4 Existing Conditions

4.6.4.1 Baseline Noise Environment

An ambient noise level survey was conducted to characterize the existing “baseline” acoustical environment in the vicinity of the Project, located at 45 Avenue Louis Pasteur in the Longwood Medical and Academic Area of Boston. Existing noise sources in the vicinity of the Project include: vehicular traffic (including trucks) on the local roadways; birds; wind noise; pedestrian conversation and foot traffic; mechanical equipment located on the surrounding buildings; and the general din of the city.

4.6.4.2 Noise Measurement Locations

The selection of the sound monitoring locations was based upon a review of the current land and building uses in the Project area. Four noise-monitoring locations were selected as representative in obtaining a sampling of the ambient baseline noise environment. The measurement locations are depicted in Figure 4.6-1 and are described below.

- Location ST-1 is on the Emmanuel College campus north of the Project site, across from the Jean Yawkey Center.
- Location ST-2 is at the northeast corner of the Project property line, at the intersection of Avenue Louis Pasteur and Blackfan Circle.
- Location ST-3 is outside of Boston Latin School southeast of the Project, on the right-of-way connecting Avenue Louis Pasteur and Palace Road.
- Location ST-4 is along Longwood Avenue southwest of the Project, on the sidewalk across from Harvard University Health Services.

4.6.4.3 Noise Measurement Methodology

Sound level measurements were taken for 20 minutes per location during the daytime (12:00 pm to 3:00 pm) on January 25, 2012, and during nighttime hours (12:00 am to 2:00 am) on January 26, 2012. Since noise impacts are greatest at night when existing noise levels are lowest, the study was designed to measure community noise levels under conditions typical of a “quiet period” for the area. Daytime measurements were scheduled to exclude peak traffic conditions.

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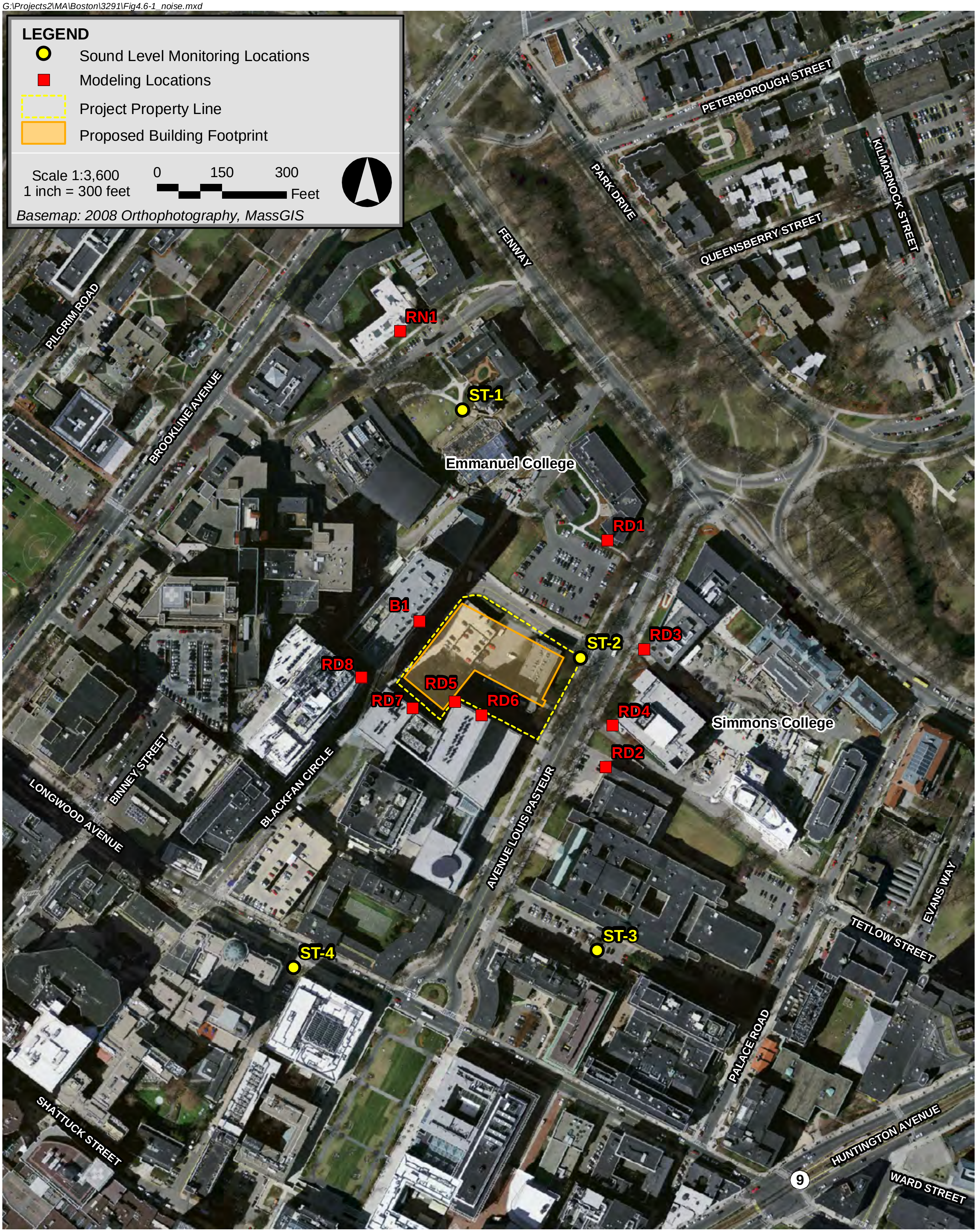

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Figure 4.6-1

Sound Level Monitoring & Modeling Locations

The sound levels were measured at publicly accessible locations at a height of approximately 1.5 meters above the ground. The measurements were made under low wind conditions, and roadway surfaces were dry. Wind speed measurements were made with a Davis Instruments TurboMeter electronic wind speed indicator, and temperature and humidity measurements were made using a General Tools digital psychrometer. Unofficial observations about meteorology, including wind speed, temperature, and humidity, as well as land use in the community were made solely to characterize the existing sound levels in the area and to estimate the noise sensitivity at properties near the proposed Project.

4.6.4.4 Measurement Equipment

A Larson Davis Model 831 sound level meter was used to collect ambient sound pressure level data. This instrumentation meets the "Type 1 - Precision" requirements set forth in American National Standards Institute (ANSI) S1.4 for acoustical measuring devices. The microphone was tripod-mounted at a height of 1.5 meters above ground and statistical descriptors (L_{eq}, L_{90}, etc.) were calculated for each 20-minute sampling period. Octave band levels for this study correspond to the same data set processed for the broadband levels. The measurement equipment was calibrated in the field before and after the surveys with an acoustical calibrator which meets the standards of IEC 942 Class 1L and ANSI S1.40-1984.

4.6.4.5 Baseline Ambient Noise Levels

The existing ambient noise environment varied depending on location. Baseline noise monitoring results are presented in Table 4.6-2, and summarized below.

- The daytime residual background (L_{90}) measurements ranged from 56 to 61 dBA;
- The nighttime residual background (L_{90}) measurements ranged from 52 to 58 dBA;
- The daytime equivalent level (L_{eq}) measurements ranged from 59 to 80 dBA; and
- The nighttime equivalent level (L_{eq}) measurements ranged from 54 to 64 dBA.

Table 4.6-2 Baseline Ambient Noise Measurements

							Octave Band Center Frequency (Hz)								
Location and Period	Start	L_{10}	L_{50}	L_{90}	L_{eq}	L_{max}	32	63	125	250	500	1000	2000	4000	8000
	Time	(dBA)	(dBA)	(dBA)	(dBA)	(dBA)	L_{90} (dB)	L_{90} (dB)	L_{90} (dB)	L_{90} (dB)	L_{90} (dB)	L_{90} (dB)	L_{90} (dB)	L_{90} (dB)	L_{90} (dB)
ST-1	12:36	61	57	56	59	80	63	62	59	56	53	52	45	34	22
ST-2	13:06	65	59	56	63	80	64	63	59	56	52	50	45	36	26
ST-3	13:32	63	60	59	61	78	65	62	59	60	57	54	48	37	25
ST-4	13:58	74	66	61	80	105	67	65	63	63	58	56	51	42	31
ST-1	0:00	55	54	53	54	61	60	58	57	54	50	48	43	31	21
ST-2	0:24	57	53	52	56	75	58	58	57	55	48	44	38	30	19
ST-3	0:49	59	59	58	59	61	63	61	59	60	55	52	47	37	25
ST-4	1:14	64	58	57	64	90	61	61	61	61	54	50	43	31	21

Notes:
1. Daytime weather: Temperature = 44º F, RH = 41%, mostly cloudy skies, winds 0-7 mph NW.
   Nighttime weather: Temperature = 36º F, RH = 58%, cloudy skies, winds 0-2 mph N.
2. Daytime measurements were collected on January 25, 2012. Nighttime measurements were collected on January 26, 2012.
3. All sampling periods were 20 minutes in duration.

4.6.5 Overview of Potential Project Noise Sources

The major sources of sound exterior to the proposed building will be a cogeneration plant consisting of two gas-fired engine generators (that is being studied for incorporation into the Project), an air compressor, cooling towers, a series of air handling units, exhaust fans, water pumps, chillers, and boilers, as well as an emergency generator. Noise emissions from the primary sources, as estimated from the equipment's capacity or from manufacturer-provided specifications, are presented in Table 1 of Appendix F, which includes broadband (dBA) sound power levels, as well as octave band sound levels.

Secondary noise sources, including electrical transformers and small booster and drainage pumps, are expected to have much lower sound levels (10 dBA or more) than the other, larger pieces of equipment and are not considered in this analysis. Additionally, the rooftop stair and elevator pressurization fans are designated for emergency use only and are not considered a continuous source of mechanical noise.

The ventilation fans and exhaust ducts will be located on the roof of the proposed building. Much of the remaining mechanical equipment for the building will be housed within a mechanical penthouse. Noise from garage ventilation fans is assumed to exit at-grade through a dedicated areaway along the north façade of the proposed building.

One emergency diesel generator (assumed 1,000 kW) will be located on the penthouse floor in a dedicated weather-proof enclosure, exhausted vertically through the roof. It is assumed that this generator will only operate during the day for brief, routine testing when the background sound levels are higher, or during an interruption of the electrical grid, in which case the rooftop mechanical equipment will not be operating.

Mitigation will be applied to multiple sources as needed, to ensure compliance with the noise regulations. Acoustical louvers will be installed along the outside wall of the mechanical penthouse to mitigate sound. The rooftop emergency generator noise will be controlled using an exhaust silencer and weather-proof enclosure. A summary of the noise mitigation measures included in this analysis is presented in Table 2 in Appendix F.

4.6.6 Modeling Methodology

Anticipated noise impacts associated with the Project were predicted at the nearest noise-sensitive receptors surrounding the Project using the CadnaA noise calculation software. This software uses the ISO 9613-2 industrial noise calculation methodology. CadnaA allows for octave band calculation of noise from multiple noise sources, as well as for computation of diffraction around building edges and multiple reflections off parallel buildings and solid ground areas. In this manner, all significant noise sources and geometric propagation effects are accounted for in the noise modeling. As a conservative assumption, no credit was taken for attenuation due to the louvered penthouse walls or ceilings in the final analysis.

4.6.7 Future Sound Level of Project

An initial analysis considered all of the mechanical equipment without the emergency generator running, to simulate typical nighttime operating conditions at nearby receptors. A second analysis combined the mechanical equipment and the emergency generators, to reflect worse-case conditions during brief, routine testing of the generators. The results with the emergency generators only and without the emergency generators as compared to existing ambient levels and the MassDEP criteria are shown in Tables 4.6-3 and 4.6-4, respectively, for receptors located 1.5 meters above-grade. Figure 4.6-1 shows the locations of each modeled receptor as well as the monitoring locations selected for background measurements. Predicted mechanical equipment noise levels from the Project at each receptor location, taking into account attenuation due to distance, structures, and noise control measures, are all below the MassDEP criteria of 10 dBA over the quietest nighttime sound levels. Additionally, no "pure-tone" conditions as defined by the MassDEP are present in the combined future levels shown in Tables 3 and 4 in Appendix F.

The predicted Project-generated exterior sound levels with appropriate mitigation measures are expected to remain below 40 dBA with only the emergency generator running, and 60 dBA with only mechanical equipment running, within the applicable zoning limits, for the City of Boston at all nearby sensitive receptors. The closest receptor that can be considered "residential" is the St. Ann Hall dormitory at Emmanuel College where predicted sound levels from the Project are within the most stringent nighttime limits. It should be noted that the existing nighttime ambient background levels already exceed the nighttime residential limit of 50 dBA at all four locations studied due to existing sources unrelated to the Project. The remaining modeled receptors can be considered either "business" or "institutional." However, since the City of Boston ordinance does not have a designation for "institutional" receptors, such structures can reasonably be compared to the daytime "residential" limits, given their daytime-only use. Octave-band sound levels at each of these modeled locations without the emergency generator and with the emergency generator only, presented in Tables 4.6-5 and 4.6-6, respectively, are at or below applicable city limits as shown in Table 4.6-1.

While the HUD noise criteria do not explicitly apply to the Project due to the absence of HUD funding, it should be noted that all exterior sound levels predicted at the nearest sensitive receptors are at or below an equivalent continuous sound level of 58 dBA, which corresponds to a day-night Ldn level of 65 dBA. Additionally, through the reasonable application of attenuation measures typical for construction in Massachusetts to be selected during detailed design, it is anticipated that the Project will have an interior auditory environment of 45 dBA (Ldn) in all noise sensitive interior spaces. Therefore, it is anticipated that the Project would be consistent with the HUD noise criteria.

Table 4.6-3 Comparison of Future Predicted Sound Levels with Existing Background – Without Emergency Generator

Modeling Location	Receptor ID	Representative Background Location	Project Only Sound Level (dBA)	L_{90} Background (dBA)	Total: Project + L_{90} Background (dBA)	Increase Over Background (dBA)[1]	Applicable MassDEP Noise Limit
Emmanuel Dorm - St. Ann Hall	RN1	ST-1 Night	48	53	54	1	≤10
Cardinal Cushing Library	RD1	ST-1 Day	56	56	59	3	≤10
Boston Latin School	RD2	ST-3 Day	58	59	61	2	≤10
Beatley Library (Simmons)	RD3	ST-2 Day	58	56	60	4	≤10
Park Science Center	RD4	ST-2 Day	58	56	60	4	≤10
Merck	B1	ST-2 Day	59	56	61	5	≤10
Harvard Medical Research 1	RD6	ST-2 Day	58	56	60	4	≤10
Harvard Medical Research 2	RD5	ST-2 Day	58	56	60	4	≤10
Harvard Medical Research 3	RD7	ST-2 Day	59	56	60	5	≤10
Wyss	RD8	ST-2 Day	54	56	58	2	≤10

1. Calculation performed using data rounded to nearest whole decibel
2. RN = Residential Night, RD = Residential Daylight, B = Business

Table 4.6-4 Comparison of Future Predicted Sound Levels with Existing Background –Emergency Generator Only

Modeling Location	Receptor ID	Representative Background Location	Project Only Sound Level (dBA)	L_{90} Background (dBA)	Total: Project + L_{90} Background (dBA)	Increase Over Background (dBA)[1]	Applicable MassDEP Noise Limit
Emmanuel Dorm - St. Ann Hall	RN1	ST-1 Night	17	53	53	0	≤10
Cardinal Cushing Library	RD1	ST-1 Day	34	56	56	0	≤10
Boston Latin School	RD2	ST-3 Day	27	59	59	0	≤10
Beatley Library (Simmons)	RD3	ST-2 Day	35	56	56	0	≤10
Park Science Center	RD4	ST-2 Day	27	56	56	0	≤10
Merck	B1	ST-2 Day	39	56	56	0	≤10
Harvard Medical Research 1	RD6	ST-2 Day	32	56	56	0	≤10
Harvard Medical Research 2	RD5	ST-2 Day	35	56	56	0	≤10
Harvard Medical Research 3	RD7	ST-2 Day	39	56	56	0	≤10
Wyss	RD8	ST-2 Day	36	56	56	0	≤10

1. Calculation performed using data rounded to nearest whole decibel
2. RN = Residential Night, RD = Residential Daylight, B = Business

Table 4.6-5 Modeling Results – Without Emergency Generator

Modeling Receptor	Receptor ID	LA90	Octave-Band Sound Pressure Level, L90 31.5	63.0	125	250	500	1000	2000	4000	8000
		(dBA)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)
Emmanuel Dorm - St. Ann Hall	RN1	48	67	61	58	52	45	40	33	28	5
Cardinal Cushing Library	RD1	56	75	68	65	58	53	48	42	38	26
Boston Latin School	RD2	58	73	71	68	61	54	49	45	40	31
Beatley Library (Simmons)	RD3	58	76	70	67	61	55	50	44	39	27
Park Science Center (Simmons)	RD4	58	73	68	67	61	55	49	43	39	28
Merck	B1	59	78	74	69	59	57	52	47	41	40
Harvard Medical Research 1	RD6	58	75	69	69	61	55	48	42	37	29
Harvard Medical Research 2	RD5	58	75	70	68	61	54	49	43	38	32
Harvard Medical Research 3	RD7	59	76	73	69	60	56	50	45	39	37
Wyss	RD8	54	73	68	63	54	53	47	43	37	34
City of Boston Limits	Residential Day (RD)	60	76	75	69	62	56	50	45	40	38
	Residential Night (RN)	50	68	67	61	52	46	40	33	28	26
	Business (B)	65	79	78	73	68	62	56	51	47	44

Table 4.6-6 Modeling Results – Emergency Generator Only

Modeling Receptor	Receptor ID	LA90	Octave-Band Sound Pressure Level, L90 31.5	63.0	125	250	500	1000	2000	4000	8000
		(dBA)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)
Emmanuel Dorm - St. Ann Hall	RN1	17	41	16	22	17	13	12	9	0	0
Cardinal Cushing Library	RD1	34	49	27	34	34	31	30	27	16	0
Boston Latin School	RD2	27	48	25	33	29	24	21	19	9	0
Beatley Library (Simmons)	RD3	35	47	27	37	34	31	30	27	16	0
Park Science Center (Simmons)	RD4	27	47	24	32	27	22	22	20	10	0
Merck	B1	39	57	36	44	40	36	34	31	23	17
Harvard Medical Research 1	RD6	32	46	25	33	29	26	27	26	18	10
Harvard Medical Research 2	RD5	35	46	27	37	33	30	30	29	22	14
Harvard Medical Research 3	RD7	39	55	33	43	39	35	34	31	23	14
Wyss	RD8	36	53	32	41	37	33	31	26	17	7
City of Boston Limits	Residential Day (RD)	60	76	75	69	62	56	50	45	40	38
	Residential Night (RN)	50	68	67	61	52	46	40	33	28	26
	Business (B)	65	79	78	73	68	62	56	51	47	44

4.6.8 Conclusions

Baseline noise levels were measured in the vicinity of the proposed Project and were compared to predicted noise levels that were derived based on information provided by the manufacturers of representative mechanical equipment or estimated from the equipment's capacity. The proposed Project, with the assumed equipment shown in Table 1 and appropriate mitigation shown in Table 2 in Appendix F, will not introduce significant outdoor mechanical equipment noise into the surrounding community.

Predicted mechanical equipment noise levels from the Project at each receptor location, taking into account attenuation due to distance, structures, and noise control measures, will be equal to or below the City of Boston Noise Zoning broadband requirements based on land-use, and will comply with all MassDEP A-weighted noise limits. When the aforementioned mitigation efforts are included, the predicted sound levels from Project-related equipment are expected to remain below 50 dBA, within the most stringent nighttime residential zoning limits for the City of Boston at the nearest "residential" receptor. It should be noted that the existing ambient background levels immediately surrounding the Project already exceed 50 dBA without any contribution from the Project. The results in Section 4.6.7 indicate that the proposed Project can operate without significant impact on the existing acoustical environment.

At this time, the mechanical equipment and noise controls are conceptual in nature. During the final design phase of the Project, mechanical equipment and noise controls will be specified and designed to meet the applicable City of Boston broadband noise limit and the corresponding octave band limits, as well as the MassDEP noise criteria and HUD noise goals. Additional mitigation may include the selection of quieter units, acoustical louvers, screening walls, mufflers, or equipment enclosures, as needed.

4.7 Water Quality/Stormwater Management

See Chapter 7 for a discussion of water quality and stormwater management.

4.8 Flood Hazard Zones / Wetlands

The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) for the site located in the City of Boston - Community Panel Number 250286 0078 G indicates the FEMA Flood Zone Designations for the Project site. The map shows that the Project is located outside of the 500-year flood plain.

The Project site is developed and does not contain wetlands.

4.9 Geotechnical/Groundwater Impacts

4.9.1 Geotechnical

Based on the results of a preliminary subsurface exploration program conducted in January 2012, the Project site is underlain by a 12 to 16 foot thick fill deposit consisting of varying amounts of ash, cinders, coal and other deleterious material, which is underlain by organic deposits up to 12.5 feet thick. Marine clay deposits were encountered beneath the organics at a depth of approximately 35 feet below ground surface. Previous subsurface exploration programs conducted at the site encountered glacial till beneath the marine deposits at a depth of approximately 92.5 feet below ground surface. Bedrock was not encountered during the subsurface exploration programs at the site, but it is anticipated to be present at depths greater than 100 feet below ground surface.

4.9.2 Groundwater

Groundwater was encountered in site groundwater monitoring wells at depths ranging from 9 to 11.8 feet below ground surface. The site is located within the Groundwater Conservation Overlay District; and the Project will be designed in compliance with the standards articulated in Article 32 of the Boston Zoning Code (i.e., conservation of groundwater levels through infiltration). BWH will coordinate with the Boston Groundwater Trust and monitor groundwater levels before, during and after construction of the Project. When the design of the Project moves forward, the Proponent will demonstrate, in a document stamped by a professional engineer registered in Massachusetts, that the Project will be designed so that it will have no negative impact on groundwater levels on the site or on adjoining lots. BWH will incorporate systems into the Project that will meet the Groundwater Conservation Standards articulated in Section 32-6 of the Code. BWH will obtain a written determination from BWSC as to whether the standards of Section 32-6 of the Code are met and will provide a copy of such certification to the BRA and the Boston Groundwater Trust prior to the issuance of the Certificate of Consistency for the Project. Accordingly, based upon the Project's compliance with the requirements of Article 32 of the Code, the Proponent will not be required to obtain a Conditional Use Permit from the Board of Appeal for the Project

4.9.3 Foundation Support and Below-grade Construction

It is anticipated that the proposed construction will incorporate a reinforced concrete diaphragm wall (i.e., slurry wall) to be installed as part of the foundation construction. The slurry wall will be designed to serve as a groundwater cut-off, provide temporary excavation support, and serve as the permanent exterior foundation wall. The slurry wall is anticipated to extend a minimum of 85 to 100 feet below ground surface into the underlying glacial till deposit across the site in order to minimize groundwater seepage into the excavation. The proposed building is anticipated to be supported on one of the following depending on the building loads to be determined by the structural engineer:

- Spread footings with an underslab drainage system.
- Fully waterproofed mat foundation with hold-down ties (anchors).
- Fully waterproofed mat foundation with partial hydrostatic relief system (underslab drainage system with header pipes extending up to a pre-determined elevation based on a required factor of safety against hydrostatic uplift pressure).

Additional analysis of existing subsurface conditions, groundwater levels, potential for ground movement and settlement during excavation and potential impact on adjacent buildings and utilities will be conducted at the appropriate phase of design.

4.10 Construction Impacts

Due to the proximity of the Project site adjacent to academic and research uses, careful scheduling will be required for material removal and delivery. Planning with the City and neighborhood will be essential to the successful development of the Project as well as continued communication with abutters and neighborhood prior to and throughout the construction period.

A Construction Management Plan ("CMP") will be submitted to the Boston Transportation Department (BTD) for review and approval. The CMP will define truck routes which will help to minimize the impact of trucks on local streets. The construction contractor will be required to comply with the details and conditions of the approved CMP.

Construction methodologies that ensure public safety and protect nearby businesses will be employed. Techniques such as barricades, walkways, painted lines, and signage will be used as necessary. Construction management and scheduling—including plans for construction worker commuting and parking, routing plans and scheduling for trucking and deliveries, protection of existing utilities, maintenance of fire access, and control of noise and dust—will minimize impacts on the surrounding environment.

The proposed construction staging plan will be designed to secure the perimeter and isolate the construction while providing safe access for pedestrians and vehicles during normal day-to-day activity and emergencies. Some construction activities will require use of the adjacent streets. BWH's construction manager will coordinate any use of streets with the BTD through the CMP.

4.10.1 Construction Methodology

Construction methodologies that ensure public safety and protect nearby businesses and tenants will be employed. Techniques such as barricades and signage will be used. Construction management and scheduling will minimize impacts on the surrounding environment and will include plans for construction worker commuting and parking, routing plans for trucking and deliveries, and the control of noise and dust.

As the design of the Project progresses, BWH and its construction team will meet with BTD to discuss the specific location of barricades, the need for lane closures, pedestrian walkways, and truck queuing areas. This will be incorporated into the CMP which will be submitted to BTD for approval prior to the commencement of the new construction work.

4.10.2 Construction Schedule

BWH anticipates construction to begin after completion of the Brigham Building for the Future.

Typical construction hours will be from 7:00 am to 6:00 pm, Monday through Friday. No sound-generating activity will occur before 7:00 am. If longer hours, additional shifts, or Saturday work is required, the construction manager will place a work permit request to the Boston Air Pollution Control Commission and BTD in advance. Notification should occur during normal business hours, Monday through Friday. It is noted that some activities such as finishing activities could run beyond 6:00 pm to ensure the structural integrity of the finished product; certain components must be completed in a single pour, and placement of concrete cannot be interrupted.

4.10.3 Construction Staging/Public Safety/Access

Access to the site and construction staging areas will be provided in the CMP.

It may be necessary to occasionally occupy pedestrian walkways and portions of Blackfan Street and Avenue Louis Pasteur. Secure fencing, signage, and covered walkways may be employed to ensure the safety and efficiency of all pedestrian and vehicular traffic flows.

Although specific construction and staging details for construction have not been finalized, BWH and its construction management consultants will work to ensure that staging areas will be located to minimize impacts to pedestrian and vehicular flow. Secure fencing and barricades will be used to isolate construction areas from pedestrian traffic adjacent to the site. In addition, sidewalk areas and walkways near construction activities will be well marked and lighted to protect pedestrians and ensure their safety. Public safety for pedestrians on abutting sidewalks will also include covered pedestrian walkways when appropriate and, if required, the suspension of the use of certain sidewalks during the most hazardous periods of overhead work activity during the construction of the superstructure. After construction is complete, finished pedestrian sidewalks will be reconstructed around the new building.

If required by BTD and the Boston Police Department, police details will be provided to facilitate traffic flow. All construction procedures will be designed to meet all Occupational Safety and Health Administration (OSHA) safety standards for specific site construction activities.

4.10.4 Construction Mitigation

BWH intends to follow City and MassDEP guidelines that will direct the evaluation and mitigation of construction impacts. As part of this process, BWH and its construction team will evaluate the Commonwealth's Clean Air Construction Initiative.

The CMP will be submitted to BTD for review and approval prior to issuance of a Building Permit. The CMP will include detailed information on construction activities, specific construction mitigation measures, and construction materials access and staging area plans to minimize impacts to abutters and the local community. The CMP will also define truck routes which will help minimize the impact of trucks on City and neighborhood streets.

In addition, BWH will install "Don't Dump - Drains to Charles River" plaques at storm drains that are replaced or installed by the Project.

4.10.5 Demolition

The Project will require the demolition of existing structures on the site. Demolition of the existing structures will utilize controlled demolition techniques.

Prior to demolition activities, a survey will be performed to ascertain the existence of any hazardous materials such as asbestos. Any hazardous materials will be treated as a special waste in accordance with MassDEP guidelines and addressed, transported, and disposed of accordingly. In addition, with respect to the demolition of the buildings, the demolition debris will be disposed of at a properly licensed solid waste disposal facility. Concrete, brick, and asphalt will be separated for crushing and possible re-use on site. During demolition, provisions will be made for the use of water spray to control the generation of dust.

Prior to the start of demolition, utilities to the existing buildings will be cut and capped and any hazardous materials within the buildings will be remediated.

4.10.6 Construction Employment and Worker Transportation

The number of workers required during the construction period will vary. It is anticipated that approximately 350 construction jobs will be created by the Project. BWH will make reasonable good-faith efforts to have at least 50% of the total employee work hours be for Boston residents, at least 25% of total employee work hours be for minorities and at least 10% of the total employee work hours be for women. In addition, BWH will enter into a jobs agreement with the City of Boston.

Contractors will be required to develop access plans for their personnel that de-emphasize auto use (such as seeking off-site parking, provide transit subsidies, on-site lockers, etc.). Construction workers will also be encouraged to use public transportation to access the Project site because no new parking will be provided for them. The Proponent will work with the BTD, MASCO, and the Boston Police Department to ensure that parking regulations in the area and in designated residential parking areas are enforced.

4.10.7 Construction Truck Routes and Deliveries

The construction team will manage deliveries to the site during morning and afternoon peak hours in a manner that minimizes disruption to traffic flow on adjacent streets. The construction team will provide subcontractors and vendors with Construction Vehicle & Delivery Truck Route Brochures in advance of construction activity. "No Idling" signs will be included at the loading, delivery, pick-up and drop-off areas.

BWH will coordinate with BTD to designate access routes for truck deliveries and truck routes which will be established in the CMP. While not specifically planned at this time, BWH will likely use Avenue Louis Pasteur via Louis Prang Street and Huntington Avenue as the principal construction traffic route to the Project site. The CMP will attempt to minimize the disruption of the traffic.

Truck traffic will vary throughout the construction period, depending on the activity. Construction truck routes to and from the Project site for contractor personnel, supplies, materials, and removal of excavations required for the Project will be coordinated with BTD. Truck access during construction will be determined by the BTD as part of the CMP. These routes will be mandated as a part of all subcontractors' contracts for the Project. Traffic logistics and routing are planned to minimize community impacts.

4.10.8 Construction Air Quality

Short-term air quality impacts from fugitive dust may be expected during demolition, the early phases of construction and during excavation. Plans for controlling fugitive dust during demolition, construction and excavation include mechanical street sweeping, wetting portions of the site during periods of high wind, and careful removal of debris by covered trucks. The construction contract will provide for a number of strictly enforced measures to be used by contractors to reduce potential emissions and minimize impacts. These measures are expected to include:

- ♦ Using wetting agents on areas of exposed soil on a scheduled basis;
- ♦ Using covered trucks;
- ♦ Minimizing spoils on the construction site;

- Monitoring of actual construction practices to ensure that unnecessary transfers and mechanical disturbances of loose materials are minimized;
- Minimizing storage of debris on the site;
- Cleaning adjacent streets and sidewalks periodically with water to minimize dust accumulations; and
- Using retrofitted equipment and ultra low-sulfur diesel (ULSD) fuel (15 ppm) in off-road construction equipment

4.10.9 Construction Noise

BWH is committed to mitigating noise impacts from the construction of the Project. Increased community sound levels, however, are an inherent consequence of construction activities. Construction work will comply with the requirements of the City of Boston Noise Ordinance. Every reasonable effort will be made to minimize the noise impact of construction activities.

Mitigation measures are expected to include:

- Instituting a proactive program to ensure compliance with the City of Boston noise limitation policy;
- Using appropriate mufflers on all equipment and ongoing maintenance of intake and exhaust mufflers;
- Muffling enclosures on continuously running equipment, such as air compressors and welding generators;
- Replacing specific construction operations and techniques by less noisy ones where feasible;
- Selecting the quietest of alternative items of equipment where feasible;
- Scheduling equipment operations to keep average noise levels low, to synchronize the noisiest operations with times of highest ambient levels, and to maintain relatively uniform noise levels;
- Turning off idling equipment; and
- Locating noisy equipment at locations that protect sensitive locations by shielding or distance.

4.10.10 Construction Vibration

The Proponent will implement a vibration control program to ensure that demolition of existing buildings, garage excavation and foundation construction for the Project will not negatively impact structures and utilities surrounding the Project. All means and methods for performing work at the Project will be evaluated for potential vibration impacts on nearby buildings and utilities.

Before construction, the Proponent will conduct studies, prepare designs and specifications, and review contractor's submittals for conformance to the Project contract documents with specific attention to protection of nearby structures and facilities, including protection from vibrations. The Project specifications will contain specific criteria for allowable threshold and limiting values for vibrations. A preconstruction measurement of vertical reference points in the Project area will be obtained prior to the start of construction.

During the construction period, a geotechnical field instrumentation program will be implemented that includes measurement of ground vibrations. To mitigate potential impacts, vibration levels during foundation construction activities will be measured and monitored at appropriate structures. Construction activities will be modified according to contingency plans for remedial measures in the event that vibration levels at adjacent buildings and streets exceed threshold response levels contained in the contract technical specifications.

4.10.11 Construction Waste

Solid Wastes

BWH will reuse or recycle construction materials to the greatest extent feasible. Construction procedures will allow for the segregation, reuse, and recycling of materials. The Proponent will also coordinate with the Boston Materials Resource Center and direct materials to them where possible to reduce the amount of surplus building material that is sent to landfills. Materials that cannot be reused or recycled will be transported in covered trucks by a contract hauler to a licensed facility, per the MassDEP regulations for Solid Waste Facilities, 310 CMR 16.00.

Hazardous Wastes

Hazardous materials encountered during construction will be handled according to local, state and federal regulations.

Should excess excavated soil be generated it will be managed in accordance with MassDEP policy and the Massachusetts Contingency Plan.

4.10.12 Protection of Utilities

Existing public and private infrastructure located within the public right-of-way will be protected during construction. The installation of proposed utilities within the public way will be in accordance with the MWRA, BWSC, Boston Public Works, Dig Safe, and the governing utility company requirements. All necessary permits will be obtained before the commencement of the specific utility installation. Specific methods for constructing proposed utilities where they are near to, or connect with, existing water, sewer and drain facilities will be reviewed by BWSC as part of its site plan review process.

4.10.13 Rodent Control

A rodent extermination certificate will be filed with the building permit application to the City. Rodent inspection monitoring and treatment will be carried out before, during, and at the completion of all construction work for the proposed Project, in compliance with the City's requirements. Rodent extermination prior to work start-up will consist of treatment of areas throughout the site. During the construction process, regular service visits will be made.

4.11 Sustainable Design

This section provides a discussion of the sustainability efforts BWH will pursue related to the Project.

BWH is committed to developing buildings that are sustainably designed, energy efficient, environmentally conscious and healthy for their researchers, staff, and visitors. These efforts ensure that BWH's operations and developments are consistent with the standards articulated in Article 37 of the Boston Zoning Code to promote sustainable development. The BWH 2012 IMP Amendment Project will be Leadership in Energy and Environmental Design (LEED) certifiable, consistent with the standards articulated in Article 37. There are seven categories in the LEED certification guidelines: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation in Design Process and the additional Regional Priority Credits. As noted in the 2012 BWH IMP Amendment, the Project is targeting Gold Certification, which would exceed the requirements of Article 37. The credits being targeted at this time are listed below, and the LEED NC v2009 checklist is included in Appendix G; the list will evolve as the Project evolves. Additional credits are still under consideration.

Sustainable Sites

Prerequisite 1: Construction Activity Pollution Prevention

The Construction Manager (CM) will create and implement an erosion and sedimentation control plan for all construction activities associated with the Project. The plan will conform to the erosion and sedimentation requirements of the 2003 EPA Construction General Permit and local standards and codes, including State of Massachusetts and City of Boston requirements.

SS Credit 1: Site Selection

The proposed site is located on a previously developed parcel within the City of Boston. In addition, the Project does not include any development that would negate gaining this credit.

SS Credit 2: Development Density and Community Connectivity

The proposed site was previously developed, is within ½ mile of a dense residential neighborhood, and is within a ½ mile walk of more than 10 basic services.

SS Credit 4.1: Alternative Transportation—Public Transportation Access

The proposed site is located within approximately 1/10 mile of multiple MBTA bus routes, including 8, 9, 19, 22, 47, and 57. The Project is also located proximate to MASCO bus routes.

SS Credit 4.2: Alternative Transportation—Bicycle Storage and Changing Rooms

Bicycle storage will be provided within 200 yards of the main entrance of the building for more than 5% of the building users. In addition, shower and changing facilities will be provided for 0.5% of all full-time equivalent occupants.

SS Credit 6.1: Stormwater Design—Quantity Control

The Project will implement a stormwater management plan that protects receiving stream channels from excessive erosion. The stormwater management plan will include stream channel protection and quantity control strategies.

SS Credit 6.2: Stormwater Design—Quality Control

The stormwater management plan referenced above will be designed to reduce impervious cover, promote infiltration and capture and treat the stormwater runoff from 90% of the average annual.

SS Credit 7.1: Heat Island Effect—Nonroof

All of the parking spaces on the Project site will be below ground.

SS Credit 7.2: Heat Island Effect—Roof

Roofing surfaces will be a combination of high-albedo and vegetated.

SS Credit 8: Light Pollution Reduction

The lighting system in the building will be designed to automatically reduce the input power by at least 50% between 11:00 pm and 5:00 am.

Water Efficiency

WE Prerequisite 1: Water Use Reduction

The building will employ strategies that in aggregate use 20% less water than the water use baseline calculated for the building.

WE Credit 1: Water Efficient Landscaping

Potable water use for irrigation will be reduced by at least 50% from a baseline case. In addition, the Project is considering using no potable water for irrigation.

WE Credit 2: Innovative Wastewater Technologies

Water conserving fixtures will be used in the Project to reduce potable water use and waste conveyance by 50%.

WE Credit 3: Water Use Reduction

While a research facility has significant water needs, the proposed Project will reduce baseline water use by 30%.

Energy and Atmosphere

EA Prerequisite 1: Fundamental Commissioning of Building Energy Systems

The proposed building will be fully commissioned prior to occupancy to confirm that all systems are operating as designed. Since 1995, BWH has commissioned mechanical systems in all new buildings to ensure systems are operating as efficiently as possible from their day of installation. A third-party review of the mechanical systems design, inspection of installation, and performance testing to ensure the systems meet the design intent is conducted.

EA Prerequisite 2: Minimum Energy Performance

While the path for achieving this prerequisite has not yet been determined, the proposed Project will be able to demonstrate minimum energy performance criteria. Currently, there are programs in place at BWH that are looking at ways to optimize energy performance. These programs include selection of more efficient equipment throughout the facilities, careful design of buildings to make them as effective as possible, and selecting medical equipment based on energy efficiency as well as intended performance. In addition, BWH has a full-time controls staff on its Campus to monitor and resolve performance issues using advanced energy management systems, which are anticipated to be a part of the proposed Project.

EA Prerequisite 3: Fundamental Refrigerant Management

CFC based refrigerants will not be used in any heating, ventilation, air condition, and refrigeration (HVAC&R) systems within the proposed building.

EA Credit 1: Optimize Energy Performance

Energy performance will be increased so that environmental impacts are reduced. Due to the nature of research facilities, the building energy use is anticipated to be reduced by 20-30% from baseline performances. Energy modeling will most likely be used to achieve this point. As mentioned above, there are programs in place at BWH that are looking at ways to optimize energy performance. These programs include selection of more efficient equipment throughout the facilities, careful design of buildings to make them as effective as possible, and selecting medical equipment based on energy efficiency as well as intended performance. In addition, BWH has a full-time controls staff on its Campus to monitor and resolve performance issues using advanced energy management systems, which are anticipated to be a part of the proposed Project.

EA Credit 3: Enhanced Commissioning

Commissioning services will begin prior to construction, and the additional commissioning activities will be performed during the course of the proposed Project. The commissioning agent will be required to review the owner's Project requirements, create, distribute and implement a commissioning plan, and perform a design review of the Project documents. As mentioned above, since 1995, BWH has commissioned mechanical systems in all new buildings to ensure systems are operating as efficiently as possible from their day of installation. A third-party review of the mechanical systems design, inspection of installation, and performance testing to ensure the systems meet the design intent is conducted.

EA Credit 4: Enhanced Refrigerant Management

Refrigerants used in the HVAC&R equipment within the proposed building will be carefully selected to conform to the requirements of this credit. Part of the strategy will be to use long-life, high-efficiency equipment.

EA Credit 5: Measurement and Verification

A measurement and verification plan will be developed by the owner and the design team to provide ongoing accountability of energy consumption over time.

EA Credit 6: Green Power

To help offset the energy use of the proposed building, the owner will engage in a contract to provide Green Power for 35% of the building's energy use.

Materials & Resources

MR Prerequisite 1: Storage and Collection of Recyclables

Space in the proposed building will be set aside for the collection and storage of recyclables. BWH has long been a leader in healthcare recycling efforts. The Hospital has established policies and procedures relating to the recycling of various materials used within the facility, such as mixed paper, cardboard, metals, batteries, and plastics among other things.

MR Credit 2: Construction Waste Management

The CM will be responsible for developing a waste management plan that keeps at least 75% of construction waste out of landfills. BWH works closely with its contractors and their sub-contractors to utilize recycling practices to minimize the generation and disposal of construction waste.

MR Credit 4: Recycled Content

The Project specifications will require materials to include pre- and/or post-consumer recycled content. During construction, material submittals will include a document indicating the percentage of both pre- and post-consumer recycled content. The CM will track the recycled content for each material with a Project goal to achieve 20% recycled-content materials based on overall Project materials costs. BWH projects favor building materials and purchases of supplies that are non-toxic, made from recycled materials, and made with low embodied energy. Recyclable and recycled materials are incorporated into the design and construction of all new construction projects as much as possible within the design scheme.

MR Credit 5: Regional Materials

Selection of specified materials will be made with a focus on those that are manufactured, harvested, and extracted within 500 miles of the Project. The goal of the Project is to use at least 20% regional materials. For all construction and renovation projects, including the BWH 2012 IMP Amendment Project, the Hospital is looking into using more materials that are manufactured regionally to minimize transportation impacts.

MR Credit 6: Rapidly Renewable Materials

A minimum of 2.5% of the materials in the Project will be considered rapidly renewable.

MR Credit 7: Certified Wood

At least 50% of the permanently installed wood in the Project will be from certified forests.

Indoor Environmental Quality

IEQ Prerequisite 1: Minimum Indoor Air Quality Performance

The building mechanical systems are designed to meet or exceed the requirements of ASHRAE Standard 61.1-2007 sections 4 through 7 and all applicable building codes, which are generally more stringent. BWH prides itself on the continuous significant improvements that have been made at the Hospital with respect to all elements of environmental quality. Since 1993, BWH has had a leading edge indoor air quality performance (IAQ) program. Through this program, BWH has adopted use of various low-emitting materials, such as adhesives, sealants, architectural coatings, paints, and flooring systems.

IEQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

Smoking will be prohibited throughout the proposed building. In addition, smoking will be prohibited within 25 feet of the building.

IEQ Credit 1: Outdoor Air Delivery Monitoring

The Project will incorporate permanent CO_2 sensors and measuring devices to provide feedback on the performance of the HVAC system. In addition, measurement devices will be provided on air intakes as required at non-densely occupied spaces.

IEQ Credit 2: Increased Ventilation

The HVAC system will be designed to increase breathing zone outdoor air ventilation rates to all occupied spaces by at least 30% above the minimum rates required by ASHRAE Standard 62.1-2007.

IEQ Credit 3.1: Construction Indoor Air Quality Management Plan—During Construction

The Project documents will be written so that the CM is required to implement an IAQ management plan that protects materials and systems from pollution created during construction. The Hospital also pioneered the use of indoor air quality construction management plans, including construction air quality monitoring during construction. For construction projects, isolation containments and effluents are monitored for airborne particulates, fungi and volatile organic compounds.

IEQ Credit 4.1: Low-Emitting Materials—Adhesives and Sealants

All adhesives and sealants will be specified to comply with the South Coast Air Quality Management District Rule 1168. As mentioned above, BWH has adopted use of various low-emitting materials, including adhesives and sealants.

IEQ Credit 4.2: Low-Emitting Materials—Paints and Coatings

All paints and coatings will be specified to comply with either the Green Seal Standard GS-11, the Green Seal Standard GC-03, or the South Coast Air Quality Management District Rule 1113 as applicable. As mentioned above, BWH has adopted use of various low-emitting materials, including architectural coatings and paints.

IEQ Credit 4.3: Low-Emitting Materials—Flooring Systems

All carpet will be specified to meet the Carpet and Rug Institute Green Label Plus program. All hard surfaces will be specified to meet the FloorScore requirements. All floor coatings will be specified to meet the South Coast Air Quality Management District Rule 1113. All tile adhesives and grouts will meet the South Coast Air Quality Management District Rule 1168. As mentioned above, BWH has adopted use of various low-emitting materials, including flooring systems.

IEQ Credit 4.4: Low-Emitting Materials—Composite Wood and Agrifiber Products

Composite wood and agrifiber products used on the interior of the building will not contain any added urea-formaldehyde resins. In addition, laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies will not contain added urea-formaldehyde resins.

IEQ Credit 5: Indoor Chemical and Pollutant Source Control

The proposed building will be designed to minimize and control the entry of pollutants into the building. The ventilation system will be designed to filter any pollutants from outdoor air. In addition, spaces where chemicals or gases are present will be properly exhausted.

IEQ Credit 6.1: Controllability of Systems—Lighting

Lighting controls will be provided throughout the building so that occupants can adjust the lighting within a space to meet their lighting needs.

IEQ Credit 8.1: Daylight and Views—Daylight

The building will be designed to have daylighting in at least 75% of regularly occupied spaces. Natural lighting is incorporated as much as possible into all new BWH project designs.

IEQ Credit 8.2: Daylight and Views—Views

The building will be designed so that 90% of building occupants have a direct line of sight to the outdoor environment.

Innovation in Design

ID Credit 1: Innovation in Design

The design team has identified Pilot Point 14 – Walkable Project Site as an opportunity for gaining an Innovation Credit.

ID Credit 2: Innovation in Design

The design team has identified Pilot Point 26 – Advanced Energy Metering as an opportunity for gaining an Innovation Credit. BWH has a full-time controls staff on its Campus to monitor and resolve performance issues using advanced energy management systems, which are anticipated to be a part of the proposed Project.

Further ID Credits: Innovation in Design

In addition to the above, there are three opportunities for Innovation credits that will be explored as the design advances.

ID Credit 2: LEED Accredited Professional

There will be multiple LEED Accredited Professionals on the Project team.

Regional Priority Credits

Since the Project will achieve Sustainable Sites Credit 6.1, Sustainable Sites Credit 7.1, and Sustainable Sites Credit 7.2, three additional points will be acquired based on the Regional Priority Credits.

4.12 Climate Change Adaptation

Impacts from climate change are anticipated to include more severe storms and more days with hotter temperatures. This section provides a discussion of the Project's plans in regard to adapting to anticipated effects of climate change. It should be noted that design of the Project is not anticipated for several years, and the Project's design as it relates to climate change adaptation will be studied further as the Project moves forward.

4.12.1 Riverine and Severe Storm Impacts

4.12.1.1 Riverine Impacts

The Project site is located more than 500 feet southwest of the Muddy River and is several feet above the 100-year flood plain related to the River. Although no impacts on the Project from the Muddy River are anticipated in the future, as the design of the Project moves forward, the Proponent will look at updated information and plan accordingly.

4.12.1.2 Severe Storms

Climate change is anticipated to result in more severe storms than currently occur. Rains from these storms may result in localized flooding and stress the existing stormwater infrastructure.

The Project will be located at a higher elevation than the surrounding streets, minimizing the potential for local flooding to impact the building. As design of the Project moves forward, the most up-to-date information will be analyzed to determine the potential impacts from localized flooding and any design adjustments that may be required to minimize the impact on the Project.

Localized flooding can be minimized by proper stormwater infrastructure in the area of the Project. As part of the permitting process, the Project will submit stormwater management plans for the Project to the BWSC. Surface drain structures required by the Project will be developed to meet the latest city and state codes and standards. Compliance with the standards for the final site design will be reviewed as part of BWSC's Site Plan Review process.

4.12.2 Heat Waves

It is anticipated that Boston will have an increased number of days above 100°F. Sustained high temperatures (heat waves) will have a number of impacts, including stress on the electrical grid resulting in possible blackouts. There are a number of design and operational choices that can help minimize the impact of heat waves. The Project is anticipated to include a green roof over the lower portion of the building adjacent to Avenue Louis Pasteur and a high-albedo roof on the rest of the Project's rooftop. As described in the

Sparking Boston's Climate Revolution, vegetated and high-albedo rooftops decrease the energy needed to heat and cool a building. It is anticipated that the Project will include high performance glazing and sunshades to minimize heat gain in the summer months.

Due to the uses proposed for the Project, the building's internal climate is very important. The research areas require proper air pressure to vent safely. As most of the building is anticipated to be used for research, operable windows are not possible. However, as the design progresses, the Proponent will study the possibility of operable windows in the office portions of the building.

In the event of a heat wave, emergency power is anticipated to be generated by a cogeneration facility that is currently being studied as part of the Project. As mentioned above, natural ventilation will not be possible in the research portion of the building. As the design of the building moves forward, the Proponent will analyze the mechanical needs of the building and what mechanical equipment can efficiently provide the needed climate control while minimizing the Project's impact on air quality.

Section 5.0

Urban Design

5.0 URBAN DESIGN

5.1 Proposed Project Design

BWH's goal is to ensure that its buildings project a commitment to provide the highest quality of care to patients and their families, while at the same time attract the best and the brightest researchers. BWH's buildings pay particular attention to public spaces both inside and out. BWH endeavors to build buildings that reflect its culture of patient centered care and innovation and constantly strives to create buildings that accommodate the most advanced medical care while offering places within and around these structures that are humane and give the feeling of warmth to those that are sick and seeking cures. Where the public or users interact with BWH facilities, materials such as wood, bricks and small windows are used and spaces are created that are scaled to the individual. BWH consistently strives and commits to improve and complement the existing skyline, while emphasizing innovation in research and medical care through architecture.

BWH both owns and operates its buildings and understands that its approach to its facilities during design and construction have a dramatic effect on the life cycle costs related to operation and maintenance. Therefore, BWH makes an effort to understand and plan for its future needs, and design its buildings according to these assessments.

The proposed building will offer transparency to the surrounding area on the lower level, in particular to Avenue Louis Pasteur and to a lesser extent, Blackfan Circle. The lower levels are anticipated to include a lobby, meeting rooms and assembly spaces. These light filled spaces will allow for movement within to be apparent and will be open visually to the activity along Avenue Louis Pasteur and Blackfan Circle.

Light filled spaces and a visual connection to the outside world are very important to the well-being of those within buildings. The Project will include glass within its design to allow for these light-filled spaces. These glass walls will be detailed and lit. It is anticipated that the materials used will limit the spilling of light out of the buildings at night and the specification and detailing of a wall system will minimize impacts on the local or migratory bird populations.

Image and Iconography

The new building will project the optimism of a high tech future while at the same time reflecting architecture that is human-scaled and sensitive to the populations that live, work and interact within the building and in the area. BWH strives to commission innovative architectural design that matches its institutional philosophy of innovation and equally contributes to the public realm.

Form making

Research buildings, if not carefully wrought, can become repetitive architecturally. The collaborative nature of BWH's research endeavors means that program spaces include significant numbers of collaborative meeting areas mixed in with science laboratories. The ultimate form of the building will not only be shaped by the internal requirements, but also by adjacent urban form and patterns so that the building fits in well and contributes to Boston's center of innovation.

Connectivity

The Project will create a new urban node at the turn of Blackfan Circle where Merck, Emmanuel College and the proposed building will come together. Here, the energy and collaboration of higher education, not for profit research and industry will all coexist in the wonderful, strong and uniquely Boston mixture.

Place making

BWH focuses a great deal of design attention on the public spaces of its buildings both inside and out. BWH has a long tradition of attracting the best and the brightest. It is a primary goal to assure that Boston and BWH remain one of the most desirable places to conduct life science research in the world. BWH contributes to this goal with high quality research space and the buildings that house them.

Natural light

The Hospital places tremendous value on the role of natural light in the healing and well-being of its patients and staff. The building is imagined to have large areas of glazed glass. BWH is also a good neighbor and aware of its buildings as a potential source of unwanted light at night. The design of the building's lighting will minimize nighttime light pollution and be designed to also ameliorate the effects of glazing under certain light conditions to minimize bird collisions.

Urban and visual corridors

The new building will contribute to one of the grandest urban corridors in Boston, Avenue Louis Pasteur, by being constructed with consistent setbacks to its neighbors. It will also complete Blackfan Circle as the new center of life science research in Boston.

5.1.1 Alternatives

The proposed massing was determined in an effort to meet the height and setback guidelines as outlined in the LMA Interim Guidelines. No other massing than that proposed for the proposed Project would allow for the research space critically needed by BWH, the widened sidewalks, appropriate setbacks, and landscaping along Avenue Louis Pasteur.

5.2 Relationship to BWH 2010 IMP Goals

The following goals were included in the BWH 2010 IMP:

- Enhance Pedestrian Circulation and the Pedestrian Experience;
- Reinforce the Hospital's institutional identity and wayfinding;
- Improve the Visual and Physical Integration of the Hospital with Adjacent Neighborhoods along BWH Campus Edges; and
- Expand and Enhance BWH Campus Green Space.

The sections below describe the proposed Project in the context of the BWH 2010 IMP goals as listed above.

5.2.1 Pedestrian Circulation and Experience

5.2.1.1 Project Site

Continuing the pattern of formal entries on Avenue Louis Pasteur, the building will have a formal threshold on the Avenue extending the public realm onto the site. Marked by landscape and a projecting canopy, this formal and ceremonial entry court will lead into the building through a porch like structure. This entry court between the Harvard Medical School New Research Building and the proposed Project will be filled with landscape elements and street furniture that signal the pedestrian friendly nature of this space. This area is not anticipated to support the entry to the garage. Truly a pedestrian oriented entry and ceremonial entryway, people on foot will dominate this space. See Figures 2-4, 5-1 and 5-2.

The Project includes elements that will dramatically improve the public realm surrounding the Project site. New, high-quality sidewalks and plantings will be includes on the edges of the Project site. In particular, Avenue Louis Pasteur will include new trees or the preservation of existing trees that have supported this formal axial space. In addition, the Project in concert with the City of Boston and its neighbors at Merck and Emmanuel College will study the inclusion of the appropriate quantity and species of street trees on Blackfan Circle. These trees will mark this important threshold between the innovation area, including research and life sciences, and Emmanuel College's educational campus.

Potential paths through and across the site are anticipated, in particular between the proposed Project and Harvard Medical School New Research Building. These informal mid-block pathways, where appropriate, will continue the strong Boston tradition of well-worn back routes though campuses by those that know them best.

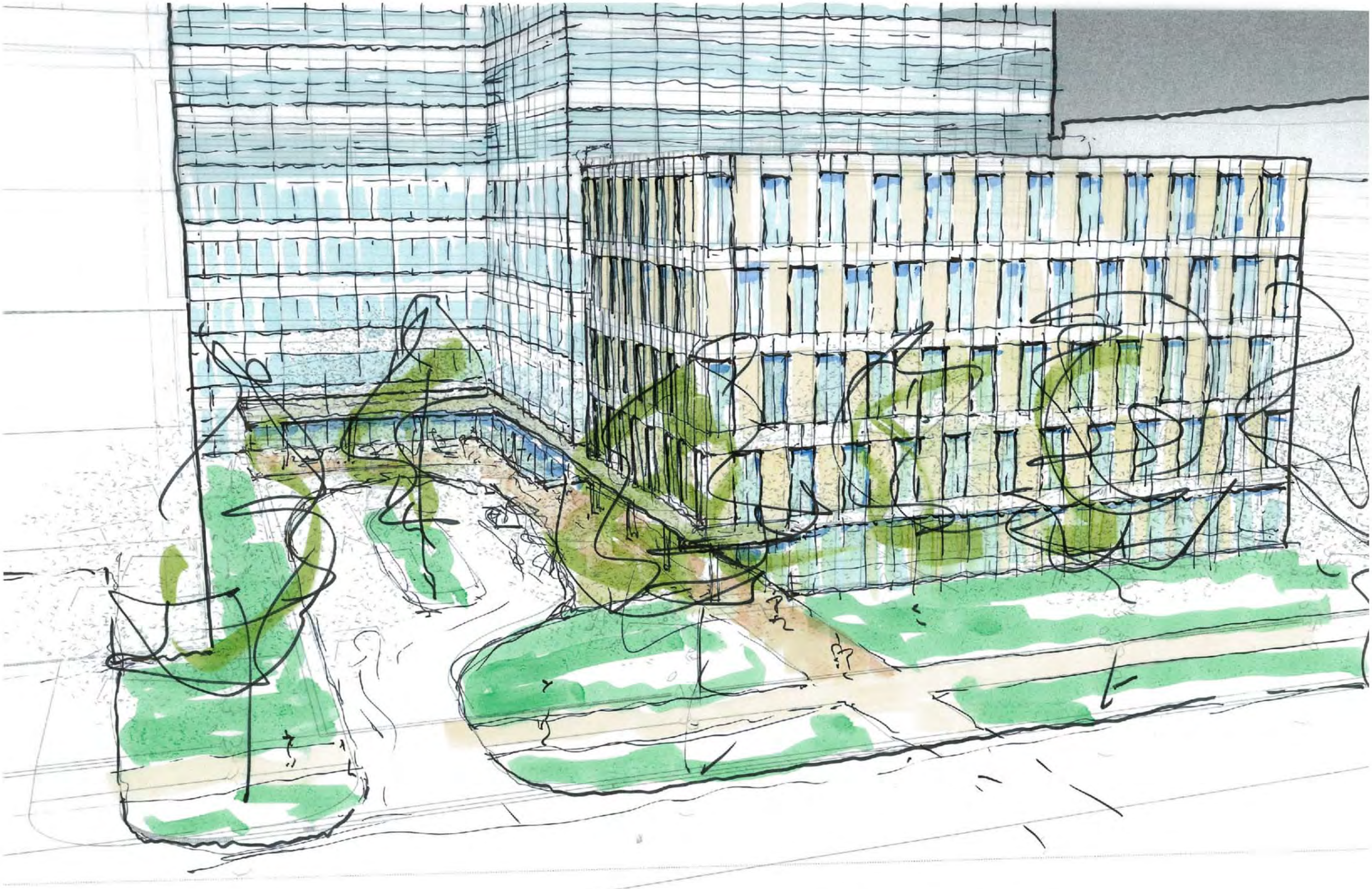

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Figure 5-1

View into New Courtyard

Figure 5-2

Aerial View

As Blackfan Circle turns on the northwest corner of the Project site, the street faces a major gateway to the Emmanuel College campus and a major threshold to the neighboring Merck building. It is anticipated that paving and roadway detailing, such as specialized paving lighting and bollards for both pedestrian and vehicular safety, will make this a focal point in the neighborhood, as well as a signal that this is a pedestrian oriented area of the streetscape.

5.2.1.2 LMA

As the Project site is located at a distance from the BWH Campus, connections between the site and the Campus, as well as through the LMA, are important. Longwood Circle is the halfway point between the main BWH Campus and the proposed Project. This important neo-classically inspired intersection and major transit hub will be the drop-off point of many of the people that work in the new building. Located a short walk from Longwood Circle (Oscar Tugo Circle), the new building is visible from this intersection just over the adjacent rooftops of the Harvard Medical School New Research Building. This is a portion of the LMA neighborhood that is very familiar to BWH staff and the modest increase in pedestrian traffic will enhance the quality of urban life here.

The Project site is an approximately eight minute walk to the BWH Campus. Increased pedestrian traffic might logically be expected from the west end of the BWH Campus along Binney Street and down the length of Blackfan Circle, or from the east end of the BWH Campus across the Harvard Medical School Quadrangle through Longwood Circle to Avenue Louis Pasteur. See Figures 5-3 and 5-4.

5.2.2 Institutional Identity and Wayfinding

Since the building is separated from the BWH Campus, special attention will be paid to wayfinding and signage. Wayfinding and signage will be coordinated with the on-going MASCO efforts in the district. As the building will predominantly be used by employees, the majority of the visitors to the building will be repeat visitors. The Hospital has experience with remotely located laboratory structures such as the facilities at 221 Longwood Avenue, a half block away.

5.2.3 Integration with Adjacent Neighborhoods

The basic building design and massing strategy starts from the pattern of architecture established by the consistent setbacks on the west side of Avenue Louis Pasteur. The forward pavilion of the design along Avenue Louis Pasteur is 75 feet tall, while the taller portions of the massing are located at the rear of the site. The program in the forward building mass is less mechanically intensive to avoid roof mounted vents and machinery that could mar the view from the street.

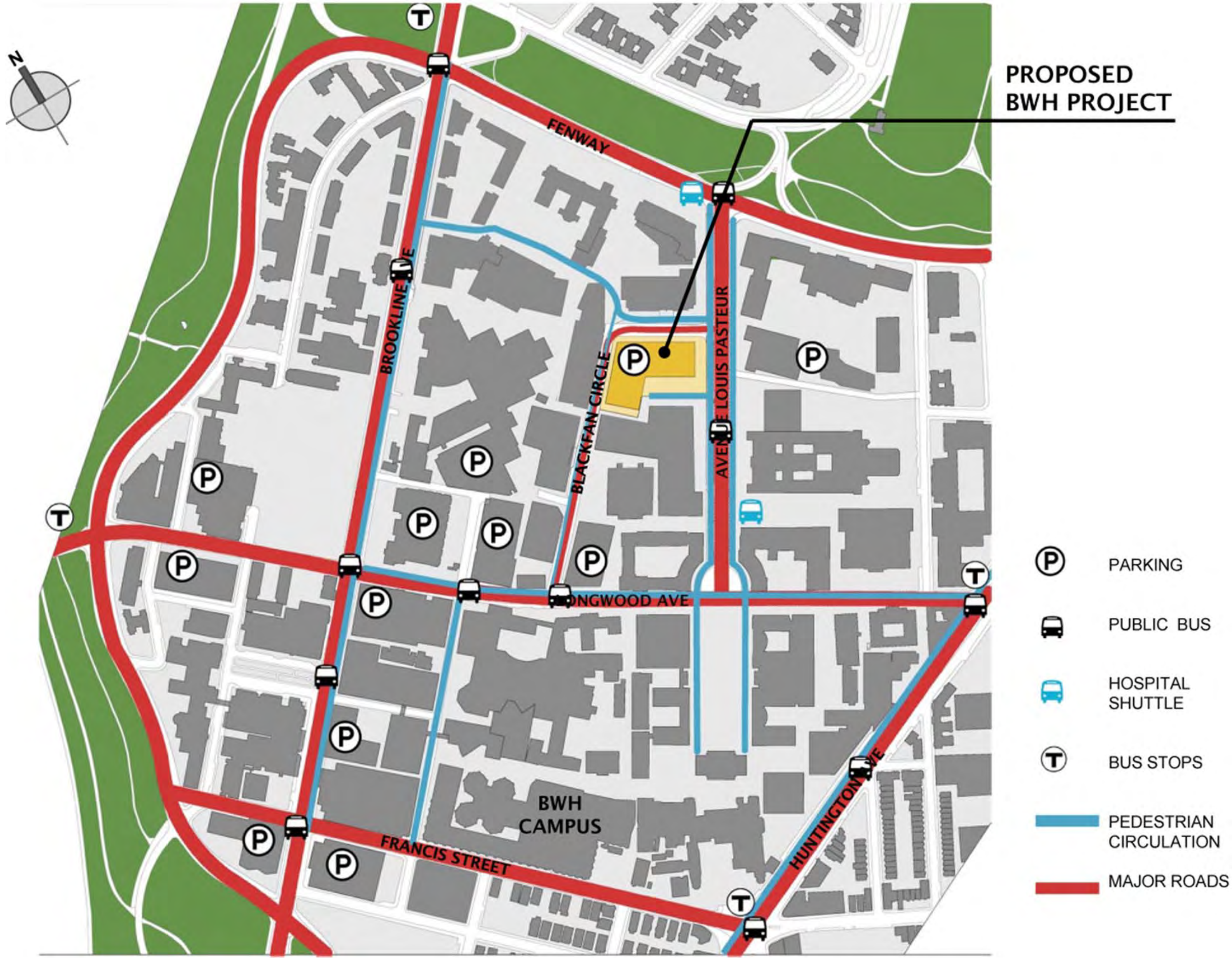

Figure 5-3

Urban Design – Pedestrian and Public Transportation

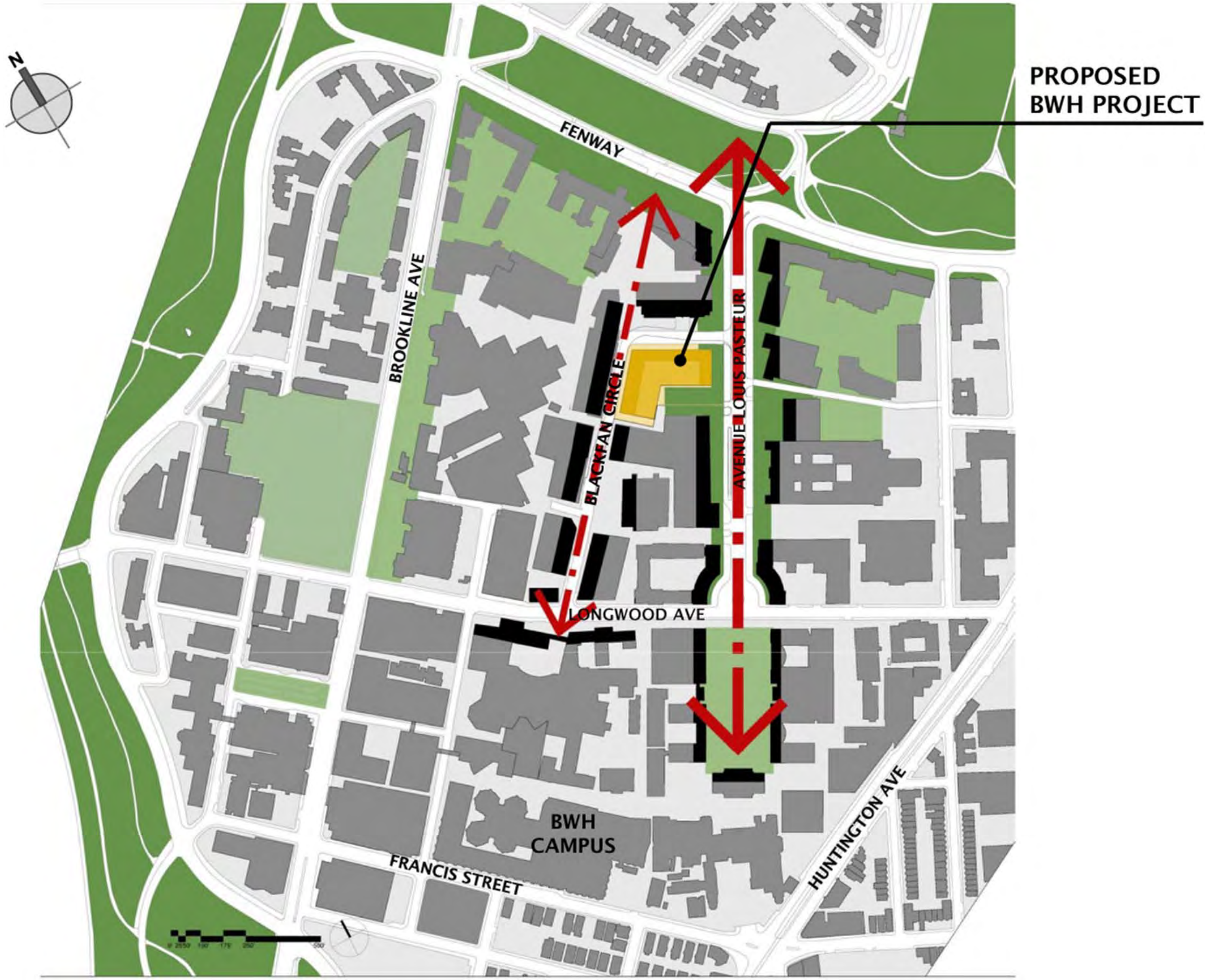

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Figure 5-4

Urban Design – Axial Relationship

The front pavilion is designed to have its own complementary architectural character, helping to give a variety of scales to the development, especially as the site is at the juncture between larger research buildings and the mid-rise buildings that are associated with the academic areas to the east and north. The structure then steps up to complement the innovation centered Blackfan Circle with a massing that mirrors those that exist there today.

Careful attention has been paid to the disposition of entry ways and to the detailing of the service areas of the building, so that Blackfan Circle is not treated as a service street. An appropriate urban density of cutting edge research centers will be logically continued here.

As mentioned previously, the proposed building will offer transparency to the surrounding area on the lower level, in particular to Avenue Louis Pasteur and to a lesser extent, Blackfan Circle. The lower levels are anticipated to include a lobby, meeting rooms and assembly spaces.

The site is well served by public transportation and the MASCO shuttles. The MBTA Green Line provides service from the east and the west, and the adjacent streets have bus stops both for MBTA service as well as MASCO shuttles, especially at the transit hub of Longwood Circle.

The building will also support large numbers of bike commuters. The design includes secured storage space within the underground parking garage. Many of BWH's life science researchers commute by bike. With bike commuting becoming increasingly popular in Boston, the building will sport a separate ramp to the garage for bikes, provide showers and generally encourage this low impact, urban friendly commuter method.

Figures 5-5 through 5-12 provide views of the proposed Project.

5.2.4 Green Spaces

The courtyard on the south side of the proposed building will be an urban room like the collegiate spaces of the adjacent Emmanuel College, a small space of respite, cool in the summer and warm in the winter. Setting up a separate identity for the new building while offering a place where people can gather, it may serve as a pleasant entry at the beginning of the path through the block or a quiet place to linger at lunch hour. The space will be non-smoking consistent with BWH Campus policy. Paved with small scaled pavers and planted with plants that require little or no irrigation, the space will feature places to sit, shade and be a quiet space. See Figure 2-4.

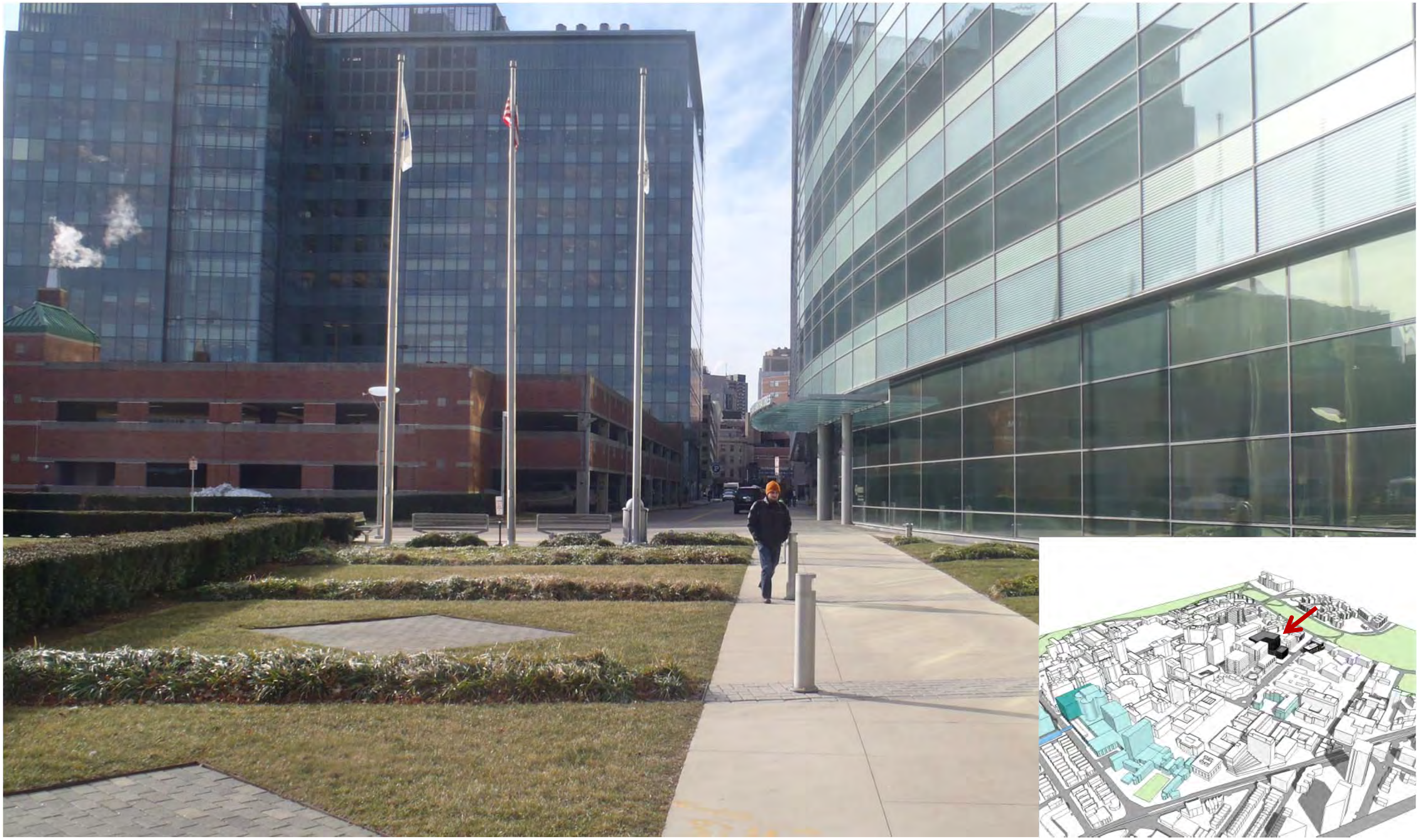

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Figure 5-5

View from Emmanuel College Looking South Along Blackfan Circle

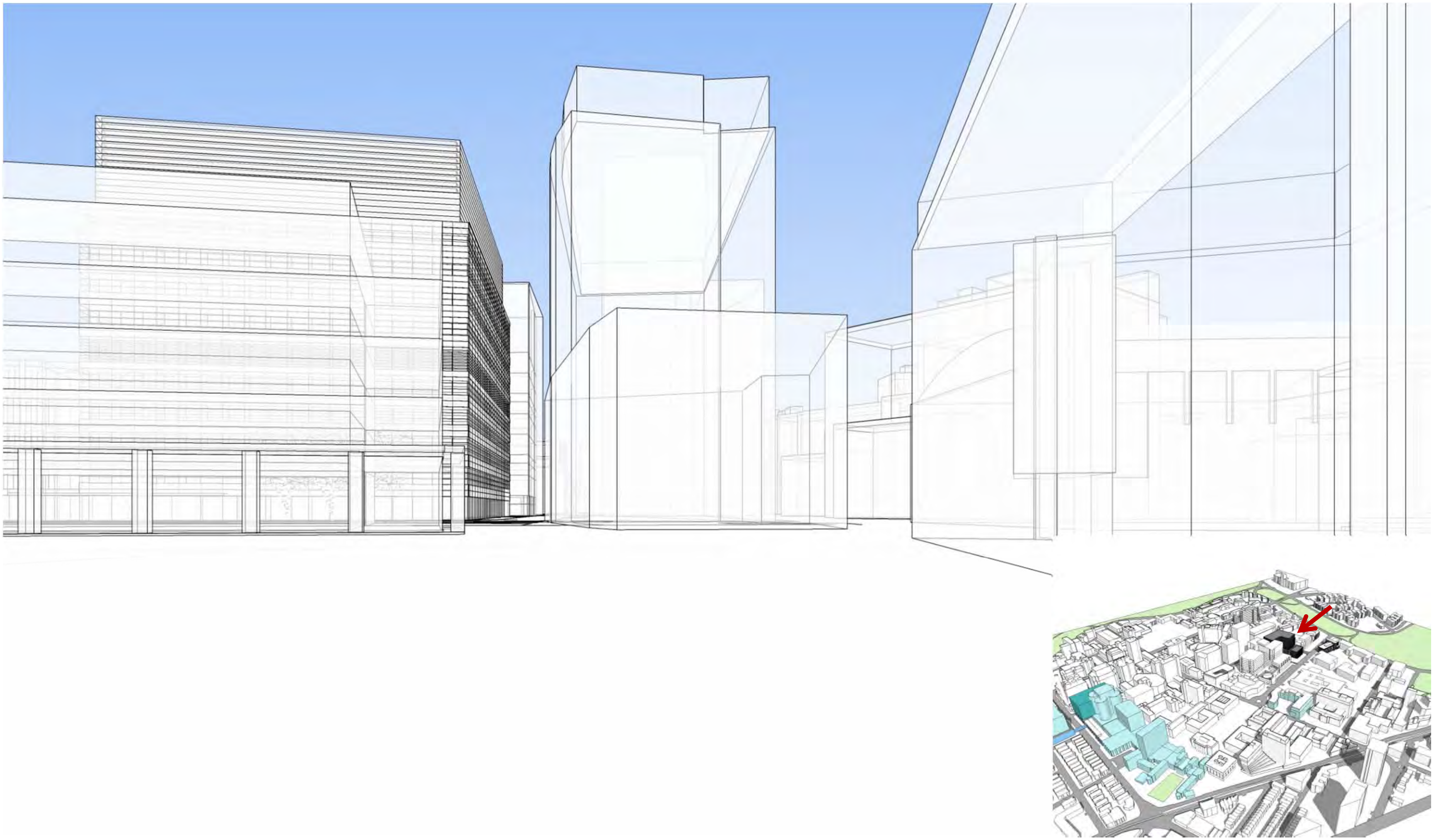

Figure 5-6

View from Emmanuel College Looking South Along Blackfan Circle

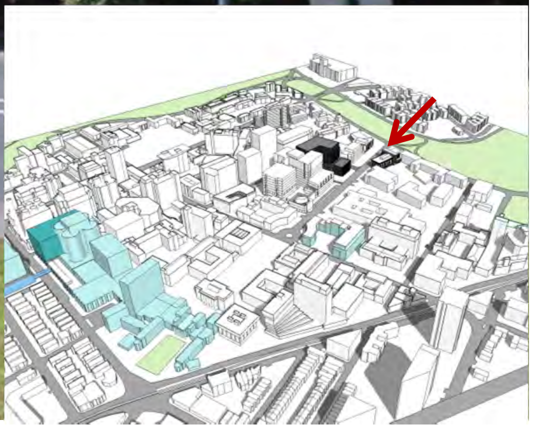

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Figure 5-7

View from the Fens Looking South on Ave. Louis Pasteur

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Figure 5-8

View from the Fens Looking South on Ave. Louis Pasteur

Figure 5-9

View from Intersection of Longwood Ave. and Ave. Louis Pasteur Looking North

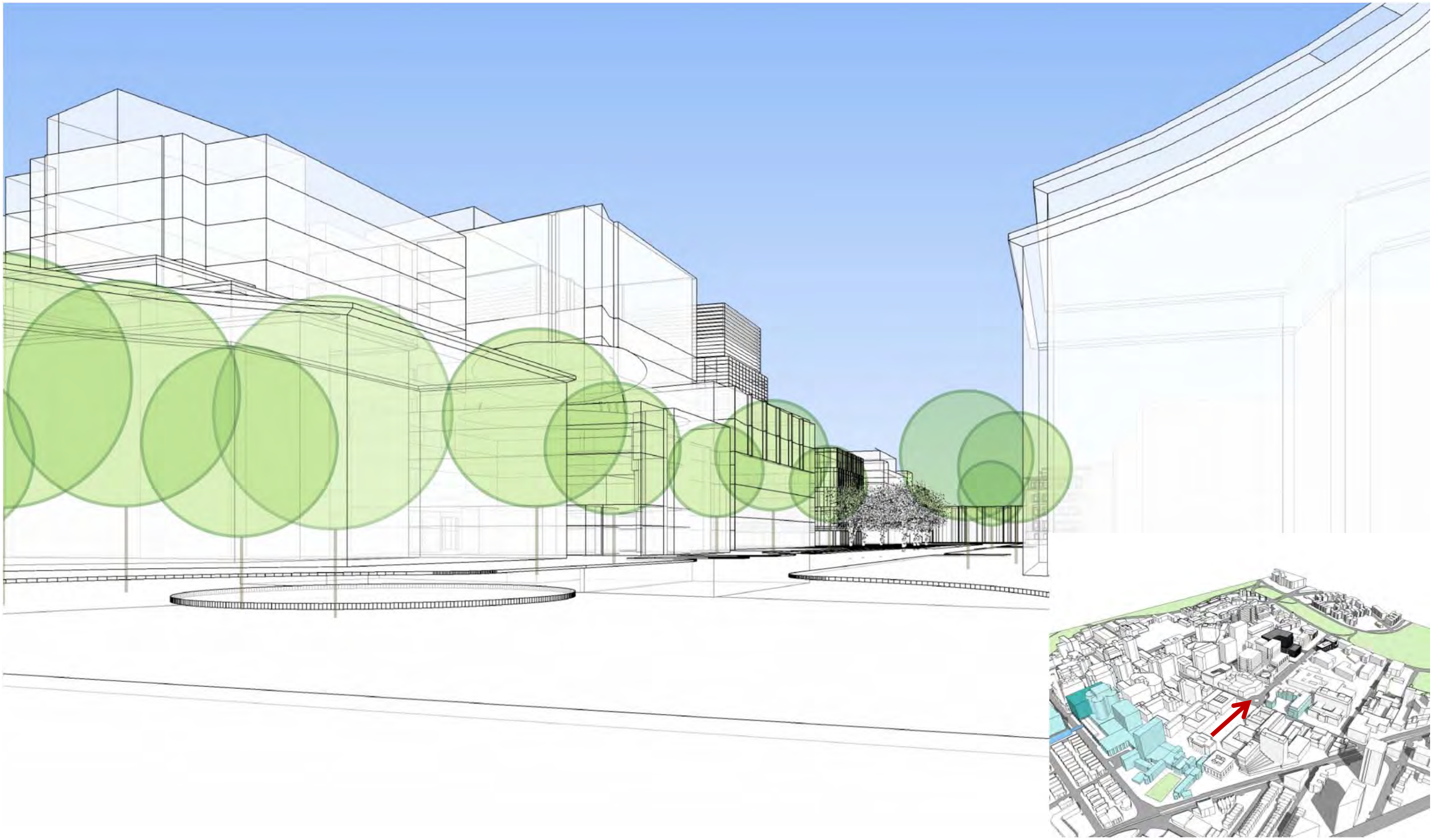

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Figure 5-10

View from Intersection of Longwood Ave. and Ave. Louis Pasteur Looking North

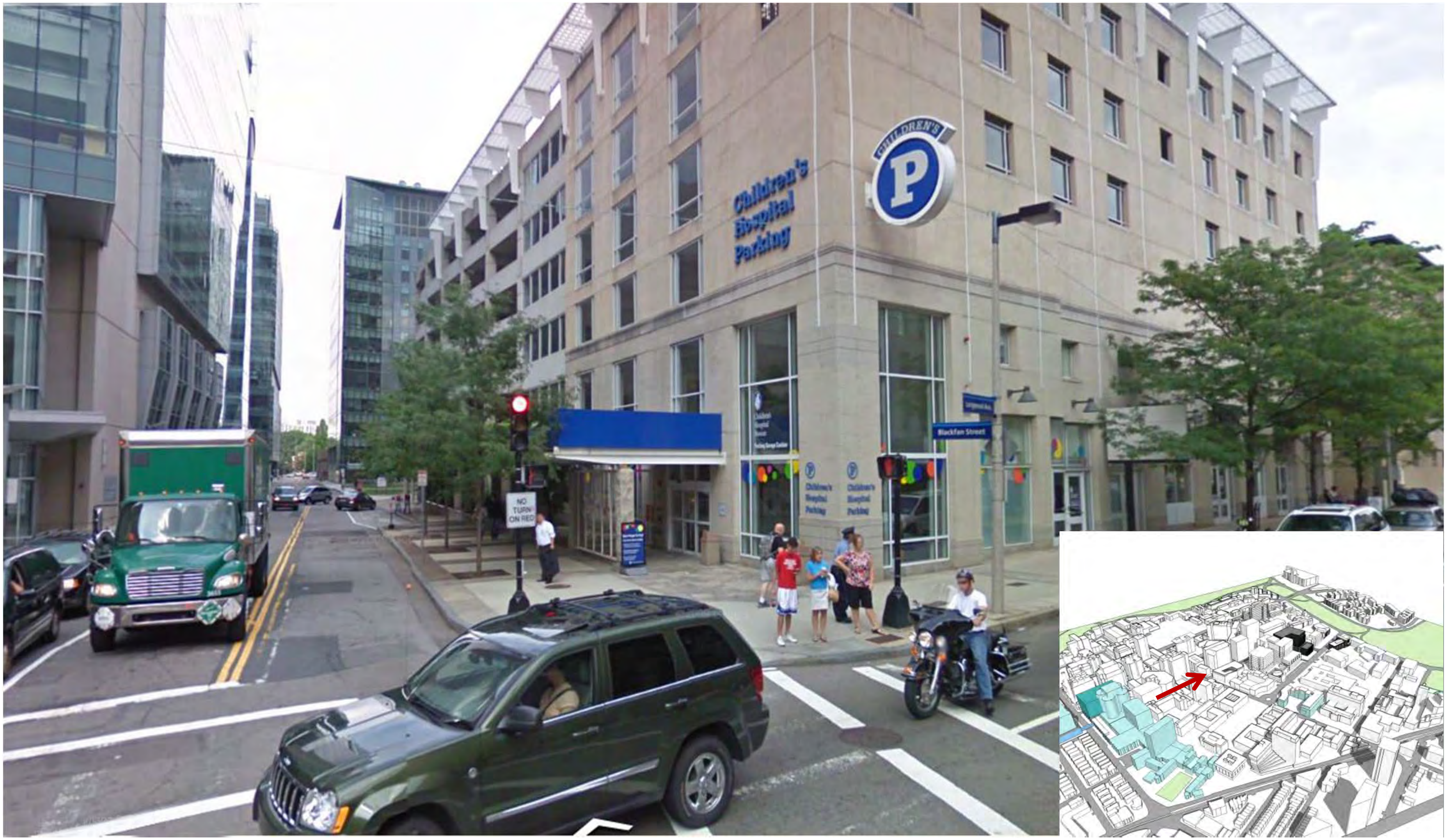

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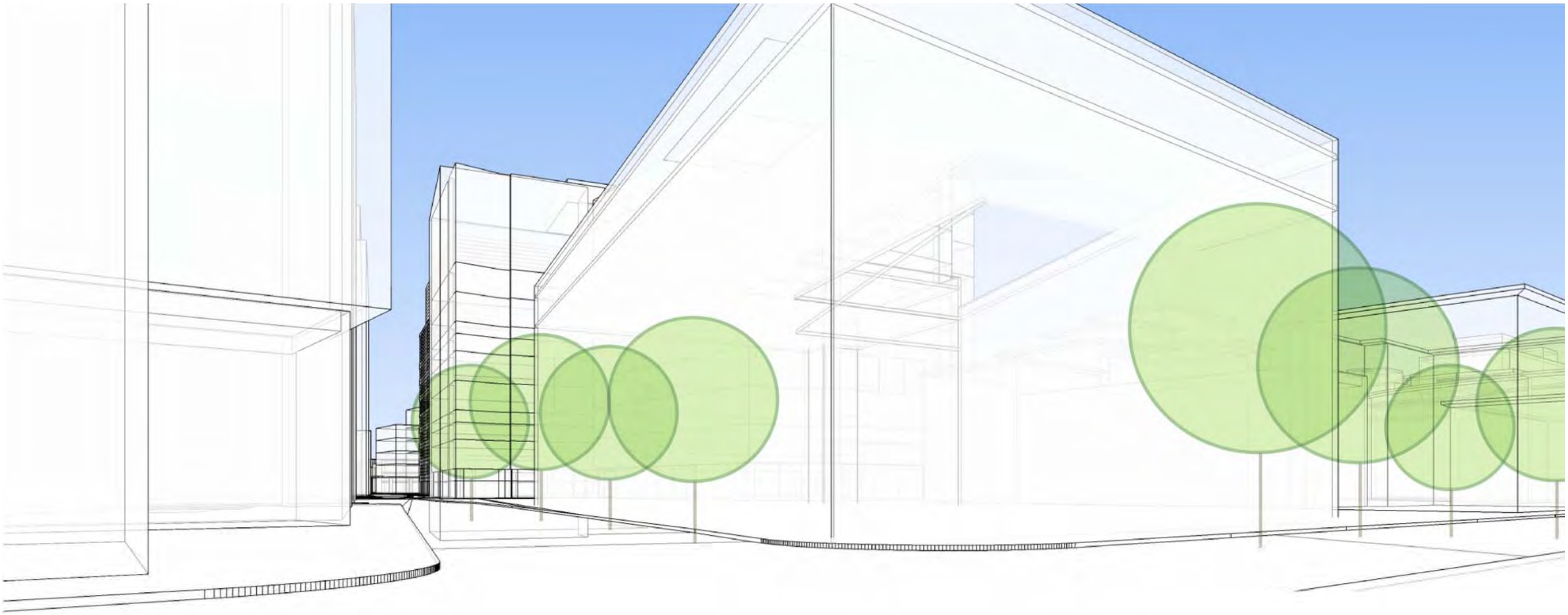
Figure 5-11
View from Intersection of Longwood Ave. and Blackfan Circle Looking North



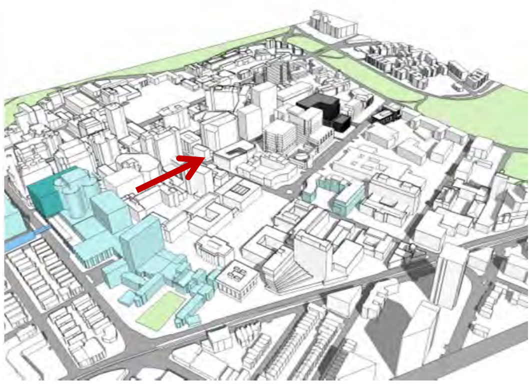


Figure 5-12
View from Intersection of Longwood Ave. and Blackfan Circle Looking North

5.3 Relationship to Current Planning on Emmanuel College's Campus

The development of the proposed Project will add to an innovation district adjacent to Emmanuel College. The adjacent innovation district includes a high concentration of research, life sciences and healthcare workers that are right at the Emmanuel College threshold. The relative openness of the building's design means that the activities both in and around the building can inspire Emmanuel students in their studies, helping Emmanuel to achieve one of its stated goals of daily student interaction in multiple activities.

The construction of the proposed Project will also help Emmanuel College by maintaining and celebrating access at multiple points to the Emmanuel campus through the enhanced research and academic gateway. Human scaled materials and streetscape elements, bollards, specialized paving and lighting at this important intersection onto Blackfan Circle will be used. This is also an important threshold for emergency vehicle access and roadway improvements. In particular the more generous tuning radius at this turn will facilitate emergency vehicle access should it be required.

Section 6.0

Historic and Archaeological Resources

6.0 HISTORIC AND ARCHAEOLOGICAL RESOURCES

6.1 Buildings on the Proposed Project Site

6.1.1 Alumnae Hall, 45 Avenue Louis Pasteur

Constructed 1947-1949, Alumnae Hall is located on Parcel C of Emmanuel College's Endowment Campus (the "Project site"). The red brick building with cast stone trim is four stories in height, with a raised basement level. L-shaped in plan, and featuring a flat roof, the building is generally consistent in style with the College's earlier 1914 Administrative Building located on the main campus. However, unlike the Administration Building, which is an excellent example of the English Collegiate Gothic style, Alumnae Hall is a much simpler and later example of the Gothic Revival style. The Project site is currently bounded to the north by a surface parking lot, the east by Avenue Louis Pasteur, the south by Harvard's 430,000 sf research building constructed in 2003, and the west by the 2004 Merck building. The Project site also includes a parking garage structure constructed in 1989 that will be demolished as part of the proposed Project.

Alumnae Hall was built to house the College's Academic Science departments and represents the transition of the College from a commuter school to a residence college. BWH currently occupies Parcel C pursuant to its lease with the Trustees of Emmanuel College of Alumnae Hall.

The northern half of the Emmanuel College campus, including the Administration Building and the Cardinal Cushing Library, is located within the Southwest Fenway Historic District, an area that has been recommended for listing in the National Register of Historic Places by the Boston Landmarks Commission ("BLC"). Alumnae Hall, located on the southern part of the campus, is not within the area defined as the National Register eligible Southwest Fenway Historic District.

6.2 Historic Resources in the Proposed Project's Vicinity

The Emmanuel College Academic Campus is included in the Massachusetts Historical Commission's ("MHC") *Inventory of Historic and Archaeological Assets of the Commonwealth*. The Emmanuel College campus encompasses nine buildings constructed between 1914 and 2009. The College was founded by the Sisters of Notre Dame de Namur in 1919 as the first Catholic College in New England for women. The centerpiece of the campus is the Administration Building (1914). Designed by the noted Boston architectural firm of Maginnis, Sullivan & Walsh, the building is an excellent example of the English Collegiate Gothic style. Since its construction, the Administration Building has been the College's main classroom building. The BLC has recommended the Administration Building for individual listing on the National Register of Historic Places and for Boston Landmark designation.

The northern half of the Emmanuel College campus, including the Administration Building and the Cardinal Cushing Library, is located within the Southwest Fenway Historic District, which has also been recommended for listing in the National Register of Historic Places by the BLC. Several additional historic resources exist within the vicinity of the Project site. Notable resources include the Olmsted Park System/Emerald Necklace Historic District, the Isabella Stewart Gardner Museum at 280 The Fenway, and the Sears Roebuck & Company Mail Order Store at 309 Park Drive.

Table 6-1 contains a complete listing of State and National Register-listed properties located within a quarter mile radius of the proposed Project Site. The locations of these properties are identified on Figure 6-1.

Table 6-1 Historic Resources in the Vicinity of the Project

Name	Address	Designation
1. Emmanuel College Campus	400 The Fenway	MHC Inventory
2. Emmanuel College Administration Building	400 The Fenway	MHC Inventory
3. Southwest Fenway Historic District	The Fenway	MHC Inventory
4. Olmsted Park System / Emerald Necklace Parks	The Riverway, Olmsted Park, and Jamaica Pond	National Register District Boston Landmark
5. Harry Hamilton Kerr Hall (Students House)	96 The Fenway	National Register listed
6. Isabella Stewart Gardner Museum	280 The Fenway	National Register listed
7. Massachusetts School of Art	364 Brookline Avenue	National Register listed
8. Vanderbilt Hall – Harvard Medical School	245 Longwood Avenue	MHC Inventory
9. Sears, Roebuck and Company Mail Order Store	309 Park Drive and 201 Brookline Avenue	National Register listed Boston Landmark
10. Harvard Medical School	230 & 240 Longwood Avenue	MHC Inventory
11. Boston Lying-In Hospital	221 Longwood Avenue	MHC Inventory
12. Boston Public Latin High School	78 Avenue Louis Pasteur	MHC Inventory

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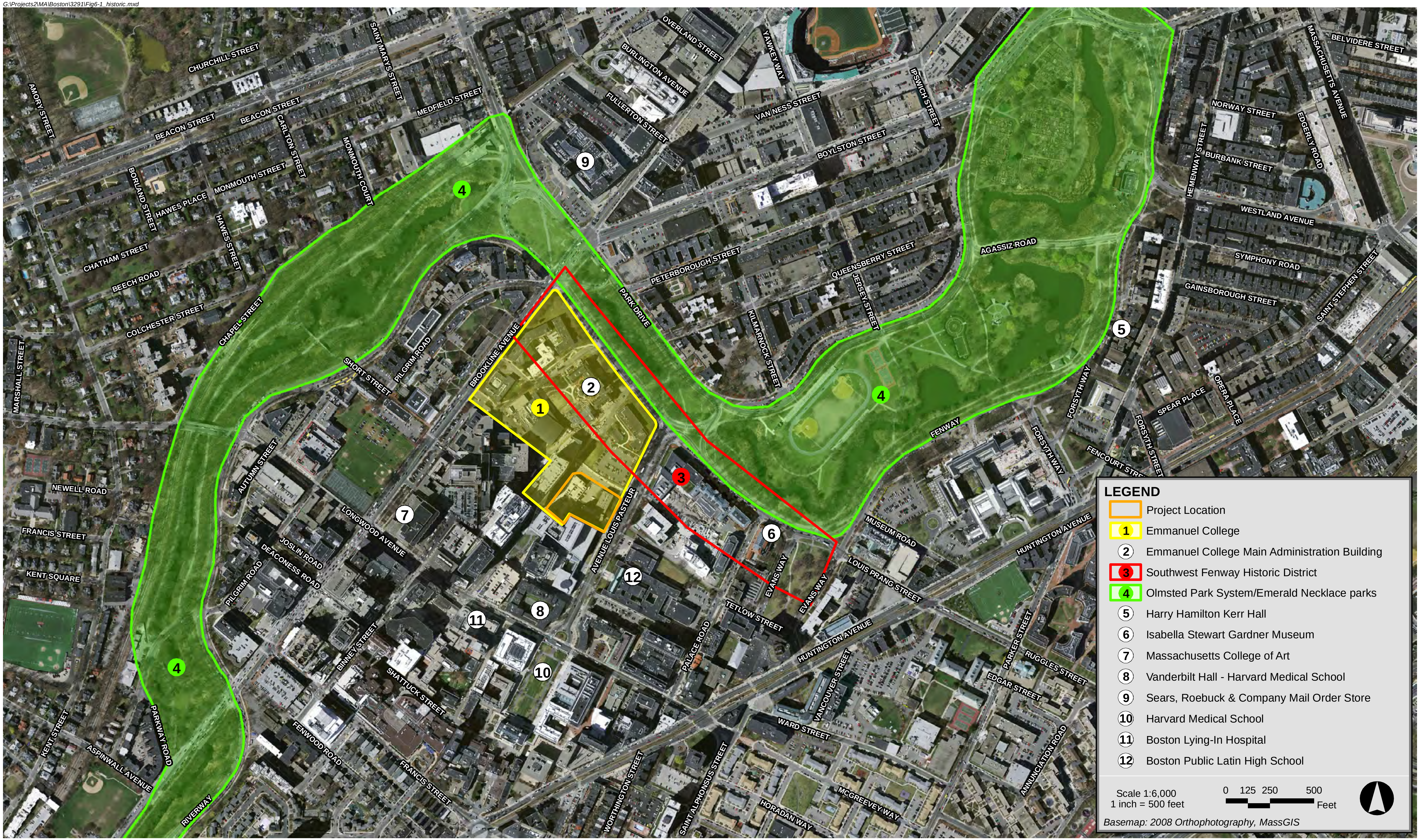

BWH 2012 IMP Amendment Project

Epsilon Associates Inc.

Figure 6-1
Historic Resources

6.3 Archaeological Resources

The Project site consists of filled land created in the late nineteenth century when the Muddy River was improved. No known archaeological sites are recorded within or in proximity to the Project site and there is little potential for significant archaeological resources to be impacted as a result of the Project.

6.4 Impacts to Historic Resources

6.4.1 Demolition of Alumnae Hall

Development of the Project will require the demolition of Alumnae Hall. As discussed above, Alumnae Hall is not listed on the State or National Registers of Historic Places. Unlike Emmanuel College's 1914 Administrative Building, which has been recommended as eligible for the National Register and identified as a potential Boston landmark as an excellent example of the English Collegiate Gothic style, Alumnae Hall is a much simpler and later example of the Gothic Revival style. Also unlike the Administration Building, Alumnae Hall is not located within the area defined as the National Register eligible Southwest Fenway Historic District.

The Project site is currently separated from the National Register eligible Southwest Fenway Historic District by a surface parking lot to the north. Its setting was further compromised by the 1989 construction of the parking garage and the 2004 Merck Building to the west. and the construction of Harvard's 430,000 sf research building to the south in 2003. The parking garage adjacent to Alumnae Hall will also be demolished as part of the Project.

6.4.2 Design and Visual Impacts

As discussed in greater detail in Chapter 5, Urban Design, the design concept for the Project starts from the basic pattern of architecture established by the consistent setbacks on the west side of Avenue Louis Pasteur. The forward pavilion of the design along Avenue Louis Pasteur is 75 feet tall, similar to the existing Alumnae Hall and range of building heights found on the Emmanuel College's campus. The Project has been intentionally designed to place taller portions of the massing at the rear of the site, closer to the Merck and Harvard buildings.

The front, lower portion of the building will feature its own complementary architectural character, helping to give a variety of scales to the development, especially as the site is at the juncture between larger research buildings and the mid-rise buildings found on the Emmanuel College campus. The program for the lower portion of the building is envisioned to be less mechanically intensive to avoid roof mounted vents and machinery that could effect the view from the street.

While respectful of the existing historic buildings within the Project's vicinity, the character of the new building will be distinctly and purposely contemporary, emblematic of the forward-looking mission of BWH as a world-class medical and research facility. The transparency of the new building will be in contrast, yet complimentary, to the heavy masonry of the Administration Building and other Emmanuel College buildings; highlighting the early 20th century craft of the historic buildings.

6.4.3 Shadow Impacts

As discussed in greater detail in Chapter 4, the Project will result in some new shadow. The shadow impact analysis looked at net new shadow created by the Project during 11 time periods. New shadow will generally be limited to the immediately surrounding streets and sidewalks, and in some cases new shadow will be cast onto nearby rooftops and portions of open space on Emmanuel College's campus. New shadow will also be cast onto a small portion of the Southwest Fenway Historic District during one time period studied. During 10 of the 11 time periods studied, no new shadow will be cast onto the Back Bay Fens. Impacts to the Back Bay Fens will be limited to the afternoon in December when shadows are typically their greatest.

All new shadows will be limited to isolated areas and last a short duration and will not have any material impact on the integrity of the historic resources in the area. At no time during any of the time periods studied will there be new shadow cast on Emmanuel College's National Register-eligible Administration Building.

6.5 Status of Project Review with Historical Agencies

Massachusetts Historical Commission

The proposed Project will require state financial assistance and/or approvals, thereby requiring review by the MHC in accordance with Massachusetts General Laws Chapter 9, ss 26-27C as amended by Chapter 254 of the Acts of 1988 (950 CMR 71.00). BWH will be filing a MHC Project Notification Form (PNF) to formally notify the MHC of the proposed Project and to initiate the MHC consultation process. BWH will consult with MHC to assess potential Project related impacts to significant historic resources. If impacts associated with the Project are unavoidable, BWH will work with MHC and interested parties, such as BLC, in developing appropriate measures to mitigate Project impacts to historic resources.

Boston Landmarks Commission

Constructed in 1947-1949, Alumnae Hall is greater than 50 years old and therefore subject to review by the BLC in accordance with Article 85 of the Boston Zoning Code. An Article 85 application for the proposed demolition of Alumnae Hall will be submitted to the BLC at the appropriate time. BWH is committed to working collaboratively with the BLC and the community throughout the Article 85 review process.

Section 7.0

Infrastructure Systems Component

7.0 INFRASTRUCTURE SYSTEMS COMPONENT

This chapter evaluates the infrastructure systems that will support the Project. Based on initial investigations and consultations with the appropriate agencies and utility companies, existing infrastructure systems are adequately sized to accept the incremental increase in demand associated with the development and operation of the proposed Project. The following utilities are evaluated: wastewater, water, stormwater management, natural gas, electricity, and telecommunications.

The final design process for the Project will adhere to applicable protocols and design standards, ensuring that the proposed building is properly supported by, and in turn properly use, the City's infrastructure. Detailed design of the Project's utility systems will proceed in conjunction with the design of the building and interior mechanical systems.

The systems discussed below include those owned or managed by the Boston Water and Sewer Commission ("BWSC"), private utility companies, and on-site infrastructure systems. There will be close coordination among these entities and with the Project engineers and architects during the ongoing permitting and design review process.

7.1 Wastewater Generation

Sanitary sewage generated by the Project will discharge to the BWSC system via the 12-inch sewer in Avenue Louis Pasteur and/or the 39-inch by 41-inch sewer in Blackfan Circle. The locations and sizes of these connections have not been determined. From there, these sanitary sewers flow to the Metropolitan District Commission ("MDC") Charles River Valley Sewer, then to the Ward Street Headworks, then, via the Boston Main Drain, to the Columbus Park Headworks and finally to the MWRA Deer Island Wastewater Treatment Plant for treatment and disposal. Please refer to Figure 7-1 for a site plan showing existing utilities.

The Massachusetts State Environmental Code (Sewer Connection and Extension Regulations, 310 CMR 15.203), does not define sewage generation rates for research and development facilities. A review of wastewater and sewage generation for similar facilities yielded a range of flow between 75 and 200 gallons per day (gpd) per 1,000 square feet (sf). Based upon the more conservative sewage generation rate of 200 gpd per 1,000 sf, the Project will generate an average daily sewer flow of approximately 72,000 gallons per day (gpd). In addition, the Project's cooling towers may require up to 7,000 gpd of "blow down" water that must also be discharged to the BWSC's sewer system. In total, the Project will generate an average daily sewer flow of approximately 79,000 gpd, of which approximately 69,000 gpd represents net new sewage flows (when taking into consideration the demolition of the existing buildings on the site). Table 7-1 summarizes anticipated future sewage generation flows from the Project site.

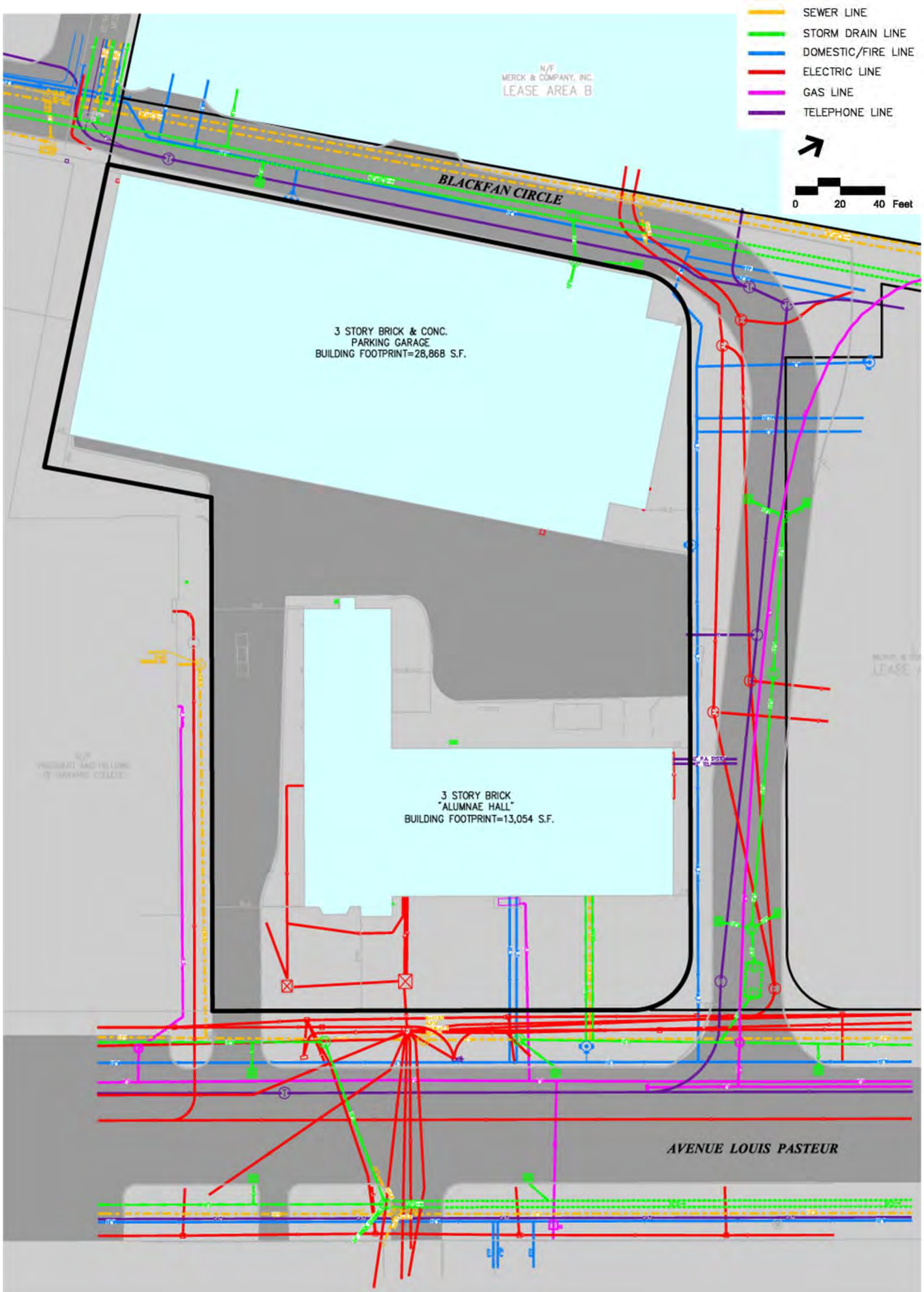

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Figure 7-1

Existing Utilities

Table 7-1 Net New Wastewater Generation

Proposed Project Use	Size (sf)	Flow Rate (gpd)	Sewage Generation (gpd)
Office/Lab/R&D	360,000	200/1,000 sf	72,000
Alumnae Hall (To be demolished)	50,000	-200/1,000 sf	-10,000
Cooling Tower	-----	7,000	7,000
Total Net New Wastewater Generation			69,000

The proposed Project will likely have at least two separate sewer connections—one sanitary sewer connection and one lab waste sewer connection. These two connections are the result of two separate plumbing systems that will likely be designed within the building.

The separate sanitary sewer system will handle traditional waste from restrooms, drinking fountains, and break-room areas.

The laboratory waste sewer system will handle waste generated during any ongoing research processes. At this time, the exact composition of the laboratory waste is not known. Once the building is designed and programmed and the composition of the waste is known, BWH will apply for a Massachusetts Water Resources Authority ("MWRA") Sewer Use Discharge Permit.

The MWRA Sewer Use Discharge Permit requires the following:

- Pretreatment Program- Identification of the complete chemical make-up of the laboratory waste sewer discharge and implementation of a pretreatment program as determined by the MWRA.

- Monitoring- Implementation of a sampling and reporting program that allows the MWRA to monitor the building's sewer discharges.

- Action Program- Development of a notification and action program in the event of a non-permitted discharge.

Compliance with the standards for the final site design will be reviewed as part of the BWSC Site Plan Review process. All lab discharges will be approved and continually monitored by the MWRA under the Project's Sewer Use Discharge Permit.

Laboratory Waste

This Project includes proposed wet laboratory space. As the wet research functions are identified during final design, the Proponent will coordinate with the MWRA Toxic Reduction and Control (TRAC) program to identify the required treatment program. All laboratory wastes shall be treated and discharged separately into a sanitary sewer.

7.2 Water Supply System

The BWSC provides domestic and fire protection water service to the Project site. The BWSC delivers water to this site via a 12-inch water main in Blackfan Circle and a 10-inch main in Avenue Louis Pasteur. These mains are supplemented by a 48-inch supply main in Longwood Avenue. Both of these mains are part of the BWSC's Southern Low (SL) distribution system. The SL distribution system is integrally connected to form loops that allow major water demands to be fed from more than one direction. This looping allows the system to perform at optimum efficiency and provides redundancy in the event of a water main break. Results of a hydrant flow test conducted on January 6, 2012 by BWSC are shown in Table 7-2.

Table 7-2 Hydrant Flow Test Results

Static	73	psi
Residual	68	psi
Total Flow	2196	gpm
Flow @20 psi	7858	gpm

7.2.1 Proposed Connection

Water generation is based upon estimated sewage generation with an added factor of 10 percent for consumption, system losses, and other usage. Based upon a sewage generation rate of 200 gpd per 1,000 sf, the building will require approximately 75,900 gpd of water.

In addition, the Project's cooling tower may require an average of 35,000 gpd "make-up" water. The Project's overall average daily water demand is expected to be approximately 110,900 gpd.

7.2.2 Domestic Water Connection

The 12-inch water main in Blackfan Circle or the 10-inch water main in Avenue Louis Pasteur will supply the Project with domestic water. Connections will be designed to meet the latest city and state codes and standards including cross connection backflow prevention. Compliance with the standards for the final site design will be reviewed as part of the BWSC Site Plan Review process.

7.2.3 Fire Protection

The proposed Project will require a separate, dedicated fire service connection to the water mains in Blackfan Circle or Avenue Louis Pasteur, likely to be an eight-inch service. The building's fire protection system will be designed to the latest Massachusetts Building Code, which refers to the National Fire Protection Association Handbook. In addition, the fire protection system will meet all applicable standards set by the Boston Fire Department ("BFD"). BWH will seek input from the BFD on emergency vehicle site access, siamese connection locations and hydrant locations during the design process.

7.3 Water Quality and Stormwater Management

The following section includes a discussion of the Project impacts on stormwater and water quality.

7.3.1 Stormwater

According to BWSC records, a 33-inch storm drain runs north along the east side of Avenue Louis Pasteur to The Fenway. A 15-inch drain runs along Avenue Louis Pasteur to The Fenway along the west side of the street. An 18-inch drain line connects the two lines in front of Alumnae Hall. A 42-inch by 42-inch brick storm drain runs along Blackfan Circle, between Parcel B and Parcel C, which runs through Emmanuel College's campus to The Fenway.

This Project will be subject to BWSC's phosphorous removal requirements and the City of Boston Article 32 requirements. To comply with both, the Project will need to infiltrate one inch of rain over all structures and impervious surfaces. These infiltration systems will also reduce runoff from the proposed Project.

Stormwater management controls will be established in compliance with BWSC standards and the Project will not introduce peak flows, pollutants, or sediments that would potentially impact the receiving waters of the local BWSC stormwater drainage system. Among the stormwater management controls considered for implementation will be deep sumped and hooded catch basins, sump cleaning, and oil/gas separators. Stormwater from the site will be collected and discharged via new connections to either the existing 15-inch drain in Avenue Louis Pasteur or the 42-inch by 42-inch brick storm drain in Blackfan Circle.

As part of the permitting process, the Project will submit stormwater management plans for the Project to the BWSC. Surface drain structures required by the Project will be developed to meet the latest city and state codes and standards. Compliance with the standards for the final site design will be reviewed as part of BWSC's Site Plan Review process.

The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) indicates the FEMA Flood Zone Designations for the site area (Map Number 25025C0078G, September 25, 2009). The map for the proposed site shows that it is not located in a designated flood plain.

As a commitment to both the goal of improving the water quality of local bodies of water and public education, the Proponent will install plaques that bear the warning "Don't Dump – Drains to Charles River" at all new and adjacent catch basins. Oil traps will also be provided for all parking areas below grade, with any discharge from these traps directed into the sanitary sewer and not the storm sewer.

7.3.2 Construction Stormwater Management

Construction of the proposed Project is not expected to produce significant changes in either the pattern of, or rate of, stormwater runoff from the site. Stormwater management controls will be established in compliance with BWSC standards. In addition, the proposed Project will improve the water quality by removing parking lot stormwater runoff from the site. A significant portion of the site is currently a parking area that is within the proposed building footprint. The stormwater runoff collected via the roof drains of the proposed building will be significantly cleaner than the existing runoff from the parking lot and parking garage.

The majority of onsite drainage will be collected internally and directed to the BWSC collection system in Blackfan Circle or Avenue Louis Pasteur. The BWSC, as part of the Site Plan Review process, will review drainage facilities and related water quality performance.

7.3.3 Compliance with MassDEP Stormwater Management Policy

This section discusses the Project's compliance with each of the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Policy Standards.

7.3.3.1 Standard #1: Untreated Stormwater

No new stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

Compliance: The Project will be designed with the goal to comply with this Standard. No new untreated stormwater is expected to be directly discharged to, nor is erosion expected to be caused to wetlands or waters of the Commonwealth as a result of stormwater discharges related to the proposed Project.

7.3.3.2 Standard #2: Post-Development Peak Discharge Rates

Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

Compliance: Preliminary hydraulic analyses show the proposed site will reduce runoff rates for the 2, 10, and 25 year storms. Preliminary analyses were based on the assumption that infiltration chambers will be provided and sized for one-inch of runoff per the Groundwater Conservation Overlay District requirements.

Storm Event	Existing Discharge Rate (cfs)	Proposed Discharge Rate (cfs)
2	5.82	4.03
10	8.74	4.89
25	10.63	5.47

7.3.3.3 Standard #3: Recharge to Groundwater

Loss of annual recharge to groundwater should be minimized through the use of infiltration measures to the maximum extent practicable. The annual recharge from the post development site should approximate the annual recharge from the pre-development or existing site conditions, based on soil types.

Compliance: The proposed Project lies within the Groundwater Conservation Overlay District and will strive to meet this Standard by complying with the Boston Zoning Code's requirement to recharge one-inch of stormwater over the entire new impervious area.

7.3.3.4 Standard #4: 80 Percent Total Suspended Solids Removal

For new development, stormwater management systems must be designed to remove 80% of the average annual load (post-development conditions) of Total Suspended Solids (TSS). It is presumed that this standard is met when: Suitable nonstructural practices for source control and pollution prevention are implemented; Stormwater management BMPs are sized to capture the prescribed runoff volume; and Stormwater management BMPs are maintained as designed.

Compliance: The Project will be designed with the goal to comply with this Standard. Within the proposed Project's limit of work, there will be mostly roof, landscaping, and pedestrian areas. Any paved areas that would contribute unwanted sediments or pollutants to the existing storm drain system will be collected by deep sump, hooded catch basins and conveyed through water quality units before discharging into the BWSC system.

7.3.3.5 Standard #5: Higher Potential Pollutant Loads

For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If, through source control and/or pollution prevention, all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt, and stormwater runoff, the proponent shall use the specific structural stormwater BMPs determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L.c. 21, §§ 26-53 and the regulations promulgated there under at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.

Compliance: The Project site does not contain land uses with higher potential pollutant loads.

7.3.3.6 Standard #6: Protection of Critical Areas

Stormwater discharge to critical areas must utilize certain stormwater management BMPs approved for critical areas. Critical areas are Outstanding Resource Waters (ORWs), shellfish beds, swimming beaches, cold-water fisheries and recharge areas for public water supplies.

Compliance: The proposed Project will not discharge untreated stormwater to a sensitive area or any other area.

7.3.3.7 Standard #7: Redevelopment Projects

A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

Compliance: The Project is a redevelopment and will be designed with the goal to comply with this Standard.

7.3.3.8 Standard #8: Erosion/Sediment Controls

Erosion and sediment controls must be implemented to prevent impacts during construction or land disturbance activities.

Compliance: The Project will be designed with the goal to comply with this standard. Sedimentation and erosion controls will be incorporated as part of the design of the Project and employed during construction.

7.3.3.9 Standard #9: Operation/Maintenance Plan

A Long-Term Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function as designed.

Compliance: The proposed Project will be devised with the goal to comply with this standard. An O&M Plan will be developed during the design and BWSC process.

7.3.3.10 Standard #10: Illicit Discharges

All illicit discharges to the stormwater management system are prohibited.

Compliance: The proposed Project will comply with this standard. There will be no illicit connections associated with the proposed Project design.

7.4 Energy Systems

7.4.1 Energy Efficiency

The Project will be designed to provide for its own heating and cooling needs. The Proponent is committed to promoting energy efficiency measures throughout the Project. Since research facilities can be by nature 24-hour operations and intense equipment users, the Proponent will take seriously its leadership role in helping control use of excess energy. The Proponent will commission mechanical systems to ensure systems are operating as efficiently as possible from the day of their installation.

The Proponent will have a program in place to ensure chlorofluorocarbon reduction in all heating, ventilation, air-conditioning, and refrigeration equipment purchased. The Proponent will incorporate efficient light fixtures to increase energy efficiency and improve illumination. The energy requirements for all major pieces of equipment will be in accordance with energy code requirements and with requirements for a LEED certification.

Additionally, the Proponent is pursuing numerous sustainable design initiatives including the optimization of energy performance and building commissioning.

7.4.2 Energy Needs

NSTAR will provide electric power to the proposed building from their infrastructure in Blackfan Circle/Longwood Avenue. Representatives of BWH are currently coordinating the building design with NSTAR. BWH will coordinate the final design and installation of electrical service. Electrical demand is estimated to be approximately 9 MW.

As the design moves forward, BWH will study the possibility of including a cogeneration facility in the Project.

National Grid provides natural gas to the Project site and has been consulted regarding this Project. Currently, an upgraded eight-inch plastic 22 PSIG (intermediate) pressure main is located in Avenue Louis Pasteur that runs to Blackfan Circle. Natural gas demand is estimated to be 100,000 cubic feet per hour (CFH).

7.4.3 Telecommunications

Verizon has been consulted regarding this Project and has available infrastructure adjacent to the Project site.

Appendix A

Scoping Determination and Comment Letters

Appendix A

An annotated copy of the Scoping Determination is included in Appendix A. Comments mentioned in the Scoping Determination and comment letters have been addressed throughout the document. The annotations on the Scoping Determination and comment letters reference the section or chapter of the Draft PIR where the response to the comment can be found. All section references refer to the Draft PIR sections unless otherwise noted. Other references are noted as to sections of the IMP Amendment.

Boston Redevelopment Authority

Boston's Planning & Economic Development Office

Thomas M. Menino, *Mayor*
Clarence J. Jones, *Chairman*
Peter Meade, *Director*

One City Hall Square
Boston, MA 02201-1007
Tel 617·722·4300
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February 17, 2012

Mr. Arthur Mombourquette
Vice President of Support Services
Interim Vice President of Human Resources
Brigham and Women's Hospital
75 Francis Street
Boston, MA 02115

Dear Mr. Mombourquette:

Re: Brigham and Women's Hospital: Institutional Master Plan Notification Form/Project Notification Form Scoping Determination

Please find enclosed the Scoping Determination for the Brigham and Women's Hospital Institutional Master Plan Notification Form/Project Notification Form ('IMPNF/PNF"). The Scoping Determination describes information required by the Boston Redevelopment Authority (the "BRA") in response to the IMPNF/PNF which was submitted under Article 80 of the Boston Zoning Code on January 3, 2012. Additional information may be required during the course of the review of the IMPNF/PNF.

We look forward to working with you and the community to achieve approval of an IMPNF/PNF that is appropriate to the location and meets the needs of Brigham and Women's Hospital.

Sincerely,

Sonal Gandhi

BOSTON REDEVELOPMENT AUTHORITY

SCOPING DETERMINATION
FOR
BRIGHAM AND WOMENS HOSPITAL
INSTITUTIONAL MASTER PLAN NOTIFICATION FORM/PROJECT NOTIFICATION FORM:
2012 INSTITUTIONAL MASTER PLAN AMENDMENT PROJECT

The Boston Redevelopment Authority ("BRA") is issuing this Scoping Determination pursuant to Section 80B-5.3 and Section 80D-5.3 of the Boston Zoning Code (the "Code") in response to an Institutional Master Plan Notification Form/Project Notification Form ("IMPNF/PNF"), submitted by Brigham and Women's Hospital ("BWH") on January 3, 2012. The IMPNF/PNF proposes to amend the existing BWH Institutional Master Plan approved by the Boston Redevelopment Authority ("BRA" or "Authority") on February 16, 2010 and the Boston Zoning Commission on March 24, 2010 , effective on March 30, 2010 ("2010 BWH IMP") and proposes one project: an approximately 360,000 square foot building dedicated to hospital uses, including laboratory, research and support spaces, as well as 355 below-grade parking spaces ("2012 BWH IMP Amendment Project") to be located at 45 Avenue Louis Pasteur (the "Project Site") on Parcel C of Emmanuel College's Endowment Campus.

Notice of the receipt by the BRA of the IMPNF/PNF ("Notice") was published in the Boston Herald on January 3, 2012 initiating a public comment period ending on February 3, 2012. The Notice and the IMPNF/PNF were sent to public agencies of the City pursuant to Section 80A-2 of the Code and the BWH Task Force. A Task Force meeting where the IMPNF/PNF was presented and discussed was held on January 18, 2012. BWH presented and discussed its IMPNF/PNF at the LMA Forum on January 23, 2012. The Scoping Determination requests information that the BRA requires for its review of the 2012 BWH IMP Amendment Project in connection with the following:

(a) Certification of Compliance and approval of the 2012 IMP Amendment Project pursuant to Article 80, Section 80B of the Code; and

(b) Certification of Consistency with the 2010 BWH IMP, as amended, pursuant to Article 80, Section 80D-10 of the Code.

The BRA is reviewing the 2012 IMP Amendment Project pursuant to multiple sections of the Code. The 2012 IMP Amendment Project is being reviewed pursuant to Article 80, Section 80B, Large Project Review, and Section 80D, Institutional Master Plan Review which set out comprehensive procedures for project review and requires the BRA to examine the urban design, transportation, environmental, and other impacts of proposed projects. BWH is required to prepare and submit to the BRA an Institutional Master Plan Amendment/Draft Project Impact Report ("IMPA/DPIR") that meets the requirements of the Scoping Determination by detailing the 2012 IMP Amendment Project's expected impacts and proposing measures to mitigate, limit, or minimize such impacts. The IMPA/DPIR shall contain the information necessary to meet the specifications of Section 80B-3 (Scope of Large Project Review; Content of Reports) and Section 80B-4 (Standards for Large Project Review Approval) as required by the Scoping Determination.

Written comments received by the BRA in response to the IMPNF/PNF from City of Boston agencies are included in Appendix A of this Scoping Determination. Written comments received by the BRA in response to the IMPNF/PNF from members of the Task Force and public are included in Appendix B of this Scoping Determination. BWH is required to respond in full to comments in Appendix A and reasonably respond to comments in Appendix B in its IMPA/DPIR. **Appendix A**

The BRA has formulated a set of Interim Guidelines to govern proposed projects in the Longwood Medical and Academic Area ("LMA"). These Interim Guidelines have been established to ensure that projects apply good planning principles in the areas of transportation, urban design, and workforce development. They describe the physical character of the LMA and outline mutually beneficial public benefits that can be provided by project proponents to achieve project heights that are greater than those specified in the Interim Guidelines. Development projects within the LMA must demonstrate compliance with guidelines for building height and setbacks, street networks, building character, environmental impacts, and transportation and workforce development. The

IMPA/DPIR shall outline how the 2012 IMP Amendment Project complies with the Interim Guidelines. **IMPA Chapter 4**

Subsequent to the end of the sixty (60) day public comment period for the IMPA/DPIR, the BRA will issue a Preliminary Adequacy Determination ("PAD") that indicates the additional steps necessary for BWH to complete in order to satisfy the requirements of this Scoping Determination and all applicable sections of Article 80 of the Code. If the BRA finds that the IMPA/DPIR adequately describes the 2012 IMP Amendment Project's impacts and, if appropriate, proposes satisfactory measures to mitigate, limit or minimize such impacts, the PAD will announce such a determination and that the requirements for the filing and review of a Final Project Impact Report ("FPIR") are waived pursuant to Section 80B-5.4(c)(iv) of the Code. Before reaching said findings, the BRA shall hold a public hearing pursuant to Article 80 of the Code. Sections 80B-6 and 80D-10 require the Director of the BRA to issue a Certification of Compliance and a Certification of Consistency, respectively, before the Commissioner of Inspectional Services can issue any building permit for the 2012 IMP Amendment Project.

PROJECT SITE

The Project Site for the 2012 IMP Amendment Project is located at 45 Avenue Louis Pasteur on Parcel C of Emmanuel College's Endowment Campus. BWH currently occupies Parcel C pursuant to its lease with the Trustees of Emmanuel College of Alumnae Hall, together with parking, for hospital use, including office and dry research. BWH intends to enter into a long-term ground lease with Emmanuel College for Parcel C in order to enable development of the 2012 IMP Amendment Project. The IMPA/DPIR must include an explanation of the zoning overlay proposed at Parcel C as a result of the 2012 IMP Amendment Project and its impact on both the Emmanuel College Institutional Master Plan as well as the BWH IMP. **IMPA Chapter 5**

2012 IMP AMENDMENT PROJECT AND IMPA:

BWH proposes one project: an approximately 360,000 square foot building dedicated to hospital uses, including laboratory, research and support spaces, as well as 355 below-grade parking spaces ("2012 BWH IMP Amendment Project") to be located at 45 Avenue Louis Pasteur (the "Project Site") on Parcel C of Emmanuel College's Endowment Campus.

The IMPA/DPIR must include a summary of all the projects within the BWH 10-year horizon describing each project and the expected phasing of each project. The IMPA/DPIR must include a summary of BWH's strategy with respect to approvals that are currently being requested for the 2012 IMP Amendment Project. **IMPA Section 1.2** **Section 2.6**

I. DEVELOPMENT REVIEW REQUIREMENTS – ARTICLE 80

SUBMISSION REQUIREMENTS

In addition to full-size scale drawings, 35 copies of a bound report containing all submission materials reduced to size 8-1/2"x11", except where otherwise specified, are required. The report should be printed on both sides of the page. In addition, an adequate number of copies must be available for community review and an electronic copy must be made available to post on the internet and distribute. A copy of this Scoping Determination must be included in the report submitted for review.

A. <u>GENERAL INFORMATION</u>

1. <u>Application Information</u>

a. Development Team **Section 1.2**

(1) Names

(a) Proponent (including description of development entity and type of corporation)

(b) Attorney

(c) Project consultants and architect

(2) Business address, telephone number and email for each

(3) Designated contact for each

b. Legal Information

(1) Legal judgements or actions pending concerning the 2012 IMP Amendment Project **Section 2.4**

(2) History of tax arrears on property owned in Boston by the Proponent

(3) Evidence of site control over the Project Site, including current ownership and purchase options of all parcels in the 2012 IMP Amendment Project, all restrictive

covenants and contractual restrictions affecting the Proponent's right or ability to accomplish the 2012 IMP Amendment Project, and the nature of the agreements for securing parcels not owned by the Proponent.

(4) Nature and extent of any and all public easements into, through or surrounding the Project Site.

c. Disclosure of Beneficial Interests

Disclosure of Beneficial Interests in the 2012 IMP Amendment Project must be provided pursuant to Section 80B-8 of the Code. **Section 2.4.4**

2. <u>Project Area</u> **Section 1.1**

a. An area map identifying the location of the 2012 IMP Amendment Project

b. Description of metes and bounds of Project Site or certified survey of Project Site

3. <u>Public Benefits</u>

a. Development Impact Project Contribution and Jobs Contribution specifying amount of housing linkage and jobs linkage contributions. **Section 1.4.2**

b. Estimated annual property taxes for each parcel, and estimated total property taxes during all construction and phased development years and after full occupancy.

c. Anticipated employment levels including the following: **Section 1.4.2**

(1) Estimated number of construction jobs

(2) Estimated number of permanent jobs

d. Current activities and programs which benefit adjacent neighborhoods and the city at large, such as: child care programs, scholarships, internships, elderly services, education and job training programs, etc. **Section 1.4.1**

e. Other public benefits, if any, to be provided. **Section 1.4.2**

4. Regulatory Controls and Permits

a. Existing zoning requirements, zoning computation forms, and any anticipated requests for zoning relief should be explained. **Section 2.5**

b. Anticipated permits required from other local, state, and federal entities with a proposed application schedule should be noted. **Section 2.6 and IMPA Chapter 5**

c. A statement on the applicability of the Massachusetts Environmental Policy Act ('MEPA") should be provided. If the 2012 IMP Amendment Project is subject to MEPA, all required documentation should be provided to the BRA, including but not limited to, copies of the Environmental Notification Form, decisions of the Secretary of Environmental Affairs, and the proposed schedule for coordination with BRA procedure. **Section 2.6.1**

5. Community Groups **Section 1.5**

a. Names and addresses of Project Site area owners, abutters, and any community of business groups which, in the opinion of the Proponent, may be substantially interested in or affected by the 2012 IMP Amendment Project and the steps the Proponent is undertaking to address any concerns thereof.

b. A list of meetings held and proposed with interested parties, including public agencies, abutters, and community and business groups.

B. PROJECT DESCRIPTION AND ALTERNATIVES **Chapter 2**

1. Project Description

The IMPA/DPIR shall contain a full description of the 2012 IMP Amendment Project and its components, including their size, physical characteristics, development schedule, costs, and proposed uses. This section of the IMPA/DPIR also shall present analysis of the development context of the 2012 IMP Amendment Project. Appropriate site and building plans to illustrate clearly the 2012 IMP Amendment Project shall be required.

2. Project Alternatives

A description of the 2012 IMP Amendment Project, including the No-Build alternative (not carrying out the 2012 IMP Amendment Project) and any alternative development proposals that were considered, shall be presented, particularly as they may affect environmental conditions. The No-Build alternative shall establish the future baseline conditions to which the effects of the 2012 IMP Amendment Project are to be compared. **Section 5.1.1**

C. TRANSPORTATION COMPONENT **Chapter 3**

The 2012 IMP Amendment Project does not involve the addition of net new parking. The transportation section will describe the transportation-related components of the 2012 IMP Amendment Project. It will adhere to the Boston Transportation Department ("BTD") Transportation Access Plan Guidelines and Article 80 development review process. The IMPA/DPIR transportation section must include complete responses to the comments submitted by BTD included in Appendix A of this Scoping Determination.

D. ENVIRONMENTAL PROTECTION COMPONENT

The IMPA/DPIR Environmental Protection Component section must include complete responses to the comments submitted by Katie Pederson, dated January 6, 2012 and David Grissino, dated February 3, 2012 included in Appendix A of this Scoping Determination.

Shadow **Section 4.2**

The IMPA/DPIR must contain a full discussion of compliance with the LMA Interim Guidelines shadow criteria. Any new shadow that will be cast on the Emerald Necklace should be mitigated. The DPIR should adequately address this potential impact. Design or other mitigation measures to minimize or avoid any adverse shadow impacts shall be identified.

Construction Impacts **Section 4.10**

A construction impact analysis shall include a description and evaluation of air quality impacts, noise generation and mitigation, construction staging, schedule, access routes, demolition, construction waste and recycling, measures to protect public safety, and rodent control.

D. <u>URBAN DESIGN COMPONENT</u> **Chapter 5**

The IMPA/DPIR Urban Design Component section must include complete responses to the comments submitted by David Grissino, dated February 3, 2012 included in Appendix A of this Scoping Determination.

E. <u>HISTORIC RESOURCES COMPONENT</u> **Chapter 6**

A historic resources analysis will assess the impacts of the 2012 IMP Amendment Project on any historic districts, open spaces, or buildings in the vicinity of the project. The IMPA/DPIR will identify, map, and describe historic resources and any other historic properties in the vicinity of the project site and shall evaluate the anticipated effects of the project on these resources. Particular attention shall be given to the design, scale, height, massing, materials, and other architectural elements of the proposed buildings as these relate to the significant architectural and historic resources in the project's vicinity. The visual impacts of the 2012 IMP Amendment Project shall be evaluated.

F. <u>INFRASTRUCTURE COMPONENT</u> **Chapter 7**

The IMPA/DPIR will address the proposed energy sources for the 2012 IMP Amendment Project (including gas, chilled water and steam), and electrical communications (including telephone, fire alarm, computer, cable, etc.) utility systems, and the need reasonably attributable to the 2012 IMP Amendment Project for additional systems facilities.

Submission Requirements

The IMPA/DPIR must include all the Submission Requirements as described in the comments submitted by David Grissino, dated February 3, 2012 included in Appendix A of this Scoping Determination.

E. PUBLIC NOTICE

BWH will be responsible for preparing and publishing in one or more newspapers of general circulation in the City of Boston a Public Notice of the submission of the IMPA/DPIR to the BRA as required by Secion 80A-2. This notice shall be published within five (5) days after the receipt of the IMPA/DPIR by the BRA. Following publication of the Notice, BWH shall submit to the BRA a copy of the published Notice together with the date of publication.

Appendix A

City Agency Comments

February 22, 2012

Peter Meade, Director
Boston Redevelopment Authority
Boston City Hall, Room 925
Boston, MA 02201
Attention: Sonal Gandhi, Senior Project Manager

Re: Brigham and Women's Hospital – Institutional Master Plan Amendment and Project Notification Form for Emmanuel College Endowment Campus Parcel C, 45 Avenue Louis Pasteur

Dear Director Meade:

The City of Boston Environment Department has reviewed Brigham and Women's Hospital's Institutional Master Plan Amendment and Project Notification Form (IMP Amendment/PNF) regarding its proposed development of Parcel C on the Endowment Campus of Emmanuel College. The site is occupied by Alumnae Hall which is leased to the Hospital for research. Parking for 328 vehicles is in a two-story garage with 27 spaces located at grade for a total of 355. They are leased to and used by Longwood Medical Area (LMA) institutions. We understand that about 350 people will work at the project site.

The project site is 45 Louis Emmanuel College's Endowment Campus Parcel C; it will be ground leased to the Hospital for an extended period. The proposed project is a 14 level plus two tall mechanical stories, 360,000 square foot, 150 foot-high (zoning height) building for uses including laboratory, research and support spaces; it includes 355 parking spaces on three below-grade levels, one level shared with service uses. Research and Imaging are proposed for the fourth, lowest, below-grade level.. A 15-foot wide sidewalk will be constructed on the eastern side of Blackfan Street as will a sidewalk on the northern side of the project site, streetscape planting and paving. Alumnae Hall, the parking garage and surface parking lot are to be demolished for the project.

GREENHOUSE GASES AND GREEN BUILDING

We commend the Proponent for planning to achieve LEED Gold and, particularly, for the choice to seek Energy and Atmosphere Credits 1, 3, 5 and 6 (Optimize Energy Performance, Enhanced Commissioning, Measurement and Verification and Green Power, respectively). The draft LEED-NC checklist shows that the Proponent has chosen for implementation credits totaling 66 points and has designated an additional 19 as questionable. Credits totaling 23 points have not been chosen for implementation. The percentage of available points chosen by LEED categories are as follows:

- Sustainable Sites (SS) - 70 percent **Section 4.11**
- Water Efficiency (WE) – 60 percent
- Energy and Atmosphere (EA) – 50 percent
- Materials and Resources (MR) – 60 percent
- Indoor Environmental Quality (IEQ) – 75 percent
- Innovation and Design Process (ID) – 50 percent
- Regional Priority (RP) – 75 percent

Human greenhouse gas (GHG) emissions come primarily from burning fossil fuels - oil, gasoline, natural gas and coal. EA Credit 2, On-Site Renewable Energy, can decrease energy costs and contribute to the Mayor's goal to reduce GHG emissions 25 percent by 2020. We encourage the Proponent to consider the advantages inherent in this credit.

CLIMATE CHANGE AND ADAPTATION

Section 4.12.2

Climate change is likely to increase average summer temperatures and the number of consecutive hign-heat days leading to increased stress on buildings, their occupants, and the electrical grid. The Draft Project Impact Report (DPIR) should assess the sufficiency of planned project systems and green infrastructure to minimize energy demand and to keep the project and its occupants safe during heat waves without the use of life-safety/emergency systems that may add to ozone pollution. Natural ventilation such as operable windows, can play a role in risk management if the ventilation and passive cooling elements are sufficient in combination to result in the necessary level of benefit. We commend the Proponent's attention to the heat island effect by choosing to implement SS 7.2, Heat Island Effect: Roof, and SS 7.1, Heat Island Effect: Non-Roof. We note that a cool roof and innovative design elements that provide passive cooling are an effective combination in raising energy efficiency.

Section 4.12.1

Climate change is also likely to increase the frequency and intensity of storms. The Proponent should determine the project's vulnerability to increased levels of riverine and other flooding in the next 100 years. If necessary, vulnerability should be assessed from both a structural and operational standpoint with an emphasis on low-level, above- and below-grade elements including storage areas, utility and mechanical system installations and other infrastructure components. The storage locations of materials that might be harmful to human health and welfare and to water quality should be carefully considered. Stormwater management systems may need to be sized for higher precipitation levels than the current design standards. Even when buildings are not compromised during a storm, roadways may flood, making them impassable. So, the potential effects on transportation accessibility must also be assessed. SS 6.1, Stormwater Design: Quantity Control, and SS 6.2, Stormwater Design: Quality Control, chosen for implementation, will provide a base for developing a plan that takes climate change into consideration.

We ask that permanent plaques which state, "Don't Dump - Drains to Charles River" be installed on the sidewalk adjacent to all existing, modified and new catch basins. Section 4.10.4

HISTORIC AND ARCHAEOLOGICAL RESOURCES AND URBAN PLANNING

The City Archaeologist has determined that while the site is on original land, the land was part of the Fens marshes and would not have been appropriate for habitation by Native Americans. The property appears to have been located fully on low-lying marsh land filled in the 1880s.

In regard to Article 85 Demolition Delay review, the Boston Landmarks Commission (BLC) is responsible for responding to the proposed demolition of all Boston buildings regardless of age. To facilitate Article 85 review for multiple buildings, the BLC suggests that a separate application be submitted for each building, as there may be instances in which a particular building is exempt from review, or will not require a hearing, while another building will require a hearing. Section 6.5

The BLC is requesting submittals, correspondence and meeting notices as an interested party in the MHC consultation process in accordance with M.G.L. Chapter 9, Sections 26-27C (950 CMR 71.00). The BLC looks forward to reviewing project related impact information, such as design and shadow materials that will be studied for the DPIR.

The BLC notes that the 2003 Longwood Medical Area (LMA) Interim Guidelines (Interim Guidelines) issued by the BRA call for "Preservation and enhancement of all buildings that contribute significantly to the history of the district...." The Interim Guidelines also list the Emerald Necklace parks as one of the "Special Study Areas" governed, in the interim, by the Parks and Boulevard Protection Zone. The list of historic resources in the Historic Resources section of the DPIR should include a list of properties on the campus or within ½ mile of the project site that are listed in the State Register of Historic Places as individual Local Landmarks, Local Historic Districts, individual National Register properties, including the Olmsted Park System (Emerald Necklace) and other nearby parks such as the Back Bay Fens, or National Register Historic Districts as well as properties listed in the Inventory of Historic and Cultural Assets of the Commonwealth (both maintained by the Massachusetts Historical Commission [MHC]).The list of historic resources should be keyed to a map. Plans for protection from identified potential Impacts on these resources should be included in the DPIR. Section 6.2

The IMP Amendment/PNF states that the project is generally consistent with the Interim Guidelines, which address the protection of assets and include dimensional guidelines that include, but are not limited to, height zones, setbacks and stepbacks. We request that the DPIR specify the elements of the Guidelines with which the project is not consistent. IMPA Chapter 4

The Institutional Master Plan Notification Form (IMPNF) filed by Emmanuel College indicated that the campus planning framework includes the letter and spirit of the institutional zoning and planning guidelines put forth by the BRA, other city agencies and community planning initiatives. Emmanuel's plans are described as consistent with the guidelines and principles of the 2003 LMA Interim Guidelines (Interim Guidelines), the Fenway Community Development Corporation's (FCDC) Urban Village Plan and the Emerald Necklace Master Plan. We ask that the DPIR include a discussion of the ways in which the proposed project is consistent with the Fenway Community Development Corporation's (FCDC) Urban Village Plan and the Emerald Necklace Master Plan. Section 2.8

The Interim Guidelines state in the Urban Design Guidelines section that, "Central to the Interim Guidelines is a set of urban design guidelines that will control the physical character of the district and of any proposed project. The urban design guidelines aim to build on and protect the physical assets of the area and will provide the framework for the development and design review of the projects."

We note that preservation and rehabilitation of historic buildings is recognized as a sustainable building practice by the U.S. Green Building Council and the City of Boston. Environment Department and BLC staff strongly encourages a thorough study of alternatives that rehabilitate or incorporate historic buildings into proposed development plans. The greenest building is a preserved building; demolition should be avoided wherever possible. The ways in which the Interim Guidelines intersect with the intent and requirements of Article 37 of the Boston Zoning Code and with Mayor Thomas M. Menino's Climate Action Plan suggest that the following elements of the Interim Guidelines are of particular importance and should be specifically addressed in the DPIR.

"ASSETS

The Interim Guidelines set principles, as described below, to enhance and protect the physical assets of the LMA -- its neighborhoods, parks, streets and sidewalks, views, landmarks, and human scale:

- Create no-build zones along the Riverway and Fenway, Avenue Louis Pasteur and Brookline Avenue to protect existing parks and parkways;

- Restrict new shadow impacts on City of Boston parks. In the interim period, no project will be approved if it casts any new shadow for more than one hour on March 21st on the Emerald Necklace, Joslin Park or Evans Way Park. This standard is consistent with the most recent shadow restrictions adopted in the City's Municipal Harbor Plan."

"CHARACTER
New projects should build on and reinforce the distinctive physical, historic, and architectural characteristics of each of the institutions within the LMA by requiring the following:

- Simplification of way-finding through enhanced institutional identity created by clear planning and distinctive architecture;
- Creation and implementation of a program that improves access for patients and visitors arriving by car, transit, or on foot, and to improve circulation within each institution's campus;
- Preservation and enhancement of all buildings that contribute significantly to the history of the district; and
- Limits on the width and spacing of tall building elements to minimize negative environmental impacts."

"SPECIAL STUDY AREAS
The Interim Guidelines provide general dimensional guidelines for the LMA district. There are, however, a number of special areas that will receive additional scrutiny and attention during the interim period and also for the master plan study. These areas are designated as Special Study Areas and include:

- The Emerald Necklace and public park system which in the interim will be governed by the Parks and Boulevard Protection Zone;
- The Longwood Avenue Corridor;
- The Huntington Avenue Corridor;
- The Fenwood Neighborhood Transition Area;
- Brigham Circle; and
- The central intersection of Longwood and Brookline Avenues."

Massing drawings and elevations should take visual impacts on historic resources into consideration. Elevations and renderings should show the heights and massing of surrounding buildings; similar elevation and renderings including the proposed project should also be provided. Potential impacts to historic resources such as construction, vibration, groundwater disturbance, wind and shadow should be assessed and discussed in detail. Of particular importance from an historic resources perspective is the potential for shadow to create perpetual damp conditions that can harm historic structures over time. **Chapter 6**

<u>TRANSPORTATION</u> **Chapter 3**
Minimizing vehicle trips in Boston is a measure necessary to achieve Mayor Menino's traffic reduction and GHG reduction goals.

The Hospital controls 5,873 parking spaces, under lease or as owner. On-campus spaces number 3,294; 2,579 are located off campus. A total of 806 spaces have been approved for the Brigham Green and the Massachusetts Mental Health Center (MMHC) site, 549 net new. Seventy-four (74) percent of existing spaces are designated for employee use. Six-hundred and fifty (650) spaces at the Servicenter Complex, owned by the Hospital, are primarily transient spaces used by other institutions. Leased spaces at the Kent Street Lot and at 850 Boylston Street, a total of 705, do not support LMA uses. The ratio of proposed parking spaces to projected employees is 1:1. The ratio per 1,000 square feet is 1.0, in excess of the 0.75 maximum allowed pursuant to the Interim Guidelines. We ask that the basis for this ratio be explained in the DPIR.

The Emmanuel College IMPNF had indicated that the 350 parking spaces presently on the project site are leased to LMA institutions; the IMP Amendments/PNF indicates that the spaces are used by the Hospital. We request that the DPIR clarify the use and, if all or part of the parking is used by other institutions, provide information regarding the number of leased spaces, the user(s) and date(s) when the use expires.

The Hospital's Transportation Demand Management (TDM) measures are identified as:

- newsletters, informational kiosks, websites, e-mail and special events are used to provide transportation information to employees;
- bicycle racks/secure bicycle storage;
- a 50 percent subsidy of MBTA passes with the cost deducted from pay on a pre-tax basis;
- location-priced parking which offers off-campus parking at a significantly lower rate than that charged for on-campus parking;
- a 50 percent parking discount for vanpool members;
- membership in the CommuteWorks Transportation Management Association (TMA) which provides:
  - commuting assistance through CommuteWorks;
  - an Emergency Ride Home program for registered employees;
  - a program, partially funded by CommuteWorks, which allows single-occupant vehicle (SOV) commuters to try transit commuting;
  - employee incentives for including walking, biking or jogging in their daily commute;
  - carpool and vanpool matching through MassRIDES;
  - free MASCO shuttles;
  - a reduced-fee membership in CommuteWorks' Zipcar program;
  - a 50 percent discount to employees who commute by non-MBTA bus services; and
  - an informal policy of telecommuting and compressed workweeks where reasonably feasible.

Zipcar for Business or car-sharing in addition to the one Zipcar on the Emmanuel campus may help to reduce vehicle trips the project; we suggest it as an option to evaluate.

This department questions the identification of significantly lower employee parking rates for off-campus parking as a TDM measure. These rates do not likely discourage single-occupant vehicle commuting and may, in fact, encourage driving. Employees may cross through the LMA to reach these parking facilities and a number of them are located adjacent to residential neighborhoods.

Projected peak hour mode splits for the project are 47 percent auto, 33 percent transit and 20 percent bike/other. We request that the DPIR how these mode shares compare with hospital-wide numbers, including non-clinical uses. We further request that the DPIR include information regarding:

- eligibility for TDM benefits;
- the number of employee who use the outlined TDM measures;
- the number of contract employees, the percentage of overall employees the number represents and the TDM benefits offered by their direct employers;
- market parking rates;

- off-campus parking rates by location;
- the total number of bicycles that can be accommodated at the 26 storage locations;
- the number of Hubway bicycles provided at the Emmanuel site; and
- the location(s) of showers and lockers rooms in on- and off-campus buildings.

ENVIRONMENTAL PROTECTION
This department looks forward to the air quality, noise, shadow and wind studies that will be part of the DPIR. We will pay particular attention to the effect of the project on parks, plazas, other open space, areas where pedestrians are likely to congregate, heavily used pedestrian areas and waiting areas. We ask that any proposed mitigation be described and that mitigated wind speeds be identified if such areas are expected to have conditions inconsistent with an existing or planned use or in the uncomfortable for walking or dangerous categories. The shadow study should include analyses for 6:00 p.m. for the Summer Solstice and Autumnal Equinox. Shadow diagrams should be of a size useful for our analysis and include:

- a north arrow; **Section**
- street names; **4.2**
- the identification of doorways, bus stops, open space and areas where pedestrians are likely to congregate (in front of historic resources or other tourist destinations, for example);
- clear delineation of shadow on both rooftops and facades; and
- clear distinctions between existing shadow and new shadow.

Diagrams should be oriented and scaled consistent with diagrams depicting wind monitoring locations, for both the Build and No Build conditions.

Although no regulatory limits have yet been set on Ultra Fine Particulates (UFP), their effect on human health is not at issue. It is essential that the buildings and systems be designed to allow for minimum pathways to exposure. Some effective measures include the installation of state-of-the-art air conditioning and filtration systems effective in trapping UFP (along with measures to maintain these systems), modifying building design features and locating intake vents as far as possible from sources of pollutants, including exhaust vents or structures.

CONSTRUCTION **Section**
According to the Massachusetts Department of Environmental Protection (DEP), about 33 percent of mobile **4.10**
source particulate matter (PM) and ten percent of all nitrogen oxide (NO_x) pollution in the northeast is caused by construction vehicles. More than 90 percent of diesel engine particulate emissions are highly respirable and carry toxins deep into the lung, exacerbating human respiratory ailments. The U. S. Environmental Protection Agency (EPA) has proposed classification of diesel exhaust as "highly likely to be carcinogenic in humans." It estimates that diesel engines currently on the road can run for 1,000,000 miles and remain in operation for as long as 20 to 30 years. This amounts to 160 to 240 tons of pollution over the life of each engine.

Beginning with model year 2007, on-road diesel vehicles are required to comply with strict EPA emissions requirements. Standards for new engines in non-road equipment will be phased in starting with the smallest engines in 2008 until all but the very largest diesel engines meet both NOx and PM standards in 2014. Some of the largest engines, 750+ horsepower, will have one additional year to meet the emissions standards.

The use of flow-through filters and diesel particulate filters on pre-2007 diesel vehicles can reduce air quality degradation caused by emissions of carbon monoxide (CO), volatile organic compounds (VOC), NO_x and air toxins generated by heavy-duty equipment. Oxidation catalysts and catalyzed particulate filters reduce toxic emissions of formaldehyde, benzene, acrolein and 1-3 butadiene by as much as 70 percent, decrease localized adverse impacts and reduce dust and odor complaints from project abutters and regulatory agencies. We ask that all pre-2007 diesel construction vehicles working on the project be retrofitted using retrofit technologies approved by the United States Environmental Protection Agency (EPA) and that contractors be required to use ultra low-sulfur diesel (ULSD) fuel (15 ppm), in all off-road construction equipment. **Section 4.10.8**

Some excess building materials may be suitable for donation to the Boston Building Resources (formerly the Boston Building Materials Resource Center). The Re-Use Center is a non-profit charity that sells new and high-quality used materials to the public with discounts based upon income eligibility. We request that the Proponent consider donations to the Re-Use Center (617-442-2262). **Section 4.10.11**

Thank you for the opportunity to comment and for your consideration.

Sincerely,

Maura T. Zlody
Senior Environmental Policy Analyst

Brigham and Women's Hospital.Emmanuel, IMP Amendment & PNF, 2.12.doc.MTZ.mtz

BRA MEMORANDUM

TO: Sonal Gandhi

FROM: Katie Pedersen

DATE: January 6, 2012

RE: Brigham and Women's Hospital
Boston, Massachusetts
Comments on the Institutional Master Plan
Notification Form/ Project Notification Form

I have reviewed the Institutional Master Plan Notification Form/Plan Notification Form (PNF) dated January 3, 2012 and submit the following comments for the Environmental Protection Component. Brigham and Women's Hospital ("BWH" or the "Proponent") is proposing a single project: an approximately 360,000 square foot (sf) building dedicated to hospital uses, including laboratory, research and support spaces, as well as 355 below-grade replacement parking spaces (the "Proposed Project"). The Proposed Project will be located at 45 Avenue Louis Pasteur on Parcel C of Emmanuel College's Endowment Campus.

The Proposed Project site is an approximately 78,588 square foot (sf) portion of Emmanuel College's Endowment Campus, known as Parcel C and as described in Emmanuel College's Institutional Master Plan, as approved in 2000. The Proposed Project site, currently leased by BWH, includes a two-story concrete and brick parking garage with 328 parking spaces, 27 surface parking spaces and Alumnae Hall, an approximately 50,000 sf, three-story building, all of which will be demolished.

Wind

In general, the Boston Redevelopment Authority (BRA) has adopted two standards for assessing the relative wind comfort of pedestrians. First, the BRA wind design criterion states that an effective gust velocity of 31 mph should not be exceeded more than one percent of the time. The second set of criteria used by the BRA to determine the acceptability of specific locations is based on the work of Melbourne. The placement of the wind measurement locations shall be based on an understanding of the pedestrian use of each of the Proposed Project and the surrounding areas. All wind tunnel test points shall be approved by the BRA staff before conduction of testing. This set of criteria is used to determine the relative level of pedestrian wind comfort for activities such as sitting, standing or walking. Section 4.1

Measurement points for the pedestrian level winds (PLW) analysis should be placed at all building entrances, entrances to public transportation stations, crosswalks and public sidewalks, public plazas and gathering areas, parks and green spaces.

To the average person adverse pedestrian level wind conditions may only a nuisance, but to the frail or disabled they may present a real threat to health and safety. It is for this reason that the Proponent shall be required to demonstrate that such conditions will not exist (or be mitigated) at and in areas surrounding the Proposed Project.

Analysis of results and effective mitigation should be presented in the Draft Project Impact Report (DPIR) using diagram methodology so that the delta or changes manifested by each of the Proposed Project relative to existing or as-of-right conditions (whichever provides the higher base impacts) are clearly understood.

Shadow

Section 4.2

The shadow impact analysis must include net new shadow from the Proposed Project as well as existing shadow and clearly illustrate the incremental impact of each. For purposes of clarity, the Proponent shall be directed to consider the use of color as an alternative to dark tonality to indicate new shadows. The shadow impact study area shall include, at a minimum, the entire area to be encompassed by the maximum shadow expected to be produced by the Proposed Project. The build condition(s) shall include all buildings under construction and any proposed buildings anticipated to be completed prior to the completion of the Proposed Project. Shadows from all existing buildings within the shadow impact study area shall be shown. A North Arrow shall be provided on all figures. Shadows shall be determined by using the applicable Boston Azimuth and Altitude data.

Particular attention shall be given to existing or proposed public open spaces and pedestrian areas, including, but not limited to, the existing sidewalks and pedestrian walkways within, adjacent to, and in the vicinity of the Proposed Project and the existing and proposed plazas, historic resources and other open space areas within the vicinity of the Proposed Project.

Daylight

Section 4.3

The Proponent shall conduct a daylight analysis for both build and no-build conditions. The analysis shall measure the percentage of skydome obstructed by the Proposed Projects and evaluate the net change in obstruction. Particular attention shall be given to existing or proposed public open spaces and pedestrian areas, including, but not limited to, the existing sidewalks and pedestrian walkways within, adjacent to, and in the vicinity of the Proposed Project and the existing and proposed plazas, historic resources, and other open space areas within the vicinity of the Proposed Project.

Daylight analyses should be taken for each major building façade within the limits of the Boston Redevelopment Authority Daylight Analysis (BRADA) program, fronting these public and quasi-public ways. The midpoint of each public access way or roadway should be taken as a study point.

Solar Glare

The Proponent has stated that the Proposed Project is not expected to incorporate the use of reflective building materials and will incorporate low E high performance glass. Consequently, the Proponent does not anticipate the creation of either an adverse solar glare impact or a solar heat buildup in nearby buildings. However, the Proponent has stated that the façade materials have yet to be finalized and thus shall be required to subsequently demonstrate that the materials selected will not create a visual nuisance and/or a hazard, (as it interferes with vision and concentration). If deemed necessary, mitigation measures to eliminate any adverse reflective glare shall be identified and described.

Air Quality

Section 4.4

The Proponent shall provide a description of the existing and projected future air quality in the vicinity of the Proposed Project and shall evaluate ambient levels to determine conformance with the National Ambient Air Quality Standards (NAAQS). Careful consideration shall be given to mitigation measures to ensure compliance with air quality standards.

A future air quality (carbon monoxide) analysis shall be required for any intersection (including garage entrance/exits) where the level of service (LOS) is expected to deteriorate to D and the Proposed Project cause a 10 percent increase in traffic or where the level of service is E or F and the Proposed Project contribute to a reduction in LOS.

The study shall analyze the existing conditions, future No-Build and future Build conditions. The methodology and parameters of the air quality analysis shall be approved in advance by the Boston Redevelopment Authority (BRA) and the Massachusetts Department of Environmental Protection (DEP). Mitigation measures to eliminate or avoid any violation of air quality standards shall be described.

A description of the Proposed Project's heating and mechanical systems including their locations and specifications, and an analysis of the impact on pedestrian level air quality and on any sensitive receptors from operation of the heating, mechanical as well as the buildings' emergency generator shall be required. Measures to avoid any violation of air quality standards shall be described.

Noise

Section 4.6

The Proponent shall establish the existing noise levels at the Proposed Project Site and vicinities and shall calculate future noise levels after project completion, thus demonstrating compliance with the Interior Design Noise Levels (not to exceed day-night average sound level of 45 decibels) established by U.S. Department of Housing and Urban Development, as well as applicable City, State and Federal noise criteria.

Appropriate low-noise mechanical equipment and noise control measures shall be required in accordance with the Regulations for Control of Noise in the City of Boston and the Commonwealth of Massachusetts. The Proponent shall also describe any other measures necessary to minimize and/or eliminate adverse noise impacts from the Proposed Project.

Solid and Hazardous Waste

Section 4.5

The Proponent shall provide a list of any known or potential contaminants on the Proposed Project site, and if applicable, a description of remediation measures to ensure their safe removal and disposal, pursuant to the M.G.L., Chapter 21E and the Massachusetts Contingency Plan.

Any potential hazardous wastes to be generated by each of the Proposed Project sites must be identified. In addition, potential waste generation must be estimated and plans for disposal indicated and measures to promote reduction of waste generation and to promote recycling in compliance with the City's recycling program described.

Geotechnical Impacts

Section 4.9

A description and analysis of the existing sub-soil conditions, including the potential for ground movement and settlement during excavation and potential impact on adjacent buildings and utility lines shall be required. This analysis shall also include a description of the foundation construction methodology, the amount and method of excavation, and the need for any blasting and/or pile driving and the impact on adjacent buildings and infrastructure. A Vibration Monitoring Plan shall be developed prior to commencing construction activities to ensure that impacts from the project construction on adjacent buildings and infrastructure are avoided. Mitigation measures to minimize and avoid damage to adjacent buildings and infrastructure must be described.

Section 4.10.10

Sustainable Design/Green Buildings

Section 4.11 and IMPA Chapter 3

The purpose of Article 37 of the Boston Zoning Code is to ensure that major buildings projects are planned, designed, constructed and managed to minimize adverse environmental impacts; to conserve natural resources; to promote sustainable development; and to enhance the quality of life in Boston. Any proposed project subject to the provisions of Article 37 shall be (at a minimum) LEED Certifiable (U.S. Green Buildings Council) under the most appropriate LEED rating system. Proponents are encouraged to integrate sustainable building practices at the pre-design phase. Proposed projects which are subject to comply with Section 80B of the Boston Zoning Code, Large Project Review, shall be subject to the requirements of Article 37.

The LEED Checklist for the Proposed Project has been included in the Institutional Master Plan Notification Form/Plan Notification Form and has indicated that the Proposed Project is striving to attain 66 points using the LEED 2009 for New Construction and Major Renovations Project Checklist. However, the Proponent did not include a comprehensive narrative describing how each of the proposed credits will be attained. As a result, the Proponent shall be required to submit an updated LEED Checklist together with an explanatory narratives demonstrating compliance with specific points. The Proponent shall also demonstrate that the Proposed Project will meet the requirements of Article 37, thus subsequently submitting a Final Article 37 Submission, which includes the most up to date LEED Checklist with appropriate supporting documentation and by certification from a LEED Accredited Professional.

Boston

Sonal Gandhi
Senior Project Manager
Boston Redevelopment Authority
One City Hall Square
Boston, MA 02201-1007

January 11, 2012

Dear Ms. Gandhi:

Regarding the Project Notification Form for Brigham & Women's Hospital project submitted to the BRA on January 3, 2012 the Boston Fire Department requires the following issues addressed by a qualified individual. **Section 2.3**

1. Emergency vehicle site access to the new buildings as well as existing buildings that might be affected.
2. Impact on availability and accessibility of hydrant locations for new buildings as well as for any existing buildings that might be impacted.
3. Impact on availability and accessibility to siamese connection locations for new buildings as well as for any existing buildings that might be impacted.
4. Impact that a transformer vault fire or explosion will have on the fire safety of the building. Particularly as it relates to the location of the vault.
5. Need for Boston Fire Department permit requirements as outlined in the Boston Fire Prevention Code, the Massachusetts Fire Prevention Regulations (527 CMR), and the Massachusetts Fire Prevention Laws (MGL CH148).
6. For projects involving air-supported structures, it is critical that the impact of the design has on fire safety relative to the interaction of the area underneath the structure to the structure as well as to the interaction of the structure to the area underneath the structure.

These items should be analyzed for all phases of the construction as well as the final design stage. This project will need permits from the Boston Fire Department as well as the Inspectional Services Department.

Respectfully,

Bart J. Shea
Acting Fire Marshal

Cc: Paul Donga, FPE, Plans Unit, BFD

Boston Groundwater Trust

229 Berkeley St, Fourth Floor, Boston, MA 02116
617.859.8439 voice – 617.266.8750 fax
www.bostongroundwater.org

January 27, 2012

Sonal Gandhi, Senior Project Manager
Boston Redevelopment Authority
One City Hall Square
Boston, MA 02201-1007

Subject: Brigham and Women's Hospital

Dear Ms. Gandhi:

Thank you for the opportunity to comment on the Institutional Master Plan Notification Form/Project Notification Form for Brigham and Women's Hospital. The Boston Groundwater Trust was established by the Boston City Council to monitor groundwater levels in sections of Boston where the integrity of building foundations is threatened by low groundwater levels and to recommend solutions to the problem. Therefore, my comments are limited to groundwater related issues.

As noted in the section of the document devoted to Stormwater Management, the proposed project is located in the Groundwater Conservation Overlay District. This fact should be noted in the zoning analysis for the project as well. I appreciate the proponent's commitment, as stated in the IMPNF/PNF, to meet the recharge requirements mandated in the GCOD.

The document includes a commitment to work with the City and the BGwT to reduce water table impacts during and after construction. However, the GCOD includes a mandate that the proponent demonstrate, in a document stamped by a professional engineer registered in Massachusetts, that the project will be designed so that it will have NO negative impact on groundwater levels on the site or on adjoining lots. I appreciate the proponent's commitment during the scoping session to meet this requirement. Because the project plans to include an underground parking garage, this commitment is particularly important. Since the zoning process is expected to be complete several years before detailed design begins on the project, it is important that there be a written commitment from the proponent to meet this standard before any zoning change is granted.

Section 4.9.2

I appreciate as well the proponent's agreement that there will be monitoring of groundwater levels before and during construction to make sure that there is no unexpected drop in levels, as well as a commitment to work with the BGwT to determine if any additional observation wells are needed. The data should be shared with the Authority and the Trust shortly after it is taken. We look forward to working with the proponent to develop a monitoring protocol that will include stopping work if adjacent groundwater levels drop more than a specified amount. When no longer needed by the project, the wells should be turned over to the BGwT to be added to the observation well network.

I look forward to working with the proponent and the Authority to assure that the project can only have a positive impact on area groundwater levels.

Very truly yours,

Elliott Laffer
Executive Director

Cc: Kathleen Pedersen, BRA
Maura Zlody, BED

Boston Water and Sewer Commission
980 Harrison Avenue
Boston, MA 02119
617-989-7000
Fax: 617-989-7718

February 3, 2012

Brian P. Golden, Executive Director/Secretary
Boston Redevelopment Authority
Attn: Ms. Sonia Gandhi
One City Hall Square
Boston, MA 02201

Re: Brigham and Women's Hospital 2012 IMP Amendment Project

Dear Ms. Gandhi:

The Boston Water and Sewer Commission (Commission) has reviewed the Brigham and Women's Hospital (BWH) 2012 Institutional Master Plan (IMP) Amendment Project. The IMP amends the plan developed by Emmanuel College in 2000 in which the proposed project site for this project, Parcel C was included. The project site is located in the Longwood Medical Area (LMA) section of Boston.

Parcel C currently contains a 3-story, 50,000 square foot building, a surface parking lot and a 2-story parking garage. The existing building and the garage will be demolished so that a new building dedicated for hospital use can be constructed on this site. The proposed building is described as a 12-story, 360,000 square foot building with four levels of parking underneath. Parcel C is located on Emmanuel College's Endowment Campus, most of the parcel's 78,588 square foot area is impervious. It appears that the footprint of the proposed building will closely overlay the current impervious area.

Alumnae Hall, the 3-story building located on Parcel C along with a 2-story parking garage, will be demolished so that BWH can construct a new 12-story building for laboratory and research space. The underground parking is intended to replicate the loss of the parking garage and surface parking. A small cafeteria is also included in the proposed building.

The project site is currently served by separate sewers: a 39-inch by 41-inch sanitary sewer and a 42-inch by 42-inch storm drain and a 12-inch sanitary sewer in Blackfan Circle and a 12-inch storm drain in Avenue Louis Pasteur. Both storm drains discharge into the Muddy River while the sanitary sewers convey flows into the Massachusetts Water Resources Authority's collection system where the flows are conveyed to the Deer Island Waste Water Treatment Plant.

The project site is in a portion of the LMA where the potential of storm drain flooding is a concern. Consequently, the Commission will require the proponent to reduce the amount of stormwater discharged directly in the storm drain system. A reduction in impervious area should be considered as one of the measures to reduce the amount of stormwater discharged from this site. **Section 7.3**

Parcel C site is also located within the Groundwater Conservation Overlay District (GCOD). Projects proposed in the GCOD are required to infiltrate at least one-inch of stormwater into the ground. The Proponent indicates that the project will include groundwater recharge systems but a specific plan has not been developed. The proponent should contact Mr. Phil Larocque at the Commission to discuss appropriate measures to comply with the GCOD's requirements and the Commission's requirements to reduce phosphorus. All of the controls will need to be detailed on the site plan submitted to the Commission for approval. **Section 7.3**

Any stormwater collected from the project site will be conveyed by the Commission's collection system into the Muddy River. The Muddy River flows into the Charles River where levels of nutrients are a growing concern. A Total Maximum Daily Load (TMDL) for nutrients has been established for the Lower Charles River Watershed by the Massachusetts Department of Environmental Protection (MassDEP). In order to achieve the reductions in phosphorus loadings required by the TMDL, phosphorus levels in the Lower Charles River must be reduced by 64 percent. To accomplish the necessary reductions in phosphorus, the Commission is requiring developers in the Lower Charles River Watershed to infiltrate stormwater discharging from the impervious areas in compliance with MassDEP. The proponent will be required to submit with the site plan a plan to reduce phosphorus from the proposed development. As part of this plan, the proponent must fully investigate methods for retaining stormwater on-site before the Commission will consider a request to discharge stormwater into the Commission's system. Under no circumstances will stormwater be allowed to discharge into a sanitary sewer. **Section 7.3**

The projects will generate an estimated average daily sewage flow of 79,000 gallons per day (gpd) which includes 7,000 gpd of cooling tower discharge. The drainage from the parking garage beneath the building will be directed to one of the sanitary sewers. The proponent will be required to separate oil and grit from water collected in the garage before discharging into a sanitary sewer. *

The proposed project will increase the amount of sanitary flow discharged into the Commission's sewer system. To offset the impact of the proposed additional sanitary flows, infiltration/inflow removal or sewer separation could be effective. *

The proponent should be aware that the Massachusetts Department of Environmental Protection (DEP) routinely requires proponents of similar projects to assist the agency in its program to reduce infiltration and inflow (I/I). In cooperation with this effort, the Massachusetts Water Resources Authority (MWRA) and its member communities are implementing a coordinated *

*** To be addressed during the Site Plan Approval process.**

approach to control extraneous flows such as I/I into the wastewater system. In this regard, the DEP has routinely required projects that add a significant amount of new wastewater flows to offset the increase with a reduction in I/I. Typically, the DEP uses a minimum ratio of 4 to 1; 4 gallons of I/I removed for each gallon of proposed wastewater. As a member community, the Commission supports the DEP and the MWRA, and will require the proponent to develop an I/I reduction plan that is consistent with their policy.

The Commission has the following general comments regarding the BWH project:

General Comments

1. If any new water mains, sewers and storm drains are required, they must be designed and constructed at the proponent's expense. Also, they must be designed and constructed in conformance with the Commission's design standards, Water Distribution System and Sewer Use Regulations, and Requirements for Site Plans. The site plan should include the locations of new, relocated and existing water mains, sewers and drains which serve the site, proposed service connections as well as water meter locations *

2. If the proponent encounters any existing water or sewer connections, they must be cut and capped according to the Commission's standards. The proponent must complete a Termination Verification Approval Form for the Demolition Permit and submit a completed form to the City of Boston's Inspectional Services Department before the Demolition Permit will be issued. *

3. The proponent is advised that the discharge of any dewatering drainage to the Commission's drainage system, whether it is temporary or on a permanent basis, requires a Drainage Discharge Permit issued by the Commission. *An NPDES Permit issued by the EPA and/or DEP does not relieve the proponent of the responsibility to obtain authorization from the Commission.* Failure to obtain a Drainage Discharge Permit from the Commission for any dewatering discharge may result in a fine of up to $ 1,000 per day per violation. *

4. BWH must submit a General Service Application and site plan to the Commission for review and approval. The site plan should show the location of all existing and proposed water lines, sewers and storm drains that serve the site. Separate service connections for sanitary flow and storm water will be required. To assure compliance with the Commission's requirements, site plans and General Service Applications should be submitted to the Commission for review when project design is 50 percent complete. *

5. With the site plan, the proponent must provide detailed and updated estimates for water demand, sanitary sewer flows and stormwater runoff generation for the proposed project. The amount of potable water required for landscape irrigation must be quantified. The proponent must also provide an analysis of the impacts of the proposed project on the Commission's water, sewer and storm drainage systems. *

*** To be addressed during the Site Plan Approval process.**

6. For any proposed masonry repair and cleaning the proponent will be required to obtain from the Boston Air Pollution Control Commission a permit for Abrasive Blasting or Chemical Cleaning. In accordance with this permit the proponent will be required to provide a detailed description as to how chemical mist and run-off will be contained and either treated before discharge to the sewer or drainage system or collected and disposed of lawfully off site. A copy of the description and any related site plans must be provided to the Commission's Engineering Customer Service Department for review before masonry repair and cleaning commences. The proponent is advised that the Commission may impose additional conditions and requirements before permitting the discharge of the treated wash water to enter the sewer or drainage system.

Water

7. The proponent is required to obtain a Hydrant Permit for use of any hydrant during the construction phase of this project. The water used from the hydrant must be metered. The proponent should contact the Commission's Operations Division for information on how to obtain a Hydrant Permit.

8. The proponent should explore opportunities for implementing water conservation measures in addition to those required by the State Plumbing Code. In particular the proponent should consider outdoor landscaping which requires minimal water. If the proponent plans to install in-ground sprinkler systems, the Commission recommends that timers, soil moisture indicators and rainfall sensors be installed. The use of sensor-operated faucets and toilets in common areas of buildings should also be considered.

9. The Commission utilizes a Fixed Radio Meter Reading System to obtain water meter readings. If a new water meter is needed for the proposed project, the Commission will provide a Meter Transmitter Unit (MTU) and connect the device to the meter. For information regarding the installation of MTUs, the proponent should contact the Commission's Meter Installation Department. *

Wastewater and Stormwater

10. The site plan must show in detail how drainage from building roofs and from other impervious areas will be managed. Roof runoff and other stormwater runoff must be conveyed separately from sanitary waste at all times. *

11. In conjunction with the site plan and General Service Application, the proponent will be required to submit a Stormwater Pollution Prevention Plan. The plan must: *

- Identify specific best management measures for controlling erosion and preventing the discharge of sediment, contaminated stormwater or construction debris to the

*** To be addressed during the Site Plan Approval process.**

Commission's drainage system when construction is underway.

- Include a site map which shows, at a minimum, existing drainage patterns and areas used for storage or treatment of contaminated soils, groundwater or stormwater, and the location of major control or treatment structures to be utilized during construction.

- Specifically identify how the project will comply with the Department of Environmental Protection's Performance Standards for Stormwater Management both during construction and after construction is complete.

12. The project proponent will be required to obtain coverage under the EPA's NPDES General Permit for Construction. A copy of the Notice of Intent and the pollution prevention plan prepared pursuant to the Permit should be provided to the Commission, prior to the commencement of construction.

    If one acre of land or more is disturbed, then the proponent will be required to obtain an NPDES General Permit for Construction from the Environmental Protection Agency and the Massachusetts Department of Environmental Protection. The proponent is responsible for determining if such a permit is required and for obtaining the permit.

    If such a permit is required, then a copy of the permit and any pollution prevention plan prepared pursuant to that permit should be provided to the Commission's Engineering Services Department, prior to the commencement of construction. The pollution prevention plan submitted pursuant to a NPDES Permit may be submitted in place of the pollution prevention plan required by the Commission provided the Plan addresses the same components identified in Item 11 above.

13. The Commission requires oil traps on drains within an enclosed parking garage. Discharges from oil traps must be directed to the sanitary sewer and not to a storm drain. The requirements for oil traps are provided in the Commission's Requirements for Site Plans. *

14. In accordance with the Commission's Sewer Use Regulations, grease traps will be required in any restaurant or commercial kitchen. If a cafeteria or a food service is built as part of this project, grease traps will be required. The proponent is advised to consult with the Commission's Operations Department prior to preparing plans for a restaurant or commercial kitchen.

15. The Commission requests that the proponent install a permanent "Don't Dump, Drains to the Charles River" castings next to any new or modified catch basin installed as part of this project. *

*** To be addressed during the Site Plan Approval process.**

16. If the proponent seeks to discharge dewatering drainage to the Commission's collection system, they will be required to obtain a Drainage Discharge Permit from the Commission's Engineering Customer Service Department prior to discharge

17. The proponent should be aware that the US Environmental Protection Agency issued a draft Remediation General Permit (RGP) for Groundwater Remediation, Contaminated Construction Dewatering, and Miscellaneous Surface Water Discharges. If groundwater contaminated with petroleum products, for example, is encountered, the proponent will be required to apply for a RGP to cover these discharges.

18. The Commission requires that existing stormwater and sanitary sewer service connections, which are to be re-used by the proposed project, be dye tested to confirm they are connected to the appropriate system. *

Thank you for the opportunity to comment on this project.

Yours truly,

John P. Sullivan, P.E.
Chief Engineer

JPS/pwk

c.

Arthur Mombourquette - BWH
M. Zlody, Boston Environment Department
Katie Pederson, BRA
P. Laroque, BWSC

*** To be addressed during the Site Plan Approval process.**

MEMORANDUM

TO: BRA Urban Design Staff
FROM: David Grissino
DATE: February 3, 2012
SUBJECT: Brigham and Women's Hospital
2012 IMP Amendment Project
Scoping Comments

URBAN DESIGN COMPONENT

Background

The Brigham and Women's Hospital (BWH) is truly one of Boston's greatest institutional assets. The patient care, research, education, and partnerships with neighboring institutions contribute to BWH's international reputation as a leader and innovator in the medical profession. It is also a major part of our local economy with approximately 15,000 employees, of which roughly 30 percent are residents of the City of Boston. In 2010, BWH filed an Institutional Master Plan (IMP) which outlined two major IMP Projects and other campus additions and upgrades.

The 2010 IMP outlined four basic Master Plan Goals:

- Enhance pedestrian circulation and the pedestrian experience;
- Reinforce the hospital's institutional identity and wayfinding;
- Improve the visual and physical integration of the hospital with adjacent neighborhoods along BWH campus edges;
- Expand and enhance BWH campus green spaces.

In addition, several Urban Design Guidelines were outlined, including:

- Image and iconography
- Form making
- Connectivity
- Place making
- Natural light
- Urban visual corridors

The Institutional Master Plan Notification Form/Project Notification Form (IMPNF/PNF) submitted on January 3, 2012, describes a project which was not previously anticipated by BWH for the 10-year planning horizon of the 2010 IMP. The proposed IMP Amendment Project (the Project) is a 360,000 square foot building located at 45 Avenue Louis Pasteur on Parcel C of Emmanuel College's campus. The building is intended to include laboratory, research and support spaces, and a 355-space parking garage. Each of the goals and guidelines listed above should be discussed as they relate to the proposed project in the IMPNF/PNF. A discussion of how the project responds to current planning on Emmanuel College's campus should also be included as part of DPIR filing.

Public Realm

The Master Plan Goals outlined in the 2010 IMP highlighted the desire to "enhance pedestrian circulation and the pedestrian experience". This is also a goal of the LMA Interim Guidelines, which seeks to "improve the character of the public realm and make navigating through the LMA easier". Because the proposed project is located remotely from the core of the BWH campus, diagrams and a narrative should be provided which define the major pedestrian routes anticipated between existing BWH facilities and the proposed project. In addition, since the majority of trip generation (53%) is anticipated to be via public transit, walking, or biking, information should be provided which addresses those means of access to the site. Particular attention should be given to documenting the location of major transit stops (subway and bus) and pedestrian routes to the project. **Section 5.2.1**

A discussion should be included which provides details of the site-specific and off-site public realm improvements which address these pedestrian patterns and connectivity to the surrounding area. Areas of particular interest are Blackfan Circle, Blackfan Street, and Avenue Louis Pasteur.

A major contribution of the project to the public realm will be the creation of an entry plaza located between the proposed project and the existing Harvard Medical School New Research Building. Current plans, however, indicate that the parking garage entrance could be located immediately adjacent to the primary pedestrian entry locations and at the western edge of the plaza. This configuration could limit the ability of this space to provide a safe and appropriate extension of the public realm into the site. An alternative should be provided which addresses this issue, either by modifications to the garage entry, main pedestrian entry location, plaza design, or a combination of these factors.

Urban Design

The goals of architecturally establishing the hospital's identity and facilitating wayfinding via signage were described in the 2010 IMP. Due to the fact that the proposed project site is located remotely from the core of the BWH campus these issues become even more challenging. Although the final architectural design of the building will be occurring at some point in the future, a series of guidelines and principles should be identified which outline the elements of the existing or desired identity which are being extended to or elaborated upon by the new design.

Signage and wayfinding concepts should be fully coordinated and reviewed in the context of on-going MASCO efforts to establish a consistent and clear system for the area. If BWH feels the need to develop a BWH-specific signage and wayfinding strategy, it should be developed in the context of a campus-wide comprehensive plan. **Section 5.2.2**

The proposed building will contribute significantly to the overall image and identity of Avenue Louis Pasteur. The IMPNF/PNF recognizes the importance of this boulevard and a detailed description of the specific strategies and design elements which enhance the **Section 5.2.3** streetscape should be provided. In particular, clarification of the design intent for the building entry located on the Avenue Louis Pasteur façade should be included, as well as a description of how this building entry relates to the strong pattern of significant entries fronting onto the Avenue at the Simmons College Library, Boston Latin, and Harvard's New Research Building. **Section 5.2.3**

While the Avenue Louis Pasteur façade may be of primary importance, careful attention must also be given to those parts of the proposed project which face Emmanuel College, Merck Laboratories, and form the edges of the major open space of the entry plaza. The analysis of the relationship to Emmanuel College should also comment upon how the proposed project relates to the "Edge Condition" and "Gateway" concepts outlined in Emanuel's IMPNF and the concepts for Parcel A.

For the proposed project, several perspective urban visual corridor studies should be conducted depicting current and proposed conditions from eye-level (Note: The future condition should include the previously permitted Parcel A building). Locations should include, but not necessarily be limited to, points:

- From the east side of Avenue Louis Pasteur at Simmons College Library looking southwest
- From the pedestrian path between the Merck Research Building and the Wilkens Science Center looking southeast toward Avenue Louis Pasteur
- From the east side of Avenue Louis Pasteur directly across from the proposed project looking west
- From the east side of Avenue Louis Pasteur near the entry to the Boston Latin School looking north

In addition to providing information regarding the architectural attitude toward Avenue Louis Pasteur, the third and fourth perspective views described above should illustrate the intended character and use of the open space plaza. A discussion should also be provided that defines this open space's relationship to the broader open space and green space network in the area.

Building and Landscape Design

For the proposed project, a conceptual ground floor plan and site plan should be provided depicting assumptions relative to loading/servicing, major entries, locations of active uses, publically accessible spaces, and the interface with public realm. Major landscape elements, features, furnishings, and materials should be described as well. A detailed discussion should be provided which explains how the lower levels of proposed building facade along Avenue Louis Pasteur may relate to the pedestrian through areas of transparency to activity inside the building. **Section 5.2.4**

Elevations of all sides of the building should provide a description of major architectural materials and systems, their relationship to overall building massing, their relationship to internal programming, and each of the general urban design guidelines described in the 2010 IMP.

Environmental Impacts

Due to the proximity of the project to important open space resources such as the Back Bay Fens, a shadow impact analysis should be performed which includes the proposed project, the previously permitted Parcel A, and other projects in the surrounding area either permitted or under review in the Article 80 process (including Julie Hall and the Cushing Library at Emmanuel College).

The shadow analysis shall be required for existing and build conditions for the hours 9:00 a.m., 12:00 noon, and 3:00 p.m. for the vernal equinox, summer solstice, autumnal equinox, and winter solstice and for 6:00 p.m. during the summer and autumn. It should be noted that due to time differences (daylight savings vs. standard), the autumnal equinox shadows would not be the same as the vernal equinox shadows and therefore separate shadow studies are required for the vernal and autumnal equinoxes. Shadows shall be determined using the Boston Altitude and Azimuth data (Sun Altitude/Azimuth Table, Boston, Massachusetts). **Section 4.2**

The shadow impact analysis must include net new shadow as well as existing shadow. Diagrams must clearly show the incremental impact of the proposed new buildings. For purposes of clarity, new shadow should be shown in a dark, contrasting tone distinguishable from existing shadow. The shadow impact study area shall include, at a minimum, the entire area to be encompassed by the maximum shadow expected to be produced by the projects (i.e., at the winter solstice). The build condition shall include all buildings under construction and any proposed buildings anticipated to be completed prior to completion of the projects. Shadow from all existing buildings within the shadow impact study area shall be shown. A North arrow shall be provided on all figures and street names, doorways, bus stops, open space and areas where pedestrians are likely to congregate (in front of historic resources or other tourist destinations, for example) should be identified.

Particular attention shall be given to areas of pedestrian use, including, but not limited to, nearby open green spaces, entrances to the proposed buildings and existing buildings in the vicinity, and the sidewalks and walkways within the adjacent area.

The IMP should propose mitigation measures to minimize or avoid any adverse shadow impact. Special attention should be given to minimize or avoid any adverse shadow impact on the Back Bay Fens and other landscaped areas.

Due to the proposed building's height and adjacency to other similarly scaled buildings in the area, a quantitative wind tunnel study should be performed to understand the impacts of the project. Locations for sensors shall be determined and modified in collaboration with BRA staff. For consistency, the same physical conditions (existing buildings, permitted projects, and projects in the development review process) should be used for both shadow and wind analysis. **Section 4.1**

Submission Requirements

For the proposed IMP Project, we suggest submitting the following urban design materials for the conceptual massing and uses. These items are in addition to any described above.

1. Written description of program elements and space allocation (in square feet) for each element, as well as Project totals.
2. Neighborhood plan at an appropriate scale (1"=200' or larger as determined by the BRA) showing relationships of the proposed projects to the neighborhood context:
   a. massing
   b. building height
   c. scaling elements
   d. open space
   e major topographic features
   f. pedestrian and vehicular circulation
   g. land use
3. Color or Black and White photographs of the site and neighborhood.
4. Sketches and diagrams to clarify design issues and massing options.
5. Eye-level perspective (reproducible line or other approved drawings) showing the proposal in the context of the surrounding area. Several view locations were described above in the "Urban Design" section. Additional views, if desired, should display a particular emphasis on important areas such as key intersections, accessways, or public parks/attractions. Long-ranged (distanced) views of the proposed project must also be studied to assess the impact on the skyline or other view lines. At least one bird's-eye perspective should also be included. All perspectives should show (in separate comparative sketches) both the build and no-build conditions. The BRA should approve the view locations before analysis is begun. View studies should be cognizant of light and shadow, massing and bulk.
6. Additional aerial or skyline views of the project, if and as requested.
7. Site sections at 1"=100' or larger (or other scale approved by the BRA) showing relationships to adjacent buildings and spaces. At least one section should be cut perpendicular to Avenue Louis Pasteur extending through the proposed project and Merck to the west and the Simmons College Science Building to the east. At least one section should be cut parallel to Avenue Louis Pasteur extending through the Harvard New Research Building, the proposed project, Parcel A, and the proposed expansion of the Cushing Library. Building areas beyond the cutline of the section should be included in a lighter tone or outline.
8. A streetscape elevation at an appropriate scale (1"=100' or larger, or as approved by the BRA) showing the proposed building in its immediate context. The extents of the elevation should be along Avenue Louis Pasteur from the Fenway to Longwood Avenue. Massing for Parcel A and the proposed expansion of the Cushing Library should be included.

BOSTON
TRANSPORTATION
DEPARTMENT

ONE CITY HALL PLAZA/ROOM 721
BOSTON, MASSACHUSETTS 02201
(617) 635-4680/FAX (617) 635-4295

February 7, 2012

Sonal Gandhi
Boston Redevelopment Authority
One City Hall Square, 9th Floor

Dear Sonal,

Thank you for the opportunity for the Boston Transportation Department (BTD) to comment on the Institutional Master Plan Notification Form/Project Notification Form (IMPNF/PNF) for the Brigham and Women's Hospital (BWH) IMP Amendment Project at 45 Avenue Louis Pasteur on Parcel C of Emmanuel College's Endowment Campus.

The proposed future project includes a 360,000 square foot (sf) research building and a 355 space underground garage to replace the existing 50,000 sf building and 328 space parking garage, plus 27 surface parking spaces. No net new parking is proposed in the plan.

As part of the submittal of the IMP/DPIR, we request clarification/additional information on the following:

- **Main entry:** The IMPNF/PNF and subsequent presentations show various alternative locations for the main entry. Given that most building users will arrive by foot (walking, transit or shuttle bus), we suggest that emphasis be given to the entries facing Avenue Louis Pasteur and the adjoining section of Blackfan. Section 5.2.1.1
- **Pickup and Dropoff:** Given that this is a research and not a clinical facility, the need for a dedicated pickup and dropoff is unclear. We request that BWH reconsider this aspect of the design in the IMP/DPIR. Section 5.2.1.1
- **Parking garage entry:** Alternative locations have been shown for the parking garage entry to the building. A garage entry on Merck side of Blackfan creates the opportunity to eliminate the curb cut on Avenue Louis Pasteur to make this a more pedestrian friendly sidewalk. We request that BWH consider this alternative in the IMP/DPIR. Section 3.3.5
- **Sidewalk and streetscape improvements:** The proposed sidewalk and streetscape improvements, particularly the addition of a 15' sidewalk on Blackfan where none exists, are welcome and appreciated. The IMP/DPIR should confirm that these facilities are consistent with the Boston Complete Streets guidelines and indicate how the design supports the vision for streets that are "multimodal, green and smart". Section 5.2
- **Bicycle access and parking:** The IMP/DPIR should include a campus-wide bicycle access and parking plan, including connections to the larger bicycle network. Bicycle parking should follow the City of Boston's Bicycle Parking Guidelines. In addition, we request that BWH support the City's efforts to improve the bicycle network and connectivity in the LMA area. Section 3.3.4

- **Motor vehicle parking:** The IMP/DPIR should address how BWH will manage the parking displaced by this project, including a robust Transportation Demand Management strategy to reduce single occupant driving throughout the BWH campus, and the use of other parking spaces within the BWH campus. In addition, the IMP/DPIR should include a commitment to accommodate shared vehicles and electric vehicle charging stations in the future garage. Section 3.3.5 Section 3.5
- **Service and loading:** The IMP/DPIR should include specific information about the location of service and loading for this building. Section 3.3.6

BTD looks forward to working collaboratively with BWH and the community in review of this project during the permitting process to address any outstanding concerns.

Sincerely,

Charlotte Fleetwood

Charlotte Fleetwood
Transportation Planner
Boston Transportation Department
Policy and Planning Division

Appendix B

Task Force and Public Comments

Children's Hospital Boston
Vice President for
Real Estate Planning and Development

A teaching affiliate of Harvard Medical School

Jan 31, 2012

Charles Weinstein, Esq.
300 Longwood Avenue
Boston, Massachusetts 02115
phone 617-355-2338 | *fax* 617-730-0019
charles.weinstein@childrens.harvard.edu

Ms. Sonal Gandhi
Boston Redevelopment Authority
One City Hall Square
Boston, MA 02201

Re: Brigham and Women's Hospital Institutional Master Plan Notification From/Project Notification Form

Dear Ms. Gandhi:

I am writing to offer support to the IMP amendment project on the Emmanuel College Parcel C Lease site.

As you are aware, the availability of affordable and state of the art research space in the Longwood Medical Area is in high demand which will continue into the future. This project is essential to the growth of research at Brigham and Women's Hospital and for them to function in an organized and efficient fashion. All the LMA research entities will benefit in some manner from the addition of this facility to the area.

The Boston Children's Hospital unequivocally supports this project and amendment to the Brigham and Women's Hospital Institutional Master Plan

Sincerely,

Charles Weinstein

Cc: A. Mombourquette

HARVARD MEDICAL SCHOOL

PLANNING OFFICE
180A LONGWOOD AVENUE
SUITE 101
BOSTON, MASSACHUSETTS 02115
(617) 432-7475
FAX (617) 432-0393

B.R.A.

2012 FEB -7 P 1:26

February 1, 2012

Mr. Peter Meade
Director
Boston Redevelopment Authority
One City Hall Square
Boston, MA 02201

Re: Brigham and Women's Hospital Institutional Master Plan Notification Form/ Project Notification Form/Emmanuel Campus

Dear Mr. Meade:

I write to express my support for the above-referenced project. Brigham and Women's Hospital (BWH) intends to enter into a long-term ground lease with Emmanuel College for the development of a research-laboratory facility on Avenue Louis Pasteur. The project will bring significant benefits to both of these two Longwood Medical Area neighbors. BWH will add new research space, new permanent jobs and construction jobs, and will be able to consolidate some of their leasing portfolio. Emmanuel will further the development of its campus in a manner consistent with their strategic and business plans.

On behalf of Harvard Medical School I want to express my support for the preliminary design concept for the new research building. The building's proposed distance from the street respects the formal "classical" aspect of Avenue Louis Pasteur, and the proposed setback of floor levels six and above will be consistent with the neighboring HMS New Research Building (NRB). We welcome the concept of the service and loading docks being accessible from Blackfan Street.

When appropriate, we look forward to working with the BWH staff on an abutter agreement-- fairly routine among Longwood neighbors-- to cover construction mitigation issues, e.g. vibration, noise, etc., but we do not anticipate any unusual difficulties associated with that. **Section 4.10**

Thank you for the opportunity to comment on this Project Notification Form.

Sincerely,

Richard M. Shea

Richard M. Shea
Associate Dean for Campus Planning and Facilities

cc: Sonal Gandhi, Boston Redevelopment Authority
Arthur Mombourquette, Brigham and Women's Hospital
Sister Anne Donovan, Emmanuel College

MASCO™
.DICAL ACADEMIC AND SCIENTIFIC COMMUNITY ORGANIZATION, INC. | People / Places / Plans / Future

February 1, 2012

Ms. Sonal Gandhi
Senior Project Manager
Boston Redevelopment Authority
One City Hall Square
Boston, MA 02201-1007

RE: BWH 2012 IMPNF/PNF For Parcel C

Dear Ms. Gandhi,

Thank you for the opportunity to comment on the Brigham and Women's proposal for a 366,000 sf research building with 355 space (no net new) below-grade garage. The plans are still highly conceptual, since the building permitting and construction are still many years away. As the Brigham advances the planning for this building in the future, we look forward to seeing additional details during the DPIR process.

- Urban Design/Building Design: The plan appears to be respectful of the development guidelines for the LMA including a lower building along Avenue Louis Pasteur up to 75', generous stepbacks for taller heights and masses away from the avenue, and accommodations for added height along Blackfan Street. This is consistent with area-wide design goals for both Blackfan Street and Avenue Louis Pasteur. It will be important to successfully relate the final design of this building to Emmanuel's campus, the Blackfan Research complex, and the grand, tree lined Avenue Louis Pasteur. **Sections 5.1, 5.2, 5.3**

- Loading Dock Design: We are pleased to see the concept plans include a loading dock, off-street, off Blackfan to reduce loading and service impacts on the adjacent roadways and sidewalks; we look forward to seeing the capacity requirements and design, as planning progresses. **Section 2.3**

- Site Design: Street trees are generally missing from Blackfan Street, due to the presence of utility tunnels. Any additional tree plantings along Blackfan would provide a welcome buffer for pedestrians; the Blackfan corridor serves as an important pedestrian corridor to connect Fenway residential area, Colleges of the Fenway, and other pedestrian trips to and from the heart of the Longwood Medical and Academic Area. Additional trees would extend the park-like feel along Avenue Louis Pasteur, created by the large historic trees there. We are pleased to see **Section 5.2.1.1**

375 Longwood Avenue / Boston, MA 02215-5328 / Tel:617.632.2310 Fax: 617.632.2759

the plans for the layout of a 15' wide sidewalk along the Blackfan side of the site, which will provide a currently missing piece of the pedestrian network. Additional enhancement of the public realm by a 20' setback on the northern side of the site will also be welcome. We look forward to further design development of this area and the plaza/open space on the Avenue Louis Pasteur side and balancing of spaces that have a public and a private feel.

- Environmental: We look forward to additional information on environmental impacts, if any, including wind and shadow studies; and mitigation, where necessary, including plans for the use of low impact development stormwater reduction techniques, groundwater and stormwater recharge systems, and utility infrastructure. **Chapter 4** **Chapter 7**

We offer our continued assistance, at the appropriate time, through CommuteWorks, to promote alternative transportation options for new employees through transportation demand management and commuter incentive programs; and through the MASCO Construction Coordination office, to assist in communication, coordination and mitigation of construction impacts to the area.

Sincerely,

Sarah J. Hamilton

Sarah J. Hamilton
Vice President, Area Planning and Development

FENWAY CDC

70 Burbank Street
Boston, MA 02115
617-267-4637
www.fenwaycdc.org

February 2, 2012

Sonal Gandhi
Boston Redevelopment Authority
One City Hall Square
Boston, MA 02201

RE: Comments on Brigham and Women's Hospital 2012 IMP Amendment Project

Dear Sonal:

We submit this letter on behalf of the Fenway Community Development Corporation (Fenway CDC), a 38-year-old, community-based organization that builds and preserves affordable housing and promotes projects that engage our full community in enhancing the neighborhood's diversity and vitality. We reviewed the Brigham and Women's Hospital (BWH) proposal against our vision for the neighborhood as a smart-growth-oriented community that welcomes the broadest spectrum of residents.[1]

We write in **support** of BWH's Institutional Master Plan (IMP) 2012 Amendment Project with the following considerations:

Sufficient and varied housing supply:

> We would like to suggest the possibility of incorporating housing into the BWH Parcel C project. As such a large employer of the area, it would benefit both BWH and the Longwood/Fenway community if the Hospital incorporated employee housing into its development plan for this project. The Fenway CDC would be happy to discuss this possibility in more detail and partner with BWH to develop the housing.
>
> We look forward to seeing the details about Linkage payments once the Draft Project Impact Report is filed, and we want to stress the importance that the linkage money stay

[1] http://www.fenwaycdc.org/programs/urban-village

in the neighborhood and be used in the Fenway. Once the exact linkage payment amounts have been calculated, we request that they be broken down by phase and include the calculations, for reference.

Pedestrian Experience:

The proposed project will provide a benefit to the pedestrian experience by demolishing an existing above-ground parking structure, and adding a new 15-foot-wide sidewalk on the eastern side of Blackfan Street. We are happy to see that no additional curb-cuts are proposed for the project, and are pleased with the proposed landscaping improvements along the street frontages.

We support the effort to keep the building in scale with the surrounding neighborhood. The proposal is consistent with the LMA guidelines, which will create a more pedestrian-friendly environment in this area.

Transportation:

The one-to-one replacement of 355 above-ground parking spaces to below-grade spaces will be a positive change for the site. However, we would like to see more detailed studies of the transportation impacts of the projects. We are glad that bicycle facilities will be provided for employees and visitors, and expect that bike lanes will be added to the Avenue Louis Pasteur to further encourage employees to bike to the facility. **Chapter 3**

BWH provides a great service to its employees and the community by subsidizing public transit passes, and we encourage the hospital to continue to do so in order to minimize the potential vehicular traffic impacts of the project.

Community Benefits:

We are glad to see that the proposed lecture auditorium will be open to the public, and hope that BWH will provide affordable educational events for the community in this space. We would like BWH to provide details about the availability of the space for outside community events, including a detailed outreach strategy to make sure community members are aware of this resource. We encourage BWH to partner with local neighborhood groups to ensure maximum community benefit from this space. We also recommend that the proposed cafeteria be open to the public, in order to encourage interaction between the medical community and the rest of the Longwood/Fenway neighborhood. **Section 1.4**

A healthy business community and jobs for residents:

BWH is already a large local employer of the area, and we want to facilitate BWH's ability to connect local jobs with residents. Our "Walk to Work" Employment specialist is Kris Anderson (Kanderson@fenwaycdc.org, 617-267-4637 x29), and we hope BWH will post jobs through Walk to Work and other local employment programs. We also **Section 1.4.2** encourage BWH to require their contractor to employ both Boston residents and minority contractors.

Construction Mitigation Efforts:

We realize that the construction timeline for this project is several years away, and we are glad to see an initial Construction Mitigation Plan. We expect that this plan will become more detailed as the project is finalized to ensure that construction does not negatively impact the nearby Back Bay/Fens Park, circulation and parking around the site, or the noise and air quality of the area. We would like to see reliable communication with the community, including notification of construction progress, schedules, changes, or delays.

Section 4.10

Overall, Brigham and Women's Hospital has proposed a project that will be beneficial to the neighborhood. We would like to have seen more community engagement about the proposal from the beginning of their process, and we hope BWH will follow through on our requests as listed above.

Sincerely,

Dharmena Downey
Fenway CDC Executive Director

Manuel Delgado
Fenway CDC, Urban Village Committee

cc: Steve Wolf, Fenway CDC Board President; Senator William Brownsberger; Senator Sonia Chang-Diaz; Representative Gloria Fox; Representative Byron Rushing; City Councilor Mike Ross; City Councilor Tito Jackson

81 Lawn Street
Roxbury, MA. 02120

February 3, 2012

Sonal Gandhi
BRA
Boston City Hall
Boston 02201

Re: BWH IMPPNF/ 2012 IMP Amendment

Dear Ms. Gandhi;

I hope my comments will lead to a closer examination of the proposed plans; with an expected 2019 construction start, there is time to carefully consider BWH's project. Granting approvals for height and massing so far in advance cannot be considered a "best practice" when so many Boston projects have been delayed or altered due to changes in the general economy and internal institutional planning.

A question too is why this parcel would now be part of BWH's Master Plan given that Emmanuel College will hold the ground lease. Is the IMP mechanism being used to bypass zoning restrictions? **Section 2.5**

Design approvals should not be granted at this early stage-
more information is required- for example, shadow impacts on the nearby parkland , if the mechanicals are 55 ' high , the proposed research building will be higher than Merck's, a structure that looms over the Fenway skyline. **Section 4.2**

The replacement of existing parking should not be a given, especially when all of BWH's physicians are also on Harvard's faculty and can be assumed to have access to Harvard's garages. Table 3-2 describes more than 5,873 BWH controlled off street parking spaces (does this count include the existing 100 plus at the MMHC site?), but less than a third are for patients and visitors. For comparison, in 2005 according to the city's Environment Dept. BWH controlled 4, 385 spaces. **Section 3.3.3**

A comment from the January 23rd LMA Forum that bear repeating-
Boston like other cities should be advocating bird friendly building design- reflective glass especially in a landscaped environment seriously affects the avian population, the architecture and lighting should be designed to reduce collisions. **Section 5.1**

Avenue Louis Pasteur- a beautiful boulevard but apparently an open parking lot for MASCO shuttle buses, dangerous for pedestrians and absent any bicycle lanes. Why are the buses given such carte blanche when signs read *no parking /no stopping*?

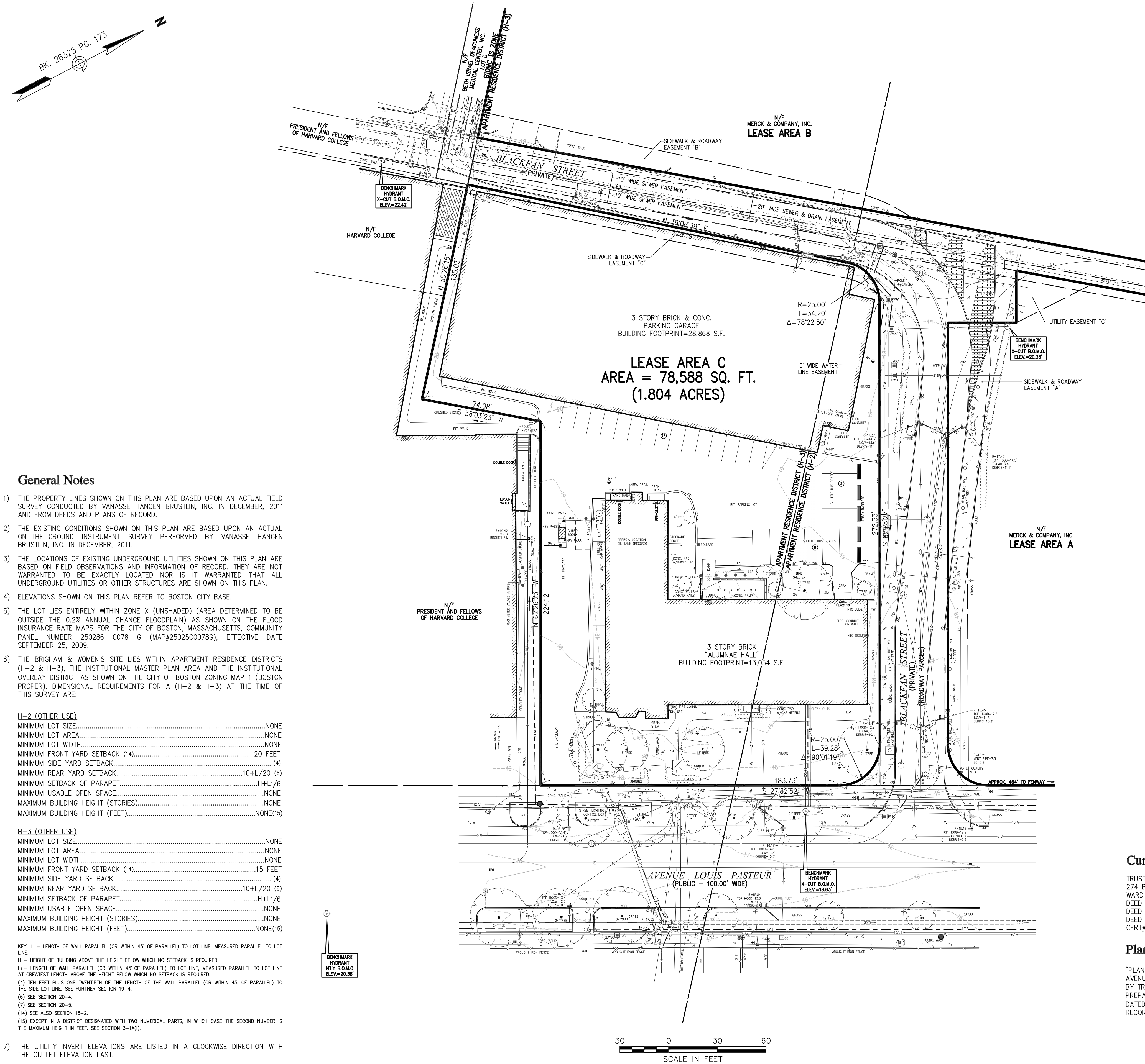
What is needed- a streetscape that actively supports public transit use (compare the BIDMC Brookline Avenue sidewalk) incorporating sidewalk level shaded seating areas and crosswalks adjacent to the bus shelters. **Section 5.2.1**

Please insist on preserving existing trees and creating ecologically sustainable landscapes (not lawns!) The pathetic three oak trees on the MMHC site survive without any obvious care despite past promises. The Hospital continues to promote grass lawns as their "green project" yet sod is purely decorative, trees and shrubs are more costly initially but give back so much more in terms of the environment. **Sections 4.11, 5.2.1.1**

In summary, many issues left to discuss.
Sincerely,
Alison Pultinas

Appendix B

Site Survey



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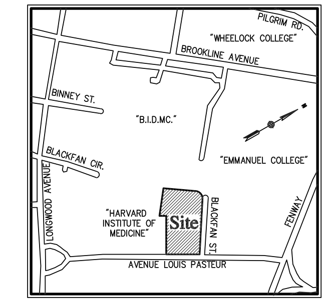


General Notes

1) THE PROPERTY LINES SHOWN ON THIS PLAN ARE BASED UPON AN ACTUAL FIELD SURVEY CONDUCTED BY VANASSE HANGEN BRUSTLIN, INC. IN DECEMBER, 2011 AND FROM DEEDS AND PLANS OF RECORD.

2) THE EXISTING CONDITIONS SHOWN ON THIS PLAN ARE BASED UPON AN ACTUAL ON-THE-GROUND INSTRUMENT SURVEY PERFORMED BY VANASSE HANGEN BRUSTLIN, INC. IN DECEMBER, 2011.

3) THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES SHOWN ON THIS PLAN ARE BASED ON FIELD OBSERVATIONS AND INFORMATION OF RECORD. THEY ARE NOT WARRANTED TO BE EXACTLY LOCATED NOR IS IT WARRANTED THAT ALL UNDERGROUND UTILITIES OR OTHER STRUCTURES ARE SHOWN ON THIS PLAN.

4) ELEVATIONS SHOWN ON THIS PLAN REFER TO BOSTON CITY BASE.

5) THE LOT LIES ENTIRELY WITHIN ZONE X (UNSHADED) (AREA DETERMINED TO BE OUTSIDE THE 0.2% ANNUAL CHANCE FLOODPLAIN) AS SHOWN ON THE FLOOD INSURANCE RATE MAPS FOR THE CITY OF BOSTON, MASSACHUSETTS, COMMUNITY PANEL NUMBER 250286 0078 G (MAP#25025C0078G), EFFECTIVE DATE SEPTEMBER 25, 2009.

6) THE BRIGHAM & WOMEN'S SITE LIES WITHIN APARTMENT RESIDENCE DISTRICTS (H-2 & H-3), THE INSTITUTIONAL MASTER PLAN AREA AND THE INSTITUTIONAL OVERLAY DISTRICT AS SHOWN ON THE CITY OF BOSTON ZONING MAP 1 (BOSTON PROPER). DIMENSIONAL REQUIREMENTS FOR A (H-2 & H-3) AT THE TIME OF THIS SURVEY ARE:

H-2 (OTHER USE)

MINIMUM LOT SIZE....NONE
MINIMUM LOT AREA....NONE
MINIMUM LOT WIDTH....NONE
MINIMUM FRONT YARD SETBACK (14)....20 FEET
MINIMUM SIDE YARD SETBACK....(4)
MINIMUM REAR YARD SETBACK....10+L/20 (6)
MINIMUM SETBACK OF PARAPET....H+L1/6
MINIMUM USABLE OPEN SPACE....NONE
MAXIMUM BUILDING HEIGHT (STORIES)....NONE
MAXIMUM BUILDING HEIGHT (FEET)....NONE(15)

H-3 (OTHER USE)

MINIMUM LOT SIZE....NONE
MINIMUM LOT AREA....NONE
MINIMUM LOT WIDTH....NONE
MINIMUM FRONT YARD SETBACK (14)....15 FEET
MINIMUM SIDE YARD SETBACK....(4)
MINIMUM REAR YARD SETBACK....10+L/20 (6)
MINIMUM SETBACK OF PARAPET....H+L1/6
MINIMUM USABLE OPEN SPACE....NONE
MAXIMUM BUILDING HEIGHT (STORIES)....NONE
MAXIMUM BUILDING HEIGHT (FEET)....NONE(15)

KEY: L = LENGTH OF WALL PARALLEL (OR WITHIN 45° OF PARALLEL) TO LOT LINE, MEASURED PARALLEL TO LOT LINE.
H = HEIGHT OF BUILDING ABOVE THE HEIGHT BELOW WHICH NO SETBACK IS REQUIRED.
L_1 = LENGTH OF WALL PARALLEL (OR WITHIN 45° OF PARALLEL) TO LOT LINE, MEASURED PARALLEL TO LOT LINE AT GREATEST LENGTH ABOVE THE HEIGHT BELOW WHICH NO SETBACK IS REQUIRED.
(4) TEN FEET PLUS ONE TWENTIETH OF THE LENGTH OF THE WALL PARALLEL (OR WITHIN 45o OF PARALLEL) TO THE SIDE LOT LINE. SEE FURTHER SECTION 19-4.
(6) SEE SECTION 20-4.
(7) SEE SECTION 20-5.
(14) SEE ALSO SECTION 18-2.
(15) EXCEPT IN A DISTRICT DESIGNATED WITH TWO NUMERICAL PARTS, IN WHICH CASE THE SECOND NUMBER IS THE MAXIMUM HEIGHT IN FEET. SEE SECTION 3-1A(I).

7) THE UTILITY INVERT ELEVATIONS ARE LISTED IN A CLOCKWISE DIRECTION WITH THE OUTLET ELEVATION LAST.

Current Owner

TRUSTEES OF EMMANUEL COLLEGE
274 BROOKLINE AVENUE
WARD 04 ASSESSORS PARCEL 1847
DEED BOOK 5637, PAGE 385
DEED BOOK 6138, PAGE 438
DEED BOOK 6145, PAGE 446
CERT# 32239

Plan Reference

"PLAN OF LAND SHOWING EASEMENTS AND LEASE AREAS, LOCATED ON AVENUE LOUIS PASTEUR AND FENWAY, BOSTON, MASSACHUSETTS OWNED BY TRUSTEES OF EMMANUEL COLLEGE"
PREPARED BY: LAND PLANNING, INC.
DATED: NOV. 20, 2000, LAST REVISED 4/23/01
RECORDED: BOOK 26325 PAGE 173

VHB
Vanasse Hangen Brustlin, Inc.

Transportation
Land Development
Environmental Services

101 Walnut Street, P.O. Box 9151
Watertown, Massachusetts 02471-9151
617 924 1770 • FAX 617 924 2286

Legend

DRAIN MANHOLE
CATCH BASIN
SEWER MANHOLE
ELECTRIC MANHOLE
TELEPHONE MANHOLE
MANHOLE
HH HAND HOLE
WATER GATE
FIRE HYDRANT
GAS GATE
STREET SIGN
LIGHT POLE
UTILITY POLE
GUY POLE
GUY WIRE
MW MONITORING WELL
FLOOD LIGHT
WELL
CNO COULD NOT OPEN
NPV NO PIPES VISIBLE
F.F.E.=45.27' FINISHED FLOOR ELEVATION
EOP EDGE OF PAVEMENT
CC CONCRETE CURB
VGC VERTICAL GRANITE CURB
SGE SLOPED GRANITE EDGE
BB BITUMINOUS BERM
BC BITUMINOUS CURB
GUARD RAIL
CHAIN LINK FENCE
DRAINAGE LINE
SEWER LINE
OHW OVERHEAD WIRE
E UNDERGROUND ELECTRIC
T TELEPHONE LINE
G GAS LINE
W WATER LINE
STONE WALL
TREE LINE

No.	Revision	Date	Appvd.

Designed by | Drawn by | Checked by
CAD checked by | Approved by
Scale 1"=30' | Date January 10, 2012

Project Title

Lease Parcel C
45 Avenue Louis Pasteur

Boston, Massachusetts

Issued for

Drawing Title

Existing Conditions Plan of Land

Drawing Number

Sv-1

Sheet 1 of 1

Project Number
11851.01

\\mabos\projects\11851.01\cad\sr\planset\11851.01-EXIST.dwg

Appendix C

Transportation

APPENDIX

Draft Project Impact Report

Submitted Pursuant to Article 80 of the Boston Zoning Code

Brigham and Women’s Hospital 2012 IMP Amendment Project






Submitted to:
Boston Redevelopment Authority
One City Hall Square
Boston, MA 02201

Submitted by:
The Brigham and Women's Hospital, Inc.
75 Francis Street
Boston, MA 02115

Prepared by:
Epsilon Associates, Inc.
3 Clock Tower Place, Suite 250
Maynard, MA 01754

In Association with:
Chan Krieger NBBJ
Nutter McClennen & Fish LLP
Vanasse Hangen Brustlin, Inc.

March 2012

Epsilon
ASSOCIATES INC.

Transportation

- **MassDOT Crash Rate Worksheets**
- **Trip Generation Calculations**
- **BTD Mode Share Guidelines – Area 5**
- **Synchro Capacity Analyses**
  - 2012 Existing Conditions
  - 2022 No-Build Conditions
  - 2022 Build Conditions

MassDOT Crash Rate Worksheets

INTERSECTION CRASH RATE WORKSHEET

BOSTON COUNT DATE : Nov-09

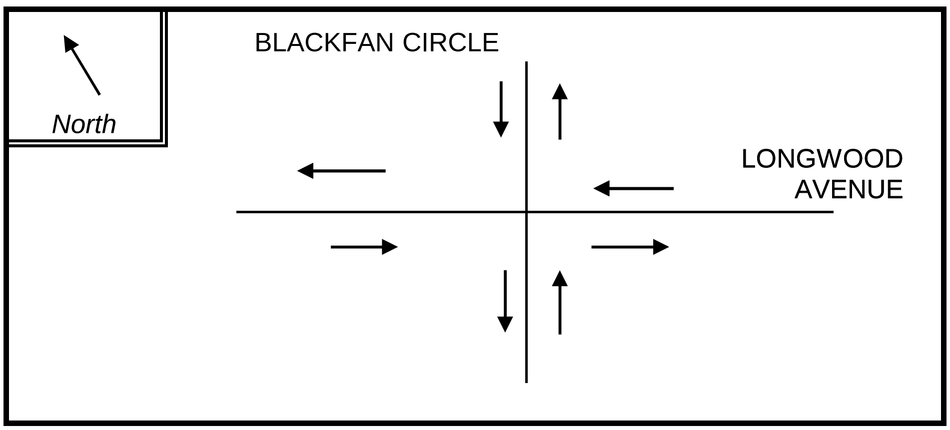
DISTRICT : 4 UNSIGNALIZED : SIGNALIZED : X

~ INTERSECTION DATA ~

MAJOR STREET : LONGWOOD AVENUE

MINOR STREET(S) : BLACKFAN CIRCLE

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	NB	SB		
PEAK HOURLY VOLUMES (AM/PM) :	603	624	100	146		1,473

" K " FACTOR : **0.080** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **18,413**

TOTAL # OF CRASHES : 4 # OF YEARS : 3 AVERAGE # OF CRASHES PER YEAR (**A**) : **1.33**

CRASH RATE CALCULATION : **0.20** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments :

Project Title & Date:

INTERSECTION CRASH RATE WORKSHEET

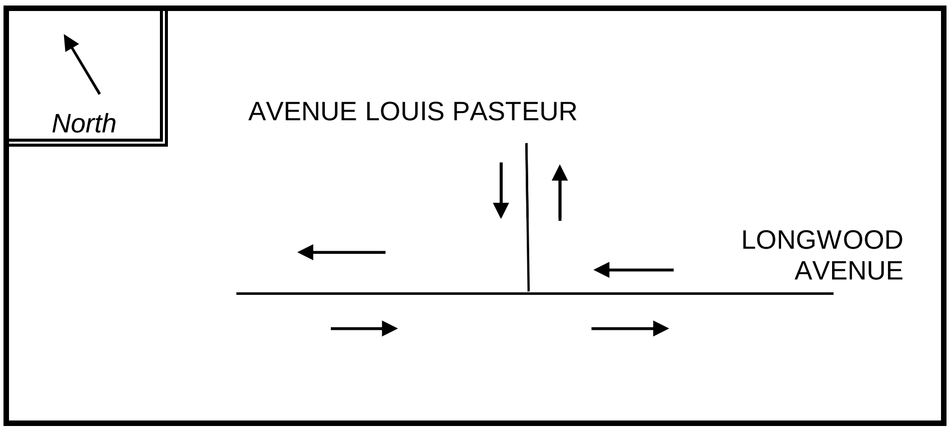
	BOSTON		COUNT DATE :	Jun-06	
DISTRICT :	4	UNSIGNALIZED :	X	SIGNALIZED :	

~ INTERSECTION DATA ~

MAJOR STREET : LONGWOOD AVENUE

MINOR STREET(S) : AVENUE LOUIS PASTEUR

INTERSECTION DIAGRAM
(Label Approaches)



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	NB	SB		
PEAK HOURLY VOLUMES (AM/PM) :	457	498	-	323		**1,278**

" K " FACTOR :	**0.080**	INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME :	**15,975**

TOTAL # OF CRASHES :	3	# OF YEARS :	3	AVERAGE # OF CRASHES PER YEAR (**A**) :	**1.00**

CRASH RATE CALCULATION : **0.17**

$$\text{RATE} = \frac{(A * 1{,}000{,}000)}{(V * 365)}$$

Comments :

Project Title & Date:

INTERSECTION CRASH RATE WORKSHEET

BOSTON | COUNT DATE : May-07

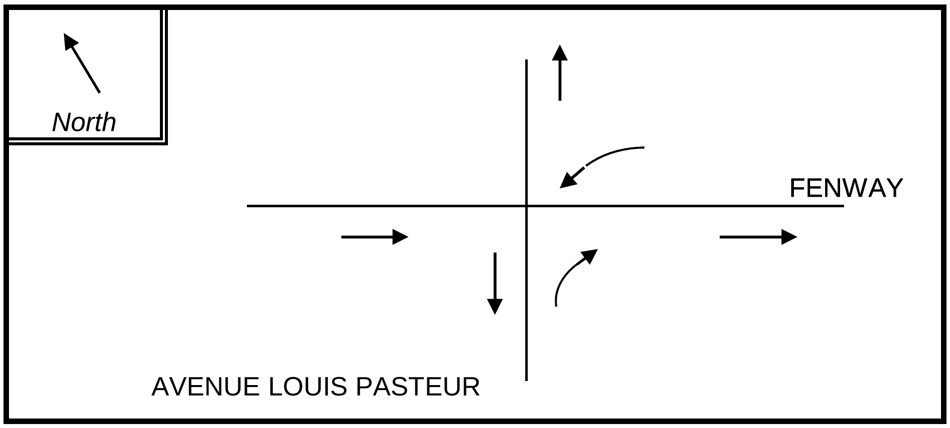
DISTRICT : 4 | UNSIGNALIZED : X | SIGNALIZED :

~ INTERSECTION DATA ~

MAJOR STREET : AVENIDA LOUIS PASTEUR

MINOR STREET(S) : FENWAY

INTERSECTION DIAGRAM
(Label Approaches)



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	NB	SB		
PEAK HOURLY VOLUMES (AM/PM) :	700	721	329	-		1,750

" K " FACTOR : **0.080**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **21,875**

TOTAL # OF CRASHES : 1

OF YEARS : 3

AVERAGE # OF CRASHES PER YEAR (**A**) : **0.33**

CRASH RATE CALCULATION : **0.04**

RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments :

Project Title & Date:

Trip Generation Calculations

Trip Generation

- **LUC 760 (Research and Development Center)** – was used to estimate the BWH research and development space planned at the Project.

Net-New Unadjusted Trip Generation*

Land Use	Land Use Code	Size	ITE Unadjusted Vehicle Trip Generation						
			AM Peak Hour			PM Peak Hour			Daily
			Enter	Exit	Total	Enter	Exit	Total	Total
Research and Development	R&D	360,000 sf	401	87	488	68	360	428	3,220
Less Alumnae Hall Demolition	R&D	50,000 sf	(-51)	(-11)	(-62)	(-8)	(-46)	(-54)	(-406)
Less Existing Parking Deck	N/A	355 Spaces**	(-95)	(-32)	(-127)	(-32)	(-95)	(-127)	(-952)
Net-New Trips			**255**	**44**	**299**	**28**	**219**	**247**	**1,862**

**Trips are not adjusted for local mode share., **Does not include any parking trips directly associated with Alumnae Hall activities.*

Table 3-7 Peak Hour Mode Splits

Mode	Work Trips
Automobile	47 %
Public Transit	33 %
Walk/Bike/Other	20 %

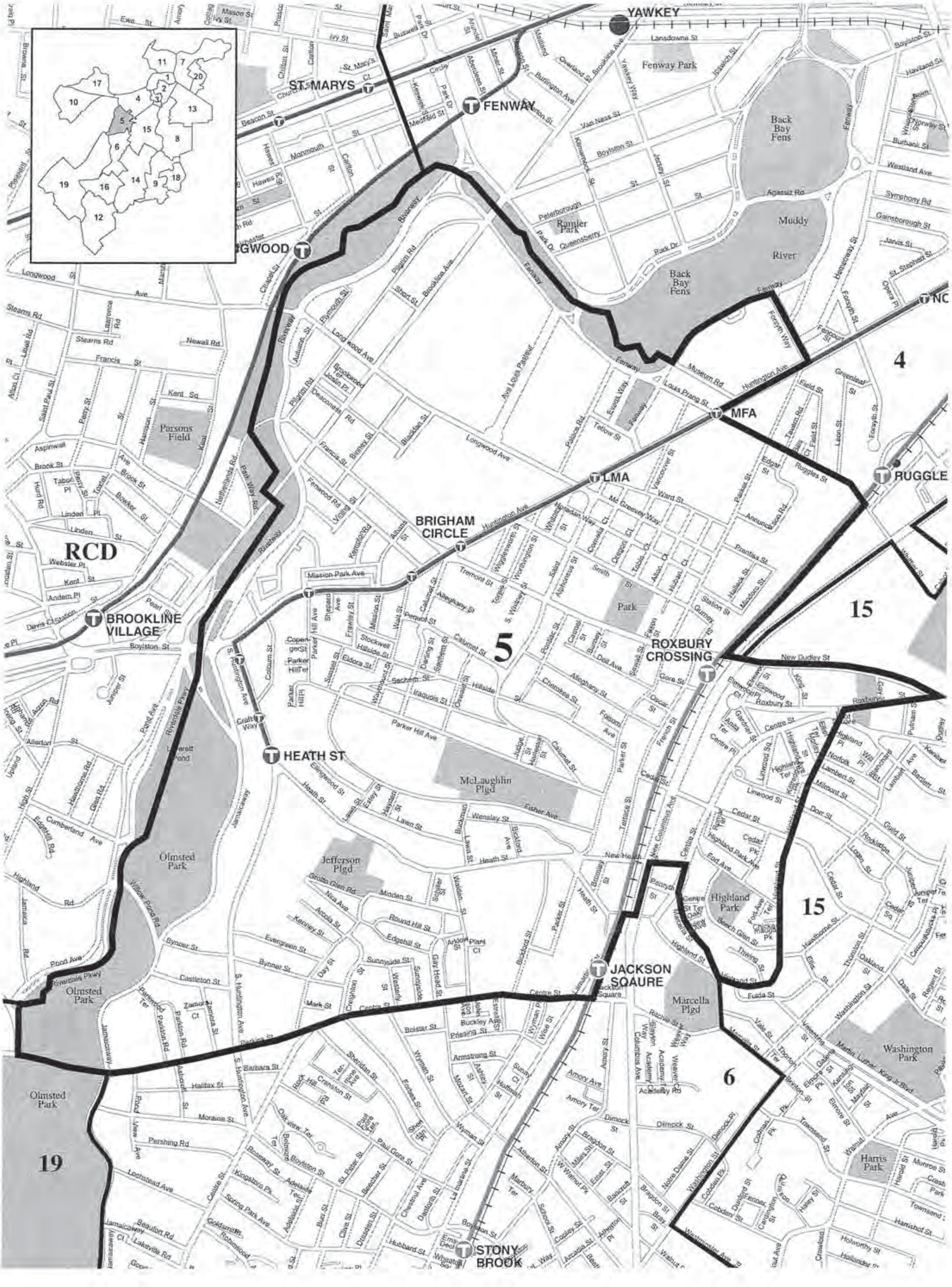
Source: BTD Guidelines, Zone 5

Table 3-8 Build Condition Project Trip Generation (Adjusted)

Time Period/Direction	Walk/Bike/Other	Transit	R&D Vehicle Trips	Less Existing Trips*	Net-New Vehicle Trips
Daily Total	**385**	**1,752**	**1,138**	**(-1,110)**	**28**
AM Peak Hour					
Inbound	49	222	144	(-115)	29
Outbound	10	46	30	(-36)	(-6)
AM Total	**59**	**268**	**174**	**(-151)**	**23**
PM Peak Hour					
Inbound	8	35	23	(-35)	(-12)
Outbound	44	198	129	(-113)	16
PM Total	**52**	**233**	**152**	**(-148)**	**4**

*Includes demolition of 50,000 sf of office space and 355 parking spaces.

BTD Mode Share Guidelines – Area 5



YAWKEY
Fenway Park
ST. MARYS
FENWAY
Back Bay Fens
Muddy River
Ramler Park
LONGWOOD
MFA
LMA
RUGGLES
BRIGHAM CIRCLE
RCD
Parsons Field
BROOKLINE VILLAGE
5
4
15
ROXBURY CROSSING
HEATH ST
McLaughlin Plgd
Jefferson Plgd
Leverett Pond
Olmsted Park
Highland Park
JACKSON SQAURE
Marcella Plgd
Washington Park
6
19
Harris Park
STONY BROOK
Huntington Ave
Longwood Ave
Tremont St
Columbus Ave
Centre St
Washington St
Riverway
Jamaicaway

Area 5

Trips Beginning by Origin Activity and Period

	All Purposes	Home	Work	Other
Daily average mode shares				
Auto	47%	46%	56%	35%
Transit	20%	15%	23%	21%
Walk	33%	38%	20%	44%
AM mode shares				
Auto	37%	37%	47%	27%
Transit	18%	17%	28%	23%
Walk	45%	45%	25%	50%
Rest of day mode shares				
Auto	48%	52%	56%	35%
Transit	20%	14%	23%	21%
Walk	31%	34%	20%	44%
PM mode shares				
Auto	42%	39%	47%	28%
Transit	31%	21%	32%	29%
Walk	26%	39%	20%	43%

Trips Ending by Destination Activity and Period

	All Purposes	Home	Work	Other
Daily average mode shares				
Auto	47%	46%	56%	35%
Transit	20%	15%	23%	21%
Walk	33%	38%	20%	44%
AM mode shares				
Auto	42%	39%	47%	28%
Transit	31%	21%	32%	29%
Walk	26%	39%	20%	43%
Rest of day mode shares				
Auto	48%	46%	63%	36%
Transit	17%	15%	16%	19%
Walk	35%	38%	20%	44%
PM mode shares				
Auto	37%	37%	47%	27%
Transit	18%	17%	28%	23%
Walk	45%	45%	25%	50%

Synchro Capacity Analyses

2012 Existing Conditions
2022 No-Build Conditions
2022 Build Conditions

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	ø2
Lane Configurations													
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	
Lane Width (ft)	10	10	10	10	10	10	14	14	14	10	10	10	
Grade (%)		0%			0%			0%			0%		
Storage Length (ft)	0		0	0		0	0		0	0		0	
Storage Lanes	1		0	1		0	0		0	1		0	
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Leading Detector (ft)	50	50		50	50		50	50		50	50		
Trailing Detector (ft)	0	0		0	0		0	0		0	0		
Turning Speed (mph)	15		9	15		9	15		9	15		9	
Right Turn on Red			No			No			No			No	
Link Speed (mph)		30			30			25			30		
Link Distance (ft)		370			505			249			313		
Travel Time (s)		8.4			11.5			6.8			7.1		
Volume (vph)	90	540	45	35	500	145	35	35	45	55	10	110	
Confl. Peds. (#/hr)													
Confl. Bikes (#/hr)													
Peak Hour Factor	0.87	0.87	0.87	0.84	0.84	0.84	0.86	0.86	0.86	0.78	0.78	0.78	
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%	
Bus Blockages (#/hr)	0	10	0	0	10	0	0	0	0	0	0	0	
Parking (#/hr)													
Mid-Block Traffic (%)		0%			0%			0%			0%		
Lane Group Flow (vph)	103	673	0	42	768	0	0	134	0	71	154	0	
Turn Type	Perm			Perm			Perm			Perm			
Protected Phases		1			1			5			5		2
Permitted Phases	1	1		1	1		5	5		5	5		
Detector Phases	1	1		1	1		5	5		5	5		
Minimum Initial (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0		8.0
Minimum Split (s)	14.0	14.0		14.0	14.0		14.0	14.0		14.0	14.0		18.0
Total Split (s)	62.0	62.0	0.0	62.0	62.0	0.0	20.0	20.0	0.0	20.0	20.0	0.0	18.0
Total Split (%)	62.0%	62.0%	0.0%	62.0%	62.0%	0.0%	20.0%	20.0%	0.0%	20.0%	20.0%	0.0%	18%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0		2.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0		0.0
Lead/Lag	Lead	Lead		Lead	Lead								Lag
Lead-Lag Optimize?													
Recall Mode	C-Max	C-Max		C-Max	C-Max		None	None		None	None		None
v/c Ratio	0.56	0.77		0.17	0.89			0.76		0.61	0.86		
Control Delay	28.9	22.7		11.8	32.6			68.2		62.9	81.4		
Queue Delay	0.0	0.0		0.0	0.0			0.0		0.0	0.0		
Total Delay	28.9	22.7		11.8	32.6			68.2		62.9	81.4		
Queue Length 50th (ft)	41	345		12	~495			82		42	96		
Queue Length 95th (ft)	#130	#569		30	#665			#158		77	#158		
Internal Link Dist (ft)		290			425			169			233		
Turn Bay Length (ft)													
Base Capacity (vph)	183	873		242	862			190		125	193		
Starvation Cap Reductn	0	0		0	0			0		0	0		
Spillback Cap Reductn	0	0		0	0			0		0	0		
Storage Cap Reductn	0	0		0	0			0		0	0		
Reduced v/c Ratio	0.56	0.77		0.17	0.89			0.71		0.57	0.80		

Intersection Summary

Area Type: CBD
Cycle Length: 100
Actuated Cycle Length: 100
Offset: 7 (7%), Referenced to phase 1:EBWB, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Blackfan Circle & Longwood Avenue

ø1	ø2	ø5
62 s	18 s	20 s

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Lane Width	10	10	10	10	10	10	14	14	14	10	10	10
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.97			0.95		1.00	0.86	
Flt Protected	0.95	1.00		0.95	1.00			0.98		0.95	1.00	
Satd. Flow (prot)	1317	1316		1330	1299			1493		1330	1208	
Flt Permitted	0.25	1.00		0.31	1.00			0.74		0.54	1.00	
Satd. Flow (perm)	348	1316		428	1299			1119		761	1208	
Volume (vph)	90	540	45	35	500	145	35	35	45	55	10	110
Peak-hour factor, PHF	0.87	0.87	0.87	0.84	0.84	0.84	0.86	0.86	0.86	0.78	0.78	0.78
Adj. Flow (vph)	103	621	52	42	595	173	41	41	52	71	13	141
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	103	673	0	42	768	0	0	134	0	71	154	0
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	10	0	0	10	0	0	0	0	0	0	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		1			1			5			5	
Permitted Phases	1	1		1	1		5	5		5	5	
Actuated Green, G (s)	65.6	65.6		65.6	65.6			14.8		14.8	14.8	
Effective Green, g (s)	65.6	65.6		65.6	65.6			14.8		14.8	14.8	
Actuated g/C Ratio	0.66	0.66		0.66	0.66			0.15		0.15	0.15	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)	228	863		281	852			166		113	179	
v/s Ratio Prot		0.51			c0.59						c0.13	
v/s Ratio Perm	0.30			0.10				0.12		0.09		
v/c Ratio	0.45	0.78		0.15	0.90			0.81		0.63	0.86	
Uniform Delay, d1	8.4	12.1		6.6	14.5			41.2		40.0	41.6	
Progression Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2	6.3	6.9		1.1	14.5			23.0		7.6	31.0	
Delay (s)	14.8	19.0		7.7	29.0			64.2		47.6	72.6	
Level of Service	B	B		A	C			E		D	E	
Approach Delay (s)		18.5			27.9			64.2			64.7	
Approach LOS		B			C			E			E	

Intersection Summary			
HCM Average Control Delay	30.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	19.6
Intersection Capacity Utilization	76.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1700	1700	1700	1700	1900	1900
Lane Width (ft)	10	10	12	12	12	14
Grade (%)		0%	0%		0%	
Storage Length (ft)	0			0	0	0
Storage Lanes	0			0	1	1
Turning Speed (mph)	15			9	15	9
Link Speed (mph)		30	30		30	
Link Distance (ft)		505	138		160	
Travel Time (s)		11.5	3.1		3.6	
Volume (vph)	0	640	515	0	115	165
Confl. Peds. (#/hr)						167
Confl. Bikes (#/hr)						5
Peak Hour Factor	0.91	0.91	0.88	0.88	0.69	0.69
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	1%	1%
Bus Blockages (#/hr)	0	0	0	0	0	10
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Lane Group Flow (vph)	0	703	585	0	167	239
Sign Control		Free	Free		Stop	

Intersection Summary	
Area Type:	CBD
Control Type: Unsignalized	

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1700	1700	1700	1700	1900	1900
Lane Width (ft)	10	10	12	12	12	12
Grade (%)		0%	0%		0%	
Storage Length (ft)	0			0	0	0
Storage Lanes	0			0	0	0
Turning Speed (mph)	15			9	15	9
Link Speed (mph)		30	30		30	
Link Distance (ft)		138	314		177	
Travel Time (s)		3.1	7.1		4.0	
Volume (vph)	300	340	515	185	0	0
Confl. Peds. (#/hr)	293			293		
Confl. Bikes (#/hr)				7		
Peak Hour Factor	0.91	0.91	0.88	0.88	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	10	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Lane Group Flow (vph)	0	704	795	0	0	0
Sign Control		Free	Free		Stop	

Intersection Summary	
Area Type:	CBD
Control Type: Unsignalized	

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	0	640	515	0	115	165
Peak Hour Factor	0.91	0.91	0.88	0.88	0.69	0.69
Hourly flow rate (vph)	0	703	585	0	167	239
Pedestrians		167				
Lane Width (ft)		10.0				
Walking Speed (ft/s)		4.0				
Percent Blockage		12				
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)		505				
pX, platoon unblocked						
vC, conflicting volume	585				937	752
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	585				937	752
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				37	24
cM capacity (veh/h)	986				265	314

Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2
Volume Total	352	352	585	167	239
Volume Left	0	0	0	167	0
Volume Right	0	0	0	0	239
cSH	1700	1700	1700	265	314
Volume to Capacity	0.21	0.21	0.34	0.63	0.76
Queue Length 95th (ft)	0	0	0	97	147
Control Delay (s)	0.0	0.0	0.0	39.0	45.4
Lane LOS				E	E
Approach Delay (s)	0.0		0.0	42.8	
Approach LOS				E	

Intersection Summary			
Average Delay	10.3		
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	300	340	515	185	0	0
Peak Hour Factor	0.91	0.91	0.88	0.88	0.92	0.92
Hourly flow rate (vph)	330	374	585	210	0	0
Pedestrians					293	
Lane Width (ft)					0.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)		643				
pX, platoon unblocked						
vC, conflicting volume	1088				1829	983
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1088				1829	983
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	48				100	100
cM capacity (veh/h)	637				33	248

Direction, Lane #	EB 1	EB 2	WB 1
Volume Total	454	249	795
Volume Left	330	0	0
Volume Right	0	0	210
cSH	637	1700	1700
Volume to Capacity	0.52	0.15	0.47
Queue Length 95th (ft)	75	0	0
Control Delay (s)	14.6	0.0	0.0
Lane LOS	B		
Approach Delay (s)	9.4		0.0
Approach LOS			

Intersection Summary			
Average Delay	4.4		
Intersection Capacity Utilization	79.1%	ICU Level of Service	D
Analysis Period (min)	15		

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	16	12	16
Grade (%)	0%			0%	0%	
Storage Length (ft)	0	0	0			0
Storage Lanes	1	0	0			0
Turning Speed (mph)	15	9	15			9
Link Speed (mph)	30			30	30	
Link Distance (ft)	304			204	473	
Travel Time (s)	6.9			4.6	10.8	
Volume (vph)	35	15	40	325	535	65
Confl. Peds. (#/hr)	18	8	73			73
Confl. Bikes (#/hr)						5
Peak Hour Factor	0.72	0.72	0.86	0.86	0.84	0.84
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	9%	9%	9%	9%	5%	5%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%			0%	0%	
Lane Group Flow (vph)	70	0	0	425	714	0
Sign Control	Stop			Free	Free	

Intersection Summary	
Area Type:	CBD
Control Type: Unsignalized	

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	35	15	40	325	535	65
Peak Hour Factor	0.72	0.72	0.86	0.86	0.84	0.84
Hourly flow rate (vph)	49	21	47	378	637	77
Pedestrians	73			8	18	
Lane Width (ft)	12.0			16.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	6			1	2	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1238	757	787			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1238	757	787			
tC, single (s)	6.5	6.3	4.2			
tC, 2 stage (s)						
tF (s)	3.6	3.4	2.3			
p0 queue free %	70	94	94			
cM capacity (veh/h)	163	369	753			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	69	424	714
Volume Left	49	47	0
Volume Right	21	0	77
cSH	196	753	1700
Volume to Capacity	0.35	0.06	0.42
Queue Length 95th (ft)	38	5	0
Control Delay (s)	33.2	1.8	0.0
Lane LOS	D	A	
Approach Delay (s)	33.2	1.8	0.0
Approach LOS	D		

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	10	11	12	12	12	12	12	16	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		1	1		0	0		1	0		0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		534			483			473			190	
Travel Time (s)		12.1			11.0			10.8			4.3	
Volume (vph)	35	380	300	300	0	0	0	0	360	0	0	0
Confl. Peds. (#/hr)	57		100	100					57			
Confl. Bikes (#/hr)			8									
Peak Hour Factor	0.81	0.81	0.81	0.83	0.83	0.83	0.76	0.76	0.76	0.25	0.25	0.25
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	10%	10%	10%	5%	0%	0%	0%	0%	12%	0%	0%	0%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	8	0	0	0
Parking (#/hr)									5			
Mid-Block Traffic (%)		0%			0%			0%			0%	
Lane Group Flow (vph)	43	469	370	361	0	0	0	0	474	0	0	0
Sign Control		Free			Free			Stop			Stop	

Intersection Summary

Area Type: CBD

Control Type: Unsignalized

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	35	380	300	300	0	0	0	0	360	0	0	0
Peak Hour Factor	0.81	0.81	0.81	0.83	0.83	0.83	0.76	0.76	0.76	0.25	0.25	0.25
Hourly flow rate (vph)	43	469	370	361	0	0	0	0	474	0	0	0
Pedestrians					57			100			57	
Lane Width (ft)					12.0			16.0			0.0	
Walking Speed (ft/s)					4.0			4.0			4.0	
Percent Blockage					5			11			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	57			940			1378	1435	626	1866	1806	57
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	57			940			1378	1435	626	1866	1806	57
tC, single (s)	4.2			4.1			7.1	6.5	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.3			2.2			3.5	4.0	3.4	3.5	4.0	3.3
p0 queue free %	97			43			100	100	0	0	100	100
cM capacity (veh/h)	1498			638			55	50	395	0	30	1015

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	NB 1
Volume Total	43	469	370	361	474
Volume Left	43	0	0	361	0
Volume Right	0	0	370	0	474
cSH	1498	1700	1700	638	395
Volume to Capacity	0.03	0.28	0.22	0.57	1.20
Queue Length 95th (ft)	2	0	0	89	478
Control Delay (s)	7.5	0.0	0.0	17.8	142.3
Lane LOS	A			C	F
Approach Delay (s)	0.4			17.8	142.3
Approach LOS					F

Intersection Summary

Average Delay	43.2		
Intersection Capacity Utilization	58.0%	ICU Level of Service	B
Analysis Period (min)	15		

Lanes, Volumes, Timings
6: Site Driveway & Avenue Louis Pasteur

Weekday Morning Peak Hour
2012 Existing Conditions

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	16	16	16	16
Grade (%)	0%			0%	0%	
Storage Length (ft)	0	0	0			0
Storage Lanes	1	0	0			0
Turning Speed (mph)	15	9	15			9
Link Speed (mph)	30			30	30	
Link Distance (ft)	190			537	204	
Travel Time (s)	4.3			12.2	4.6	
Volume (vph)	15	15	35	350	490	60
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.72	0.72	0.86	0.86	0.84	0.84
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	9%	9%	5%	5%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%			0%	0%	
Lane Group Flow (vph)	42	0	0	448	654	0
Sign Control	Stop			Free	Free	

Intersection Summary	
Area Type:	CBD
Control Type: Unsignalized	

HCM Unsignalized Intersection Capacity Analysis
6: Site Driveway & Avenue Louis Pasteur

Weekday Morning Peak Hour
2012 Existing Conditions

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	15	15	35	350	490	60
Peak Hour Factor	0.72	0.72	0.86	0.86	0.84	0.84
Hourly flow rate (vph)	21	21	41	407	583	71
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1107	619	655			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1107	619	655			
tC, single (s)	6.4	6.2	4.2			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.3			
p0 queue free %	91	96	95			
cM capacity (veh/h)	222	489	900			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	42	448	655
Volume Left	21	41	0
Volume Right	21	0	71
cSH	305	900	1700
Volume to Capacity	0.14	0.05	0.39
Queue Length 95th (ft)	12	4	0
Control Delay (s)	18.7	1.3	0.0
Lane LOS	C	A	
Approach Delay (s)	18.7	1.3	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	62.8%	ICU Level of Service	B
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	ø2
Lane Configurations													
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	
Lane Width (ft)	10	10	10	10	10	10	14	14	14	10	10	10	
Grade (%)		0%			0%			0%			0%		
Storage Length (ft)	0		0	0		0	0		0	0		0	
Storage Lanes	1		0	1		0	0		0	1		0	
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Leading Detector (ft)	50	50		50	50		50	50		50	50		
Trailing Detector (ft)	0	0		0	0		0	0		0	0		
Turning Speed (mph)	15		9	15		9	15		9	15		9	
Right Turn on Red			No			No			No			No	
Link Speed (mph)		30			30			25			30		
Link Distance (ft)		370			505			249			313		
Travel Time (s)		8.4			11.5			6.8			7.1		
Volume (vph)	70	415	75	25	335	50	60	30	50	170	45	260	
Confl. Peds. (#/hr)													
Confl. Bikes (#/hr)													
Peak Hour Factor	0.82	0.82	0.82	0.95	0.95	0.95	0.81	0.81	0.81	0.86	0.86	0.86	
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Heavy Vehicles (%)	2%	2%	2%	10%	10%	10%	2%	2%	2%	2%	2%	2%	
Bus Blockages (#/hr)	0	10	0	0	10	0	0	0	0	0	0	0	
Parking (#/hr)													
Mid-Block Traffic (%)		0%			0%			0%			0%		
Lane Group Flow (vph)	85	597	0	26	406	0	0	173	0	198	354	0	
Turn Type	Perm			Perm			Perm			Perm			
Protected Phases		1			1			5			5		2
Permitted Phases	1	1		1	1		5	5		5	5		
Detector Phases	1	1		1	1		5	5		5	5		
Minimum Initial (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0		8.0
Minimum Split (s)	14.0	14.0		14.0	14.0		14.0	14.0		14.0	14.0		18.0
Total Split (s)	72.0	72.0	0.0	72.0	72.0	0.0	30.0	30.0	0.0	30.0	30.0	0.0	18.0
Total Split (%)	60.0%	60.0%	0.0%	60.0%	60.0%	0.0%	25.0%	25.0%	0.0%	25.0%	25.0%	0.0%	15%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0		2.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0		0.0
Lead/Lag	Lead	Lead		Lead	Lead								Lag
Lead-Lag Optimize?	Yes	Yes		Yes	Yes								Yes
Recall Mode	C-Max	C-Max		C-Max	C-Max		None	None		None	None		None
v/c Ratio	0.22	0.73		0.11	0.53			2.06		1.14	1.34		
Control Delay	13.8	24.2		13.2	17.6			541.4		155.6	212.2		
Queue Delay	0.0	0.0		0.0	0.0			0.0		0.0	0.0		
Total Delay	13.8	24.2		13.2	17.6			541.4		155.6	212.2		
Queue Length 50th (ft)	31	350		9	195			~211		~180	~357		
Queue Length 95th (ft)	57	437		25	299			#314		#312	#514		
Internal Link Dist (ft)		290			425			169			233		
Turn Bay Length (ft)													
Base Capacity (vph)	384	823		242	765			84		173	265		
Starvation Cap Reductn	0	0		0	0			0		0	0		
Spillback Cap Reductn	0	0		0	0			0		0	0		
Storage Cap Reductn	0	0		0	0			0		0	0		
Reduced v/c Ratio	0.22	0.73		0.11	0.53			2.06		1.14	1.34		

Intersection Summary

Area Type: CBD

Cycle Length: 120

Actuated Cycle Length: 120

Offset: 40 (33%), Referenced to phase 1:EBWB, Start of Green

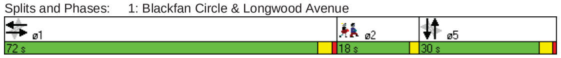
Natural Cycle: 100

Control Type: Actuated-Coordinated

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Blackfan Circle & Longwood Avenue



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Lane Width	10	10	10	10	10	10	14	14	14	10	10	10
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.98			0.95		1.00	0.87	
Flt Protected	0.95	1.00		0.95	1.00			0.98		0.95	1.00	
Satd. Flow (prot)	1330	1313		1233	1222			1491		1330	1221	
Flt Permitted	0.46	1.00		0.33	1.00			0.25		0.57	1.00	
Satd. Flow (perm)	642	1313		427	1222			387		796	1221	
Volume (vph)	70	415	75	25	335	50	60	30	50	170	45	260
Peak-hour factor, PHF	0.82	0.82	0.82	0.95	0.95	0.95	0.81	0.81	0.81	0.86	0.86	0.86
Adj. Flow (vph)	85	506	91	26	353	53	74	37	62	198	52	302
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	85	597	0	26	406	0	0	173	0	198	354	0
Heavy Vehicles (%)	2%	2%	2%	10%	10%	10%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	10	0	0	10	0	0	0	0	0	0	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		1			1			5			5	
Permitted Phases	1	1		1	1		5	5		5	5	
Actuated Green, G (s)	74.4	74.4		74.4	74.4			26.0		26.0	26.0	
Effective Green, g (s)	74.4	74.4		74.4	74.4			26.0		26.0	26.0	
Actuated g/C Ratio	0.62	0.62		0.62	0.62			0.22		0.22	0.22	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)	398	814		265	758			84		172	265	
v/s Ratio Prot		c0.45			0.33						0.29	
v/s Ratio Perm	0.13			0.06				c0.45		0.25		
v/c Ratio	0.21	0.73		0.10	0.54			2.06		1.15	1.34	
Uniform Delay, d1	10.0	15.9		9.2	13.0			47.0		47.0	47.0	
Progression Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2	1.2	5.8		0.7	2.7			515.3		115.1	174.5	
Delay (s)	11.2	21.7		10.0	15.7			562.3		162.1	221.5	
Level of Service	B	C		A	B			F		F	F	
Approach Delay (s)		20.4			15.3			562.3			200.2	
Approach LOS		C			B			F			F	

Intersection Summary			
HCM Average Control Delay	124.2	HCM Level of Service	F
HCM Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	19.6
Intersection Capacity Utilization	87.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1700	1700	1700	1700	1900	1900
Lane Width (ft)	10	10	12	12	12	14
Grade (%)		0%	0%		0%	
Storage Length (ft)	0			0	0	0
Storage Lanes	0			0	1	1
Turning Speed (mph)	15			9	15	9
Link Speed (mph)		30	30		30	
Link Distance (ft)		505	138		160	
Travel Time (s)		11.5	3.1		3.6	
Volume (vph)	0	635	245	0	130	165
Confl. Peds. (#/hr)						169
Confl. Bikes (#/hr)						5
Peak Hour Factor	0.97	0.97	0.90	0.90	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	1%	1%	1%	1%
Bus Blockages (#/hr)	0	0	0	0	0	10
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Lane Group Flow (vph)	0	655	272	0	141	179
Sign Control		Free	Free		Stop	

Intersection Summary	
Area Type:	CBD
Control Type: Unsignalized	

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1700	1700	1700	1700	1900	1900
Lane Width (ft)	10	10	12	12	12	12
Grade (%)		0%	0%		0%	
Storage Length (ft)	0			0	0	0
Storage Lanes	0			0	0	0
Turning Speed (mph)	15			9	15	9
Link Speed (mph)		30	30		30	
Link Distance (ft)		138	314		177	
Travel Time (s)		3.1	7.1		4.0	
Volume (vph)	190	445	245	70	0	0
Confl. Peds. (#/hr)	327			327		
Confl. Bikes (#/hr)				23		
Peak Hour Factor	0.97	0.97	0.90	0.90	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	1%	1%	2%	2%
Bus Blockages (#/hr)	10	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Lane Group Flow (vph)	0	655	350	0	0	0
Sign Control		Free	Free		Stop	

Intersection Summary	
Area Type:	CBD
Control Type: Unsignalized	

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	0	635	245	0	130	165
Peak Hour Factor	0.97	0.97	0.90	0.90	0.92	0.92
Hourly flow rate (vph)	0	655	272	0	141	179
Pedestrians		169				
Lane Width (ft)		10.0				
Walking Speed (ft/s)		4.0				
Percent Blockage		12				
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)		505				
pX, platoon unblocked						
vC, conflicting volume	272				600	441
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	272				600	441
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				68	64
cM capacity (veh/h)	1288				435	500

Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2
Volume Total	327	327	272	141	179
Volume Left	0	0	0	141	0
Volume Right	0	0	0	0	179
cSH	1700	1700	1700	435	500
Volume to Capacity	0.19	0.19	0.16	0.32	0.36
Queue Length 95th (ft)	0	0	0	35	40
Control Delay (s)	0.0	0.0	0.0	17.2	16.2
Lane LOS				C	C
Approach Delay (s)	0.0		0.0	16.6	
Approach LOS				C	

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	41.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	190	445	245	70	0	0
Peak Hour Factor	0.97	0.97	0.90	0.90	0.92	0.92
Hourly flow rate (vph)	196	459	272	78	0	0
Pedestrians					327	
Lane Width (ft)					0.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)		643				
pX, platoon unblocked						
vC, conflicting volume	677				1259	638
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	677				1259	638
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	78				100	100
cM capacity (veh/h)	911				128	419

Direction, Lane #	EB 1	EB 2	WB 1
Volume Total	349	306	350
Volume Left	196	0	0
Volume Right	0	0	78
cSH	911	1700	1700
Volume to Capacity	0.22	0.18	0.21
Queue Length 95th (ft)	20	0	0
Control Delay (s)	6.7	0.0	0.0
Lane LOS	A		
Approach Delay (s)	3.6		0.0
Approach LOS			

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	52.1%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	16	16	12
Grade (%)	0%			0%	0%	
Storage Length (ft)	0	0	0			0
Storage Lanes	1	0	0			0
Turning Speed (mph)	15	9	15			9
Link Speed (mph)	30			30	30	
Link Distance (ft)	304			204	473	
Travel Time (s)	6.9			4.6	10.8	
Volume (vph)	115	30	15	195	320	40
Confl. Peds. (#/hr)	25	3	129			129
Confl. Bikes (#/hr)						5
Peak Hour Factor	0.87	0.87	0.96	0.96	0.87	0.87
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	1%	1%	12%	12%	17%	17%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%			0%	0%	
Lane Group Flow (vph)	166	0	0	219	414	0
Sign Control	Stop			Free	Free	

Intersection Summary	
Area Type:	CBD
Control Type: Unsignalized	

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	115	30	15	195	320	40
Peak Hour Factor	0.87	0.87	0.96	0.96	0.87	0.87
Hourly flow rate (vph)	132	34	16	203	368	46
Pedestrians	129			3	25	
Lane Width (ft)	12.0			16.0	16.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	11			0	3	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	779	523	543			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	779	523	543			
tC, single (s)	6.4	6.2	4.2			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.3			
p0 queue free %	58	93	98			
cM capacity (veh/h)	312	495	872			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	167	219	414
Volume Left	132	16	0
Volume Right	34	0	46
cSH	337	872	1700
Volume to Capacity	0.49	0.02	0.24
Queue Length 95th (ft)	65	1	0
Control Delay (s)	25.6	0.8	0.0
Lane LOS	D	A	
Approach Delay (s)	25.6	0.8	0.0
Approach LOS	D		

Intersection Summary			
Average Delay	5.6		
Intersection Capacity Utilization	41.4%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	10	11	12	12	12	12	12	16	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		1	1		0	0		1	0		0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		534			483			473			190	
Travel Time (s)		12.1			11.0			10.8			4.3	
Volume (vph)	55	495	110	250	0	0	0	0	310	0	0	0
Confl. Peds. (#/hr)	117		163	163					117			
Confl. Bikes (#/hr)			7									
Peak Hour Factor	0.92	0.92	0.92	0.86	0.86	0.86	0.96	0.96	0.96	0.25	0.25	0.25
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	3%	3%	3%	5%	5%	5%	0%	0%	11%	0%	0%	0%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	6	0	0	0
Parking (#/hr)									5			
Mid-Block Traffic (%)		0%			0%			0%			0%	
Lane Group Flow (vph)	60	538	120	291	0	0	0	0	323	0	0	0
Sign Control		Free			Free			Stop			Stop	

Intersection Summary

Area Type: CBD

Control Type: Unsignalized

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	55	495	110	250	0	0	0	0	310	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.86	0.86	0.86	0.96	0.96	0.96	0.25	0.25	0.25
Hourly flow rate (vph)	60	538	120	291	0	0	0	0	323	0	0	0
Pedestrians					117			163			117	
Lane Width (ft)					12.0			16.0			0.0	
Walking Speed (ft/s)					4.0			4.0			4.0	
Percent Blockage					10			18			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	117			821			1402	1519	818	1796	1639	117
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	117			821			1402	1519	818	1796	1639	117
tC, single (s)	4.1			4.1			7.1	6.5	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.4	3.5	4.0	3.3
p0 queue free %	96			55			100	100	0	0	100	100
cM capacity (veh/h)	1465			651			54	52	268	0	44	941

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	NB 1
Volume Total	60	538	120	291	323
Volume Left	60	0	0	291	0
Volume Right	0	0	120	0	323
cSH	1465	1700	1700	651	268
Volume to Capacity	0.04	0.32	0.07	0.45	1.21
Queue Length 95th (ft)	3	0	0	58	374
Control Delay (s)	7.6	0.0	0.0	14.9	161.8
Lane LOS	A			B	F
Approach Delay (s)	0.6			14.9	161.8
Approach LOS					F

Intersection Summary			
Average Delay	42.9		
Intersection Capacity Utilization	63.4%	ICU Level of Service	B
Analysis Period (min)	15		

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	16	16	12
Grade (%)	0%			0%	0%	
Storage Length (ft)	0	0	0			0
Storage Lanes	1	0	0			0
Turning Speed (mph)	15	9	15			9
Link Speed (mph)	30			30	30	
Link Distance (ft)	190			537	204	
Travel Time (s)	4.3			12.2	4.6	
Volume (vph)	50	45	10	160	330	20
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.87	0.87	0.96	0.96	0.87	0.87
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	12%	12%	17%	17%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%			0%	0%	
Lane Group Flow (vph)	109	0	0	177	402	0
Sign Control	Stop			Free	Free	

Intersection Summary	
Area Type:	CBD
Control Type: Unsignalized	

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	50	45	10	160	330	20
Peak Hour Factor	0.87	0.87	0.96	0.96	0.87	0.87
Hourly flow rate (vph)	57	52	10	167	379	23
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	578	391	402			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	578	391	402			
tC, single (s)	6.4	6.2	4.2			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.3			
p0 queue free %	88	92	99			
cM capacity (veh/h)	473	658	1104			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	109	177	402
Volume Left	57	10	0
Volume Right	52	0	23
cSH	546	1104	1700
Volume to Capacity	0.20	0.01	0.24
Queue Length 95th (ft)	19	1	0
Control Delay (s)	13.2	0.6	0.0
Lane LOS	B	A	
Approach Delay (s)	13.2	0.6	0.0
Approach LOS	B		

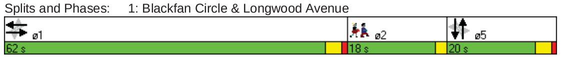
Intersection Summary			
Average Delay	2.2		
Intersection Capacity Utilization	33.5%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	ø2
Lane Configurations													
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	
Lane Width (ft)	10	10	10	10	10	10	14	14	14	10	10	10	
Grade (%)		0%			0%			0%			0%		
Storage Length (ft)	0		0	0		0	0		0	0		0	
Storage Lanes	1		0	1		0	0		0	1		0	
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Leading Detector (ft)	50	50		50	50		50	50		50	50		
Trailing Detector (ft)	0	0		0	0		0	0		0	0		
Turning Speed (mph)	15		9	15		9	15		9	15		9	
Right Turn on Red			No			No			No			No	
Link Speed (mph)		30			30			25			30		
Link Distance (ft)		370			505			249			313		
Travel Time (s)		8.4			11.5			6.8			7.1		
Volume (vph)	65	582	55	42	556	152	41	49	49	61	17	112	
Confl. Peds. (#/hr)													
Confl. Bikes (#/hr)													
Peak Hour Factor	0.87	0.87	0.87	0.84	0.84	0.84	0.86	0.86	0.86	0.78	0.78	0.78	
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%	
Bus Blockages (#/hr)	0	10	0	0	10	0	0	0	0	0	0	0	
Parking (#/hr)													
Mid-Block Traffic (%)		0%			0%			0%			0%		
Lane Group Flow (vph)	75	732	0	50	843	0	0	162	0	78	166	0	
Turn Type	Perm			Perm			Perm			Perm			
Protected Phases		1			1			5			5		2
Permitted Phases	1	1		1	1		5	5		5	5		
Detector Phases	1	1		1	1		5	5		5	5		
Minimum Initial (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0		8.0
Minimum Split (s)	14.0	14.0		14.0	14.0		14.0	14.0		14.0	14.0		18.0
Total Split (s)	62.0	62.0	0.0	62.0	62.0	0.0	20.0	20.0	0.0	20.0	20.0	0.0	18.0
Total Split (%)	62.0%	62.0%	0.0%	62.0%	62.0%	0.0%	20.0%	20.0%	0.0%	20.0%	20.0%	0.0%	18%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0		2.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0		0.0
Lead/Lag	Lead	Lead		Lead	Lead								Lag
Lead-Lag Optimize?													
Recall Mode	C-Max	C-Max		C-Max	C-Max		None	None		None	None		None
v/c Ratio	0.55	0.85		0.25	0.99			0.95		0.70	0.86		
Control Delay	33.2	28.6		14.0	50.3			99.7		73.6	79.2		
Queue Delay	0.0	0.0		0.0	0.0			0.0		0.0	0.0		
Total Delay	33.2	28.6		14.0	50.3			99.7		73.6	79.2		
Queue Length 50th (ft)	29	414		15	~621			103		48	104		
Queue Length 95th (ft)	#105	#651		37	#763			#216		#98	#176		
Internal Link Dist (ft)		290			425			169			233		
Turn Bay Length (ft)													
Base Capacity (vph)	136	859		203	851			173		112	195		
Starvation Cap Reductn	0	0		0	0			0		0	0		
Spillback Cap Reductn	0	0		0	0			0		0	0		
Storage Cap Reductn	0	0		0	0			0		0	0		
Reduced v/c Ratio	0.55	0.85		0.25	0.99			0.94		0.70	0.85		

Intersection Summary

Area Type: CBD
Cycle Length: 100
Actuated Cycle Length: 100
Offset: 7 (7%), Referenced to phase 1:EBWB, Start of Green
Natural Cycle: 130
Control Type: Actuated-Coordinated
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Blackfan Circle & Longwood Avenue



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Lane Width	10	10	10	10	10	10	14	14	14	10	10	10
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.97			0.95		1.00	0.87	
Flt Protected	0.95	1.00		0.95	1.00			0.99		0.95	1.00	
Satd. Flow (prot)	1317	1314		1330	1301			1502		1330	1218	
Flt Permitted	0.20	1.00		0.27	1.00			0.70		0.50	1.00	
Satd. Flow (perm)	280	1314		372	1301			1070		693	1218	
Volume (vph)	65	582	55	42	556	152	41	49	49	61	17	112
Peak-hour factor, PHF	0.87	0.87	0.87	0.84	0.84	0.84	0.86	0.86	0.86	0.78	0.78	0.78
Adj. Flow (vph)	75	669	63	50	662	181	48	57	57	78	22	144
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	75	732	0	50	843	0	0	162	0	78	166	0
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	10	0	0	10	0	0	0	0	0	0	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		1			1			5			5	
Permitted Phases	1	1		1	1		5	5		5	5	
Actuated Green, G (s)	64.6	64.6		64.6	64.6			15.8		15.8	15.8	
Effective Green, g (s)	64.6	64.6		64.6	64.6			15.8		15.8	15.8	
Actuated g/C Ratio	0.65	0.65		0.65	0.65			0.16		0.16	0.16	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)	181	849		240	840			169		109	192	
v/s Ratio Prot		0.56			c0.65						0.14	
v/s Ratio Perm	0.27			0.13				c0.15		0.11		
v/c Ratio	0.41	0.86		0.21	1.00			0.96		0.72	0.86	
Uniform Delay, d1	8.6	14.1		7.2	17.7			41.8		40.0	41.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2	6.9	11.2		2.0	31.9			56.0		16.9	30.0	
Delay (s)	15.4	25.4		9.2	49.6			97.8		56.9	71.1	
Level of Service	B	C		A	D			F		E	E	
Approach Delay (s)		24.4			47.4			97.8			66.5	
Approach LOS		C			D			F			E	

Intersection Summary			
HCM Average Control Delay	44.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	19.6
Intersection Capacity Utilization	88.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1700	1700	1700	1700	1900	1900
Lane Width (ft)	10	10	12	12	12	14
Grade (%)		0%	0%		0%	
Storage Length (ft)	0			0	0	0
Storage Lanes	0			0	1	1
Turning Speed (mph)	15			9	15	9
Link Speed (mph)		30	30		30	
Link Distance (ft)		505	138		160	
Travel Time (s)		11.5	3.1		3.6	
Volume (vph)	0	692	574	0	121	175
Confl. Peds. (#/hr)						167
Confl. Bikes (#/hr)						5
Peak Hour Factor	0.91	0.91	0.88	0.88	0.69	0.69
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	1%	1%
Bus Blockages (#/hr)	0	0	0	0	0	10
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Lane Group Flow (vph)	0	760	652	0	175	254
Sign Control		Free	Free		Stop	

Intersection Summary
Area Type: CBD
Control Type: Unsignalized

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1700	1700	1700	1700	1900	1900
Lane Width (ft)	10	10	12	12	12	12
Grade (%)		0%	0%		0%	
Storage Length (ft)	0			0	0	0
Storage Lanes	0			0	0	0
Turning Speed (mph)	15			9	15	9
Link Speed (mph)		30	30		30	
Link Distance (ft)		138	314		177	
Travel Time (s)		3.1	7.1		4.0	
Volume (vph)	316	375	574	209	0	0
Confl. Peds. (#/hr)	293			293		
Confl. Bikes (#/hr)				7		
Peak Hour Factor	0.91	0.91	0.88	0.88	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	10	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Lane Group Flow (vph)	0	759	890	0	0	0
Sign Control		Free	Free		Stop	

Intersection Summary
Area Type: CBD
Control Type: Unsignalized

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	0	692	574	0	121	175
Peak Hour Factor	0.91	0.91	0.88	0.88	0.69	0.69
Hourly flow rate (vph)	0	760	652	0	175	254
Pedestrians		167				
Lane Width (ft)		10.0				
Walking Speed (ft/s)		4.0				
Percent Blockage		12				
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)		505				
pX, platoon unblocked						
vC, conflicting volume	652				1032	819
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	652				1032	819
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				24	10
cM capacity (veh/h)	930				230	283

Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2
Volume Total	380	380	652	175	254
Volume Left	0	0	0	175	0
Volume Right	0	0	0	0	254
cSH	1700	1700	1700	230	283
Volume to Capacity	0.22	0.22	0.38	0.76	0.90
Queue Length 95th (ft)	0	0	0	135	202
Control Delay (s)	0.0	0.0	0.0	57.8	69.4
Lane LOS				F	F
Approach Delay (s)	0.0		0.0	64.7	
Approach LOS				F	

Intersection Summary			
Average Delay	15.1		
Intersection Capacity Utilization	63.6%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	316	375	574	209	0	0
Peak Hour Factor	0.91	0.91	0.88	0.88	0.92	0.92
Hourly flow rate (vph)	347	412	652	238	0	0
Pedestrians					293	
Lane Width (ft)					0.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)		643				
pX, platoon unblocked						
vC, conflicting volume	1183				1965	1064
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1183				1965	1064
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	41				100	100
cM capacity (veh/h)	586				22	219

Direction, Lane #	EB 1	EB 2	WB 1
Volume Total	485	275	890
Volume Left	347	0	0
Volume Right	0	0	238
cSH	586	1700	1700
Volume to Capacity	0.59	0.16	0.52
Queue Length 95th (ft)	97	0	0
Control Delay (s)	17.7	0.0	0.0
Lane LOS	C		
Approach Delay (s)	11.3		0.0
Approach LOS			

Intersection Summary			
Average Delay	5.2		
Intersection Capacity Utilization	86.5%	ICU Level of Service	E
Analysis Period (min)	15		

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	16	12	16
Grade (%)	0%			0%	0%	
Storage Length (ft)	0	0	0			0
Storage Lanes	1	0	0			0
Turning Speed (mph)	15	9	15			9
Link Speed (mph)	30			30	30	
Link Distance (ft)	304			204	473	
Travel Time (s)	6.9			4.6	10.8	
Volume (vph)	37	16	42	356	601	68
Confl. Peds. (#/hr)	18	8	73			73
Confl. Bikes (#/hr)						5
Peak Hour Factor	0.72	0.72	0.86	0.86	0.84	0.84
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	9%	9%	9%	9%	5%	5%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%			0%	0%	
Lane Group Flow (vph)	73	0	0	463	796	0
Sign Control	Stop			Free	Free	

Intersection Summary	
Area Type:	CBD
Control Type: Unsignalized	

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	37	16	42	356	601	68
Peak Hour Factor	0.72	0.72	0.86	0.86	0.84	0.84
Hourly flow rate (vph)	51	22	49	414	715	81
Pedestrians	73			8	18	
Lane Width (ft)	12.0			16.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	6			1	2	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1359	837	869			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1359	837	869			
tC, single (s)	6.5	6.3	4.2			
tC, 2 stage (s)						
tF (s)	3.6	3.4	2.3			
p0 queue free %	62	93	93			
cM capacity (veh/h)	136	332	701			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	74	463	796
Volume Left	51	49	0
Volume Right	22	0	81
cSH	166	701	1700
Volume to Capacity	0.44	0.07	0.47
Queue Length 95th (ft)	51	6	0
Control Delay (s)	43.0	2.0	0.0
Lane LOS	E	A	
Approach Delay (s)	43.0	2.0	0.0
Approach LOS	E		

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	72.4%	ICU Level of Service	C
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	10	11	12	12	12	12	12	16	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		1	1		0	0		1	0		0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		534			483			473			190	
Travel Time (s)		12.1			11.0			10.8			4.3	
Volume (vph)	37	396	293	376	0	0	0	0	392	0	0	0
Confl. Peds. (#/hr)	57		100	100					57			
Confl. Bikes (#/hr)			8									
Peak Hour Factor	0.81	0.81	0.81	0.83	0.83	0.83	0.76	0.76	0.76	0.25	0.25	0.25
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	10%	10%	10%	5%	0%	0%	0%	0%	12%	0%	0%	0%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	8	0	0	0
Parking (#/hr)									5			
Mid-Block Traffic (%)		0%			0%			0%			0%	
Lane Group Flow (vph)	46	489	362	453	0	0	0	0	516	0	0	0
Sign Control		Free			Free			Stop			Stop	

Intersection Summary

Area Type: CBD

Control Type: Unsignalized

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	37	396	293	376	0	0	0	0	392	0	0	0
Peak Hour Factor	0.81	0.81	0.81	0.83	0.83	0.83	0.76	0.76	0.76	0.25	0.25	0.25
Hourly flow rate (vph)	46	489	362	453	0	0	0	0	516	0	0	0
Pedestrians					57			100			57	
Lane Width (ft)					12.0			16.0			0.0	
Walking Speed (ft/s)					4.0			4.0			4.0	
Percent Blockage					5			11			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	57			951			1586	1643	646	2116	2005	57
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	57			951			1586	1643	646	2116	2005	57
tC, single (s)	4.2			4.1			7.1	6.5	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.3			2.2			3.5	4.0	3.4	3.5	4.0	3.3
p0 queue free %	97			28			100	100	0	0	100	100
cM capacity (veh/h)	1498			632			30	25	385	0	15	1015

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	NB 1
Volume Total	46	489	362	453	516
Volume Left	46	0	0	453	0
Volume Right	0	0	362	0	516
cSH	1498	1700	1700	632	385
Volume to Capacity	0.03	0.29	0.21	0.72	1.34
Queue Length 95th (ft)	2	0	0	150	608
Control Delay (s)	7.5	0.0	0.0	23.8	198.4
Lane LOS	A			C	F
Approach Delay (s)	0.4			23.8	198.4
Approach LOS					F

Intersection Summary			
Average Delay	60.8		
Intersection Capacity Utilization	61.1%	ICU Level of Service	B
Analysis Period (min)	15		

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	16	16	16	16
Grade (%)	0%			0%	0%	
Storage Length (ft)	0	0	0			0
Storage Lanes	1	0	0			0
Turning Speed (mph)	15	9	15			9
Link Speed (mph)	30			30	30	
Link Distance (ft)	190			537	204	
Travel Time (s)	4.3			12.2	4.6	
Volume (vph)	16	16	37	382	554	63
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.72	0.72	0.86	0.86	0.84	0.84
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	9%	9%	5%	5%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%			0%	0%	
Lane Group Flow (vph)	44	0	0	487	735	0
Sign Control	Stop			Free	Free	

Intersection Summary	
Area Type:	CBD
Control Type: Unsignalized	

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	16	16	37	382	554	63
Peak Hour Factor	0.72	0.72	0.86	0.86	0.84	0.84
Hourly flow rate (vph)	22	22	43	444	660	75
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1227	697	735			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1227	697	735			
tC, single (s)	6.4	6.2	4.2			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.3			
p0 queue free %	88	95	95			
cM capacity (veh/h)	187	441	840			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	44	487	735
Volume Left	22	43	0
Volume Right	22	0	75
cSH	262	840	1700
Volume to Capacity	0.17	0.05	0.43
Queue Length 95th (ft)	15	4	0
Control Delay (s)	21.5	1.4	0.0
Lane LOS	C	A	
Approach Delay (s)	21.5	1.4	0.0
Approach LOS	C		

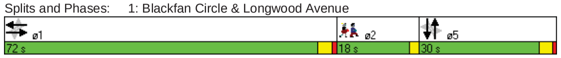
Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	66.5%	ICU Level of Service	C
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	ø2
Lane Configurations													
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	
Lane Width (ft)	10	10	10	10	10	10	14	14	14	10	10	10	
Grade (%)		0%			0%			0%			0%		
Storage Length (ft)	0		0	0		0	0		0	0		0	
Storage Lanes	1		0	1		0	0		0	1		0	
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Leading Detector (ft)	50	50		50	50		50	50		50	50		
Trailing Detector (ft)	0	0		0	0		0	0		0	0		
Turning Speed (mph)	15		9	15		9	15		9	15		9	
Right Turn on Red			No			No			No			No	
Link Speed (mph)		30			30			25			30		
Link Distance (ft)		370			505			249			313		
Travel Time (s)		8.4			11.5			6.8			7.1		
Volume (vph)	74	481	82	28	364	53	69	37	57	179	57	274	
Confl. Peds. (#/hr)													
Confl. Bikes (#/hr)													
Peak Hour Factor	0.82	0.82	0.82	0.95	0.95	0.95	0.81	0.81	0.81	0.86	0.86	0.86	
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Heavy Vehicles (%)	2%	2%	2%	10%	10%	10%	2%	2%	2%	2%	2%	2%	
Bus Blockages (#/hr)	0	10	0	0	10	0	0	0	0	0	0	0	
Parking (#/hr)													
Mid-Block Traffic (%)		0%			0%			0%			0%		
Lane Group Flow (vph)	90	687	0	29	439	0	0	201	0	208	385	0	
Turn Type	Perm			Perm			Perm			Perm			
Protected Phases		1			1			5			5		2
Permitted Phases	1	1		1	1		5	5		5	5		
Detector Phases	1	1		1	1		5	5		5	5		
Minimum Initial (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0		8.0
Minimum Split (s)	14.0	14.0		14.0	14.0		14.0	14.0		14.0	14.0		18.0
Total Split (s)	72.0	72.0	0.0	72.0	72.0	0.0	30.0	30.0	0.0	30.0	30.0	0.0	18.0
Total Split (%)	60.0%	60.0%	0.0%	60.0%	60.0%	0.0%	25.0%	25.0%	0.0%	25.0%	25.0%	0.0%	15%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0		2.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0		0.0
Lead/Lag	Lead	Lead		Lead	Lead								Lag
Lead-Lag Optimize?	Yes	Yes		Yes	Yes								Yes
Recall Mode	C-Max	C-Max		C-Max	C-Max		None	None		None	None		None
v/c Ratio	0.25	0.83		0.15	0.57			3.94		1.27	1.45		
Control Delay	14.4	31.0		14.5	18.8			1383.6		199.4	256.5		
Queue Delay	0.0	0.0		0.0	0.0			0.0		0.0	0.0		
Total Delay	14.4	31.0		14.5	18.8			1383.6		199.4	256.5		
Queue Length 50th (ft)	34	460		10	219			~283		~203	~406		
Queue Length 95th (ft)	61	#594		29	336			#357		#337	#564		
Internal Link Dist (ft)		290			425			169			233		
Turn Bay Length (ft)													
Base Capacity (vph)	362	824		193	766			51		164	266		
Starvation Cap Reductn	0	0		0	0			0		0	0		
Spillback Cap Reductn	0	0		0	0			0		0	0		
Storage Cap Reductn	0	0		0	0			0		0	0		
Reduced v/c Ratio	0.25	0.83		0.15	0.57			3.94		1.27	1.45		

Intersection Summary

Area Type: CBD
Cycle Length: 120
Actuated Cycle Length: 120
Offset: 40 (33%), Referenced to phase 1:EBWB, Start of Green
Natural Cycle: 150
Control Type: Actuated-Coordinated
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Blackfan Circle & Longwood Avenue



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Lane Width	10	10	10	10	10	10	14	14	14	10	10	10
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.98			0.95		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00			0.98		0.95	1.00	
Satd. Flow (prot)	1330	1315		1233	1222			1493		1330	1226	
Flt Permitted	0.43	1.00		0.27	1.00			0.15		0.54	1.00	
Satd. Flow (perm)	609	1315		354	1222			236		757	1226	
Volume (vph)	74	481	82	28	364	53	69	37	57	179	57	274
Peak-hour factor, PHF	0.82	0.82	0.82	0.95	0.95	0.95	0.81	0.81	0.81	0.86	0.86	0.86
Adj. Flow (vph)	90	587	100	29	383	56	85	46	70	208	66	319
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	90	687	0	29	439	0	0	201	0	208	385	0
Heavy Vehicles (%)	2%	2%	2%	10%	10%	10%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	10	0	0	10	0	0	0	0	0	0	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		1			1			5			5	
Permitted Phases	1	1		1	1		5	5		5	5	
Actuated Green, G (s)	74.4	74.4		74.4	74.4			26.0		26.0	26.0	
Effective Green, g (s)	74.4	74.4		74.4	74.4			26.0		26.0	26.0	
Actuated g/C Ratio	0.62	0.62		0.62	0.62			0.22		0.22	0.22	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)	378	815		219	758			51		164	266	
v/s Ratio Prot		c0.52			0.36						0.31	
v/s Ratio Perm	0.15			0.08				c0.85		0.27		
v/c Ratio	0.24	0.84		0.13	0.58			3.94		1.27	1.45	
Uniform Delay, d1	10.2	18.1		9.4	13.5			47.0		47.0	47.0	
Progression Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2	1.5	10.3		1.3	3.2			1369.2		159.9	221.2	
Delay (s)	11.6	28.5		10.7	16.7			1416.2		206.9	268.2	
Level of Service	B	C		B	B			F		F	F	
Approach Delay (s)		26.5			16.4			1416.2			246.7	
Approach LOS		C			B			F			F	

Intersection Summary			
HCM Average Control Delay	225.2	HCM Level of Service	F
HCM Volume to Capacity ratio	1.64		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	19.6
Intersection Capacity Utilization	95.5%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1700	1700	1700	1700	1900	1900
Lane Width (ft)	10	10	12	12	12	14
Grade (%)		0%	0%		0%	
Storage Length (ft)	0			0	0	0
Storage Lanes	0			0	1	1
Turning Speed (mph)	15			9	15	9
Link Speed (mph)		30	30		30	
Link Distance (ft)		505	138		160	
Travel Time (s)		11.5	3.1		3.6	
Volume (vph)	0	716	272	0	137	173
Confl. Peds. (#/hr)						169
Confl. Bikes (#/hr)						5
Peak Hour Factor	0.97	0.97	0.90	0.90	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	1%	1%	1%	1%
Bus Blockages (#/hr)	0	0	0	0	0	10
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Lane Group Flow (vph)	0	738	302	0	149	188
Sign Control		Free	Free		Stop	

Intersection Summary	
Area Type:	CBD
Control Type: Unsignalized	

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1700	1700	1700	1700	1900	1900
Lane Width (ft)	10	10	12	12	12	12
Grade (%)		0%	0%		0%	
Storage Length (ft)	0			0	0	0
Storage Lanes	0			0	0	0
Turning Speed (mph)	15			9	15	9
Link Speed (mph)		30	30		30	
Link Distance (ft)		138	314		177	
Travel Time (s)		3.1	7.1		4.0	
Volume (vph)	200	517	272	74	0	0
Confl. Peds. (#/hr)	327			327		
Confl. Bikes (#/hr)				23		
Peak Hour Factor	0.97	0.97	0.90	0.90	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	1%	1%	2%	2%
Bus Blockages (#/hr)	10	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Lane Group Flow (vph)	0	739	384	0	0	0
Sign Control		Free	Free		Stop	

Intersection Summary	
Area Type:	CBD
Control Type: Unsignalized	

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	0	716	272	0	137	173
Peak Hour Factor	0.97	0.97	0.90	0.90	0.92	0.92
Hourly flow rate (vph)	0	738	302	0	149	188
Pedestrians		169				
Lane Width (ft)		10.0				
Walking Speed (ft/s)		4.0				
Percent Blockage		12				
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)		505				
pX, platoon unblocked						
vC, conflicting volume	302				671	471
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	302				671	471
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				62	61
cM capacity (veh/h)	1256				392	478

Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2
Volume Total	369	369	302	149	188
Volume Left	0	0	0	149	0
Volume Right	0	0	0	0	188
cSH	1700	1700	1700	392	478
Volume to Capacity	0.22	0.22	0.18	0.38	0.39
Queue Length 95th (ft)	0	0	0	43	46
Control Delay (s)	0.0	0.0	0.0	19.7	17.3
Lane LOS				C	C
Approach Delay (s)	0.0		0.0	18.4	
Approach LOS				C	

Intersection Summary			
Average Delay	4.5		
Intersection Capacity Utilization	44.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	200	517	272	74	0	0
Peak Hour Factor	0.97	0.97	0.90	0.90	0.92	0.92
Hourly flow rate (vph)	206	533	302	82	0	0
Pedestrians					327	
Lane Width (ft)					0.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)		643				
pX, platoon unblocked						
vC, conflicting volume	711				1349	670
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	711				1349	670
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	77				100	100
cM capacity (veh/h)	884				109	399

Direction, Lane #	EB 1	EB 2	WB 1
Volume Total	384	355	384
Volume Left	206	0	0
Volume Right	0	0	82
cSH	884	1700	1700
Volume to Capacity	0.23	0.21	0.23
Queue Length 95th (ft)	23	0	0
Control Delay (s)	6.8	0.0	0.0
Lane LOS	A		
Approach Delay (s)	3.5		0.0
Approach LOS			

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	56.9%	ICU Level of Service	B
Analysis Period (min)	15		

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	16	16	12
Grade (%)	0%			0%	0%	
Storage Length (ft)	0	0	0			0
Storage Lanes	1	0	0			0
Turning Speed (mph)	15	9	15			9
Link Speed (mph)	30			30	30	
Link Distance (ft)	304			204	473	
Travel Time (s)	6.9			4.6	10.8	
Volume (vph)	121	32	16	205	336	42
Confl. Peds. (#/hr)	25	3	129			129
Confl. Bikes (#/hr)						5
Peak Hour Factor	0.87	0.87	0.96	0.96	0.87	0.87
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	1%	1%	12%	12%	17%	17%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%			0%	0%	
Lane Group Flow (vph)	176	0	0	231	434	0
Sign Control	Stop			Free	Free	

Intersection Summary

Area Type: CBD

Control Type: Unsignalized

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	121	32	16	205	336	42
Peak Hour Factor	0.87	0.87	0.96	0.96	0.87	0.87
Hourly flow rate (vph)	139	37	17	214	386	48
Pedestrians	129			3	25	
Lane Width (ft)	12.0			16.0	16.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	11			0	3	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	811	542	563			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	811	542	563			
tC, single (s)	6.4	6.2	4.2			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.3			
p0 queue free %	53	92	98			
cM capacity (veh/h)	298	482	857			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	176	230	434
Volume Left	139	17	0
Volume Right	37	0	48
cSH	324	857	1700
Volume to Capacity	0.54	0.02	0.26
Queue Length 95th (ft)	76	1	0
Control Delay (s)	28.6	0.9	0.0
Lane LOS	D	A	
Approach Delay (s)	28.6	0.9	0.0
Approach LOS	D		

Intersection Summary			
Average Delay	6.2		
Intersection Capacity Utilization	43.3%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	10	11	12	12	12	12	12	16	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		1	1		0	0		1	0		0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		534			483			473			190	
Travel Time (s)		12.1			11.0			10.8			4.3	
Volume (vph)	58	520	116	263	0	0	0	0	326	0	0	0
Confl. Peds. (#/hr)	117		163	163					117			
Confl. Bikes (#/hr)			7									
Peak Hour Factor	0.92	0.92	0.92	0.86	0.86	0.86	0.96	0.96	0.96	0.25	0.25	0.25
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	3%	3%	3%	5%	5%	5%	0%	0%	11%	0%	0%	0%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	6	0	0	0
Parking (#/hr)									5			
Mid-Block Traffic (%)		0%			0%			0%			0%	
Lane Group Flow (vph)	63	565	126	306	0	0	0	0	340	0	0	0
Sign Control		Free			Free			Stop			Stop	

Intersection Summary	
Area Type:	CBD
Control Type: Unsignalized	

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	58	520	116	263	0	0	0	0	326	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.86	0.86	0.86	0.96	0.96	0.96	0.25	0.25	0.25
Hourly flow rate (vph)	63	565	126	306	0	0	0	0	340	0	0	0
Pedestrians					117			163			117	
Lane Width (ft)					12.0			16.0			0.0	
Walking Speed (ft/s)					4.0			4.0			4.0	
Percent Blockage					10			18			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	117			854			1466	1583	845	1877	1709	117
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	117			854			1466	1583	845	1877	1709	117
tC, single (s)	4.1			4.1			7.1	6.5	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.4	3.5	4.0	3.3
p0 queue free %	96			52			100	100	0	0	100	100
cM capacity (veh/h)	1465			633			46	44	258	0	37	941

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	NB 1
Volume Total	63	565	126	306	340
Volume Left	63	0	0	306	0
Volume Right	0	0	126	0	340
cSH	1465	1700	1700	633	258
Volume to Capacity	0.04	0.33	0.07	0.48	1.31
Queue Length 95th (ft)	3	0	0	66	436
Control Delay (s)	7.6	0.0	0.0	15.9	205.0
Lane LOS	A			C	F
Approach Delay (s)	0.6			15.9	205.0
Approach LOS					F

Intersection Summary			
Average Delay	53.5		
Intersection Capacity Utilization	65.9%	ICU Level of Service	C
Analysis Period (min)	15		

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	16	16	12
Grade (%)	0%			0%	0%	
Storage Length (ft)	0	0	0			0
Storage Lanes	1	0	0			0
Turning Speed (mph)	15	9	15			9
Link Speed (mph)	30			30	30	
Link Distance (ft)	190			537	204	
Travel Time (s)	4.3			12.2	4.6	
Volume (vph)	53	47	11	168	347	21
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.87	0.87	0.96	0.96	0.87	0.87
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	12%	12%	17%	17%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)	0%			0%	0%	
Lane Group Flow (vph)	115	0	0	186	423	0
Sign Control	Stop			Free	Free	

Intersection Summary

Area Type: CBD

Control Type: Unsignalized

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	53	47	11	168	347	21
Peak Hour Factor	0.87	0.87	0.96	0.96	0.87	0.87
Hourly flow rate (vph)	61	54	11	175	399	24
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	609	411	423			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	609	411	423			
tC, single (s)	6.4	6.2	4.2			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.3			
p0 queue free %	87	92	99			
cM capacity (veh/h)	454	641	1085			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	115	186	423
Volume Left	61	11	0
Volume Right	54	0	24
cSH	526	1085	1700
Volume to Capacity	0.22	0.01	0.25
Queue Length 95th (ft)	21	1	0
Control Delay (s)	13.8	0.6	0.0
Lane LOS	B	A	
Approach Delay (s)	13.8	0.6	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	34.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Lane Width	10	10	10	10	10	10	14	14	14	10	10	10
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.97			0.95		1.00	0.87	
Flt Protected	0.95	1.00		0.95	1.00			0.99		0.95	1.00	
Satd. Flow (prot)	1317	1314		1330	1301			1502		1330	1219	
Flt Permitted	0.20	1.00		0.26	1.00			0.71		0.49	1.00	
Satd. Flow (perm)	283	1314		370	1301			1084		691	1219	
Volume (vph)	71	585	55	42	554	152	41	49	49	61	17	109
Peak-hour factor, PHF	0.87	0.87	0.87	0.84	0.84	0.84	0.86	0.86	0.86	0.78	0.78	0.78
Adj. Flow (vph)	82	672	63	50	660	181	48	57	57	78	22	140
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	82	735	0	50	841	0	0	162	0	78	162	0
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	10	0	0	10	0	0	0	0	0	0	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		1			1			5			5	
Permitted Phases	1	1		1	1		5	5		5	5	
Actuated Green, G (s)	64.7	64.7		64.7	64.7			15.7		15.7	15.7	
Effective Green, g (s)	64.7	64.7		64.7	64.7			15.7		15.7	15.7	
Actuated g/C Ratio	0.65	0.65		0.65	0.65			0.16		0.16	0.16	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)	183	850		239	842			170		108	191	
v/s Ratio Prot		0.56			c0.65						0.13	
v/s Ratio Perm	0.29			0.13				c0.15		0.11		
v/c Ratio	0.45	0.86		0.21	1.00			0.95		0.72	0.85	
Uniform Delay, d1	8.8	14.1		7.2	17.6			41.8		40.1	41.0	
Progression Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2	7.7	11.4		2.0	30.7			54.6		18.2	26.9	
Delay (s)	16.5	25.5		9.2	48.3			96.3		58.2	67.9	
Level of Service	B	C		A	D			F		E	E	
Approach Delay (s)		24.6			46.1			96.3			64.8	
Approach LOS		C			D			F			E	

Intersection Summary			
HCM Average Control Delay	43.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	19.6
Intersection Capacity Utilization	88.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	0	695	574	0	120	174
Peak Hour Factor	0.91	0.91	0.88	0.88	0.69	0.69
Hourly flow rate (vph)	0	764	652	0	174	252
Pedestrians		167				
Lane Width (ft)		10.0				
Walking Speed (ft/s)		4.0				
Percent Blockage		12				
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)		505				
pX, platoon unblocked						
vC, conflicting volume	652				1034	819
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	652				1034	819
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				24	11
cM capacity (veh/h)	930				230	283

Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2
Volume Total	382	382	652	174	252
Volume Left	0	0	0	174	0
Volume Right	0	0	0	0	252
cSH	1700	1700	1700	230	283
Volume to Capacity	0.22	0.22	0.38	0.76	0.89
Queue Length 95th (ft)	0	0	0	133	199
Control Delay (s)	0.0	0.0	0.0	57.4	68.4
Lane LOS				F	F
Approach Delay (s)	0.0		0.0	63.9	
Approach LOS				F	

Intersection Summary			
Average Delay	14.8		
Intersection Capacity Utilization	63.5%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	320	495	574	216	0	0
Peak Hour Factor	0.91	0.91	0.88	0.88	0.92	0.92
Hourly flow rate (vph)	352	544	652	245	0	0
Pedestrians					293	
Lane Width (ft)					0.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)		643				
pX, platoon unblocked						
vC, conflicting volume	1191				2043	1068
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1191				2043	1068
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	40				100	100
cM capacity (veh/h)	582				19	218

Direction, Lane #	EB 1	EB 2	WB 1
Volume Total	533	363	898
Volume Left	352	0	0
Volume Right	0	0	245
cSH	582	1700	1700
Volume to Capacity	0.60	0.21	0.53
Queue Length 95th (ft)	100	0	0
Control Delay (s)	17.9	0.0	0.0
Lane LOS	C		
Approach Delay (s)	10.7		0.0
Approach LOS			

Intersection Summary			
Average Delay	5.3		
Intersection Capacity Utilization	91.4%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	52	22	71	340	538	144
Peak Hour Factor	0.72	0.72	0.86	0.86	0.84	0.84
Hourly flow rate (vph)	72	31	83	395	640	171
Pedestrians	73			8	18	
Lane Width (ft)	12.0			16.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	6			1	2	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1378	807	885			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1378	807	885			
tC, single (s)	6.5	6.3	4.2			
tC, 2 stage (s)						
tF (s)	3.6	3.4	2.3			
p0 queue free %	42	91	88			
cM capacity (veh/h)	126	345	691			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	72	31	478	812
Volume Left	72	0	83	0
Volume Right	0	31	0	171
cSH	126	345	691	1700
Volume to Capacity	0.58	0.09	0.12	0.48
Queue Length 95th (ft)	71	7	10	0
Control Delay (s)	66.8	16.4	3.3	0.0
Lane LOS	F	C	A	
Approach Delay (s)	51.8		3.3	0.0
Approach LOS	F			

Intersection Summary			
Average Delay	5.0		
Intersection Capacity Utilization	82.2%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	37	396	296	386	0	0	0	0	391	0	0	0
Peak Hour Factor	0.81	0.81	0.81	0.83	0.83	0.83	0.76	0.76	0.76	0.25	0.25	0.25
Hourly flow rate (vph)	46	489	365	465	0	0	0	0	514	0	0	0
Pedestrians					57			100			57	
Lane Width (ft)					12.0			16.0			0.0	
Walking Speed (ft/s)					4.0			4.0			4.0	
Percent Blockage					5			11			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	57			954			1610	1667	646	2139	2033	57
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	57			954			1610	1667	646	2139	2033	57
tC, single (s)	4.2			4.1			7.1	6.5	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.3			2.2			3.5	4.0	3.4	3.5	4.0	3.3
p0 queue free %	97			26			100	100	0	0	100	100
cM capacity (veh/h)	1498			630			27	22	385	0	13	1015

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	NB 1
Volume Total	46	489	365	465	514
Volume Left	46	0	0	465	0
Volume Right	0	0	365	0	514
cSH	1498	1700	1700	630	385
Volume to Capacity	0.03	0.29	0.21	0.74	1.34
Queue Length 95th (ft)	2	0	0	161	605
Control Delay (s)	7.5	0.0	0.0	25.1	197.0
Lane LOS	A			D	F
Approach Delay (s)	0.4			25.1	197.0
Approach LOS					F

Intersection Summary			
Average Delay	60.3		
Intersection Capacity Utilization	61.1%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	53	24	105	110	5	21
Peak Hour Factor	0.78	0.78	0.83	0.83	0.92	0.92
Hourly flow rate (vph)	68	31	127	133	5	23
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)	937					
pX, platoon unblocked						
vC, conflicting volume			99		469	83
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			99		469	83
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			92		99	98
cM capacity (veh/h)			1494		506	976

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	99	259	28
Volume Left	0	127	5
Volume Right	31	0	23
cSH	1700	1494	828
Volume to Capacity	0.06	0.08	0.03
Queue Length 95th (ft)	0	7	3
Control Delay (s)	0.0	4.1	9.5
Lane LOS		A	A
Approach Delay (s)	0.0	4.1	9.5
Approach LOS			A

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	29.6%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis | Weekday Evening Peak Hour
1: Blackfan Circle & Longwood Avenue | 2022 Build Condition

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Lane Width	10	10	10	10	10	10	14	14	14	10	10	10
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.98			0.95		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00			0.98		0.95	1.00	
Satd. Flow (prot)	1330	1315		1233	1223			1493		1330	1225	
Flt Permitted	0.43	1.00		0.27	1.00			0.14		0.54	1.00	
Satd. Flow (perm)	605	1315		356	1223			208		757	1225	
Volume (vph)	71	480	82	28	368	53	69	37	57	179	57	281
Peak-hour factor, PHF	0.82	0.82	0.82	0.95	0.95	0.95	0.81	0.81	0.81	0.86	0.86	0.86
Adj. Flow (vph)	87	585	100	29	387	56	85	46	70	208	66	327
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	87	685	0	29	443	0	0	201	0	208	393	0
Heavy Vehicles (%)	2%	2%	2%	10%	10%	10%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	10	0	0	10	0	0	0	0	0	0	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		1			1			5			5	
Permitted Phases	1	1		1	1		5	5		5	5	
Actuated Green, G (s)	74.4	74.4		74.4	74.4			26.0		26.0	26.0	
Effective Green, g (s)	74.4	74.4		74.4	74.4			26.0		26.0	26.0	
Actuated g/C Ratio	0.62	0.62		0.62	0.62			0.22		0.22	0.22	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)	375	815		221	758			45		164	265	
v/s Ratio Prot		c0.52			0.36						0.32	
v/s Ratio Perm	0.14			0.08				c0.97		0.27		
v/c Ratio	0.23	0.84		0.13	0.58			4.47		1.27	1.48	
Uniform Delay, d1	10.1	18.1		9.4	13.6			47.0		47.0	47.0	
Progression Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2	1.4	10.2		1.2	3.3			1609.9		159.9	236.5	
Delay (s)	11.6	28.3		10.7	16.9			1656.9		206.9	283.5	
Level of Service	B	C		B	B			F		F	F	
Approach Delay (s)		26.4			16.5			1656.9			257.0	
Approach LOS		C			B			F			F	

Intersection Summary			
HCM Average Control Delay	252.0	HCM Level of Service	F
HCM Volume to Capacity ratio	1.78		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	19.6
Intersection Capacity Utilization	95.9%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis | Weekday Evening Peak Hour
2: Longwood Avenue & Avenue Louis Pasteur | 2022 Build Condition

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	0	715	272	0	139	177
Peak Hour Factor	0.97	0.97	0.90	0.90	0.92	0.92
Hourly flow rate (vph)	0	737	302	0	151	192
Pedestrians		169				
Lane Width (ft)		10.0				
Walking Speed (ft/s)		4.0				
Percent Blockage		12				
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)		505				
pX, platoon unblocked						
vC, conflicting volume	302				671	471
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	302				671	471
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				61	60
cM capacity (veh/h)	1256				392	478

Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2
Volume Total	369	369	302	151	192
Volume Left	0	0	0	151	0
Volume Right	0	0	0	0	192
cSH	1700	1700	1700	392	478
Volume to Capacity	0.22	0.22	0.18	0.39	0.40
Queue Length 95th (ft)	0	0	0	44	48
Control Delay (s)	0.0	0.0	0.0	19.8	17.5
Lane LOS				C	C
Approach Delay (s)	0.0		0.0	18.5	
Approach LOS				C	

Intersection Summary			
Average Delay	4.6		
Intersection Capacity Utilization	44.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	198	656	272	71	0	0
Peak Hour Factor	0.97	0.97	0.90	0.90	0.92	0.92
Hourly flow rate (vph)	204	676	302	79	0	0
Pedestrians					327	
Lane Width (ft)					0.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)		643				
pX, platoon unblocked						
vC, conflicting volume	708				1415	669
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	708				1415	669
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	77				100	100
cM capacity (veh/h)	886				99	400

Direction, Lane #	EB 1	EB 2	WB 1
Volume Total	430	451	381
Volume Left	204	0	0
Volume Right	0	0	79
cSH	886	1700	1700
Volume to Capacity	0.23	0.27	0.22
Queue Length 95th (ft)	22	0	0
Control Delay (s)	6.3	0.0	0.0
Lane LOS	A		
Approach Delay (s)	3.1		0.0
Approach LOS			

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	61.3%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	177	61	18	152	315	58
Peak Hour Factor	0.87	0.87	0.96	0.96	0.87	0.87
Hourly flow rate (vph)	203	70	19	158	362	67
Pedestrians	129			3	25	
Lane Width (ft)	12.0			16.0	16.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	11			0	3	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	745	527	558			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	745	527	558			
tC, single (s)	6.4	6.2	4.2			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.3			
p0 queue free %	37	86	98			
cM capacity (veh/h)	325	492	861			

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total	203	70	177	429
Volume Left	203	0	19	0
Volume Right	0	70	0	67
cSH	325	492	861	1700
Volume to Capacity	0.63	0.14	0.02	0.25
Queue Length 95th (ft)	99	12	2	0
Control Delay (s)	32.9	13.5	1.2	0.0
Lane LOS	D	B	A	
Approach Delay (s)	28.0		1.2	0.0
Approach LOS	D			

Intersection Summary			
Average Delay	8.9		
Intersection Capacity Utilization	43.4%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
5: Fenway & Avenue Louis Pasteur

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	58	520	114	259	0	0	0	0	329	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.86	0.86	0.86	0.96	0.96	0.96	0.25	0.25	0.25
Hourly flow rate (vph)	63	565	124	301	0	0	0	0	343	0	0	0
Pedestrians					117			163			117	
Lane Width (ft)					12.0			16.0			0.0	
Walking Speed (ft/s)					4.0			4.0			4.0	
Percent Blockage					10			18			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	117			852			1457	1574	845	1870	1698	117
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	117			852			1457	1574	845	1870	1698	117
tC, single (s)	4.1			4.1			7.1	6.5	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.4	3.5	4.0	3.3
p0 queue free %	96			52			100	100	0	0	100	100
cM capacity (veh/h)	1465			634			47	46	258	0	38	941

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	NB 1
Volume Total	63	565	124	301	343
Volume Left	63	0	0	301	0
Volume Right	0	0	124	0	343
cSH	1465	1700	1700	634	258
Volume to Capacity	0.04	0.33	0.07	0.48	1.33
Queue Length 95th (ft)	3	0	0	64	445
Control Delay (s)	7.6	0.0	0.0	15.7	209.7
Lane LOS	A			C	F
Approach Delay (s)	0.6			15.7	209.7
Approach LOS					F

Intersection Summary			
Average Delay	55.2		
Intersection Capacity Utilization	66.1%	ICU Level of Service	C
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
6: Blackfan St & Site Driveway

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	152	2	18	58	30	86
Peak Hour Factor	0.83	0.83	0.78	0.78	0.92	0.92
Hourly flow rate (vph)	183	2	23	74	33	93
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)	925					
pX, platoon unblocked						
vC, conflicting volume			186		305	184
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			186		305	184
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		95	89
cM capacity (veh/h)			1389		676	858

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	186	97	126
Volume Left	0	23	33
Volume Right	2	0	93
cSH	1700	1389	802
Volume to Capacity	0.11	0.02	0.16
Queue Length 95th (ft)	0	1	14
Control Delay (s)	0.0	1.9	10.3
Lane LOS		A	B
Approach Delay (s)	0.0	1.9	10.3
Approach LOS			B

Intersection Summary			
Average Delay	3.6		
Intersection Capacity Utilization	31.3%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix D

Wind

DRAWING LIST FOR MODEL CONSTRUCTION

The drawings and information listed below were received from NBBJ and were used to construct the scale model of the proposed BWH 2012 IMP Amendment Project. Should there be any design changes that deviate from this list of drawings, the results may change.

File Name	File Type	Date Received (dd/mm/yyyy)
BWH_alumnae_hall_site_model_01_012312.skp	SketchUp	24/01/2012
Ground floor plan option-w traffic and entry.jpg	Jpeg Image	25/01/2012
BWH_alumnae_hall_site_model_-currenta	SketchUp	20/02/2012
120214_IMP report model revise	SketchUp	20/02/2012

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
1	A	Spring	11		Sitting	16		Acceptable
		Summer	9		Sitting	13		Acceptable
		Fall	10		Sitting	15		Acceptable
		Winter	10		Sitting	15		Acceptable
		Annual	10		Sitting	15		Acceptable
	B	Spring	12		Sitting	18	+13%	Acceptable
		Summer	9		Sitting	14		Acceptable
		Fall	11	+10%	Sitting	17	+13%	Acceptable
		Winter	12	+20%	Sitting	19	+27%	Acceptable
		Annual	11	+10%	Sitting	18	+20%	Acceptable
2	A	Spring	11		Sitting	16		Acceptable
		Summer	9		Sitting	13		Acceptable
		Fall	11		Sitting	16		Acceptable
		Winter	10		Sitting	16		Acceptable
		Annual	11		Sitting	16		Acceptable
	B	Spring	12		Sitting	17		Acceptable
		Summer	11	+22%	Sitting	14		Acceptable
		Fall	12		Sitting	16		Acceptable
		Winter	11	+10%	Sitting	16		Acceptable
		Annual	12		Sitting	16		Acceptable
3	A	Spring	16		Walking	22		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	16		Walking	23		Acceptable
		Annual	16		Walking	22		Acceptable
	B	Spring	19	+19%	Walking	27	+23%	Acceptable
		Summer	15	+15%	Standing	21	+17%	Acceptable
		Fall	18	+20%	Walking	25	+19%	Acceptable
		Winter	21	+31%	Uncomfortable	29	+26%	Acceptable
		Annual	19	+19%	Walking	26	+18%	Acceptable
4	A	Spring	9		Sitting	15		Acceptable
		Summer	7		Sitting	12		Acceptable
		Fall	8		Sitting	14		Acceptable
		Winter	9		Sitting	16		Acceptable
		Annual	9		Sitting	14		Acceptable
	B	Spring	15	+67%	Standing	22	+47%	Acceptable
		Summer	12	+71%	Sitting	17	+42%	Acceptable
		Fall	14	+75%	Standing	20	+43%	Acceptable
		Winter	16	+78%	Walking	23	+44%	Acceptable
		Annual	14	+56%	Standing	21	+50%	Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			**Mean Wind Speed**			**Effective Gust Wind Speed**		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
5	A	Spring	11		Sitting	17		Acceptable
		Summer	9		Sitting	14		Acceptable
		Fall	11		Sitting	16		Acceptable
		Winter	12		Sitting	18		Acceptable
		Annual	11		Sitting	17		Acceptable
	B	Spring	14	+27%	Standing	19	+12%	Acceptable
		Summer	11	+22%	Sitting	16	+14%	Acceptable
		Fall	13	+18%	Standing	19	+19%	Acceptable
		Winter	13		Standing	20	+11%	Acceptable
		Annual	13	+18%	Standing	19	+12%	Acceptable
6	A	Spring	14		Standing	21		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	14		Standing	20		Acceptable
	B	Spring	15		Standing	21		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	16		Walking	22		Acceptable
		Annual	14		Standing	21		Acceptable
7	A	Spring	8		Sitting	13		Acceptable
		Summer	7		Sitting	11		Acceptable
		Fall	8		Sitting	13		Acceptable
		Winter	8		Sitting	13		Acceptable
		Annual	8		Sitting	13		Acceptable
	B	Spring	13	+63%	Standing	20	+54%	Acceptable
		Summer	10	+43%	Sitting	15	+36%	Acceptable
		Fall	12	+50%	Sitting	18	+38%	Acceptable
		Winter	14	+75%	Standing	20	+54%	Acceptable
		Annual	13	+63%	Standing	18	+38%	Acceptable
8	A	Spring	10		Sitting	15		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	10		Sitting	15		Acceptable
		Winter	10		Sitting	15		Acceptable
		Annual	10		Sitting	15		Acceptable
	B	Spring	11	+10%	Sitting	16		Acceptable
		Summer	9	+13%	Sitting	13		Acceptable
		Fall	11	+10%	Sitting	16		Acceptable
		Winter	11	+10%	Sitting	16		Acceptable
		Annual	10		Sitting	16		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

<u>Configurations</u>

A - Existing
B – Build

<u>Mean Wind Speed Criteria</u>

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

<u>Effective Gust Criteria</u>

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
9	A	Spring	8		Sitting	12		Acceptable
		Summer	7		Sitting	10		Acceptable
		Fall	8		Sitting	12		Acceptable
		Winter	8		Sitting	12		Acceptable
		Annual	8		Sitting	12		Acceptable
	B	Spring	12	+50%	Sitting	18	+50%	Acceptable
		Summer	9	+29%	Sitting	13	+30%	Acceptable
		Fall	12	+50%	Sitting	17	+42%	Acceptable
		Winter	13	+63%	Standing	18	+50%	Acceptable
		Annual	12	+50%	Sitting	17	+42%	Acceptable
10	A	Spring	3		Sitting	5		Acceptable
		Summer	3		Sitting	4		Acceptable
		Fall	3		Sitting	5		Acceptable
		Winter	4		Sitting	6		Acceptable
		Annual	3		Sitting	5		Acceptable
	B	Spring	11	+267%	Sitting	17	+240%	Acceptable
		Summer	8	+167%	Sitting	13	+225%	Acceptable
		Fall	10	+233%	Sitting	16	+220%	Acceptable
		Winter	11	+175%	Sitting	17	+183%	Acceptable
		Annual	10	+233%	Sitting	16	+220%	Acceptable
11	A	Spring	15		Standing	21		Acceptable
		Summer	13		Standing	17		Acceptable
		Fall	15		Standing	20		Acceptable
		Winter	14		Standing	20		Acceptable
		Annual	14		Standing	20		Acceptable
	B	Spring	17	+13%	Walking	23	+10%	Acceptable
		Summer	14		Standing	19	+12%	Acceptable
		Fall	16		Walking	22	+10%	Acceptable
		Winter	16	+14%	Walking	23	+15%	Acceptable
		Annual	16	+14%	Walking	22	+10%	Acceptable
12	A	Spring	13		Standing	19		Acceptable
		Summer	9		Sitting	14		Acceptable
		Fall	11		Sitting	18		Acceptable
		Winter	12		Sitting	19		Acceptable
		Annual	12		Sitting	18		Acceptable
	B	Spring	9	-30%	Sitting	14	-25%	Acceptable
		Summer	8	-10%	Sitting	11	-20%	Acceptable
		Fall	9	-17%	Sitting	13	-27%	Acceptable
		Winter	9	-24%	Sitting	14	-25%	Acceptable
		Annual	9	-24%	Sitting	13	-27%	Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
13	A	Spring	4		Sitting	7		Acceptable
		Summer	3		Sitting	5		Acceptable
		Fall	4		Sitting	6		Acceptable
		Winter	4		Sitting	7		Acceptable
		Annual	4		Sitting	6		Acceptable
	B	Spring	9	+125%	Sitting	13	+86%	Acceptable
		Summer	7	+133%	Sitting	11	+120%	Acceptable
		Fall	8	+100%	Sitting	12	+100%	Acceptable
		Winter	9	+125%	Sitting	13	+86%	Acceptable
		Annual	8	+100%	Sitting	13	+116%	Acceptable
14	A	Spring	4		Sitting	6		Acceptable
		Summer	3		Sitting	4		Acceptable
		Fall	3		Sitting	5		Acceptable
		Winter	4		Sitting	6		Acceptable
		Annual	4		Sitting	6		Acceptable
	B	Spring	10	+150%	Sitting	14	+133%	Acceptable
		Summer	8	+167%	Sitting	12	+200%	Acceptable
		Fall	9	+200%	Sitting	14	+180%	Acceptable
		Winter	10	+150%	Sitting	14	+133%	Acceptable
		Annual	10	+150%	Sitting	14	+133%	Acceptable
15	A	Spring	17		Walking	23		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	17		Walking	24		Acceptable
		Annual	16		Walking	23		Acceptable
	B	Spring	15	-11%	Standing	22		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	16		Walking	23		Acceptable
		Annual	15		Standing	22		Acceptable
16	A	Spring	14		Standing	21		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	14		Standing	21		Acceptable
	B	Spring	14		Standing	21		Acceptable
		Summer	11		Sitting	17		Acceptable
		Fall	13		Standing	20		Acceptable
		Winter	14		Standing	22		Acceptable
		Annual	13		Standing	21		Acceptable

Notes:
1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
17	A	Spring	12		Sitting	18		Acceptable
		Summer	9		Sitting	14		Acceptable
		Fall	12		Sitting	17		Acceptable
		Winter	13		Standing	19		Acceptable
		Annual	12		Sitting	17		Acceptable
	B	Spring	11		Sitting	17		Acceptable
		Summer	8	-10%	Sitting	13		Acceptable
		Fall	10	-16%	Sitting	16		Acceptable
		Winter	11	-14%	Sitting	17	-10%	Acceptable
		Annual	10	-16%	Sitting	16		Acceptable
18	A	Spring	17		Walking	24		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	18		Walking	24		Acceptable
		Annual	16		Walking	23		Acceptable
	B	Spring	13	-23%	Standing	18	-24%	Acceptable
		Summer	11	-14%	Sitting	15	-16%	Acceptable
		Fall	12	-24%	Sitting	17	-22%	Acceptable
		Winter	12	-32%	Sitting	18	-24%	Acceptable
		Annual	12	-24%	Sitting	18	-21%	Acceptable
19	A	Spring	10		Sitting	15		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	10		Sitting	15		Acceptable
		Winter	10		Sitting	16		Acceptable
		Annual	10		Sitting	15		Acceptable
	B	Spring	11	+10%	Sitting	17	+13%	Acceptable
		Summer	9	+13%	Sitting	13		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11	+10%	Sitting	16		Acceptable
		Annual	11	+10%	Sitting	16		Acceptable
20	A	Spring	11		Sitting	18		Acceptable
		Summer	9		Sitting	14		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	17		Acceptable
		Annual	11		Sitting	17		Acceptable
	B	Spring	12		Sitting	19		Acceptable
		Summer	9		Sitting	15		Acceptable
		Fall	11	+10%	Sitting	17		Acceptable
		Winter	11		Sitting	18		Acceptable
		Annual	11		Sitting	17		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
21	A	Spring	8		Sitting	13		Acceptable
		Summer	7		Sitting	11		Acceptable
		Fall	8		Sitting	12		Acceptable
		Winter	8		Sitting	13		Acceptable
		Annual	8		Sitting	13		Acceptable
	B	Spring	8		Sitting	13		Acceptable
		Summer	6	-13%	Sitting	10		Acceptable
		Fall	7	-12%	Sitting	12		Acceptable
		Winter	8		Sitting	13		Acceptable
		Annual	7	-12%	Sitting	12		Acceptable
22	A	Spring	14		Standing	21		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	14		Standing	21		Acceptable
	B	Spring	14		Standing	21		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	13		Standing	20		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	13		Standing	20		Acceptable
23	A	Spring	14		Standing	21		Acceptable
		Summer	11		Sitting	17		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	13		Standing	20		Acceptable
	B	Spring	14		Standing	21		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	13		Standing	19		Acceptable
24	A	Spring	16		Walking	23		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	16		Walking	23		Acceptable
		Annual	15		Standing	22		Acceptable
	B	Spring	16		Walking	23		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	15		Standing	23		Acceptable
		Annual	14		Standing	21		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

<u>Configurations</u>

A - Existing
B – Build

<u>Mean Wind Speed Criteria</u>

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

<u>Effective Gust Criteria</u>

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			**Mean Wind Speed**			**Effective Gust Wind Speed**		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
25	A	Spring	14		Standing	19		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	13		Standing	18		Acceptable
		Winter	14		Standing	20		Acceptable
		Annual	13		Standing	19		Acceptable
	B	Spring	14		Standing	19		Acceptable
		Summer	11		Sitting	15		Acceptable
		Fall	13		Standing	18		Acceptable
		Winter	14		Standing	19		Acceptable
		Annual	13		Standing	18		Acceptable
26	A	Spring	13		Standing	19		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	13		Standing	19		Acceptable
		Annual	12		Sitting	19		Acceptable
	B	Spring	13		Standing	19		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	13		Standing	19		Acceptable
		Annual	12		Sitting	19		Acceptable
27	A	Spring	17		Walking	24		Acceptable
		Summer	14		Standing	20		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	17		Walking	24		Acceptable
		Annual	16		Walking	23		Acceptable
	B	Spring	18		Walking	24		Acceptable
		Summer	15		Standing	20		Acceptable
		Fall	17		Walking	23		Acceptable
		Winter	17		Walking	24		Acceptable
		Annual	17		Walking	23		Acceptable
28	A	Spring	15		Standing	22		Acceptable
		Summer	11		Sitting	17		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	14		Standing	21		Acceptable
	B	Spring	15		Standing	23		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	15		Standing	23		Acceptable
		Annual	14		Standing	21		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
29	A	Spring	14		Standing	21		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	13		Standing	20		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	13		Standing	20		Acceptable
	B	Spring	13		Standing	20		Acceptable
		Summer	11		Sitting	17		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	13		Standing	20		Acceptable
		Annual	13		Standing	20		Acceptable
30	A	Spring	14		Standing	21		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	13		Standing	20		Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	14		Standing	21		Acceptable
	B	Spring	14		Standing	20		Acceptable
		Summer	11		Sitting	17		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	13	-12%	Standing	20		Acceptable
		Annual	13		Standing	19		Acceptable
31	A	Spring	16		Walking	23		Acceptable
		Summer	13		Standing	19		Acceptable
		Fall	15		Standing	22		Acceptable
		Winter	16		Walking	24		Acceptable
		Annual	16		Walking	23		Acceptable
	B	Spring	14	-12%	Standing	21		Acceptable
		Summer	12		Sitting	17	-10%	Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	14	-12%	Standing	21	-12%	Acceptable
		Annual	14	-12%	Standing	20	-12%	Acceptable
32	A	Spring	15		Standing	22		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	16		Walking	23		Acceptable
		Annual	15		Standing	22		Acceptable
	B	Spring	13	-12%	Standing	20		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	14	-12%	Standing	20	-12%	Acceptable
		Annual	13	-12%	Standing	19	-13%	Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations	Mean Wind Speed Criteria		Effective Gust Criteria	
A - Existing	Comfortable for Sitting:	≤ 12 mph	Acceptable:	≤ 31 mph
B – Build	Comfortable for Standing:	> 12 and ≤ 15 mph	Unacceptable:	> 31 mph
	Comfortable for Walking:	> 15 and ≤ 19 mph		
	Uncomfortable for Walking:	> 19 and ≤ 27 mph		
	Dangerous Conditions:	> 27 mph		

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
33	A	Spring	11		Sitting	16		Acceptable
		Summer	9		Sitting	14		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	17		Acceptable
		Annual	10		Sitting	16		Acceptable
	B	Spring	11		Sitting	16		Acceptable
		Summer	9		Sitting	13		Acceptable
		Fall	10		Sitting	15		Acceptable
		Winter	10		Sitting	16		Acceptable
		Annual	10		Sitting	16		Acceptable
34	A	Spring	8		Sitting	13		Acceptable
		Summer	6		Sitting	10		Acceptable
		Fall	8		Sitting	12		Acceptable
		Winter	8		Sitting	13		Acceptable
		Annual	8		Sitting	13		Acceptable
	B	Spring	7	-12%	Sitting	12		Acceptable
		Summer	6		Sitting	9		Acceptable
		Fall	7	-12%	Sitting	11		Acceptable
		Winter	7	-12%	Sitting	12		Acceptable
		Annual	7	-12%	Sitting	11	-14%	Acceptable
35	A	Spring	11		Sitting	17		Acceptable
		Summer	9		Sitting	14		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	18		Acceptable
		Annual	10		Sitting	16		Acceptable
	B	Spring	11		Sitting	17		Acceptable
		Summer	8	-10%	Sitting	13		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	17		Acceptable
		Annual	10		Sitting	16		Acceptable
36	A	Spring	14		Standing	22		Acceptable
		Summer	12		Sitting	19		Acceptable
		Fall	13		Standing	21		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	13		Standing	21		Acceptable
	B	Spring	15		Standing	22		Acceptable
		Summer	12		Sitting	19		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	14		Standing	21		Acceptable

Notes:
1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			**Mean Wind Speed**			**Effective Gust Wind Speed**		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
37	A	Spring	13		Standing	20		Acceptable
		Summer	11		Sitting	17		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	13		Standing	20		Acceptable
		Annual	12		Sitting	19		Acceptable
	B	Spring	13		Standing	20		Acceptable
		Summer	11		Sitting	17		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	13		Standing	20		Acceptable
		Annual	12		Sitting	19		Acceptable
38	A	Spring	12		Sitting	19		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	11		Sitting	18		Acceptable
		Winter	13		Standing	21		Acceptable
		Annual	12		Sitting	19		Acceptable
	B	Spring	12		Sitting	19		Acceptable
		Summer	9		Sitting	15		Acceptable
		Fall	11		Sitting	18		Acceptable
		Winter	13		Standing	21		Acceptable
		Annual	12		Sitting	19		Acceptable
39	A	Spring	13		Standing	19		Acceptable
		Summer	10		Sitting	16		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	13		Standing	21		Acceptable
		Annual	12		Sitting	19		Acceptable
	B	Spring	13		Standing	19		Acceptable
		Summer	10		Sitting	16		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	13		Standing	21		Acceptable
		Annual	12		Sitting	19		Acceptable
40	A	Spring	10		Sitting	16		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	16		Acceptable
		Annual	10		Sitting	16		Acceptable
	B	Spring	11	+10%	Sitting	16		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	17		Acceptable
		Annual	10		Sitting	16		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

CONSULTING ENGINEERS & SCIENTISTS

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
41	A	Spring	12		Sitting	19		Acceptable
		Summer	10		Sitting	16		Acceptable
		Fall	11		Sitting	18		Acceptable
		Winter	11		Sitting	18		Acceptable
		Annual	12		Sitting	18		Acceptable
	B	Spring	12		Sitting	19		Acceptable
		Summer	10		Sitting	16		Acceptable
		Fall	11		Sitting	18		Acceptable
		Winter	11		Sitting	18		Acceptable
		Annual	11		Sitting	18		Acceptable
42	A	Spring	14		Standing	22		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	16		Walking	24		Acceptable
		Annual	14		Standing	22		Acceptable
	B	Spring	14		Standing	20		Acceptable
		Summer	11		Sitting	16	-10%	Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	15		Standing	21	-12%	Acceptable
		Annual	13		Standing	20		Acceptable
43	A	Spring	13		Standing	21		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	14		Standing	22		Acceptable
		Annual	13		Standing	20		Acceptable
	B	Spring	11	-14%	Sitting	17	-18%	Acceptable
		Summer	8	-26%	Sitting	13	-18%	Acceptable
		Fall	10	-16%	Sitting	15	-20%	Acceptable
		Winter	11	-20%	Sitting	17	-22%	Acceptable
		Annual	10	-22%	Sitting	16	-19%	Acceptable
44	A	Spring	12		Sitting	18		Acceptable
		Summer	10		Sitting	14		Acceptable
		Fall	11		Sitting	17		Acceptable
		Winter	13		Standing	19		Acceptable
		Annual	12		Sitting	18		Acceptable
	B	Spring	12		Sitting	17		Acceptable
		Summer	9		Sitting	13		Acceptable
		Fall	11		Sitting	16		Acceptable
		Winter	12		Sitting	18		Acceptable
		Annual	11		Sitting	16	-10%	Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

<u>Configurations</u>

A - Existing
B – Build

<u>Mean Wind Speed Criteria</u>

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

<u>Effective Gust Criteria</u>

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

CONSULTING ENGINEERS & SCIENTISTS

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
45	A	Spring	12		Sitting	17		Acceptable
		Summer	9		Sitting	13		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	17		Acceptable
		Annual	11		Sitting	16		Acceptable
	B	Spring	11		Sitting	17		Acceptable
		Summer	8	-10%	Sitting	13		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	17		Acceptable
		Annual	10		Sitting	16		Acceptable
46	A	Spring	13		Standing	19		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	13		Standing	20		Acceptable
		Annual	12		Sitting	18		Acceptable
	B	Spring	13		Standing	19		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	11		Sitting	17		Acceptable
		Winter	12		Sitting	19		Acceptable
		Annual	11		Sitting	18		Acceptable
47	A	Spring	13		Standing	19		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	13		Standing	20		Acceptable
	B	Spring	13		Standing	20		Acceptable
		Summer	10		Sitting	16		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	14		Standing	22		Acceptable
		Annual	13		Standing	20		Acceptable
48	A	Spring	15		Standing	23		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	14		Standing	22		Acceptable
		Winter	16		Walking	25		Acceptable
		Annual	15		Standing	23		Acceptable
	B	Spring	17	+13%	Walking	24		Acceptable
		Summer	13		Standing	19		Acceptable
		Fall	16	+14%	Walking	23		Acceptable
		Winter	18	+13%	Walking	26		Acceptable
		Annual	16		Walking	24		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
49	A	Spring	15		Standing	23		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	14		Standing	22		Acceptable
		Winter	16		Walking	25		Acceptable
		Annual	15		Standing	23		Acceptable
	B	Spring	18	+20%	Walking	25		Acceptable
		Summer	14	+17%	Standing	20	+11%	Acceptable
		Fall	17	+21%	Walking	23		Acceptable
		Winter	19	+19%	Walking	26		Acceptable
		Annual	17	+13%	Walking	25		Acceptable
50	A	Spring	13		Standing	20		Acceptable
		Summer	10		Sitting	16		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	14		Standing	22		Acceptable
		Annual	13		Standing	20		Acceptable
	B	Spring	15	+15%	Standing	21		Acceptable
		Summer	12	+20%	Sitting	17		Acceptable
		Fall	14	+17%	Standing	20		Acceptable
		Winter	16	+14%	Walking	23		Acceptable
		Annual	14		Standing	21		Acceptable
51	A	Spring	13		Standing	19		Acceptable
		Summer	10		Sitting	16		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	13		Standing	20		Acceptable
		Annual	12		Sitting	19		Acceptable
	B	Spring	15	+15%	Standing	22	+16%	Acceptable
		Summer	12	+20%	Sitting	18	+13%	Acceptable
		Fall	14	+17%	Standing	21	+11%	Acceptable
		Winter	16	+23%	Walking	23	+15%	Acceptable
		Annual	15	+25%	Standing	22	+16%	Acceptable
52	A	Spring	15		Standing	22		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	16		Walking	22		Acceptable
		Annual	15		Standing	21		Acceptable
	B	Spring	16		Walking	22		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	16		Walking	23		Acceptable
		Annual	15		Standing	22		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

CONSULTING ENGINEERS & SCIENTISTS

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
53	A	Spring	14		Standing	21		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	15		Standing	23		Acceptable
		Annual	15		Standing	21		Acceptable
	B	Spring	15		Standing	22		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	17	+13%	Walking	23		Acceptable
		Annual	16		Walking	22		Acceptable
54	A	Spring	14		Standing	20		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	14		Standing	20		Acceptable
	B	Spring	15		Standing	21		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	21	+11%	Acceptable
		Winter	16		Walking	23		Acceptable
		Annual	15		Standing	22	+10%	Acceptable
55	A	Spring	17		Walking	23		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	16		Walking	23		Acceptable
		Winter	18		Walking	25		Acceptable
		Annual	17		Walking	24		Acceptable
	B	Spring	17		Walking	24		Acceptable
		Summer	14		Standing	19		Acceptable
		Fall	17		Walking	23		Acceptable
		Winter	18		Walking	25		Acceptable
		Annual	17		Walking	24		Acceptable
56	A	Spring	15		Standing	22		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	16		Walking	22		Acceptable
		Annual	15		Standing	21		Acceptable
	B	Spring	16		Walking	22		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	22		Acceptable
		Winter	17		Walking	23		Acceptable
		Annual	16		Walking	22		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations	Mean Wind Speed Criteria		Effective Gust Criteria	
A - Existing	Comfortable for Sitting:	≤ 12 mph	Acceptable:	≤ 31 mph
B – Build	Comfortable for Standing:	> 12 and ≤ 15 mph	Unacceptable:	> 31 mph
	Comfortable for Walking:	> 15 and ≤ 19 mph		
	Uncomfortable for Walking:	> 19 and ≤ 27 mph		
	Dangerous Conditions:	> 27 mph		

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
57	A	Spring	17		Walking	23		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	18		Walking	25		Acceptable
		Annual	17		Walking	23		Acceptable
	B	Spring	17		Walking	24		Acceptable
		Summer	14		Standing	19		Acceptable
		Fall	17		Walking	23		Acceptable
		Winter	18		Walking	25		Acceptable
		Annual	17		Walking	24		Acceptable
58	A	Spring	18		Walking	25		Acceptable
		Summer	14		Standing	20		Acceptable
		Fall	17		Walking	24		Acceptable
		Winter	19		Walking	26		Acceptable
		Annual	18		Walking	25		Acceptable
	B	Spring	18		Walking	24		Acceptable
		Summer	14		Standing	19		Acceptable
		Fall	17		Walking	23		Acceptable
		Winter	19		Walking	26		Acceptable
		Annual	18		Walking	25		Acceptable
59	A	Spring	17		Walking	23		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	18		Walking	25		Acceptable
		Annual	17		Walking	23		Acceptable
	B	Spring	16		Walking	22		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	17		Walking	24		Acceptable
		Annual	16		Walking	22		Acceptable
60	A	Spring	17		Walking	24		Acceptable
		Summer	13		Standing	19		Acceptable
		Fall	16		Walking	23		Acceptable
		Winter	18		Walking	26		Acceptable
		Annual	17		Walking	24		Acceptable
	B	Spring	16		Walking	23		Acceptable
		Summer	13		Standing	19		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	18		Walking	25		Acceptable
		Annual	17		Walking	24		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations	Mean Wind Speed Criteria		Effective Gust Criteria	
A - Existing	Comfortable for Sitting:	≤ 12 mph	Acceptable:	≤ 31 mph
B – Build	Comfortable for Standing:	> 12 and ≤ 15 mph	Unacceptable:	> 31 mph
	Comfortable for Walking:	> 15 and ≤ 19 mph		
	Uncomfortable for Walking:	> 19 and ≤ 27 mph		
	Dangerous Conditions:	> 27 mph		

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
61	A	Spring	16		Walking	23		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	22		Acceptable
		Winter	17		Walking	24		Acceptable
		Annual	16		Walking	23		Acceptable
	B	Spring	17		Walking	24		Acceptable
		Summer	14		Standing	19		Acceptable
		Fall	17	+13%	Walking	23		Acceptable
		Winter	18		Walking	25		Acceptable
		Annual	17		Walking	24		Acceptable
62	A	Spring	16		Walking	23		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	17		Walking	23		Acceptable
		Annual	16		Walking	22		Acceptable
	B	Spring	15		Standing	21		Acceptable
		Summer	12		Sitting	16	-10%	Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	15	-11%	Standing	22		Acceptable
		Annual	14	-12%	Standing	20		Acceptable
63	A	Spring	14		Standing	21		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	13		Standing	19		Acceptable
	B	Spring	13		Standing	19		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	13		Standing	20		Acceptable
		Annual	13		Standing	18		Acceptable
64	A	Spring	14		Standing	20		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	14		Standing	20		Acceptable
	B	Spring	15		Standing	21		Acceptable
		Summer	12		Sitting	16		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	16		Walking	22		Acceptable
		Annual	15		Standing	20		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations	Mean Wind Speed Criteria		Effective Gust Criteria	
A - Existing	Comfortable for Sitting:	≤ 12 mph	Acceptable:	≤ 31 mph
B – Build	Comfortable for Standing:	> 12 and ≤ 15 mph	Unacceptable:	> 31 mph
	Comfortable for Walking:	> 15 and ≤ 19 mph		
	Uncomfortable for Walking:	> 19 and ≤ 27 mph		
	Dangerous Conditions:	> 27 mph		

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
65	A	Spring	15		Standing	22		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	16		Walking	22		Acceptable
		Annual	15		Standing	21		Acceptable
	B	Spring	18	+20%	Walking	25	+14%	Acceptable
		Summer	15	+25%	Standing	20	+18%	Acceptable
		Fall	18	+29%	Walking	24	+14%	Acceptable
		Winter	20	+25%	Uncomfortable	26	+18%	Acceptable
		Annual	18	+20%	Walking	24	+14%	Acceptable
66	A	Spring	12		Sitting	18		Acceptable
		Summer	10		Sitting	14		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	12		Sitting	18		Acceptable
		Annual	12		Sitting	18		Acceptable
	B	Spring	17	+42%	Walking	24	+33%	Acceptable
		Summer	14	+40%	Standing	19	+36%	Acceptable
		Fall	16	+33%	Walking	23	+28%	Acceptable
		Winter	18	+50%	Walking	25	+39%	Acceptable
		Annual	17	+42%	Walking	23	+28%	Acceptable
67	A	Spring	13		Standing	20		Acceptable
		Summer	10		Sitting	16		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	13		Standing	20		Acceptable
		Annual	12		Sitting	19		Acceptable
	B	Spring	15	+15%	Standing	22	+10%	Acceptable
		Summer	12	+20%	Sitting	17		Acceptable
		Fall	14	+17%	Standing	21	+11%	Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	14	+17%	Standing	21	+11%	Acceptable
68	A	Spring	11		Sitting	17		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	18		Acceptable
		Annual	11		Sitting	17		Acceptable
	B	Spring	DATA NOT AVAILABLE					
		Summer	DATA NOT AVAILABLE					
		Fall	DATA NOT AVAILABLE					
		Winter	DATA NOT AVAILABLE					
		Annual	DATA NOT AVAILABLE					

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
69	A	Spring	13		Standing	22		Acceptable
		Summer	11		Sitting	17		Acceptable
		Fall	13		Standing	21		Acceptable
		Winter	15		Standing	23		Acceptable
		Annual	14		Standing	22		Acceptable
	B	Spring	DATA NOT AVAILABLE					
		Summer	DATA NOT AVAILABLE					
		Fall	DATA NOT AVAILABLE					
		Winter	DATA NOT AVAILABLE					
		Annual	DATA NOT AVAILABLE					
70	A	Spring	9		Sitting	15		Acceptable
		Summer	7		Sitting	12		Acceptable
		Fall	9		Sitting	14		Acceptable
		Winter	10		Sitting	16		Acceptable
		Annual	9		Sitting	15		Acceptable
	B	Spring	DATA NOT AVAILABLE					
		Summer	DATA NOT AVAILABLE					
		Fall	DATA NOT AVAILABLE					
		Winter	DATA NOT AVAILABLE					
		Annual	DATA NOT AVAILABLE					
71	A	Spring	9		Sitting	15		Acceptable
		Summer	8		Sitting	12		Acceptable
		Fall	9		Sitting	15		Acceptable
		Winter	10		Sitting	16		Acceptable
		Annual	9		Sitting	15		Acceptable
	B	Spring	DATA NOT AVAILABLE					
		Summer	DATA NOT AVAILABLE					
		Fall	DATA NOT AVAILABLE					
		Winter	DATA NOT AVAILABLE					
		Annual	DATA NOT AVAILABLE					
72	A	Spring	18		Walking	25		Acceptable
		Summer	14		Standing	20		Acceptable
		Fall	17		Walking	24		Acceptable
		Winter	19		Walking	27		Acceptable
		Annual	17		Walking	25		Acceptable
	B	Spring	13	-27%	Standing	20	-19%	Acceptable
		Summer	11	-20%	Sitting	16	-19%	Acceptable
		Fall	12	-28%	Sitting	19	-20%	Acceptable
		Winter	14	-25%	Standing	21	-21%	Acceptable
		Annual	13	-23%	Standing	20	-19%	Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

CONSULTING ENGINEERS & SCIENTISTS

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
73	A	Spring	12		Sitting	17		Acceptable
		Summer	10		Sitting	14		Acceptable
		Fall	12		Sitting	17		Acceptable
		Winter	13		Standing	18		Acceptable
		Annual	12		Sitting	17		Acceptable
	B	Spring	9	-24%	Sitting	14	-17%	Acceptable
		Summer	7	-29%	Sitting	11	-20%	Acceptable
		Fall	9	-24%	Sitting	14	-17%	Acceptable
		Winter	10	-22%	Sitting	15	-16%	Acceptable
		Annual	9	-24%	Sitting	14	-17%	Acceptable
74	A	Spring	11		Sitting	18		Acceptable
		Summer	9		Sitting	14		Acceptable
		Fall	11		Sitting	17		Acceptable
		Winter	12		Sitting	19		Acceptable
		Annual	11		Sitting	17		Acceptable
	B	Spring	10		Sitting	16	-10%	Acceptable
		Summer	8	-10%	Sitting	12	-13%	Acceptable
		Fall	9	-17%	Sitting	15	-11%	Acceptable
		Winter	10	-16%	Sitting	16	-15%	Acceptable
		Annual	9	-17%	Sitting	15	-11%	Acceptable
75	A	Spring	11		Sitting	17		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	11		Sitting	16		Acceptable
		Winter	11		Sitting	18		Acceptable
		Annual	11		Sitting	17		Acceptable
	B	Spring	DATA NOT AVAILABLE					
		Summer	DATA NOT AVAILABLE					
		Fall	DATA NOT AVAILABLE					
		Winter	DATA NOT AVAILABLE					
		Annual	DATA NOT AVAILABLE					
76	A	Spring	12		Sitting	19		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	13		Standing	20		Acceptable
		Annual	12		Sitting	19		Acceptable
	B	Spring	DATA NOT AVAILABLE					
		Summer	DATA NOT AVAILABLE					
		Fall	DATA NOT AVAILABLE					
		Winter	DATA NOT AVAILABLE					
		Annual	DATA NOT AVAILABLE					

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

<u>Configurations</u>

A - Existing
B – Build

<u>Mean Wind Speed Criteria</u>

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

<u>Effective Gust Criteria</u>

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
77	A	Spring	13		Standing	20		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	13		Standing	20		Acceptable
	B	Spring	14		Standing	22	+10%	Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	21	+11%	Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	14		Standing	21		Acceptable
78	A	Spring	15		Standing	22		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	16		Walking	23		Acceptable
		Annual	15		Standing	22		Acceptable
	B	Spring	14		Standing	21		Acceptable
		Summer	11		Sitting	17		Acceptable
		Fall	13		Standing	20		Acceptable
		Winter	14	-12%	Standing	22		Acceptable
		Annual	13	-12%	Standing	21		Acceptable
79	A	Spring	12		Sitting	19		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	13		Standing	20		Acceptable
		Annual	12		Sitting	19		Acceptable
	B	Spring	14	+17%	Standing	21	+11%	Acceptable
		Summer	11	+10%	Sitting	16		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	15	+15%	Standing	21		Acceptable
		Annual	13		Standing	19		Acceptable
80	A	Spring	10		Sitting	16		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	17		Acceptable
		Annual	10		Sitting	16		Acceptable
	B	Spring	13	+30%	Standing	18	+13%	Acceptable
		Summer	11	+38%	Sitting	15	+15%	Acceptable
		Fall	13	+30%	Standing	18	+13%	Acceptable
		Winter	12		Sitting	17		Acceptable
		Annual	12	+20%	Sitting	17		Acceptable

Notes:
1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
81	A	Spring	16		Walking	23		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	17		Walking	24		Acceptable
		Annual	16		Walking	23		Acceptable
	B	Spring	13	-18%	Standing	20	-12%	Acceptable
		Summer	10	-22%	Sitting	16	-10%	Acceptable
		Fall	12	-24%	Sitting	19	-13%	Acceptable
		Winter	14	-17%	Standing	22		Acceptable
		Annual	13	-18%	Standing	20	-12%	Acceptable
82	A	Spring	13		Standing	20		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	13		Standing	20		Acceptable
		Winter	14		Standing	22		Acceptable
		Annual	13		Standing	20		Acceptable
	B	Spring	12		Sitting	18		Acceptable
		Summer	9	-17%	Sitting	14	-12%	Acceptable
		Fall	11	-14%	Sitting	17	-14%	Acceptable
		Winter	12	-13%	Sitting	19	-13%	Acceptable
		Annual	11	-14%	Sitting	18		Acceptable
83	A	Spring	23		Uncomfortable	31		Acceptable
		Summer	18		Walking	25		Acceptable
		Fall	22		Uncomfortable	30		Acceptable
		Winter	25		Uncomfortable	34		Unacceptable
		Annual	24		Uncomfortable	32		Unacceptable
	B	Spring	18	-21%	Walking	25	-18%	Acceptable
		Summer	14	-21%	Standing	20	-19%	Acceptable
		Fall	18	-17%	Walking	24	-19%	Acceptable
		Winter	20	-19%	Uncomfortable	27	-20%	Acceptable
		Annual	18	-24%	Walking	26	-18%	Acceptable
84	A	Spring	14		Standing	21		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	13		Standing	20		Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	14		Standing	21		Acceptable
	B	Spring	12	-13%	Sitting	18	-13%	Acceptable
		Summer	9	-17%	Sitting	14	-12%	Acceptable
		Fall	11	-14%	Sitting	17	-14%	Acceptable
		Winter	12	-19%	Sitting	19	-13%	Acceptable
		Annual	11	-20%	Sitting	18	-13%	Acceptable

Notes:
1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

<u>Configurations</u>

A - Existing
B – Build

<u>Mean Wind Speed Criteria</u>

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

<u>Effective Gust Criteria</u>

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			**Mean Wind Speed**			**Effective Gust Wind Speed**		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
85	A	Spring	12		Sitting	18		Acceptable
		Summer	9		Sitting	15		Acceptable
		Fall	11		Sitting	18		Acceptable
		Winter	12		Sitting	20		Acceptable
		Annual	12		Sitting	18		Acceptable
	B	Spring	11		Sitting	18		Acceptable
		Summer	9		Sitting	14		Acceptable
		Fall	11		Sitting	17		Acceptable
		Winter	12		Sitting	19		Acceptable
		Annual	11		Sitting	18		Acceptable
86	A	Spring	13		Standing	19		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	13		Standing	19		Acceptable
	B	Spring	13		Standing	19		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	13		Standing	19		Acceptable
87	A	Spring	17		Walking	24		Acceptable
		Summer	14		Standing	20		Acceptable
		Fall	16		Walking	23		Acceptable
		Winter	16		Walking	24		Acceptable
		Annual	16		Walking	23		Acceptable
	B	Spring	13	-23%	Standing	19	-20%	Acceptable
		Summer	10	-28%	Sitting	16	-19%	Acceptable
		Fall	12	-24%	Sitting	19	-16%	Acceptable
		Winter	13	-18%	Standing	20	-16%	Acceptable
		Annual	13	-18%	Standing	19	-16%	Acceptable
88	A	Spring	12		Sitting	18		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	13		Standing	19		Acceptable
		Annual	12		Sitting	18		Acceptable
	B	Spring	13		Standing	20	+11%	Acceptable
		Summer	11	+10%	Sitting	15		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	13		Standing	20		Acceptable
		Annual	13		Standing	19		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			**Mean Wind Speed**			**Effective Gust Wind Speed**		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
89	A	Spring	12		Sitting	17		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	11		Sitting	16		Acceptable
		Winter	11		Sitting	17		Acceptable
		Annual	11		Sitting	17		Acceptable
	B	Spring	12		Sitting	18		Acceptable
		Summer	9		Sitting	14		Acceptable
		Fall	11		Sitting	17		Acceptable
		Winter	12		Sitting	18		Acceptable
		Annual	11		Sitting	17		Acceptable
90	A	Spring	13		Standing	18		Acceptable
		Summer	11		Sitting	15		Acceptable
		Fall	12		Sitting	17		Acceptable
		Winter	12		Sitting	18		Acceptable
		Annual	12		Sitting	18		Acceptable
	B	Spring	12		Sitting	18		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	12		Sitting	17		Acceptable
		Winter	12		Sitting	18		Acceptable
		Annual	12		Sitting	17		Acceptable
91	A	Spring	16		Walking	21		Acceptable
		Summer	12		Sitting	16		Acceptable
		Fall	14		Standing	19		Acceptable
		Winter	16		Walking	21		Acceptable
		Annual	14		Standing	19		Acceptable
	B	Spring	13	-18%	Standing	18	-13%	Acceptable
		Summer	10	-16%	Sitting	13	-18%	Acceptable
		Fall	12	-13%	Sitting	16	-15%	Acceptable
		Winter	13	-18%	Standing	18	-13%	Acceptable
		Annual	12	-13%	Sitting	16	-15%	Acceptable
92	A	Spring	16		Walking	24		Acceptable
		Summer	13		Standing	19		Acceptable
		Fall	16		Walking	23		Acceptable
		Winter	17		Walking	25		Acceptable
		Annual	16		Walking	24		Acceptable
	B	Spring	14	-12%	Standing	22		Acceptable
		Summer	11	-14%	Sitting	17	-10%	Acceptable
		Fall	14	-12%	Standing	21		Acceptable
		Winter	15	-11%	Standing	23		Acceptable
		Annual	14	-12%	Standing	22		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			**Mean Wind Speed**			**Effective Gust Wind Speed**		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
93	A	Spring	12		Sitting	19		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	13		Standing	21		Acceptable
		Annual	12		Sitting	20		Acceptable
	B	Spring	12		Sitting	19		Acceptable
		Summer	9		Sitting	15		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	13		Standing	20		Acceptable
		Annual	12		Sitting	19		Acceptable
94	A	Spring	13		Standing	19		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	13		Standing	18		Acceptable
		Winter	14		Standing	20		Acceptable
		Annual	13		Standing	19		Acceptable
	B	Spring	14		Standing	19		Acceptable
		Summer	11	+10%	Sitting	15		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	15		Standing	21		Acceptable
		Annual	14		Standing	20		Acceptable
95	A	Spring	17		Walking	22		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	17		Walking	22		Acceptable
		Annual	16		Walking	21		Acceptable
	B	Spring	16		Walking	21		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	16		Walking	22		Acceptable
		Annual	15		Standing	20		Acceptable
96	A	Spring	18		Walking	25		Acceptable
		Summer	14		Standing	20		Acceptable
		Fall	17		Walking	23		Acceptable
		Winter	18		Walking	25		Acceptable
		Annual	17		Walking	23		Acceptable
	B	Spring	17		Walking	23		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	17		Walking	23		Acceptable
		Annual	16		Walking	22		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
97	A	Spring	10		Sitting	16		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	9		Sitting	15		Acceptable
		Winter	10		Sitting	16		Acceptable
		Annual	9		Sitting	15		Acceptable
	B	Spring	10		Sitting	17		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	9		Sitting	16		Acceptable
		Winter	11	+10%	Sitting	18	+13%	Acceptable
		Annual	10	+11%	Sitting	17	+13%	Acceptable
98	A	Spring	9		Sitting	15		Acceptable
		Summer	8		Sitting	12		Acceptable
		Fall	9		Sitting	15		Acceptable
		Winter	9		Sitting	15		Acceptable
		Annual	9		Sitting	14		Acceptable
	B	Spring	10	+11%	Sitting	15		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	10	+11%	Sitting	15		Acceptable
		Winter	10	+11%	Sitting	15		Acceptable
		Annual	9		Sitting	15		Acceptable
99	A	Spring	15		Standing	22		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	14		Standing	20		Acceptable
	B	Spring	15		Standing	22		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	14		Standing	21		Acceptable
100	A	Spring	11		Sitting	18		Acceptable
		Summer	9		Sitting	15		Acceptable
		Fall	11		Sitting	17		Acceptable
		Winter	12		Sitting	19		Acceptable
		Annual	11		Sitting	18		Acceptable
	B	Spring	11		Sitting	18		Acceptable
		Summer	9		Sitting	15		Acceptable
		Fall	11		Sitting	17		Acceptable
		Winter	12		Sitting	19		Acceptable
		Annual	11		Sitting	18		Acceptable

Notes:
1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
101	A	Spring	18		Walking	24		Acceptable
		Summer	14		Standing	19		Acceptable
		Fall	17		Walking	23		Acceptable
		Winter	19		Walking	26		Acceptable
		Annual	18		Walking	25		Acceptable
	B	Spring	17		Walking	23		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	18		Walking	25		Acceptable
		Annual	17		Walking	23		Acceptable
102	A	Spring	18		Walking	25		Acceptable
		Summer	15		Standing	20		Acceptable
		Fall	18		Walking	24		Acceptable
		Winter	19		Walking	27		Acceptable
		Annual	18		Walking	25		Acceptable
	B	Spring	18		Walking	25		Acceptable
		Summer	15		Standing	20		Acceptable
		Fall	18		Walking	24		Acceptable
		Winter	20		Uncomfortable	27		Acceptable
		Annual	18		Walking	25		Acceptable
103	A	Spring	10		Sitting	17		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	18		Acceptable
		Annual	10		Sitting	16		Acceptable
	B	Spring	10		Sitting	17		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	18		Acceptable
		Annual	10		Sitting	17		Acceptable
104	A	Spring	10		Sitting	16		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	9		Sitting	15		Acceptable
		Winter	11		Sitting	17		Acceptable
		Annual	10		Sitting	16		Acceptable
	B	Spring	12	+20%	Sitting	19	+19%	Acceptable
		Summer	10	+25%	Sitting	15	+15%	Acceptable
		Fall	12	+33%	Sitting	19	+27%	Acceptable
		Winter	13	+18%	Standing	21	+24%	Acceptable
		Annual	13	+30%	Standing	20	+25%	Acceptable

Notes:
1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations

A - Existing
B – Build

Mean Wind Speed Criteria

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

Effective Gust Criteria

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

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Table D1: Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed(mph)	%Change	RATING	Speed(mph)	%Change	RATING
105	A	Spring	11		Sitting	17		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	17		Acceptable
		Annual	10		Sitting	16		Acceptable
	B	Spring	13	+18%	Standing	21	+24%	Acceptable
		Summer	10	+25%	Sitting	16	+23%	Acceptable
		Fall	12	+20%	Sitting	20	+25%	Acceptable
		Winter	13	+18%	Standing	22	+29%	Acceptable
		Annual	13	+30%	Standing	21	+31%	Acceptable
106	A	Spring	11		Sitting	18		Acceptable
		Summer	10		Sitting	16		Acceptable
		Fall	11		Sitting	18		Acceptable
		Winter	12		Sitting	20		Acceptable
		Annual	11		Sitting	19		Acceptable
	B	Spring	12		Sitting	19		Acceptable
		Summer	10		Sitting	17		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	12		Sitting	20		Acceptable
		Annual	12		Sitting	19		Acceptable
107	A	Spring	9		Sitting	15		Acceptable
		Summer	8		Sitting	12		Acceptable
		Fall	9		Sitting	15		Acceptable
		Winter	9		Sitting	15		Acceptable
		Annual	9		Sitting	15		Acceptable
	B	Spring	10	+11%	Sitting	16		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	9		Sitting	15		Acceptable
		Winter	9		Sitting	15		Acceptable
		Annual	9		Sitting	15		Acceptable
108	A	Spring	12		Sitting	19		Acceptable
		Summer	10		Sitting	16		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	12		Sitting	18		Acceptable
		Annual	12		Sitting	18		Acceptable
	B	Spring	12		Sitting	19		Acceptable
		Summer	10		Sitting	16		Acceptable
		Fall	11		Sitting	18		Acceptable
		Winter	12		Sitting	18		Acceptable
		Annual	12		Sitting	18		Acceptable

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

<u>Configurations</u>

A - Existing
B – Build

<u>Mean Wind Speed Criteria</u>

Comfortable for Sitting:	≤ 12 mph
Comfortable for Standing:	> 12 and ≤ 15 mph
Comfortable for Walking:	> 15 and ≤ 19 mph
Uncomfortable for Walking:	> 19 and ≤ 27 mph
Dangerous Conditions:	> 27 mph

<u>Effective Gust Criteria</u>

Acceptable:	≤ 31 mph
Unacceptable:	> 31 mph

Appendix E

Air Quality

APPENDIX E

Introduction

This Air Quality Appendix provides modeling assumptions and backup for results presented in Section 5.5 of the report. Included within this documentation is a brief description of the methodology employed along with pertinent calculations and data used in the emissions and dispersion calculations supporting the microscale and stationary source air quality analyses.

Motor Vehicle Emissions

The EPA MOBILE6.2 computer program generated motor vehicle emissions used in the garage stationary source analysis along with the mobile source CAL3QHC modeling and mesoscale analysis. The model input parameters were provided by MassDEP. Emission rates were derived for 2012 and 2022 for speed limits of 2.5, 10, 15, and 30 mph for use in the microscale analyses. The 10 mph rate was used to estimate parking garage emissions.

CAL3QHC

For the intersections studied, the CAL3QHC model was applied to calculate CO concentrations at sensitive receptor locations using emission rates derived in MOBILE6.2. The intersection's queue links and free flow links were input to the model along with sensitive receptors at all locations nearby each intersection. The meteorological assumptions input into the model were a 1.0 meter per second wind speed, Pasquill-Gifford Class D stability combined with a mixing height of 1000 meters. For each direction, the full range of wind directions at 10 degree intervals was examined. In addition, a surface roughness (z_0) of 321 cm was used for all intersections except Louis Pasteur and Fenway (127 cm). Idle emission rates for queue links were based on 2.5 mph emission rates derived in MOBILE6.2 and converted from grams per mile to grams per hour. Emission rates for speeds of 10, 15, and 30 mph were used for right turn, left turn, and free flow links, respectively.

Stationary Source Emissions

Emissions for the heating combustion units were calculated using the latest DEP emission limits for boilers based on the Boiler Environmental Results Program (ERP). Emissions for the emergency generators and cooling towers were obtained from vendor information for a similar size unit. The resulting hourly emission rate in pounds per hour were converted to grams per second and input to the AERMOD model. For the NAAQS analysis, a similar approach was conducted for CO, SO_2, NO_x, PM-10, and PM-2.5. The emergency generator emissions were calculated based on a g/bhp-hr emission factor provided by vendor information for typical size units.

All assumptions and data used in the stationary source emissions and stack parameter calculations are provided herein.

AERMOD

The EPA AERMOD model was used to calculate air quality impacts due to the installation of heating combustion boilers, emergency generators, parking garage vents, loading dock vents and cooling towers. For non-combustion sources, ambient temperature releases were assumed; otherwise temperatures from the exhaust gas were used. Urban dispersion coefficients were used. Building downwash was accounted for in the modeling based on the building heights and projected widths of the buildings. The maximum modeled impacts from the garage vents and the stack sources were conservatively added to monitored background values for comparison to the NAAQS.

Boiler, Cooling Tower, Emergency Generator, Garage Vent, and Loading Dock Exhaust Vent Emissions Calculations

3291 Brigham & Womens Hospital Alumnae Hall Project - Calculation of Stationary Source Emissions

Heating Boilers

			Notes
Source Name		B01-20	
Make		N/A	
Model		N/A	
Qty.		20	20 @ 3mmBTU/hr = 60 mmBTU/hr
Boiler Heat Input	MMBTU/hr (ea.):	3.000	from M-PH1 drawing
Boiler Emission Rates	lb/MMBTU	g/s (ea.)	
NOx	0.035	0.01323	ERP limits
CO	0.080	0.03024	ERP limits
VOC	0.030	0.01134	ERP limits
PM-2.5	0.010	0.00378	ERP limits Assume PM10=PM2.5
PM-10	0.010	0.00378	ERP limits Assume PM10=PM2.5
SO2	0.0006	0.00022	AP42 Table 1.4-2 (assuming 1040 Btu/scf)
CO2	115.385	43.61442	AP42 Table 1.4-2 (assuming 1040 Btu/scf)
Gas Exit Temp	°F	170	Assumed
Gas Exit Temp	°K	349.8	
Exhaust air (CFM)	CFM	1486.44	Assumed
Gas Exit Velocity	fps	56.08	calculated, 40 fps minimum
Gas Exit Velocity	mps	17.09	
Roof Height	feet	195.00	from site plans
Stack height	feet above roofline	10	ERP minimum
Stack height	feet	205	calculated
Stack height	meters	62.484	
Stack Diameter	feet	0.750	Assumed
Stack Diameter	meters	0.229	

Cooling Towers

			Notes
Designation		CT1-3	
Make		N/A	
Model		N/A	
Cooling Tower Rate	tons	3600	from M-PH2 drawing
Tower Overall Dimensions	feet	N/A	
CT Stack Height (above roofline)	feet	10	assumed
Primary Building Height (ft)	feet	195.00	
CT Stack Height	feet	205	calculated
CT Stack Height	meters	62.48	
Number of cells (per tower)	#	3	from M-PH2 drawing
Cooling Tower Specs			
Cooling Tower Exhaust Flow	CFM	1440000	assumed 400 cfm per ton
Cooling Tower Cell Exhaust Flow	CFM	480000	per cell
Cooling Tower Cell Exhaust Flow	kg/s	252.5	calculated
Cooling Tower Exhaust Temp	°F	78	assumed
Cooling Tower Cell Diameter	feet	10	assumed
Cooling Tower Cell Diameter	meters	3.05	
Cooling Tower Stack Velocity	fps	101.86	calculated
Cooling Tower Stack Velocity	mps	31.05	
Cooling Tower Drift			
Drift Rate	% of circ water	0.001	assumed
Circulating Water Rate	gpm	10,800	assumed 3gpm/ton cooling
Circulating Water Rate	gph	648,000	calculated
TDS+TSS concentration in drift	mg/L	1,500	assumed
PM emission rate in drift (per cell)	lb/hr	0.027	calculated
PM emission rate in drift (per cell)	g/s	0.00342	calculated

3291 Brigham & Womens Hospital Alumnae Hall Project - Calculation of Stationary Source Emissions

Emergency Generator

			Notes
Designation		EG1	
Number		1	
Electrical output	kilowatts	1250	from Mech report
Make		Cummins	Assumed
model		DQGAA	Assumed
Engine Horsepower	BHP	1848.00	Mfg data
Engine power	kilowatts	1378.05	calculated
Fuel consumption @full load	gph	92.70	Mfg data
Heat Input	MMBTU/hr:	12.6999	calculated
Stack Parameters			
Exhaust Temperature	°F	813	Mfg data
Exhaust Temperature	°K	707.0	calculated
Total Exhaust Flow	ACFM	10570	Mfg data
Flange Diameter	in.	12	assumed
Maximum Backpressure	in. H2O	27	Mfg data
Maximum velocity	fpm	15737.51	calculated
Flow area required	sq. ft	0.672	calculated
Number of exhausts (typ. 1 or 2)	#	1	assumed
Selected silencer diameter	in	12	assumed
Actual silencer opening area	sq. ft each	0.785	calculated
Actual velocity	fpm each	13458.142	calculated
Actual velocity	fps each	224.302	calculated
Single Stack Effective Diameter	ft	1.000	calculated
Single Stack Effective Diameter	m	0.305	calculated
Single Stack Effective Velocity	fps	224.302	calculated
Single Stack Effective Velocity	mps	68.367	calculated
Primary Building Height	ft	195.00	
Stack Height (10' above roofline)	ft	*205.00*	calculated
Stack Height	m	*62.48*	calculated
Pollutant	Emission factor unit	Emission factor	
NOx	g/BHP-hr	5.40	EF from mfg data
CO	g/BHP-hr	0.44	EF from mfg data
VOC	g/BHP-hr	0.10	EF from mfg data
PM10	g/BHP-hr	0.03	EF from mfg data
PM2.5	g/BHP-hr	0.03	EF from mfg data
SO2	g/BHP-hr	0.11	EF from mfg data
HAPs	lb/MMBTU	0.00149	emission factor from EPA AP-42 (Table 3.4-3&4)
CO2	lb/MMBTU	165	emission factor from EPA AP-42 (Table 3.4-1)
Short Term Emission Rate			
NOx	g/s	0.0949	uses EPA 'intermittent" factor
CO	g/s	0.2259	calculated
VOC	g/s	0.0513	calculated
PM10	g/s	0.0154	calculated
PM2.5	g/s	0.0154	calculated
SO2	g/s	0.0565	calculated
Long Term (300 hr/yr) Emission Rate			
NOx	g/s	0.0949	calculated
CO	g/s	0.0077	calculated
VOC	g/s	0.0018	calculated
PM10	g/s	0.0005	calculated
PM2.5	g/s	0.0005	calculated
SO2	g/s	0.0019	calculated

3291 Brigham & Womens Hospital Alumnae Hall Project - Calculation of Stationary Source Emissions

Cogeneration Unit

			Notes
Designation		COGEN1-2	
Number		2	
Electrical output	kilowatts	1000	from Mech report
Make		Cummins	Assumed
model		C1000 N6C	Assumed
Engine Horsepower	BHP	1393.00	Mfg data
Engine power	kilowatts	1038.76	calculated
Fuel consumption @full load	scf/hr	7778.85	calculated
Heat Input	MMBTU/hr:	8.09	Mfg data
Stack Parameters			
Exhaust Temperature	°F	*777*	Mfg data
Exhaust Temperature	°K	687.0	calculated
Total Exhaust Flow	ACFM	6440	Mfg data
Flange Diameter	in.	10.9	Mfg data
Maximum Backpressure	in. H2O	20	Mfg data
Maximum velocity	fpm	13351.80	calculated
Flow area required	sq. ft	0.482	calculated
Number of exhausts (typ. 1 or 2)	#	1	assumed
Selected silencer diameter	in	10	assumed
Actual silencer opening area	sq. ft each	0.545	calculated
Actual velocity	fpm each	11807.514	calculated
Actual velocity	fps each	196.792	calculated
Single Stack Effective Diameter	ft	0.833	calculated
Single Stack Effective Diameter	m	0.254	calculated
Single Stack Effective Velocity	fps	196.792	calculated
Single Stack Effective Velocity	mps	59.982	calculated
Primary Building Height	ft	195.00	
Stack Height (10' above roofline)	ft	*205.00*	calculated
Stack Height	m	*62.48*	calculated

Pollutant	Emission factor unit	Emission factor	
NOx	g/BHP-h	1.00	EF from mfg data (D-3470)
CO	g/BHP-h	1.40	EF from mfg data (D-3470)
VOC	g/BHP-h	2.50	EF from mfg data (D-3470)
PM10	g/BHP-h	0.03	EF from mfg data (D-3470)
PM2.5	g/BHP-h	0.03	EF from mfg data (D-3470)
SO2	lb/MMBTU	5.88E-04	emission factor from EPA AP-42 (Table 3.2-2)
HAPs	g/BHP-h	0.40000	EF from mfg data (D-3470)
CO2	lb/MMBTU	1.10E+02	emission factor from EPA AP-42 (Table 3.2-2)

Emission Rates			
NOx	g/s	0.3869	calculated
CO	g/s	0.5417	calculated
VOC	g/s	0.9674	calculated
PM10	g/s	0.0116	calculated
PM2.5	g/s	0.0116	calculated
SO2	g/s	0.0002	calculated

3291 Brigham & Womens Hospital Alumnae Hall Project - Calculation of Stationary Source Emissions

Loading Dock Active Exhaust Vent

	2013 M6.2 Emission factors (g/hr/veh)	Hourly Idle Time (min/veh)	# Vehicles	Emission Rate (g/s)	Notes
Composite VOC :	2.643	5	2	0.000122	calculated
Composite CO :	27.370	5	2	0.001267	calculated
Composite NOX :	3.328	5	2	0.000154	calculated
Composite CO2 :	3117.736	5	2	0.144340	calculated
Total PM2.5:	0.088	5	2	0.000004	calculated
Total PM10:	0.149	5	2	0.000007	calculated
SO2:	0.035	5	2	0.000002	calculated

assumption: Loading dock is capable of handling 2 trucks at a time. Assume dock is used from 7am-4pm consistently with 2 trucks idling maximum of 5 minutes per hour (MGL Chapter 90, Section 16A).

Vent Parameters		Vent 1	
Stack Exhaust Flow	ACFM	3900	1.5 cfm/sq ft
Stack Exhaust Temperature	F	70	assumed
Stack Exhaust Temperature	K	294.3	
outlet area	sq ft	3	
effective diameter	ft	1.95	calculated
effective diameter	m	0.596	
Stack Velocity	fps	21.7	calculated
Stack Velocity	mps	6.604	
Stack height	feet above grade	20	assumed
Stack height	meters above grade	6.096	

Garage Exhaust Vents

Description	355 spaces under bldg.	
total spaces	355	from project description
Residential spaces	0	from project description
Retail/commercial spaces	355	from project description
# vehicles entering garage/hr	266.25	assume peak turnover of 75% of total spaces
Levels	3	from project description
Garage Area (sq ft)	173333	from project description
Number of vents	4	Assumed
Stack Exhaust Flow (acfm)	130000	1.5 cfm/sq ft.
Stack Exhaust Temperature (°F)	*70*	Assumed underground temp remains consistent
outlet area per vent (sqft)	50	Assumed
effective diameter (ft)	*7.97885*	Vents are covered Louvers. Thus model as BETA
Stack Velocity (fpm)	649.99875	
Stack Velocity (fps)	10.83331	
Stack height (ft)	20	assumed
Garage Distance Traveled (ft)	500	Approximate distance to center of garage
Hourly garage mileage (VMT)	25.213	

Total Emissions

	Per Vent Emission Rates	2022 10mph Emission Factors	M6.2 g/mile
Composite VOC (g/s):	0.00058	Composite VOC (g/mile):	0.332
Composite CO (g/s):	0.01944	Composite CO (g/mile):	11.104
Composite NOX (g/s):	0.00034	Composite NOX (g/mile):	0.196
Total PM2.5 (g/s):	0.00002	Total PM2.5 (g/mile):	0.011
Total PM10 (g/s):	0.00004	Total PM10 (g/mile):	0.025
SO2 (g/s):	0.00001	SO2 (g/mile):	0.008

Example Emissions Assumption.

Example Emissions Assumption: 4 levels underground, 1000 spaces

Of the 1000 spaces, assume 750 residential, 250 commercial. It is assumed that the garage is on average 75% full. Residential spaces are assumed to turn over 25% per hour, while commercial spaces turn over hourly.

(750 x 0.25) + (250 x 1.0) x 0.75 = 328 vehicles per hour

It is assumed that the vehicles travel halfway, on average, into the garage at any time (travel to midpoint of mid level). Some travel through all 4 levels. Some find parking on the uppermost level. In this example, the distance to the center of the garage is assumed to be approximately 500 feet.

Using this assumption, a total VMT of 31.1 miles is traveled (500 feet/level x 328 cars / 5,280 feet per mile).

Emission factor is assumed to be weighted average of 10 mph LDGV, LDGT<6000gvw, LDDV, and MC. Higher of summer/winter values.

Since traffic in/out of garage will not be at peak hour for all 24 hrs per day, the following factors were assumed to account for fluctuating usage

Hour	Factor
1 AM to 5 AM	0.25
6 AM to 8 AM	1.00
9 AM to 5 PM	0.50
6 PM to 7 PM	1.00
8 PM to 12 AM	0.25

summer 2022 2.5 mph

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
VMT Distribution:	0.2607	0.4379	0.1723		0.0375	0	0.0015	0.0864	0.0036	1
Fuel Economy (mpg):	24.1	18.5	14.2	17	9.9	32.4	18.4	7.3	50	16
Composite Emission	Factors (g/	mi):								
Composite VOC :	1.607	1.364	1.423	1.381	1.65	0.612	0.174	0.776	11.5	1.432
Composite CO :	10.44	9.34	9.75	9.45	25.3	5.183	1.013	1.617	120.29	10.017
Composite NOX :	0.322	0.268	0.37	0.297	0.203	0.903	0.082	1.719	1.12	0.426
Composite CO2 :	368	479.4	624.5	520.4	894.4	314.1	552.3	1398.5	177.4	569.38
Total PM2.5:	0.0112	0.0113	0.0113	0.0113	0.0182	0.0948	0.0165	0.0418	0.0207	0.0142
Total PM10:	0.0247	0.0247	0.0247	0.0247	0.0328	0.1156	0.0304	0.0701	0.0372	0.029
SO2:	0.0065	0.0087	0.0115	0.0095	0.0163	0.0029	0.0052	0.013	0.0033	0.0092

Winter 2022 2.5 mph

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
VMT Distribution:	0.261	0.4386	0.1723		0.0371	0	0.0015	0.0858	0.0036	1
Fuel Economy (mpg):	24.1	18.5	14.2	17	9.9	32.4	18.4	7.3	50	16
Composite Emission	Factors (g/	mi):								
Composite VOC :	1.464	1.254	1.36	1.284	1.694	0.603	0.174	0.782	10.7	1.335
Composite CO :	20.56	18.36	18.68	18.45	32.38	5.128	1.009	1.681	104.23	18.357
Composite NOX :	0.234	0.276	0.39	0.309	0.229	0.897	0.084	1.808	1.56	0.419
Composite CO2 :	368	479.4	624.5	520.3	894.4	314.1	552.2	1399.6	177.4	568.73
Total PM2.5:	0.0112	0.0113	0.0113	0.0113	0.0184	0.0948	0.0165	0.0426	0.0207	0.0143
Total PM10:	0.0247	0.0247	0.0247	0.0247	0.033	0.1156	0.0305	0.0711	0.0372	0.0291
SO2:	0.0065	0.0087	0.0115	0.0095	0.0163	0.0029	0.0052	0.013	0.0033	0.0092

Summer Loading Dock vehicles :		HDGV	HDDV	SUM
	actual fractic	0.0375	0.0864	0.1239
	garage fractic	0.3027	0.6973	1
				Composite EF
	Composite VOC	1.65	0.776	1.041
	Composite CO	25.3	1.617	8.785
	Composite NOX	0.203	1.719	1.260
	Composite CO2	894.4	1398.5	1245.927
	Total PM2.5:	0.0182	0.0418	0.035
	Total PM10:	0.0328	0.0701	0.059
	SO2:	0.0163	0.013	0.014

Winter Loading Dock vehicles :		HDGV	HDDV	SUM
	actual fractic	0.0371	0.0858	0.1229
	garage fractic	0.3019	0.6981	1
				Composite EF
	Composite VOC	1.694	0.782	1.057
	Composite CO	32.38	1.681	10.948
	Composite NOX	0.229	1.808	1.331
	Composite CO2	894.4	1399.6	1247.095
	Total PM2.5:	0.0184	0.0426	0.035
	Total PM10:	0.033	0.0711	0.060
	SO2:	0.0163	0.013	0.014

summer 2022 10 mph

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
VMT Distribution:	0.2607	0.4379	0.1723		0.0375	0	0.0015	0.0864	0.0036	1
Fuel Economy (mpg):	24.1	18.5	14.2	17	9.9	32.4	18.4	7.3	50	16
Composite Emission	Factors (g/	mi):								
Composite VOC :	0.313	0.306	0.351	0.318	0.447	0.464	0.126	0.536	4.94	0.357
Composite CO :	4.3	4.37	4.56	4.43	13.45	3.406	0.609	0.91	36.49	4.538
Composite NOX :	0.202	0.186	0.257	0.206	0.219	0.682	0.062	1.291	1	0.302
Composite CO2 :	368	479.4	624.5	520.4	894.4	314.1	552.3	1398.5	177.4	569.38
Total PM2.5:	0.0112	0.0113	0.0113	0.0113	0.0182	0.0948	0.0165	0.0418	0.0207	0.0142
Total PM10:	0.0247	0.0247	0.0247	0.0247	0.0328	0.1156	0.0304	0.0701	0.0372	0.029
SO2:	0.0065	0.0087	0.0115	0.0095	0.0163	0.0029	0.0052	0.013	0.0033	0.0092

Winter 2022 10 mph

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
VMT Distribution:	0.261	0.4386	0.1723		0.0371	0	0.0015	0.0858	0.0036	1
Fuel Economy (mpg):	24.1	18.5	14.2	17	9.9	32.4	18.4	7.3	50	16
Composite Emission	Factors (g/	mi):								
Composite VOC :	0.27	0.283	0.356	0.304	0.479	0.457	0.125	0.539	4.39	0.336
Composite CO :	11.93	10.43	10.34	10.41	17.21	3.36	0.606	0.946	33.28	10.31
Composite NOX :	0.17	0.2	0.282	0.223	0.247	0.678	0.063	1.358	1.38	0.312
Composite CO2 :	368	479.4	624.5	520.3	894.4	314.1	552.2	1399.6	177.4	568.73
Total PM2.5:	0.0112	0.0113	0.0113	0.0113	0.0184	0.0948	0.0165	0.0426	0.0207	0.0143
Total PM10:	0.0247	0.0247	0.0247	0.0247	0.033	0.1156	0.0305	0.0711	0.0372	0.0291
SO2:	0.0065	0.0087	0.0115	0.0095	0.0163	0.0029	0.0052	0.013	0.0033	0.0092

Summer garage vehicles :	LDGV	LDGT12	LDDV	MC	SUM
actual fractic	0.2607	0.4379	0	0.0036	0.7022
garage fractic	0.3713	0.6236	0.0000	0.0051	1
					Composite EF
Composite VOC	0.313	0.306	0.464	4.94	0.332
Composite CO	4.3	4.37	3.406	36.49	4.509
Composite NOX	0.202	0.186	0.682	1	0.196
Composite CO2	368	479.4	314.1	177.4	436.493
Total PM2.5:	0.0112	0.0113	0.0948	0.0207	0.011
Total PM10:	0.0247	0.0247	0.1156	0.0372	0.025
SO2:	0.0065	0.0087	0.0029	0.0033	0.008

Winter garage vehicles :	LDGV	LDGT12	LDDV	MC	SUM
actual fractic	0.261	0.4386	0	0.0036	0.7032
garage fractic	0.3712	0.6237	0.0000	0.0051	1
					Composite EF
Composite VOC	0.27	0.283	0.457	4.39	0.299
Composite CO	11.93	10.43	3.36	33.28	11.104
Composite NOX	0.17	0.2	0.678	1.38	0.195
Composite CO2	368	479.4	314.1	177.4	436.507
Total PM2.5:	0.0112	0.0113	0.0948	0.0207	0.011
Total PM10:	0.0247	0.0247	0.1156	0.0372	0.025
SO2:	0.0065	0.0087	0.0029	0.0033	0.008

Brigham & Womens Hospital - Alumnae Hall
Calculation of Microscale Modeling Emission Rates
Summary of MOBILE6.2 Output

Carbon Monoxide Only

Queues	Idle
Free Flow	30 mph
Right Turns	10 mph
Left Turns	15 mph

Summer	**2012**	**2022**	**Units**
Idle	32.245	25.043	g/hr
2.5 mph	12.898	10.017	g/mile
10 mph	5.783	4.538	g/mile
15 mph	4.897	3.829	g/mile
30 mph	4.017	3.097	g/mile

Winter	**2012**	**2022**	**Units**
Idle	50.753	45.893	g/hr
2.5 mph	20.301	18.357	g/mile
10 mph	10.920	10.310	g/mile
15 mph	9.803	9.364	g/mile
30 mph	8.727	8.468	g/mile

Due to excessive size AERMOD, CAL3QHC, and MOBILE6.2 input and output files are available on digital media upon request.

Appendix F

Noise

Table 1 Reference Equipment Noise Levels – Per Unit

Noise Source	Form of Data	Ref. Distance (feet)	Overall Level	Sound Levels (dB) per Octave Band Center Frequency (Hz)									No.	Location
			(dBA)	32	63	125	250	500	1000	2000	4000	8000		
Quadraplex Vacuum Pump (15 HP, 120 scfm at 19 in. W.C.)[1]	Sound Pressure	3ft	84	73	74	75	77	77	80	77	73	67	1	M-PH1
Quadraplex Air Compressor (20 HP, 200 scfm at 100 PSI)[2]	Sound Pressure	3ft	97	92	87	87	86	89	92	92	90	87	1	M-PH1
Centrifugal Chiller (1,200-ton)[3]	Sound Power	-	98	64	64	74	80	90	91	95	89	87	3	M-PH1
Chilled Water Variable Flow Primary Pump with VFDs[4]	Sound Pressure	3ft	86	75	76	77	79	79	82	79	75	69	5	M-PH1
Chilled Water Variable Flow Secondary Pump with VFDs[4]	Sound Pressure	3ft	86	75	76	77	79	79	82	79	75	69	5	M-PH1
Condenser Water Variable Volume Pump[4]	Sound Pressure	3ft	86	75	76	77	79	79	82	79	75	69	3	M-PH1
Gas-fired Condensing Boiler (x20)[5]	Sound Power	-	84	53	65	70	72	76	77	76	76	74	1	M-PH1
Hot Water Variable Flow Primary Pump with VFDs[4]	Sound Pressure	3ft	86	75	76	77	79	79	82	79	75	69	5	M-PH1
Hot Water Variable Flow Secondary Pump with VFDs[4]	Sound Pressure	3ft	86	75	76	77	79	79	82	79	75	69	5	M-PH1
Air Handling Unit (50,000 CFM) (Sound Attenuation)[6]	Sound Power	-	99	59	72	89	91	94	93	91	88	78	16	M-PH1
Garage Exhaust Fan (130,000 CFM)[7]	Sound Power	-	94	80	80	87	85	89	88	83	81	75	1	At-Grade
Co-Gen Pumps[4]	Sound Pressure	3ft	86	75	76	77	79	79	82	79	75	69	3	M-PH1
Supply and Return Air Ventilation Fan (60,000 CFM)[8]	Sound Power	-	91	77	77	84	82	86	85	80	78	72	3	M-PH1
Cooling Tower (1,200-ton)[9]	Sound Power	-	99	78	78	86	94	94	93	87	82	77	3	M-PH2
EAHU (134,000 CFM) with 3 45,000 CFM Exhaust Fans[10]	Sound Power		97	79	79	92	87	90	92	86	83	78	5	M-PH2
Gas-Fired Generator (1,000 kW) (Enclosed) – Mechanical[11]	Sound Power	-	86	63	63	86	76	60	60	57	53	53	2	M-PH2
Gas-Fired Generator (1,000 kW) – Exhaust[12]	Sound Pressure	23ft	102	55	68	94	96	93	94	96	96	91	2	Roof
Emergency Generator – Mechanical[13]	Sound Power	-	95	57	57	79	83	86	90	91	85	82	1	M-PH2
Emergency Generator – Exhaust[14]	Sound Power	-	117	75	75	105	114	109	108	108	98	81	1	Roof

Notes:
1. Used Hoover & Keith "Noise Control for Buildings and Manufacturing Plants" Table 7-12; Assumed 15 HP at 1600-1800 RPM
2. Used Hoover & Keith "Noise Control for Buildings and Manufacturing Plants" Table 7-15; Assumed 10-75 HP
3. Assumed 2 530-ton York Centrifugal Liquid Chillers (Model YKFQFRQ7-CPG)
4. Used Hoover & Keith "Noise Control for Buildings and Manufacturing Plants" Table 7-12; Assumed 25 HP at 1600-1800 RPM
5. Used Edison Electric Institute "Electric Power Plant Environmental Noise Guide" Table 4.2; Assumed 20 boilers at 0.879 MW each
6. Assumed Trane Indoor M-Series Climate Changer AHU (50,000 CFM); No attenuation
7. Assumed 2 65,000 CFM Greenheck 54-AFDW-21 Exhaust Fan
8. Assumed 65,000 CFM Greenheck 54-AFDW-21 Exhaust Fan
9. Assumed BAC Series 3000 #3412C-2 2-Cell Cooling Tower with single 25HP fan per BAC Cooling Tower Selection Program (Release 6.10 NA); with Directivity of Large Vertical Exhaust Stack per Edison Electric Institute (EEI) Electric Power Plant Environmental Noise Guide, Table 4.19
10. Assumed 43,000 CFM Greenheck 44-AFDW-21 Exhaust Fan
11. Assumed 1kW Caterpillar DM6703 Gen Set Package with 30dBA acoustical enclosure
12. Assumed 1kW Caterpillar DM6703 Gen Set Package; Unsilenced exhaust
13. Assumed Caterpillar Model C32; 1,000 kW, 100%Load
14. Assumed Caterpillar Model C32; 1,000 kW, 100%Load

Table 2 Attenuation Values Used for Sound Level Modeling (dB)

Noise Source	Form of Mitigation	Octave Band Center Frequency (Hz)								
		32	63	125	250	500	1000	2000	4000	8000
Vacuum Pump	Quieter Unit	7	0	0	0	0	0	0	0	0
Air Compressor	Quieter Unit/Enclosure	25	0	0	0	5	5	7	7	0
Chillers	Quieter Unit	0	0	0	0	0	5	10	8	0
Chilled Water Pumps	Quieter Unit	7	0	0	0	0	0	0	0	0
Condenser Water Pumps	Quieter Unit	7	0	0	0	0	0	0	0	0
Hot Water Pumps	Quieter Unit/Enclosure	7	0	0	0	0	2	5	0	0
Air Handling Units	Quieter Unit/Enclosure	0	0	0	0	5	7	7	7	0
Co-Gen Pumps	Quieter Unit/Enclosure	7	0	0	0	0	2	5	0	0
Ventilation Fans	Quieter Unit	7	0	0	0	0	0	0	0	0
Cooling Towers	Quieter Unit	5	0	0	0	0	0	0	0	0
EAHU Fans	Quieter Unit/Muffler	7	0	1	0	0	5	7	7	0
Gas-Fired Generator Exhausts	Silencer	12	23	38	35	26	21	25	20	20

Table 3 Modeling Results – Without Emergency Generator

Combined Future Levels

Modeling Receptor	Receptor ID	Ambient ID	Period	LA90	Octave-Band Sound Pressure Level, L90 31.5	63.0	125	250	500	1000	2000	4000	8000
				(dBA)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)
Emmanuel Dorm - St. Ann Hall	RN1	ST-1	Night	54	68	63	61	56	51	49	43	33	21
Cardinal Cushing Library	RD1	ST-1	Day	59	76	69	66	60	56	53	47	40	27
Boston Latin School	RD2	ST-3	Day	61	73	71	68	63	59	55	50	42	32
Beatley Library (Simmons)	RD3	ST-2	Day	60	76	71	68	62	56	53	47	41	30
Park Science Center (Simmons)	RD4	ST-2	Day	60	73	70	68	62	56	53	47	41	30
Merck	B1	ST-2	Day	61	78	74	69	61	58	54	49	42	40
Harvard Medical Research 1	RD6	ST-2	Day	60	75	70	69	62	56	52	47	40	31
Harvard Medical Research 2	RD5	ST-2	Day	60	75	71	69	62	56	53	47	40	33
Harvard Medical Research 3	RD7	ST-2	Day	60	76	73	70	61	58	53	48	41	37
Wyss	RD8	ST-2	Day	58	73	70	65	58	55	52	47	39	35

Table 4 Modeling Results – Emergency Generator Only

Combined Future Levels

Modeling Receptor	Receptor ID	Ambient ID	Period	LA90	Octave-Band Sound Pressure Level, L90 31.5	63.0	125	250	500	1000	2000	4000	8000
				(dBA)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)
Emmanuel Dorm - St. Ann Hall	RN1	ST-1	Night	53	60	58	57	54	50	48	43	31	21
Cardinal Cushing Library	RD1	ST-1	Day	56	63	62	59	56	53	52	45	34	22
Boston Latin School	RD2	ST-3	Day	59	65	62	59	60	57	54	48	37	25
Beatley Library (Simmons)	RD3	ST-2	Day	56	64	63	59	57	52	50	45	36	26
Park Science Center (Simmons)	RD4	ST-2	Day	56	64	63	59	56	52	50	45	36	26
Merck	B1	ST-2	Day	56	65	63	60	57	52	51	45	36	26
Harvard Medical Research 1	RD6	ST-2	Day	56	64	63	59	56	52	50	45	36	26
Harvard Medical Research 2	RD5	ST-2	Day	56	64	63	59	57	52	50	45	36	26
Harvard Medical Research 3	RD7	ST-2	Day	56	64	63	60	57	52	51	45	36	26
Wyss	RD8	ST-2	Day	56	64	63	59	57	52	50	45	36	26

Appendix G

LEED Checklist

LEED 2009 for New Construction and Major Renovations

Project Checklist

Brigham and Women's Hospital - Alumnae Hall Site

Dec-11

Sustainable Sites — Possible Points: 26

Y	?	N			
18	3	3	**Sustainable Sites**	Possible Points:	26
Y			Prereq 1	Construction Activity Pollution Prevention	
1			Credit 1	Site Selection	1
5			Credit 2	Development Density and Community Connectivity	5
		1	Credit 3	Brownfield Redevelopment	1
6			Credit 4.1	Alternative Transportation—Public Transportation Access	6
1			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
	1		Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
	2		Credit 4.4	Alternative Transportation—Parking Capacity	2
		1	Credit 5.1	Site Development—Protect or Restore Habitat	1
		1	Credit 5.2	Site Development—Maximize Open Space	1
1			Credit 6.1	Stormwater Design—Quantity Control	1
1			Credit 6.2	Stormwater Design—Quality Control	1
1			Credit 7.1	Heat Island Effect—Non-roof	1
1			Credit 7.2	Heat Island Effect—Roof	1
1			Credit 8	Light Pollution Reduction	1

Water Efficiency — Possible Points: 10

Y	?	N			
6	2	2	**Water Efficiency**	Possible Points:	10
Y			Prereq 1	Water Use Reduction—20% Reduction	
2	2		Credit 1	Water Efficient Landscaping	2 to 4
2			Credit 2	Innovative Wastewater Technologies	2
2		2	Credit 3	Water Use Reduction	2 to 4

Energy and Atmosphere — Possible Points: 35

Y	?	N			
17	7	11	**Energy and Atmosphere**	Possible Points:	35
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
8	5	6	Credit 1	Optimize Energy Performance	1 to 19
	2	5	Credit 2	On-Site Renewable Energy	1 to 7
2			Credit 3	Enhanced Commissioning	2
2			Credit 4	Enhanced Refrigerant Management	2
3			Credit 5	Measurement and Verification	3
2			Credit 6	Green Power	2

Materials and Resources — Possible Points: 14

Y	?	N			
8		6	**Materials and Resources**	Possible Points:	14
Y			Prereq 1	Storage and Collection of Recyclables	
		3	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
		1	Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
2			Credit 2	Construction Waste Management	1 to 2
		2	Credit 3	Materials Reuse	1 to 2

Materials and Resources, Continued

Y	?	N			
2			Credit 4	Recycled Content	1 to 2
2			Credit 5	Regional Materials	1 to 2
1			Credit 6	Rapidly Renewable Materials	1
1			Credit 7	Certified Wood	1

Indoor Environmental Quality — Possible Points: 15

Y	?	N			
11	4		**Indoor Environmental Quality**	Possible Points:	15
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Outdoor Air Delivery Monitoring	1
1			Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
	1		Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
1			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
1			Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems—Lighting	1
	1		Credit 6.2	Controllability of Systems—Thermal Comfort	1
	1		Credit 7.1	Thermal Comfort—Design	1
	1		Credit 7.2	Thermal Comfort—Verification	1
1			Credit 8.1	Daylight and Views—Daylight	1
1			Credit 8.2	Daylight and Views—Views	1

Innovation and Design Process — Possible Points: 6

Y	?	N			
3	3		**Innovation and Design Process**	Possible Points:	6
1			Credit 1.1	Innovation in Design: Pilot Credit 14 - Walkable Project Site	1
1			Credit 1.2	Innovation in Design: Pilot Credit 26 - Advanced Energy Metering	1
	1		Credit 1.3	Innovation in Design: Specific Title	1
	1		Credit 1.4	Innovation in Design: Specific Title	1
	1		Credit 1.5	Innovation in Design: Specific Title	1
1			Credit 2	LEED Accredited Professional	1

Regional Priority Credits — Possible Points: 4

Y	?	N			
3		1	**Regional Priority Credits**	Possible Points:	4
1			Credit 1.1	Regional Priority: SSc6.1	1
1			Credit 1.2	Regional Priority: SSc7.1	1
1			Credit 1.3	Regional Priority: SSc7.2	1
		1	Credit 1.4	Regional Priority: Specific Credit	1

Total — Possible Points: 110

Y	?	N		
66	19	23	**Total**	Possible Points: 110

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110