Notice of Project Change

Brooke Charter High School

December 9, 2016

Submitted To: Boston Planning and Development Agency
One City Hall Square, 9th Floor
Boston, MA 02201

Proponent: Brooke Charter School
190 Cummins Highway
Roslindale, MA 02131

Prepared By: VHB
99 High Street, 10th Floor
Boston, MA 02110

In Association With:
Arrowstreet Inc.
Feldman Land Surveyors
Garcia, Galuska, DeSousa Consulting Engineers, Inc.
Klein Hornig LLP
MDM Transportation Consultants, Inc.
Nitsch Engineering
Qroe Preservation Development, LLC
Ransom Consulting Engineers and Scientists
STV | DPM

BCS Brooke CHARTER SCHOOLS

vhb

December 9, 2016

Ref: 13679.00

Mr. Brian Golden, Director
Boston Planning and Development Agency
One City Hall Square
Boston, MA 02201

Re: Notice of Project Change
Brooke Charter High School
American Legion Highway and Kingbird Road, Mattapan

Dear Director Golden:

On behalf of Brooke Charter School (the "Proponent"), VHB is pleased to submit a Notice of Project Change (NPC) for the development of a new public school known as the *Brooke Charter High School (*the "Project") to be located within the Olmsted Green Planned Development Area No. 67. The approximately 2.32-acre Project Site, which is currently vacant, is located within the boundaries of Olmsted Green, a project approved by the BRA board on January 26, 2006. The Project Site is located immediately adjacent to the existing Brooke School Mattapan, opened in 2014, which serves 510 students in grades K-8.

The NPC describes the construction of a school to accommodate approximately 780 students in grades 8 through 12. The proposed building will include core and specialty classrooms, a gymnasium, a cafeteria, an auditorium, administrative spaces, and various support spaces. The Project will also include outdoor educational space, a garden area, approximately 60 off-street parking spaces and loading/circulation areas. At approximately 95,000 total square feet, the Project is subject to Large Project Review under Article 80B of the City of Boston Zoning Code.

The Proponent hereby agrees to extend the comment period to sixty (60) days from thirty (30) days required under Article 80B. We look forward to working with you and your staff in your review of the Project. If you have any questions or would like any additional information, please do not hesitate to contact me.

Sincerely,

Stephanie Kruel

Stephanie Kruel, ENV SP
Senior Environmental Planner
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Brooke Charter High School

Boston, Massachusetts

SUBMITTED TO **Boston Planning and Development Agency**
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PROPONENT **Brooke Charter School**
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Executive Summary

In accordance with Article 80B of the Boston Zoning Code, this Notice of Project Change (NPC) is being submitted by Brooke Charter School (the "Proponent") for the proposed construction of a new public school known as the Brooke Charter High School (the "Project") at American Legion Highway and Kingbird Road in Mattapan (the "Site"). The Site is a component of the Olmsted Green Project, for which an Article 80 Large Project Review Draft Project Impact Report (DPIR) was approved in 2006 by the Boston Planning and Development Agency (BPDA), then known as the Boston Redevelopment Authority (BRA). This NPC does not modify any other component of the Olmsted Green Project, except for minor traffic modifications incidental to the school use. The proposed Project is consistent with the goals of the original master plan to provide the community with new social, educational and economic benefits and services.

Project Background

This NPC reflects changes in the proposed use of the Site, which is within the Olmsted Green Planned Development Area (PDA) No. 67. Lena New Boston LLC filed a DPIR for Olmsted Green on November 5, 2005 and the BPDA Board approved the project on January 26, 2006. Since that time, the Olmsted Green project has advanced, with many components now complete, including Hearth at Olmsted Green Senior Housing development, three phases of the East and West Campus residential developments, and infrastructure and open space areas.

At the time of the DPIR, the Project Site was proposed to include a 123-bed skilled nursing facility to be developed, owned, and operated by the Vinfen Corporation (referred to in the DPIR as Parcel 2B-2), and office, program and exhibition space for Heritage House, serving Department of Mental Health clients (referred to in the DPIR as Parcel 2B-3). These facilities are no longer needed due to the construction of several DMH community-based group home facilities and future plans to construct an additional group home at Harvard Commons. The proposed use for the Project Site has since changed to include the Brooke Charter High School. Concurrently with this NPC, the Proponent is submitting an application to amend the PDA Plan to incorporate the changes described in this NPC, as well as the corresponding amendments to the land disposition agreement with the Division of Capital Asset Management and Maintenance.

Massachusetts Environmental Policy Act

While the Project will not exceed any of the MEPA review thresholds set forth in 301 CMR 11.03, the Proponent has filed a Request for Advisory Opinion with the Executive Office of Energy and Environmental Affairs (EOEEA), to determine whether the Project is required to submit a Notice of Project Change, Environmental Notification Form or Environmental Impact Report to the Secretary, due to the fact that the Site was included in a previous MEPA filing.

Project Site Context

The Project Site is an approximately 2.32 acre parcel located on American Legion Highway at Kingbird Road in the Mattapan neighborhood of Boston. It lies across the street from Franklin Park and is adjacent to the Brooke School Mattapan, the Massachusetts Department of Youth Services Correctional facility, and the Hearth at Olmsted residential development.

Project Description

Brooke Charter School (BCS) is a network of three high performing K-8 public charter schools in the Boston neighborhoods of Roslindale, Mattapan and East Boston. The newest addition to the BCS is Brooke Charter High School, which was opened in August 2016 in a temporary facility in South Boston. The school is seeking to construct a permanent facility adjacent to their Brooke Mattapan location at 150 American Legion Highway to house 600 students in grades 9 through 12 and an Eighth Grade Academy with an enrollment of 180 students for a total of 780 students. Enrollment at Brooke Mattapan will decrease to 480 Students. The approximately 95,000 gross square foot building will include core and specialty classrooms, a gymnasium, a cafeteria, an auditorium, administrative spaces, and various support spaces. The Project will also include outdoor educational space, a garden area, approximately 60 off-street parking spaces and loading/circulation areas. The building will be up to approximately 65 feet tall with an FAR of 0.94. BCS plans to open this new facility in summer of 2018.

Summary of Project Impacts

The proposed Project, which is larger than the originally proposed project by approximately 25,000 square feet, is expected to result in increased impacts related to trip generation, water use, and wastewater generation. No significant impacts are anticipated related to shadow, solar glare, air quality, water quality, flood hazards, noise, groundwater, geotechnical, or historic resources. The anticipated impacts of the proposed Project are summarized below.

Urban Design

- The Brooke Charter High School building will reflect Brooke Charter School's educational vision, core values and academic mission to ensure students are prepared to enter into and succeed in college.

- The Site location and design will allow for a direct connection between the existing and new schools, resulting in a true educational campus.
- The selected exterior materials will give the building a contemporary appearance. Materials will be selected by balancing first-cost and life-cycle cost considerations.
- On American Legion Highway trees will be newly planted or preserved to provide a continuous green canopy along the pedestrian path. Native trees, shrubs and ground covers that are non-invasive and easily maintainable are proposed.
- A new parking area will be constructed on the corner of Kingbird and American Legion Highway to serve the staff and the community, and will include a drop-off/pick-up location.

Sustainability and Green Building

- The Project will be LEED v4 certifiable.
- The Project will be designed using efficient heating, cooling and lightings systems resulting in an energy cost savings of 26% as compared to the LEED v4 baseline.
- The Project's stormwater management system will be designed to adequately manage on-site stormwater for the Project's design life.

Transportation

- The student population will primarily utilize public transportation to travel to the Site.
- While the Project will generate approximately 939 total weekday morning peak period trips (200 automobile, 481 transit and 159 school bus) and 640 weekday evening peak period trips (219 automobile, 320 transit, and 81 school bus), only approximately 34% and 37%, respectively, are anticipated to be vehicular trips due to the ability of students to access the Project Site by public transit, school bus, bicycle and foot.
- On-site parking includes 60 spaces for staff, three of which are accessible. On street parking for visitors is available on both East Main and Austin streets.
- The Project will not significantly impact overall Level of Service at study area intersections.
- A construction management plan will be created to minimize transportation impacts during the construction period.

Daylight

- Under the Build Condition, all viewpoints are expected to experience an increase in skyplane obstruction as follows: 25.6% obstruction along American Legion Highway; 10.8% along Austin Street; 32.3% along East Main Street. This effect is to be expected and cannot be avoided when a new building is constructed on a vacant parcel.

Solid and Hazardous Materials

- Hazardous materials releases on the Site associated with the former Boston State Hospital East Campus are tracked under Release Tracking Numbers (RTNs) 3-13282 and 3-19713. Upon completion in 2006 of several Release Abatement Measures (RAMs) a Class A-3 Response Action Outcome (RAO) Statement indicated that a Permanent Solution had been achieved.
- A recent Phase I Environmental Site Assessment (ESA) found no evidence of storage or a release of oil or hazardous material (OHM), or a significant amount of solid waste at the Site.
- If encountered, urban fill at the Site will require management in accordance with the Massachusetts Contingency Plan.

Construction

- A plan to control construction-related impacts including erosion, sedimentation, and other pollutant sources during construction and any land disturbance activities will be developed and implemented. All regulations related to construction-period air quality, noise, traffic and parking, trucks, hazardous materials, rodent control, and public safety will be adhered to.

Stormwater

- Although the proposed Project will increase impervious cover on the Site, it will also incorporate an upgraded stormwater system designed to treat and recharge stormwater to the maximum extent practicable.
- The Project will be designed to comply with the Massachusetts Stormwater Management Standards, and will decrease or maintain the peak flow rate and volume of stormwater runoff from the site.

Water Demand and Sanitary Sewage Generation

- The water demand for the Project is estimated to be 18,986 gallons per day (gpd).
- The Project is expected to generate 17,260 gpd of wastewater.

Summary of Proposed Mitigation

Mitigation will include the following transportation-related actions:

- Site Access and Circulation Improvements: New signage and pavement markings to clarify directional flow on East Main Street; maintenance of low vegetation to maintain sight lines; designated loading and service activity areas; designated student drop-off/pick-up area; and school zone signage enhancements.

- American Legion Highway/Kingbird Road Intersection: The Proponent will work with the BTD to determine whether modifications to the traffic signal timing or increased left turn storage capacity at the American Legion Highway/Kingbird Road intersection will be required to address the projected vehicle delay and queuing increase at the intersection.
- Traffic Management Plan: Clear and efficient circulation for student pick-up/drop-off area; staggered start and dismissal times for the two adjacent schools; use of a designated bus lane on Austin Street; managed internal pedestrian crossings; and enforcement of "no stopping" areas along American Legion Highway.
- Pedestrian Improvements: Sidewalks and ADA compliant crosswalks constructed to connect to adjacent pedestrian facilities and promote pedestrian activity. A pedestrian access path, entry forecourt and site identification signage will be constructed at the corner of Kingbird and American Legion Highway, in addition to surface parking and edge buffered landscape to serve the staff and community.

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General Information and Project Description

The Brooke Charter School (the "Proponent") submits this Notice of Project Change (NPC) to the Boston Planning and Development Agency (BPDA) to initiate the Article 80B Large Project Review process required by the Boston Zoning Code and Enabling Act for construction of a new public secondary school at American Legion Highway and Kingbird Road in Mattapan (the "Project").

This chapter provides an overview of the existing site conditions and describes the Project and its public benefits as well as identifies the anticipated required permits and approvals. This chapter also describes how the Project is consistent with applicable plans and policies, and how it compares to the program previously approved for the Project Site as part of the Olmsted Green project approved by the BPDA Board on January 26, 2006.

1.1 Site Context and Existing Conditions

The Project Site is located in the Mattapan neighborhood (Figure 1.1), which is home to a diverse population primarily made up of Haitians, other Caribbean immigrants, and African Americans. The housing mix includes small apartment buildings, single-family homes, public housing, and Boston's traditional "triple-deckers." Mattapan residents enjoy a significant amount of green space, including Franklin Park, a permanently protected open space located directly across the street from the Project Site.

The Project Site consists of two vacant parcels of land, known as Parcels 2B-2 and 2B-3, totaling 2.32 acres. It is bordered on the northwest by American Legion Highway and Franklin Park; on the northeast by Austin Street and the Lena Park Community Development Corporation (CDC) and the Brooke Charter School Mattapan (510 students in grades K-8); on the southeast by East Main Street and the Massachusetts Department of Youth Services Correctional Facility and Lena Park CDC's Brown Kaplan multifamily development; and on the southwest by Kingbird Road and the Hearth at Olmsted Green residential development (159 units) (Figures 1.2, 1.3, and 1.4)

The Project Site is located within the eastern section of Olmsted Green, a project begun in 2005 to redevelop the site of the former Boston State Hospital (1839 – 1985), which sat vacant

for 20 years after its decommissioning. New Boston Fund partnered with Lena Park CDC, Boston's oldest African American CDC, to redevelop the Site. The Project Site was originally envisioned as the site for a 123-bed skilled nursing facility, to be developed, owned, and operated by the Vinfen Corporation (Parcel 2B-2), and Heritage House, envisioned as a clubhouse and day program for Department of Mental Health (DMH) clients, offices for the Alliance for the Mentally Ill, and an exhibition space to display and honor the mental health heritage of the former Boston State Hospital (Parcel 2B-3).

The Vinfen proposal was withdrawn several years ago and these facilities are no longer needed due to the construction of several DMH community-based group home facilities and future plans to construct an additional group home at Harvard Commons. In an October 27, 2016 letter to Commissioner Carol Gladstone of Commonwealth of Massachusetts Division of Capital Asset Management and Maintenance (DCAMM), the Boston State Hospital Citizens Advisory Committee (CAC) formally recommended the deprogramming of Parcel 2B-3 originally designated for the construction of Heritage House in order to allow for the inclusion of the site "as part of any assembly of the former Vinfen site for development."

1.2 Project Description

Founded in 2002, Brooke Charter School (BCS) is a network of three high performing K-8 public charter schools in the Boston neighborhoods of Roslindale, Mattapan, and East Boston. Brooke's mission is to provide an academically rigorous public education to students from the cities of Boston and Chelsea that will ensure that they are prepared to attend and succeed in college. In February 2016, the Massachusetts Department of Elementary and Secondary Education (DESE) approved the consolidation of the charters of Brooke Charter School Roslindale, Brooke Charter School Mattapan, and Brooke Charter School East Boston into one charter. They also authorized an expansion of an additional 690 seats to include a 600-seat high school for grades 9 through 12 and 30 additional K-8 students.

The Brooke Charter High School was opened in August 2016 in a temporary facility at 7 Elkins Street in South Boston to accommodate its first class of 9th grade students. Although generally in good condition, the existing location does not provide the type of educational spaces necessary to meet the school's needs and expand its enrollment. The school is seeking to relocate to a new site adjacent to its Brooke Mattapan location at 150 American Legion Highway and construct a new school building to house 600 students in grades 9 through 12 and an Eighth Grade Academy with an enrollment of 180 students for a total of 780 students. Enrollment at Brooke Mattapan will decrease to 480 students. BCS plans to open the new facility in time for the 2018/2019 School Year.

1.2.1 Development Program

The Proponent has identified the following Educational Program improvement priorities:

- Support a student population of 600, grades 9 through 12;

- Support a student population of 180, grade 8;
- Support a staff population of 83;
- Provide regulation basketball gymnasium to support use by high school students, afterschool programs and the surrounding community;
- Provide a cafeteria space to support lunch seating for 300 students;
- Provide an auditorium space to support seating for 650 people for morning meeting, special events, afterschool programs, community events;
- Create Main office suite and satellite offices; and
- Create teacher work room areas.

To address BCS's stated priorities, the following spaces are being proposed for the new school.

- Core Classrooms
  - Eighth grade
  - Spanish
  - Humanities
  - Math
  - Buffer classroom
- Shared Spaces
  - Chemistry labs
  - Biology lab
  - Physics lab
  - Computer Science labs
  - Robotics labs
  - Art room
  - Break out rooms
  - Dance studio
  - Workout room
  - Cafeteria
  - Gymnasium
  - Auditorium
- Administrative Spaces
  - Reception area
  - Nurse office
  - Director of Operations
  - Network office
  - Principal's office
  - Dean of Students' office
  - Assistant Principal's office
  - Counselor's office
  - Special Education office
  - Conference rooms
  - College Counsel suite
- Teacher Work Rooms
- Support Spaces
  - Servery
  - Storage
  - Copy rooms
  - Locker rooms
  - Rest rooms

Figure 1.5 depicts the proposed site plan for the Project. Figure 1.6 is a rendering of the Project as viewed from American Legion Highway. Figures 1.7a-e provide the Project's floorplans, while Figure 1.8 includes building sections. Table 1.1 below includes the proposed development program.

TABLE 1.1 PROPOSED DEVELOPMENT PROGRAM

Site Area	2.32 acres
Building Gross Square Footage	95,000 gsf
FAR	0.94*
Height	Up to 65 feet
Parking	60 spaces

*FAR based on Project Site as described in this NPC.

1.2.2 Schedule

BCS will need to relocate the new high school from its temporary site at 7 Elkins Street in South Boston to the new Project Site by August of 2018 in order to welcome students for the 2018-2019 School Year. Major development milestones for the Project are listed in Table 1.2 below.

TABLE 1.2 PROJECT DEVELOPMENT MILESTONES

Project Milestones	Date
CM at Risk Selection	January 2017
Site Acquisition	May 2017
Design	April (early release) June 100%
Bidding	April 2017
Permitting Completed	May 2017
Construction Start	May 2017
Occupancy	August 2018

The Project will take approximately 15 months to construct. It is expected to employ 150 FTEs in construction related jobs with an emphasis on the hiring of Boston residents and MBE/WBE participation. Approximately 40 permanent jobs will be created for faculty and staff as the school approaches its projected full enrollment. Opportunities for contracting services will also exist for maintenance, waste management, landscaping, food and custodial services.

1.2.3 Summary of Public Benefits

The Project will result in the following community benefits:

- The BCS opened its first school in the Roslindale neighborhood of Boston in 2002 serving grades K-8. It has since grown to serve the East Boston and Mattapan neighborhoods. The introduction of grades 9-12 will allow BCS to continue providing consistency in learning as its student population matriculates to high school.
- The Project will bring convenient access to another high performing charter school for the Roxbury, Dorchester, Mattapan, and Jamaica Plain neighborhoods.
- Brooke Charter High School will create an atmosphere of achievement, both in the school and in the community, where students value focus, integrity, respect, self-determination, and teamwork.
- The Project Site is adjacent to the Department of Youth Services Correctional Facility, which has long evoked a negative perception of the city's youth. Brooke Charter High School will help to counter that impression by showing the city's youth in a positive light.
- The school's gymnasium and auditorium will provide space for community events outside of regular school hours. The community will also be able to enjoy the Project's outdoor learning area and garden.

1.3 Regulatory Context

This section lists the anticipated permits and approvals as well as the local planning and regulatory controls applicable to the Project.

1.3.1 Olmsted Green Planned Development Area No. 67

The currently proposed Project will have similar impacts as the projects previously proposed for the Project Site related environmental impacts, stormwater management, and considerations for sustainable design. Table 1.3 below compares impacts that would differ between the previous and current proposals.

TABLE 1.3 COMPARISON OF PREVIOUSLY APPROVED AND PROPOSED PROJECTS

Impacts	Previously Proposed Project	Currently Proposed Project	Difference
Building Characteristics			
Building Size (gsf)	69,587	95,000	+25,415
Height (feet)	36	65	+29
FAR	0.69*	0.94*	+0.25
Traffic			
Vehicular Trip Generation – Weekday Morning Peak	22	323	+301
Vehicular Trip Generation – Weekday Evening Peak	28	239	+211
Parking Spaces	40	60	+20
Infrastructure			
Water Use (gpd)	Unavailable	18,986	Unavailable
Wastewater Generation (gpd)	Unavailable	17,260	Unavailable

*FAR is based on the Project Site as described in this NPC.

1.3.2 Anticipated Permits/Approvals

Table 1.4 lists the permits and approvals from state and local governmental agencies that are anticipated to be required for the Project.

TABLE 1.4 ANTICIPATED PROJECT PERMITS AND APPROVALS

Agency/Department	Permit/Approval/Action
Commonwealth of Massachusetts	
Division of Capital Asset management and Maintenance (DCAMM)	Land Disposition Agreement consent for project change
Massachusetts Historical Commission	State Register Review

Agency/Department	Permit/Approval/Action
Department of Environmental Protection Division of Water Pollution Control	Sewer Connection and Extension Permit
Department of Environmental Protection, Division of Air Quality Control	Air Plan Approval (if boilers >40,000 MMBTU)
City of Boston	
Boston Planning and Development Agency	Article 80 Large Project Review Amendment to Development Plan for PDA Cooperation Agreement Boston Residents Construction Employment Plan (BRCEP) Agreement
Boston Parks Commission	Approval of construction within 100 feet of a park
Boston Transportation Department	Construction Management Plan Transportation Access Plan Amendment
Boston Water and Sewer Commission	Sewer Use Discharge Permit Site Plan Approval Construction Dewatering Permit Sewer Extension/ Connection Permit Stormwater Connection
Public Improvement Commission	Specific Repair Approval
Zoning Commission	Amendment to Development Plan for PDA
Boston Inspectional Services Department	Building and Occupancy Permits
Boston Public Improvement Commission	Street and Sidewalk Occupation Permits
Boston Public Works Department	Curb Cut Permit; Street Occupancy Permit
Boston Fire Department	Plan Review

1.3.3 Local Planning and Regulatory Controls

The following is a description of elements of the City of Boston Zoning code and the Article 80 process that are relevant to the Project.

City of Boston Zoning

The Project is situated in the Enterprise Protection (EP) Subdistrict of the Greater Mattapan Neighborhood District, Article 60 of the Boston Zoning Code (Code). The Project is also situated in the following overlay districts:

- American Legion Highway Greenbelt Protection Overlay District (GPOD) pursuant to Section 29-7.3 of the Code;
- Planned Development Area No. 67 established pursuant to Sections 3-1A.a and 60-30 of the Code; and
- Olmsted Green Smart Growth Overlay District (SGOD) established pursuant to Article 87A of the Code.

Uses

The Proponents intended construction and operation of an elementary or secondary school on the Site is an allowed use in the EP Subdistrict.

Dimensional Requirements

Table 1.5 below outlines the dimensional regulations for the EP Subdistrict as modified by the PDA Plan as well as the proposed Project dimensions.

TABLE 1.5 ZONING CODE DIMENSIONAL REGULATIONS VS. PROPOSED PROJECT DIMENSIONS

Dimensional Requirements	EP Subdistrict/ PDA No. 67	Proposed Project
Maximum Floor Area Ratio	0.5 (overall in PDA)	0.94*
Maximum Building Height	55 feet	65 feet
Minimum Front Yard	20 feet	< 20 feet

*FAR is based on the Project Site as described in this NPC.

Parking and Loading

Section 60-40 of the Code provides that parking and loading requirements will be determined in the Article 80 Large Project Review process. The PDA Plan requires approximately 371 parking spaces on the Olmsted Green East Campus of which approximately 253 spaces are to be off-street and approximately 118 spaces are to be on-street. The Project will provide 60 off-street parking spaces.

GPOD

The Development Plan for Planned Development Area No. 67 (PDA Plan) provides that inclusion of a Project in the PDA Plan constitutes compliance with GPOD requirements.

PDA

Concurrently with this NPC, the Proponent is submitting an application to amend the PDA Plan to incorporate the changes described in this NPC.

SGOD

Section 87-4 of the Code provides that in a SGOD the use and other regulations of the underlying zoning and any other overlay districts shall remain in full force and effect, unless an applicant requests approval of a Smart Growth Development Plan. The Proponent does not intend to request approval of a Smart Growth Development Plan for the Project.

City of Boston Zoning Code Article 80 – Large Project Review

The Project is one component of the Olmsted Green development (Olmsted Green) undertaken by Lena New Boston LLC (Lena New Boston). The entire Olmstead Green project included construction and rehabilitation of up to 852,000 square feet of residential and

community services facilities on approximately 42.5 acres in Mattapan, located on a portion of the site of the former Boston State Hospital and an adjacent parcel owned by Lena Park CDC. Olmstead Green has been the subject of Large Project Review by the BPDA pursuant to Article 80B, Large Project Review of the Code.

On January 18, 2005, Lena New Boston initiated Article 80 Large Project Review for Olmsted Green by filing a Project Notification Form (PNF) for Large Project Review. The BPDA issued a Scoping Determination, pursuant to Section 80B-5 of the Code, on March 22, 2005. On November 3, 2005, Lena New Boston filed a Draft Project Impact Report (DPIR) for Olmsted Green. On January 22, 2006, the BPDA Board voted to issue a Preliminary Adequacy Determination under Section 80B-4(c)(iv) which (i) found that the DPIR adequately described the potential impacts of the Olmsted Green and provides sufficient mitigation measures to minimize these impacts, and (ii) waived further review, subject to continuing design review by the BPDA.

On September 6, 2012, Lena Park CDC and the Proponent, in conjunction with Lena New Boston, filed a Notice of Project Change (2012 NPC) to update the DPIR for Olmsted Green pursuant to Article 80 of the Code, to reflect a change in the proposed development of the Lena Park Parcel from the training, education, job training center and recreation facility described in the DPIR to a school and community center. On November 15, 2012, the BPDA Board voted to issue a Determination under Section 80A-6 of the Code, which (i) found that 2012 NPC adequately described the potential impacts arising from the renovation of the building located at 150-160 American Legion Highway for the Edward W. Brooke Charter School, and (ii) waived further review of the Edward W. Brooke Charter School portion of the Olmsted Green project, subject to continuing design review by the BPDA.

This NPC is submitted pursuant to Section 80A-6 of the Code and presents details about the Project and provides an analysis of the changes in transportation, environmental protection, infrastructure, and other components of the proposed Project, in order to inform city agencies and neighborhood residents about the Project, its potential impacts and mitigation proposed to address those potential impacts. Based on a comprehensive approach to address potential impacts similar to the level of information presented in in the DPIR, the Proponent requests that the BPDA, after reviewing public and agency comments on this NPC and any further responses to comments made by the Proponent, issue a Scoping Determination Waiving Further Review pursuant to the Article 80B process.

1.3.4 Massachusetts Environmental Policy Act

The Project Site is a portion of the former Boston State Hospital property. The disposition of State property including the Site by DCAMM to Lena New Boston LLC was subject to MEPA review in Docket No. 10681. DCAMM commenced the MEPA review process by filing an Environmental Notification Form in 1996. DCAMM subsequently submitted an Environmental Impact Report and several notices of project changes. The most recent activity in this matter

was the issuance of a determination by EOEEA dated March 14, 2008 that no further review was required.

While the Project will not exceed any of the MEPA review thresholds set forth in 301 CMR 11.03, the Proponent has filed a Request for Advisory Opinion with the Executive Office of Energy and Environmental Affairs (EOEEA), to determine whether the Project is required to submit a Notice of Project Change, Environmental Notification Form or Environmental Impact Report to the Secretary.

1.4 Agency Coordination and Community Outreach

The Project Team and Lena New Boston has been meeting with residents, neighborhood groups, community leaders, elected officials, City of Boston officials, and other stakeholders to seek input and feedback as the redevelopment plan evolves. Additional community meetings will take place following the submission of the NPC. To date, the following meetings have taken place:

- BPDA: Brooke Project Team with BPDA, November, 2016;
- City Council: Brooke Co-Director Jon Clark and Andrea Campbell, District 4;
- Community Groups: Lena Park CDC; attendance at three Boston State Hospital Citizens' Advisory Committee meetings;
- City Departments: Rahn Dorsey, Chief of Education; Office of the Mayor; and
- State Officials: State Representative Russell Holmes; State Senator Sonia Chang-Diaz; Commissioner of DCAMM, Carol Gladstone.

1.4.1 Impact Advisory Group

The Boston State Hospital Citizen's Advisory Committee (CAC) is the designated Impact Advisory Group for the Project. The CAC first was convened in 1985 to advise the State on development guidelines and review the environmental impacts of possible uses for the land formerly known as the Boston State Hospital site, which was a complex of care facilities related to mental health in operation from the 1700s until it closed in 1979.

In 1993, a Master Plan for the Boston State Hospital site was completed by State officials, the CAC, the Massachusetts Audubon Society, and Franklin Place Associates, among others. Since that time, the CAC has led community meetings, provided oversight and served as the IAG for the Olmstead Green redevelopment project.

1.5 Development Team

Proponent	Brooke Charter Schools 190 Cummins Highway Roslindale, MA 02131 Jon Clark, Co-Director 617-325-7977 jclark@brooke.org
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Owner's Project Manager	STV|DPM One Gateway Center, Suite 951 Newton, MA 02458-2805 James Kolb, Vice President 617-614-9306 James.Kolb@stvinc.com
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Legal Counsel	Klein Hornig LLP 101 Arch Street, Suite 1101 Boston, MA 02111 John Achatz 617-224-0608 jachatz@kleinhornig.com
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Civil Engineer	Nitsch Engineering 186 Lincoln Street, #200 Boston, MA 02111

	Chelsea Christenson, Project Manager Phone: 617-338-0063 cchristenson@nitscheng.com
Environmental/Hazardous Materials Consultant	Ransom Consulting Engineers and Scientists 12 Kent Way, Suite 100 Byfield, MA 01922 Tim Snay, LSP 978-465-1822 tsnay@ransomenv.com
MEP/FP Engineering	Garcia, Galuska, DeSousa Consulting Engineers, Inc. 370 Faunce Corner Rd Dartmouth, MA 02747 Carlos DeSousa 508-998-5700
Surveyor	Feldman Land Surveyors 112 Shawmut Avenue Boston, MA 02118 Michael Feldman 617-357-9740 mfeldman@harryfeldman.com

1.6 Legal Information

1.6.1 Legal Judgments or Actions Pending Concerning the Proposed Project

The Proponent is not aware of any legal judgments or actions pending concerning the Project.

1.6.2 History of Tax Arrears on Property Owned in Boston by the Proponent

The Proponent owns no property in the City of Boston for which property taxes are in arrears.

1.6.3 Site Control/Public Easements

The Proponent has entered into an agreement with Lena New Boston LLC, the current owner of the Project Site, to purchase the Project Site.

Title to the Project Site includes a fee interest to the centerline of Austin Street.

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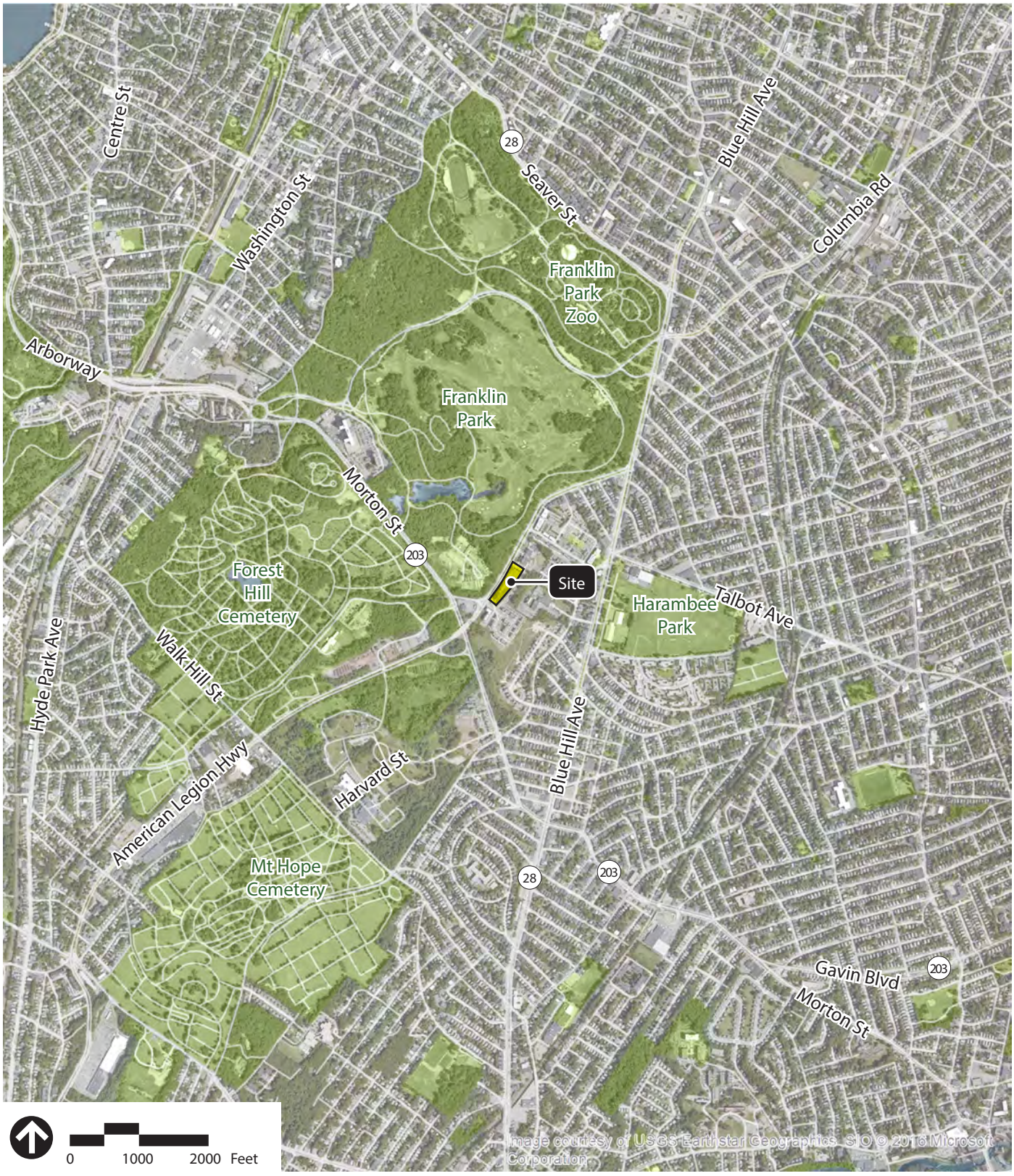

Figure 1.1

Site Location Map

Brooke Charter High School
Boston, Massachusetts

Source: ArcGIS Bing Aerial

Project Site

Figure 1.2

Project Site Context

Brooke Charter High School
Boston, Massachusetts

Source: ArcGIS Bing Aerial

Project Site

MBTA Bus Stop

Figure 1.3

Existing Conditions

Brooke Charter High School
Boston, Massachusetts

American Legion Highway and Austin Street

American Legion Highway and Kingbird Road

Kingbird Road and Main Street

Source: Arrowstreet

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Figure 1.4
Existing Site Photographs

Brooke Charter High School
Boston, Massachusetts

Source: Arrowstreet

ARROWSTREET

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Figure 1.5
Proposed Conditions

Brooke Charter High School
Boston, Massachusetts

Source: Arrowstreet

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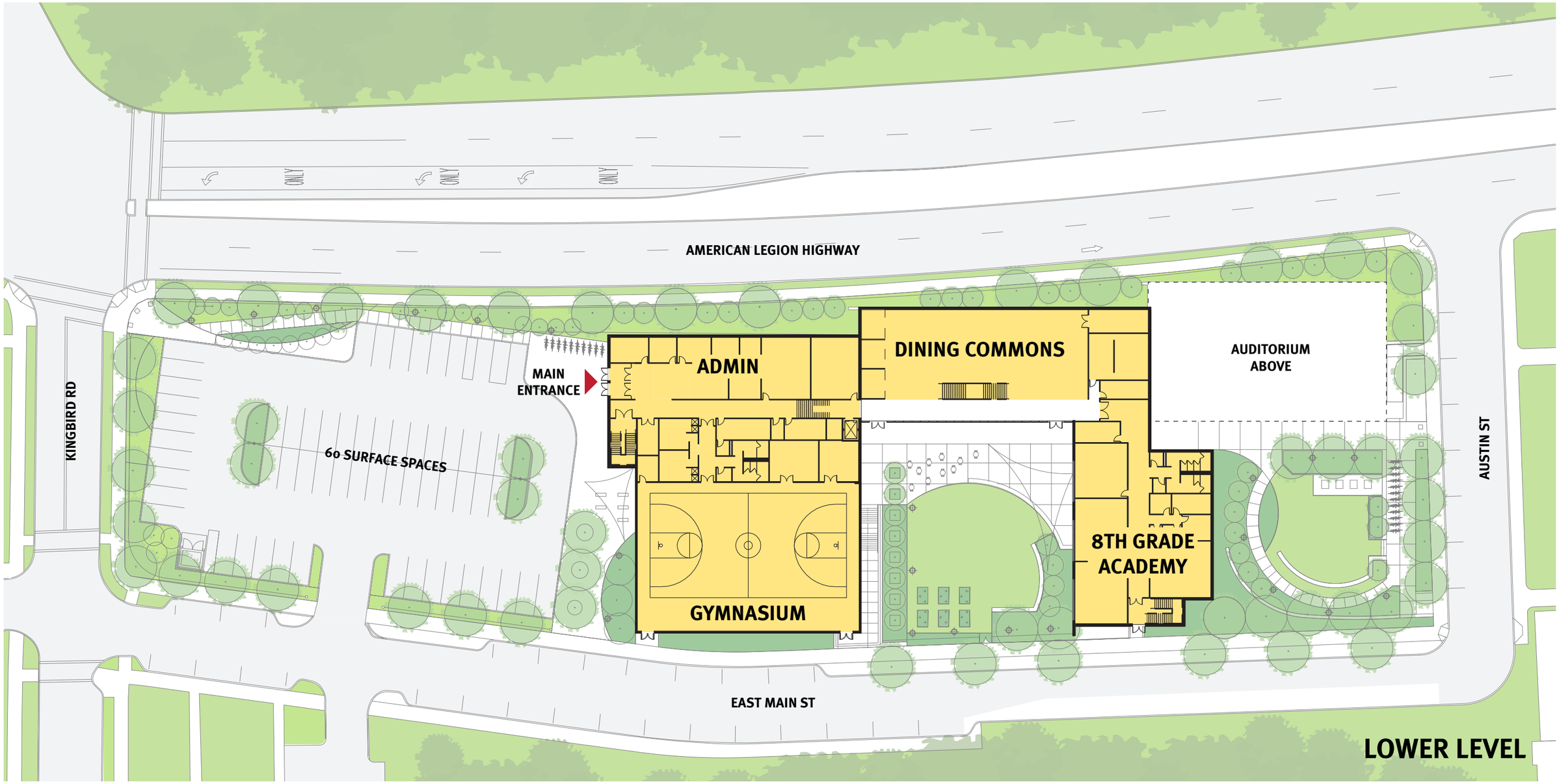
Figure 1.6
Project Rendering

Brooke Charter High School
Boston, Massachusetts



Source: Arrowstreet

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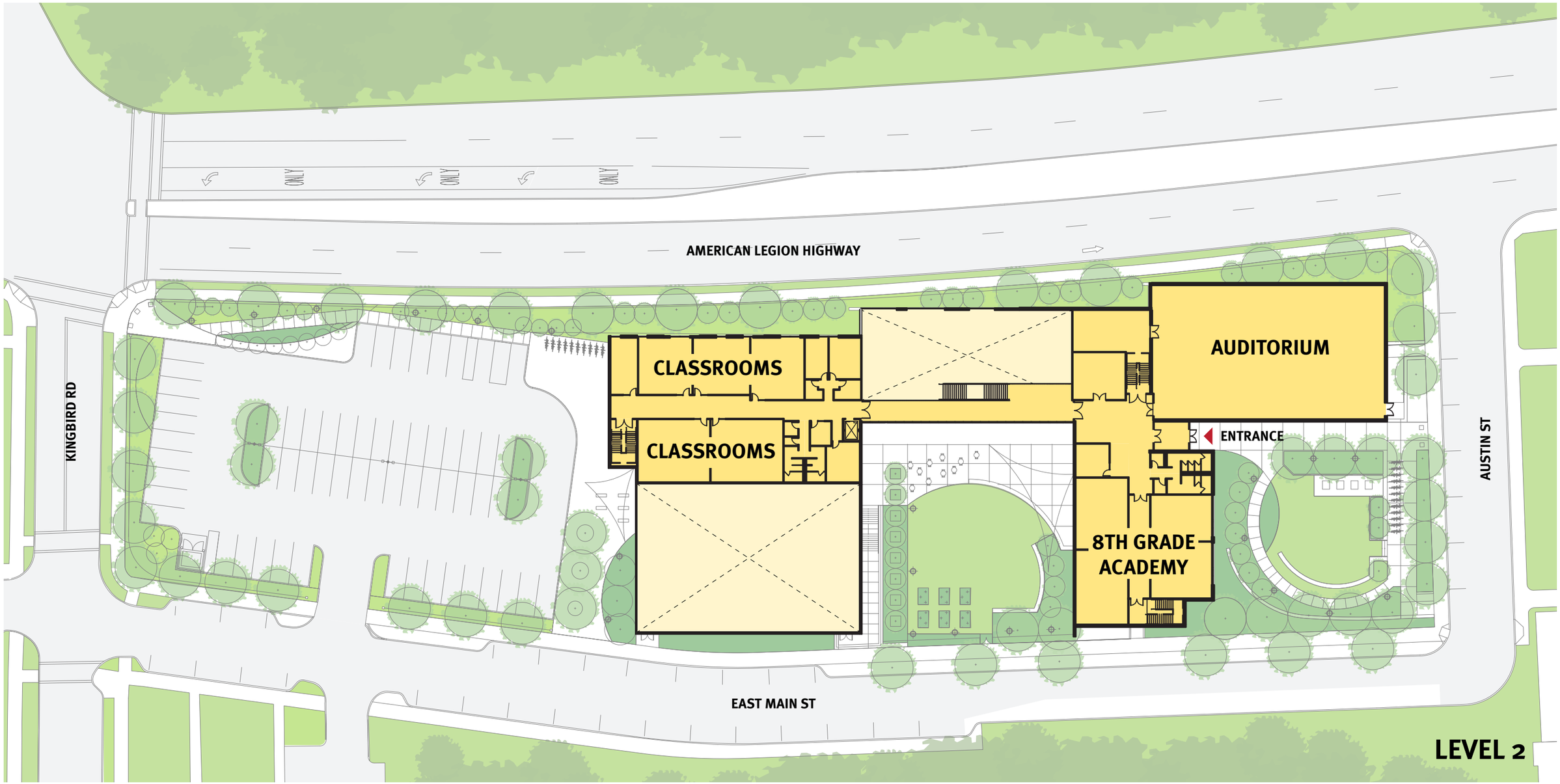
Figure 1.7a

Project Floorplans
Ground Floor

Brooke Charter High School
Boston, Massachusetts



Source: Arrowstreet

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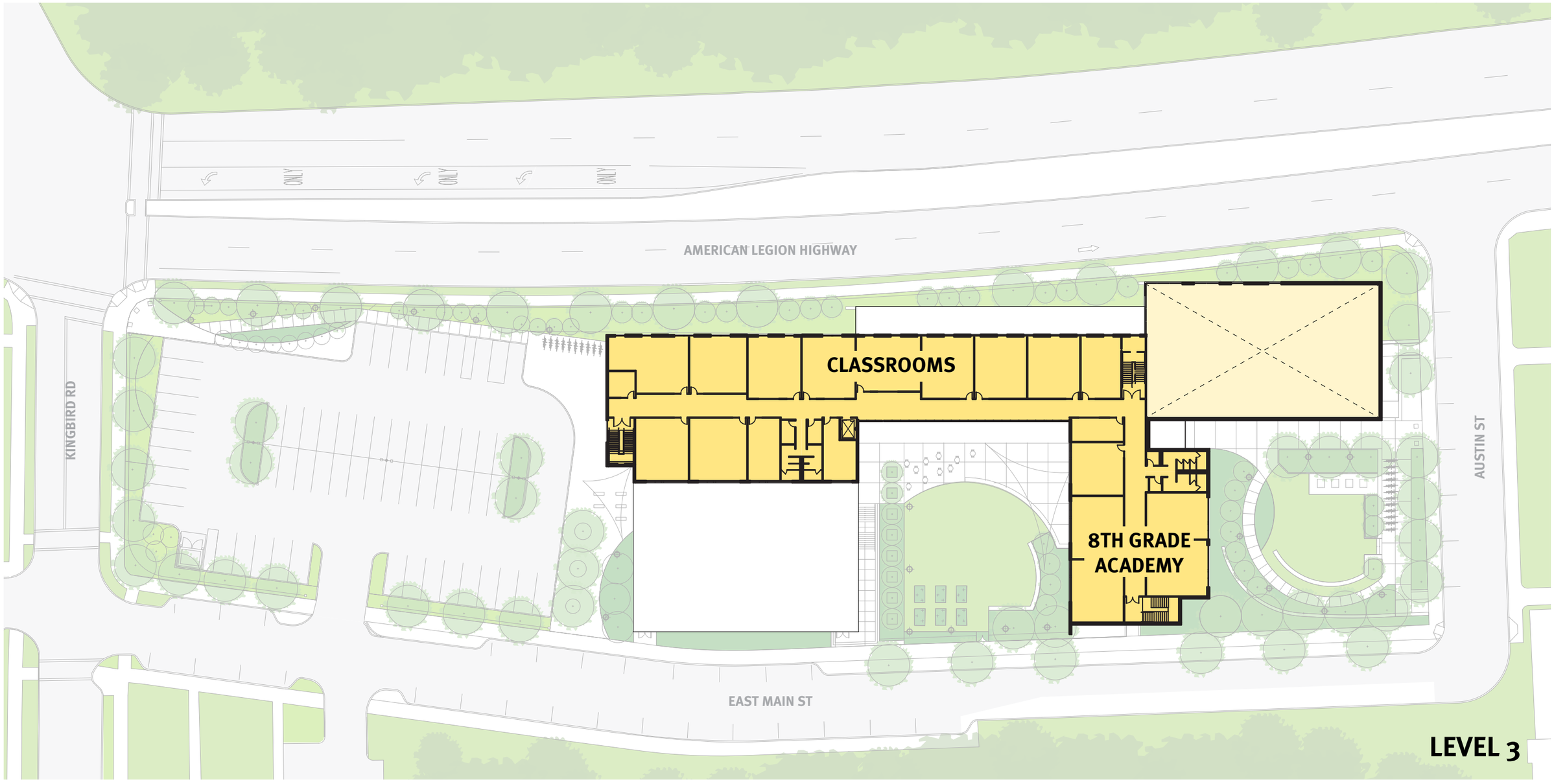
Figure 1.7b

Project Floorplans
Level 2

Brooke Charter High School
Boston, Massachusetts



Source: Arrowstreet

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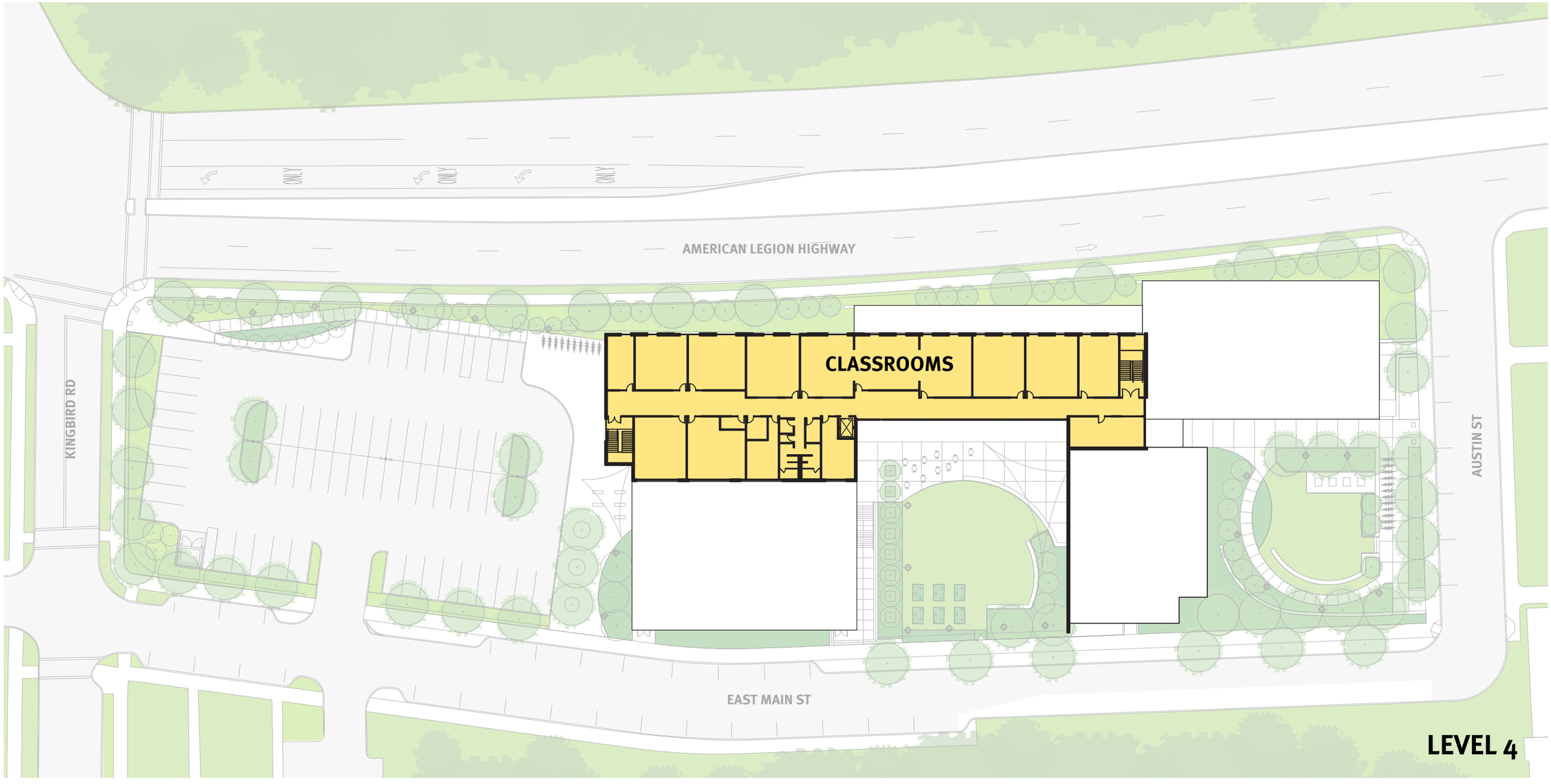
Figure 1.7c

Project Floorplans
Level 3

Brooke Charter High School
Boston, Massachusetts



Source: Arrowstreet

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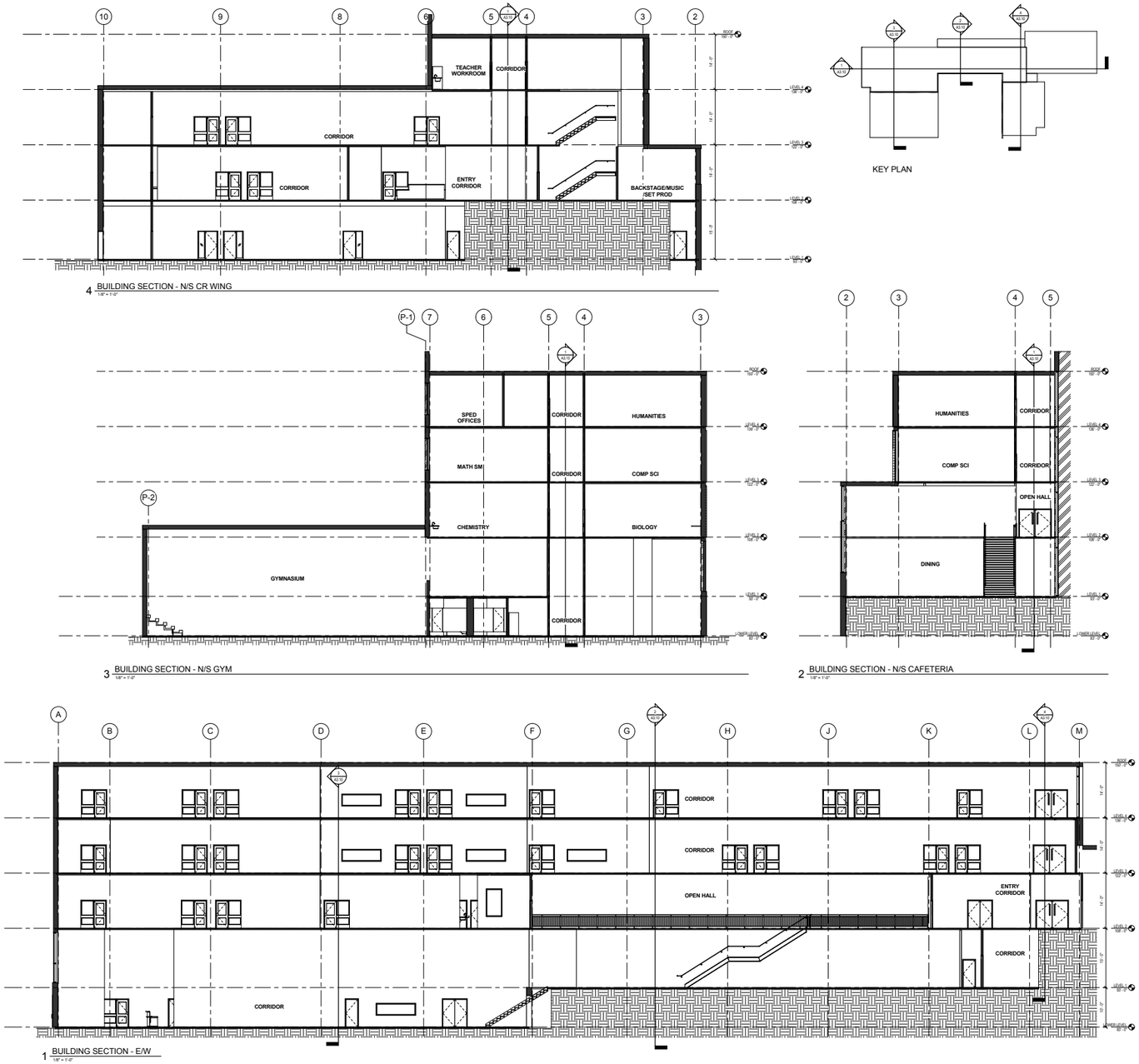
Figure 1.7d

Project Floorplans
Level 4

Brooke Charter High School
Boston, Massachusetts



Source: Arrowstreet

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Figure 1.8
Building Sections

Brooke Charter High School
Boston, Massachusetts

2

Urban Design

This chapter describes the existing urban context of the Project Site, and discusses the planning principles and design goals for the Project. It also describes the proposed conditions urban design characteristics (i.e., height and massing) and public realm improvements, including proposed landscaping. Supporting graphics include building massing, building elevations, and a landscaping plan. Refer to Figure 1.5 for the Proposed Site Plan.

2.1 Key Findings and Benefits

- The Brooke Charter High School building will reflect Brooke Charter School's educational vision, core values and academic mission to ensure students are prepared to enter into and succeed in college.
- The Project Site will allow for a direct connection between the existing and new schools, resulting in a true educational campus.
- The sloped topography of the Project Site works in the Project's favor to reduce massing and minimize its visual impact. The height of the building varies and will be up to approximately 65'-0" above grade at its highest point.
- The character of the School will be both welcoming and inclusive, achieved through building massing and organization and the placement of fenestration which allows for a clear understanding of its function. The exterior skin will combine two warm-tone durable materials giving the building a contemporary appearance, while respecting the traditional character of the existing adjacent school building. Materials will be selected by balancing first-cost and life-cycle cost considerations.
- The pedestrian realm will be enhanced with a number of conveniences throughout the Project Site. Key elements will include a forecourt at the intersection of Kingbird Road and American Legion Highway and pedestrian walking paths through and around the Project Site.
- Trees along American Legion Highway will be newly planted or preserved to provide a continuous green canopy along the pedestrian path. Native trees, shrubs and ground covers that are non-invasive and easily maintainable are proposed.

- The site design concept is to create several green spaces acting as courtyards and garden areas along East Main Street to serve the academic goals for the School and provide students with exterior amenities.
- As part of the formal site organization the Project will respond to the gateway context at the intersection of American Legion and Kingbird Road, which is the entry point to new residential developments within Olmstead Green.
- A new pedestrian access path, entry forecourt and site identification signage will be constructed at the corner of Kingbird Road and American Legion Highway, in addition to surface parking and edge buffered landscaping, to serve the staff and community.
- The on-site parking area includes 60 spaces, three of which are accessible, to accommodate staff. It also includes a parent drop-off/pick-up area. Approximately 30 on-street parking spaces on East Main and Austin streets are available for visitors.
- The Project will improve accessibility around and through the Project Site with accessible grades, walkways, curb cuts and detection strips.

2.2 Neighborhood Context

The Project Site consists of two vacant, formerly developed parcels of land within the Olmsted Green Campus adjacent to the existing Brooke Mattapan School at 150 American Legion Highway. The Project Site has a sloping topography with an approximately 33-foot grade change from Kingbird Road to Austin Street. To the east and south of the Project Site are several multi-level residential structures ranging from 4 to 6 stories in height. Directly across the street from the Project Site is Franklin Park, a "country park" designed by Frederick Law Olmsted in 1885.

2.3 Planning Principles and Design Goals

The Brooke Charter High School is designed to be an innovative and high performing High School serving a growing 9th through 12th Grade student population and an 8th Grade Academy. The building will reflect Brooke Charter School's (BCS) educational vision, core values and academic mission to ensure students are prepared to enter into and succeed in college. The site location will allow for a direct connection between the existing and new schools, resulting in a true educational campus that will serve the surrounding community.

2.4 Design Concept and Development

The Site design locates the building on the northern side of the Project Site near Austin Street, reinforcing the connection to the adjacent school. It also creates compact pathways within the school building, rather than stretching them over the entire 600-foot length of the Project Site. Parking and pick-up/drop-off circulation is located close to Kingbird Road, allowing the School's

primary entrance and community oriented spaces such as the gymnasium to be oriented to the adjacent Olmsted Green community to the southeast of the Project Site.

2.4.1 Height and Massing

The sloped topography of the Project Site works in the Project's favor to reduce massing and minimize its visual impact. The maximum height for the building will be approximately 65'-0" above grade at the lowest end of the Project Site adjacent to the parking area. Utilizing the site grades to step the building, the height will be approximately 28'-0" above grade adjacent to Austin Street (Figure 2.1).

The gymnasium massing is strategically placed along East Main Street to allow the more detailed facades of the academic building and cafeteria to face American Legion Highway to optimize transparency into the new school through glazing. The 8th Grade Academy is designed as its own wing of the building to serve its 8th grade population and staff holistically.

2.4.2 Character and Exterior Materials

The character of the School will be both welcoming and inclusive, achieved through building massing and organization and the placement of fenestration which allows for a clear understanding of its function. The exterior skin will combine two warm-tone durable materials giving the building a contemporary appearance. The fenestration pattern on the elevation facing American Legion Highway animates the façade while the elevation facing East Main Street reflects the character of the neighboring residences. Large classroom windows on all elevations allow for a high degree of transparency in the envelope. The floor to ceiling glazing at the courtyard façade offers views into the outdoor landscape (Figure 2.2). Given the sustainable goals for the Project, materials that are selected for the Project will be considered from both a first-cost and life-cycle cost perspective, using an optimal balance between those two considerations.

2.4.3 Signage

A freestanding site sign will be located at the corner of Kingbird Road and American Legion Highway visible to the surrounding neighborhood and acting as a welcoming beacon. Additional building identification signage will be mounted on the building at both building entrances, providing a sense of place and orientation for the visiting public and regular occupants alike.

2.5 Public Realm

The pedestrian realm will be enhanced with a number of conveniences throughout the Site. Key elements will include a forecourt at the intersection of Kingbird Road and American Legion Highway that identifies the street edge, pedestrian walking paths through and around the site, accessible surfaces and street trees and plantings.

Trees along American Legion Highway will be newly planted or preserved to provide a continuous green canopy along the pedestrian path. A perimeter site fence will be placed along the extent of American Legion Highway in front of the property to define the street edge and minimize unplanned vehicular stops and pedestrian foot travel from the public right-of-way into the Site.

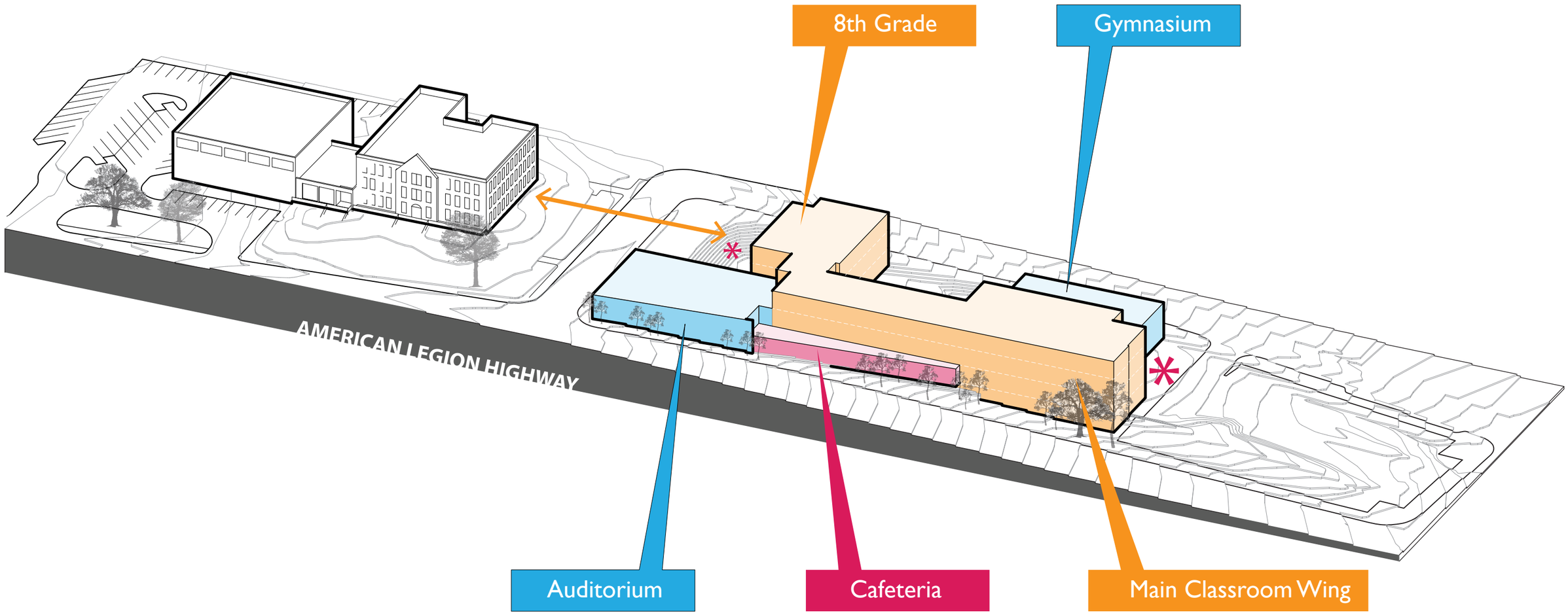
At the two entrances to the building paving and plantings will create an arrival plaza. Accessible drop-off areas will be included on both Kingbird Road and Austin Street for car, bus and foot traffic.

2.6 Site Landscaping

The Project Site is currently vacant with a variety of trees along American Legion Highway. The Site design concept is to create several green spaces acting as courtyards and garden areas along East Main Street to serve the academic goals for the school and provide students with exterior amenities. A new parking area will be constructed on the corner of Kingbird and American Legion Highway to serve the staff and the community, and will include a drop-off/pick-up location. The existing trees along American legion Highway will be evaluated for health and opportunity to remain as a green buffer between the parking area and street. Native trees, shrubs and ground covers that are non-invasive and easily maintainable are proposed (Figure 2.3).

2.7 Accessibility

This Project will improve accessibility around and through the Project Site with accessible grades, walkways, curb cuts and detection strips. Two accessible parking spaces for automobiles and one for vans will be located within the parking lot. For details, refer to the Accessibility Checklist and Accessibility Route Diagram provided in Appendix A, *BPDA Checklists*.



Source: Arrowstreet

ARROWSTREET

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Figure 2.1
Building Massing

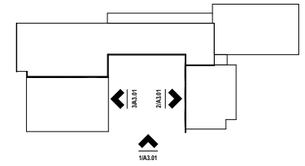
Brooke Charter High School
Boston, Massachusetts

EXTERIOR FINISH LEGEND

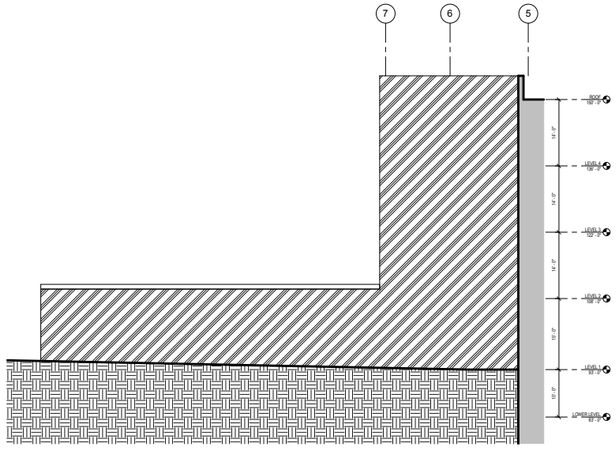
BRICK

STANDING SEAM METAL SIDING

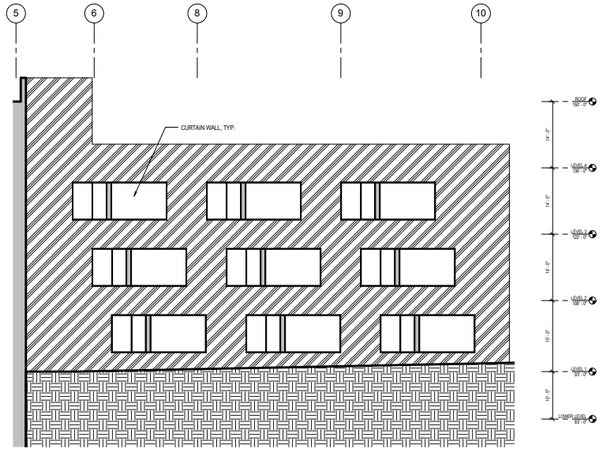
TRANSLUCENT PANEL



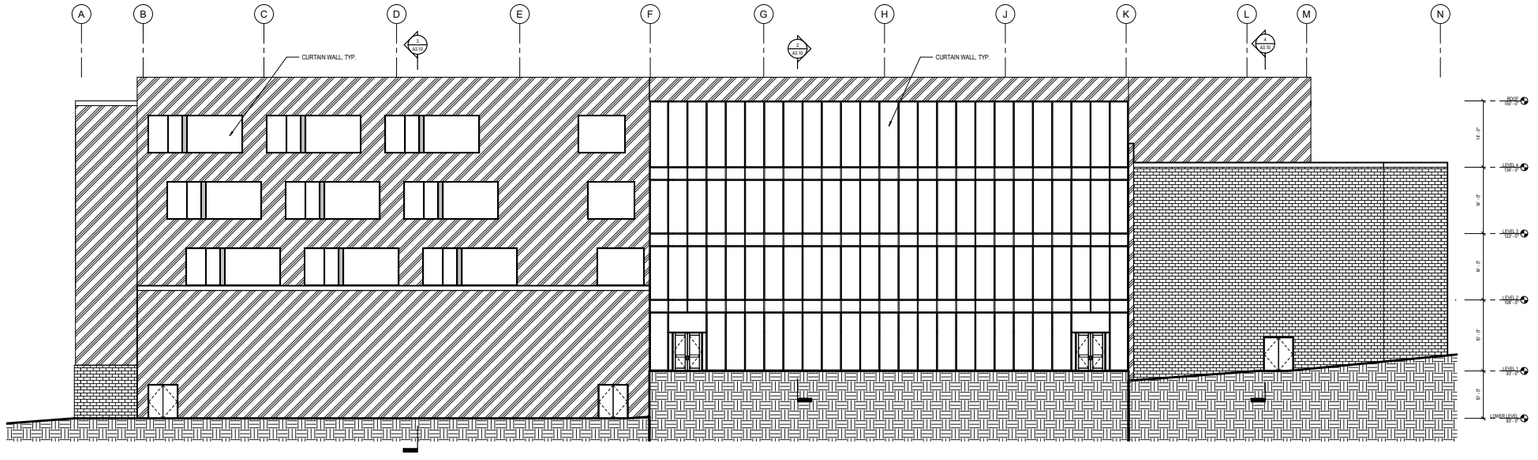
KEY PLAN



3 COURTYARD WEST ELEVATION



2 COURTYARD EAST ELEVATION



1 SOUTH ELEVATION

Source: Arrowstreet

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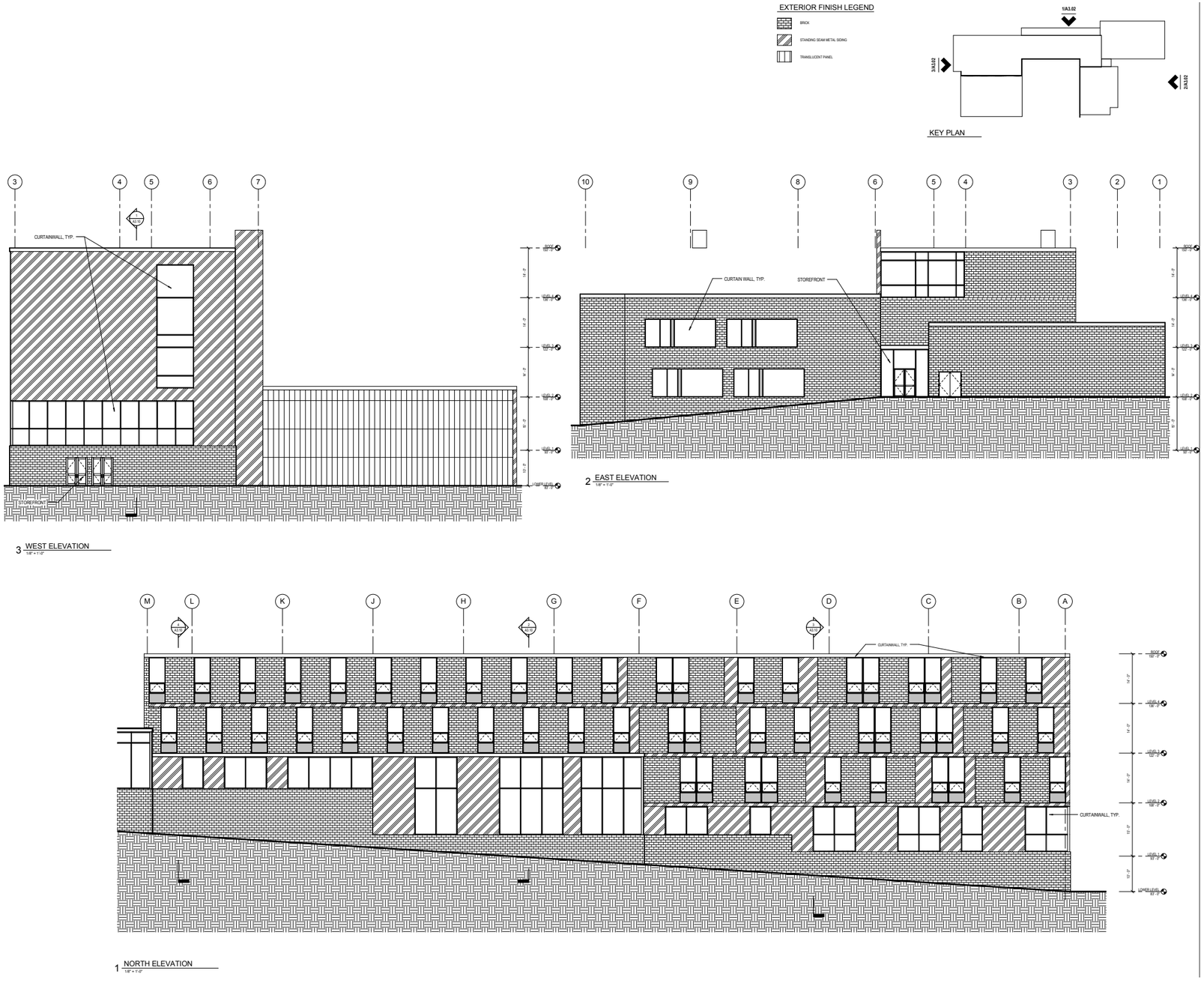
Figure 2.2a
Project Elevations

Brooke Charter High School
Boston, Massachusetts



Source: Arrowstreet

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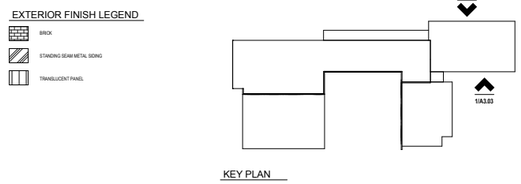
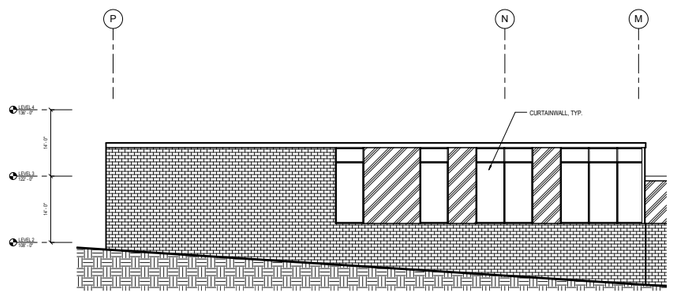
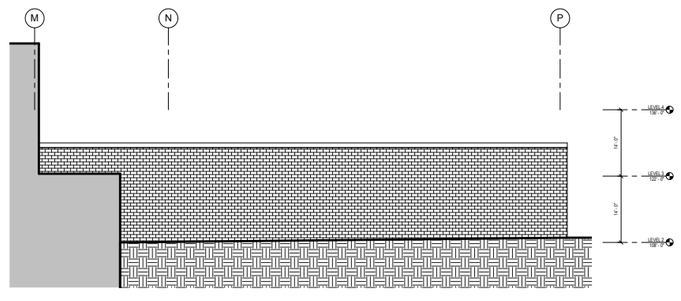
Figure 2.2b
Project Elevations

Brooke Charter High School
Boston, Massachusetts







Source: Arrowstreet

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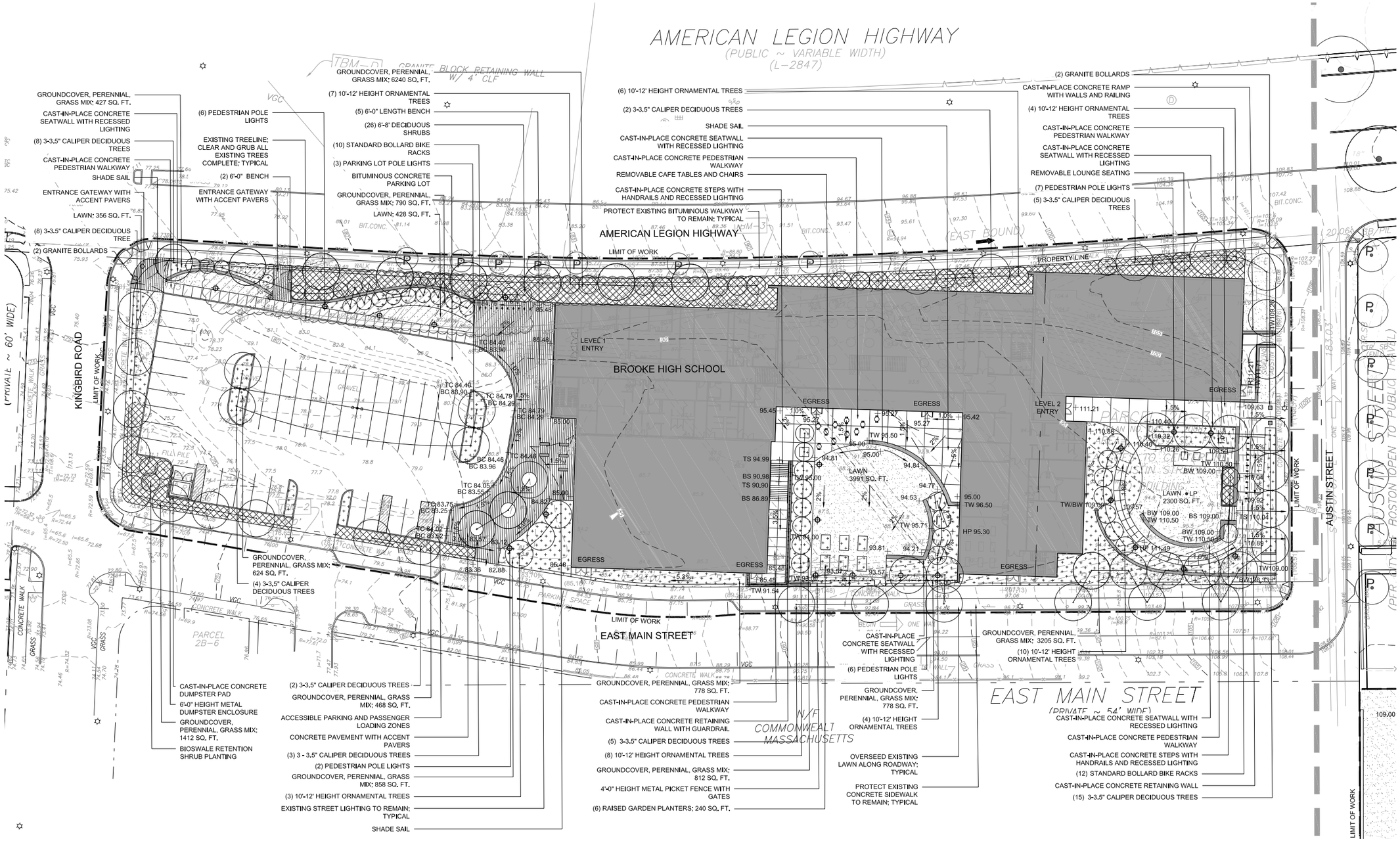
Figure 2.2c
Project Elevations

Brooke Charter High School
Boston, Massachusetts



Source: Arrowstreet

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Figure 2.3
Landscaping Plan

Brooke Charter High School
Boston, Massachusetts

3

Sustainability and Green Building

This chapter provides preliminary information regarding the Project's sustainability, green building and climate resiliency strategies. It identifies the proposed U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) rating system and outcome, describes building-specific strategies for each LEED category and how key credits will be achieved. It also discusses a framework for considering present and future climate conditions in project design.

3.1 Key Findings and Benefits

- The student population will primarily utilize public transportation to travel to and from the Project Site.
- The Project will redevelop a previously developed parcel and restore vegetated areas.
- The Project will be designed using efficient heating, cooling and lightings systems, resulting in an energy cost savings of 26% as compared to the LEED version 4 (v4) baseline.
- The Project will select materials that provide disclosure and transparency certifications, and meet the LEEDv4 emissions requirements.
- Due to its distance from the coast, sea level rise will not impact the Project.
- Boston Water and Sewer Commission (BWSC)'s 2015 design standards for projected precipitation were used for the Project to design a system that can adequately manage on-site stormwater for its design life.
- As the Project moves toward final design, future temperature-related conditions will be taken into consideration when choosing building materials and features.

3.2 Sustainability Approach

To comply with Article 37 of the Code, the Project intends to use the framework of the LEEDv4 BD+C Schools rating system to track the sustainable features of the Project. The Project aims to achieve points in the following categories: Location and Transportation, Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and Innovation in Design. LEED checklist is included as Figure 3.1, and shows the credits the Project anticipates achieving. The checklist will be updated regularly as the design develops and engineering assumptions are substantiated.

3.2.1 Preliminary LEED Scorecard

The following section is a synopsis of LEED prerequisites and potential credits under review for the Project.

Location and Transportation

- Sensitive Land Protection: The Project footprint is located on land that has been previously developed.
- Surrounding Density and Diverse Uses**:** The building entrance is within ½-mile walking distance to numerous amenities, and is located in a densely populated area.
- Access to Quality Transit**:** The Project is located within ½-mile walking distance from multiple bus stops that meet the required trips/day.
- Bicycle Facilities**:** The Project will evaluate the need for long-term bicycle parking and determine its comparison to the LEEDv4 requirement.
- Green Vehicles**:** The Project will evaluate the cost feasibility of installing Electrical Vehicle (EV) charging stations.

Sustainable Sites

- Prerequisite - Construction Activity Pollution Prevention: The Proponent will comply with the National Pollutant Discharge Elimination System (NPDES) program as established by the U.S. Environmental Protection Agency (EPA).
- Prerequisite - Environmental Site Assessment: No remediation will be part of Project as the Project Site is not known to require it.
- Open Space: The Project Site incorporates open landscaped areas, meeting the credit standard.
- Rainwater Management: The Project will evaluate the design against the LEED requirements as design progresses.
- Heat Island Reduction: The Project will incorporate a high Solar Reflectivity Index (SRI) roof and the shading from vegetation will be evaluated as the design progresses.

- Light Pollution Reduction: Light pollution will be minimized with the use of high-efficiency lighting fixtures that are dark sky compliant. Fixtures for area lighting will be pole-mounted cut-off luminaires in the parking areas. Building perimeter fixtures will be wall mounted cut-off luminaires over exterior doors. Exterior lighting will be controlled by photocell on and timed off operation.
- Joint Use of Facilities: The community will have access to at least three spaces within the building, including the auditorium, gym, and cafeteria, as well as play areas and/or parking.

Water Efficiency

- Prerequisite and Credit - Outdoor Water Use Reduction: Water use will be reduced by a minimum of 50%.
- Prerequisite and Credit - Indoor Water Use Reduction: Low flow toilet, urinals, and low flow faucets will be employed to reduce water usage. System will reduce water consumption by 30% from a code required system.
- Prerequisite - Building-Level Water Metering: Water use will be metered and data shared with USGBC.
- Water Metering: The Project will install water meters for two subsystems for irrigation, plumbing fixtures, domestic hot water, boiler, and other process water.

Energy and Atmosphere

- Prerequisite and Credit - Enhanced Commissioning and Verification: A commissioning agent will be hired to develop a commissioning plan meeting the requirement to achieve this credit.
- Prerequisite and Credit - Optimize Energy Performance: The building will demonstrate improvement of at least 16% over an equivalent baseline building.
- Prerequisite and Credit - Building-Level and Advanced Energy Metering: All forms of energy will be monitored for a minimum of 5 years. Individual uses that use at least 10% of total energy consumption will be monitored.
- Prerequisite - Fundamental Refrigerant Management: New Heating, Ventilation, and Air Conditioning (HVAC) systems will not utilize CFC refrigerants and will use HFC only; no ozone depleting refrigerants are used in the new cooling systems.
- Renewable Energy Production: The building will be designed to be solar-ready at a minimum. The Project is currently searching for a potential PPA vendor to determine what percentage of the building's total energy use the available roof area may generate with on-site photovoltaic system.
- Green Power and Carbon Offsets: The Project will engage in a contract to supply 100% of the projects energy from green power, carbon offsets, or renewable energy certificates (RECs).

Materials and Resources

- Prerequisite - Storage and Collection of Recyclables: Recycling bins will be provided in each classroom and office. In addition, a dedicated recycling collection/storage area will be located within the dumpster enclosure to facilitate the recycling program.
- Prerequisite - Construction and Demolition Waste Management Planning: The construction contractor will be required to implement a waste management plan to divert at least 50% of construction and demolition material to recycling and salvage facilities.
- Building Product Disclosure and Optimization - Environmental Product Declarations: At least 20 different permanently installed products will be sourced from at least five different manufacturers that have source/extraction reporting.
- Building Product Disclosure and Optimization – Sourcing Materials: Although not likely to meet the LEED requirement, materials that document source/extracting reporting, recycled content, and FSC-certified wood will be selected where possible.
- Building Product Disclosure and Optimization - Material Ingredients: At least 20 different permanently installed products will be sourced from at least five different manufacturers that have Health Product Declaration/Cradle to Cradle (HPD/CtoC). Although not likely to meet the LEED requirement, materials that document ingredients to GreenScreen/CtoC/ REACH certification or with supply chain optimization will be selected where possible.
- Construction and Demolition Waste Management: The Project will divert at least 50% of the total construction and demolition material for at least three material streams.

Indoor Environmental Quality

- Prerequisite - Minimum Indoor Air Quality Performance: The Project will meet the minimum requirements of the Massachusetts Building Code and ASHRAE 62.1-2010 for ventilation and indoor air quality.
- Prerequisite - Environmental Tobacco Smoke Control: Smoking will be prohibited on school grounds per Massachusetts General Law.
- Prerequisite - Minimum Acoustic Performance: The HVAC system will be designed to meet the ASHRAE Handbook, Chapter 47, requirement under Option 2. Designs for classrooms and other core learning spaces will be acoustically designed so that they are quiet, allowing teachers to speak to the class without straining their voices and allowing for effective communication. Designs for these spaces will be in compliance with ANSI Standard S12.60-2002.
- Enhanced Indoor Air Quality Strategies: Entry mat systems will be installed in all entries. Direct ventilation to outside will be provided in all chemical storage areas, including housekeeping spaces. A Minimum Efficiency Reporting Value (MERV) 13 filter will be specified to meet the standard for this credit.

- Low-Emitting Materials: Adhesives, sealants, paints, coatings, flooring, composite wood, ceiling, insulation and exterior material systems will be evaluated on their certification to meet the low Volatile Organic Compound (VOC) emissions limits.
- Construction Indoor Air Quality (IAQ) Management Plan: Construction specifications will require the contractor to submit an IAQ plan for the construction period to protect the HVAC system and prevent moisture and contaminants from contact with carpeting, ceiling tiles, and other absorptive surfaces.
- Thermal Comfort: All single occupant offices as well as shared multi-occupant spaces will have thermal controls. The Project will not able to achieve the LEED credit because the credit requires that all seats in the teacher work rooms to have individual thermal controls.
- Interior Lighting: Interior lighting controls and levels will be provided to meet the credit requirements.
- Daylight: At least 75% of the classroom spaces within the school will be provided with sufficient daylight to provide the teachers and students with a connection to the outdoors. This will be primarily accomplished through the use of large classroom windows which allow ample opportunity for daylight to permeate the classroom spaces.
- Quality Views: Approximately 75% of regularly occupied spaces will have a direct line of sight and/or unobstructed views to outdoor natural areas.

Innovation

- The Project will evaluate exemplary performance and pilot credits as well as other innovative ideas.

LEED Accredited Professional

- The Project design team has at least one LEED Accredited Professional (AP) in each of the major disciplines.

Boston Green Building Credits

- The Project will meet all of the Boston Public Health Commission prerequisites.
- As outlined in the Brooke Charter High School Engineering Economical Analysis Report, a preliminary energy model has been performed to determine the most cost effective mechanical system for the project. Multiple options were compared to a baseline ASHRAE VAV system to determine the lowest combined savings over a 30 year cycle to determine the most advantageous system considering electrical costs, gas costs, maintenance costs, and initial construction costs. Our observations of the performed Life Cycle Cost Analysis suggested that the design variable air volume dehumidification displacement ventilation system represents the lowest life cycle cost of the systems studied by yielding an approximate $1,041,184 savings over the 30 year study period with an instant payback as it has a lower installed cost than the code baseline system.

- Once the most cost effective mechanical system was determined, an additional ASHRAE Standard 90.1-2010 baseline building simulation was performed to compare the design building against to determine the energy cost savings based on LEED v4 requirements. The preliminary analysis comparison of the Design Building against the LEED v4 ASHRAE Standard 90.1-2010 Baseline Building indicated that the current design results in an energy cost savings of 26.8% for 11 points for EAc1.

3.2.2 Preliminary Energy Model

As outlined in the Brooke Charter High School Engineering Economical Analysis Report included in Appendix B, a preliminary energy model analysis has been performed to determine the most cost effective mechanical system for the project. Multiple options were compared to a baseline ASHRAE VAV system to determine the lowest combined savings over a 30 year cycle to determine the most advantageous system considering electrical costs, gas costs, maintenance costs, and initial construction costs. Our observations of the performed Life Cycle Cost Analysis suggested that the design variable air volume dehumidification displacement ventilation system represents the lowest life cycle cost of the systems studied by yielding an approximate $1,041,184 savings over the 30 year study period with an instant payback as it has a lower installed cost than the code baseline system.

Once the most cost effective mechanical system was determined, an additional ASHRAE Standard 90.1-2010 baseline building simulation was performed to compare the design building against to determine the energy cost savings based on LEED v4 requirements. The preliminary analysis comparison of the Design Building against the LEED v4 ASHRAE Standard 90.1-2010 Baseline Building indicated that the current design results in an energy cost savings of 26.8% for 11 points for EAc1.

3.2.3 Clean and Renewable Energy Analysis

The building will be designed to be solar-ready at a minimum. The Project is currently searching for a potential Power Purchase Agreement (PPA) vendor to determine the percentage of the building's total energy use which the available roof area may generate with on-site photovoltaic system.

3.2.4 Energy Efficiency Assistance

The Project will be highly energy efficient due to an improved building envelope, increased insulation at walls and roof, improved windows, and high efficiency lighting, lighting controls, and daylight harvesting to reduce lighting energy need. The Project will also include a high efficiency HVAC system including condensing boilers, demand control ventilation, heat recovery wheels, and a dehumidification displacement ventilation system.

3.3 Climate Change Preparedness and Resiliency

This section discusses the approach to preparing for anticipated changes in climate, in accordance with Appendix 7 of Article 80 of the Code. Regional changes in temperature and precipitation will impact the Project over its lifetime of approximately 60 years. However, due to its distance from the coast, sea level rise will not impact the Project. The required Climate Change Resiliency and Preparedness Checklist has been completed for the Project and is provided in Appendix B, *BPDA Checklists*.

As detailed in the Executive Office of Energy and Environmental Affairs (EOEEA)'s *2011 Climate Change Adaptation Report*, the Commonwealth's climate is already changing and will continue to do so over the course of this century. The average ambient temperature has increased by approximately 1.8 degrees since 1970 and average sea surface temperature by 2.3 degrees between 1970 and 2002. These warming trends have been associated with other observed changes, including a rise of 22 centimeters in sea level between 1921 and 2006, more frequent days with temperatures above 90 degrees, reduced snowpack, and earlier snow melt and spring peak flows. In addition, very heavy precipitation (defined as the heaviest one percent of all events) increased by 71% in the Northeast between 1958 and 2012. According to BWSC, annual rainfall in the region has increased over the past 60 years by 21% to an approximate average of 52 inches per year in 2012 based on a trend-line calculation. The 10-year, 24-hour design storm has been calculated to have increased from 4.80 inches to as much as 5.20 inches with a peak hourly intensity increasing from 1.52 inches per hour to 1.65 inches per hour.

3.3.1 Temperature

Climate change will result in more extreme weather events including higher year-round average temperatures, higher peak temperatures, and more periods of extended peak temperatures. This section examines how the Project, over the course of its design life, may be affected by and will prepare for these phenomena.

The City of Boston (COB)'s *Climate Change and Sea Level Rise Projections for Boston: The Boston Research Advisory Group Report* indicates that by the end of the century, under the Intergovernmental Panel on Climate Change's (IPCC) high emissions scenario, the Boston region would experience a 5 to 10 degree increase in average ambient temperature, with several more days of extreme heat during the summer months. Days with temperatures greater than 95 degrees are predicted to increase from the one to two days annually that the region experiences today to between approximately 6 and 66 days annually. Winter temperatures are expected to increase by approximately 5 to 14 degrees. Table 3.1 below provides detailed projections.

TABLE 3.1 CONSOLIDATED TEMPERATURE PROJECTIONS FOR THE BOSTON REGION[a]

Parameter	Baseline (1961-2010)	Near-Term (2030)	Mid-Century (2050)	End-of-Century (2100)
Average Annual Temperature (°F)[b]	46°	--	50° to 51°	51° to 56°
Average Summer Temperature (°F)[c]	68.9°	69.7° to 72.5°	70.7° to 75.8°	73.4° to 84.2°
Over 95°F (days/yr)[c]	1.3	1.5 to 5.6	2 to 17.8	6.4 to 66.4
Average Winter Temperature (°F)[c]	28.1°	30° to 32.9°	30.1° to 35.5°	33.7° to 42°

[a] High emissions scenario
Source: City of Boston, 2016: [B] Cash *et al.*, 2011; [C] Houser *et al.*, 2015

3.3.2 Precipitation

By Late/End-of-Century, annual precipitation is expected to increase by 7 to 14%, with a slight decrease in the summer—a time when river flows are already low. Winter precipitation—mostly in the form of rain—is expected to increase by 12 to 30%. According to BWSC's *Wastewater and Storm Drainage System Facilities Plan*,[1] annual precipitation may increase by between four and seven inches by 2100. While heavier-than-normal snowfalls have occurred during some recent snow seasons, historically the frequency of high-extreme snowfall years has been decreasing, while the frequency of low-extreme snowfall years has been increasing.[2] This trend is expected to continue, and the number of snow events during the snow season is predicted to decrease from five each month on average to one to three each month on average.[3]

More specific projected rainfall data for the Boston Metro Area can be found in the BWSC's *Wastewater and Storm Drainage System Facilities Plan*, which analyzed climate change scenarios related to increased precipitation, river flooding, sea level rise and storm surge. In particular, it describes how recent trends in regional rainfall data indicate that average annual rainfall and daily maximum rainfalls are increasing in volume, and provides corresponding design standards. For example, the 10-year, 24-hour design storm is forecasted to increase to as much as 6.65 inches with a peak hourly intensity of 2.11 inches per hour by the year 2100 with climate change (see Table 3.2). This information is being used to design the Project's closed piping system. BWSC's 2015 design standards for projected precipitation were used for the Project to design a system that can adequately manage on-site stormwater for its design life.

▼

[1] BWSC, 2015.
[2] Kunkel *et al.*, 2009.
[3] Hayhoe *et al*., 2006.

TABLE 3.2 PROJECTED CHANGES IN MASSACHUSETTS' PRECIPITATION:[A]

Parameter	Baseline Conditions (1961-1990)	Mid-Century Conditions (2035-2064)	Late/End-of-Century Conditions (2070-2100)
Average Annual Precipitation[b]	41″	43.1″ to 44.3″	43.9″ to 46.7″
Average Winter Precipitation[b]	8″	8.5″ to 9.3″	8.96″ to 10.4″
Average Summer Precipitation[b]	11″	10.9″ to 10.7″	10.9″ to 11.0″
Average Snow Days (number of days/month)[c]	5 days	3 days	1 to 2 days
10-year, 24 Hour Design Storm Peak Hourly Intensity, Precautionary scenario (inches/hour)[d]	1.64″	1.78″ to 1.91″	2.11″

[a] Adapted from the Cash *et al.*, 2011.
Sources: [b] Frumhoff *et al.*, 2007 & Hayhoe *et al.*, 2006; [c] Hayhoe *et al.*, 2006; [d] BWSC, 2015.

3.3.3 Mitigation

Future increases in temperature will be mitigated on-site through the use of landscaping. As described in Section 2.2, a number of building design and operation measures will be implemented to reduce energy usage. These have the added benefit of increasing resiliency to future climate conditions. For example, cool roofs will be specified to reduce heat gain, and water conserving fixtures will be installed in all buildings, reducing the amount of water needed for occupants. As the Project moves toward final design, future temperature-related conditions will be taken into consideration when choosing building materials and features.

3.3.4 Sources

Boston Water and Sewer Commission (BWSC), 2015. *Wastewater and Storm Drainage System Facilities Plan, Final Report*. Boston, MA.

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City of Boston, June 2016. *Climate Change and Sea Level Rise Projections for Boston: The Boston Research Advisory Group Report*. Climate Ready Boston. Boston, MA.

Frumhoff P.C.; McCarthy J.J.; Melillo J.M.; Moser S.C., and Wuebbles D.J., 2007. *Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis report of the Northeast Climate Impacts Assessment.* Union of Concerned Scientists. Cambridge, MA.

Hayhoe, K.; Wake C.P.; Huntington T.G.; Luo L.; Schwartz M.D.; Sheffield J.; Wood E.; Anderson B.; Bradbury J.; Degaetano A.; Troy T.J., and Wolfe D., 2006. Past and Future Changes in Climate and Hydrological Indicators in the U.S. Northeast. *Climate Dynamics* 28, pp 381-407.

Houser, T., Hsiang, S., Kopp, R., & Larsen, K. (2015). *Economic risks of climate change: An American Prospectus*. Columbia University Press.

Kunkel K. E.; Palecki M.A.; Ensor L.; Easterling D.; Hubbard K.G., Robinson D., and Redmond K., 2009. Trends in Twentieth-Century U.S. Extreme Snowfall Seasons. *Journal of Climate*, 22, pp 6204-6216.

LEED v4 for BD+C: Schools

Project Checklist

Project Name: Brooke Charter High School
Date: 11/4/2016
Prepared By: Arrowstreet - KB

Y	?	N			
0	0	1	Credit 1	Integrative Process	1

Y	?	N		Location and Transportation	15
0	0	na	Credit 1	LEED for Neighborhood Development Location	15
1	0	0	Credit 2	Sensitive Land Protection	1
0	2	0	Credit 3	High Priority Site	2
1	4	0	Credit 4	Surrounding Density and Diverse Uses	5
2	2	0	Credit 5	Access to Quality Transit	4
0	1	0	Credit 6	Bicycle Facilities	1
0	1	0	Credit 7	Reduced Parking Footprint	1
0	1	0	Credit 8	Green Vehicles	1

Y	?	N		Sustainable Sites	12
Y			Prereq 1	Construction Activity Pollution Prevention	Required
Y			Prereq 2	Environmental Site Assessment	Required
0	1	0	Credit 1	Site Assessment	1
0	2	0	Credit 2	Site Development - Protect or Restore Habitat	2
1	0	0	Credit 3	Open Space	1
0	3	0	Credit 4	Rainwater Management	3
0	2	0	Credit 5	Heat Island Reduction	2
0	1	0	Credit 6	Light Pollution Reduction	1
0	0	1	Credit 7	Site Master Plan	1
1	0	0	Credit 8	Joint Use of Facilities	1

Y	?	N		Water Efficiency	12
Y			Prereq 1	Outdoor Water Use Reduction	Required
Y			Prereq 2	Indoor Water Use Reduction	Required
Y			Prereq 3	Building-Level Water Metering	Required
0	2	0	Credit 1	Outdoor Water Use Reduction	2
3	1	2	Credit 2	Indoor Water Use Reduction	7
0	0	2	Credit 3	Cooling Tower Water Use	2
1	0	0	Credit 4	Water Metering	1

Y	?	N		Energy and Atmosphere	31
Y			Prereq 1	Fundamental Commissioning and Verification	Required
Y			Prereq 2	Minimum Energy Performance	Required
Y			Prereq 3	Building-Level Energy Metering	Required
Y			Prereq 4	Fundamental Refrigerant Management	Required
4	2	0	Credit 1	Enhanced Commissioning	6
8	8	0	Credit 2	Optimize Energy Performance	16
1	0	0	Credit 3	Advanced Energy Metering	1
0	2	0	Credit 4	Demand Response (All electric site)	2
0	3	0	Credit 5	Renewable Energy Production	3
0	1	0	Credit 6	Enhanced Refrigerant Management	1
2	0	0	Credit 7	Green Power and Carbon Offsets	2

Y	?	N		Materials and Resources	13
Y			Prereq 1	Storage and Collection of Recyclables	Required
Y			Prereq 2	Construction and Demolition Waste Management Planning	Required
0	5	0	Credit 1	Building Life-Cycle Impact Reduction	5
2	0	0	Credit 2	Building Product Disclosure and Optimization - Environmental Product Declarations	2
0	2	0	Credit 3	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
1	1	0	Credit 4	Building Product Disclosure and Optimization - Material Ingredients	2
1	1	0	Credit 5	Construction and Demolition Waste Management	2

Y	?	N		Indoor Environmental Quality	16
Y			Prereq 1	Minimum Indoor Air Quality Performance	Required
Y			Prereq 2	Environmental Tobacco Smoke Control	Required
Y			Prereq 3	Minimum Acoustic Performance	Required
1	1	0	Credit 1	Enhanced Indoor Air Quality Strategies	2
1	1	1	Credit 2	Low-Emitting Materials	3
1	0	0	Credit 3	Construction Indoor Air Quality Management Plan	1
0	1	1	Credit 4	Indoor Air Quality Assessment	2
1	0	0	Credit 5	Thermal Comfort	1
0	2	0	Credit 6	Interior Lighting	2
2	1	0	Credit 7	Daylight	3
1	0	0	Credit 8	Quality Views	1
0	1	0	Credit 9	Acoustic Performance	1

Y	?	N		Innovation	6
1	0	0	Credit 1.1	Exemplary Performance MRc5 Construction and Demolition Waste Manageme	1
1	0	0	Credit 1.2	Green Housekeeping	1
1	0	0	Credit 1.3	Innovation: Building as a Teaching Tool	1
1	0	0	Credit 1.4	Pilot Credit: Food Production	1
1	0	0	Credit 1.5	Pilot Credit: Social Equity within Project Team (Construction Workers)	1
1	0	0	Credit 2	LEED Accredited Professional	1

Y	?	N		Regional Priority	4
0	1	0	Credit 1	Regional Priority: Rainwater Management 2 of 3 points	1
0	1	0	Credit 2	Regional Priority: Indoor Water Use Reduction 4 of 7 points	1
1	0	0	Credit 3	Regional Priority: Optimize Energy Performance 8 of 16 points	1
1	0	0	Credit 4	Regional Priority: Renewable Energy Production 2 of 3 points	1

Y	?	N		TOTALS	Possible Points:	110
44	57	8				

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

Figure 3.1
LEED Checklist

Brooke Charter High School
Boston, Massachusetts

4

Transportation

This chapter consists of a transportation study prepared following the Boston Transportation Department (BTD) *Transportation Access Plan Guidelines* as well as traffic study guidelines as jointly issued by the Commonwealth of Massachusetts Executive Office of Energy & Environmental Affairs/Massachusetts Department of Transportation (EOEEA/MassDOT) in support of the Boston Planning and Development Agency (BPDA) Article 80 review process. The evaluation documents 2016 Baseline transportation conditions, 2021 No-Build conditions, 2021 Build conditions with the Project, and describes access, pedestrian and transportation improvements that serve to accommodate Project-related traffic, loading and pedestrian activity including elements of a Transportation Demand Management (TDM) program for the Project.

4.1 Key Findings and Benefits

The following are key findings and benefits related to transportation:

- The Project Site is served by an Urban Collector roadway as well as three Local roadways, as well as one signalized intersection.
- The study area is served by an existing sidewalk system that connects the Project Site with the local neighborhoods and nearby MBTA bus stops, which are served by bus routes 14, 21, 22, 28, 29, and 31.
- On-street bicycle facilities are provided on major roadways including American Legion Highway and Morton Street.
- While the Project will generate approximately 939 total weekday morning peak period trips (299 automobile, 481 transit, and 159 school bus) and 640 weekday evening peak period trips (219 automobile, 320 transit, and 81 school bus), only approximately 34% and 37%, respectively, are anticipated to be vehicular trips due to the ability of students to access the Project Site by public transit, school bus, bicycle and foot.
- Overall Level of Service at study area intersections will not be significantly impacted by the Project.

- Mitigation will include Site access and circulation improvements, a traffic management plan, and pedestrian improvements.
- A construction management plan will be created to minimize transportation impacts during the construction period.

4.2 Project Description

The Project Site consists of two undeveloped parcels of land totaling approximately 2.3 acres. Land development was initially planned as part of the Olmstead Green re-development project to include a 123-bed Vinfen rehabilitation facility (Parcel 2B-2) and an 11,000 square foot (sf) Heritage House (Parcel 2B-3) that was proposed to house programs and activities for Department of Health clients living in the surrounding communities.

The location of the Project Site relative to the adjacent roadway network is shown in Figure 4.1. The Site has frontage on American Legion Highway, Kingbird Road, East Main Street and Austin Street. A sidewalk is provided along the entire Site perimeter. Three (3) access and egress driveways were contemplated along East Main Street as part of prior planning and development efforts for Olmstead Green, however, no curb cuts have been constructed.

The Project includes construction of a high school (grades 9 through 12) with an Eighth Grade Academy wing and associated parking and outdoor space to provide secondary education opportunities for its students. The entire facility is expected to accommodate a maximum of 780 students and approximately 83 staff. Vehicle access points are expected to be identified as the Project moves into the design phase, however, access to the Project Site is expected to be provided along East Main Street between Kingbird Road and Austin Street. Off-street parking will be provided for approximately 60 vehicles. A preliminary Site plan is presented in Figure 4.2.

The Brooke Charter High School's proposed hours of operations are as follows:

- The general hours of operation will be 8:00 AM to 3:45 PM with sports and extra-curricular activities to follow until 5:30 PM. The primary morning drop-off periods will be 7:30 AM to 8:00 AM, and the evening pick-up period will be 3:45 PM to 6:00 PM. Approximately three school buses are expected to service the proposed high school and will primarily serve students from East Boston and Chelsea.
- Consistent with operations at other Brooke Charter Schools in Boston, it is anticipated that the majority of professional staff will typically arrive 30 minutes or more before school starting hours and leave approximately 15 minutes after dismissal unless leading an after-school activity.

A traffic management plan (TMP) will be implemented at Brooke Charter High School to coordinate pick-up/drop-off activity and vehicle queue management. TMP practices for the proposed facility as described in more detail under section 4.7.1, *Site Access and Circulation*.

4.3 Study Methodology

This transportation impact and access evaluation was conducted in accordance with EEA/MassDOT guidelines, and consists of several steps. The first step documents existing conditions in the transportation study area including an inventory of roadway geometry, observed traffic volumes, public transportation, and safety characteristics. Next, future year traffic conditions are forecast that account for other planned area developments, normal area growth, and development-related traffic increases. The third step quantifies operating characteristics of the study intersection. Specific attention is given to the incremental impacts of the proposed development. Finally, improvements are identified to address specific development-related requirements as needed.

4.3.1 Study Area Intersections

This TIAS evaluates transportation characteristics of roadways and intersections that provide a primary means of access to the Site, and that are likely to sustain a measurable level of traffic impact from the development. The study area includes the following primary intersections:

- American Legion Hwy at Canterbury Street/ Kingbird Road (Signalized)
- American Legion Hwy at Austin Street (Unsignalized)
- Kingbird Road at East Main Street (Unsignalized)
- East Main Street at Proposed Site Driveway (Unsignalized)

4.3.2 Mode Share Assumptions

Mode split rates were developed for the school based on existing student (7th and 8th Grade) travel modes observed at the adjacent Brooke Mattapan school and extrapolated for grades nine through twelve. As outlined in section 4.4.5, *Public Transportation Facilities*, the Project Site is located within an area of the City with excellent access to an extensive sidewalk system with connections to MBTA bus service. The parent auto, walk/bicycle, MBTA, and school bus mode share for the Brooke Charter High School is summarized in Table 4.1.

TABLE 4.1: MODE SHARE SPLITS[A]

Period/Direction	Auto	Walk/Bike	MBTA	School Bus
Weekday Morning Drop-Off Peak Hour (7:00-8:00 AM)				
Student	18%	Negligible	62%	20%
Staff	85%	Negligible	15%	n/a
Weekday Evening Pick-Up Peak-Hour (4:30-5:30 PM)				
Student	18%	Negligible	72%	10%
Staff	85%	Negligible	15%	n/a

[a] Mode share assumptions per data provided by Brooke Charter High School.

As summarized in Table 4.1, transit and school bus trips are projected to account for approximately 82% of the trips generated by students, thus alternative transportation modes significantly reduce the dependence on automobile trips. Some of the staff will also use the MBTA, walk/bike, and/or carpool. Based on discussions with the school it was assumed that 85% of staff related trips will be via automobile while approximately 15% will use transit.

4.4 Existing Conditions

In order to provide a basis for quantifying the transportation impacts of the development, the existing roadway system and the existing traffic operations at study area intersections were reviewed. This section describes the existing transportation characteristics within the study area including existing traffic volumes, pedestrian and bicycle facilities and volumes, parking and public transportation systems serving the area.

4.4.1 Roadway Network

The study area roadways are described briefly in this section. A general description of the physical roadway features is provided in the following sections. The study area includes roadways under local and private jurisdiction.

American Legion Highway

American Legion Highway is classified by MassDOT as an Urban Collector roadway under local (City) jurisdiction. ALH is generally a northeast-southwest roadway in the project area that connects Blue Hill Avenue (Route 28) to the northeast with Hyde Park Avenue to the southwest. In the study area American Legion Highway provides two-way traffic flow, has a width of approximately 56 feet, and provides sidewalks and a bike lane along both sides of the roadway. An approximately 18-foot landscaped median separates the two northeast bound from the two southwest bound travel lanes with median curb breaks at its major intersections, including at Franklin Hill Avenue and Kingbird Road. The regulatory (posted) speed limit along American Legion Highway is 35 mph in both travel directions within the study area. Land uses along American Legion Highway within the project area include recreational, commercial, educational, and residential uses, and a community development center.

East Main Street

East Main Street is classified by MassDOT as a Local roadway under private jurisdiction. East Main Street is generally a northeast-southwest roadway that connects Austin Street to the northeast with Kingbird Road to the southwest. For half of its length, East Main Street provides two-way traffic flow, has a width of approximately 35 feet, provides sidewalks along both sides of the roadway and has on-street parking and street lighting. East Main Street becomes a one-way (northeast bound) roadway approximately 250 feet west of Austin Street with a bus lane for Brooke Charter School Mattapan. A sidewalk is provided along the entire length on the Site side of the road and on approximately half of the opposite side of the street. There are no

formal bicycle accommodations along East Main Street. Land uses along East Main Street include the undeveloped Site, townhomes, and a Department of Youth Services facility.

Austin Street

Austin Street is classified by MassDOT as a Local roadway under private jurisdiction. Austin Street is generally a north-south roadway that connects East Main Street to the south with American Legion Highway to the north. Austin Street is a one-way (northbound) roadway that provides a bus lane for Brooke Charter School Mattapan, a single travel lane and a parking lane. There are no formal bicycle accommodations along Austin Street. Sidewalks are provides along both sides of the roadway. Land uses along Austin Street include the undeveloped Site, the Lena Park Community Development Corporation, and the Brooke Charter School Mattapan.

Kingbird Road

Kingbird Road is classified by MassDOT as a Local roadway under private jurisdiction. Kingbird Road is generally a north-south roadway that connects the Olmstead Green residential neighborhood to the south with American Legion Highway to the north. Kingbird Road is a two-lane roadway with sidewalks provided along both sides of the roadway. Land uses along Kingbird Road include the undeveloped Site and the Hearth at Olmsted Green residential neighborhood.

Canterbury Street

Canterbury Street is classified by MassDOT as an Urban Collector roadway under local (City) jurisdiction. Canterbury Street is generally a north-south roadway that connects American Legion Highway to the south with Morton Street (Route 203) to the north. Canterbury Street is generally a two lane roadway with an additional turn lane at its intersection with American Legion Highway. There are no formal bicycle accommodations along Canterbury Street. Sidewalk are provides along both sides of the roadway. Land uses along Canterbury Street include Franklin Park and a VFW facility.

4.4.2 Intersection Descriptions

This section includes a description of the three Project intersections.

American Legion Highway at Kingbird Road/Canterbury Street

American Legion Highway meets Kingbird Road and Canterbury Street to form a four-way signalized intersection. The northbound and southbound American Legion Highway approaches to the intersection provide an exclusive left-turn lane, a through lane and a shared through-right turn lane. The Canterbury Street eastbound approach provides a shared left-turn/through lane and an exclusive right-turn lane. The Kingbird Road westbound approach provides a single approach lane. Sidewalks and marked crosswalks are provided

across all approaches to the intersection. Land uses at the intersection consist of Franklin Park, a VFW facility, senior residential apartments and a vacant parcel (Site).

The intersection operates under actuated traffic signal control. The traffic signal phasing includes concurrent pedestrian phasing and is controlled by pedestrian pushbutton actuation.

American Legion Highway at Austin Street

American Legion Highway meets Austin Street to form a three-way unsignalized intersection. The American Legion Highway northbound and southbound approaches to the intersection provides two through travel lanes separated by a raised median. The Austin Street approach provides an exclusive right-turn lane under "STOP" sign control. A marked crosswalk is provided across the Austin Street approach. Land uses at the intersection consist the undeveloped Site, Lena Park Community Development Corporation, and the Brooke Charter School Mattapan.

Kingbird Road at East Main Street

Kingbird Road meets East Main Street to form a four-way unsignalized intersection. All of the approaches provide a single lane approach. The East Main Street and Hearth at Olmstead Green Driveway approaches are under "STOP" sign control. Marked crosswalks are provided across all of the approaches. Land uses at the intersection consist of the undeveloped Site and the Hearth at Olmsted Green residential neighborhood.

4.4.3 Vehicular Traffic Volumes

Traffic volume data was collected at the study area intersections during the weekday morning (7:00 AM - 9:00 AM) and weekday evening (3:00 PM – 6:00 PM) periods to coincide with peak traffic activity of the proposed Brooke Charter High School and the adjacent streets. Review of MassDOT permanent count station data indicates that September is an above average traffic month (approximately three percent above average month conditions). As a conservative measure, no adjustment (reduction) was made to the traffic counts to represent average conditions. The resulting existing (baseline) weekday morning and weekday evening peak-hour traffic volumes for the study intersections are depicted in Figure 4.3 and Figure 4.4, respectively. Turning movement counts and permanent count station data are provided in Appendix C.

4.4.4 Pedestrian Facilities

An inventory of the existing sidewalk system and pedestrian crossings in the study area has been conducted and is documented in Figure 4.5. The study area is served by an existing sidewalk system that connects the Site with the local neighborhoods and area MBTA bus stops.

4.4.5 Bicycle Facilities

An inventory of the bicycle accommodations within a half-mile radius of the Site has been conducted and is documented in Figure 4.6. As shown, local on-street bicycle facilities are provided along sections of American Legion Highway and Morton Street.

4.4.6 Pedestrian and Bicycle Volumes

Given the characteristic of the study area and the close proximity to the public transportation services provided near the Site, the pedestrian and bicycle traffic activity was also observed. The resulting weekday morning and weekday evening peak hour pedestrian and bicycle traffic volumes at the study intersections are provide in Figure 4.7 and Figure 4.8.

4.4.7 Public Transportation

The Massachusetts Bay Transportation Authority (MBTA) operates the following bus lines in the surrounding area as shown in Figure 4.9. Three (3) bus routes provide service along American Legion Highway and/or Morton Street and three (3) bus routes provide service along Blue Hills Avenue. Specific route and schedule information is provided in Appendix C.

- Route 14 – Roslindale Square – Heath Street Station: This bus route provides service between the Roslindale Square and Heath Street Station (Green Line) via Dudley Station (Silver Line), & Jackson Square Station (Orange Line and Commuter Rail). This MBTA bus service generally operates between 6am and 8pm during weekdays. This route provides a stop on both sides of American Legion Highway at its intersection with Kingbird Road and at the signalized pedestrian crossing located just north of the Austin Street.
- Route 21 – Ashmont Station – Forest Hill Station: This bus route provides service between the Forest Hill Station (Orange Line and Commuter Rail) and Ashmont Station (Red Line) via Morton Street, Gallivan Boulevard and Dorchester Avenue. This MBTA bus service generally operates between 4:40am and 12:50am during weekdays. This route provides a stop on both sides of the Morton Street at its intersection with Canterbury Street.
- Route 22 – Ashmont Station – Ruggles Station: This bus route provides service between the Ashmont Station (Red Line) and Ruggles Station (Orange Line and Commuter Rail) via Blue Hill Avenue and Talbot Avenue. This MBTA bus service generally operates between 5:00am and 1:30am during weekdays. This route provides a stop on both sides of the Blue Hill Avenue near its intersection with Talbot Avenue.
- Route 28 – Mattapan Station – Ruggles Station: This bus route provides service between the Mattapan Station (Red Line) and Ruggles Station (Orange Line and Commuter Rail) via Blue Hill Avenue. This MBTA bus service generally operates between 3:20am and 1:40am during weekdays. This route provides a stop on both sides of the Blue Hill Avenue near its intersections American Legion Highway, Harvard Street and Westview Street.
- Route 29 – Mattapan Station – Jackson Square Station: This bus route provides service between the Mattapan Station (Red Line) and Jackson Square Station (Orange Line and

Commuter Rail) via Blue Hill Avenue. This MBTA bus service generally operates between 5:55am and 1:21am during weekdays. This route provides a stop on both sides of the Blue Hill Avenue near its intersections American Legion Highway, Harvard Street and Westview Street.

- Route 31 – Mattapan Station – Forest Hill Station: This bus route provides service between the Mattapan Station (Red Line) and Forest Hill Station (Orange Line and Commuter Rail) via Morton Street and Blue Hill Avenue. This MBTA bus service generally operates between 4:50am and 1:18am during weekdays. This route provides a stop on both sides of the Morton Street at its intersection with Canterbury Street.

These bus routes provided extensive connections to/from area MBTA transit stations, including the Forest Hills Station on the Orange Line and the Ashmont and Mattapan Stations on the Red line, Heath Street (Green Line), commuter rail stations and connecting bus routes.

4.5 Future Conditions

Evaluation of the proposed development impacts requires the establishment of a future baseline analysis condition. This section estimates future roadway and traffic conditions with and without the proposed development. To be consistent with industry standard guidelines, a five-year planning horizon was selected.

To determine the impact of Site-generated traffic volumes on the roadway network under future conditions, baseline traffic volumes in the study area were projected to a future year condition. Traffic volumes on the roadway network at that time, in the absence of the development (that is, the No-Build condition), would include existing traffic and new traffic due to general background traffic growth. Consideration of these factors resulted in the development of No-Build traffic volumes. Anticipated Site-generated traffic volumes were then superimposed upon these No-Build traffic-flow networks to develop future Build conditions.

The following sections provide an overview of the future No-Build traffic volumes and projected Build traffic volumes.

4.5.1 Historical Area Growth

Nearby permanent count station data published by MassDOT indicates a flat (-0.1 percent per year) growth rate. A discussion with the Metropolitan Area Planning Council (MAPC) staff indicates a 0.38 percent per year annual growth rate is appropriate for the immediate study area based on projected land uses and travel patterns. For purposes of this evaluation, a 0.5 percent compounded annual growth rate was used (2.5 percent increase over a 5-year horizon). This growth rate is higher than historic rates and is also expected to account for any small fluctuation in hourly traffic as may occur from time to time in the study area and traffic associated with other potential small developments or vacancies in the area. MassDOT permanent count station data and background growth calculations are provided in Appendix C.

4.5.2 Background Development-Related Growth

Development of future No-Build traffic volumes also considers traffic generated through the study area from other specific area developments. Review of BPDA projects indicates that there is one (1) background project in the area that may impact the study area intersections.

- Harvard Commons: The final phase of Harvard Commons, a 99-unit housing development, is under construction. As part of the final phase, Harvard Commons will provide an internal roadway connection to Kingbird Road thus a connection between Harvard Street and American Legion Highway will be established. Site-specific trip tracings for the projected Harvard Commons traffic through the study intersections are provided in Appendix C.

4.5.3 2021 No-Build Traffic Volumes

To account for future traffic growth along the corridor, the 0.5 percent annual growth rate was applied to existing traffic volumes over a five-year period as well as traffic associated with the Harvard Commons buildout and interconnection. Future 2021 No-Build traffic volumes are displayed in Figure 4.10 and Figure 4.11.

4.5.4 Trip Generation

Trip generation estimates are derived for the critical school activity periods including morning and evening pick-up/drop-off periods based on projected Site programming characteristics for Brooke Charter High School. A detailed trip generation summary for the Site, based on a projected maximum student enrollment of 780 students and approximately 83 staff members, including a breakdown of vehicular trips by staff member and student pick-up/drop off is presented in Table 4.2 and is described below. In general, it is expected that the majority of students will use MBTA bus service to travel to and from the Site, based on data provided by Brooke Charter High School.

TABLE 4.2 DETAILED VEHICULAR TRIP-GENERATION SUMMARY[A]

Period/Direction	Staff Automobile	Student Automobile[b]	School Bus	Total
Weekday Morning Drop-Off Peak Hour (7:00-8:00 AM)[b]				
Entering	71	111	3	185
Exiting	--	111	3	114
Total	*71*	*222*	*6*	*299*
Weekday Evening Pick-Up Peak-Hour (4:30-5:30 PM)				
Entering	--	74	0	74
Exiting	71	74	0	145
Total	*71*	*148*	*0*	*219*

[a] Peak hour trip estimates based on empirical trip generation data provided by the Brooke Charter High School assuming full capacity (780 students) and ±83 staff. The analysis also assumes that 2/3 of the students would participate in the after-school program per school requirements.
[b] Assumes a vehicle occupancy rate (VOR) of 1.26 students per vehicle per observation at Brooke schools.

The following is a summary of the information presented in Table 4.2:

- Weekday Morning Drop-Off Peak Hour: Trip generation during the morning peak hour is approximately 299 vehicle-trips (185 entering and 114 exiting), including 111 parent/guardian drop-off vehicles, 3 school buses/vans and 71 staff vehicles.
- Weekday Evening Pick-Up Peak Hour: Trip generation during the evening peak hour is approximately 219 vehicle-trips (74 entering and 145 exiting), including 74 parent/guardian pick-up vehicles and 71 staff vehicles.

In summary, the projected peak design volume for school pick-up/drop-off activity (i.e., trips that must be actively managed by staff within the Site or along East Main Street) is 111 autos and 3 school buses during the drop/off and pick-up periods. As shown, a limited number of students (approximately 18 percent) are expected to be dropped-off/ picked-up by a parent/guardian vehicle while the remaining students will utilize the public transit system (MBTA), walk/ bicycle, or take a school bus to the Site.

The trips summarized in Table 4.2 have been further defined into automobile, walk/bike, school bus and transit trips using the mode share splits shown in Table 4.1. A vehicle occupancy rate of one person per vehicle (ppv) was assumed to generate walk, bike and transit trips. Detailed trip generation calculations are provided in Appendix C.

TABLE 4.3 TRIP GENERATION BY MODE SHARE BROOKE CHARTER HIGH SCHOOL (780 STUDENTS)

Period/Direction	Automobile[a]	Walk/ Bike[b]	Transit[c]	School Bus[d]	Total
Weekday Morning Drop-Off Peak Hour *(7:00-8:00 AM)*					
Entering	185	Negligible	481	159	825
Exiting	114	Negligible	0	0	114
Total	*299*	Negligible	*481*	*159*	*939*
Weekday Evening Pick-Up Peak-Hour (4:30-5:30 PM)					
Entering	74	Negligible	0	0	74
Exiting	145	Negligible	320	81	546
Total	*219*	Negligible	*320*	*81*	*620*

[a]Student/ Staff Automobile Trips and School Bus/ Van Trips in vehicles
[b]Walk/ Bike Trips in students
[c]Transit Trips in students
[d]School Bus Trips in students

As summarized in Table 4.3, the proposed school is estimated to generate approximately 640 new transit and school bus trips during the weekday morning drop-off peak hour and 401 new transit and school bus/van trips during the weekday evening pick-up peak hour.

Trip Generation – Permitted vs. Proposed

For comparison purposes, the trip generation for the permitted use at the Site for a 123 bed Vinfen rehabilitation facility (Parcel 2B-2) and an 11,000 square foot (sf) Heritage House (Parcel 2B-3) is estimated based on the trip generation estimates presented in the DPIR[1] prepared for Olmsted Green (which includes the Site). Table 4.4 presents a summary and comparison of the trip generation characteristics for the permitted and currently proposed Site use(s).

Table 4.4: Vehicular Trip Generation Comparison: Permitted versus Proposed Site Use

Period/Direction	Permitted			Proposed	Difference
	Vinfen[a]	Community Center[b]	Total Permitted	Brooke High School[c]	
Weekday Morning Drop-Off Peak Hour *(7:00-8:00 AM)*					
Entering	7	7	14	185	+171
Exiting	4	4	8	114	+106
Total	*11*	*11*	*22*	*299*	*+277*
Weekday Evening Pick-Up Peak-Hour (4:30-5:30 PM)					
Entering	8	3	11	74	+63
Exiting	10	7	17	145	+128
Total	*18*	*10*	*28*	*219*	*+191*

[a] Based on trip generation estimates for the permitted use at the Site in the DPIR for Olmsted Green prepared by Daylor Consulting and dated November 3, 2005 (123 Bed Rehabilitation Center).
[b] Based on trip generation estimates for the permitted use at the Site in the DPIR for Olmsted Green prepared by Daylor Consulting and dated November 3, 2005 (11,000 sf Heritage House).
[c] Peak hour trip estimates based on empirical trip generation rates for Brooke Charter High School applied to 780 students.

Based on the Site trip generation as summarized in Table 4.4, compared to the previously planned Vinfen facility and Heritage House identified in the Olmsted Green DPIR filing, the proposed use is estimated to generate approximately 277 additional vehicular trips during the weekday morning peak hour and an additional 191 additional vehicular trips during the weekday evening peak hour. This level of activity results in an additional three to five vehicle-trips per minute during peak hours relative to the permitted uses at the Site.

4.5.5 Trip Distribution

The distribution for projected traffic for the proposed Brooke Charter High School facility is based on the existing student and staff residence information and the primary travel routes to/from the proposed East Main Street location. The resulting trip distribution patterns are presented in Figure 4.12. Trip distribution calculations are provided in Appendix C.

▼

[1] *Draft Project Impact Report, Olmsted Green, American Legion Highway, Morton Street & Harvard Street, Boston, Massachusetts*; prepared by Daylor Consulting Group; November 3, 2005.

4.5.6 2021 Build Traffic Volumes

Site-generated trips for the development were assigned to the roadway network using the trip-generation estimates shown in Table 4.2 and the distribution patterns described above. The resulting Site-generated traffic generation on area roadways for the weekday morning and weekday evening drop-off and pick-up peak hours are presented in Figure 4.13 and Figure 4.14. To produce the 2021 Build traffic volume networks, trips associated with the proposed development were added to the 2021 No-Build traffic volume networks. The resulting 2021 Build traffic volume networks are presented in Figure 4.15 and Figure 4.16.

4.6 Traffic Operations Analysis

This section provides an overview of operational analysis methodology, a capacity analysis assessment of intersection operations, including the adjacent signalized intersection of American Legion Highway and Kingbird Road/ Canterbury Street, under existing (baseline) and projected future No-build and Build conditions.

4.6.1 Intersection Capacity Analysis

Intersection capacity analyses are presented in this section for the Baseline and future No-Build and Build traffic-volume conditions. Capacity analyses, conducted in accordance with City of Boston and MassDOT guidelines, provide an index of how well the roadway facilities serve the traffic demands placed upon them. The operational results provide the basis for any recommended access improvements.

Capacity analysis of intersections is developed using the Synchro® computer software, which implements the methods of the 2010 Highway Capacity Manual (HCM). The resulting analysis presents a level-of-service (LOS) designation for individual intersection movements. The LOS is a letter designation that provides a qualitative measure of operating conditions based on several factors including roadway geometry, speeds, ambient traffic volumes, traffic controls, and driver characteristics. Since the LOS of a traffic facility is a function of the traffic flows placed upon it, such a facility may operate at a wide range of LOS, depending on the time of day, day of week, or period of year. A range of six levels of service are defined on the basis of average delay, ranging from LOS A (the least delay) to LOS F (delays greater than 50 seconds for unsignalized movements and greater than 80 seconds for signalized movements). The specific control delays and associated LOS designations are presented in Appendix C.

Capacity Analysis Results

Level-of-Service (LOS) analyses were conducted for the Baseline and future No-Build and Build conditions for the study intersections. The results of the intersection capacity analyses are summarized below in Table 4.5 and Table 4.6 and explained in detail in Appendix C.

TABLE 4.5 INTERSECTION CAPACITY ANALYSIS RESULTS: WEEKDAY MORNING (DROP-OFF) PEAK HOUR

Approach	2016 Baseline			2021 No-Build			2021 Build		
	v/c[a]	Delay[b]	LOS[c]	v/c	Delay	LOS	v/c	Delay	LOS
American Legion Highway at Kingbird Road/ Canterbury Street									
Eastbound	0.61	16	B	0.66	18	B	0.71	22	C
Westbound	0.71	20	B	0.77	22	C	0.78	27	C
Northbound	0.26	24	C	0.33	25	C	0.64	39	D
Southbound	0.50	24	C	0.51	24	C	0.63	28	C
Overall	*0.71*	*19*	*B*	*0.77*	*21*	*C*	*0.78*	*26*	*C*
American Legion Highway at Austin Street									
NB Right Turn	0.09	15	B	0.10	16	C	0.23	17	C
Kingbird Road at East Main Street									
Eastbound	0.00	9	A	0.00	10	A	0.01	15	C
Westbound	0.04	9	A	0.04	9	A	0.14	10	A
Northbound	0.00	<5	A	0.00	<5	A	0.00	<5	A
Southbound	0.04	5	A	0.04	<5	A	0.23	7	A
East Main Street at Site Driveway									
Eastbound	n/a[d]	n/a	n/a	n/a	n/a	n/a	0.00	<5	A
Westbound	n/a	n/a	n/a	n/a	n/a	n/a	0.00	<5	A
Southbound	n/a	n/a	n/a	n/a	n/a	n/a	0.00	<5	A

[a] Volume-to-capacity ratio
[b] Average control delay per vehicle (in seconds)
[c] Level of service
[d] n/a = not applicable

TABLE 4.6 INTERSECTION CAPACITY ANALYSIS RESULTS: WEEKDAY EVENING (PICK-UP) PEAK HOUR

Approach	2016 Baseline			2021 No-Build			2021 Build		
	v/c[a]	Delay[b]	LOS[c]	v/c	Delay	LOS	v/c	Delay	LOS
American Legion Highway at Kingbird Road/ Canterbury Street									
Eastbound	0.46	12	B	0.48	12	B	0.62	17	B
Westbound	0.76	18	B	0.78	20	B	0.91	29	C
Northbound	0.18	21	C	0.24	21	C	0.62	37	D
Southbound	0.32	19	B	0.35	19	B	0.37	19	B
Overall	*0.76*	*16*	*B*	*0.78*	*17*	*B*	*0.91*	*24*	*C*
American Legion Highway at Austin Street									
NB Right Turn	0.07	16	C	0.08	16	C	0.23	19	C
Kingbird Road at East Main Street									
Eastbound	0.01	9	A	0.01	9	A	0.02	12	B
Westbound	0.02	9	A	0.02	9	A	0.13	9	A
Northbound	0.00	<5	A	0.00	<5	A	0.00	<5	A
Southbound	0.01	<5	A	0.01	<5	A	0.08	5	A
East Main Street at Site Driveway									
Eastbound	n/a[d]	n/a	n/a	n/a	n/a	n/a	0.00	<5	A
Westbound	n/a	n/a	n/a	n/a	n/a	n/a	0.00	<5	A
Southbound	n/a	n/a	n/a	n/a	n/a	n/a	0.00	<5	A

[a] Volume-to-capacity ratio
[b] Average control delay per vehicle (in seconds)
[c] Level of service
[d] n/a = not applicable

As summarized in Table 4.5 and Table 4.6,

- American Legion Highway at Kingbird Road: Under future No-build conditions, the intersection of American Legion Highway at Kingbird Road will operate at an overall level of service (LOS) C or better during the weekday morning and weekday evening peak hour drop-off/ pick-up periods. With the Project in place under Build conditions the intersection will continue to operate an overall LOS C or better during the peak hours of the school. The most significant increase in delay will be for the northbound Kingbird Road approach to American Legion Highway which will operate at LOS D or better during the weekday morning drop-off period and weekday evening pick-up period with a moderate but manageable increase in delay on the remaining approaches.
- American Legion Highway at Austin Street: Under Build conditions the Austin Street approach to American Legion Highway will continue to operate at LOS C or better during the weekday morning and weekday evening peak hour drop-off/ pick-up periods.

- Kingbird Road at East Main Street: Under Build conditions the East Main Street approach to Kingbird Road will operate with minimal delay (LOS A) during the weekday morning and weekday evening peak hour drop-off/ pick-up periods.
- East Main Street at Proposed Site Driveway: Under Build conditions the Proposed Site Driveway approach to East Main Street will operate with minimal delay (LOS A) during the weekday morning and weekday evening peak hour drop-off/ pick-up periods.

In summary, peak hourly Site traffic increases on area roadway as described above will generally have minor impact on operations at the study intersections. Proposed mitigation including Site access and circulation improvements, a traffic management plan, and pedestrian improvements will reduce the impact of the proposed Site programming.

Vehicle Queue Analysis Results

Vehicle queue results are presented for the signalized study intersection. These vehicle queues are compared to available storage lengths, which are defined as lengths of exclusive turn lanes or the distance to the nearest major intersection for through lanes. Vehicle queue results from the capacity analysis are summarized in Table 4.7. Detailed worksheets of the queuing analysis are provided in Appendix C.

TABLE 4.7: VEHICLE QUEUE ANALYSIS : AMERICAN LEGION HIGHWAY AT KINGBIRD ROAD/CANTERBURY STREET

Approach	Storage Length (feet)	2021 No-Build		2021 Build	
		Average Queue Length[a]	95th Percentile Queue Length[a]	Average Queue Length	95th Percentile Queue Length
Weekday Morning Drop-Off Peak Hour (7:00-8:00 AM)					
Eastbound L	200±	82	179	87	194
Eastbound T & T/R	>1500	155	247	188	309
Westbound L	125±	39	90	77	201
Westbound T & T/R	1200±	203	316	215	346
Northbound L/T/R	450±	24	63	66	123
Southbound L/T	375±	48	97	64	122
Southbound R	375±	<25	33	<25	32
Weekday Evening Pick-Up Peak-Hour (4:30-5:30 PM)					
Eastbound L	200±	39	85	42	93
Eastbound T & T/R	>1500	147	228	179	285
Westbound L	125±	25	64	40	99
Westbound T & T/R	1200±	284	525	324	616
Northbound L/T/R	450±	<25	42	58	122
Southbound L/T	375±	<25	60	31	72
Southbound R	375±	<25	34	<25	33

[a]Average and 95th percentile queue lengths are reported in feet per lane.

As presented in Table 4.7, under No-Build conditions the average and 95th percentile vehicle queues at the signalized study intersections are contained within available storage lanes during the weekday morning and weekday evening peak hour drop-off/ pick-up periods. Under Build condition with the school development in place, the average and 95th percentile queues are also generally contained within available storage lanes during the weekday morning and weekday evening peak hour drop-off/ pick-up periods, however, the American Legion Highway westbound left turn lane could potentially extend beyond the storage length for brief periods during the morning drop-off period. The Proponent will work with the BTD to determine whether modifications to the traffic signal timing or left turn storage capacity will be required to address this condition.

4.7 Recommendations

Access improvements that support projected traffic associated with the proposed development are identified that minimize or offset Project-related traffic impacts and address access needs for the Site. The Proponent will work with BTD to create a project that efficiently serves vehicle trips, improves the pedestrian environment, and encourages transit and bicycle use. In addition, the Proponent will amend the Transportation Access Plan Agreement (TAPA) prepared by BTD and Lena New Boston LLC during the development of the Olmsted Green project. The proposed recommendations listed below will be considered as part of the amendment to the TAPA.

Recommended improvements include (a) access-related improvements, (b) pedestrian improvements, and (c) transportation demand management (TDM). The Proponent will also produce a Construction Management Plan (CMP) for review and approval by BTD. The CMP will detail the schedule, staging, parking, delivery, and other associated impacts of the construction of the Project.

4.7.1 Site Access and Circulation

The following recommended access-related improvements are aimed at enhancing traffic operations and/or travel safety, and are subject to further engineering evaluation/design:

- Pedestrian Access: A pedestrian access path, entry forecourt and Site identification signage will be constructed at the corner of Kingbird Road and American Legion Highway, in addition to surface parking and edge buffered landscape to serve the staff and community.
- Parent Drop-Off/Pick-Up: A designated parent drop-off/pick-up area will be provided on-site to facilitate student arrival and dismissal operations.
- Parking: On-site parking includes 60 spaces with 2 accessible spaces and a space for vans to accommodate staff parking. On street parking for visitors is available on both East Main Streets and Austin Street.

- Loading and Service Activity: Loading and service areas will be designated on-site to handle the loading demands of the Project including, trash and recycle operations and meal and school supply deliveries. The majority if not all of the truck trips are expected to occur during off-peak hours.
- American Legion Highway/Kingbird Road Intersection: The Proponent will work with the BTD to determine whether modifications to the traffic signal timing or increased left turn storage capacity at the American Legion Highway/Kingbird Road intersection will be required to address the projected vehicle delay and queuing increase at the intersection.
- School Zone Enhancements: Enhance the existing school zone along American Legion Highway to include applicable pavement markings, signs and programmable flashing yellow warning beacons.
- Signage and Pavement Markings: Install MUTCD compliant signs including "Do Not Enter", "One-way" and "Stop" signs to designate the one-way vehicle circulation through the Site and driveway operations. Likewise, pavement markings are recommended to enhance the one-way versus two-way flow areas within the Site and along East Main Street.
- Sight Lines: Plantings (shrubs, bushes) and structures (walls, fences, signs etc.) will be maintained at a height of 2 feet or less within the sight lines in vicinity of the Site driveways to provide unobstructed view of approaching traffic.

4.7.2 Traffic Management Plan

A traffic management plan (TMP) is recommended to ensure efficient operations of school pick-up/drop-off, parking activity, and student circulation. Key aspects of the TMP include the following parking and drop-off/pick-up operations guidelines:

- Provide internal parking and circulation aisles to provide a parent pick-up/drop-off area that will not block access to the Site driveways.
- Stagger the Brooke Mattapan and Brooke High School start and dismissal times to avoid impact to bus operations for Brooke Mattapan.
- Continue to direct all bus loading and unloading operations to the designated bus lane on Austin Street. Accordingly, the existing crosswalk at the intersection of Austin Street and East Main Street should be utilized for access/egress between the school's main entrance and the designated bus area.
- Staff members should be available to direct students to/from the school building entrances and the drop-off/pick-up areas. Likewise, Staff members should actively manage all internal pedestrian crossings.
- Off-site parent pick-up/drop-off activity should be prohibited and enforced by the school. Fencing and "No Stopping" signs will be installed along American Legion Highway in order to discourage pick-up/drop-off activity in this area.

4.7.3 Pedestrian Improvements

Sidewalks and ADA compliant crosswalks are recommended where feasible to connect the Site and adjacent pedestrian facilities to accommodate and promote pedestrian activity. The Site plan envisions a system of interconnected walkways that achieve this objective.

4.7.4 Construction Management Plan

Details of the overall construction schedule, working hours, number of construction workers, worker transportation, and parking, number of construction vehicles, and routes will be addressed in detail in a Construction Management Plan (CMP) to be filed with BTD in accordance with the City's transportation maintenance plan requirements. The CMP will also address the need for pedestrian detours, lane closures, and/or parking restrictions, if necessary to accommodate a safe and secure work zone.

To minimize transportation impacts during the construction period, the following measures will be considered for the CMP:

- Construction workers will be encouraged to use public transportation and/or carpool; and
- Secure spaces will be provided on-site for workers' supplies and tools so they do not need to be brought to the Project Site each day.

The CMP will be executed with BTD prior to commencement of construction and will document all committed measures.

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FIGURE 4-1

SITE LOCATION

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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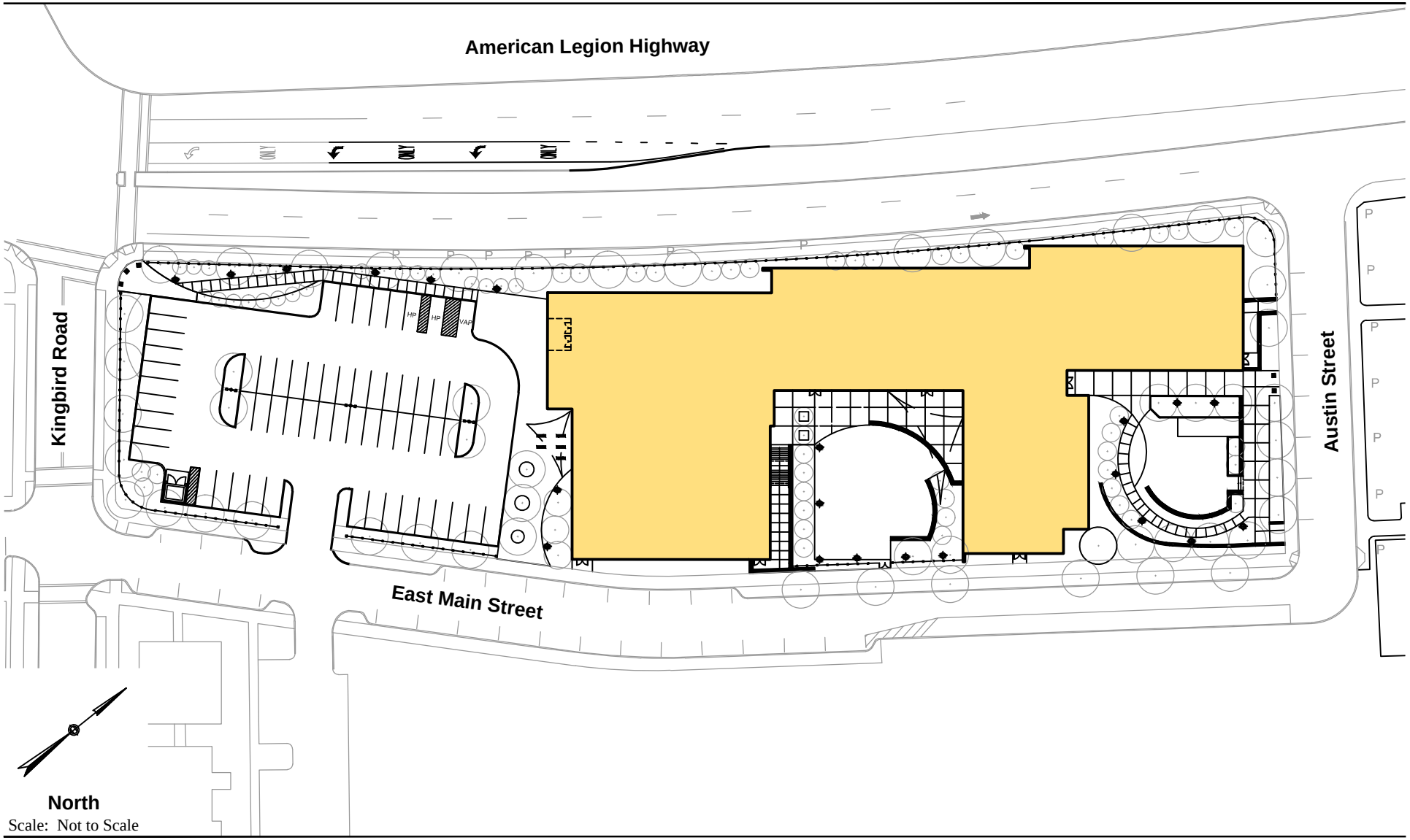

SITE PLAN SOURCE: VHB

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PREPARED BY ARROWSTREET

FIGURE 4-2

PRELIMINARY SITE PLAN

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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FIGURE 4-3

2016 BASELINE CONDITION
WEEKDAY AM PEAK HOUR VOLUMES

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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FIGURE 4-4

2016 BASELINE CONDITION
WEEKDAY PM PEAK HOUR VOLUMES

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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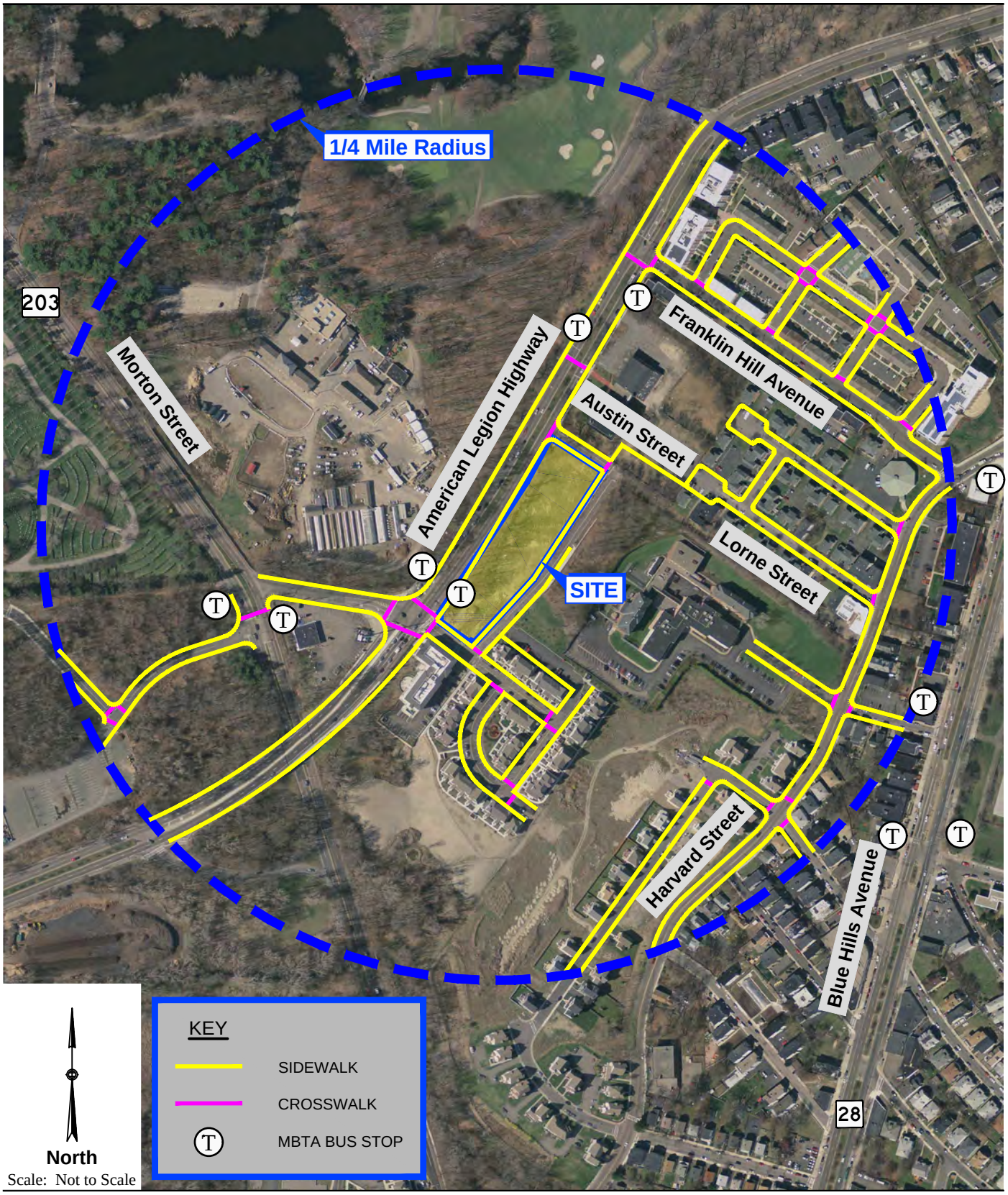

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FIGURE 4-5

PEDESTRIAN FACILITIES

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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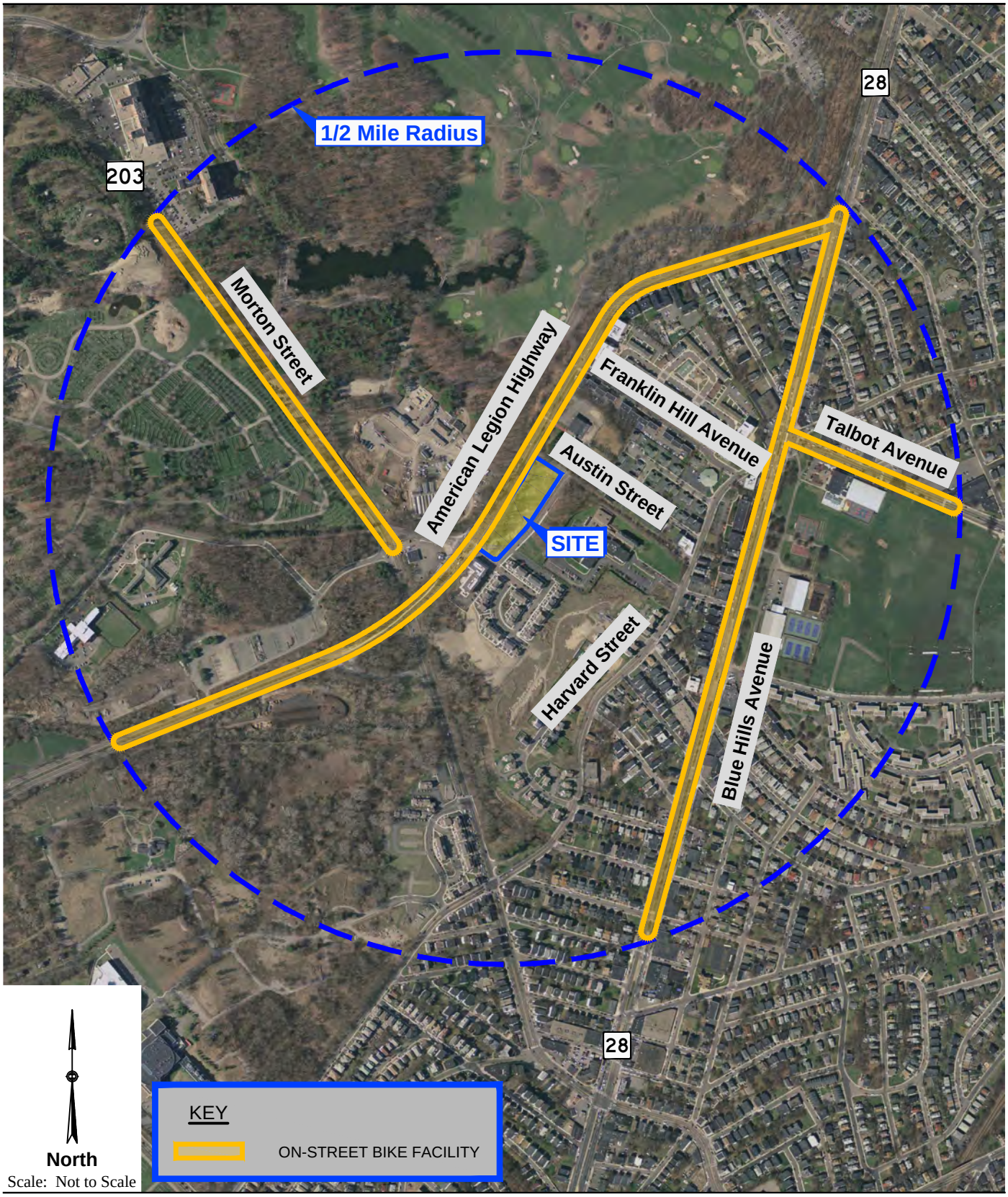

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FIGURE 4-6

BICYCLE FACILITIES

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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FIGURE 4-7

2016 BASELINE CONDITION PEDS/BIKES WEEKDAY AM PEAK HOUR VOLUMES

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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FIGURE 4-8

2016 BASELINE CONDITION PEDS/BIKES
WEEKDAY PM PEAK HOUR VOLUMES

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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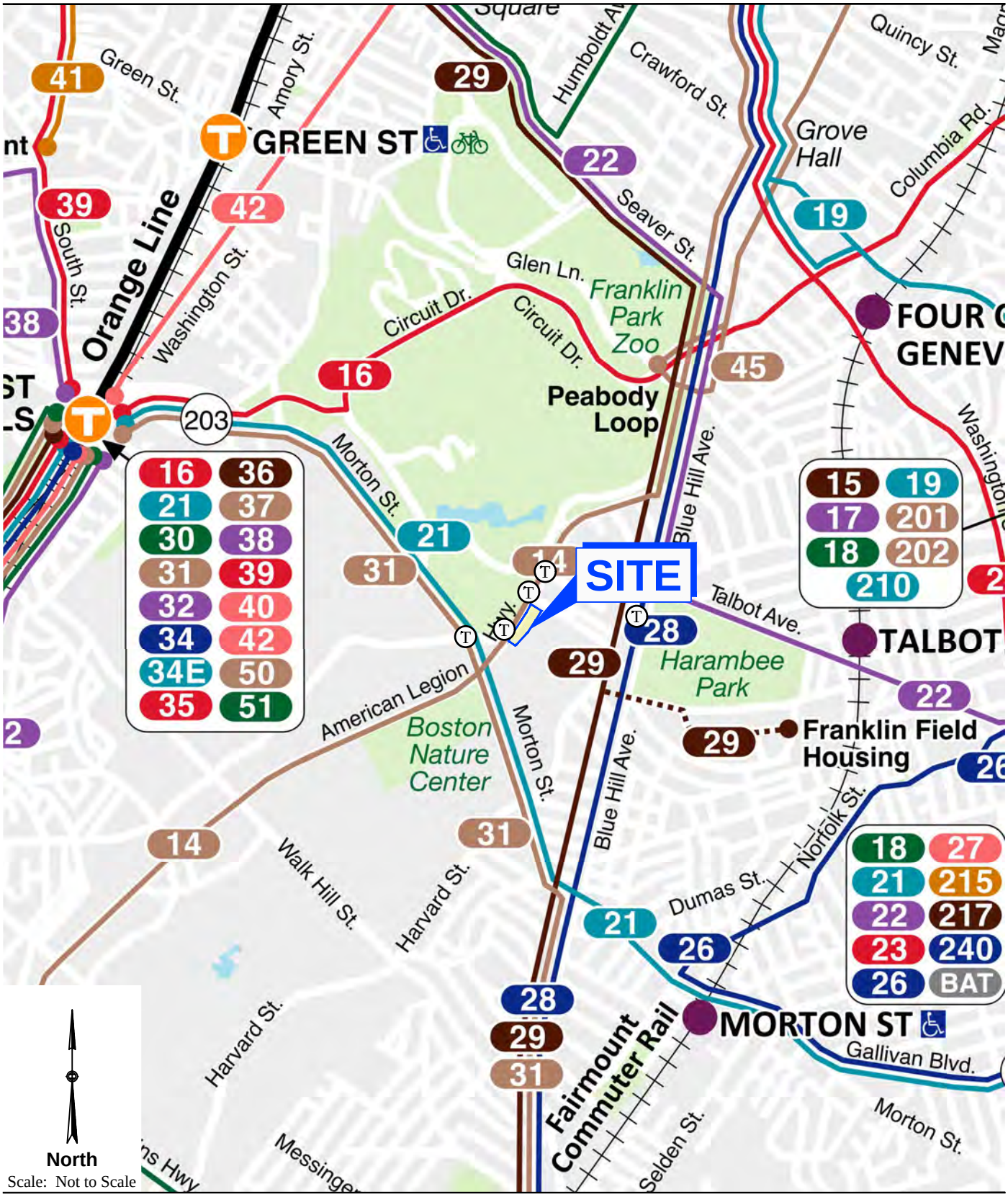

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FIGURE 4-9

PUBLIC TRANSPORTATION

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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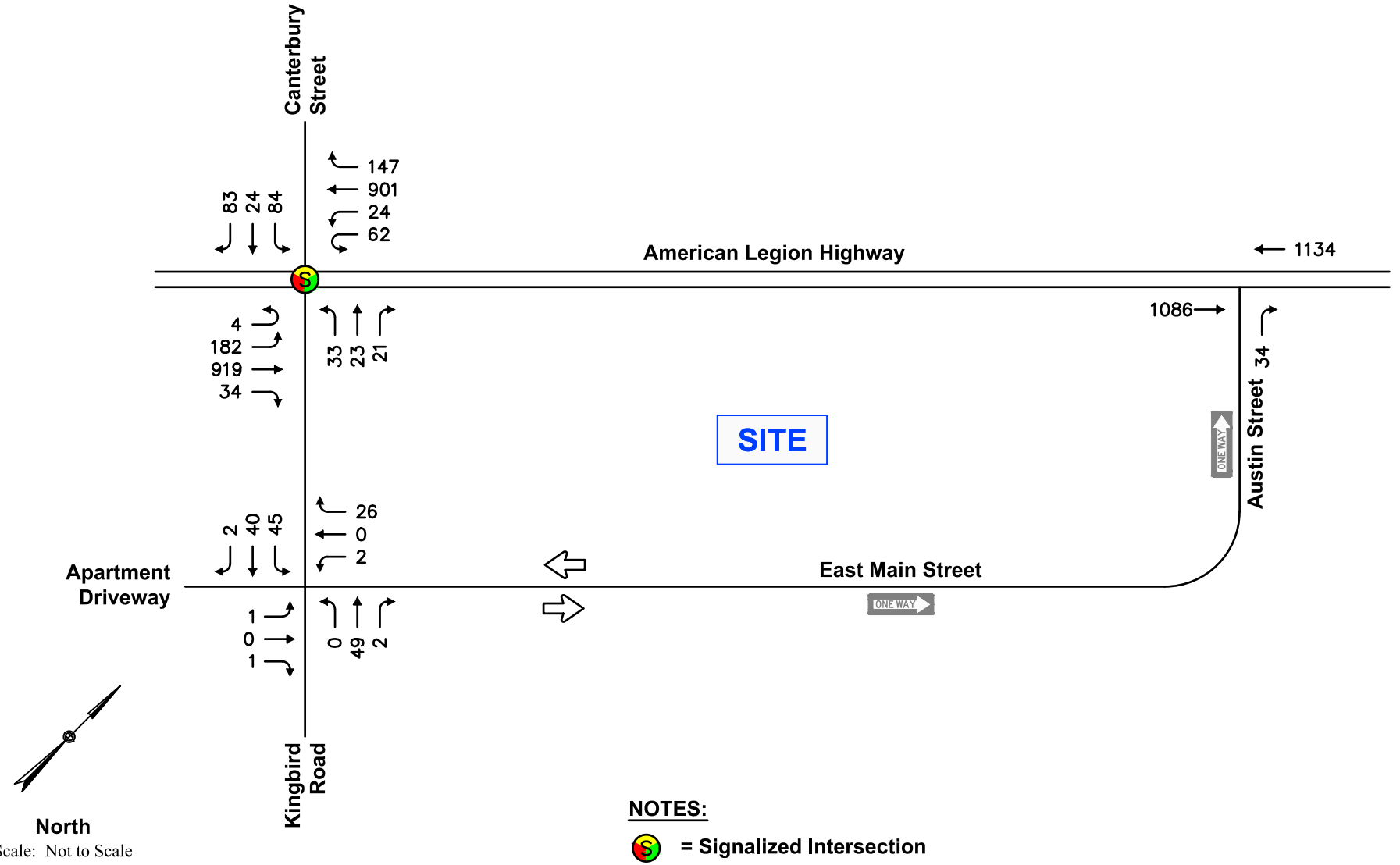

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FIGURE 4-10

2021 NO-BUILD CONDITION
WEEKDAY AM PEAK HOUR VOLUMES

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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FIGURE 4-11

2021 NO-BUILD CONDITION
WEEKDAY PM PEAK HOUR VOLUMES

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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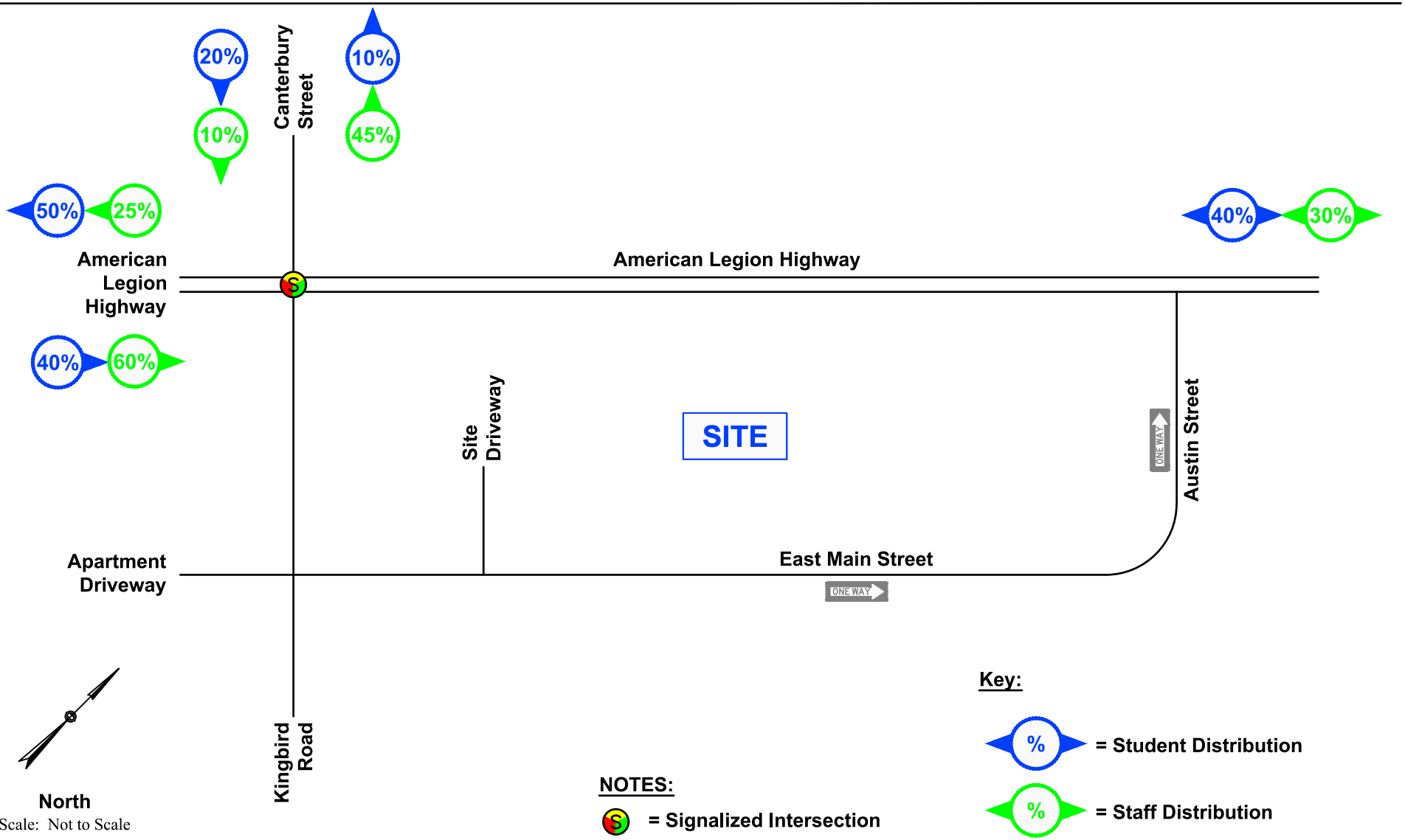

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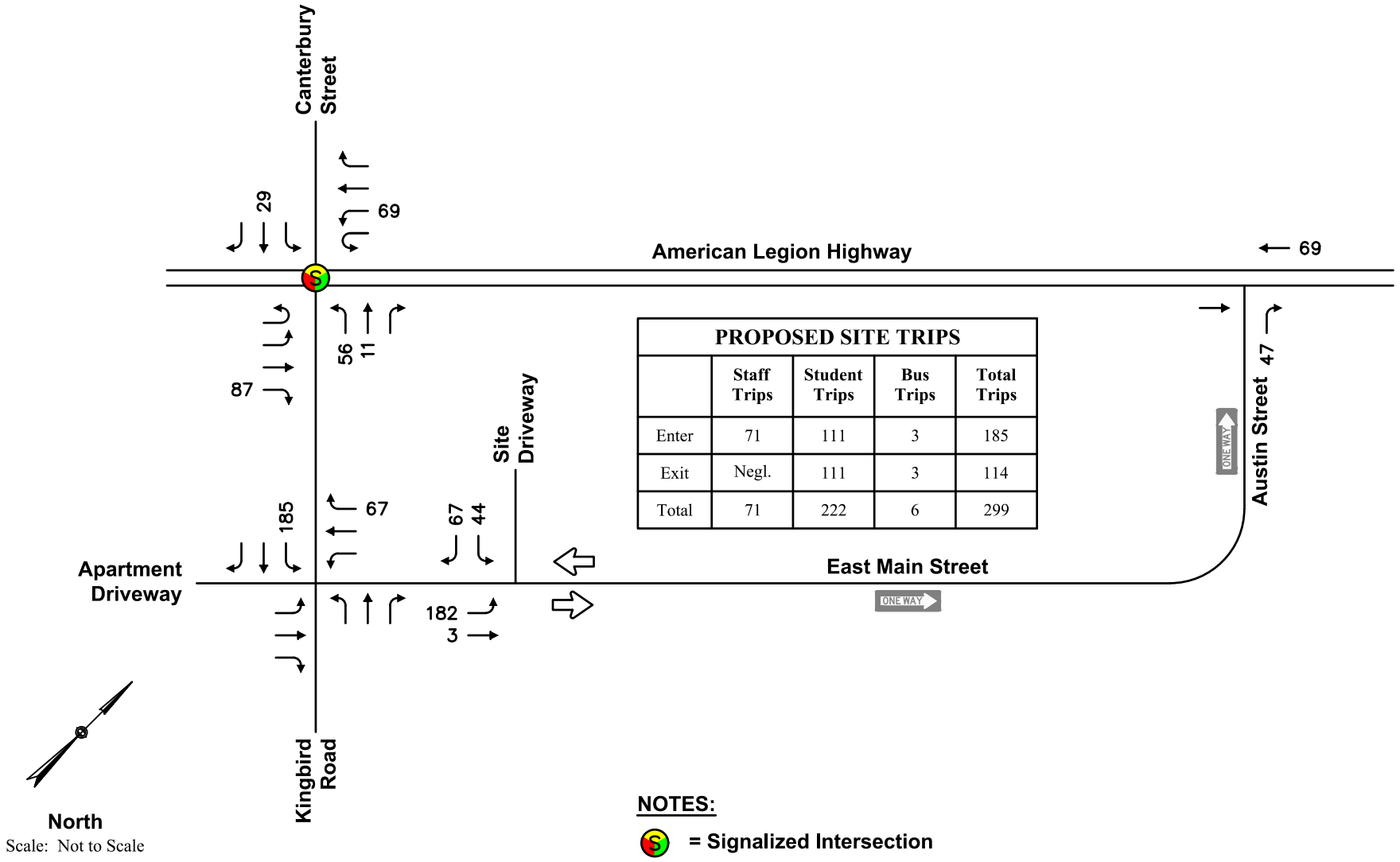
FIGURE 4-12

TRIP DISTRIBUTION

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA



PROPOSED SITE TRIPS				
	Staff Trips	Student Trips	Bus Trips	Total Trips
Enter	71	111	3	185
Exit	Negl.	111	3	114
Total	71	222	6	299

NOTES:

S = Signalized Intersection

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FIGURE 4-13

SITE GENERATED TRIPS
WEEKDAY AM PEAK HOUR VOLUMES

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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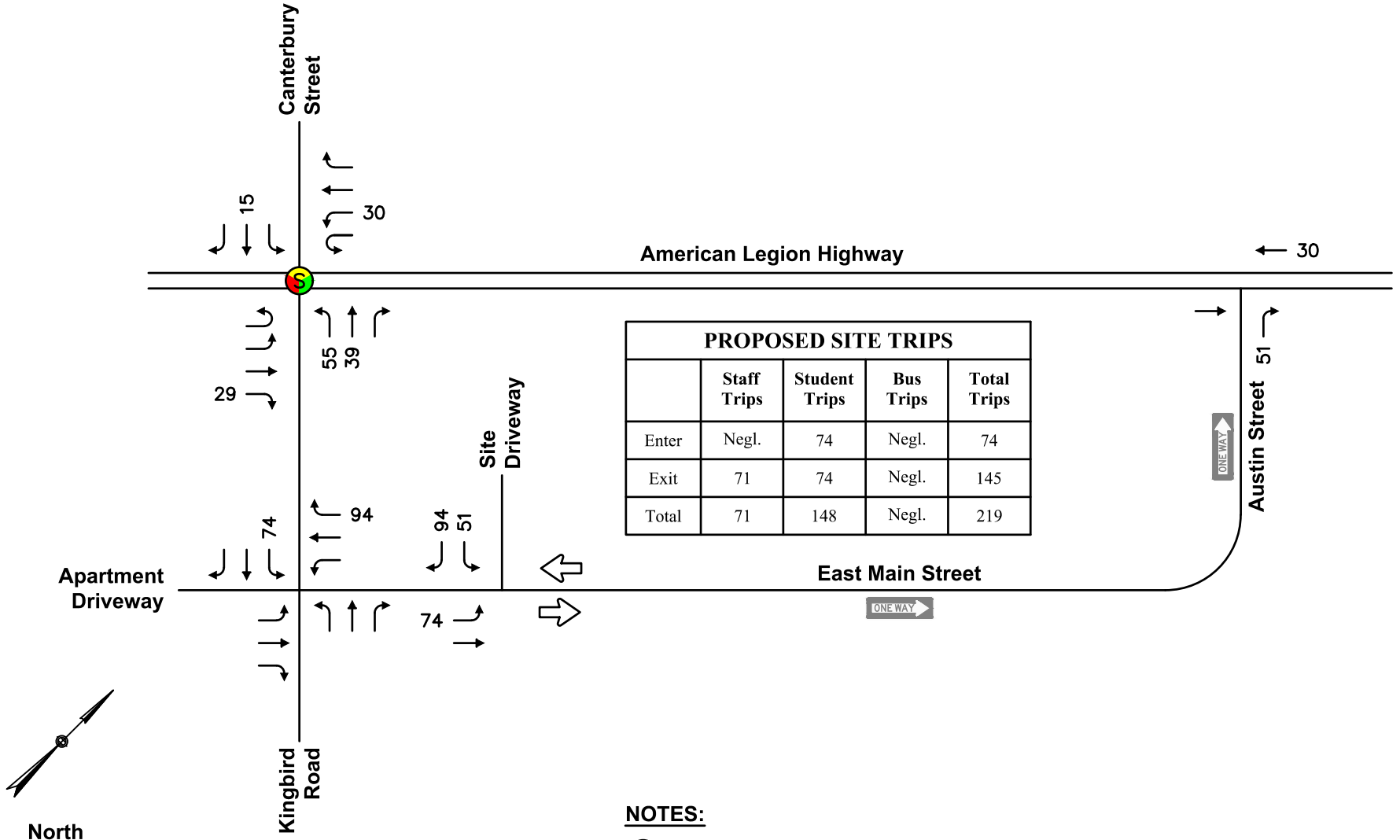

PROPOSED SITE TRIPS				
	Staff Trips	Student Trips	Bus Trips	Total Trips
Enter	Negl.	74	Negl.	74
Exit	71	74	Negl.	145
Total	71	148	Negl.	219

NOTES:

S = Signalized Intersection

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FIGURE 4-14

SITE GENERATED TRIPS
WEEKDAY PM PEAK HOUR VOLUMES

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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FIGURE 4-15

2021 BUILD CONDITION
WEEKDAY AM PEAK HOUR VOLUMES

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

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FIGURE 4-16

2021 BUILD CONDITION
WEEKDAY PM PEAK HOUR VOLUMES

BROOKE CHARTER HIGH SCHOOL
BOSTON, MA

5

Environmental Protection

This chapter presents information on the existing environmental conditions in the vicinity of the Project Site and the potential changes that may occur as a result of the Project. The goal of the Project is to better utilize the Project Site and complement adjacent uses while avoiding or minimizing potential adverse environmental impacts to the Project Site to the greatest extent feasible.

5.1 Key Findings and Benefits

- Shadow: Shadow studies indicate that the Project will not produce significant new shadow impacts outside of the Project Site.
- Daylight: Under the Build Condition, all viewpoints are expected to experience an increase in skyplane obstruction as follows: 25.6 percent obstruction along American Legion Highway; 10.8 percent along Austin Street; 32.3 percent along East Main Street. This effect is to be expected and cannot be avoided when a new building is constructed on a vacant parcel.
- Solar Glare: The Project will not include large areas of reflective glass or other materials that would contribute to solar glare.
- Air Quality: No violation of the National Ambient Air Quality Standards (NAAQS) are expected to be created; no increase in the frequency or severity of any existing violations (none of which are related to this development) would be anticipated to occur; and no delay in attainment of any NAAQS would be expected to result due to the implementation of the proposed action. Based upon the analysis presented in this report, no significant adverse air quality impacts from the Project are anticipated.
- Water Quality: The Project will not adversely affect the water quality of nearby water bodies.
- Flood Hazard: The Project Site is not susceptible to flooding.
- Noise: The daytime and nighttime sound levels within the study area are currently below the City of Boston's daytime and nighttime standard of 60 dB(A) and 50 dB(A), respectively. As a result of the preliminary design, the Project's operations will have no adverse noise impacts at nearby sensitive receptor locations.

- Solid and Hazardous Materials: Hazardous materials releases on the Project Site associated with the former Boston State Hospital East Campus are tracked under Release Tracking Numbers (RTNs) 3-13282 and 3-19713. Upon completion in 2006 of several Release Abatement Measures (RAMs) a Class A-3 Response Action Outcome (RAO) Statement indicated that a Permanent Solution had been achieved. A recent Phase I Environmental Site Assessment (ESA) found no evidence of storage or a release of oil or hazardous material (OHM), or a significant amount of solid waste at the Project Site. If encountered, urban fill at the Project Site will require management in accordance with the Massachusetts Contingency Plan (MCP).
- Groundwater: Test borings indicate that the groundwater table is likely below the top of the bedrock surface. The Project is not anticipated to have any impact on groundwater.
- Geotechnical: Subsurface conditions consist of a native sand deposit directly overlying bedrock with fill materials in some areas. From a geotechnical standpoint, no adverse impacts on adjacent buildings, utilities, or other infrastructure is anticipated as a result of the Project.
- Historic Resources: The Project Site is located within the Boston Lunatic Hospital inventoried area. The Project is not anticipated to have any impact on Historic Resources within the vicinity of the Project.
- Construction: A plan to control construction-related impacts including erosion, sedimentation, and other pollutant sources during construction and any land disturbance activities will be developed and implemented. All regulations related to construction-period air quality, noise, traffic and parking, trucks, hazardous materials, rodent control, and public safety will be adhered to.

5.2 Shadow

The Project is located in an urban-scale neighborhood at the threshold between the open green space of the Mass Audubon Boston Nature Center, Forest Hills Cemetery and Franklin Park Zoo, and extensive multi-family residential neighborhoods. Recognizing the importance of natural daylight in maintaining and enhancing the quality of the streetscape and the surrounding residential properties, the Proponent has conducted a detailed shadow analysis to assess the Project's shadow impacts within its urban context. The primary purpose of the shadow analysis is to examine the extent to which the Project creates net-new shadow on the surrounding area.

Shadow studies were conducted for the following dates and times, consistent with customary practice:

- March 21 (spring equinox): 9:00AM, 12:00PM, 3:00PM
- June 21 (summer solstice): 9:00AM, 12:00PM, 3:00PM, 6:00PM

- September 21 (fall equinox): 9:00AM, 12:00PM, 3:00PM
- December 21 (winter solstice): 9:00AM, 12:00PM, 3:00PM

The graphic results of the shadow studies are presented in Figures 5.1a through 5.3d. In summary, the shadow studies yielded the following conclusions about the Project's shadow impacts:

- The position of the proposed structure is located at the corner of the Project Site that is furthest from the adjacent new residential properties and closest to the recently renovated Brooke Charter School Mattapan building.
- The Project will cast minimal net-new shadows on public streets and sidewalks. The main impact was found to be during the late afternoon hours where the affected area is primarily at Austin Street and the northern end of East Main Street. Secondly, in the early morning the primary impact is on American Legion Highway.
- Most of the Project's shadow impacts fall within the Project Site area and over surrounding roadways and parking lots.

5.3 Daylight

The following section describes the anticipated effect on daylight coverage at the Project Site as a result of the Project. An analysis of the percentage of skydome obstructed under the Build and No-Build conditions is a requirement of the Article 80 Large Project Review as part of the Environmental Protection component (Section 80B-2(c) of the City of Boston Zoning Code). The daylight analysis was prepared using the BPDA's Daylight Analysis Program (BRADA) and has been completed in accordance with the requirements of Article 80 of the City of Boston Zoning Code. The results of the analysis are presented in Figures 5.2a-c.

5.3.1 Methodology

The Project was analyzed using the BRADA and by comparing the Existing/No-Build Condition and Build Condition. This section provides a description of the methodology used for the analysis.

BRADA Software

The BRADA program was developed in 1985 by the Massachusetts Institute of Technology to estimate the pedestrian's view of the skydome taking into account the massing and building materials used. The software approximates a pedestrian's view of a site based on input parameters such as: location of viewpoint, length and height of buildings and the relative reflectivity of the building facades. The model typically uses the midpoint of an adjacent right-of-way or sidewalk as the analysis viewpoint. Based on these data, the model calculates the perceived skydome obstruction and provides a graphic depicting the analysis conditions.

The model inputs used for the study presented in this NPC were taken from a combination of the BPDA City model, an existing conditions survey prepared by VHB, and schematic design plans prepared by the Project Architect. As described above, the BRADA software considers

the relative reflectivity of building facades when calculating perceived daylight obstruction. Highly reflective materials are thought to reduce the perceived skydome obstruction when compared to non-reflective materials. For this daylight analysis, the building facades are considered non-reflective, resulting in a conservative estimate of daylight obstruction.

Viewpoints

The following viewpoints were used for this daylight analysis:

- Center of American Legion Highway (Figure 5.2a)
- Center of Austin Street (Figure 5.2b)
- Center of East Main Street (Figure 5.2c)

No viewpoint from Kingbird Road was included in the analysis because the building facades are beyond allowable daylighting impacts as defined by the parameters of the BRADA program.

5.3.2 Daylight Existing/No-Build Conditions

Since the Project Site is currently vacant, there are no existing skyplane impacts (zero percent obstruction from all viewpoints).

5.3.3 Daylight Build Conditions

Under the Build Condition, all viewpoints are expected to experience an increase in skyplane obstruction as follows: 25.6 percent obstruction along American Legion Highway; 10.8 percent from along Austin Street; 32.3 percent along East Main Street. This effect is to be expected and cannot be avoided when a new building is constructed on a vacant parcel.

5.4 Solar Glare

The Project materials are still being studied and glazing of the windows will be determined as the design progresses. The Proponent does not expect to use reflective glazing or other mirror finish materials, therefore solar glare impacts are not anticipated.

5.5 Air Quality

This section presents an overview of and the results of the preliminary mobile source assessment conducted for this filing. The purpose of the air quality assessment is to demonstrate that the Project satisfies applicable regulatory requirements, and to determine whether it complies with the 1990 Clean Air Act Amendments (CAAA) following the local and the U.S. Environmental Protection Agency (EPA) policies and procedures.

The air quality assessment conducted for the Project includes a qualitative localized (microscale), or “hot spot”, analysis of carbon monoxide (CO) concentrations in accordance with BRA screening guidance. The microscale analysis evaluated potential CO impacts from

vehicles traveling through congested intersections in the Project area under the existing conditions, as well as considering site-specific impacts under the future conditions. The results from this evaluation are subject to the NAAQS.

5.5.1 Background

The CAAA resulted in states being divided into attainment and non-attainment areas, with classifications based upon the severity of their air quality problems. Air quality control regions are classified and divided into one of three categories: attainment, non-attainment and maintenance areas depending upon air quality data and ambient concentrations of pollutants. Attainment areas are regions where ambient concentrations of a pollutant are below the respective NAAQS; non-attainment areas are those where concentrations exceed the NAAQS. A maintenance area is an area that used to be non-attainment, but has demonstrated that the air quality has improved to attainment. After 20 years of clean air quality, maintenance areas can be re-designated to attainment. Projects located in a CO maintenance area are required to evaluate their CO concentrations with the NAAQS.

The Project is located in the City of Boston, which under the EPA designation is a CO Maintenance area. As such, CO concentrations need to be considered for this Project.

5.5.2 Air Quality Standards

The EPA has established the NAAQS to protect the public health. Massachusetts has adopted similar standards as those set by the EPA for CO. Table 5.1 presents the NAAQS for CO.

TABLE 5.1 NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Primary Standards		
	Level	Averaging Time	Form
Carbon Monoxide	9 ppm (10 mg/m3)	8-hour	Not to be exceeded more than once per year
	35 ppm (40 mg/m3)	1-hour	

CO is directly emitted by motor vehicles. The predominant source of air pollution anticipated from typical project developments is emissions from Project-related motor vehicle traffic. A product of incomplete combustion, CO is a colorless and odorless gas that prevents the lungs from passing oxygen to the blood stream. Brief exposure to high levels of CO can also impair vision, physical coordination, and the perception of time. According to the EPA, 60 percent of CO emissions result from motor vehicle exhaust, while other sources of CO emissions include industrial processes, non-transportation fuel combustion and natural sources (i.e., wildfires).[1] In cities, as much as 95 percent of CO emissions may emanate from automobile exhaust.[2]

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[1] Environmental Protection Agency, *National Air Quality and Emissions Trends Report*, 1999, March 2001.
[2] Ibid.

The Department of Environmental Protection (MassDEP) maintains a network of air quality monitors to measure background CO concentrations. Background concentrations are ambient pollution levels from all stationary, mobile, and area sources. Background CO concentrations are determined by choosing the maximum of the 2nd-high annual values from the previous three years. Looking at the air quality monitor closest to the Project Site (Harrison Avenue) for the years 2013-2015, the CO background values are 1.9 ppm for the 1-hour averaging time and 1.1 ppm for the 8-hour averaging time. These values are much less than the 1-hour and 8-hour NAAQS. The background values are presented in Table 5.2.

TABLE 5.2 AIR QUALITY BACKGROUND CONCENTRATIONS

Pollutant	Background Concentrations		NAAQS	
	Level	Averaging Time	Level	Averaging Time
Carbon Monoxide	1.1 ppm	8-hour	9 ppm	8-hour
	1.9 ppm	1-hour	35 ppm	1-hour

Monitoring Location: Harrison Avenue, Boston, MA. Years 2013-2015.

The potential CO concentrations from motor vehicle traffic related to the Project will be considered in conjunction with these background concentrations to demonstrate that the Project will comply with the NAAQS Standards.

5.5.3 BPDA Development Review Guidelines

The BPDA Development Review Guidelines require "a microscale analysis predicting localized carbon monoxide concentrations should be performed, including identification of any locations projected to exceed the National or Massachusetts Ambient Air Quality Standards, for projects in which:

- 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; or
- Project traffic would increase traffic volumes on nearby roadways by 10 percent or more (unless the increase in traffic volume is less than 100 vehicles per hour); or
- The Project will generate 3,000 or more new average daily trips on roadways providing access to a single location.

5.5.4 Traffic Data

The air quality study uses traffic data (volumes, delays, and speeds) developed for the analysis conditions based upon the traffic analysis. The traffic study area includes the following intersections:

- American Legion Highway at Kingbird Road/Canterbury Street
- American Legion Highway at Austin Street
- Kingbird Road at East Main Street

- East Main Street at the School Driveway

The traffic study predicted the Project's generated trips and trip distribution. The Project is expected to generate 314 new vehicle trips in the morning peak hour and 230 new vehicle trips in the evening peak hour.

5.5.5 Microscale Screening Analysis

The CAAA resulted in states being divided into attainment and non-attainment areas, with classifications based upon the severity of their air quality problems. The Project is located in the Boston Metropolitan area, which has been classified as a "Maintenance" area for CO.

An evaluation of the traffic data was conducted under the review guidelines developed by the BPDA for determination of potential for CO impacts. It was determined that:

- Project traffic is not expected to impact intersections or roadway links currently operating at Level of Service (LOS) D, E, or F and is not expected to cause LOS to decline to D, E, or F. All intersections are expected to operate at a LOS C or better in the Build condition as detailed in *Chapter 4, Transportation*.
- Project traffic would not increase traffic volumes on nearby major roadways by 10 percent or more (the increase in traffic volume on American Legion Highway is less than 100 vehicles per hour). While traffic volumes on East Main Street, an approximately 600-foot long local side streets leading to the Project Site's driveway, will increase by 10 percent or more, CO impact is expected to be negligible at such low overall volumes and minimal intersection delays.
- The Project will generate fewer than 3,000 vehicles per day. All generated trips are associated with either student drop-off/pick-up or school staff. In total, there are 544 vehicle trips during the drop-off and pick-up periods.

Thus, the Project would not be expected to cause or contribute to a violation of the NAAQS and a quantitative microscale analysis is not required. The traffic impacts by the Project are minor compared to the background traffic of the existing transportation network. Since CO emissions are directly correlated to vehicular traffic, it is probable that the Project will create similarly insignificant CO emissions when compared to the background concentrations and the NAAQS.

Violation of the CO standard set by the NAAQS has become increasingly infrequent. This is due to a number of factors. Primarily, the vehicular emission rates of CO have decreased and will continue to decrease with the passage of time due to newer, more controlled vehicles entering the fleet[3]. Additionally, the CO background concentration in Boston has decreased with time[4].

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[3] "Transportation Air Quality Facts and Figures" *Vehicle Emissions*, Federal Highway Administration. January 2006. <https://www.fhwa.dot.gov/environment/air_quality/publications/fact_book/page15.cfm.>

[4] "Massachusetts Annual Air Quality Report" *Department of Environmental Protection, Bureau of Air and Waste, Division of Air and Climate Programs.* Multiple Years.

Based on these three controlling factors for the determination of CO impact (traffic, background concentration, and emission rates), it is highly unlikely for CO impacts to exist or to be created with the introduction of the Project. The Project will generate minimal vehicular activity in the surrounding network. The CO emission rates of the fleet will decrease over time, and the background CO concentration is a relatively small 5 percent and 12 percent of the respective 1-hour and 8-hour NAAQS.

5.5.6 Summary of Findings

The air quality evaluation demonstrated that the development of the proposed Project would not result in adverse air quality impacts. The microscale analysis evaluated the potential site-specific impacts from the vehicles traveling through the study area. This analysis demonstrates that all existing and future carbon monoxide concentrations are expected to be below the NAAQS. The air quality study demonstrates that the Project conforms to the CAAA and the State Implementation Plan (SIP) because:

- No violation of the NAAQS are expected to be created.
- No increase in the frequency or severity of any existing violations (none of which are related to this development) would be anticipated to occur.
- No delay in attainment of any NAAQS would be expected to result due to the implementation of the proposed action.

Based upon the analysis presented herein and the conclusions summarized above, no significant adverse air quality impacts from the Project are anticipated.

5.6 Water Quality

The Project will not adversely affect the water quality of nearby water bodies. Erosion and sediment control measures will be implemented during construction to minimize the transport of soils from the Project Site to off-site areas and adjacent storm drain systems. During construction, existing catch basins will be protected with filter fabric, straw bales and/or crushed stone, to provide for sediment removal from runoff. These controls will be inspected and maintained throughout the construction phase until the areas of disturbance have been stabilized through the placement of pavement, structure, or vegetative cover.

If required, dewatering will be conducted in accordance with applicable Massachusetts Water Resources Authority MWRA) and Boston Water and Sewer Commission (BWSC) discharge permits. Once construction is complete, the Project will be in compliance with local and state stormwater management policies, as described below.

5.7 Flood Hazard

The Project Site is not susceptible to flooding. According to the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Map (FIRM) panels 25025C0086G and 25025C0087G, effective September 25, 2009, the Project Site is more than 970 feet from the nearest special flood hazard areas. An area determined to be Isolated Land Subject to Flooding (ILSF) is located approximately 400 feet southwest of the Project Site.[5]

5.8 Noise

The noise impact assessment evaluated the potential noise impacts associated with the Project's activities, including mechanical equipment and loading activities. This section discusses the fundamentals of noise, noise impact criteria, noise analysis methodology, and potential noise impacts. Noise monitoring was conducted to determine existing ambient sound levels. The analysis demonstrates that the Project will comply with City of Boston noise regulations.

5.8.1 Fundamentals of Noise

Noise is defined as unwanted or excessive sound. Sound becomes unwanted when it interferes with normal activities such as sleep, communication, work, or recreation. How people perceive sound depends on several measurable physical characteristics, which include the following:

- Intensity: Sound intensity is often equated to loudness.
- Frequency: Sounds are comprised of acoustic energy distributed over a variety of frequencies. Acoustic frequencies, commonly referred to as tone or pitch, are typically measured in Hertz. Pure tones have all their energy concentrated in a narrow frequency range.

Sound levels are most often measured on a logarithmic scale of decibels (dB). The decibel scale compresses the audible acoustic pressure levels which can vary from the threshold of hearing (zero dB) to the threshold of pain (120 dB). Because sound levels are measured in dB, the addition of two sound levels is not linear. Adding two equal sound levels creates a 3 dB increase in the overall level. Research indicates the following general relationships between sound level and human perception:

- A 3 dB increase is a doubling of acoustic energy and is the threshold of perceptibility to the average person.
- A 10 dB increase is a tenfold increase in acoustic energy but is perceived as a doubling in loudness to the average person.

The human ear does not perceive sound levels from each frequency as equally loud. To compensate for this phenomenon in perception, a frequency filter known as A-weighted

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1 ILSF calculations were included in a Request for Determination of Applicability submitted to the Boston Conservation Commission on June 12, 2006.

[dB(A)] is used to evaluate environmental noise levels. Table 5.3 presents a list of common outdoor and indoor sound levels.

TABLE 5.3 COMMON OUTDOOR AND INDOOR SOUND LEVELS

Outdoor Sound Levels	Sound Pressure (μPa)*		Sound Level dB(A)**	Indoor Sound Levels
	6,324,555	-	110	Rock Band at 5 m
Jet Over Flight at 300 m		-	105	
	2,000,000	-	100	Inside New York Subway Train
Gas Lawn Mower at 1 m		-	95	
	632,456	-	90	Food Blender at 1 m
Diesel Truck at 15 m		-	85	
Noisy Urban Area—Daytime	200,000	-	80	Garbage Disposal at 1 m
		-	75	Shouting at 1 m
Gas Lawn Mower at 30 m	63,246	-	70	Vacuum Cleaner at 3 m
Suburban Commercial Area		-	65	Normal Speech at 1 m
	20,000	-	60	
Quiet Urban Area—Daytime		-	55	Quiet Conversation at 1 m
	6,325	-	50	Dishwasher Next Room
Quiet Urban Area—Nighttime		-	45	
	2,000	-	40	Empty Theater or Library
Quiet Suburb—Nighttime		-	35	
	632	-	30	Quiet Bedroom at Night
Quiet Rural Area—Nighttime		-	25	Empty Concert Hall
Rustling Leaves	200	-	20	
		-	15	Broadcast and Recording Studios
	63	-	10	
		-	5	
Reference Pressure Level	20	-	0	Threshold of Hearing

Source: *Highway Noise Fundamentals*. Federal Highway Administration, September 1980.

* μPA – MicroPascals, which describe pressure. The pressure level is what sound level monitors measure.

** dB(A) – A-weighted decibels, which describe pressure logarithmically with respect to 20 μPa (the reference pressure level).

A variety of sound level indicators can be used for environmental noise analysis. These indicators describe the variations in intensity and temporal pattern of the sound levels. The following is a list of common sound level descriptors used for environmental noise analyses:

- L90 is the sound level which is exceeded for 90 percent of the time during the time period. The L90 is generally considered to be the ambient or background sound level.
- Leq is the A-weighted sound level, which averages the background sound levels with short-term transient sound levels and provides a uniform method for comparing sound levels that vary over time.

5.8.2 Methodology

The noise analysis evaluated the potential noise impacts associated with the Project's operations, which include mechanical equipment and loading/service activities. The noise analysis included measurements of existing ambient background sound levels and a qualitative evaluation of potential noise impacts associated with the proposed mechanical equipment (e.g., HVAC units, emergency generator) and loading activities. The study area was evaluated and sensitive receptor locations in the vicinity of the Project were identified and examined. The layout and building design, as it relates to the loading area and management of deliveries at the Project Site, were also considered. The analysis considered sound level reductions due to distance, proposed building design, and obstructions from surrounding structures.

Receptor Locations

The noise analysis included an evaluation of the study area to identify nearby sensitive receptor locations, which typically include areas of sleep and areas of outdoor activities that may be sensitive to noise associated with the Project. The noise analysis identified two nearby sensitive receptor locations in the vicinity of the Project. As shown on Figure 5.3, the receptor locations include the following:

- R1 – Kingbird Road
- R2 – Austin Street

These receptor locations, selected based on land use considerations, represent the most sensitive locations in the vicinity of the Project Site.

5.8.3 City of Boston Noise Impact Criteria

The City of Boston has developed noise standards that establish noise thresholds deemed to result in adverse impacts. The noise analysis for the Project used these standards to evaluate whether the proposed development will generate sound levels that result in potential adverse impacts.

Under Chapter 40, Section 21 of the General Laws of the Commonwealth of Massachusetts and Title 7, Section 50 of the City of Boston Code, the Air Pollution Control Commission of the City of Boston has adopted Regulations for the Control of Noise in the City of Boston. These regulations establish maximum allowable sound levels based upon the land use affected by the proposed development. Table 5.4 summarizes the maximum allowable sound levels that should not be exceeded.

TABLE 5.4 CITY OF BOSTON NOISE STANDARDS BY ZONING DISTRICT

Land Use Zone District	Daytime (7:00 AM – 6:00 PM)	All Other Times (6:00 PM – 7:00 AM)
Residential	60 dB(A)	50 dB(A)
Residential/Industrial	65 dB(A)	55 dB(A)
Business	65 dB(A)	65 dB(A)
Industrial	70 dB(A)	70 dB(A)

Source: Regulations for the Control of Noise in the *City of Boston, Air Pollution Control Commission*.

For a residential zoning district, the maximum noise level affecting residential uses shall not exceed the Residential Noise Standard, which is 60 dB(A) for daytime periods (7:00 AM to 6:00 PM) and 50 dB(A) for nighttime conditions (6:00 PM to 7:00 AM).

5.8.4 Existing Noise Conditions

A noise monitoring program was developed to establish existing ambient sound levels. The existing sound levels were measured using a Type 1 sound analyzer (Larson Davis Sound Expert LxT). Measurements were conducted during the weekday daytime period (approximately 2:00 PM to 3:30 PM) and the nighttime period (4:00 AM to 5:00 AM) in the vicinity of the Project area on November 2, 2016. During the daytime period, the measured sound levels data under existing conditions were composed of noise from vehicles on local roadways, such as American Legion Highway. The nighttime period sound levels were generally associated with mechanical equipment from nearby building and vehicles on American Legion Highway. The existing measured sound level data are presented in Table 5.5.

TABLE 5.5 EXISTING AMBIENT SOUND LEVELS, DB(A)

Monitoring Location	City of Boston Residential District Noise Standard		Measured L90 Sound Levels	
	Daytime	Nighttime	Daytime	Nighttime
M1 – Kingbird Road	60	50	52	42
M2 – Austin Street	60	50	58	47

Source: VHB
Note: Refer to Figure 5.3 for monitoring locations.

The L90 sound levels range from 52 dB(A) to 58 dB(A) during the daytime period and from 42 dB(A) to 47 dB(A) during the nighttime period. The result of the noise monitoring program indicates that the daytime and nighttime sound levels within the study area are currently below the City of Boston's daytime and nighttime standard of 60 dB(A) and 50 dB(A), respectively.

5.8.5 Future Noise Conditions

The noise analysis evaluated the potential noise impacts associated with the Project's proposed mechanical equipment and loading activities. The analysis determined the potential sound level impacts at the nearby sensitive receptor locations.

Mechanical Equipment

Since the Project is in the early stages of the design process, the specific details related to the final selection of mechanical equipment are unknown at the time of this noise assessment. Based on preliminary plans, the anticipated mechanical equipment associated with the Project are expected to potentially include air handling units and boiler.

The mechanical equipment is expected to be located on the rooftop of the proposed building. During the design and selection process, the appropriate low-noise mechanical equipment will be selected, including potential noise mitigation measures, such as acoustical enclosures and/or acoustical silencers. The Project will incorporate noise attenuation measures necessary to comply with City of Boston's noise criteria at the sensitive receptor locations.

The systems would be strategically located on the rooftop, utilizing the height of the building in providing noise attenuation. Noise attenuation could be achieved by the Project's building design as the height of the proposed building is similar or greater than the height of the nearest sensitive receptors. The rooftop of the Project's buildings would serve as a barrier and break the direct line of exposure between the noise sources and nearest receptors. It is expected the sound levels will dissipate over distance and will be negligible at the surrounding sensitive receptor locations.

The Project will not include an emergency generator.

Service and Loading Activities

The Project is expected to experience daily loading activities associated with trash/recycle operations and meals/supply deliveries. These services consist of deliveries by small vehicles such as FedEx/DHL vans and single unit box trucks. Loading/service activities, associated with the proposed building, will occur within the lower level of the building with access via East Main Street. The loading activities will be managed so that service and loading operations do not impact the circulation on the adjacent roadways. Since loading activities will be shielded by surround buildings and will be managed, noise impacts to the sensitive receptor locations is expected to be negligible.

5.8.6 Conclusion of Noise Impact Assessment

The noise analysis evaluated the sound levels associated with the Project. This analysis determined that the sensitive receptor locations in the vicinity of the Project Site currently experience sound levels below the City of Boston's daytime and nighttime noise criteria. Due to the anticipated location of the proposed equipment on the rooftop, the sound levels associated with the Project's mechanical equipment are expected to have no adverse noise impacts at nearby sensitive receptor locations. The Project Site is designed such that the loading areas will be enclosed or surrounded by building structures, which will attenuate sound levels associated with the loading activities. As a result of the preliminary design, the Project's operations will have no adverse noise impacts at nearby sensitive receptor locations.

5.9 Solid and Hazardous Materials

During the completion of an ASTM Phase I Environmental Site Assessment (ESA), neither evidence of the storage or a release of oil or hazardous material (OHM) nor a significant amount of solid waste was observed at the Project Site.

Elevated concentrations of lead, polycyclic aromatic hydrocarbons (PAHs), and asbestos were identified in the debris remaining at the location of the former Staff Building at the Project Site as well as other locations associated with the former Boston State Hospital East Campus (of which the Project Site was a part), during environmental assessments performed in 1995. This release is tracked by the Massachusetts Department of Environmental Protection (MassDEP) by Release Tracking Numbers (RTNs) 3-13282 and 3-19713. Debris and soil were removed from the Project Site as part of several Release Abatement Measures (RAMs) which were completed in July 2006. In September 2006, a Class A-3 Response Action Outcome (RAO) Statement was submitted to the MA DEP indicating that a Permanent Solution had been achieved.

Based on past uses of the Project Site and surrounding area, residual urban fill soils may be encountered during future construction activities at the Project Site. If encountered, urban fill at the Project Site will require management in accordance with the Massachusetts Contingency Plan (MCP), specifically under the Remediation Waste and "anti-degradation" provisions and will need to be completed under the direction of a Massachusetts Licensed Site Professional (LSP).

5.10 Groundwater

Groundwater was not encountered in the five test borings which were advanced to depths of 5 to 11 feet below the existing grades. This indicates that the groundwater table is probably below the top of the bedrock surface and not within the unconsolidated overburden deposits.

5.11 Geotechnical

The Project Site is currently undeveloped and had building debris, foundation and urban fill soils excavated from the vicinity of the former Staff Building associated with the Boston State Hospital from about 2006 to 2009. Subsurface conditions consist of a native sand deposit directly overlying bedrock (with fill materials penetrated in one of the test borings).

5.11.1 Fill Materials

Approximately four feet of Fill Materials were encountered in a test boring which was drilled in the central part of the Project Site. The Fill Materials generally consist of dense to very dense, light brown, silty fine sand with gravel (USCS designation SM), which contains brick fragments. The Fill Materials resemble the native soils at the Project Site, and they were probably disturbed during excavation and used as a borrow source for local construction.

5.11.2 Sand Deposit

A native sand deposit was encountered at ground surface in the test borings (or directly beneath the Fill Materials in the central portion of the Project Site. The sand deposit consisted of dense to very dense, brown to light brown, silty fine sand with varying amounts of gravel (USCS designation SM).

5.11.3 Drilling Refusal/Bedrock Surface

Drilling refusal, the depth at which the drilling equipment was not able to penetrate the deeper geologic units, and which we interpret to be the top of bedrock, was encountered in the test borings at depths ranging from approximately 5 to 11 feet below the existing grades (corresponding to approximate elevations of 63 to 83 feet above MSL). Bedrock elevations rise from south to north across the Project Site, generally consistent with the elevation change of the surficial topography of the Project Site and neighboring properties.

5.11.4 Foundation System

The proposed buildings could be founded on a conventional shallow foundation system of strip and spread footings.

From a geotechnical standpoint, at this time, we do not anticipate adverse impacts on adjacent buildings, utilities, or other infrastructure from the proposed development of the Project Site.

5.12 Historic Resources

This section identifies the historic and archaeological resources within a one-quarter mile radius of the Project Site, and describes the potential project-related impacts on these resources. A review of the State and National Registers of Historic Places, Inventory of Historic and Archaeological Assets of the Commonwealth (Inventory) maintained by the Massachusetts Historical Commission (MHC), and the and Massachusetts Cultural Resource Information System (MACRIS), was undertaken to identify historic resources.

5.12.1 Historic Resources in the Project Vicinity

The Project Site is located within the Boston Lunatic Hospital inventoried area. In addition, within a one-quarter mile radius of the Project Site are three National Register-listed districts (Olmstead Park System, Franklin Park, and the Morton Street Metropolitan Park System of Greater Boston Multiple Property Survey), two properties listed individually in the National Register (Forest Hills Cemetery and the Home for Destitute Jewish Children), and four Inventoried properties and areas.

The names and addresses of properties listed in the State and National Registers of Historic Places and properties included in the State Inventory within a one-quarter-mile of the Project Site are listed in Table 5.6 and depicted in Figure 5.4.

TABLE 5.6 HISTORIC RESOURCES IN THE VICINITY OF THE PROJECT SITE

No.	Resource Name	Address	Designation
A	Forest Hills Cemetery	Morton St, Canterbury St, Walk Hill St	NRIND
B	Olmstead Park System	Storrow Dr to Franklin Park	NRDIS
C	Morton Street Metropolitan Park System of Greater Boston	Arborway to Fairmont St	NRDIS
D	Franklin Park	Forest Hills St, Seaver St, Blue Hill Ave, American Legion Hwy, Morton St, Forest Hills Cemetery	LL/NRDIS
E	Home for Destitute Jewish Children	150-160 American Legion Highway	NRIND
1	Boston Lunatic Hospital	Morton Street, Mt. Hope Cemetery, Forest Hills Cemetery, Franklin Park	INV
2	Frederick Holbrow House	8 Franklin Hill Avenue	INV
3	Harvard Street Area	3224-652 Harvard Street	INV
4	32-58 Franklin Hill Avenue	32-58 Franklin Hill Avenue	INV
5	M. J. Kenney House	8 Paxton Street	INV

NRIND National Register of Historic Places, Individual Listing
NRDIS National Register of Historic Places, District
LL Local Landmark (State Register of Historic Places)
INV Listed in the Inventory of Historic and Archaeological Assets of the Commonwealth; no current designation

5.12.2 Archaeological Resources

No previously identified archaeological resources are located within the Project Site. Due to previous development activities and disturbances, it is anticipated that the Project Site does not contain significant archaeological resources and, therefore, no impacts to archaeological resources are anticipated as a result of the Project.

5.13 Construction Impacts

The Proponent will work and coordinate with the utility companies to assure compliance and integrity of the Project. A plan to control construction-related impacts including erosion, sedimentation, and other pollutant sources during construction and any land disturbance activities shall be developed and implemented.

5.13.1 Construction Air Quality

The Project will implement an outdoor construction management plan that includes provisions for wheel washing, site vacuuming, and truck covers. The Commonwealth of Massachusetts anti-idling law will be enforced during the construction phase of the Project with the installation of on-site anti-idling signage.

The Project will comply with the requirements of the Clean Construction Equipment Initiative aimed at reducing air emissions from diesel-powered construction equipment. Oxidation catalysts and catalyzed particulate filters will be utilized on all construction vehicles and equipment to reduce air quality degradation caused by emissions from heavy-duty, diesel-powered construction equipment. All pre-2007 diesel construction vehicles working on the

Project will be retrofitted using retrofit technologies approved by the United States Environmental Protection Agency (EPA). Additionally, ultra-low-sulfur diesel (ULSD) fuel (15 parts per million) will be used for all off-road diesel equipment.

5.13.2 Construction Noise

The construction activity associated with the Project may temporarily increase nearby sound levels due to the use of heavy machinery. Heavy machinery is expected to be used intermittently throughout the Project's construction phases, typically during daytime periods. The construction phases that will generate the highest sound levels include site excavation, ledge removal and grading, and construction of the foundations for the proposed building. The City of Boston Regulations for the Control of Noise considers construction sound levels to be an impact to residential land uses if the L10 is in excess of 75 dB(A) or the Lmax is in excess of 86 dB(A). A construction management program will be developed with the City of Boston to ensure that the City of Boston noise regulation related to construction noise is met.

The Project is subject to construction-hour restrictions and the residential sound limits established under the Regulations for the Control of Noise in the City of Boston. Residential neighbors will be provided with contact names and telephone numbers for comments/complaints regarding these and other construction-related issues.

5.13.3 Construction Traffic and Parking

Construction workers and construction trucks will be properly managed to minimize significant impacts on traffic conditions on surrounding streets during construction. The Project Site offers adequate space for on-site construction staging and limited parking. Street parking is available. The Proponent will work with the BTD to develop a site-specific Construction Management Plan (CMP).

The following elements are typically addressed in the CMP:

- Designation of truck routes for deliveries;
- Protection of pedestrian walkways;
- Location and sizing of staging areas for on-site storage of construction materials;
- Definition of worker parking parameters and measures to maximize related use of public transportation;
- Identification of truck waiting areas;
- Police officer traffic management;
- Construction graphics program;
- Interim traffic operation improvements;
- Definition of street and sidewalk occupancies; and

- Definition of work hours.

5.13.4 Construction Trip Generation and Worker Parking

The number of workers required during the construction will vary daily. Because the workforce will arrive and depart prior to peak commuter traffic periods, these trips are not expected to have a large impact on the area's transportation system. Workers will be encouraged to take public transport to reduce the need to park on the Project Site or on adjacent streets. The Proponent will work to reduce construction employee vehicle trips through TDM measures, such as:

- Provide secure, on-site storage so that workers do not have to transport tools and equipment each day;
- Post transit schedules in a prominent area; and/or
- Hire local workers.

5.13.5 Construction Truck Routes and Volumes

The construction work is not anticipated to generate a high volume during peak hours. Police details may be assigned to all active gate locations to ensure that vehicles are not impacting traffic operations as necessary.

5.13.6 Construction Hazardous Materials and Solid Waste

All solid waste generated will be recycled off-site or disposed of in accordance with federal, state, and city regulations. The Construction Manager will implement a waste management plan that will seek to divert at least 75 percent and up to 95 percent of construction and demolition waste material removed from the Project Site from landfills through recycling and salvaging.

5.13.7 Rodent Control During Construction

The City of Boston has declared the infestation of rodents in the city a serious problem. In order to control this infestation, the City enforces the requirements established under the Massachusetts State Sanitary Code, Chapter 211, 105 CMR 410.550 and the State Building Code, Section 108.6. Policy Number 87-4 (City of Boston) established that preparation of a program for the extermination of rodents shall be required for issuance of permits for demolition, excavation, foundation, and basement rehabilitation. The Proponent will prepare and adhere to a rodent control program throughout the duration of construction.

5.13.8 Public Safety During Construction

The entire perimeter of the construction site limits will be protected with a 6-foot high temporary chain link construction fence. Vehicular gates will be provided for construction traffic on perimeter roads to allow safe entrance and exiting for construction vehicles and personnel. Additionally, signage will be posted on fencing and construction trailers to alert all personnel to the safety requirements.

Larger deliveries of construction materials may require the use of police details to assist in managing vehicular and pedestrian traffic. Coordination with the Boston Police Department will be essential in providing safe travel routes for pedestrians during peak construction periods.

5.14 Rodent Control Post-Construction

Trash and solid waste removal will be handled by the building maintenance staff. The Proponent will maintain a service contract with a professional pest control firm to address rodent/pest control during the operational phase of the Project. In addition, no open top dumpsters will be allowed as an additional precaution to deter infestation.

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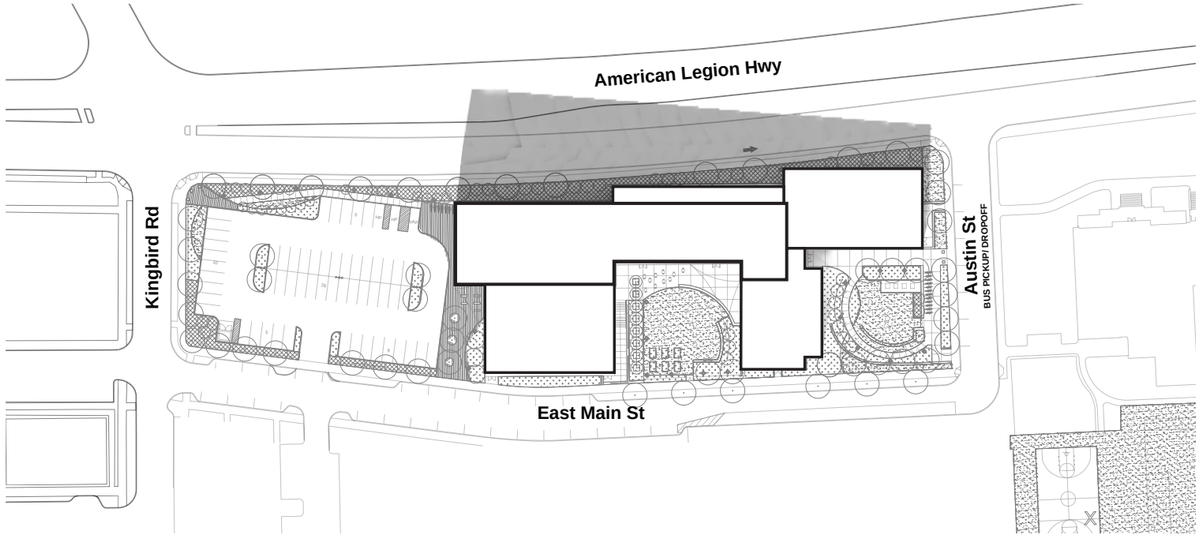
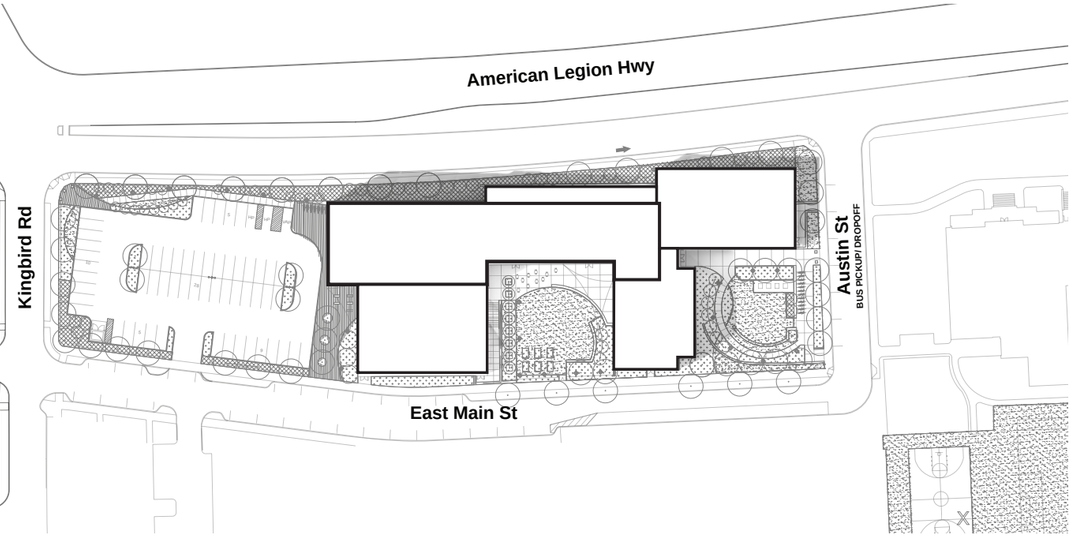


March 9 AM



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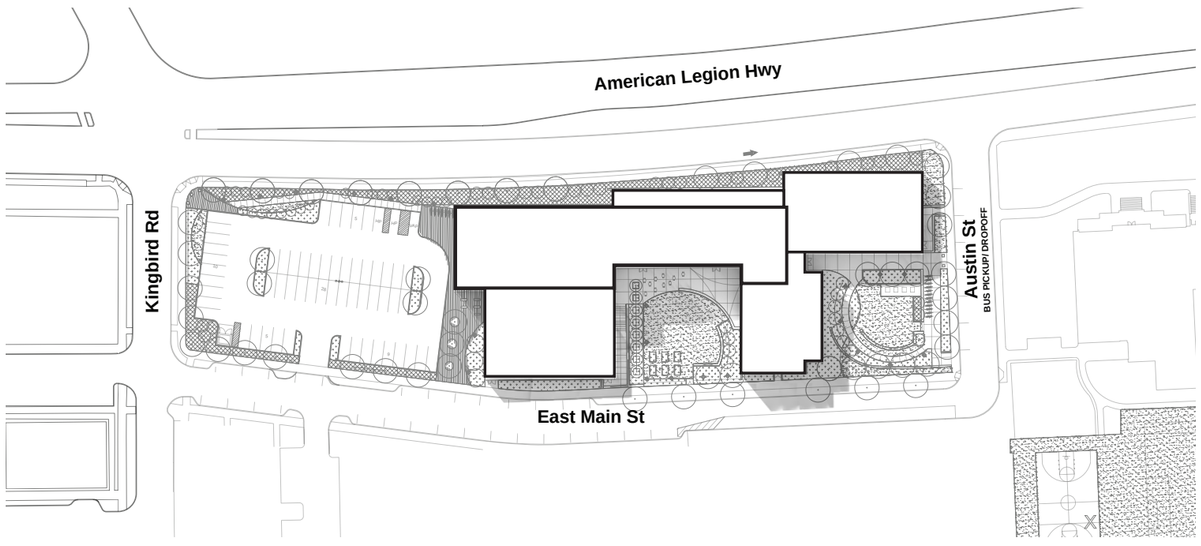


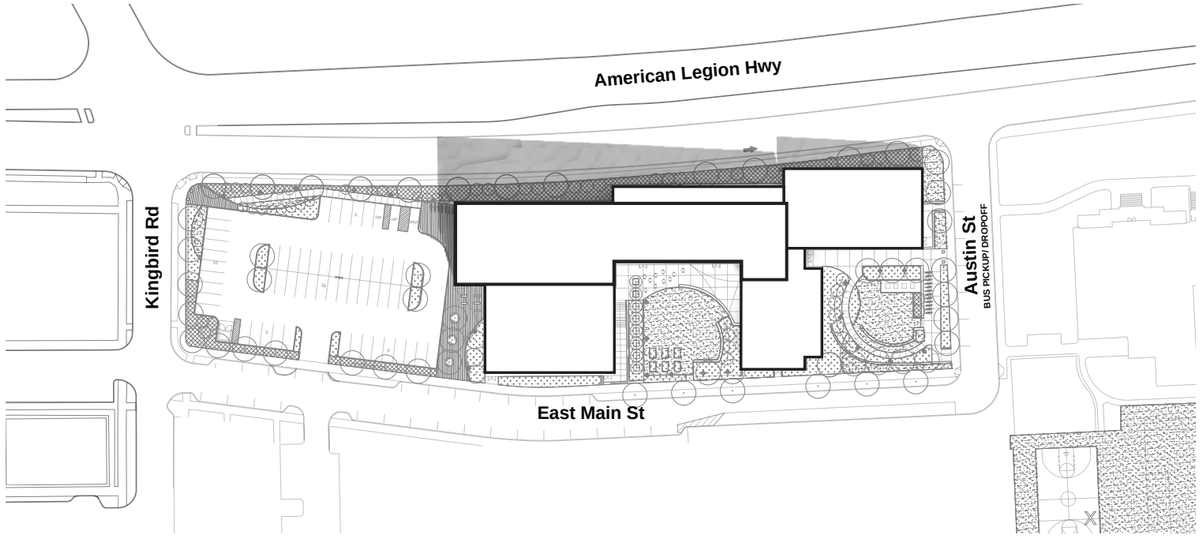
March 3 PM

Source: Arrowstreet

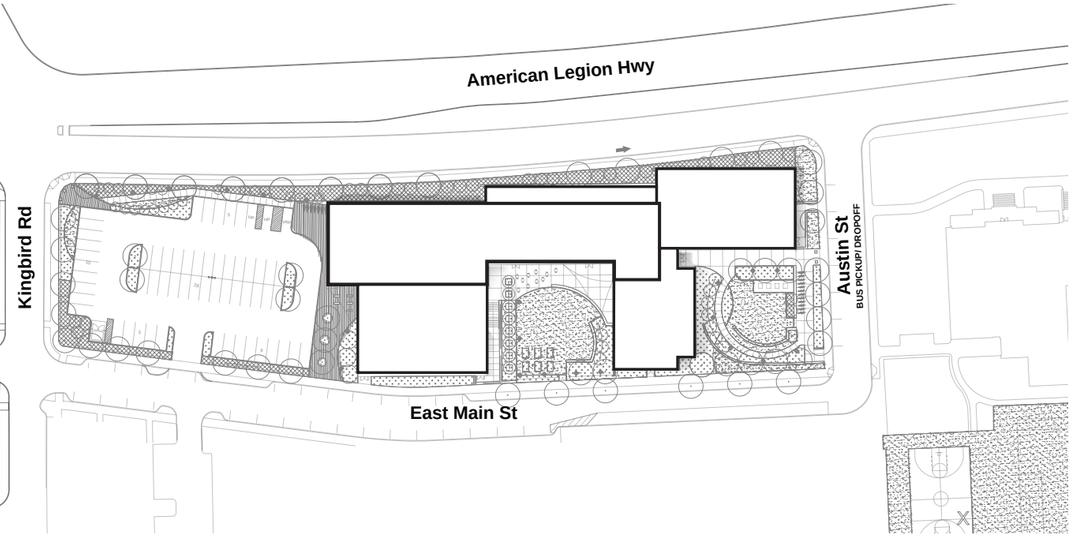
Figure 5.1a

Shadow Studies
Spring Equinox

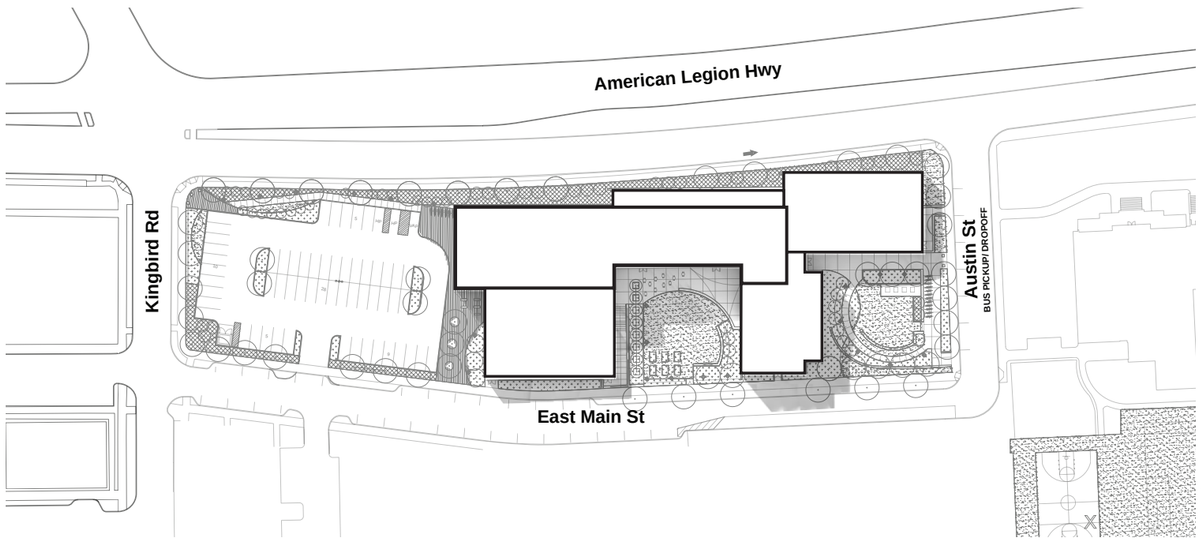
Brooke Charter High School
Boston, Massachusetts



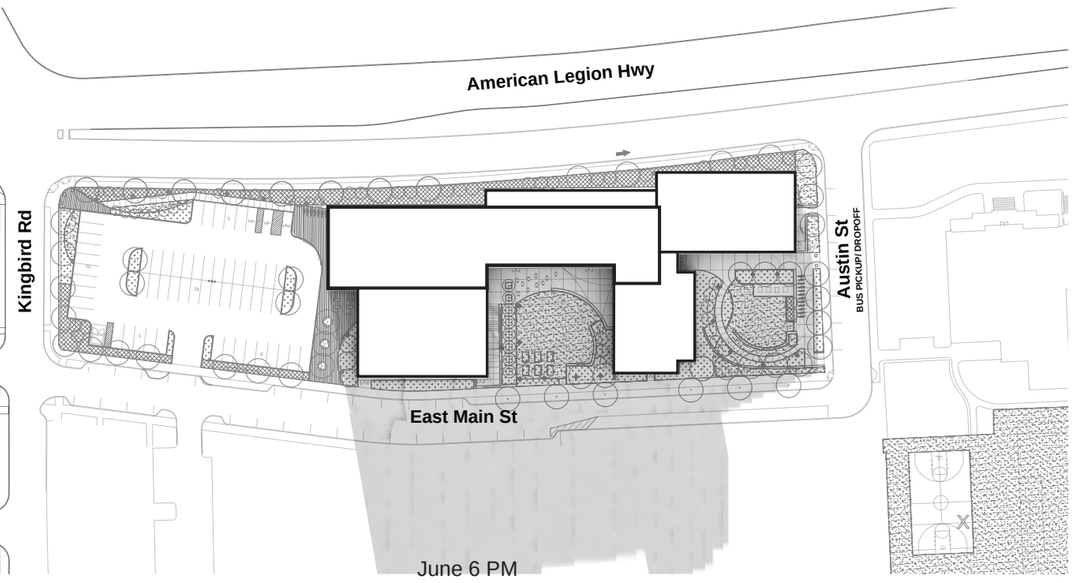
June 9 AM



June 12 PM



June 3 PM



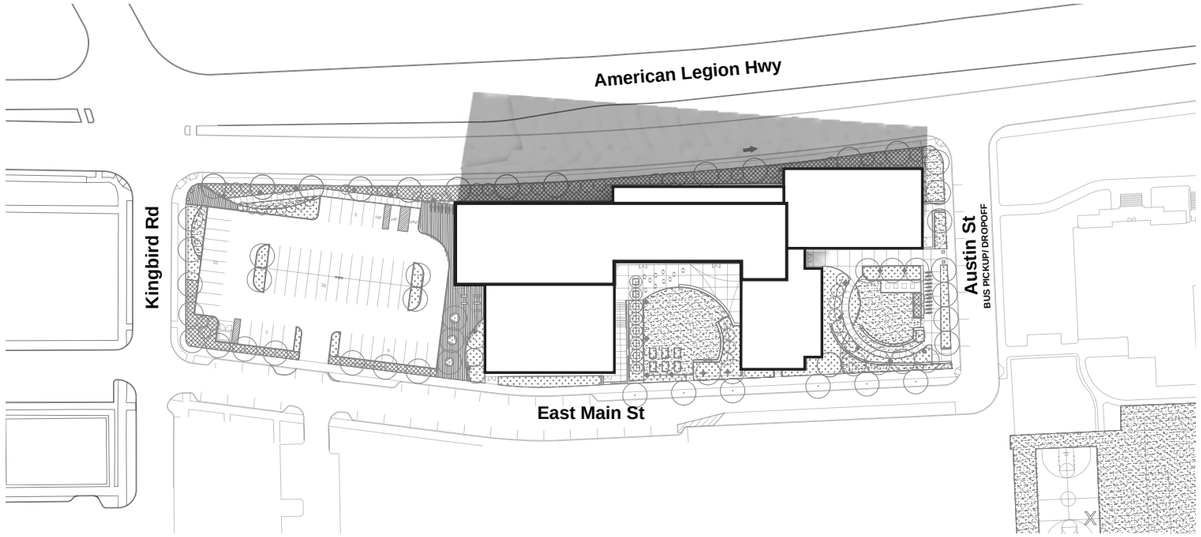
June 6 PM

Source: Arrowstreet

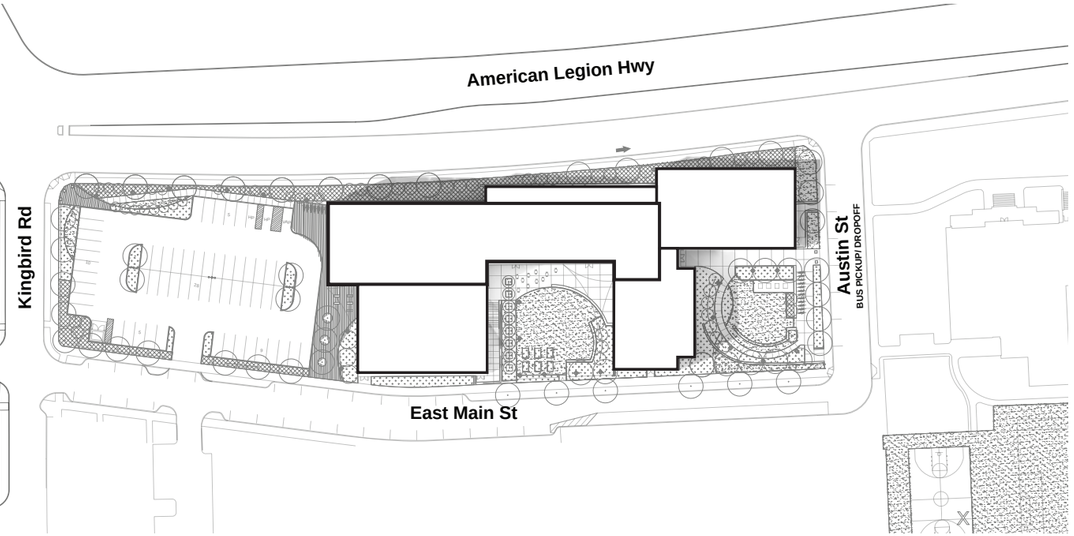
Figure 5.1b

Shadow Studies
Summer Solstice

Brooke Charter High School
Boston, Massachusetts



September 9 AM



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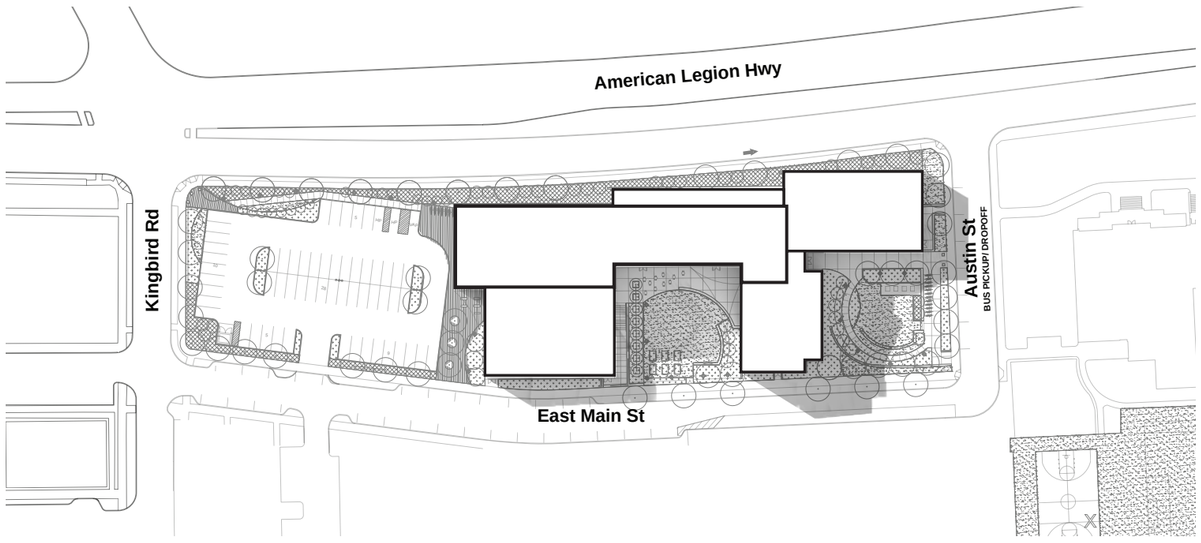

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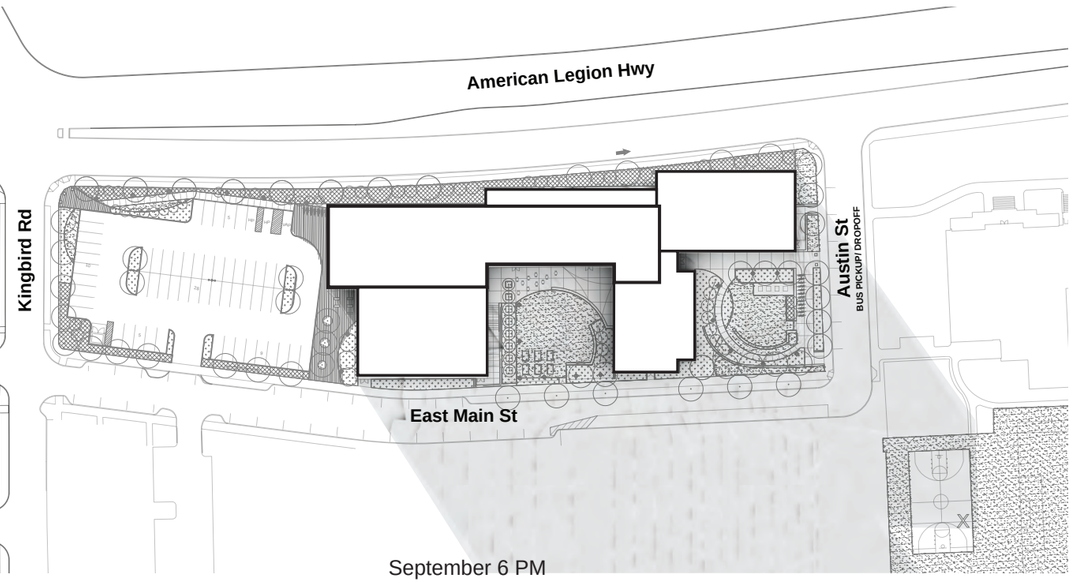


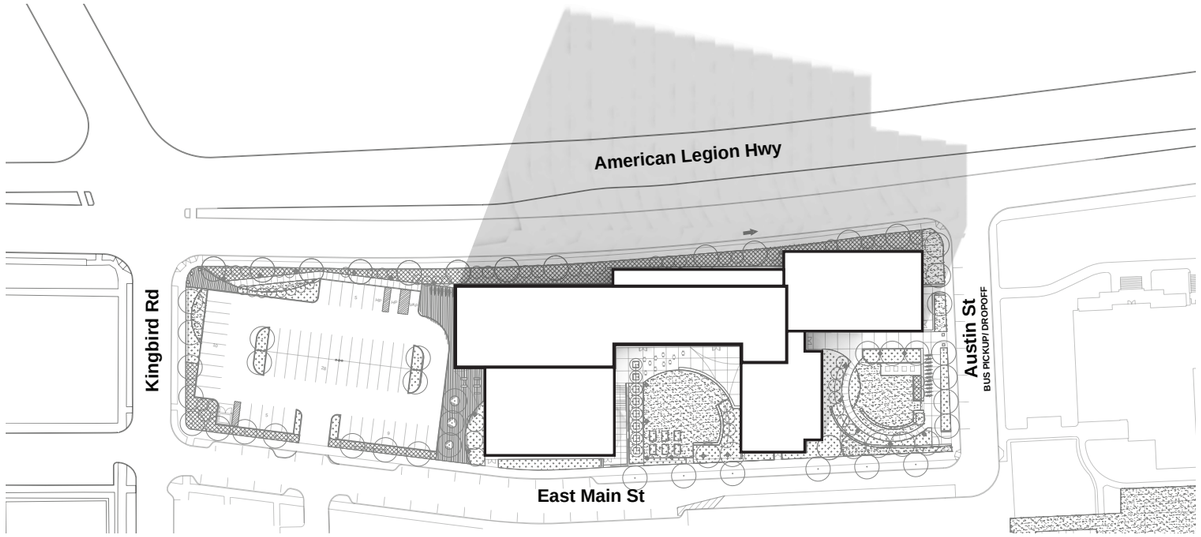
September 6 PM

Source: Arrowstreet

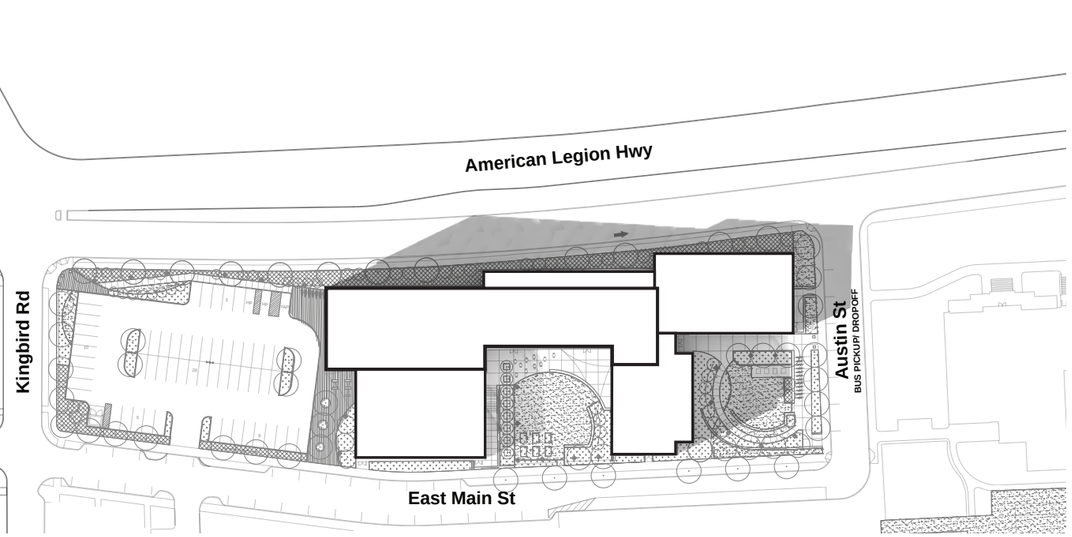
Figure 5.1c

Shadow Studies
Autumn Equinox

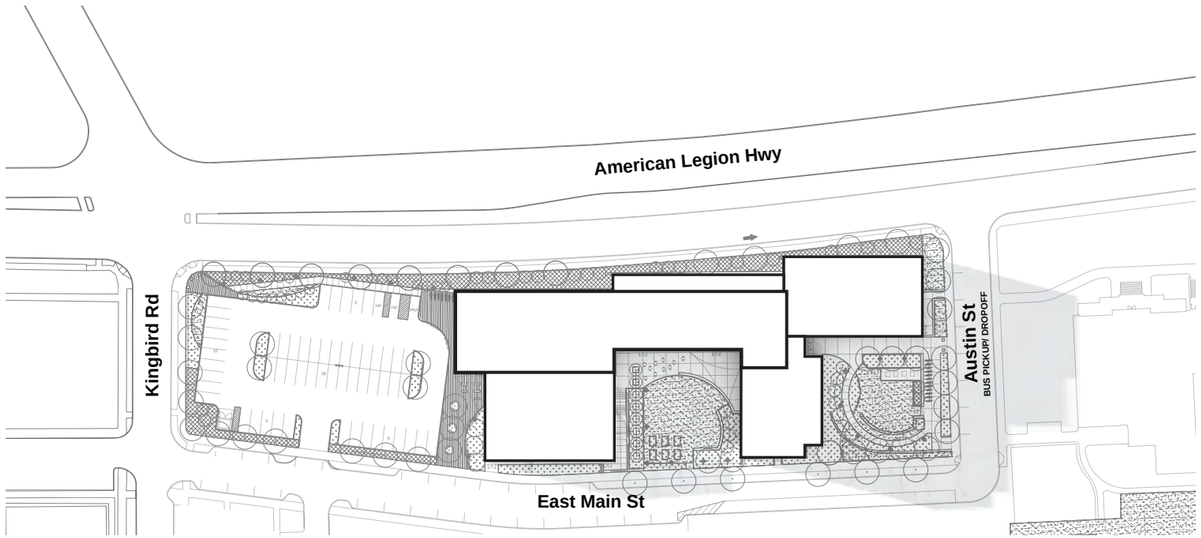
Brooke Charter High School
Boston, Massachusetts



December 9 AM



December 12 PM



December 3 PM

Source: Arrowstreet

ARROWSTREET

vhb

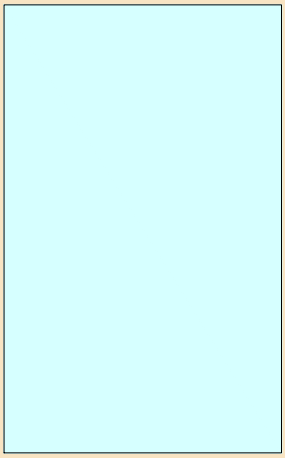
Figure 5.1d

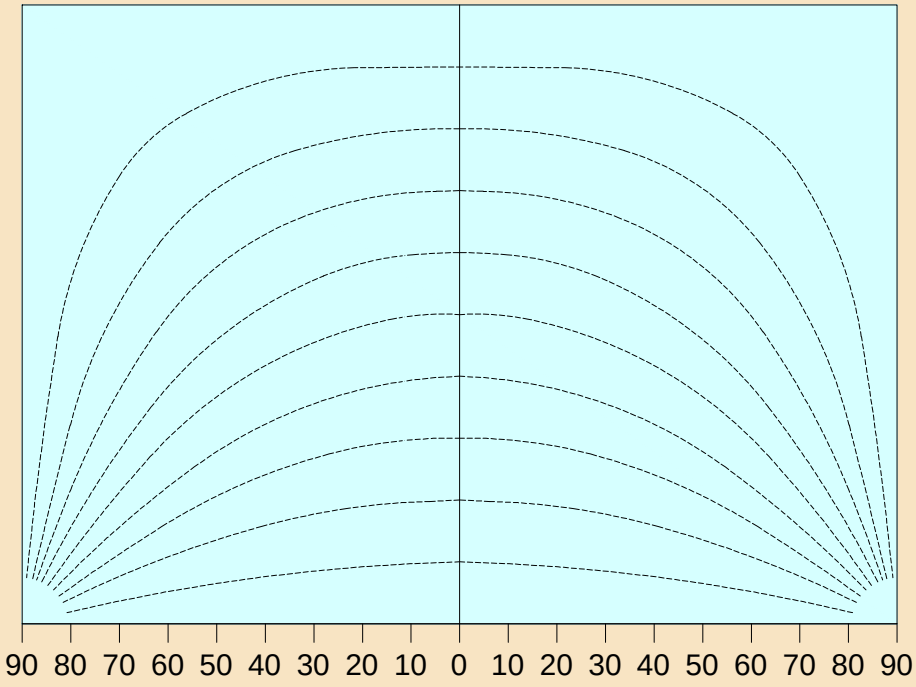
Shadow Studies
Winter Solstice

Brooke Charter High School
Boston, Massachusetts

Existing

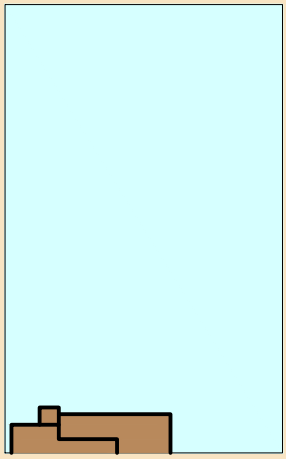
Obstruction of
Skyplane = 0.0%





Proposed

Obstruction of
Skyplane = 25.6%



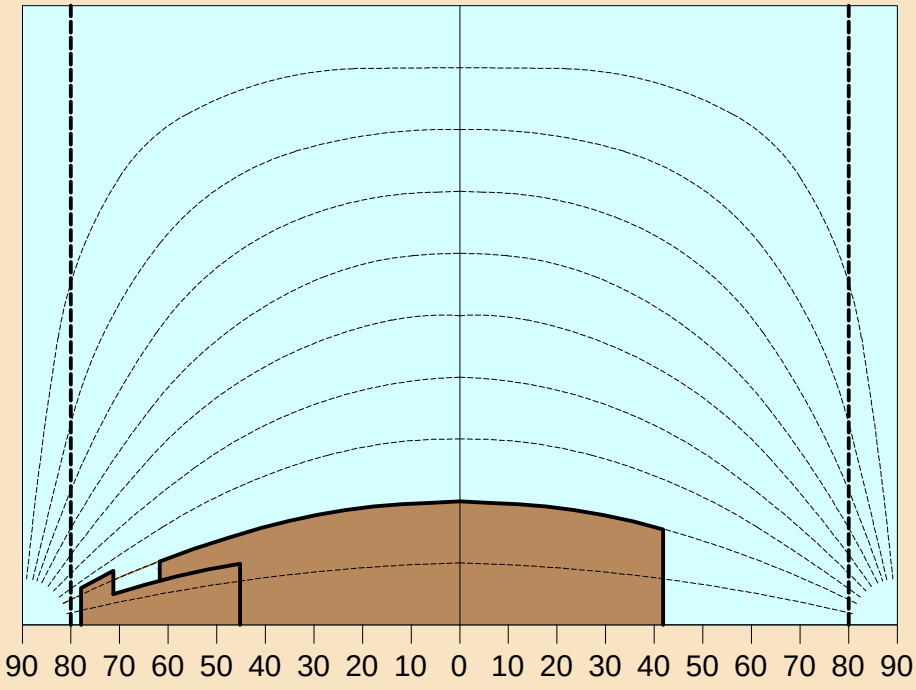


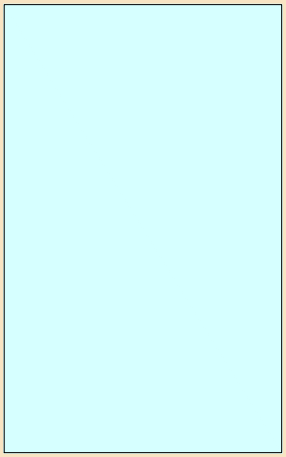
Figure 5.2a

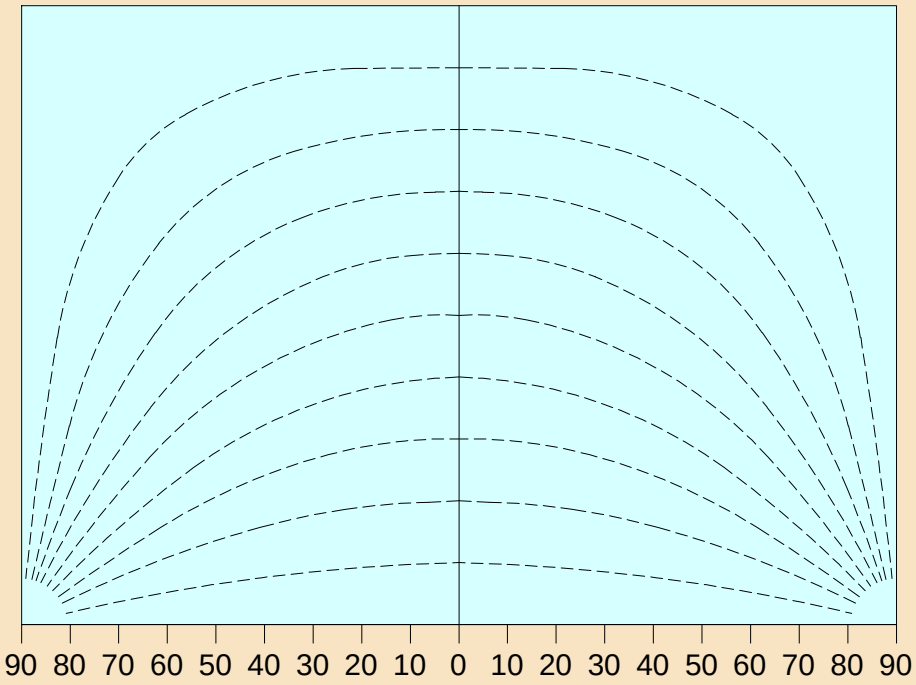
Daylighting Analysis
Center of American Legion Highway

Brook Charter High School
Boston, Massachusetts

Existing

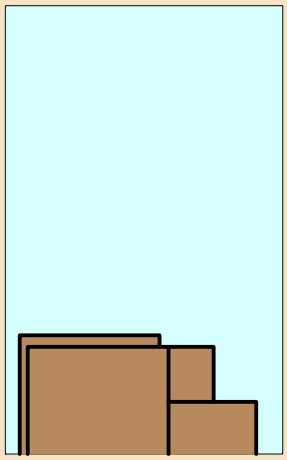
Obstruction of
Skyplane = 0.0%





Proposed

Obstruction of
Skyplane = 10.8%



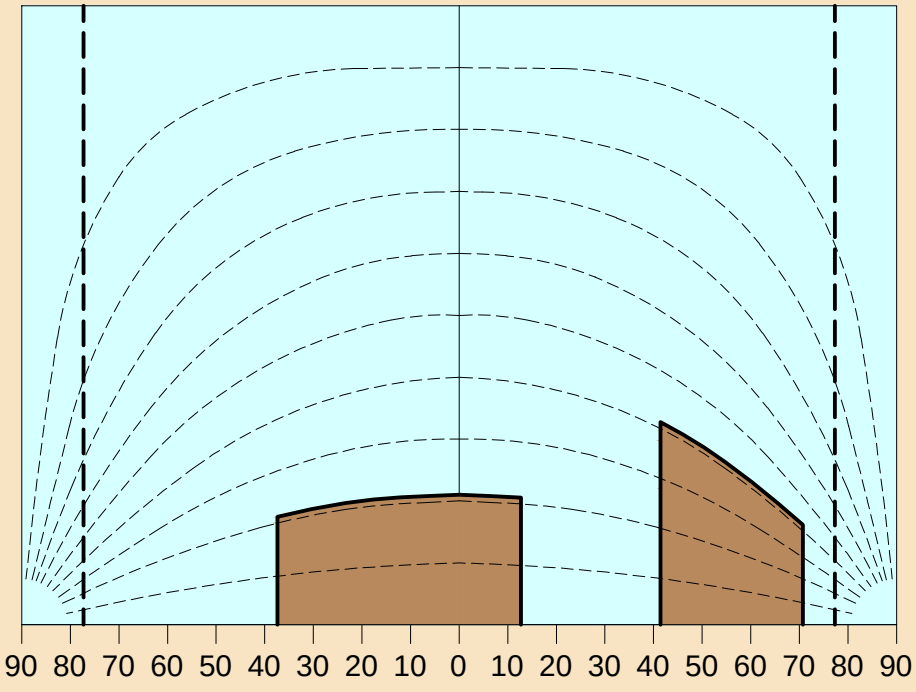


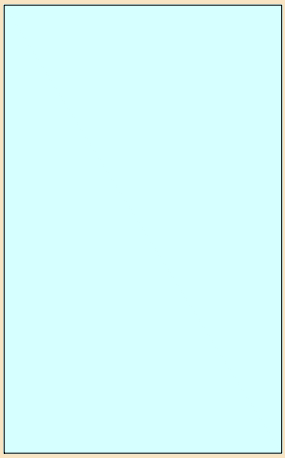
Figure 5.2b

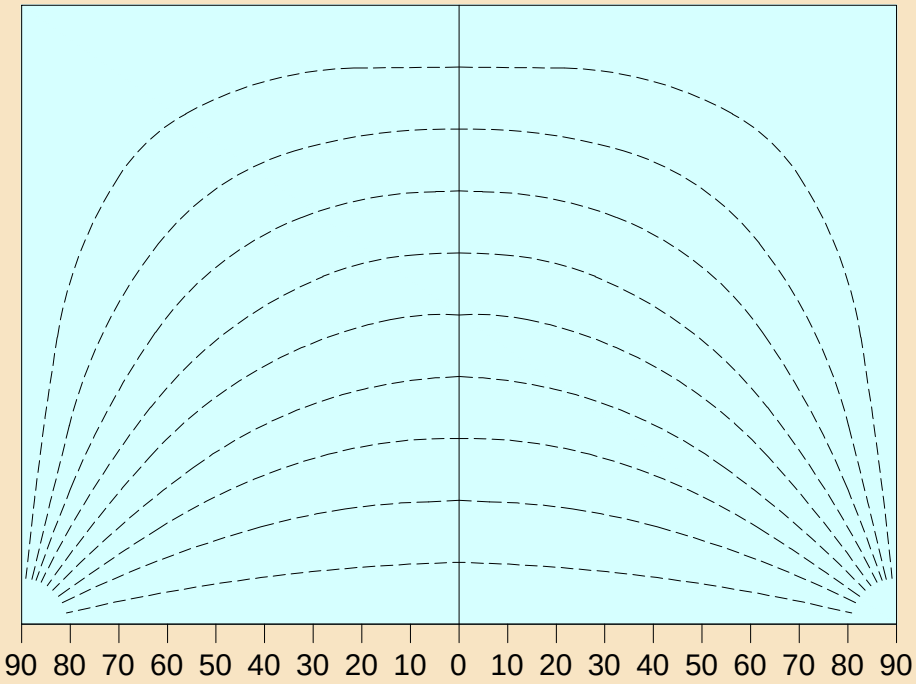
Daylighting Analysis
Center of Austin Street

Brook Charter High School
Boston, Massachusetts

Existing

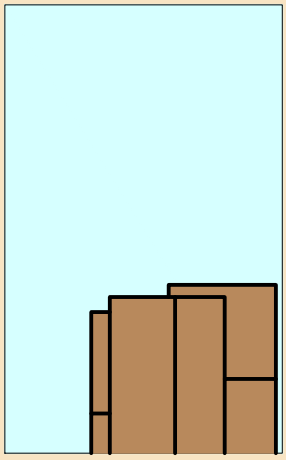
Obstruction of
Skyplane = 0.0%





Proposed

Obstruction of
Skyplane = 32.3%



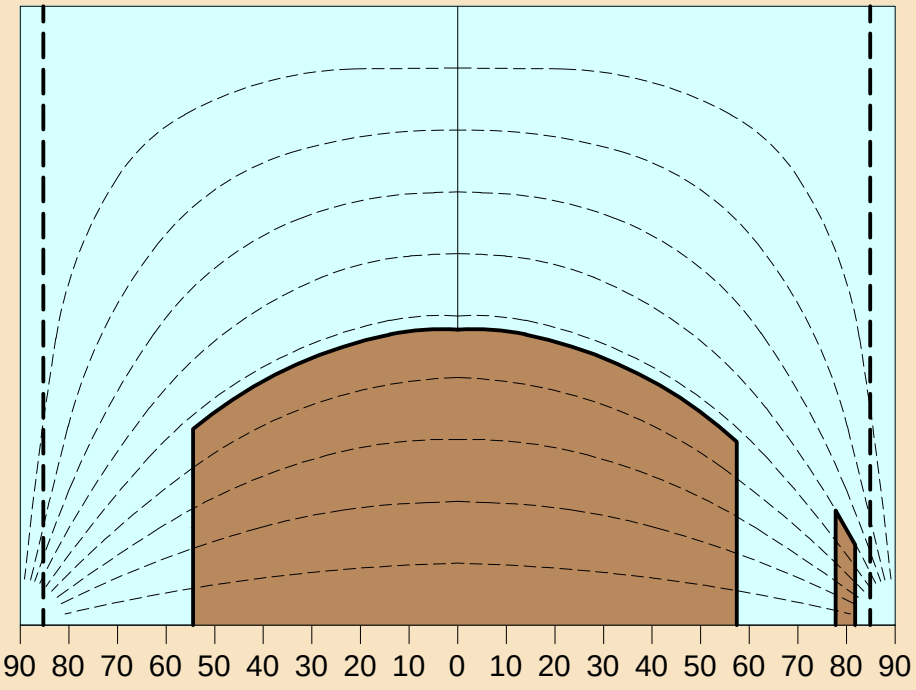
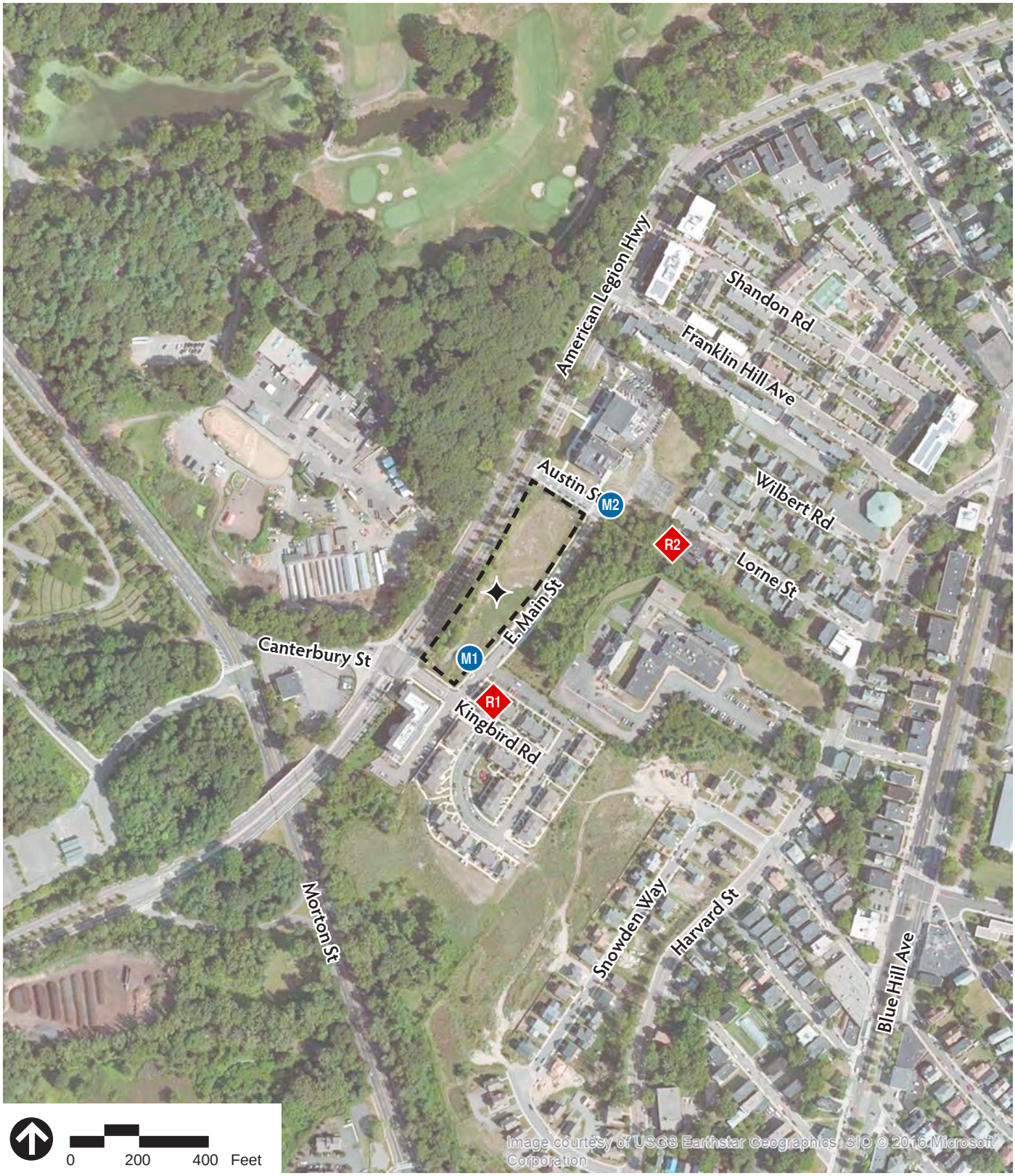


Figure 5.2c

Daylighting Analysis
Center of East Main Street

Brook Charter Highh School
Boston, Massachusetts



Source: ArcGIS Bing Aerial

Project Site

M# Monitoring Locations

R# Receptor Locations

Figure 5.3

Noise Monitoring and Receptor Locations

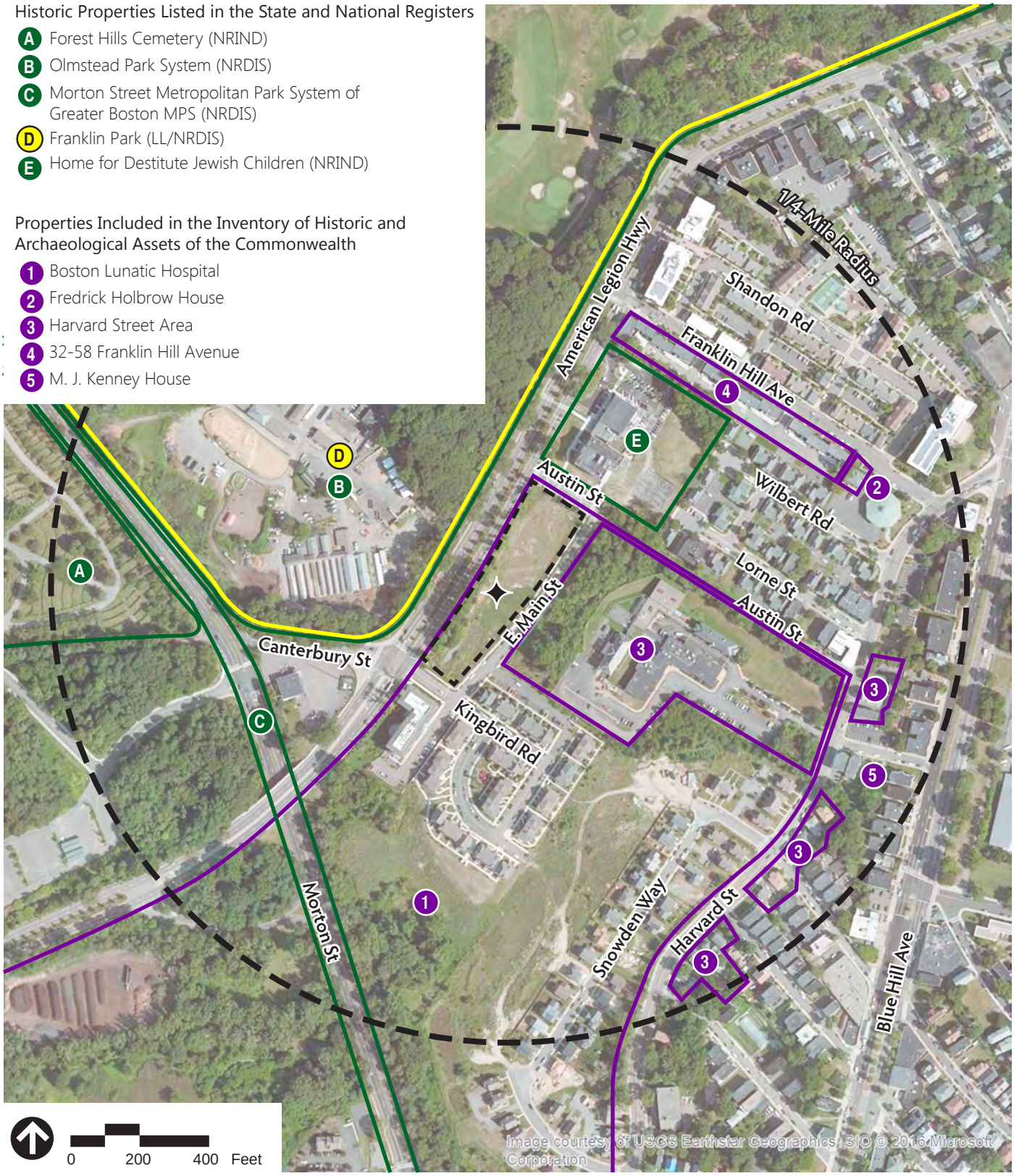
Brook Charter High School
Boston, Massachusetts

Historic Properties Listed in the State and National Registers

- A Forest Hills Cemetery (NRIND)
- B Olmstead Park System (NRDIS)
- C Morton Street Metropolitan Park System of Greater Boston MPS (NRDIS)
- D Franklin Park (LL/NRDIS)
- E Home for Destitute Jewish Children (NRIND)

Properties Included in the Inventory of Historic and Archaeological Assets of the Commonwealth

- 1 Boston Lunatic Hospital
- 2 Fredrick Holbrow House
- 3 Harvard Street Area
- 4 32-58 Franklin Hill Avenue
- 5 M. J. Kenney House



Source: ArcGIS Bing Aerial

Project Site

NRIND National Register of Historic Places, Individual Listing
NRDIS National Register of Historic Places, District
LL Local Landmark (State Register of Historic Places)

Figure 5.4
Historic Resources

Brooke Charter High School
Boston, Massachusetts

6 Infrastructure

This chapter describes the infrastructure systems that will support the Project. The following utilities are evaluated: wastewater, water, stormwater management, natural gas, electricity, and telecommunications.

6.1 Key Findings and Benefits

- Although the proposed Project will increase impervious cover on the Site, it will also incorporate an upgraded stormwater system designed to treat and recharge stormwater to the maximum extent practicable.
- The Project will be designed to comply with the Massachusetts Stormwater Management Standards, and will decrease or maintain the peak flow rate and volume of stormwater runoff from the site.
- The Project is expected to generate 17,260 gpd of wastewater.
- The water demand for the Project is estimated to be 18,986 gpd.
- The Project will include natural gas, electricity and telecommunication utilities.

6.2 Regulatory Context

The Project will require Boston Water and Sewer Commission Site Plan Review, as well as review by the Boston Department of Public Works. The Project will be designed to comply with the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards.

6.3 Stormwater Management

This section describes the existing and proposed drainage conditions, and discusses compliance with the MassDEP Stormwater Management Standards.

6.3.1 Existing Drainage Conditions

There is an existing BWSC storm drain located in American Legion Highway on the northwestern side of the Highway, and an existing 12-inch storm drain main in East Main Street. The storm drain main in East Main Street combines into a storm drain system in King Bird Road, and flows southwest through neighboring properties through an 18-inch private drain main. There are existing drain laterals which are stubbed within the southern edge of the property, and connect to the drain main in East Main Street.

The capacity of the 12-inch drain main in East Main Street is summarized below in Table 6.1. The capacity of the drain main in American Legion Highway was not analyzed because the Project does not intend to connect to the storm drain. Pipe diameter and inverts used to calculate the capacities are a combination of information obtained from the BWSC wastewater infrastructure system map (Figure 6-3) and survey information provided by Feldman Land Surveyors.

Flow capacity of existing storm drains were calculated in cubic feet per second (cfs) using Manning's Equation.

TABLE 6.1 STORM DRAIN HYDRAULIC CAPACITY ANALYSIS TABLE – EAST MAIN STREET

Manhole (BWSC Number)	Distance (feet)	Invert Elevation (Up)	Invert Elevation (Down)	Slope %	Diameter	Flow Capacity (cfs)	Flow Capacity (MGD)
368 to 151	164	88.47	84.21	2.6%	12"	6.22	4.02
151 to 150	360	83.53	71.19	3.4%	12"	7.15	4.62
150 to DMH	45	67.80	65.50	5.1%	18"	25.73	16.63

Notes:
1. Flow Calculations based on Manning Equation, with an assumed Manning's Number 0.012
2. Manhole numbers were taken from BWSC Sewer system Map.
3. Elevations refer to Boston City Base (BCB)

Table 6.1 indicates the hydraulic capacity of the 12-inch storm drain in East Main Street. The minimum hydraulic capacity is 4.02 MGD or 6.22 CFS.

6.3.2 Proposed Drainage Conditions

The proposed Project will increase impervious cover on the Site while incorporating an upgraded stormwater management system. The upgraded stormwater closed drainage collection and treatment system will recharge stormwater to the maximum extent practicable prior to overflowing to the BWSC storm drain system. Stormwater peak rates of runoff from the site will be reduced or meet existing rates of runoff from the Site. No storm main impacts are expected within the stormwater systems in East Main Street, or any of the other adjacent streets.

Site runoff will be collected by a closed drainage system and treated before overflowing to the BWSC storm drainage system. Stormwater runoff will be collected by a series of catch basins which will then flow to a proposed treatment and/or recharge system. Roof runoff will flow to a proposed recharge system.

The stormwater management system will decrease or maintain the peak flow rate and volume of stormwater runoff from the site. New stormwater runoff will not be directed towards abutters.

6.3.3 DEP Stormwater Management Standards

In March 1997, MassDEP adopted a new Stormwater Management Policy to address non-point source pollution. In 1997, MassDEP published the Massachusetts Stormwater Handbook as guidance on the Stormwater Policy, which was revised in February 2008. The Policy prescribes specific stormwater management standards for development projects, including urban pollutant removal criteria for projects that may impact environmental resource areas. Compliance is achieved through the implementation of Best Management Practices (BMPs) in the stormwater management design. The Policy is administered locally pursuant to MGL Ch. 131, s. 40.

A brief explanation of each Policy Standard and the system compliance is provided below:

- Standard 1: 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 proposed design will comply with this Standard. No new untreated stormwater will be directly discharged to, nor will erosion be caused to wetlands or waters of the Commonwealth as a result of stormwater discharges related to the Project.

- Standard 2: Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for discharges to land subject to coastal storm flowage as defined in 310 CMR.

  Compliance: The proposed design will comply with this Standard. The post-development peak discharge rates will not exceed the pre-development peak discharge rates through methods involving infiltration and stormwater recharge on site.

- Standard 3: Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmental sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

  Compliance: The Project is a new development project; the Project will comply with this standard to the maximum extent practicable.

- Standard 4: Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This Standard is met when:

a. Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained;

b. Structural stormwater best management practices are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and

c. Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.

Compliance: The proposed design will comply with this standard. The Project will not have an impact on stormwater runoff quality. The Project storm drain service will not discharge to a combined sewer.

- Standard 5: 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 thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.

  Compliance: The proposed design will comply with this standard. The Project is not associated with Higher Potential Pollutant Loads (per the Policy, Volume I, page 1-6).

- Standard 6: Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment. A "storm water discharge" as defined in 314 CMR 3.04(2)(a)1 or (b) to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of a public water supply.

  Compliance: The proposed design will comply with this Standard. The Project will not discharge untreated stormwater to a sensitive area or any other area.

- Standard 7: 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 proposed design is a new development and thus this standard is not applicable.

- Standard 8: A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.

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

- Standard 9: 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 Project will comply with this standard. An O&M Plan including long-term BMP operation requirements will be prepared for the Proposed Project and will assure proper maintenance and functioning of the stormwater management system.

- Standard 10: All illicit discharges to the stormwater management system are prohibited.

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

6.4 Sanitary Sewage

This section describes the existing and proposed sanitary sewer systems.

6.4.1 Existing Sewer System

Existing sanitary sewer mains are located in East Main Street. The 10-inch sewer main East Main Street flows southwest and connects to the 10-inch sanitary sewer main in King Bird Street. The sanitary sewer main is eventually collected by the Massachusetts Water Resources Authority (MWRA) Metropolitan High Level Sewer System which ultimately flows to the MWRA Deer Island Waste Water Treatment Plant for treatment and disposal. See Figure 6.2 for the Existing BWSC Sanitary Sewer System Map. There are existing sanitary sewer laterals which are stubbed within the southern edge of the property, and connect to the sanitary sewer main in East Main Street.

The capacity of the 10-inch sanitary sewer main in East Main Street is summarized below in Table 6.2. Pipe diameter and inverts used to calculate the capacities are a combination of information obtained from the BWSC wastewater infrastructure system map (Figure 6.2) and survey information provided by Feldman Land Surveyors.

Flow capacity of existing storm drains were calculated in cubic feet per second (cfs) using Manning's Equation.

TABLE 6.2 SANITARY SEWER HYDRAULIC CAPACITY ANALYSIS TABLE – EAST MAIN STREET

Manhole (BWSC Number)	Distance (feet)	Invert Elevation (Up)	Invert Elevation (Down)	Slope %	Diameter	Flow Capacity (cfs)	Flow Capacity (MGD)
367 to 140	276	82.71	74.78	2.9%	10"	4.83	3.12
140 to 139	310	74.78	65.70	2.9%	10"	4.87	3.15

Notes:
1. Flow Calculations based on Manning Equation, with an assumed Manning's Number 0.012
2. Manhole numbers were taken from BWSC Sewer system Map.
3. Elevations refer to Boston City Base (BCB)

Table 6.2 indicates the hydraulic capacity of the 10-inch sanitary sewer in East Main Street. The minimum hydraulic capacity is 3.12 million gallons per day (MGD) or 4.83 cubic feet per second (CFS).

6.4.2 Proposed Sewage Flow and Connection

The Project's sewage generation rates were estimated using the Department of Environmental Protection State Environmental Code (Title V) Section 310 CMR 15.00 and the proposed building program. 310 CMR 15.00 lists typical sewage generation values for the proposed building use, as shown in Table 6.3. Typical generation values are conservative values for estimating the sewage flows from new construction and are used to evaluate new sewage flows. The existing site is vacant and therefore there are no existing sewer flows accounted for from the Site. The Project includes the construction of a new school building. Table 6.3 describes the increased sewage generation in gallons per day (gpd) due to the Project.

The total sanitary sewage flow as a result of the Project is estimated to be 17,260 gpd.

TABLE 6.3 SEWER GENERATION

Program Type	Units	Generation Rate	Sewer Generation (GPD)
School Building	863 Students/Staff	20 GPD/Units	17,260
TOTAL			17,260

Note: Based on DEP 314 CMR 7.15 flow calculation factors

The Proponent will coordinate with the BWSC on the design and capacity of the proposed connections to the existing sewer system. The Project is expected to generate an increase in wastewater flows of approximately 17,260 gallons per day. Approval for the increase in sanitary flow will come from BWSC.

The sewer services for the Project will attempt to connect to the existing BWSC sewer stubs located within the property, which connect to the sanitary sewer main in East Main Street. Proposed improvements will be reviewed as part of the BWSC's Site Plan Review process for the Project. This process will include a comprehensive design review of the proposed service connections, an assessment of Project demands and system capacity, and the establishment of service accounts.

Based on an average daily flow estimate for the Project of 17,260GPD or .017 MGD; and with a factor of safety of 10 (total estimate = 0.017 MGD x 10 = 0.17 MGD), no capacity problems are expected within the BWSC sewer systems in East Main Street.

6.5 Domestic Water and Fire Protection

This section describes the existing and proposed water supply systems.

6.5.1 Existing Water Supply System

Water for the Project site will be provided by the BWSC. There are five water systems within the City which provide service to portions of the City based on ground surface elevation. The five systems are southern low (commonly known as low service), southern high (commonly known as high service), southern extra high, northern low, and northern high. Existing BWSC water mains are located in Regis Road and Cummins Highway. See Figure 6-3 for the BWSC Water System Map.

BWSC owns and operates a 12-inch southern high water main in American Legion Highway, an 8-inch southern high water main in King Bird Road and an 8-inch southern high water main in East Main Street. The existing water system information was obtained from the BWSC System Map (See Figure 6-3). There are existing water services that are stubbed within the southern edge of the property and connect to the 8-inch water main in East Main Street.

BWSC record flow test data containing actual flow and pressure for hydrants within the vicinity of the Site was requested by the Proponent. Hydrant flow data was available for one hydrant near the Site. The existing hydrant flow data is available in Table 6.4. As the design progresses, the Proponent will request hydrant flows be conducted by BWSC adjacent to the Site, as hydrant flow data should be less than a year old to be used as a design tool.

TABLE 6.4 EXISTING HYDRANT FLOW DATA

Date of Test	Flow Hydrant Number	Static Hydrant	Pressure Zone	Elev. (ft.)	Static (psi)	Residual (psi)	Total Flow (MGD)	Flow @ 20 psi (MGD)
7/10/12	H14	H12	SH	109	78	72	2126	7238

6.5.2 Proposed Water Demand and Connection

The Project's water demand estimate for domestic services is based on the Project's estimated sewage generation, described in the section above. A conservative factor of 1.1 (110%) is applied to the estimated average daily wastewater flows to account for consumption, system losses and other usages to estimate an average daily water demand for the office portions of the Project. The water demand for the Proposed Project is estimated to be 18,986 gpd. The water for the Project will connect to the stubs located within the Property, and will be supplied by the BWSC system in East Main Street.

Measures to reduce water consumption will be incorporated into the Project Design. Aeration fixtures and appliances will be chosen for water conservation qualities. In public areas, sensor operated faucets and toilets will be installed.

New water services will be installed in accordance with the latest local, state, and federal codes and standards. The Project will comply with the Commonwealth's Stretch Energy Code and as such, will reduce energy use from the baseline energy conservation by approximately 30%. Backflow preventers will be installed at both domestic and fire protection service connections. New meters will be installed with Meter Transmitter Units ("MTU's") as part of the BWSC's Automatic Meter Reading ("AMR") system.

The State Building Code requires the use of water-conserving fixtures. Water conservation measures such as low-flow toilets and restricted flow faucets will help reduce the domestic water demand on the existing distribution system. The installation of sensor-operated sinks with water conserving aerators and sensor-operated toilets in all non-residential restrooms will be incorporated into the design plans for the Project.

6.6 Other Utilities

The Project will utilize existing utilities to make connections for necessary services including natural gas, electric and telecommunications.

6.6.1 Natural Gas Service

Presently there exists a 4-inch gas main in East Main Street. A new natural gas service will be provided to the building from this main. Efficient water heaters, boilers, and roof top units will be selected for this school, and the approximate gas load will be 70 BTU/ SF.

6.6.2 Electrical Service

Underground electrical service will be provided via proposed connections to the local utility company electrical distribution system on East Main Street. The Proponent will coordinate with the local utility company to determine specific requirements, a connection point, and obtain appropriate approvals as the project design advances.

6.6.3 Telephone and Telecommunications

The Proponent will select the telecommunications companies to provide telephone, cable, and internet services to meet the needs of Brooke High School. An underground telecommunications service will be provided via proposed connections to the selected service providers system on East Main Street. Once the service providers are selected, the Proponent will coordinate with the service providers the location connection points and infrastructure requirements to service the building.

6.6.4 Protection of Utilities

Existing public and private infrastructure located within nearby public rights-of-way will be protected during Project construction. The installation of proposed utility connections within public ways will be undertaken in accordance with BWSC, Boston Public Works Department, the Dig-Safe Program, and applicable utility company requirements. Specific methods for constructing proposed utilities where they are near to, or connect with, existing water, sewer, and drain facilities will be reviewed by the BWSC as part of its Site Plan Review process. All necessary permits will be obtained before the commencement of work.

The Proponent will continue to work and coordinate with the BWSC and the utility companies to ensure safe and coordinated utility operations in connection with the Project.

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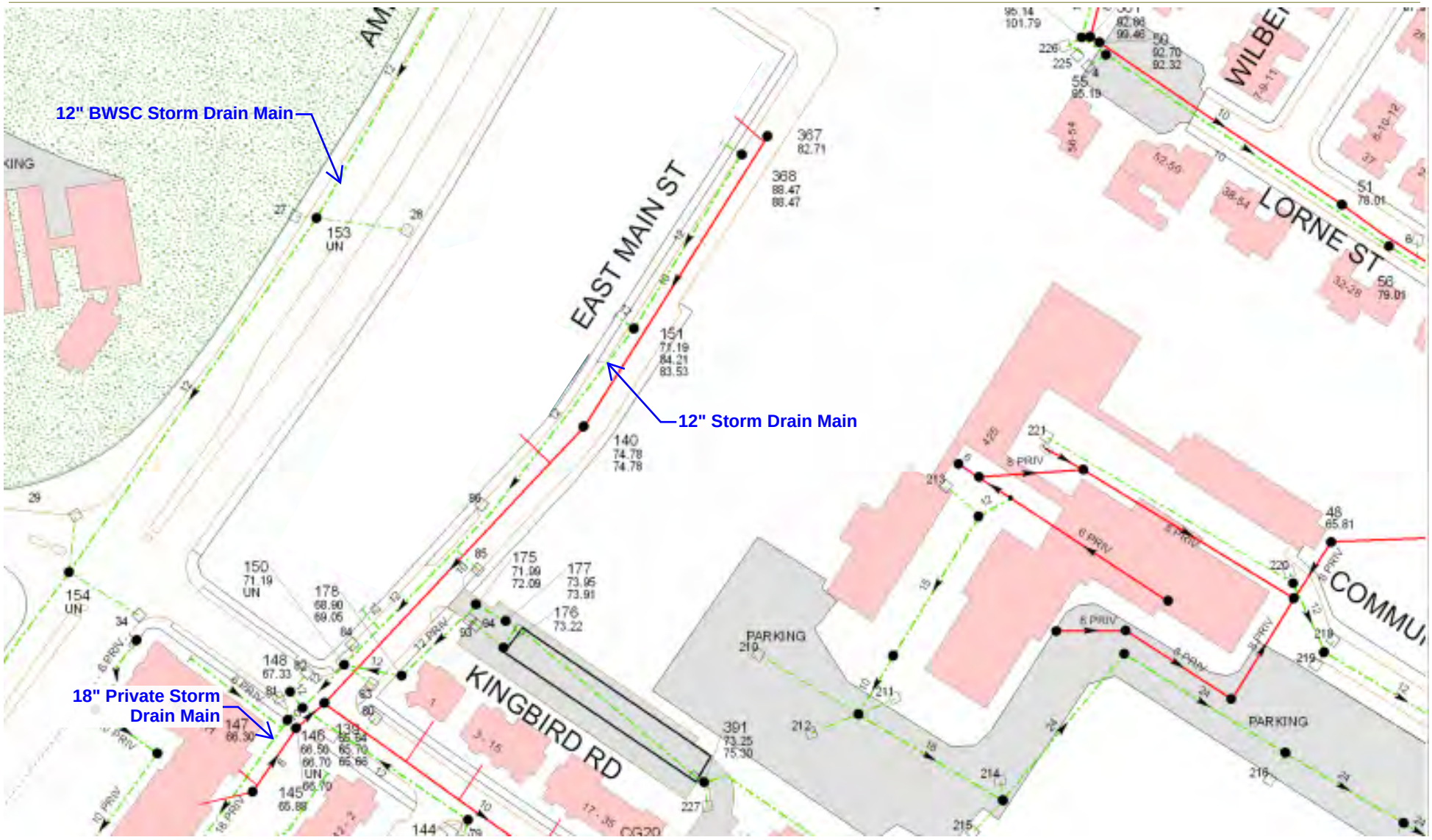


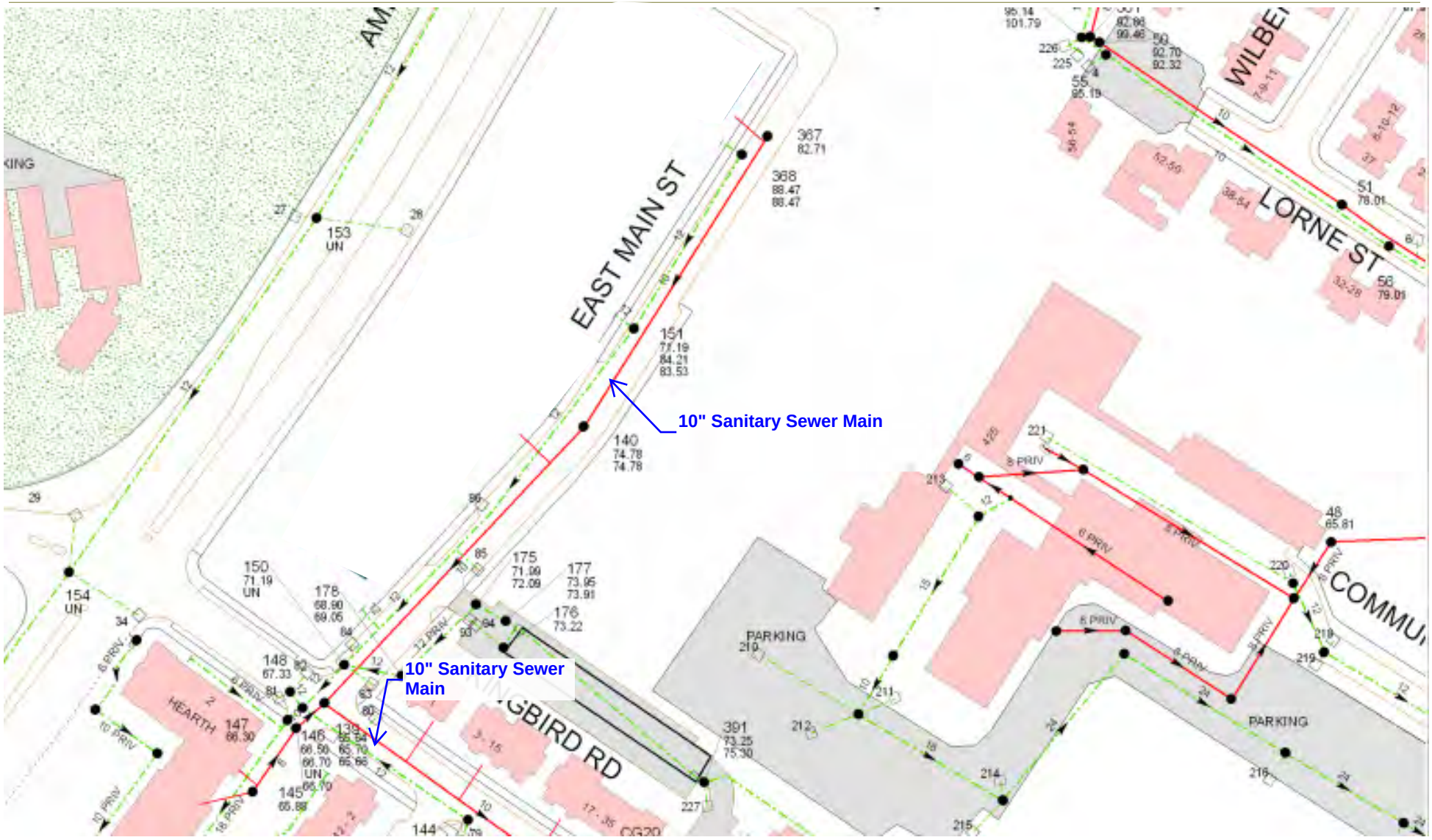
BWSC GIS
Not To Scale

Nitsch Engineering

vhb

Figure 6.1
BWSC Storm
Drainage Map

Brooke Charter High School
Boston, Massachusetts



BWSC GIS
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Nitsch Engineering

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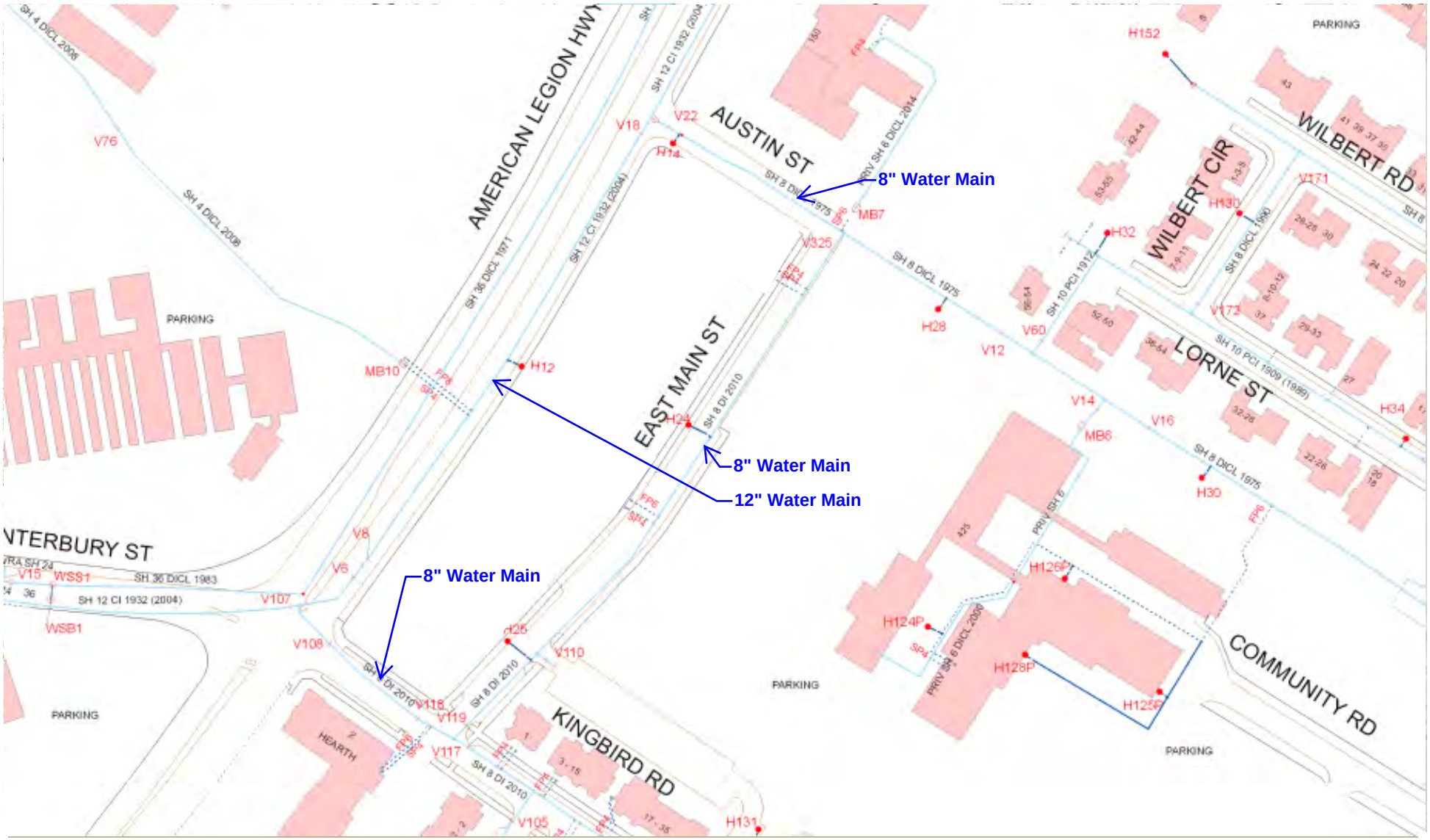
Figure 6.2

BWSC Sanitary
Sewer System Map

Brooke Charter High School
Boston, Massachusetts



BWSC GIS
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Figure 6.3

BWSC Water System Map

Brooke Charter High School
Boston, Massachusetts

7

Project Certification

This Notice of Project Change has been submitted to the Boston Planning and Development Agency, as required by Article 80B of the Zoning Code, on the 9th of December, 2016.

Proponent
Brooke Charter School

Jon Clark
Co-Director

Preparer
VHB

Stephanie Kruel, ENV SP
Senior Environmental Planner

APPENDIX A: BPDA Checklists

Accessibility Checklist

Climate Change Preparedness and Resiliency Checklist

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Accessibility Checklist

(to be added to the BRA Development Review Guidelines)

In 2009, a nine-member Advisory Board was appointed to the Commission for Persons with Disabilities in an effort to reduce architectural, procedural, attitudinal, and communication barriers affecting persons with disabilities in the City of Boston. These efforts were instituted to work toward creating universal access in the built environment.

In line with these priorities, the Accessibility Checklist aims to support the inclusion of people with disabilities. In order to complete the Checklist, you must provide specific detail, including descriptions, diagrams and data, of the universal access elements that will ensure all individuals have an equal experience that includes full participation in the built environment throughout the proposed buildings and open space.

In conformance with this directive, all development projects subject to Boston Zoning Article 80 Small and Large Project Review, including all Institutional Master Plan modifications and updates, are to complete the following checklist and provide any necessary responses regarding the following:

- improvements for pedestrian and vehicular circulation and access;
- encourage new buildings and public spaces to be designed to enhance and preserve Boston's system of parks, squares, walkways, and active shopping streets;
- ensure that persons with disabilities have full access to buildings open to the public;
- afford such persons the educational, employment, and recreational opportunities available to all citizens; and
- preserve and increase the supply of living space accessible to persons with disabilities.

We would like to thank you in advance for your time and effort in advancing best practices and progressive approaches to expand accessibility throughout Boston's built environment.

Accessibility Analysis Information Sources:

1. Americans with Disabilities Act – 2010 ADA Standards for Accessible Design
    a. http://www.ada.gov/2010ADAstandards_index.htm
2. Massachusetts Architectural Access Board 521 CMR
    a. http://www.mass.gov/eopss/consumer-prot-and-bus-lic/license-type/aab/aab-rules-and-regulations-pdf.html
3. Boston Complete Street Guidelines
    a. http://bostoncompletestreets.org/
4. City of Boston Mayors Commission for Persons with Disabilities Advisory Board
    a. http://www.cityofboston.gov/Disability
5. City of Boston – Public Works Sidewalk Reconstruction Policy
    a. http://www.cityofboston.gov/images_documents/sidewalk%20policy%200114_tcm3-41668.pdf
6. Massachusetts Office On Disability Accessible Parking Requirements
    a. www.mass.gov/anf/docs/mod/hp-parking-regulations-mod.doc
7. MBTA Fixed Route Accessible Transit Stations
    a. http://www.mbta.com/about_the_mbta/accessibility/

Article 80 | ACCESSIBILTY CHECKLIST

Project Information

Project Name:	Brooke Charter High School
Project Address Primary:	American Legion Highway & Kingbird Road
Project Address Additional:	TBD
Project Contact (name / Title / Company / email / phone):	Jon Clark, Co-Director, Brooke Charter School, 190 Cummins Highway, Roslindale, MA , Jclark@ebrooke.org, 617-325-7977

Owner / Developer:	Brooke Charter School
Architect:	Arrowstreet Inc.
Engineer (building systems):	Garcia, Galuska, DeSousa Consulting Engineers
Sustainability / LEED:	Arrowstreet Inc.
Permitting:	VHB
Construction Management:	STV | DPM

Project Permitting and Phase

At what phase is the project – at time of this questionnaire?

Notice of Project Change	Draft / Final Project Impact Report Submitted	BPDA Board Approved
BRA Design Approved	Under Construction	Construction just completed:

Building Classification and Description

What are the principal Building Uses - select all appropriate uses?

Residential – One to Three Unit	Residential - Multi-unit, Four +	Institutional	**Education**
Commercial	Office	Retail	Assembly
Laboratory / Medical	Manufacturing / Industrial	Mercantile	Storage, Utility and Other
First Floor Uses (List)	**High School – Administration, classrooms, gymnasium, cafeteria, auditorium**		

Article 80 | ACCESSIBILTY CHECKLIST

What is the Construction Type – select most appropriate type?

Wood Frame	Masonry	**Steel Frame**	Concrete

Describe the building?

Site Area:	101,060 *SF*	Building Area:	95,000 *SF*
Building Height:	*57 Ft.*	Number of Stories:	*4 Flrs.*
First Floor Elevation:	Level 1: 85.5 Cafeteria 95.5 Level 2: 111.25	Are there below grade spaces:	*Yes / **No***

Assessment of Existing Infrastructure for Accessibility:

This section explores the proximity to accessible transit lines and proximate institutions such as, but not limited to hospitals, elderly and disabled housing, and general neighborhood information. The proponent should identify how the area surrounding the development is accessible for people with mobility impairments and should analyze the existing condition of the accessible routes through sidewalk and pedestrian ramp reports.

Provide a description of the development neighborhood and identifying characteristics.	The Site is primarily bordered by open green space to the west and south (Franklin Park) and housing and commercial/institutional development to the north and east.
List the surrounding ADA compliant MBTA transit lines and the proximity to the development site: Commuter rail, subway, bus, etc.	The closest MBTA services are bus routes 14, 21, 28, 29 and 31.
List the surrounding institutions: hospitals, public housing and elderly and disabled housing developments, educational facilities, etc.	Nearby educational facilities include the Brooke Mattapan Charter School, which is adjacent to the Project Site Public housing borders the Site to the east and south.
Is the proposed development on a priority accessible route to a key public use facility? List the surrounding: government buildings, libraries, community centers and recreational facilities and other related facilities.	The Site is adjacent to green space, and community and recreational facilities including Lena Park Community Center, Forest Hills Cemetery, Franklin Park, and Franklin Park Zoo.

Surrounding Site Conditions – Existing:

This section identifies the current condition of the sidewalks and pedestrian ramps around the development site.

Are there sidewalks and pedestrian ramps existing at the development site?	Yes
If yes above, list the existing sidewalk and pedestrian ramp materials and physical condition at the development site.	Concrete. Good condition.
Are the sidewalks and pedestrian ramps existing-to-remain? If yes, have the sidewalks and pedestrian ramps been verified as compliant? If yes, please provide surveyors report.	Some sidewalks will remain. Any locations that are found to not be accessible will be replaced.
Is the development site within a historic district? If yes, please identify.	No

Surrounding Site Conditions – Proposed

This section identifies the proposed condition of the walkways and pedestrian ramps in and around the development site. The width of the sidewalk contributes to the degree of comfort and enjoyment of walking along a street. Narrow sidewalks do not support lively pedestrian activity, and may create dangerous conditions that force people to walk in the street. Typically, a five foot wide Pedestrian Zone supports two people walking side by side or two wheelchairs passing each other. An eight foot wide Pedestrian Zone allows two pairs of people to comfortable pass each other, and a ten foot or wider Pedestrian Zone can support high volumes of pedestrians.

Are the proposed sidewalks consistent with the Boston Complete Street Guidelines? See: www.bostoncompletestreets.org	No new sidewalks
If yes above, choose which Street Type was applied: Downtown Commercial, Downtown Mixed-use, Neighborhood Main, Connector, Residential, Industrial, Shared Street, Parkway, Boulevard.	

What is the total width of the proposed sidewalk? List the widths of the proposed zones: Frontage, Pedestrian and Furnishing Zone.	
List the proposed materials for each Zone. Will the proposed materials be on private property or will the proposed materials be on the City of Boston pedestrian right-of-way?	
If the pedestrian right-of-way is on private property, will the proponent seek a pedestrian easement with the City of Boston Public Improvement Commission?	N/A
Will sidewalk cafes or other furnishings be programmed for the pedestrian right-of-way?	No
If yes above, what are the proposed dimensions of the sidewalk café or furnishings and what will the right-of-way clearance be?	N/A

Proposed Accessible Parking:

See Massachusetts Architectural Access Board Rules and Regulations 521 CMR Section 23.00 regarding accessible parking requirement counts and the Massachusetts Office of Disability Handicap Parking Regulations.

What is the total number of parking spaces provided at the development site parking lot or garage?	60
What is the total number of accessible spaces provided at the development site?	3 (2 automobile, 1 van)

Will any on street accessible parking spaces be required? If yes, has the proponent contacted the Commission for Persons with Disabilities and City of Boston Transportation Department regarding this need?	No
Where is accessible visitor parking located?	To the south of the building near the main entrance.
Has a drop-off area been identified? If yes, will it be accessible?	Yes. Yes.
Include a diagram of the accessible routes to and from the accessible parking lot/garage and drop-off areas to the development entry locations. Please include route distances.	See attached.

Circulation and Accessible Routes:

The primary objective in designing smooth and continuous paths of travel is to accommodate persons of all abilities that allow for universal access to entryways, common spaces and the visit-ability* of neighbors.

**Visit-ability – Neighbors ability to access and visit with neighbors without architectural barrier limitations*

Provide a diagram of the accessible route connections through the site.	See attached.
Describe accessibility at each entryway: Flush Condition, Stairs, Ramp Elevator.	Both south and north entries are flush conditions.
Are the accessible entrance and the standard entrance integrated?	Yes

If no above, what is the reason?	N/A
Will there be a roof deck or outdoor courtyard space? If yes, include diagram of the accessible route.	Outdoor courtyard spaces are accessible. See attached.
Has an accessible routes way-finding and signage package been developed? If yes, please describe.	No

Accessible Units: (If applicable)

In order to facilitate access to housing opportunities this section addresses the number of accessible units that are proposed for the development site that remove barriers to housing choice.

What is the total number of proposed units for the development?	
How many units are for sale; how many are for rent? What is the market value vs. affordable breakdown?	
How many accessible units are being proposed?	
Please provide plan and diagram of the accessible units.	
How many accessible units will also be affordable? If none, please describe reason.	
Do standard units have architectural barriers that would prevent entry or use of common space for persons with mobility impairments? Example: stairs at entry or step to balcony. If yes, please provide reason.	
Has the proponent reviewed or presented the proposed plan to the City of Boston Mayor's Commission	

for Persons with Disabilities Advisory Board?	
Did the Advisory Board vote to support this project? **If no,** what recommendations did the Advisory Board give to make this project more accessible?	

Thank you for completing the Accessibility Checklist!

For questions or comments about this checklist or accessibility practices, please contact:

kathryn.quigley@boston.gov | Mayors Commission for Persons with Disabilities

LEGEND

- ACCESSIBLE ENTRANCE
- EGRESS ONLY
- ACCESSIBLE ROUTE
- 2HP — ACCESSIBLE PARKING
  (NOTE: TOTAL ACCESSIBLE SPACES WILL BE DETERMINED UPON FINAL PARKING LAYOUT)

terrain
landscape architecture

BROOKE CHARTER HIGH SCHOOL

NOT TO SCALE . DIAGRAM PREPARED FOR PERMITTING

ACCESSIBLE ROUTES

Brooke Charter School
Design Development
December 2016

Climate Change Preparedness and Resiliency Checklist for New Construction

In November 2013, in conformance with the Mayor's 2011 Climate Action Leadership Committee's recommendations, the Boston Redevelopment Authority adopted policy for all development projects subject to Boston Zoning Article 80 Small and Large Project Review, including all Institutional Master Plan modifications and updates, are to complete the following checklist and provide any necessary responses regarding project resiliency, preparedness, and to mitigate any identified adverse impacts that might arise under future climate conditions.

For more information about the City of Boston's climate policies and practices, and the 2011 update of the climate action plan, *A Climate of Progress*, please see the City's climate action web pages at http://www.cityofboston.gov/climate

In advance we thank you for your time and assistance in advancing best practices in Boston.

Climate Change Analysis and Information Sources:

1. Northeast Climate Impacts Assessment (www.climatechoices.org/ne/)
2. USGCRP 2009 (http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/)
3. Army Corps of Engineers guidance on sea level rise (http://planning.usace.army.mil/toolbox/library/ECs/EC11652212Nov2011.pdf)
4. Proceeding of the National Academy of Science, "Global sea level rise linked to global temperature", Vermeer and Rahmstorf, 2009 (http://www.pnas.org/content/early/2009/12/04/0907765106.full.pdf)
5. "Hotspot of accelerated sea-level rise on the Atlantic coast of North America", Asbury H. Sallenger Jr*, Kara S. Doran and Peter A. Howd, 2012 (http://www.bostonredevelopmentauthority.org/planning/Hotspot of Accelerated Sea-level Rise 2012.pdf)
6. "Building Resilience in Boston": Best Practices for Climate Change Adaptation and Resilience for Existing Buildings, Linnean Solutions, The Built Environment Coalition, The Resilient Design Institute, 2103 (http://www.greenribboncommission.org/downloads/Building_Resilience_in_Boston_SML.pdf)

Checklist

Please respond to all of the checklist questions to the fullest extent possible. For projects that respond "Yes" to any of the D.1 – Sea-Level Rise and Storms, Location Description and Classification questions, please respond to all of the remaining Section D questions.

Checklist responses are due at the time of initial project filing or Notice of Project Change and final filings just prior seeking Final BRA Approval. A PDF of your response to the Checklist should be submitted to the Boston Redevelopment Authority via your project manager.

Please Note: When initiating a new project, please visit the BRA web site for the most current Climate Change Preparedness & Resiliency Checklist.

A.1 - Project Information

Project Name:	Brooke Charter High School
Project Address Primary:	American Legion Highway & Kingbird Road
Project Address Additional:	
Project Contact (name / Title / Company / email / phone):	Jon Clark, Co-Director, Brooke Charter School, 190 Cummins Highway, Roslindale, MA , Jclark@ebrooke.org, 617-325-7977

A.2 - Team Description

Owner / Developer:	Brooke Charter Schools
Architect:	Arrowstreet Inc.
Engineer (building systems):	Garcia, Galuska, DeSousa Consulting Engineers
Sustainability / LEED:	Arrowstreet Inc.
Permitting:	VHB
Construction Management:	STV | DPM
Climate Change Expert:	Arrowstreet Inc., VHB

A.3 - Project Permitting and Phase NOTICE OF PROJECT CHANGE

At what phase is the project – most recent completed submission at the time of this response?

PNF / Expanded PNF Submission	Draft / Final Project Impact Report Submission	BRA Board Approved	**Notice of Project Change**
Planned Development Area	BRA Final Design Approved	Under Construction	Construction just completed:

A.4 - Building Classification and Description

List the principal Building Uses:	**Education – Secondary School**
List the First Floor Uses:	**Administration, classrooms, gymnasium, cafeteria, auditorium**

What is the principal Construction Type – select most appropriate type?

Wood Frame	Masonry	**Steel Frame**	Concrete

Describe the building?

Site Area:	101,060 *SF*	Building Area:	95,000 SF
Building Height:	57 *Ft.*	Number of Stories:	4 *Flrs.*
First Floor Elevation (reference Boston City Base):	Level 1: 85.5 Cafeteria 95.5 Level 2: 111.25	Are there below grade spaces/levels, if yes how many:	No / *Number of Levels*

A.5 - Green Building

Which LEED Rating System(s) and version has or will your project use (by area for multiple rating systems)?

Select by Primary Use:	New Construction	Core & Shell	Healthcare	**Schools v4**
	Retail	Homes Midrise	Homes	Other
Select LEED Outcome:	Certified	**Silver**	Gold	Platinum

Will the project be USGBC Registered and / or USGBC Certified?

Registered:	*Yes / **No***	Certified:	*Yes / **No***

A.6 - Building Energy

What are the base and peak operating energy loads for the building?

Electric:	*267.88 (kW)*	Heating:	*2.241 (MMBtu/hr)*
What is the planned building Energy Use Intensity:	*40.90 (kbut/SF)*	Cooling:	*139.5 (Tons/hr)*

What are the peak energy demands of your critical systems in the event of a service interruption?

Electric:	**No Generator**	Heating:	*(MMBtu/hr)*
		Cooling:	*(Tons/hr)*

What is nature and source of your back-up / emergency generators?

Electrical Generation:	**No Generator**		Fuel Source:	
System Type and Number of Units:	Combustion Engine	Gas Turbine	Combine Heat and Power	*(Units)*

B - Extreme Weather and Heat Events

Climate change will result in more extreme weather events including higher year round average temperatures, higher peak temperatures, and more periods of extended peak temperatures. The section explores how a project responds to higher temperatures and heat waves.

B.1 - Analysis

What is the full expected life of the project?

Select most appropriate:	10 Years	25 Years	**50 Years**	75 Years

What is the full expected operational life of key building systems (e.g. heating, cooling, ventilation)?

Select most appropriate:	10 Years	**25 Years**	50 Years	75 Years

What time span of future Climate Conditions was considered?

Select most appropriate:	10 Years	25 Years	50 Years	75 Years

Near term: 2030 for Sea Level Rise (SLR) and storm surge and span of 2015-2045 for temperature and precipitation.

Longer term: 2070 for SLR and storm surge and 2050 and 2100 for precipitation.

Analysis Conditions - What range of temperatures will be used for project planning – Low/High?

7/89 Deg.

What Extreme Heat Event characteristics will be used for project planning – Peak High, Duration, and Frequency?

89 Deg.	*2.55 Days*	*1 Events / yr.*

What Drought characteristics will be used for project planning – Duration and Frequency?

45 Days	*1 Events / yr.*

What Extreme Rain Event characteristics will be used for project planning – Seasonal Rain Fall, Peak Rain Fall, and Frequency of Events per year?

Inches / yr.	*Inches*	*Events / yr.*

What Extreme Wind Storm Event characteristics will be used for project planning – Peak Wind Speed, Duration of Storm Event, and Frequency of Events per year?

There is still significant uncertainty with respect to how wind patterns and intensities will change with respect to future climatological conditions. Some models predict that a warming would lessen the difference in air mass temperatures, others show a decrease in atmospheric wind shear aspects – both of which would potentially lead to less intense wind events. Other models predict an increase in wind intensities based on the increase of energy in the atmosphere. El Nino/La Nina add another layer of complexity to the projections. Based on this uncertainty, current wind design criteria are adopted for the Project.

Peak Wind	*Hours*	*Events / yr.*

B.2 - Mitigation Strategies

What will be the overall energy performance, based on use, of the project and how will performance be determined?

Building energy use below code:	*21.8 %*
How is performance determined:	Energy model simulation comparing the design building verse IECC 2015 requirements

What specific measures will the project employ to reduce building energy consumption?

Select all appropriate:	High performance building envelop	High performance lighting & controls	Building day lighting	EnergyStar equip. / appliances
	High performance HVAC equipment	Energy recovery ventilation	No active cooling (in some spaces)	No active heating
Describe any added measures:				

What are the insulation (R) values for building envelop elements?

Roof:	R = 30	Walls / Curtain Wall Assembly:	R = 25
Foundation:	R = 10	Basement / Slab:	R = 15 for 24in.
Windows:	R = 2.63/ U =.38	Doors:	R =2.7 / U =.37

What specific measures will the project employ to reduce building energy demands on the utilities and infrastructure?

On-site clean	Building-wide	Thermal energy	Ground source

	energy / CHP system(s)	power dimming	storage systems	heat pump
	On-site Solar PV	On-site Solar Thermal	Wind power	None
Describe any added measures:				

Will the project employ Distributed Energy / Smart Grid Infrastructure and /or Systems?

Select all appropriate:	Connected to local distributed electrical	Building will be Smart Grid ready	Connected to distributed steam, hot, chilled water	Distributed thermal energy ready

Will the building remain operable without utility power for an extended period?

	Yes / **No**	If yes, for how long:	*Days*
If Yes, is building "Islandable?			
If Yes, describe strategies:			

Describe any non-mechanical strategies that will support building functionality and use during an extended interruption(s) of utility services and infrastructure:

Select all appropriate:	Solar oriented – longer south walls	Prevailing winds oriented	External shading devices	Tuned glazing,
	Building cool zones	**Operable windows**	Natural ventilation	Building shading
	Potable water for drinking / food preparation	Potable water for sinks / sanitary systems	Waste water storage capacity	**High Performance Building Envelop**
Describe any added measures:				

What measures will the project employ to reduce urban heat-island effect?

Select all appropriate:	**High reflective paving materials**	**Shade trees & shrubs**	**High reflective roof materials**	Vegetated roofs
Describe other strategies:				

What measures will the project employ to accommodate rain events and more rain fall?

Select all appropriate:	**On-site retention systems & ponds**	**Infiltration galleries & areas**	vegetated water capture systems	Vegetated roofs
Describe other strategies:				

What measures will the project employ to accommodate extreme storm events and high winds?

Select all appropriate:	**Hardened building structure & elements**	**Buried utilities & hardened infrastructure**	Hazard removal & protective landscapes	**Soft & permeable surfaces (water infiltration)**
Describe other strategies:				

C - Sea-Level Rise and Storms

Rising Sea-Levels and more frequent Extreme Storms increase the probability of coastal and river flooding and enlarging the extent of the 100 Year Flood Plain. This section explores if a project is or might be subject to Sea-Level Rise and Storm impacts.

C.1 - Location Description and Classification:

Do you believe the building to susceptible to flooding now or during the full expected life of the building?

	*Yes / **No***

Describe site conditions?

Site Elevation – Low/High Points:	*Boston City Base Elev.(Ft.)*
Building Proximity to Water:	Approx 0.3 mi to Scarboro Pond

Is the site or building located in any of the following?

Coastal Zone:	*Yes / **No***	Velocity Zone:	*Yes / **No***
Flood Zone:	*Yes / **No***	Area Prone to Flooding:	*Yes / **No***

Will the 2013 Preliminary FEMA Flood Insurance Rate Maps or future floodplain delineation updates due to Climate Change result in a change of the classification of the site or building location?

2013 FEMA Prelim. FIRMs:	*Yes / **No***	Future floodplain delineation updates:	*Yes / **No***

What is the project or building proximity to nearest Coastal, Velocity or Flood Zone or Area Prone to Flooding?

Approx. 0.3mi Zone A Scarboro Pond

***If you answered YES to any of the above Location Description and Classification questions, please complete the following questions.** Otherwise you have completed the questionnaire; thank you!*

C - Sea-Level Rise and Storms

This section explores how a project responds to Sea-Level Rise and / or increase in storm frequency or severity.

C.2 - Analysis

How were impacts from higher sea levels and more frequent and extreme storm events analyzed:

Sea Level Rise:	*Ft.*	Frequency of storms:	*per year*

C.3 - Building Flood Proofing

Describe any strategies to limit storm and flood damage and to maintain functionality during an extended periods of disruption.

What will be the Building Flood Proof Elevation and First Floor Elevation:

Flood Proof Elevation:	*Boston City Base Elev.(Ft.)*	First Floor Elevation:	*Boston City Base Elev. (Ft.)*

Will the project employ temporary measures to prevent building flooding (e.g. barricades, flood gates):

	Yes / No	If Yes, to what elevation	*Boston City Base Elev. (Ft.)*
If Yes, describe:			

What measures will be taken to ensure the integrity of critical building systems during a flood or severe storm event:

Systems located above 1st Floor.	Water tight utility conduits	Waste water back flow prevention	Storm water back flow prevention

Were the differing effects of fresh water and salt water flooding considered:

Yes / No

Will the project site / building(s) be accessible during periods of inundation or limited access to transportation:

Yes / No	If yes, to what height above 100 Year Floodplain:	*Boston City Base Elev. (Ft.)*

Will the project employ hard and / or soft landscape elements as velocity barriers to reduce wind or wave impacts?

Yes / No

If Yes, describe:

Will the building remain occupiable without utility power during an extended period of inundation:

Yes / No	If Yes, for how long:	*days*

Describe any additional strategies to addressing sea level rise and or sever storm impacts:

C.4 - Building Resilience and Adaptability

Describe any strategies that would support rapid recovery after a weather event and accommodate future building changes that respond to climate change:

Will the building be able to withstand severe storm impacts and endure temporary inundation?

Select appropriate:	*Yes / No*	Hardened / Resilient Ground Floor Construction	Temporary shutters and or barricades	Resilient site design, materials and construction

Can the site and building be reasonably modified to increase Building Flood Proof Elevation?

Select appropriate:	*Yes / No*	Surrounding site elevation can be raised	Building ground floor can be raised	Construction been engineered
Describe additional strategies:				

Has the building been planned and designed to accommodate future resiliency enhancements?

Select appropriate:	*Yes / No*	Solar PV	Solar Thermal	Clean Energy / CHP System(s)
		Potable water storage	Wastewater storage	Back up energy systems & fuel
Describe any specific or additional strategies:				

Thank you for completing the Boston Climate Change Resilience and Preparedness Checklist!

For questions or comments about this checklist or Climate Change Resiliency and Preparedness best practices, please contact: John.Dalzell.BRA@cityofboston.gov

APPENDIX B: Energy Analysis Supporting Documentation

Engineering Economic Analysis
for
Brooke Charter High School

Dorchester, MA

November 23, 2016

Prepared for:

Prepared by:

Garcia, Galuska & DeSousa
Consulting Engineers, Inc.

Brooke Charter High School Engineering Economic Analysis

Table of Contents

EXECUTIVE SUMMARY

Section 1.0: Executive Summary

The goal of the mechanical lifecycle engineering economic analysis is to assess the performance of various mechanical systems in comparison to a baseline mechanical system.

Each option is compared to the baseline system to determine the lowest combined savings over a 30 year cycle to determine the most advantageous system considering electrical costs, gas costs, maintenance costs, and initial construction costs.

The classroom areas of the Baseline and Options 2 & 3 are simulated to maintain indoor air temperature conditions of 70ºF DB for heating and 75°F DB with 55% RH for cooling. Option 1 studies a dehumidification displacement system serving the classroom areas, which will have a maximum cooling set point of 78°F DB with 55% RH. Unoccupied temperature setback of 60°F DB heating and 85ºF DB cooling is provided for all options.

By comparison of each option to the baseline system, the option with the greatest total life-cycle savings is generally recommended. To further enhance controllability and overall system performance, additional options should be considered that will enhance year round temperature control and comfort at a possible marginal increase in capital cost.

Section 1.1: Mechanical System Analysis

1.1.A: Baseline Mechanical System – ASHRAE Baseline Packaged DX Cooling/Hot Water Coil Heating Rooftop Units with Variable Air Volume System

- Hot water coil heating/direct expansion cooling air handling units with energy recovery wheels with terminal variable air volume boxes with hot water reheat coils serving the classroom, administration, auditorium, cafeteria, gym, lockers, and support areas
- Hot water coil heating/direct expansion cooling air handling unit with terminal variable air volume boxes with hot water reheat coils serving the, stage
- Overhead fiberglass insulated supply and return air ductwork distribution system
- Limited use of radiant heating panels and unit heaters
- (2) 2,250 MBH standard-efficiency gas-fired boilers
- Two-pipe hot water distribution system serving rooftop units, VAV reheat coils, radiant heating panels, and unit heaters
- Hot water primary pumping with variable frequency drives
- Direct digital controls throughout

1.1.B: Mechanical System Option One – Variable Air Volume Dehumidification Displacement Ventilation Packaged DX Cooling/Gas-Fired Heating Rooftop Unit Systems

- Multiple low wall-mounted displacement diffusers at approximately 200-300 CFM (2 per classroom, 1 per support area) each for each classroom and support area

- Multiple low wall-mounted displacement diffusers located throughout the cafeteria area
- Variable air volume boxes with demand ventilation control and temperature sensor to modulate airflow based on occupancy and space heating/cooling demand for all occupied areas
- Dedicated overhead galvanized ventilation distribution system feeding each displacement diffuser
- 100% outside air variable air volume gas-fired heating/direct expansion dehumidification air handling units with energy recovery wheels and demand control ventilation providing dehumidification displacement ventilation to the terminal variable air volume boxes serving the classroom, cafeteria, and support areas
- Radiant heating panels located along exterior wall between displacement diffusers
- Variable air volume gas-fired heating/direct expansion cooling air handling unit with energy recovery wheel and demand control ventilation providing mixed-air overhead ventilation through terminal variable air volume boxes with hot water reheat coils serving the administration areas
- Variable air volume gas-fired heating/direct expansion cooling air handling units with energy recovery wheels and demand control ventilation providing mixed-air overhead ventilation serving the auditorium, gym, and stage areas
- 100% outside air variable air volume gas-fired heating/direct expansion dehumidification air handling unit with energy recovery wheel providing dehumidification ventilation to the locker room areas
- Overhead fiberglass insulated supply and return air ductwork distribution system
- Limited use of radiant heating panels and unit heaters serving non-academic areas
- (2) 2,000 MBH high-efficiency gas-fired condensing boilers power plant
- Two-pipe hot water distribution system serving radiant heating panels and unit heaters
- Hot water primary pumping with variable frequency drives
- Direct digital controls throughout

1.1.C: Mechanical System Option Two – Variable Air Volume Full AC Displacement Ventilation Packaged DX Cooling/Gas-Fired Heating Rooftop Unit Systems

- Multiple low wall-mounted displacement diffusers at approximately 300-400 CFM (2 per classroom, 1 per support area) each for each classroom and support area
- Multiple low wall-mounted displacement diffusers located throughout the cafeteria area
- Variable air volume boxes with demand ventilation control and temperature sensor to modulate airflow based on occupancy and space heating/cooling demand for all occupied areas

- Dedicated overhead galvanized ventilation distribution system feeding each displacement diffuser

- Variable air volume gas-fired heating/direct expansion cooling air handling units with energy recovery wheels and demand control ventilation providing cooling and displacement ventilation to the terminal variable air volume boxes serving the classroom, cafeteria, and support areas

- Radiant heating panels located along exterior wall between displacement diffusers

- Variable air volume gas-fired heating/direct expansion cooling air handling unit with energy recovery wheel and demand control ventilation providing mixed-air overhead ventilation through terminal variable air volume boxes with hot water reheat coils serving the administration areas

- Variable air volume gas-fired heating/direct expansion cooling air handling units with energy recovery wheels and demand control ventilation providing mixed-air overhead ventilation serving the auditorium, gym, and stage areas

- 100% outside air variable air volume gas-fired heating/direct expansion dehumidification air handling unit with energy recovery wheel providing dehumidification ventilation to the locker room areas

- Overhead fiberglass insulated supply and return air ductwork distribution system

- Limited use of radiant heating panels and unit heaters serving non-academic areas

- (2) 2,000 MBH high-efficiency gas-fired condensing boilers power plant

- Two-pipe hot water distribution system serving radiant heating panels and unit heaters

- Hot water primary pumping with variable frequency drives

- Direct digital controls throughout

1.1.D: Mechanical System Option Three – Variable Air Volume Packaged DX Cooling/Gas-Fired Heating Rooftop Unit Induction Unit Systems

- Multiple four-pipe two coil heating and cooling induction units serving the administration and classroom areas

- Variable air volume boxes with demand ventilation control and temperature sensor to modulate airflow based on occupancy and space heating/cooling demand for all occupied areas

- Primary air ducted directly to induction units

- 100% outside air variable air volume gas-fired heating/direct expansion dehumidification air handling units with energy recovery wheels and demand control ventilation providing ventilation to the terminal variable air volume boxes and induction units serving the induction units of the classroom and administration areas

- Multiple low wall-mounted displacement diffusers located throughout the cafeteria area

- Dedicated overhead galvanized ventilation distribution system feeding each displacement diffuser

- Variable air volume gas-fired heating/direct expansion cooling air handling unit with energy recovery wheel and demand control ventilation providing cooling and displacement ventilation to the terminal variable air volume boxes serving the cafeteria, area

- Radiant heating panels located along exterior wall between displacement diffusers

- Variable air volume gas-fired heating/direct expansion cooling air handling units with energy recovery wheels and demand control ventilation providing mixed-air overhead ventilation serving the auditorium, gym, and stage areas

- 100% outside air variable air volume gas-fired heating/direct expansion dehumidification air handling unit with energy recovery wheel providing dehumidification ventilation to the locker room areas

- Overhead fiberglass insulated supply and return air ductwork distribution system

- Limited use of radiant heating panels and unit heaters serving non-academic areas

- (2) 2,000 MBH high-efficiency gas-fired condensing boilers power plant

- 90 ton high-efficiency air-cooled chiller plant

- Four-pipe heating/cooling piping system serving induction units

- Two-pipe hot water distribution system serving radiant heating panels and unit heaters

- Chilled and hot water primary pumping with variable frequency drives

- Direct digital controls throughout

Section 1.2: Mechanical System Analysis Conclusion

The variable air volume air handling unit system is selected as the baseline system since it is an ASHRAE Standard 90.1 baseline system that results in a low installed cost and relatively energy efficient system. Unfortunately, the selection results in overall ownership costs that in some cases are higher when compared to the alterative systems primarily relating to the increased annual operating costs while also compromising the thermal comfort of the building. The option comparison of each alternative system to the baseline assesses the benefits of improved systems with potentially reduced combined operating costs and improved thermal comfort with the goal of selecting the system with the highest ownership savings over the 30 year study period.

Annual electrical and gas consumption is calculated thru the results of a thermal dynamic heat transfer analysis utilizing Department of Energy (DOE-2)/eQuest software with all architectural data provided by Arrowstreet Architecture & Design.

The building envelope consists of the following insulation values: The main building roof has 5” minimum continuous polyisocyanurate insulation (R-32.5 average) and the walls have continuous mineral wool insulation (R-15 average) plus 3-1/2” mineral wool between stud cavities (R-7.4

average). The pre-engineered building has an R-21.1 roof assembly and an R-20 wall assembly. Windows and curtainwall have a U-Value of 0.38 and a S.C. of 0.45.

Utility cost data for electricity and natural gas were based on published data by the U.S. Energy Information Administration for the area. The rates are $0.17/kWh for Electricity and $1.20/therm for Natural Gas.

The “Building Life-Cycle” analysis included future worth of each system option considered using standard industry discount, inflation, and interest rates.

Our observations of the Mechanical System Payback Summary suggest that Option 1, variable air volume dehumidification displacement ventilation systems, represents the lowest life cycle cost by yielding an approximate $1,041,184 savings over the 30 year study period with an instant payback as it has a lower installed cost than the code baseline system.

It should be noted that the classroom and cafeteria areas served by dehumidification displacement ventilation in Option 1 are simulated with a cooling setpoint of 78°F DB and 55% RH and will not maintain fully air-conditioned set points year round under peak conditions.

Section 2.0: LEED Energy Savings Summary

Once the most cost effective mechanical system has been determined, an additional ASHRAE Standard 90.1-2010 baseline building simulation has been performed to compare the design building (as outlined above) against to determine the energy cost savings based on LEED v4 requirements.

The LEED v4 ASHRAE Standard 90.1-2010 baseline building is as follows:

- Envelope:
  - Wall: R-13 + R-7.5 c.i.
  - Roof: R-20 c.i.
  - Underslab: R-10 c.i.
  - Windows: 0.55 U-Value, 0.40 SHGC
  - Curtainwall: 0.45 U-Value, 0.40 SHGC
- Mechanical System:
  - Hot water coil heating/direct expansion cooling VAV AHU systems with energy recovery wheels (where required) serving terminal VAV boxes with hot water reheat coils
  - (2) 80% efficient gas-fired hot water boilers
- Domestic Hot Water System:
  - 80% efficient gas-fired domestic hot water system
- Lighting System:
  - 0.99 w/s.f.

Section 2.1: LEED Energy Savings Analysis Conclusion

As indicated in the LEED Energy Savings Summary Chart, a comparison of the Design Building against the LEED v4 ASHRAE Standard 90.1-2010 Baseline Building results in an energy cost savings of 26.8%.

Note:

The values indicated in this report are based on energy modelling performed for system comparison purposes only. Our office strongly recommends adding a 30% safety factor to the calculated values of this report for budgeting purposes to account for potential variances to the actual operation of the building. Per ASHRAE Standard 90.1-2010:

Neither the proposed building performance nor the baseline building performance are predictions of actual energy consumption or costs for the proposed design after construction. Actual experience will differ from these calculations due to variations such as occupancy, building operation and maintenance, weather, energy use not covered by this procedure, changes in energy rates between design of the building and occupancy, and the precision of the calculation tool.

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Brooke Charter High School - Mechanical System Payback Summary

Baseline	System	Gross Capital Investment*	Annual Elec. Cons. (kWh)	Annual Gas Cons. (MBTU)	Annual Electric Cost	Annual Gas Cost	Combined Utility Cost	Annual Utility $/s.f.	Annual kBTU/s.f. (EUI)	Annual Maint. Cost	Combined Annual Expense	Combined Expense Savings**	Total Life-Cycle Savings***	Discounted Payback (Years)****
-	1. Hot water coil heating/dx cooling VAV AHU system with energy recovery and terminal VAV boxes with hot water reheat coils 2. Code efficient gas-fired non-condensing boiler plant	$3,710,650	517,450	2,722.8	$87,967	$32,673	$120,640	$1.36	50.5	$24,175	$144,815	-	-	-

Option	System	Gross Capital Investment*	Annual Elec. Cons. (kWh)	Annual Gas Cons. (MBTU)	Annual Electric Cost	Annual Gas Cost	Combined Utility Cost	Annual Utility $/s.f.	Annual kBTU/s.f. (EUI)	Annual Maint. Cost	Combined Annual Expense	Combined Expense Savings**	Total Life-Cycle Savings***	Discounted Payback (Years)****
1	1. Displacement ventilation diffusers with terminal VAV boxes and perimeter hot water radiant heating panels 2. Gas-fired heating/dx dehumidification 100% O.A. VAV displacement ventilation units with energy recovery and demand ventilation serving the classroom and cafeteria areas 3. Gas-fired heating/dx cooling heating/dx cooling overhead VAV units with energy recovery and demand ventilation serving the administration areas 4. Gas-fired heating/dx cooling overhead VAV unit with energy recovery and demand ventilation serving the auditorium, stage, and gym areas 5. High efficiency gas-fired condensing central boiler plant	$3,225,560	451,280	2,091.9	$76,717	$25,103	$101,820	$1.15	40.9	$21,225	$123,045	$21,770	$1,041,184	Instant*****
2	1. Displacement ventilation diffusers with terminal VAV boxes and perimeter hot water radiant heating panels 2. Gas-fired heating/dx VAV full AC displacement ventilation units with energy recovery and demand ventilation serving the classroom and cafeteria areas 3. Gas-fired heating/dx cooling heating/dx cooling overhead VAV units with energy recovery and demand ventilation serving the administration areas 4. Gas-fired heating/dx cooling overhead VAV units with energy recovery and demand ventilation serving the auditorium, stage, and gym areas 5. High efficiency gas-fired condensing central boiler plant	$3,511,710	463,160	2,141.9	$78,737	$25,703	$104,440	$1.18	41.9	$21,225	$125,665	$19,150	$687,099	Instant******
3	1. Hot/chilled water coil induction units serving the classroom and administration areas 2. Gas-fired heating/dx cooling 100% O.A. VAV ventilating units with energy recovery and demand ventilation serving induction units 3. Gas-fired heating/dx cooling overhead VAV unit with energy recovery and demand ventilation serving the auditorium, stage, and gym areas 4. High efficiency gas-fired condensing central boiler plant 5. High efficiency air-cooled chiller plant	$3,732,810	533,970	2,091.1	$90,776	$25,093	$115,869	$1.30	44.1	$26,650	$142,519	$2,296	$56,456	8

* Gross capital investment based upon in-house cost estimate utilizing cost data from similar past projects and industry standard estimating references. Costs have been estimated for system comparison purposes only and do not incorporate all supplemental/independent HVAC system costs which would be required for all systems studied (i.e. kitchen exhaust, overhead and profit).
** Combined expense savings is the difference between the combined annual expense of the baseline and system in comparison.
*** Total life-cycle savings is based on a 30 year study period.
**** Discounted payback years is based upon BLCC5 Life Cycle Analysis.
***** Discounted payback never reached within 30 year study period.
****** Discounted payback never reached because system is more efficient and/or less expensive than baseline system.

Note 1: Values based on energy model performed for HVAC System Life Cycle Cost Analysis purposes. A 30% safety factor should be applied for budgeting purposes to account for potential variances to the actual operation of the building. Per ASHRAE Standard 90.1-2010:

Neither the proposed building performance nor the baseline building performance are predictions of actual energy consumption or costs for the proposed design after construction. Actual experience will differ from these calculations due to variations such as occupancy, building operation and maintenance, weather, energy use not covered by this procedure, changes in energy rates between design of the building and occupancy, and the precision of the calculation tool.

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Brooke Charter High School - LEED Energy Savings Summary

Baseline	System	Annual Elec. Cons. (kWh)	Annual Gas Cons. (MBTU)	Annual Electric Cost	Annual Gas Cost	Combined Utility Cost	Annual Utility $/s.f.	Annual kBTU/s.f. (EUI)	Combined Expense Savings*	Energy Cost Savings Percentage
LEED Baseline	1. ASHRAE Standard 90.1-2010 Envelope (Wall Insulation R-13 + R-7.5 c.i., Roof Insulation R-20 c.i., Windows 0.55 U-Value/0.40 SHGC, Curtainwall 0.45 U-Value/0.40 SHGC) 2. ASHRAE Standard 90.1-2010 Mechanical Systems (System 5 - Packaged VAV w/ How Water Reheat with 80% Eff. Hot-Water Boilers) 3. ASHRAE Standard 90.1-2010 Lighting Systems (0.99 w/s.f.) 4. ASHRAE Standard 90.1-2010 Domestic Hot Water Systems (80% Eff. Hot Water Heaters)	616,430	2,856.5	$104,793	$34,278	$139,071	$1.57	55.85	-	-

Option	System	Annual Elec. Cons. (kWh)	Annual Gas Cons. (MBTU)	Annual Electric Cost	Annual Gas Cost	Combined Utility Cost	Annual Utility $/s.f.	Annual kBTU/s.f. (EUI)	Combined Expense Savings*	Energy Cost Savings Percentage
Design Building	1. Design Envelope (Wall Insulation R-16 c.i., Roof Insulation R-40 c.i., Windows 0.44 U-Value w/ 0.40/0.53 SHGC, Curtainwall 0.38/0.5 U-Value w/ 0.40 SHGC) 2. Design Mechanical Systems (VAV Displacement Ventilation and Overhead VAV Systems with High-Efficiency Condensing Boilers) 3. Design High-Efficiency Lighting Systems (0.6 w/s.f.) 4. Design High-Efficiency Domestic Hot Water Systems (94% Eff. Hot Water Heaters)	451,280	2,091.9	$76,717	$25,103	$101,820	$1.15	40.90	$37,251	**26.8%**

*Combined expense savings is the difference between the combined annual expense of the baseline and building in comparison.

LIFE CYCLE ANALYSES

NIST BLCC 5.3-15: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology in OMB Circular A-94

Base Case: Baseline - VAV

Alternative: Option 1 - VAV Dehum. Displacement

General Information

File Name:	C:\Users\keith_lane\BLCC 5\projects\Brooke Charter High School.xml
Date of Study:	Wed Nov 23 08:56:46 EST 2016
Project Name:	Brooke Charter High School
Project Location:	Massachusetts
Analysis Type:	OMB Analysis, Non-Energy Project
Analysis Purpose:	Public Investment or Regulatory Analysis
Analyst:	Keith Lane
Base Date:	September 1, 2018
Service Date:	September 1, 2018
Study Period:	30 years 0 months(September 1, 2018 through August 31, 2048)
Discount Rate:	4.3%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$3,710,650	$3,225,560	$485,090
Future Costs:			
Energy Consumption Costs	$3,135,122	$2,642,843	$492,279
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$522,957	$459,143	$63,815
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	$0	$0
	---	---	---
Subtotal (for Future Cost Items)	$3,658,079	$3,101,986	$556,094
	---	---	---
Total PV Life-Cycle Cost	$7,368,729	$6,327,546	$1,041,184

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings $556,094

- Increased Total Investment	-$485,090

Net Savings	$1,041,184

NOTE: Meaningful SIR, AIRR and Payback can not be computed unless incremental savings and total savings are both positive.

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	-----Average Base Case	Annual Alternative	Consumption----- Savings	Life-Cycle Savings
Electricity	517,450.0 kWh	451,280.0 kWh	66,170.0 kWh	1,985,009.4 kWh
Natural Gas	27,228.0 Therm	20,919.0 Therm	6,309.0 Therm	189,261.4 Therm

Energy Savings Summary (in MBtu)

Energy Type	-----Average Base Case	Annual Alternative	Consumption----- Savings	Life-Cycle Savings
Electricity	1,765.6 MBtu	1,539.8 MBtu	225.8 MBtu	6,773.1 MBtu
Natural Gas	2,722.8 MBtu	2,091.9 MBtu	630.9 MBtu	18,926.2 MBtu

Emissions Reduction Summary

Energy Type	-----Average Base Case	Annual Alternative	Emissions----- Reduction	Life-Cycle Reduction
Electricity				
CO2	318,612.64 kg	277,869.39 kg	40,743.26 kg	1,222,241.95 kg
SO2	884.88 kg	771.72 kg	113.16 kg	3,394.52 kg
NOx	277.57 kg	242.08 kg	35.50 kg	1,064.81 kg
Natural Gas				
CO2	143,814.80 kg	110,491.47 kg	33,323.33 kg	999,654.24 kg
SO2	1,160.63 kg	891.70 kg	268.93 kg	8,067.53 kg
NOx	120.66 kg	33.11 kg	87.55 kg	2,626.44 kg
Total:				
CO2	462,427.45 kg	388,360.86 kg	74,066.59 kg	2,221,896.19 kg
SO2	2,045.51 kg	1,663.43 kg	382.09 kg	11,462.05 kg
NOx	398.23 kg	275.19 kg	123.05 kg	3,691.25 kg

NIST BLCC 5.3-15: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology in OMB Circular A-94

Base Case: Baseline - VAV

Alternative: Option 2 - VAV AC Displacement

General Information

File Name:	
Date of Study:	Wed Nov 23 09:06:30 EST 2016
Project Name:	Brooke Charter High School
Project Location:	Massachusetts
Analysis Type:	OMB Analysis, Non-Energy Project
Analysis Purpose:	Public Investment or Regulatory Analysis
Analyst:	Keith Lane
Base Date:	September 1, 2018
Service Date:	September 1, 2018
Study Period:	30 years 0 months(September 1, 2018 through August 31, 2048)
Discount Rate:	4.3%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$3,710,650	$3,511,710	$198,940
Future Costs:			
Energy Consumption Costs	$3,135,122	$2,710,778	$424,344
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$522,957	$459,143	$63,815
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	$0	$0
	---	---	---
Subtotal (for Future Cost Items)	$3,658,079	$3,169,920	$488,159
	---	---	---
Total PV Life-Cycle Cost	$7,368,729	$6,681,630	$687,099

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings $488,159

- Increased Total Investment	-$198,940

Net Savings	$687,099

NOTE: Meaningful SIR, AIRR and Payback can not be computed unless incremental savings and total savings are both positive.

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	-----Average Base Case	Annual Alternative	Consumption----- Savings	Life-Cycle Savings
Electricity	517,450.0 kWh	463,160.0 kWh	54,290.0 kWh	1,628,625.7 kWh
Natural Gas	27,228.0 Therm	21,419.0 Therm	5,809.0 Therm	174,262.0 Therm

Energy Savings Summary (in MBtu)

Energy Type	-----Average Base Case	Annual Alternative	Consumption----- Savings	Life-Cycle Savings
Electricity	1,765.6 MBtu	1,580.4 MBtu	185.2 MBtu	5,557.1 MBtu
Natural Gas	2,722.8 MBtu	2,141.9 MBtu	580.9 MBtu	17,426.3 MBtu

Emissions Reduction Summary

Energy Type	-----Average Base Case	Annual Alternative	Emissions----- Reduction	Life-Cycle Reduction
Electricity				
CO2	318,612.64 kg	285,184.33 kg	33,428.31 kg	1,002,803.62 kg
SO2	884.88 kg	792.04 kg	92.84 kg	2,785.08 kg
NOx	277.57 kg	248.45 kg	29.12 kg	873.63 kg
Natural Gas				
CO2	143,814.80 kg	113,132.41 kg	30,682.39 kg	920,429.78 kg
SO2	1,160.63 kg	913.01 kg	247.62 kg	7,428.16 kg
NOx	120.66 kg	33.90 kg	86.76 kg	2,602.70 kg
Total:				
CO2	462,427.45 kg	398,316.74 kg	64,110.71 kg	1,923,233.40 kg
SO2	2,045.51 kg	1,705.05 kg	340.46 kg	10,213.24 kg
NOx	398.23 kg	282.35 kg	115.88 kg	3,476.33 kg

NIST BLCC 5.3-15: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology in OMB Circular A-94

Base Case: Baseline - VAV

Alternative: Option 3 - VAV Induction Units

General Information

File Name:	
Date of Study:	Wed Nov 23 09:07:47 EST 2016
Project Name:	Brooke Charter High School
Project Location:	Massachusetts
Analysis Type:	OMB Analysis, Non-Energy Project
Analysis Purpose:	Public Investment or Regulatory Analysis
Analyst:	Keith Lane
Base Date:	September 1, 2018
Service Date:	September 1, 2018
Study Period:	30 years 0 months(September 1, 2018 through August 31, 2048)
Discount Rate:	4.3%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$3,710,650	$3,732,810	-$22,160
Future Costs:			
Energy Consumption Costs	$3,135,122	$3,002,966	$132,156
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$522,957	$576,497	-$53,540
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	$0	$0
	---	---	---
Subtotal (for Future Cost Items)	$3,658,079	$3,579,463	$78,616
	---	---	---
Total PV Life-Cycle Cost	$7,368,729	$7,312,273	$56,456

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings $78,616

- Increased Total Investment	$22,160

Net Savings	$56,456

Savings-to-Investment Ratio (SIR)

SIR = 3.55

Adjusted Internal Rate of Return

AIRR = 8.80%

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback occurs in year	7
Discounted Payback occurs in year	8

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	-----Average Base Case	Annual Alternative	Consumption----- Savings	Life-Cycle Savings
Electricity	517,450.0 kWh	533,970.0 kWh	-16,520.0 kWh	-495,577.4 kWh
Natural Gas	27,228.0 Therm	20,911.0 Therm	6,317.0 Therm	189,501.4 Therm

Energy Savings Summary (in MBtu)

Energy Type	-----Average Base Case	Annual Alternative	Consumption----- Savings	Life-Cycle Savings
Electricity	1,765.6 MBtu	1,822.0 MBtu	-56.4 MBtu	-1,691.0 MBtu
Natural Gas	2,722.8 MBtu	2,091.1 MBtu	631.7 MBtu	18,950.2 MBtu

Emissions Reduction Summary

Energy Type	-----Average Base Case	Annual Alternative	Emissions----- Reduction	Life-Cycle Reduction
Electricity				
CO2	318,612.64 kg	328,784.60 kg	-10,171.96 kg	-305,144.88 kg
SO2	884.88 kg	913.13 kg	-28.25 kg	-847.48 kg
NOx	277.57 kg	286.43 kg	-8.86 kg	-265.84 kg
Natural Gas				
CO2	143,814.80 kg	110,449.22 kg	33,365.58 kg	1,000,921.83 kg
SO2	1,160.63 kg	891.36 kg	269.27 kg	8,077.76 kg
NOx	120.66 kg	33.10 kg	87.56 kg	2,626.82 kg
Total:				

CO2	462,427.45 kg	439,233.82 kg	23,193.62 kg	695,776.95 kg
SO2	2,045.51 kg	1,804.49 kg	241.02 kg	7,230.28 kg
NOx	398.23 kg	319.53 kg	78.70 kg	2,360.98 kg

COST ESTIMATES

GARCIA • GALUSKA • DESOUSA
Consulting Engineers Inc.
370 Faunce Corner Road, Dartmouth, MA 02747-1217

PROJECT: Brooke Charter High School
JOB NO: 63001300
CLIENT: Arrowstreet Architecture & Design
DATE: 11/23/2016 **BY:** KL

Baseline - ASHRAE Standard 2010/IECC 2012 DX Cooling/HHW Reheat Coil VAV System

ITEM OF WORK	NO.	UNIT PRICE	AREA	PRICE/S.F.	TOTAL
VAV Box with Hot Water Reheat Coils	109	$1,500			$ 163,500.00
RTU-1: Gym VAV AC w/ ERV	7,500 CFM	$12/CFM			$ 90,000.00
RTU-2: Administration VAV AC w/ ERV	6,500 CFM	$12/CFM			$ 78,000.00
RTU-3: Lockers 100% O.A. VAV Dehumidifcation w/ ERV	3,000 CFM	$13/CFM			$ 39,000.00
RTU-4: Classrooms VAV AC w/ ERV	18,000 CFM	$12/CFM			$ 216,000.00
RTU-5: Dining VAV AC w/ ERV	9,500 CFM	$12/CFM			$ 114,000.00
RTU-6: Stage VAV AC	4,000 CFM	$12/CFM			$ 48,000.00
RTU-7: Auditorium VAV AC w/ ERV	7,500 CFM	$12/CFM			$ 90,000.00
RTU-8: Classrooms VAV AC w/ ERV	28,000 CFM	$12/CFM			$ 336,000.00
(2) 2,250 MBH Code-Efficient Gas-Fired Boilers	2	$40,000			$ 80,000.00
Pumps (HHW) including VFD's	2	$8,025			$ 16,050.00
HHW Piping & Insulation including Terminal Heating Units			88,800	$6.0	$ 532,800.00
Ductwork including GRD's, Dampers, & General Exhaust Systems			88,800	$13.0	$ 1,154,400.00
ATC/DDC Controls			88,800	$6.0	$ 532,800.00
Split System Ductless Cooling Units	3	$7,500			$ 22,500.00
Exhaust Fans (Misc. Areas)					$ 20,000.00
HVAC General Conditions (as-builts, coordination, shop drawings, testing and balancing, Cx support, Project Management)			88,800	$2.0	$ 177,600.00
				TOTAL	$ 3,710,650.00
				TOTAL ($/FT²)	$ 41.79

Cost estimates have been derived for system comparison purposes only. Estimates do not necessarily include HVAC systems and equipment that would typically be required for all system options studied; example: supplemental cooling systems for elevator machine rooms, tel/data rooms, etc. and radiation heating for unoccupied areas such as storage rooms, corridors, vestibules etc.

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Consulting Engineers Inc.
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PROJECT: Brooke Charter High School
JOB NO: 63001300
CLIENT: Arrowstreet Architecture & Design
DATE: 11/23/2016 **BY:** KL

Option 1 - VAV Dehumidification Displacement Ventilation System

ITEM OF WORK	NO.	UNIT PRICE	AREA	PRICE/S.F.	TOTAL
Displacement Diffuser Assemblies	102	$475			$ 48,450.00
VAV Box with Hot Water Reheat Coils	27	$1,500			$ 40,500.00
VAV Box with Demand Ventilation Controls	64	$1,200			$ 76,800.00
RTU-1: Gym VAV AC w/ ERV & DCV	7,500 CFM	$12/CFM			$ 90,000.00
RTU-2: Administration VAV AC w/ ERV & DCV	6,500 CFM	$13/CFM			$ 84,500.00
RTU-3: Lockers 100% O.A. VAV Dehumidifcation w/ ERV	3,000 CFM	$13/CFM			$ 39,000.00
RTU-4: Classrooms VAV Dehumid. Displacement w/ ERV & DCV	9,000 CFM	$12/CFM			$ 108,000.00
RTU-5: Dining VAV Dehumid. Displacement w/ ERV & DCV	6,500 CFM	$13/CFM			$ 78,000.00
RTU-6: Stage VAV AC w/ ERV & DCV	4,000 CFM	$13/CFM			$ 52,000.00
RTU-7: Auditorium VAV AC w/ ERV & DCV	7,500 CFM	$12/CFM			$ 90,000.00
RTU-8: Classrooms VAV Dehumid. Displacement w/ ERV & DCV	12,000 CFM	$12/CFM			$ 144,000.00
(2) 2,000 MBH High-Efficiency Gas-Fired Condensing Boilers	2	$47,880			$ 95,760.00
Pumps (HHW) including VFD's	2	$8,025			$ 16,050.00
HHW Piping & Insulation including Terminal Heating Units			88,800	$6.0	$ 532,800.00
Ductwork including GRD's, Dampers, & General Exhaust Systems			88,800	$11.0	$ 976,800.00
ATC/DDC Controls			88,800	$6.0	$ 532,800.00
Split System Ductless Cooling Units	3	$7,500			$ 22,500.00
Exhaust Fans (Misc. Areas)					$ 20,000.00
HVAC General Conditions (as-builts, coordination, shop drawings, testing and balancing, Cx support, Project Management)			88,800	$2.0	$ 177,600.00
				TOTAL	$ 3,225,560.00
				TOTAL ($/FT²)	$ 36.32

Cost estimates have been derived for system comparison purposes only. Estimates do not necessarily include HVAC systems and equipment that would typically be required for all system options studied; example: supplemental cooling systems for elevator machine rooms, tel/data rooms, etc. and radiation heating for unoccupied areas such as storage rooms, corridors, vestibules etc.

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PROJECT: Brooke Charter High School
JOB NO: 63001300
CLIENT: Arrowstreet Architecture & Design
DATE: 11/23/2016 **BY:** KL

Option 2 - VAV Full AC Displacement Ventilation System

ITEM OF WORK	NO.	UNIT PRICE	AREA	PRICE/S.F.	TOTAL
Displacement Diffuser Assemblies	102	$650			$ 66,300.00
VAV Box with Hot Water Reheat Coils	27	$1,500			$ 40,500.00
VAV Box with Demand Ventilation Controls	64	$1,200			$ 76,800.00
RTU-1: Gym VAV AC w/ ERV & DCV	7,500 CFM	$12/CFM			$ 90,000.00
RTU-2: Administration VAV AC w/ ERV & DCV	6,500 CFM	$12/CFM			$ 78,000.00
RTU-3: Lockers 100% O.A. VAV Dehumidifcation w/ ERV	3,000 CFM	$13/CFM			$ 39,000.00
RTU-4: Classrooms VAV AC Displacement w/ ERV & DCV	14,000 CFM	$12/CFM			$ 168,000.00
RTU-5: Dining VAV AC Displacement w/ ERV & DCV	8,000 CFM	$12/CFM			$ 96,000.00
RTU-6: Stage VAV AC w/ ERV & DCV	4,000 CFM	$13/CFM			$ 52,000.00
RTU-7: Auditorium VAV AC w/ ERV & DCV	7,500 CFM	$12/CFM			$ 90,000.00
RTU-8: Classrooms VAV AC Displacement w/ ERV & DCV	21,000 CFM	$12/CFM			$ 252,000.00
(2) 2,000 MBH High-Efficiency Gas-Fired Condensing Boilers	2	$47,880			$ 95,760.00
Pumps (HHW) including VFD's	2	$8,025			$ 16,050.00
HHW Piping & Insulation including Terminal Heating Units			88,800	$6.0	$ 532,800.00
Ductwork including GRD's, Dampers, & General Exhaust Systems			88,800	$12.0	$ 1,065,600.00
ATC/DDC Controls			88,800	$6.0	$ 532,800.00
Split System Ductless Cooling Units	3	$7,500			$ 22,500.00
Exhaust Fans (Misc. Areas)					$ 20,000.00
HVAC General Conditions (as-builts, coordination, shop drawings, testing and balancing, Cx support, Project Management)			88,800	$2.0	$ 177,600.00
				TOTAL	$ 3,511,710.00
				TOTAL ($/FT²)	$ 39.55

Cost estimates have been derived for system comparison purposes only. Estimates do not necessarily include HVAC systems and equipment that would typically be required for all system options studied; example: supplemental cooling systems for elevator machine rooms, tel/data rooms, etc. and radiation heating for unoccupied areas such as storage rooms, corridors, vestibules etc.

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PROJECT: Brooke Charter High School
JOB NO: 63001300
CLIENT: Arrowstreet Architecture & Design
DATE: 11/23/2016 **BY:** KL

Option 3 - VAV Induction Unit System

ITEM OF WORK	NO.	UNIT PRICE	AREA	PRICE/S.F.	TOTAL
Induction Units	224	$1,400			$ 313,600.00
VAV Box with Demand Ventilation Controls	91	$1,200			$ 109,200.00
RTU-1: Gym VAV AC w/ ERV & DCV	7,500 CFM	$12/CFM			$ 90,000.00
RTU-2: Administration VAV IU DOAS w/ ERV & DCV	4,000 CFM	$13/CFM			$ 52,000.00
RTU-3: Lockers 100% O.A. VAV Dehumidifcation w/ ERV	3,000 CFM	$13/CFM			$ 39,000.00
RTU-4: Classrooms VAV IU DOAS w/ ERV & DCV	7,000 CFM	$12/CFM			$ 84,000.00
RTU-5: Dining VAV AC Displacement w/ ERV & DCV	8,000 CFM	$13/CFM			$ 96,000.00
RTU-6: Stage VAV AC w/ ERV & DCV	4,000 CFM	$13/CFM			$ 52,000.00
RTU-7: Auditorium VAV AC w/ ERV & DCV	7,500 CFM	$12/CFM			$ 90,000.00
RTU-8: Classrooms VAV IU DOAS w/ ERV & DCV	9,500 CFM	$12/CFM			$ 114,000.00
(2) 2,000 MBH High-Efficiency Gas-Fired Condensing Boilers	2	$47,880			$ 95,760.00
Pumps (HHW) including VFD's	2	$8,025			$ 16,050.00
90 Ton High-Efficiency Air-Cooled Chiller Plant	90 tons	$1,250/ton			$ 62,500.00
Pumps (CHW) including VFD's	2	$7,500			$ 15,000.00
HHW Piping & Insulation including Terminal Heating Units			88,800	$6.0	$ 532,800.00
CHW Piping & Insulation and Condensate Piping			60,000	$5.5	$ 330,000.00
Ductwork including GRD's, Dampers, & General Exhaust Systems			88,800	$9.5	$ 843,600.00
ATC/DDC Controls			88,800	$6.5	$ 577,200.00
Split System Ductless Cooling Units	3	$7,500			$ 22,500.00
Exhaust Fans (Misc. Areas)					$ 20,000.00
HVAC General Conditions (as-builts, coordination, shop drawings, testing and balancing, Cx support, Project Management)			88,800	$2.0	$ 177,600.00
				TOTAL	$ 3,732,810.00
				TOTAL ($/FT²)	$ 42.04

Cost estimates have been derived for system comparison purposes only. Estimates do not necessarily include HVAC systems and equipment that would typically be required for all system options studied; example: supplemental cooling systems for elevator machine rooms, tel/data rooms, etc. and radiation heating for unoccupied areas such as storage rooms, corridors, vestibules etc.

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370 Faunce Corner Road, Dartmouth, MA 02747-1217

Brooke Charter High School - Annual Maintenance Costs

Baseline - Overhead VAV

Unit Type	Quantity	Cost/Unit	Annual Cost
VAV Box w/ Reheat Coil	109	$75	$8,175
Large DX RTU's	6	$2,000	$12,000
Small DX RTU's	2	$1,500	$3,000
Boiler Plant	1	$1,000	$1,000
		TOTAL	**$24,175**

Option 1 - VAV Dehumidification Displacement

Unit Type	Quantity	Cost/Unit	Annual Cost
VAV Box	64	$50	$3,200
VAV Box w/ Reheat Coil	27	$75	$2,025
Large DX RTU's	6	$2,000	$12,000
Small DX RTU's	2	$1,500	$3,000
Boiler Plant	1	$1,000	$1,000
		TOTAL	**$21,225**

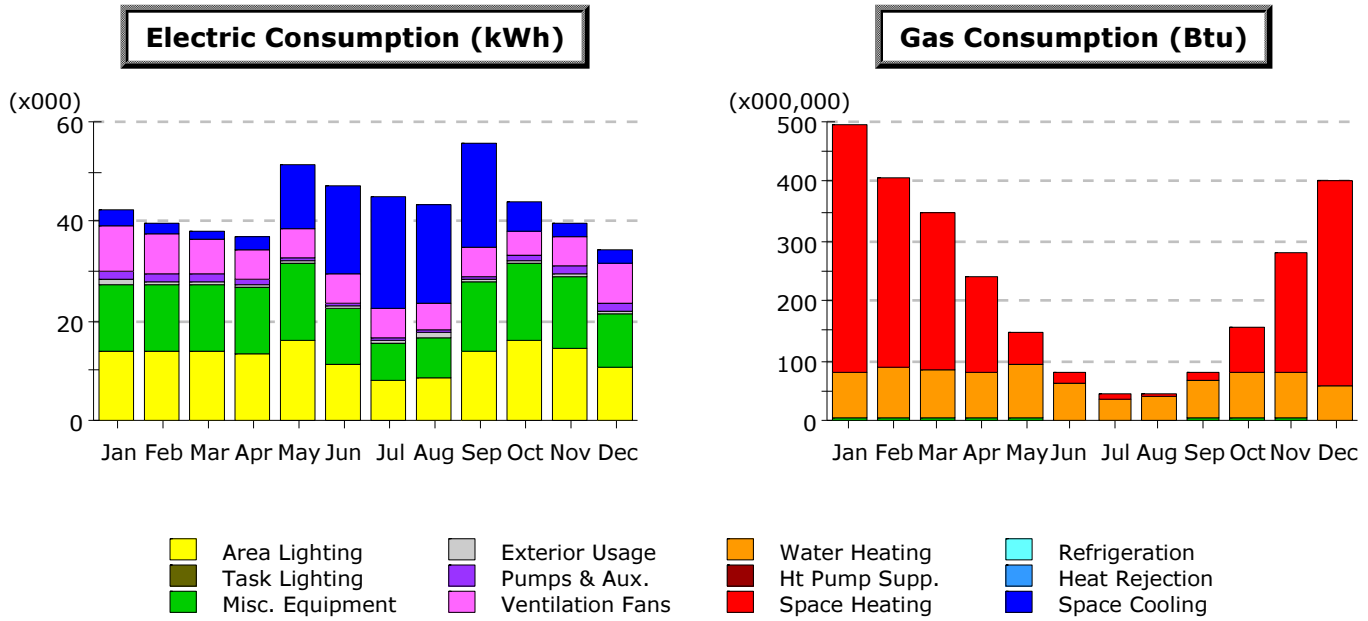
Option 2 - VAV AC Displacement

Unit Type	Quantity	Cost/Unit	Annual Cost
VAV Box	64	$50	$3,200
VAV Box w/ Reheat Coil	27	$75	$2,025
Large DX RTU's	6	$2,000	$12,000
Small DX RTU's	2	$1,500	$3,000
Boiler Plant	1	$1,000	$1,000
		TOTAL	**$21,225**

Option 3 - VAV Induction Units

Unit Type	Quantity	Cost/Unit	Annual Cost
VAV Box	91	$50	$4,550
Induction Units	224	$25	$5,600
Large DX RTU's	5	$2,000	$10,000
Small DX RTU's	3	$1,500	$4,500
Boiler Plant	1	$1,000	$1,000
Chiller Plant	1	$1,000	$1,000
		TOTAL	**$26,650**

ENERGY PROFILES



Electric Consumption (kWh x000)

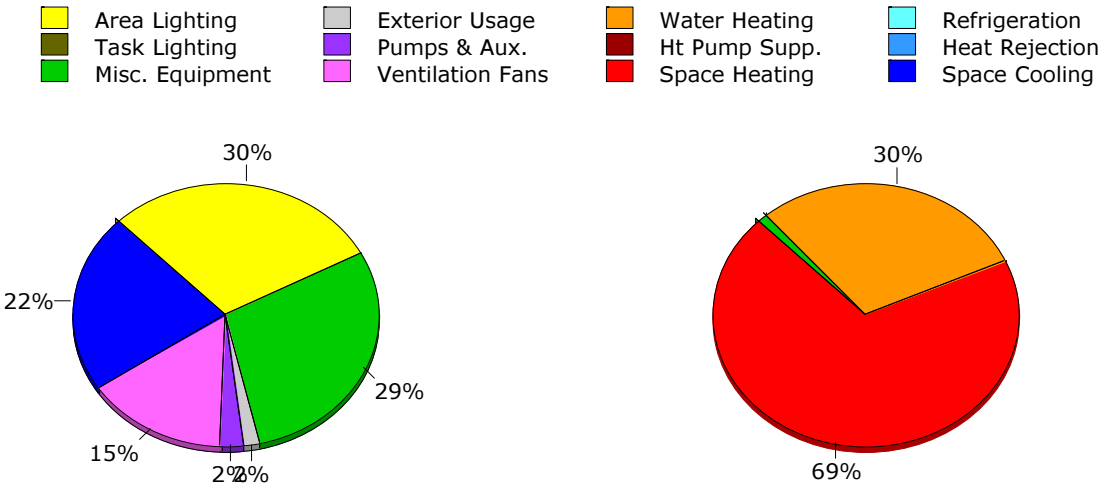
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	3.04	2.23	1.64	2.68	12.89	17.83	22.31	19.76	20.84	5.89	2.40	2.79	114.30
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	9.55	7.92	6.87	5.51	6.01	5.69	5.72	5.35	6.11	4.92	6.03	8.21	77.90
Pumps & Aux.	1.49	1.41	1.46	1.25	0.73	0.62	0.78	0.69	0.50	0.82	1.32	1.32	12.39
Ext. Usage	0.85	0.65	0.72	0.70	0.50	0.48	0.50	0.81	0.79	0.81	0.82	0.85	8.50
Misc. Equip.	13.48	13.48	13.38	13.06	15.51	10.93	7.45	7.96	13.61	15.51	14.22	10.39	148.97
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	13.99	13.90	13.93	13.58	16.00	11.51	8.14	8.71	14.04	16.00	14.67	10.95	155.41
Total	42.40	39.59	38.00	36.78	51.63	47.06	44.91	43.28	55.88	43.95	39.47	34.52	517.45

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	411.0	317.3	263.7	161.8	54.5	18.9	5.9	7.8	13.5	73.7	201.0	345.2	1,874.5
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	78.9	83.2	80.2	77.4	88.2	58.3	37.8	38.8	64.6	76.3	74.8	54.5	812.9
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	3.5	3.9	3.3	3.3	4.6	2.1	0.0	0.0	4.0	4.6	4.2	1.9	35.4
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	493.5	404.5	347.2	242.5	147.3	79.3	43.7	46.6	82.0	154.6	280.0	401.6	2,722.8

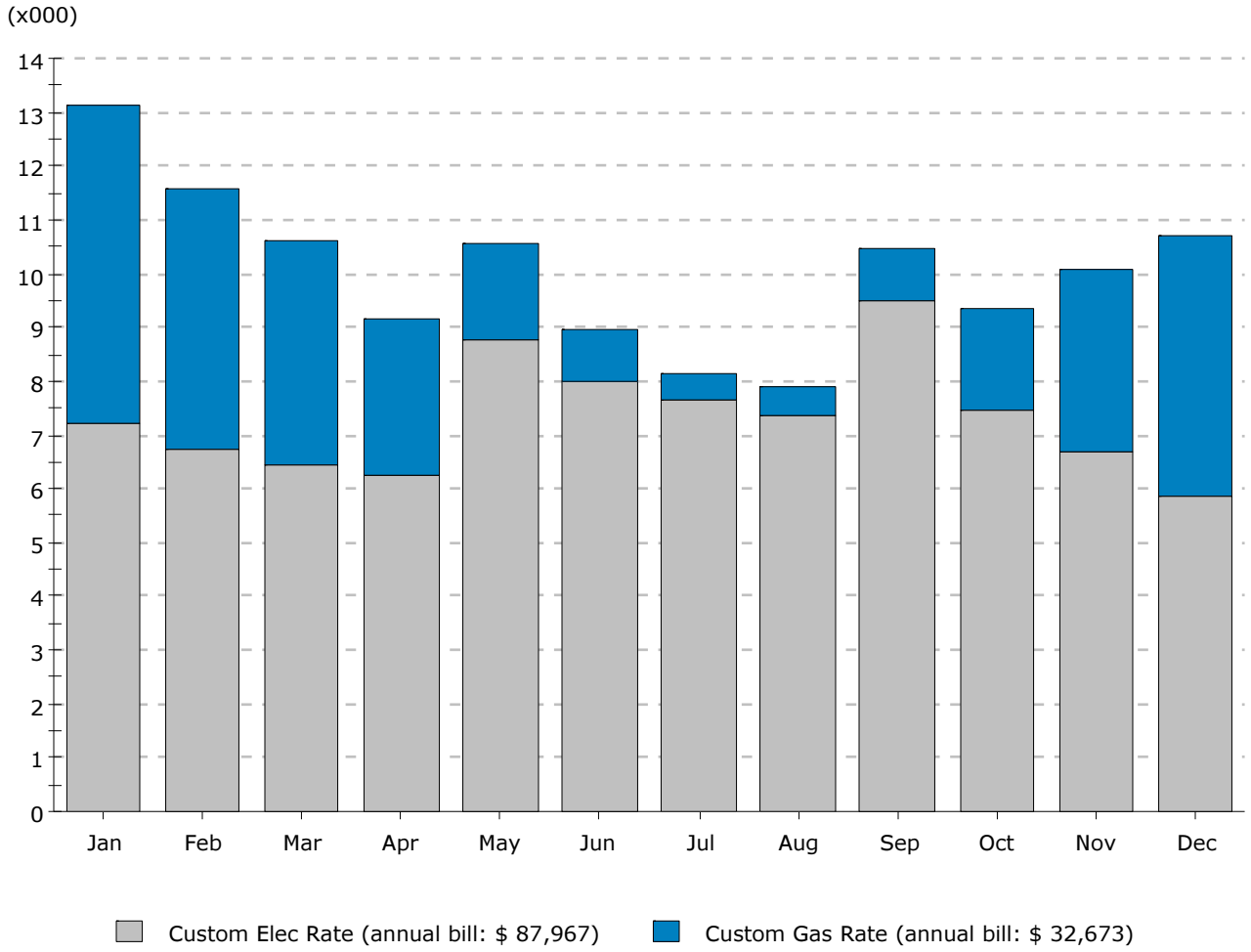
Annual Energy Consumption by Enduse

	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	114.30	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	-	1,874.5	-	-
HP Supp.	-	-	-	-
Hot Water	-	812.9	-	-
Vent. Fans	77.90	-	-	-
Pumps & Aux.	12.39	-	-	-
Ext. Usage	8.50	-	-	-
Misc. Equip.	148.97	35.4	-	-
Task Lights	-	-	-	-
Area Lights	155.41	-	-	-
Total	517.45	2,722.8	-	-

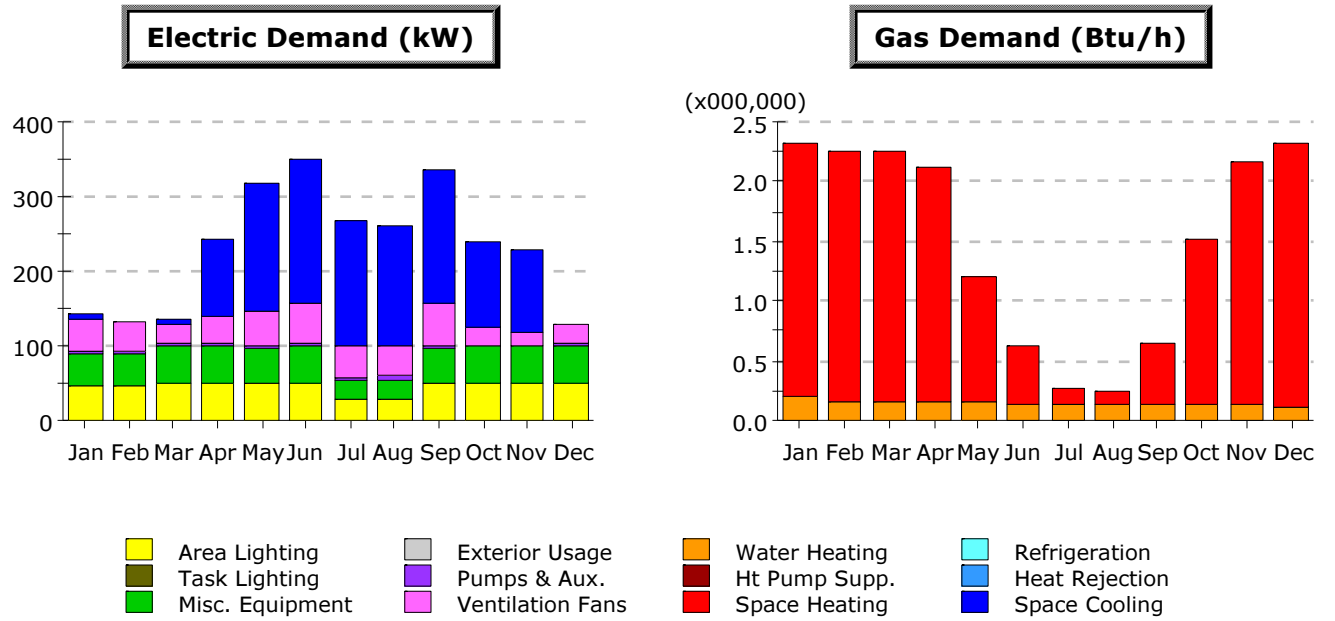


Electricity **Natural Gas**

Monthly Utility Bills ($)



Total Annual Bill Across All Rates: $ 120,640



Electric Demand (kW)

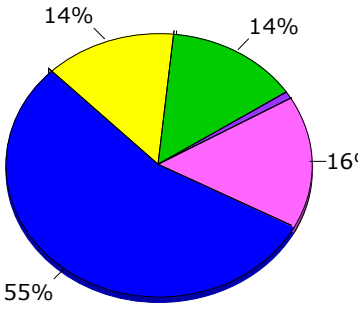
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	6.8	0.1	9.2	105.8	173.3	190.0	167.9	162.3	177.7	116.4	110.4	1.1	1,221.0
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	43.5	39.2	23.7	35.4	44.2	55.9	44.1	40.4	55.6	23.7	17.4	24.3	447.6
Pumps & Aux.	4.7	5.1	4.4	3.7	3.7	3.7	3.7	3.7	3.7	1.2	0.8	4.7	42.9
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	43.8	43.8	49.0	48.6	47.6	49.0	24.9	26.2	47.6	49.3	48.6	49.3	527.6
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	45.3	45.3	49.9	49.9	49.4	49.9	27.9	29.1	49.4	49.9	49.9	49.9	545.6
Total	144.1	133.4	136.2	243.3	318.3	348.5	268.4	261.6	334.0	240.6	227.0	129.3	2,784.7

Gas Demand (Btu/h x000,000)

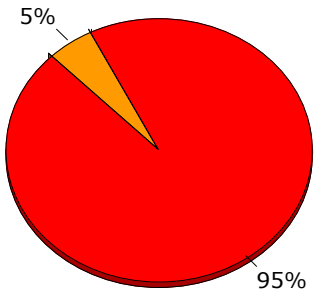
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.12	2.09	2.09	1.95	1.06	0.47	0.12	0.12	0.52	1.39	2.04	2.20	16.16
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.20	0.16	0.17	0.16	0.15	0.14	0.14	0.14	0.13	0.13	0.14	0.12	1.79
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.00	0.00	0.00	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	0.01
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	2.32	2.25	2.26	2.12	1.21	0.61	0.26	0.26	0.64	1.53	2.18	2.32	17.96

Annual Peak Demand by Enduse

	Electricity kW	Natural Gas Btu/h (x000)	Steam Btu/h	Chilled Water Btu/h
Space Cool	190.03	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	-	2,202.5	-	-
HP Supp.	-	-	-	-
Hot Water	-	121.2	-	-
Vent. Fans	55.91	-	-	-
Pumps & Aux.	3.68	-	-	-
Ext. Usage	-	-	-	-
Misc. Equip.	48.99	-	-	-
Task Lights	-	-	-	-
Area Lights	49.86	-	-	-
Total	348.47	2,323.7	-	-



Electricity



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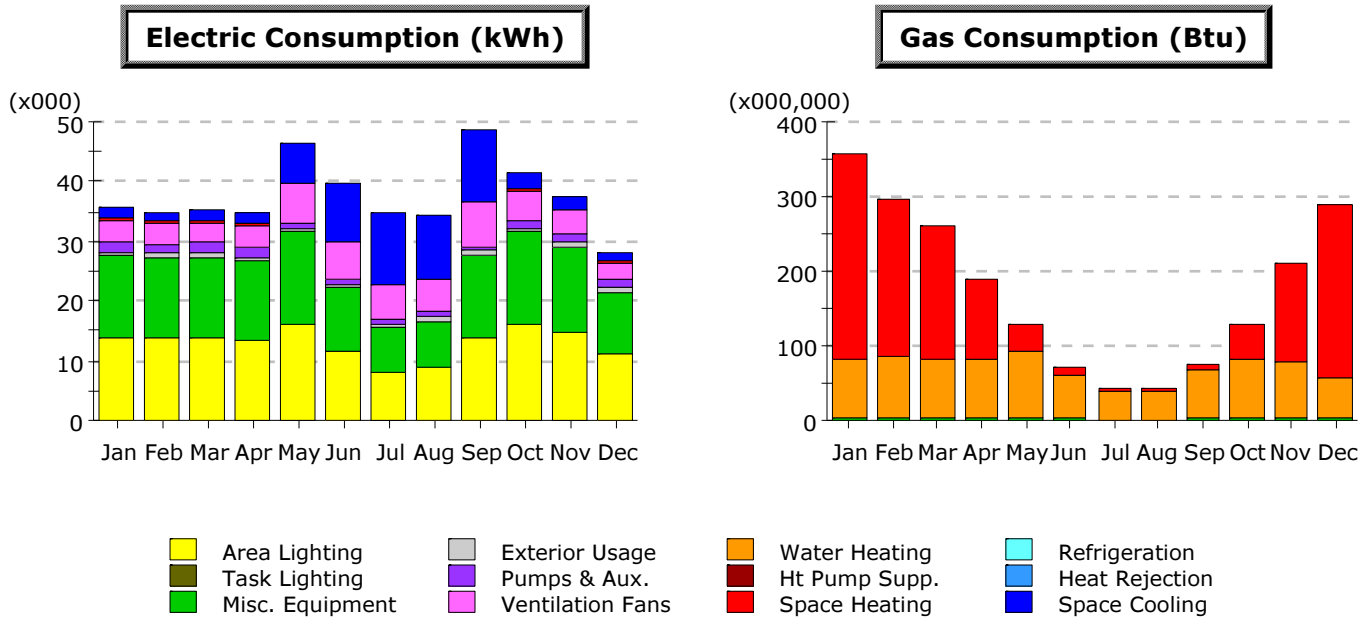


Electric Consumption (kWh x000)

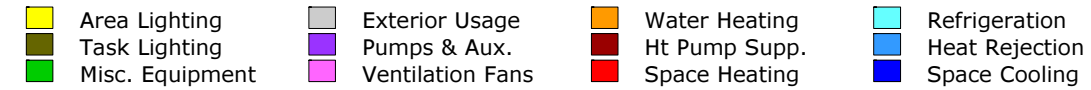
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	1.59	1.55	1.57	1.93	6.91	9.69	11.95	10.74	11.84	3.11	1.99	1.13	63.99
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.46	0.38	0.33	0.22	0.10	0.04	0.01	0.02	0.03	0.13	0.25	0.39	2.36
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	3.39	3.42	3.52	3.84	6.56	6.19	5.66	5.06	7.40	5.06	3.83	2.73	56.66
Pumps & Aux.	1.79	1.65	1.70	1.47	0.98	0.84	1.01	0.91	0.73	1.13	1.57	1.59	15.39
Ext. Usage	0.85	0.65	0.72	0.70	0.50	0.48	0.50	0.81	0.79	0.81	0.82	0.85	8.50
Misc. Equip.	13.48	13.48	13.38	13.06	15.51	10.93	7.45	7.96	13.61	15.51	14.22	10.39	148.97
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	13.99	13.90	13.93	13.58	16.00	11.51	8.14	8.71	14.04	16.00	14.67	10.95	155.41
Total	35.55	35.03	35.15	34.80	46.56	39.68	34.71	34.22	48.44	41.74	37.35	28.02	451.28

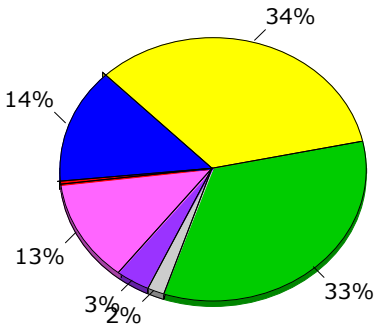
Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	275.2	209.8	175.9	107.4	35.4	11.9	3.9	5.6	8.2	46.4	130.7	233.5	1,243.9
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	78.9	83.2	80.1	77.3	88.2	58.3	37.8	38.8	64.6	76.3	74.8	54.5	812.7
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	3.5	3.9	3.3	3.3	4.6	2.1	0.0	0.0	4.0	4.6	4.2	1.9	35.4
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	357.6	296.9	259.4	188.1	128.2	72.2	41.7	44.4	76.7	127.3	209.6	289.9	2,091.9

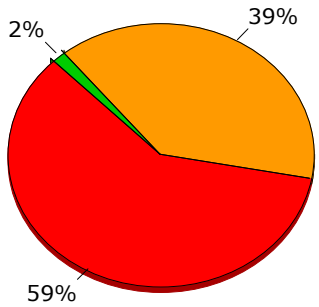
Annual Energy Consumption by Enduse

	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	63.99	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	2.36	1,243.9	-	-
HP Supp.	-	-	-	-
Hot Water	-	812.7	-	-
Vent. Fans	56.66	-	-	-
Pumps & Aux.	15.39	-	-	-
Ext. Usage	8.50	-	-	-
Misc. Equip.	148.97	35.4	-	-
Task Lights	-	-	-	-
Area Lights	155.41	-	-	-
Total	451.28	2,091.9	-	-



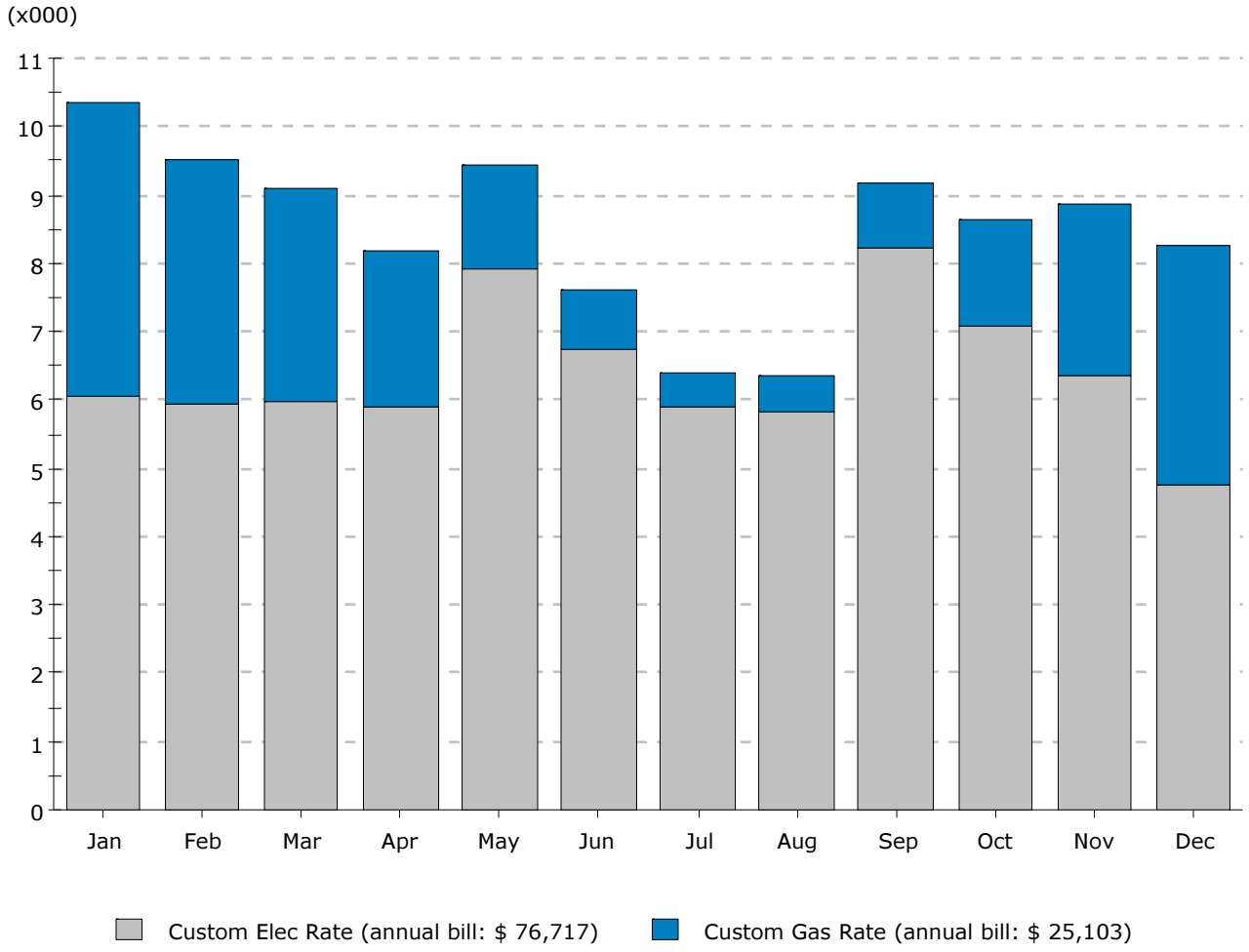


Electricity

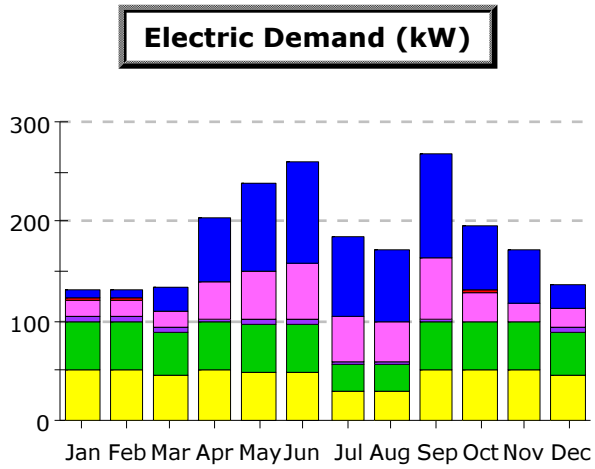


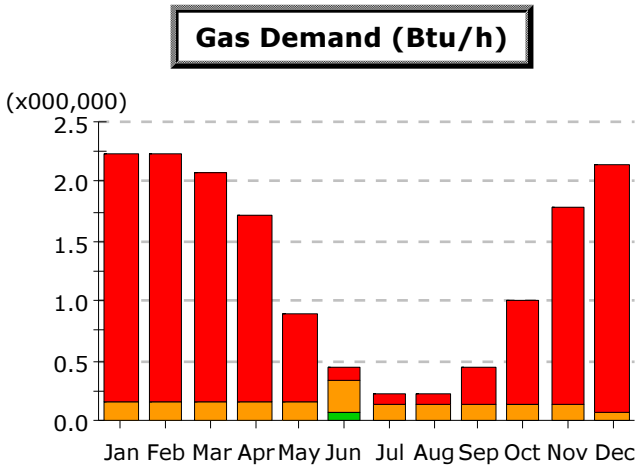
Natural Gas

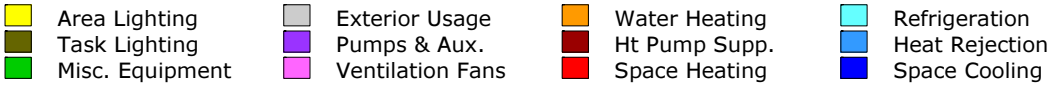
Monthly Utility Bills ($)



Total Annual Bill Across All Rates: $ 101,820







Electric Demand (kW)

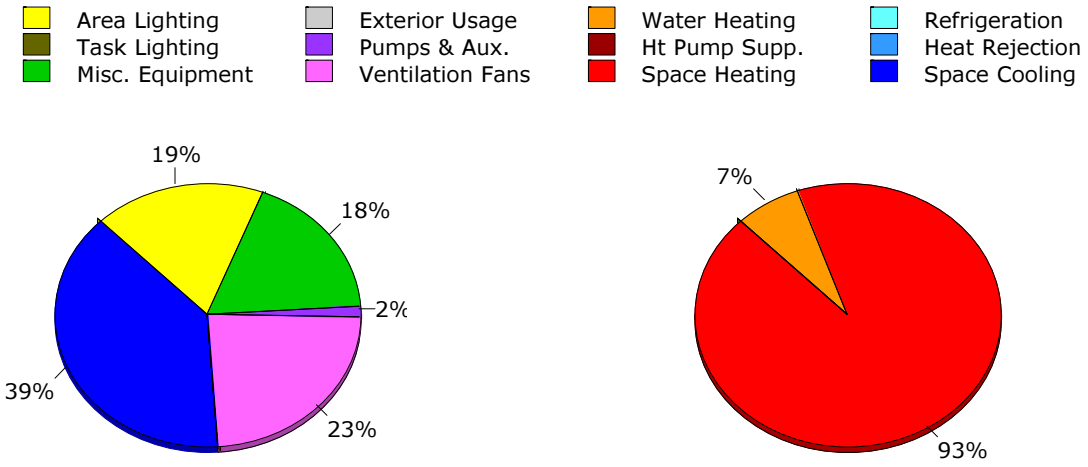
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	8.7	9.9	23.4	65.9	89.8	101.6	81.2	72.3	103.7	64.3	54.6	23.7	699.1
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.8	0.9	0.9	-	0.2	-	-	-	0.2	0.1	0.1	0.9	4.0
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	17.7	18.0	15.9	36.1	48.0	57.6	45.3	39.3	61.8	29.8	18.3	18.3	406.0
Pumps & Aux.	4.6	4.9	5.0	4.1	4.1	4.1	4.1	4.1	4.1	0.9	0.9	4.8	45.6
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	49.3	49.0	43.8	48.2	47.6	47.6	26.2	26.2	48.2	49.3	48.6	43.8	527.7
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	49.9	49.9	45.3	49.9	49.4	49.4	29.1	29.1	49.9	49.9	49.9	45.3	546.9
Total	131.0	132.4	134.2	204.1	239.1	260.4	185.9	171.1	267.9	194.3	172.3	136.7	2,229.3

Gas Demand (Btu/h x000,000)

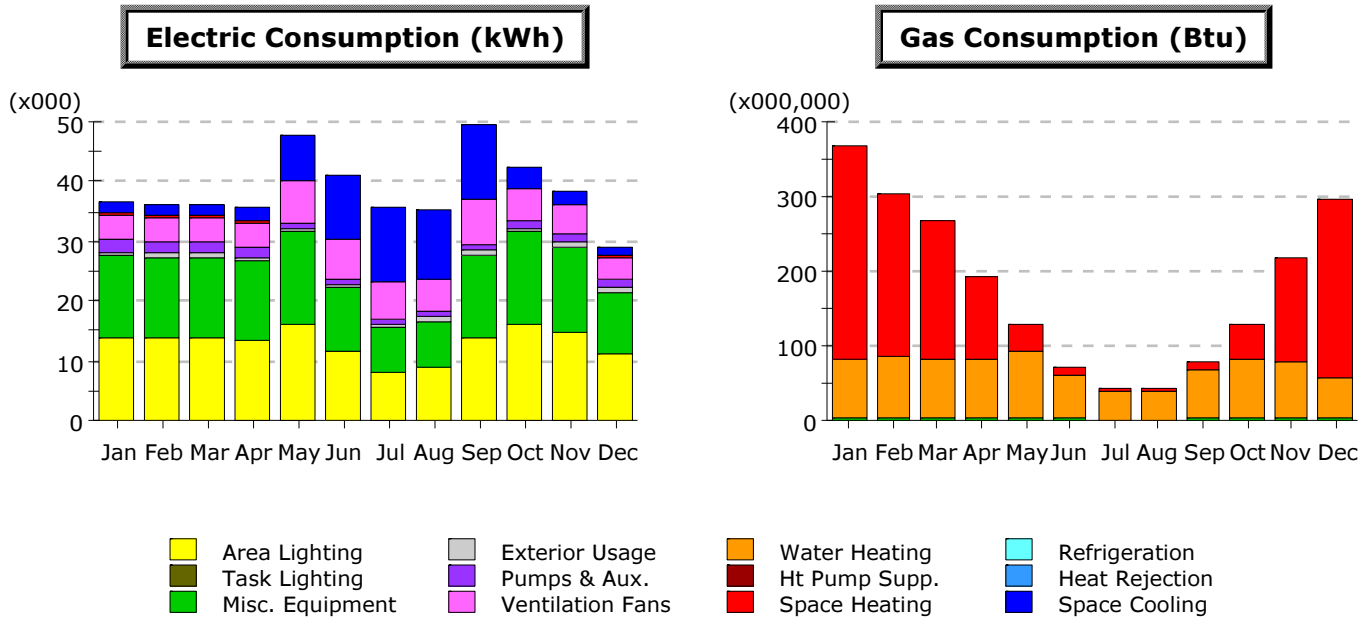
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.06	2.08	1.90	1.55	0.74	0.11	0.08	0.08	0.32	0.87	1.64	2.07	13.49
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.16	0.16	0.17	0.16	0.15	0.28	0.14	0.14	0.13	0.13	0.14	0.07	1.83
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.00	0.00	0.00	0.00	0.00	0.06	-	-	0.00	0.00	0.00	-	0.07
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	2.22	2.24	2.07	1.71	0.89	0.45	0.22	0.21	0.45	1.00	1.78	2.14	15.39

Annual Peak Demand by Enduse

	Electricity kW	Natural Gas Btu/h (x000)	Steam Btu/h	Chilled Water Btu/h
Space Cool	103.68	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	0.25	2,076.0	-	-
HP Supp.	-	-	-	-
Hot Water	-	164.7	-	-
Vent. Fans	61.82	-	-	-
Pumps & Aux.	4.10	-	-	-
Ext. Usage	-	-	-	-
Misc. Equip.	48.17	0.6	-	-
Task Lights	-	-	-	-
Area Lights	49.86	-	-	-
Total	267.88	2,241.3	-	-



Electricity **Natural Gas**



Electric Consumption (kWh x000)

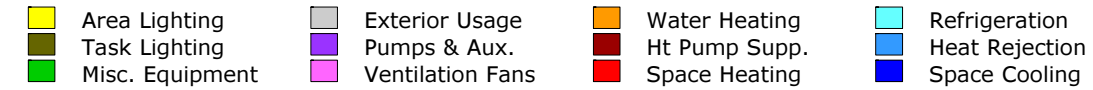
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	1.63	1.56	1.54	2.09	7.86	10.50	12.48	11.19	12.73	3.62	2.07	1.28	68.55
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.49	0.40	0.35	0.23	0.11	0.04	0.01	0.02	0.03	0.13	0.27	0.41	2.50
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	4.29	4.34	4.37	4.37	6.94	6.57	6.04	5.37	7.73	5.27	4.64	3.37	63.31
Pumps & Aux.	1.85	1.70	1.74	1.48	1.02	0.91	1.09	0.99	0.80	1.12	1.61	1.63	15.93
Ext. Usage	0.85	0.65	0.72	0.70	0.50	0.48	0.50	0.81	0.79	0.81	0.82	0.85	8.50
Misc. Equip.	13.48	13.48	13.38	13.06	15.51	10.93	7.45	7.96	13.61	15.51	14.22	10.39	148.97
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	13.99	13.90	13.93	13.58	16.00	11.51	8.14	8.71	14.04	16.00	14.67	10.95	155.41
Total	36.58	36.03	36.04	35.52	47.93	40.94	35.71	35.05	49.73	42.45	38.29	28.87	463.16

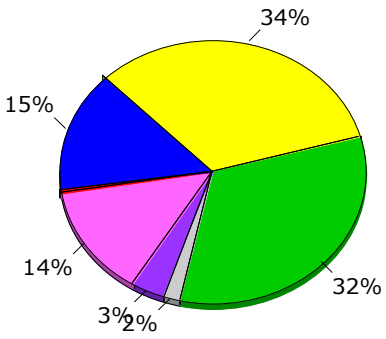
Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	284.5	217.9	183.7	112.0	37.3	12.8	4.0	5.8	8.6	48.8	137.5	241.0	1,293.9
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	78.9	83.2	80.1	77.3	88.2	58.3	37.8	38.8	64.6	76.3	74.8	54.5	812.7
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	3.5	3.9	3.3	3.3	4.6	2.1	0.0	0.0	4.0	4.6	4.2	1.9	35.4
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	366.9	305.1	267.2	192.6	130.0	73.1	41.9	44.5	77.1	129.7	216.5	297.3	2,141.9

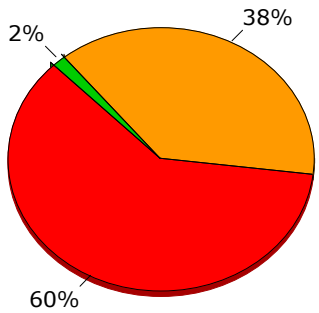
Annual Energy Consumption by Enduse

	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	68.55	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	2.50	1,293.9	-	-
HP Supp.	-	-	-	-
Hot Water	-	812.7	-	-
Vent. Fans	63.31	-	-	-
Pumps & Aux.	15.93	-	-	-
Ext. Usage	8.50	-	-	-
Misc. Equip.	148.97	35.4	-	-
Task Lights	-	-	-	-
Area Lights	155.41	-	-	-
Total	463.16	2,141.9	-	-



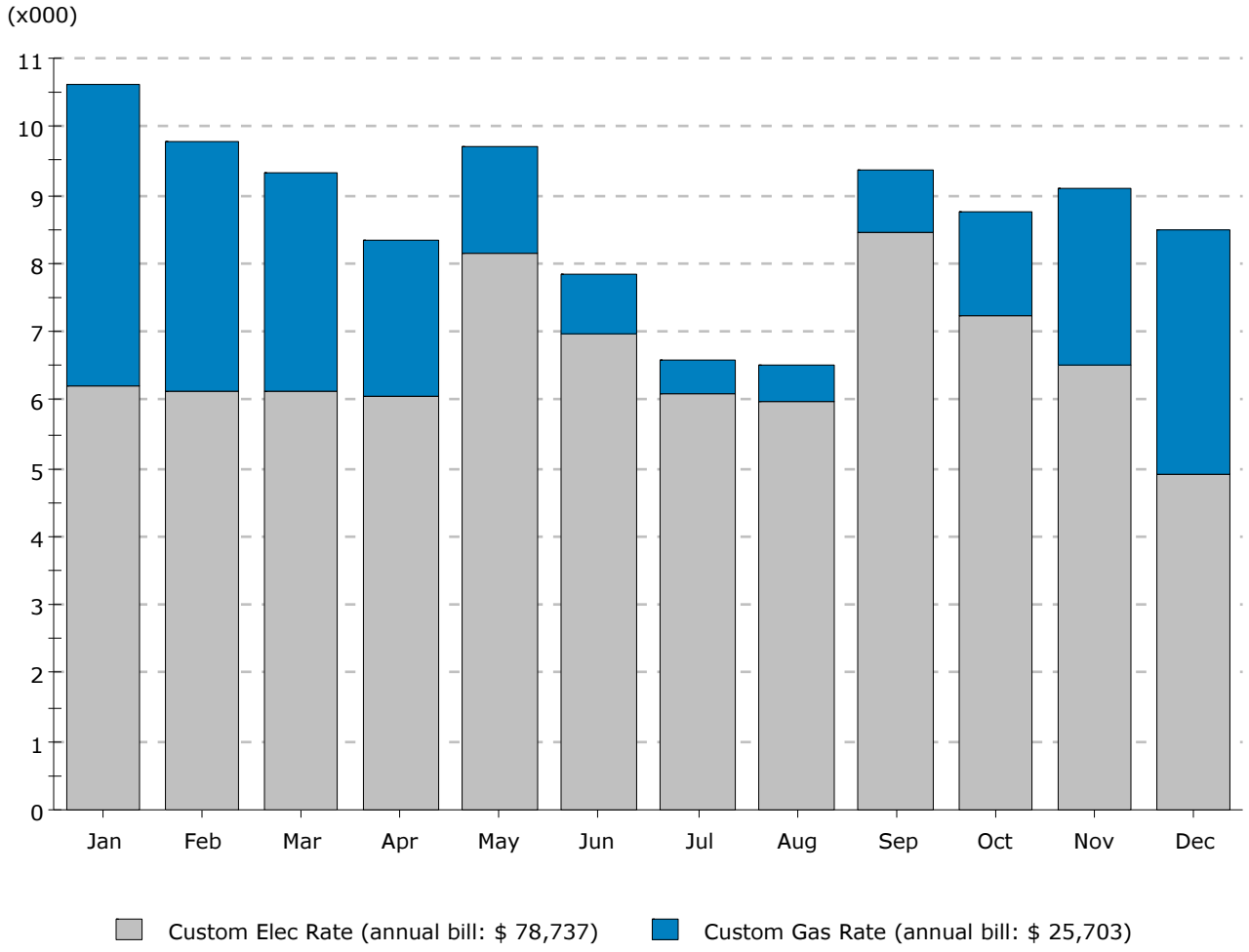


Electricity

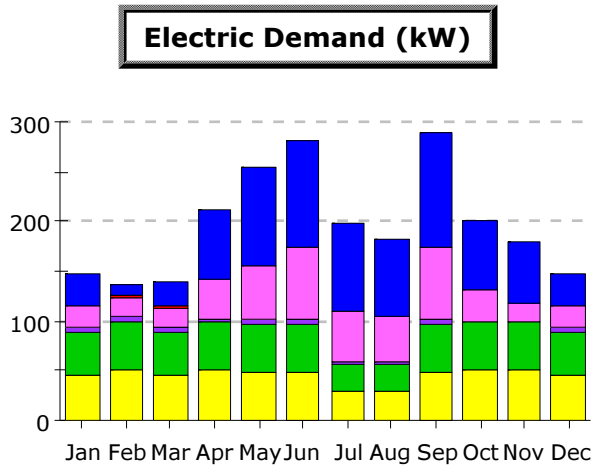


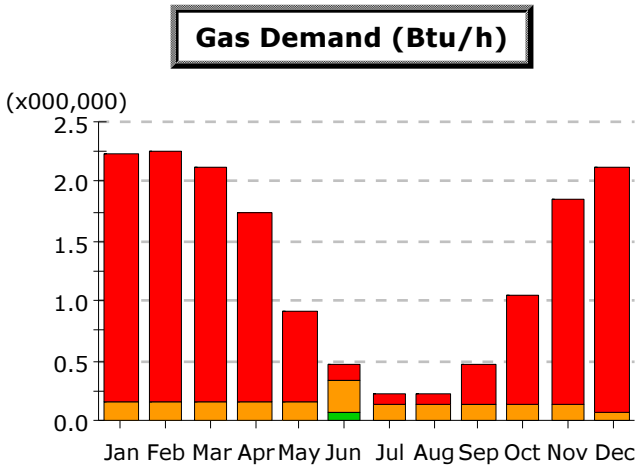
Natural Gas

Monthly Utility Bills ($)



Total Annual Bill Across All Rates: $ 104,440





Electric Demand (kW)

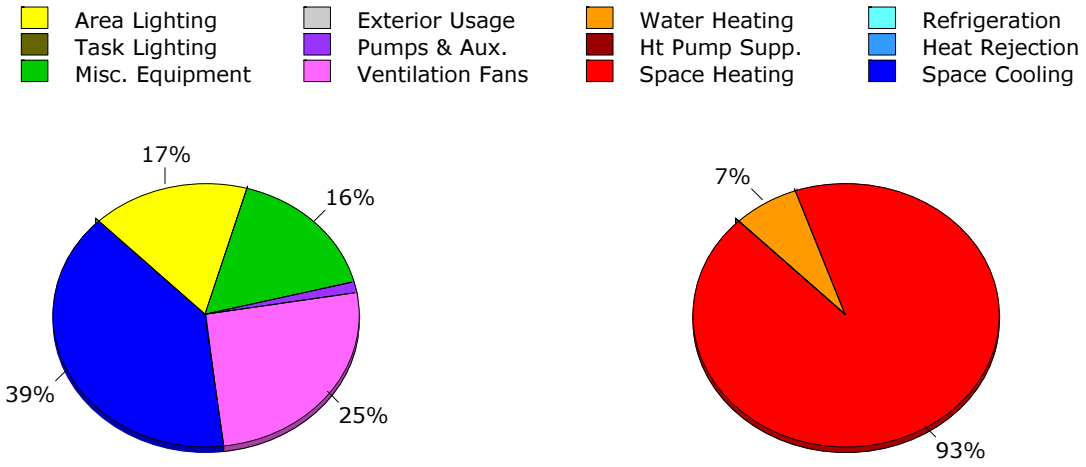
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	32.0	10.2	26.3	69.8	97.6	107.6	87.3	77.7	113.9	69.9	60.6	30.1	783.1
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.9	0.8	0.9	0.1	0.2	-	-	-	-	0.1	0.1	0.9	4.1
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	19.9	21.0	19.3	40.0	54.9	73.5	50.7	44.1	73.5	30.7	19.6	21.0	468.1
Pumps & Aux.	5.0	4.3	5.0	4.2	4.2	4.2	4.2	4.2	4.2	1.0	0.9	4.9	46.1
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	43.8	49.3	43.8	48.6	47.6	47.6	26.2	26.2	47.6	49.3	48.6	43.8	522.4
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	45.3	49.9	45.3	49.9	49.4	49.4	29.1	29.1	49.4	49.9	49.9	45.3	541.8
Total	146.9	135.5	140.6	212.5	253.9	282.3	197.4	181.2	288.7	200.9	179.6	146.0	2,365.6

Gas Demand (Btu/h x000,000)

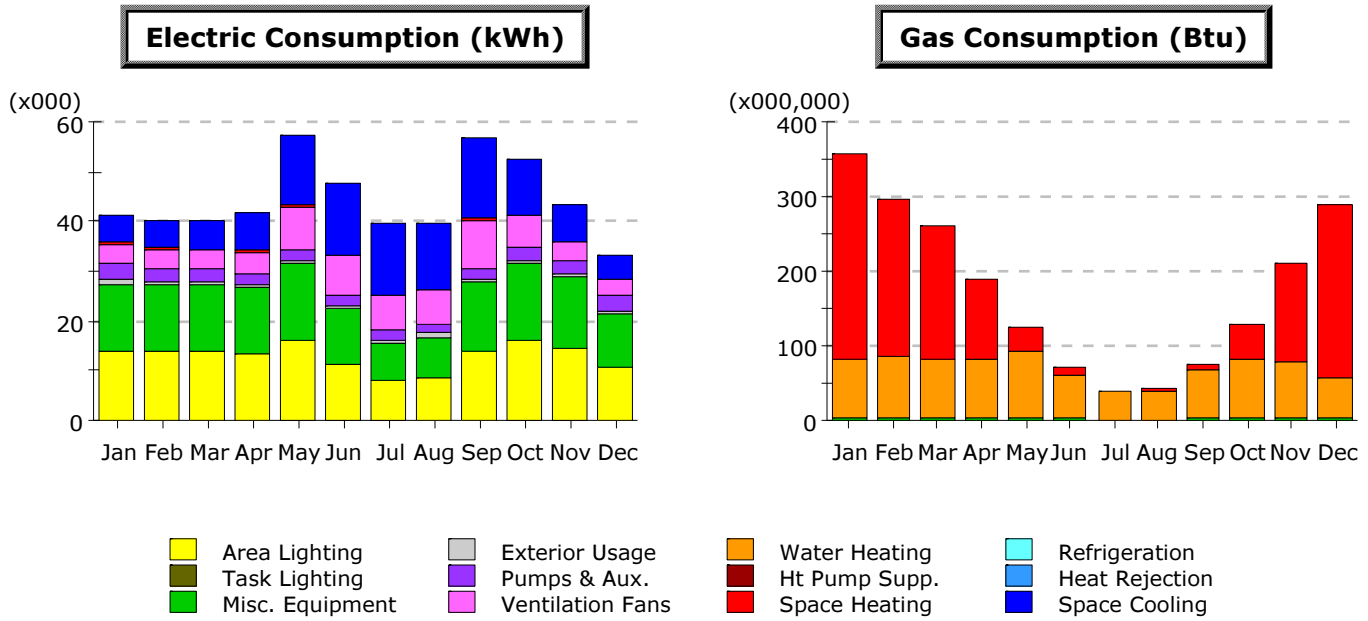
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.07	2.08	1.96	1.58	0.77	0.12	0.08	0.08	0.34	0.92	1.71	2.06	13.77
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.16	0.16	0.17	0.16	0.15	0.28	0.14	0.14	0.13	0.13	0.14	0.07	1.83
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.00	0.00	0.00	0.00	0.00	0.06	-	-	0.00	0.00	0.00	-	0.07
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	2.23	2.25	2.13	1.75	0.92	0.46	0.22	0.22	0.47	1.06	1.85	2.13	15.67

Annual Peak Demand by Enduse

	Electricity kW	Natural Gas Btu/h (x000)	Steam Btu/h	Chilled Water Btu/h
Space Cool	113.92	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	-	2,081.7	-	-
HP Supp.	-	-	-	-
Hot Water	-	164.7	-	-
Vent. Fans	73.51	-	-	-
Pumps & Aux.	4.18	-	-	-
Ext. Usage	-	-	-	-
Misc. Equip.	47.62	0.6	-	-
Task Lights	-	-	-	-
Area Lights	49.43	-	-	-
Total	288.66	2,247.0	-	-



Electricity **Natural Gas**



Electric Consumption (kWh x000)

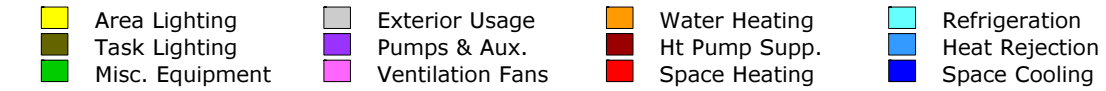
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	5.44	5.53	5.93	7.58	14.40	14.29	14.44	13.31	16.51	11.23	7.25	4.64	120.56
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.48	0.39	0.34	0.22	0.10	0.04	0.01	0.02	0.02	0.12	0.26	0.40	2.40
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	3.94	3.64	3.58	4.22	8.74	8.09	7.37	6.92	9.90	6.56	3.85	3.34	70.16
Pumps & Aux.	3.06	2.61	2.48	2.25	2.32	2.08	1.90	1.86	2.10	2.27	2.31	2.73	27.98
Ext. Usage	0.85	0.65	0.72	0.70	0.50	0.48	0.50	0.81	0.79	0.81	0.82	0.85	8.50
Misc. Equip.	13.48	13.48	13.38	13.06	15.51	10.93	7.45	7.96	13.61	15.51	14.22	10.39	148.97
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	13.99	13.90	13.93	13.58	16.00	11.51	8.14	8.71	14.04	16.00	14.67	10.95	155.41
Total	41.24	40.21	40.37	41.61	57.57	47.42	39.81	39.59	56.98	52.52	43.38	33.30	533.97

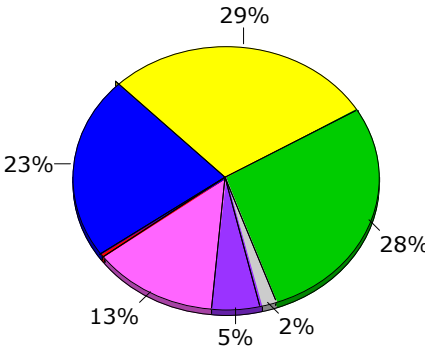
Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	276.2	210.5	177.2	108.3	34.0	11.0	2.7	5.0	6.8	46.1	131.8	233.5	1,243.1
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	78.9	83.2	80.1	77.3	88.2	58.3	37.8	38.8	64.6	76.3	74.8	54.5	812.7
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	3.5	3.9	3.3	3.3	4.6	2.1	0.0	0.0	4.0	4.6	4.2	1.9	35.4
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	358.6	297.6	260.7	188.9	126.7	71.3	40.5	43.8	75.4	126.9	210.8	289.8	2,091.1

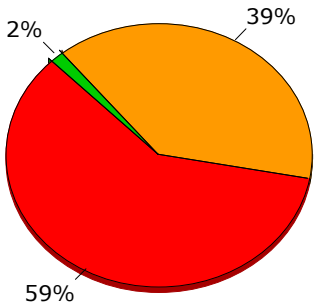
Annual Energy Consumption by Enduse

	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	120.56	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	2.40	1,243.1	-	-
HP Supp.	-	-	-	-
Hot Water	-	812.7	-	-
Vent. Fans	70.16	-	-	-
Pumps & Aux.	27.98	-	-	-
Ext. Usage	8.50	-	-	-
Misc. Equip.	148.97	35.4	-	-
Task Lights	-	-	-	-
Area Lights	155.41	-	-	-
Total	533.97	2,091.1	-	-



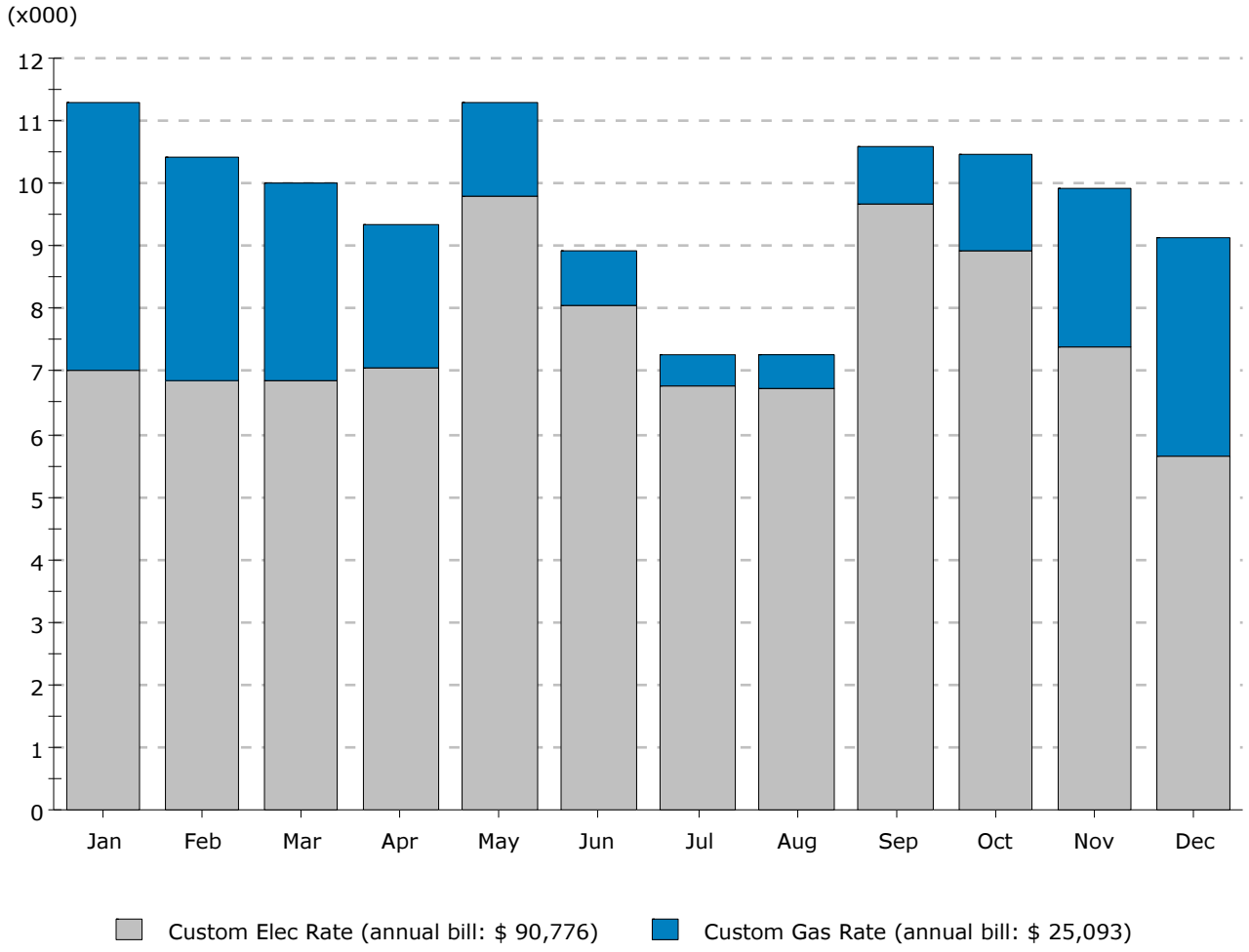


Electricity

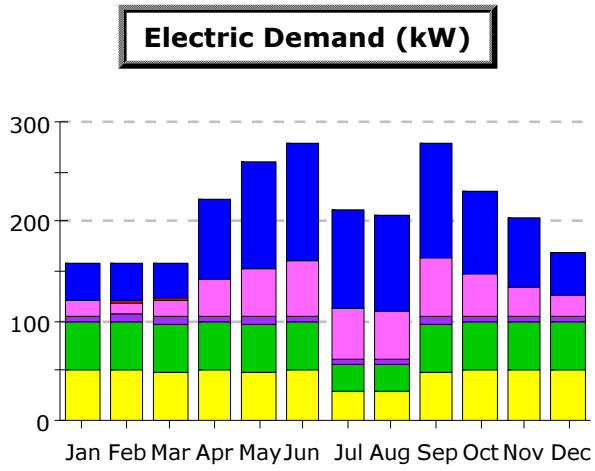


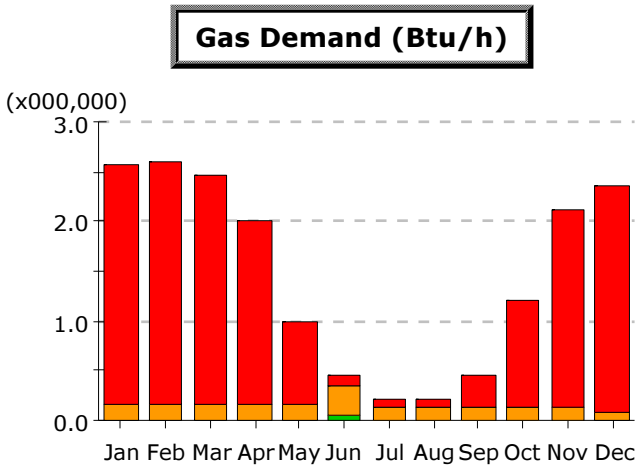
Natural Gas

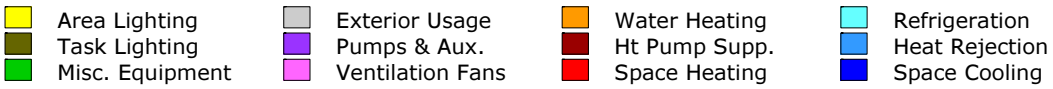
Monthly Utility Bills ($)



Total Annual Bill Across All Rates: $ 115,869







Electric Demand (kW)

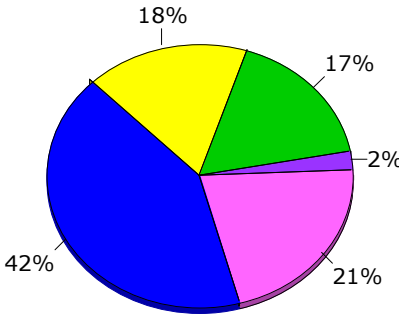
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	37.2	39.3	34.8	78.4	109.1	116.6	97.9	95.1	116.7	83.6	72.0	41.9	922.5
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.7	0.9	0.7	0.2	0.2	-	-	-	-	0.1	0.1	0.4	3.3
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	15.4	11.3	17.9	38.2	48.0	55.4	51.6	49.1	59.3	42.2	28.0	20.1	436.5
Pumps & Aux.	6.5	9.0	6.3	5.7	6.7	6.4	5.8	6.3	6.1	6.5	6.2	6.5	78.1
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	48.2	48.2	47.6	49.2	47.6	49.2	26.2	26.2	47.6	49.3	48.6	49.2	537.0
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	49.9	49.9	49.4	49.9	49.4	49.9	29.1	29.1	49.4	49.9	49.9	49.9	555.6
Total	157.9	158.5	156.7	221.6	260.9	277.5	210.5	205.9	279.2	231.7	204.8	167.9	2,533.0

Gas Demand (Btu/h x000,000)

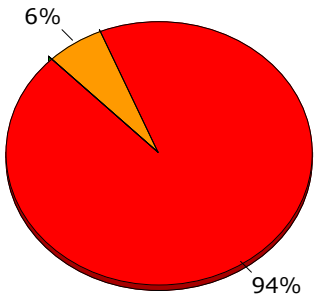
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.41	2.43	2.29	1.85	0.83	0.11	0.08	0.08	0.33	1.08	1.99	2.29	15.75
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.16	0.16	0.17	0.16	0.15	0.28	0.14	0.14	0.13	0.13	0.14	0.07	1.84
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.00	0.00	0.00	0.00	0.00	0.06	-	-	0.00	0.00	0.00	-	0.07
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	2.57	2.59	2.46	2.01	0.98	0.45	0.22	0.21	0.46	1.21	2.13	2.36	17.65

Annual Peak Demand by Enduse

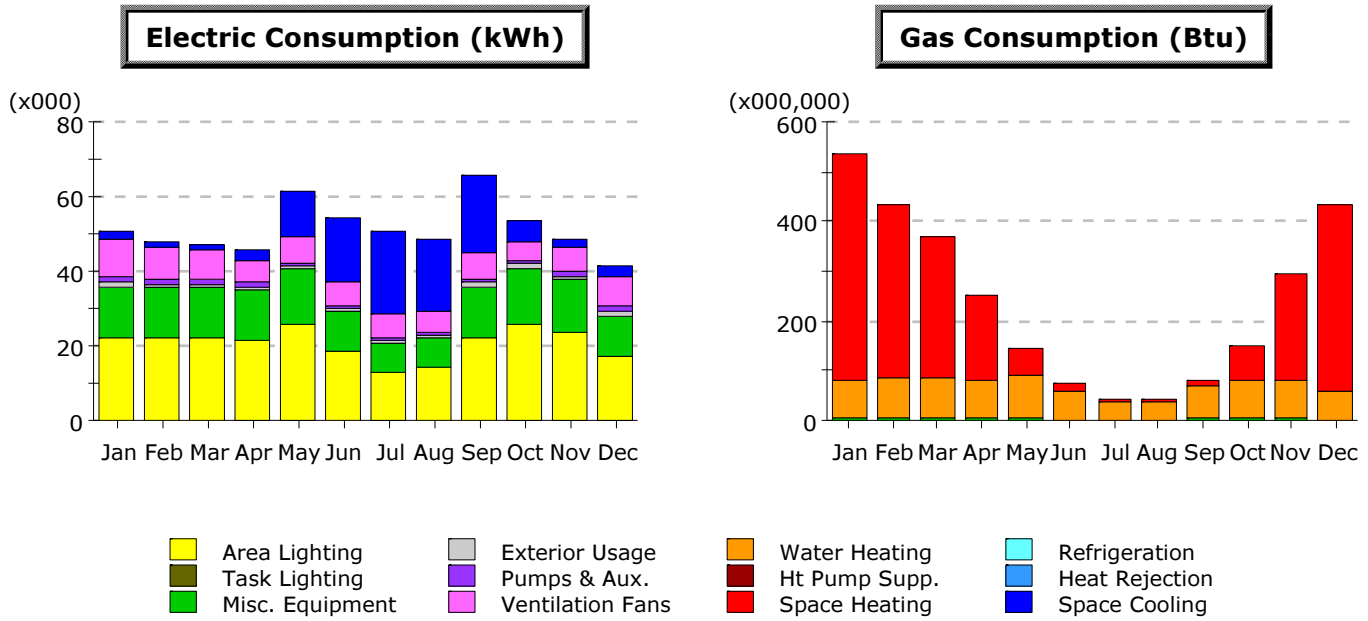
	Electricity kW	Natural Gas Btu/h (x000)	Steam Btu/h	Chilled Water Btu/h
Space Cool	116.68	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	-	2,427.9	-	-
HP Supp.	-	-	-	-
Hot Water	-	164.7	-	-
Vent. Fans	59.34	-	-	-
Pumps & Aux.	6.09	-	-	-
Ext. Usage	-	-	-	-
Misc. Equip.	47.62	0.6	-	-
Task Lights	-	-	-	-
Area Lights	49.43	-	-	-
Total	279.16	2,593.3	-	-



Electricity



Natural Gas



Electric Consumption (kWh x000)

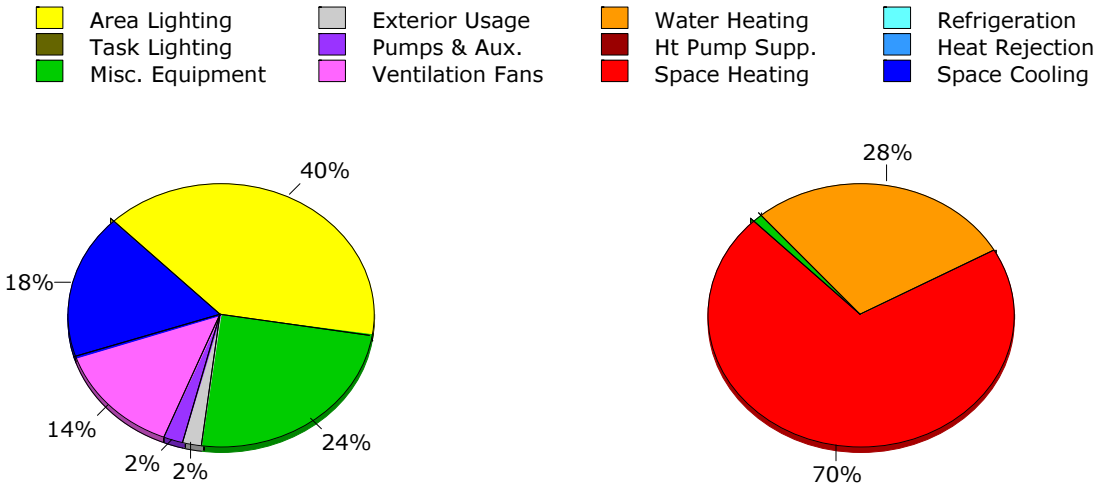
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	2.41	1.99	1.77	2.93	12.43	17.28	22.13	19.26	20.79	5.32	2.22	2.43	110.97
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	9.75	8.18	7.36	6.03	6.81	6.49	6.49	5.81	7.27	5.25	6.32	8.39	84.15
Pumps & Aux.	1.70	1.49	1.52	1.26	0.75	0.61	0.77	0.67	0.48	0.87	1.34	1.47	12.93
Ext. Usage	1.21	0.93	1.03	1.00	0.71	0.69	0.71	1.16	1.12	1.16	1.17	1.21	12.12
Misc. Equip.	13.48	13.48	13.38	13.06	15.51	10.93	7.45	7.96	13.61	15.51	14.22	10.39	148.97
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	22.24	22.08	22.16	21.60	25.41	18.34	13.04	13.96	22.30	25.41	23.30	17.45	247.29
Total	50.79	48.14	47.22	45.87	61.63	54.34	50.60	48.83	65.58	53.52	48.57	41.34	616.43

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	452.9	349.3	287.5	169.7	49.6	15.0	3.3	5.6	12.1	71.1	215.5	377.5	2,008.9
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	79.0	83.3	80.2	77.4	88.1	58.1	37.7	38.6	64.5	76.2	74.8	54.6	812.3
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	3.5	3.9	3.3	3.3	4.6	2.1	0.0	0.0	4.0	4.6	4.2	1.9	35.4
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	535.4	436.5	371.0	250.4	142.3	75.1	40.9	44.2	80.5	151.9	294.5	433.9	2,856.5

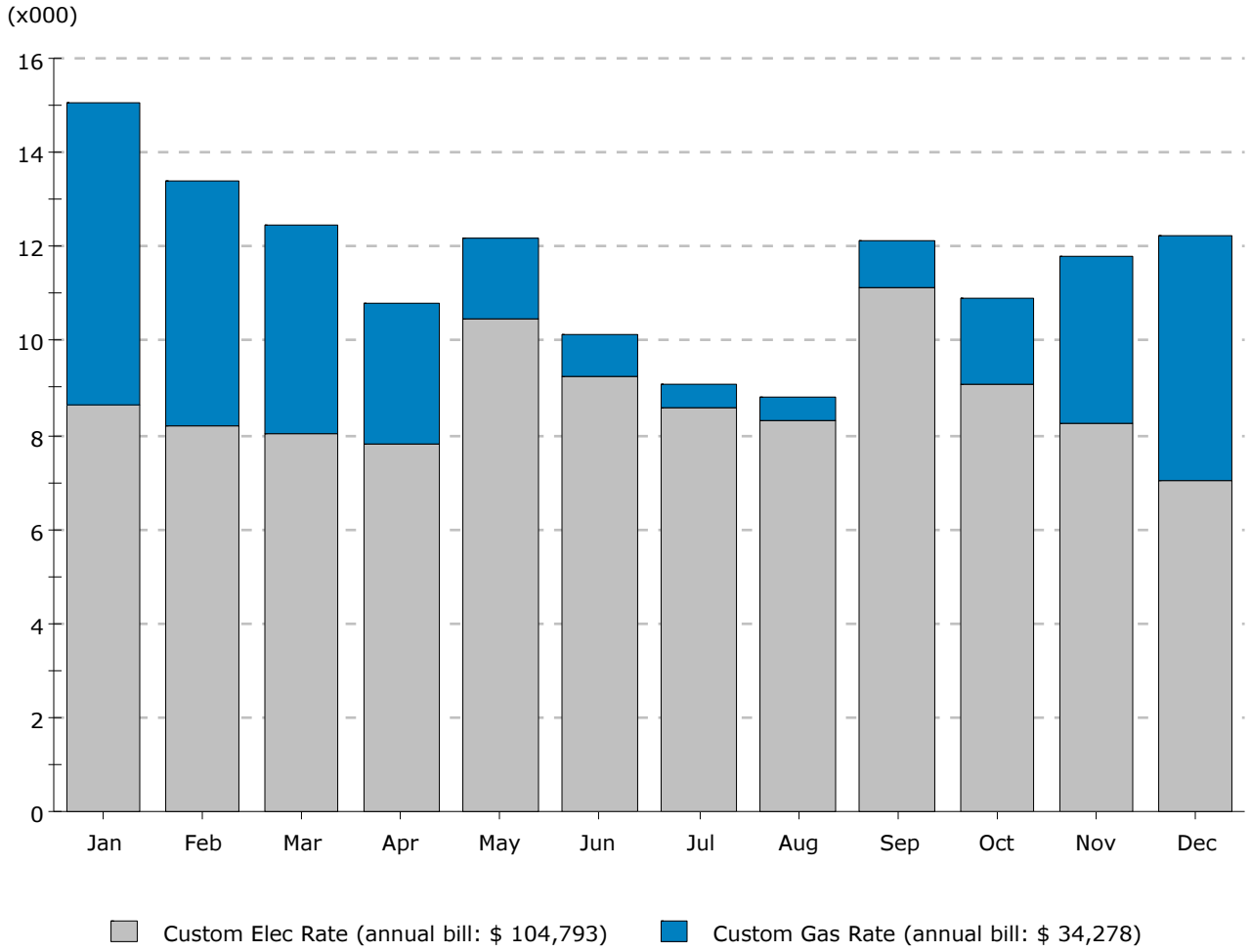
Annual Energy Consumption by Enduse

	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	110.97	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	-	2,008.9	-	-
HP Supp.	-	-	-	-
Hot Water	-	812.3	-	-
Vent. Fans	84.15	-	-	-
Pumps & Aux.	12.93	-	-	-
Ext. Usage	12.12	-	-	-
Misc. Equip.	148.97	35.4	-	-
Task Lights	-	-	-	-
Area Lights	247.29	-	-	-
Total	616.43	2,856.5	-	-

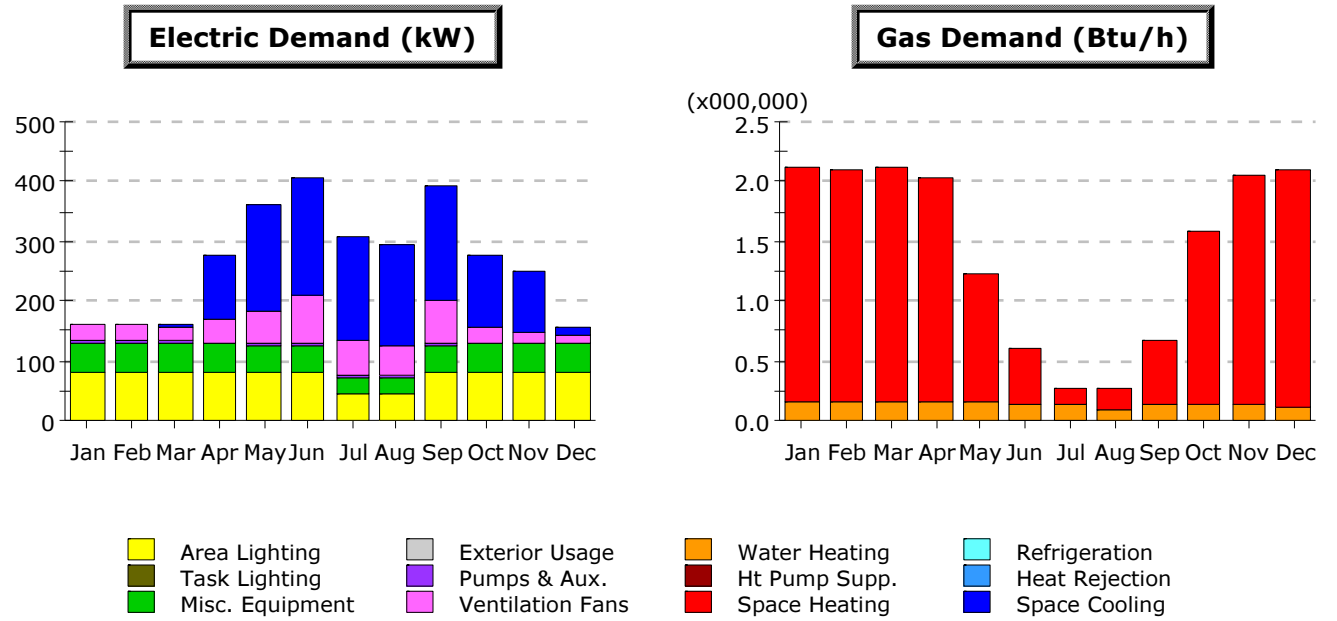


Electricity **Natural Gas**

Monthly Utility Bills ($)



Total Annual Bill Across All Rates: $ 139,071



Electric Demand (kW)

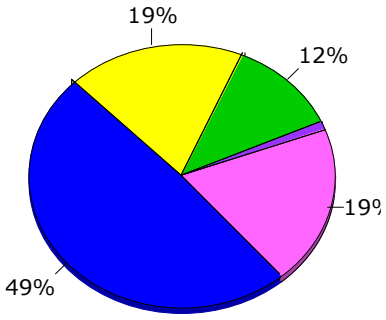
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.1	0.2	4.8	105.4	177.4	197.9	173.9	166.4	189.2	118.1	103.5	14.3	1,251.1
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	30.4	28.1	22.4	39.8	54.3	78.7	57.7	50.4	73.0	27.4	18.7	14.8	495.7
Pumps & Aux.	4.9	4.9	4.2	3.7	3.7	3.7	3.7	3.7	3.7	0.7	0.5	0.8	38.1
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	48.3	48.3	49.3	48.6	47.6	47.6	26.2	26.2	47.6	49.3	48.6	49.2	536.8
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	79.1	79.1	79.1	79.1	78.4	78.4	46.7	46.7	78.4	79.1	79.1	79.1	882.6
Total	162.9	160.6	159.8	276.5	361.4	406.3	308.2	293.4	392.0	274.7	250.4	158.2	3,204.3

Gas Demand (Btu/h x000,000)

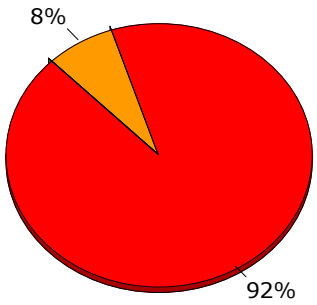
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	1.96	1.94	1.95	1.87	1.08	0.47	0.12	0.19	0.54	1.46	1.92	2.00	15.50
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.16	0.16	0.17	0.16	0.15	0.14	0.14	0.08	0.13	0.13	0.14	0.10	1.67
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.00	0.00	0.00	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	0.01
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	2.12	2.11	2.12	2.04	1.24	0.61	0.26	0.27	0.66	1.59	2.06	2.10	17.17

Annual Peak Demand by Enduse

	Electricity kW	Natural Gas Btu/h (x000)	Steam Btu/h	Chilled Water Btu/h
Space Cool	197.88	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	-	-	-	-
Space Heat	-	1,959.1	-	-
HP Supp.	-	-	-	-
Hot Water	-	159.3	-	-
Vent. Fans	78.67	-	-	-
Pumps & Aux.	3.67	-	-	-
Ext. Usage	-	-	-	-
Misc. Equip.	47.62	0.6	-	-
Task Lights	-	-	-	-
Area Lights	78.44	-	-	-
Total	406.29	2,119.1	-	-



Electricity



Natural Gas

APPENDIX C: Transportation Supporting Documentation

Traffic Volume Data

Yearly/Seasonal Calculations

Background Projects

Public Transportation Information

Trip Distribution Calculations

Capacity Analyses

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□ Traffic Volume Data

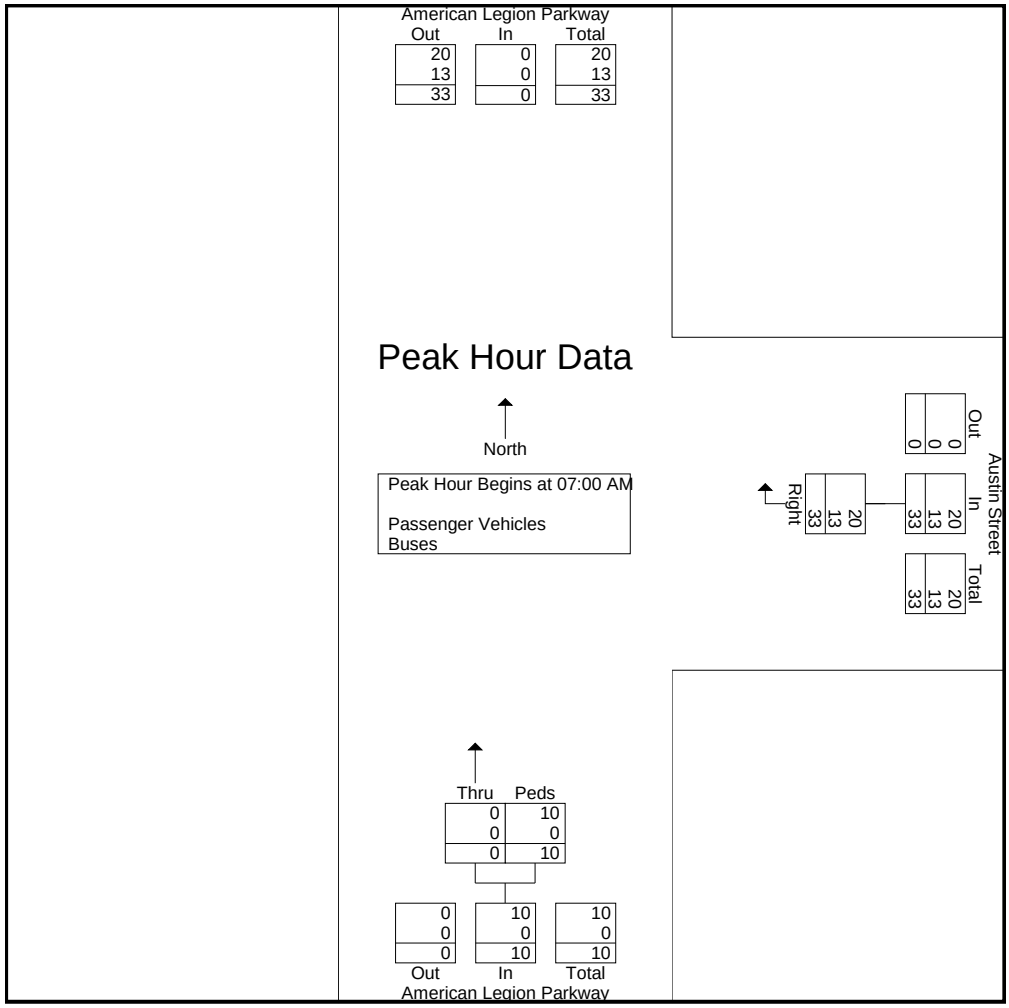
MDM Transportation Consultants, INC.

28 Lord Road, Suite 280
Marlborough, MA

N/S: American Legion Highway
E: Austin Street
Boston, MA

File Name : American Legion Hwy at Austin St 7-8
Site Code : 882
Start Date : 9/15/2016
Page No : 2

	Austin Street From East		American Legion Parkway From South			
Start Time	Right	App. Total	Thru	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1						
Peak Hour for Entire Intersection Begins at 07:00 AM						
07:00 AM	3	3	0	3	3	6
07:15 AM	**15**	**15**	0	**4**	**4**	**19**
07:30 AM	12	12	0	3	3	15
07:45 AM	3	3	0	0	0	3
Total Volume	33	33	0	10	10	43
% App. Total	100		0	100		
PHF	.550	.550	.000	.625	.625	.566
Passenger Vehicles	20	20	0	10	10	30
% Passenger Vehicles	60.6	60.6	0	100	100	69.8
Buses	13	13	0	0	0	13
% Buses	39.4	39.4	0	0	0	30.2



MDM Transportation Consultants, INC.

28 Lord Road, Suite 280
Marlborough, MA

N/S: American Legion Highway
E: Austin Street
Boston, MA

File Name : American Legion Hwy at Austin St 7-8
Site Code : 882
Start Date : 9/15/2016
Page No : 1

Groups Printed- Passenger Vehicles - Buses

	Austin Street From East		American Legion Parkway From South			
Start Time	Right	App. Total	Thru	Peds	App. Total	Int. Total
07:00 AM	3	3	0	3	3	6
07:15 AM	15	15	0	4	4	19
07:30 AM	12	12	0	3	3	15
07:45 AM	3	3	0	0	0	3
Total	33	33	0	10	10	43
Grand Total	33	33	0	10	10	43
Apprch %	100		0	100		
Total %	76.7	76.7	0	23.3	23.3	
Passenger Vehicles	20	20	0	10	10	30
% Passenger Vehicles	60.6	60.6	0	100	100	69.8
Buses	13	13	0	0	0	13
% Buses	39.4	39.4	0	0	0	30.2

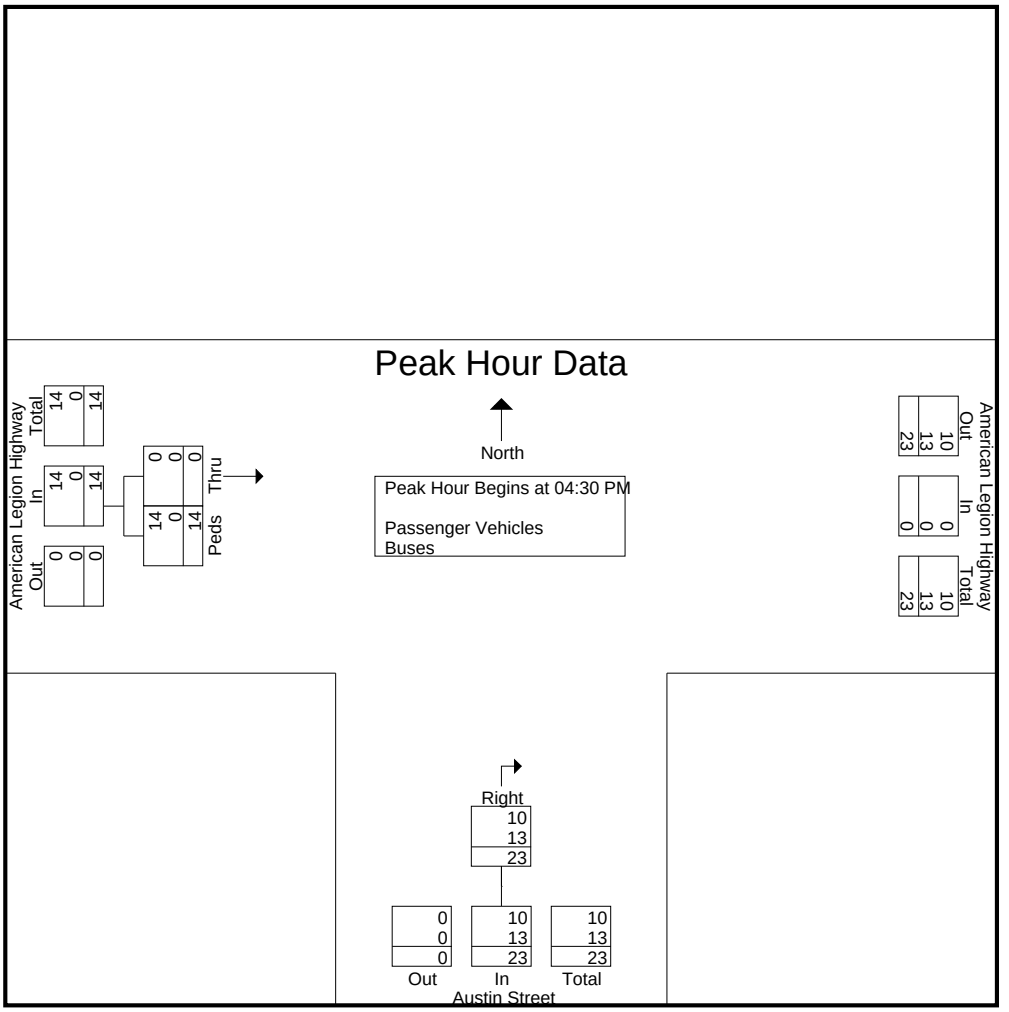
MDM Transportation Consultants, INC.

28 Lord Road, Suite 280
Marlborough, MA

N/S: American Legion Parkway
E: Austin Street
Boston, MA

File Name : American Legion Hwy at Austin St 345-545
Site Code : 882
Start Date : 9/15/2016

	Austin Street From South		American Legion Highway From West			
Start Time	Right	App. Total	Thru	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:30 PM to 05:30 PM - Peak 1 of 1						
Peak Hour for Entire Intersection Begins at 04:30 PM						
04:30 PM	7	7	0	2	2	9
04:45 PM	**9**	**9**	0	3	3	**12**
05:00 PM	5	5	0	4	4	9
05:15 PM	2	2	0	**5**	**5**	7
Total Volume	23	23	0	14	14	37
% App. Total	100		0	100		
PHF	.639	.639	.000	.700	.700	.771
Passenger Vehicles	10	10	0	14	14	24
% Passenger Vehicles	43.5	43.5	0	100	100	64.9
Buses	13	13	0	0	0	13
% Buses	56.5	56.5	0	0	0	35.1



MDM Transportation Consultants, INC.

28 Lord Road, Suite 280
Marlborough, MA

N/S: American Legion Parkway
E: Austin Street
Boston, MA

File Name : American Legion Hwy at Austin St 345-545
Site Code : 882
Start Date : 9/15/2016

Groups Printed- Passenger Vehicles - Buses

	Austin Street From South		American Legion Highway From West			
Start Time	Right	App. Total	Thru	Peds	App. Total	Int. Total
03:45 PM	1	1	0	0	0	1
Total	1	1	0	0	0	1
04:00 PM	3	3	0	3	3	6
04:15 PM	2	2	0	9	9	11
04:30 PM	7	7	0	2	2	9
04:45 PM	9	9	0	3	3	12
Total	21	21	0	17	17	38
05:00 PM	5	5	0	4	4	9
05:15 PM	2	2	0	5	5	7
05:30 PM	3	3	0	2	2	5
Grand Total	32	32	0	28	28	60
Apprch %	100		0	100		
Total %	53.3	53.3	0	46.7	46.7	
Passenger Vehicles	19	19	0	28	28	47
% Passenger Vehicles	59.4	59.4	0	100	100	78.3
Buses	13	13	0	0	0	13
% Buses	40.6	40.6	0	0	0	21.7

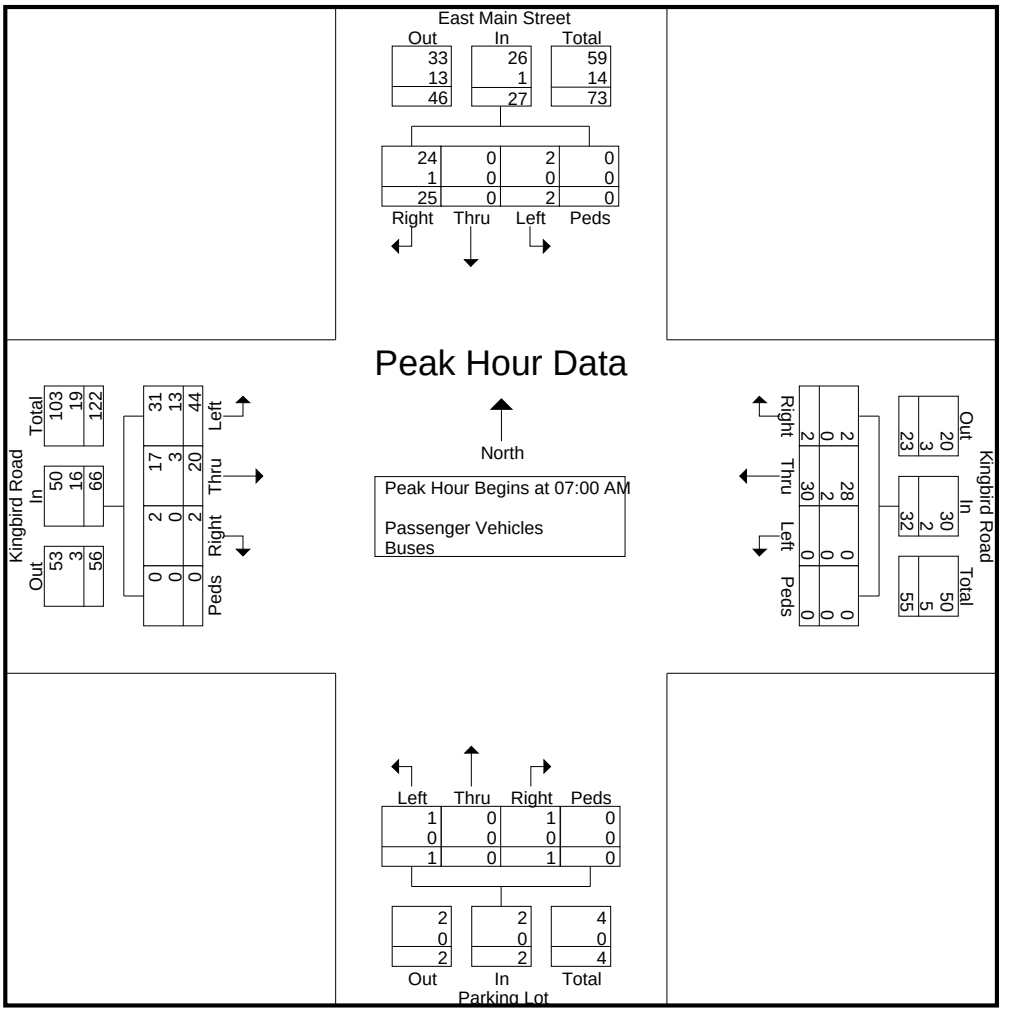
MDM Transportation Consultants, INC.

28 Lord Road, Suite 280
Marlborough, MA

N/S: East Main Street/ Parking Lot
E/W: Kingbird Road
Boston, MA

File Name : Kingbird Road at E Main 7-8
Site Code : 882
Start Date : 9/15/2016
Page No : 2

	East Main Street From North					Kingbird Road From East					Parking Lot From South					Kingbird Road From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	2	0	0	0	2	**1**	**8**	0	0	**9**	0	0	0	0	0	**1**	2	8	0	11	22
07:15 AM	**10**	0	**1**	0	**11**	0	7	0	0	7	0	0	0	0	0	0	**7**	**18**	0	**25**	**43**
07:30 AM	7	0	1	0	8	0	7	0	0	7	0	0	**1**	0	**1**	1	6	16	0	23	39
07:45 AM	6	0	0	0	6	1	8	0	0	9	**1**	0	0	0	1	0	5	2	0	7	23
Total Volume	25	0	2	0	27	2	30	0	0	32	1	0	1	0	2	2	20	44	0	66	127
% App. Total	92.6	0	7.4	0		6.2	93.8	0	0		50	0	50	0		3	30.3	66.7	0		
PHF	.625	.000	.500	.000	.614	.500	.938	.000	.000	.889	.250	.000	.250	.000	.500	.500	.714	.611	.000	.660	.738
Passenger Vehicles	24	0	2	0	26	2	28	0	0	30	1	0	1	0	2	2	17	31	0	50	108
% Passenger Vehicles																					
Buses	1	0	0	0	1	0	2	0	0	2	0	0	0	0	0	0	3	13	0	16	19
% Buses	4.0	0	0	0	3.7	0	6.7	0	0	6.3	0	0	0	0	0	0	15.0	29.5	0	24.2	15.0



MDM Transportation Consultants, INC.

28 Lord Road, Suite 280
Marlborough, MA

N/S: East Main Street/ Parking Lot
E/W: Kingbird Road
Boston, MA

File Name : Kingbird Road at E Main 7-8
Site Code : 882
Start Date : 9/15/2016
Page No : 1

Groups Printed- Passenger Vehicles - Buses

	East Main Street From North					Kingbird Road From East					Parking Lot From South					Kingbird Road From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	2	0	0	0	2	1	8	0	0	9	0	0	0	0	0	1	2	8	0	11	22
07:15 AM	10	0	1	0	11	0	7	0	0	7	0	0	0	0	0	0	7	18	0	25	43
07:30 AM	7	0	1	0	8	0	7	0	0	7	0	0	1	0	1	1	6	16	0	23	39
07:45 AM	6	0	0	0	6	1	8	0	0	9	1	0	0	0	1	0	5	2	0	7	23
Total	25	0	2	0	27	2	30	0	0	32	1	0	1	0	2	2	20	44	0	66	127
Grand Total	25	0	2	0	27	2	30	0	0	32	1	0	1	0	2	2	20	44	0	66	127
Apprch %	92.6	0	7.4	0		6.2	93.8	0	0		50	0	50	0		3	30.3	66.7	0		
Total %	19.7	0	1.6	0	21.3	1.6	23.6	0	0	25.2	0.8	0	0.8	0	1.6	1.6	15.7	34.6	0	52	
Passenger Vehicles	24	0	2	0	26	2	28	0	0	30	1	0	1	0	2	2	17	31	0	50	108
% Passenger Vehicles																					
Buses	1	0	0	0	1	0	2	0	0	2	0	0	0	0	0	0	3	13	0	16	19
% Buses	4	0	0	0	3.7	0	6.7	0	0	6.2	0	0	0	0	0	0	15	29.5	0	24.2	15

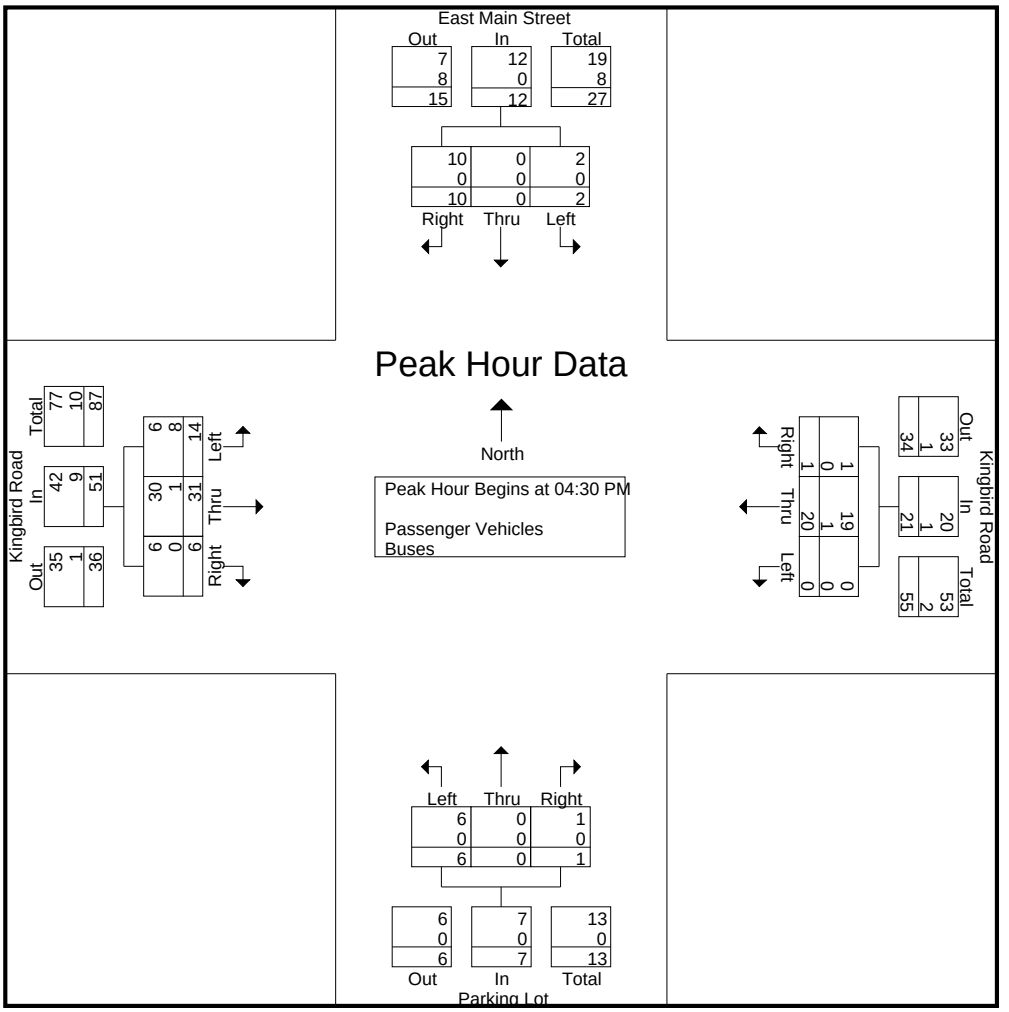
MDM Transportation Consultants, INC.

28 Lord Road, Suite 280
Marlborough, MA

N/S: East Main Street/ Parking Lot
E/W: Kingbird Road
Boston, MA

File Name : Kingbird Road at E Main 345-545
Site Code : 882
Start Date : 9/15/2016
Page No : 2

	East Main Street From North				Kingbird Road From East				Parking Lot From South				Kingbird Road From West				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 04:30 PM to 05:15 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:30 PM																	
04:30 PM	**4**	0	**1**	**5**	0	5	0	5	0	0	**3**	**3**	1	**11**	4	**16**	**29**
04:45 PM	1	0	1	2	**1**	3	0	4	0	0	0	0	**3**	8	**5**	16	22
05:00 PM	3	0	0	3	0	**8**	0	**8**	0	0	2	2	1	6	5	12	25
05:15 PM	2	0	0	2	0	4	0	4	**1**	0	1	2	1	6	0	7	15
Total Volume	10	0	2	12	1	20	0	21	1	0	6	7	6	31	14	51	91
% App. Total	83.3	0	16.7		4.8	95.2	0		14.3	0	85.7		11.8	60.8	27.5		
PHF	.625	.000	.500	.600	.250	.625	.000	.656	.250	.000	.500	.583	.500	.705	.700	.797	.784
Passenger Vehicles	10	0	2	12	1	19	0	20	1	0	6	7	6	30	6	42	81
% Passenger Vehicles																	
Buses	0	0	0	0	0	1	0	1	0	0	0	0	0	1	8	9	10
% Buses	0	0	0	0	0	5.0	0	4.8	0	0	0	0	0	3.2	57.1	17.6	11.0



MDM Transportation Consultants, INC.

28 Lord Road, Suite 280
Marlborough, MA

N/S: East Main Street/ Parking Lot
E/W: Kingbird Road
Boston, MA

File Name : Kingbird Road at E Main 345-545
Site Code : 882
Start Date : 9/15/2016
Page No : 1

Groups Printed- Passenger Vehicles - Buses

	East Main Street From North				Kingbird Road From East				Parking Lot From South				Kingbird Road From West				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
03:45 PM	1	0	0	1	0	2	0	2	0	0	0	0	1	1	1	3	6
Total	1	0	0	1	0	2	0	2	0	0	0	0	1	1	1	3	6
04:00 PM	1	0	1	2	0	4	0	4	0	0	2	2	1	7	8	16	24
04:15 PM	0	0	1	1	0	4	0	4	1	0	3	4	0	3	5	8	17
04:30 PM	4	0	1	5	0	5	0	5	0	0	3	3	1	11	4	16	29
04:45 PM	1	0	1	2	1	3	0	4	0	0	0	0	3	8	5	16	22
Total	6	0	4	10	1	16	0	17	1	0	8	9	5	29	22	56	92
05:00 PM	3	0	0	3	0	8	0	8	0	0	2	2	1	6	5	12	25
05:15 PM	2	0	0	2	0	4	0	4	1	0	1	2	1	6	0	7	15
05:30 PM	0	0	0	0	2	2	0	4	1	0	0	1	1	9	3	13	18
Grand Total	12	0	4	16	3	32	0	35	3	0	11	14	9	51	31	91	156
Apprch %	75	0	25		8.6	91.4	0		21.4	0	78.6		9.9	56	34.1		
Total %	7.7	0	2.6	10.3	1.9	20.5	0	22.4	1.9	0	7.1	9	5.8	32.7	19.9	58.3	
Passenger Vehicles	12	0	4	16	3	30	0	33	3	0	11	14	9	49	18	76	139
% Passenger Vehicles																	
Buses	0	0	0	0	0	2	0	2	0	0	0	0	0	2	13	15	17
% Buses	0	0	0	0	0	6.2	0	5.7	0	0	0	0	0	3.9	41.9	16.5	10.9

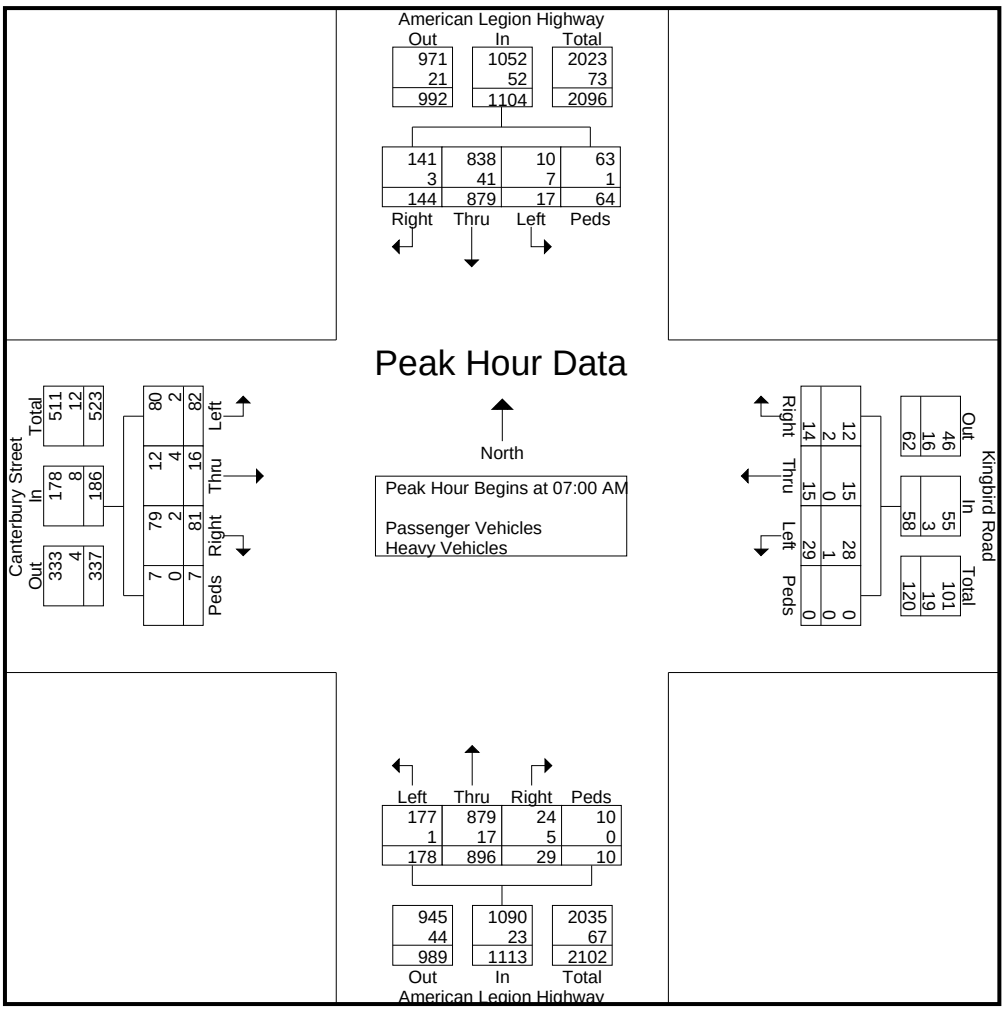
MDM Transportation Consultants, INC.

28 Lord Road, Suite 280
Marlborough, MA

N/S: American Legion Highway
E/W: Kingbird Road/Canterbury Street
Boston, MA

File Name : American Legion Hwy at Kingbird Rd 7-8
Site Code : 882
Start Date : 9/15/2016
Page No : 2

	American Legion Highway From North						Kingbird Road From East					American Legion Highway From South						Canterbury Street From West					
Start Time	Right	Thru	Left	U-turn	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-turn	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																							
Peak Hour for Entire Intersection Begins at 07:00 AM																							
07:00 AM	36	174	2	13	**2**	227	3	0	5	0	8	7	**298**				**358**	16	2	**29**	**4**		
07:15 AM	**44**	**237**	**9**	**21**	**1**	**312**	**3**	**7**	**11**	**0**	**21**	**9**	**187**	**52**	**2**	**0**	**250**	**26**	**4**	**18**	**1**	**49**	**632**
07:30 AM	**34**	**267**	4	21	1	**327**	**4**	**4**	**7**	**0**	**15**	**9**	**210**	**39**	**1**	**4**	**263**	**23**	**9**	**23**	**2**	**57**	**662**
07:45 AM	30	201	2	5	0	238	4	4	6	0	14	4	201	36	0	1	242	16	1	12	0	29	523
Total Volume	144	879	17	60	4	1104	14	15	29	0	58	29	896	178	4	6	1113	81	16	82	7	186	2461
% App. Total	13	79.6	1.5	5.4	0.4		24.1	25.9	50	0		2.6	80.5	16	0.4	0.5		43.5	8.6	44.1	3.8		
PHF	.818	.823	.472	.714	.500	.844	.875	.536	.659	.000	.690	.806	.752	.856	.500	.375	.777	.779	.444	.707	.438	.816	.929
Passenger Vehicles																							
% Passenger Vehicles	97.9	95.3	58.8	100	75.0	95.3	85.7	100	96.6	0	94.8	82.8	98.1	99.4	100	100	97.9	97.5	75.0	97.6	100	95.7	96.5
Heavy Vehicles	3	41	7	0	1	52	2	0	1	0	3	5	17	1	0	0	23	2	4	2	0	8	86
% Heavy Vehicles	2.1	4.7	41.2	0	25.0	4.7	14.3	0	3.4	0	5.2	17.2	1.9	0.6	0	0	2.1	2.5	25.0	2.4	0	4.3	3.5



MDM Transportation Consultants, INC.

28 Lord Road, Suite 280
Marlborough, MA

N/S: American Legion Highway
E/W: Kingbird Road/Canterbury Street
Boston, MA

File Name : American Legion Hwy at Kingbird Rd 7-8
Site Code : 882
Start Date : 9/15/2016
Page No : 1

Groups Printed- Passenger Vehicles - Heavy Vehicles

	American Legion Highway From North						Kingbird Road From East					American Legion Highway From South						Canterbury Street From West					
Start Time	Right	Thru	Left	U-turn	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-turn	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	36	174	2	13	2	227	3	0	5	0	8	7	298	51	1	1	358	16	2	29	4	51	644
07:15 AM	44	237	9	21	1	312	3	7	11	0	21	9	187	52	2	0	250	26	4	18	1	49	632
07:30 AM	34	267	4	21	1	327	4	4	7	0	15	9	210	39	1	4	263	23	9	23	2	57	662
07:45 AM	30	201	2	5	0	238	4	4	6	0	14	4	201	36	0	1	242	16	1	12	0	29	523
Total	144	879	17	60	4	1104	14	15	29	0	58	29	896	178	4	6	1113	81	16	82	7	186	2461
Grand Total	144	879	17	60	4	1104	14	15	29	0	58	29	896	178	4	6	1113	81	16	82	7	186	2461
Apprch %	13	79.6	1.5	5.4	0.4		24.1	25.9	50	0		2.6	80.5	16	0.4	0.5		43.5	8.6	44.1	3.8		
Total %	5.9	35.7	0.7	2.4	0.2	44.9	0.6	0.6	1.2	0	2.4	1.2	36.4	7.2	0.2	0.2	45.2	3.3	0.7	3.3	0.3	7.6	
Passenger Vehicles																							
% Passenger Vehicles	97.9	95.3	58.8	100	75	95.3	85.7	100	96.6	0	94.8	82.8	98.1	99.4	100	100	97.9	97.5	75	97.6	100	95.7	96.5
Heavy Vehicles	3	41	7	0	1	52	2	0	1	0	3	5	17	1	0	0	23	2	4	2	0	8	86
% Heavy Vehicles	2.1	4.7	41.2	0	25	4.7	14.3	0	3.4	0	5.2	17.2	1.9	0.6	0	0	2.1	2.5	25	2.4	0	4.3	3.5

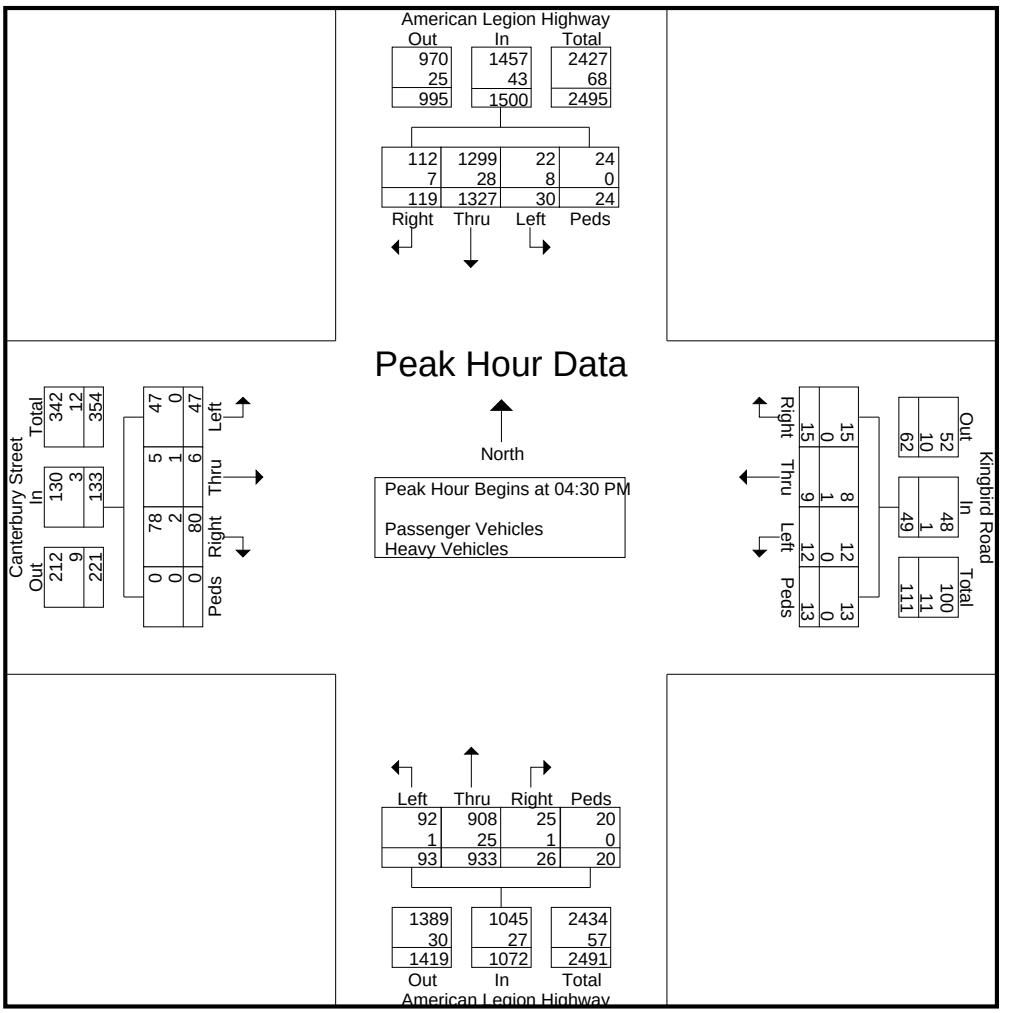
MDM Transportation Consultants, INC.

28 Lord Road, Suite 280
Marlborough, MA

N/S: American Legion Highway
E/W: Kingbird Road/ Canterbury Street
Boston, MA

File Name : American Legion Hwy at Kingbird Rd 345-545
Site Code : 882
Start Date : 9/15/2016
Page No : 2

	American Legion Highway From North						Kingbird Road From East					American Legion Highway From South						Canterbury Street From West					
Start Time	Right	Thru	Left	U-turn	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-turn	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 03:45 PM to 05:30 PM - Peak 1 of 1																							
Peak Hour for Entire Intersection Begins at 04:30 PM																							
04:30 PM	**36**	**358**	7	**8**	0	**409**	3	**4**	3	2	12	6	251	**25**	0	2	284	**24**	**2**	**15**	0	**41**	**746**
04:45 PM	36	338	**11**	7	0	392	3	2	1	3	9	**13**	**252**	25	0	4	**294**	20	2	14	0	36	731
05:00 PM	27	303	8	5	0	343	**7**	1	**5**	1	**14**	4	206	18	**1**	5	234	16	2	13	0	31	622
05:15 PM	20	328	4	4	0	356	2	2	3	**7**	14	3	224	25	0	**8**	260	20	0	5	0	25	655
Total Volume	119	1327	30	24	0	1500	15	9	12	13	49	26	933	93	1	19	1072	80	6	47	0	133	2754
% App. Total	7.9	88.5	2	1.6	0		30.6	18.4	24.5	26.5		2.4	87	8.7	0.1	1.8		60.2	4.5	35.3	0		
PHF	.826	.927	.682	.750	.000	.917	.536	.563	.600	.464	.875	.500	.926	.930	.250	.594	.912	.833	.750	.783	.000	.811	.923
Passenger Vehicles	112	1299	22	24	0	1457	15	8	12	13	48	25	908	92	1	19	1045	78	5	47	0	130	2680
% Passenger Vehicles	94.1	97.9	73.3	100	0	97.1	100	88.9	100	100	98.0	96.2	97.3	98.9	100	100	97.5	97.5	83.3	100	0	97.7	97.3
Heavy Vehicles	7	28	8	0	0	43	0	1	0	0	1	1	25	1	0	0	27	2	1	0	0	3	74
% Heavy Vehicles	5.9	2.1	26.7	0	0	2.9	0	11.1	0	0	2.0	3.8	2.7	1.1	0	0	2.5	2.5	16.7	0	0	2.3	2.7



MDM Transportation Consultants, INC.

28 Lord Road, Suite 280
Marlborough, MA

N/S: American Legion Highway
E/W: Kingbird Road/ Canterbury Street
Boston, MA

File Name : American Legion Hwy at Kingbird Rd 345-545
Site Code : 882
Start Date : 9/15/2016
Page No : 1

Groups Printed- Passenger Vehicles - Heavy Vehicles

	American Legion Highway From North						Kingbird Road From East					American Legion Highway From South						Canterbury Street From West					
Start Time	Right	Thru	Left	U-turn	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-turn	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
03:45 PM	17	309	1	6	0	333	2	2	2	1	7	1	227	22	1	3	254	25	2	13	0	40	634
Total	17	309	1	6	0	333	2	2	2	1	7	1	227	22	1	3	254	25	2	13	0	40	634
04:00 PM	17	303	7	8	1	336	3	0	3	3	9	6	211	24	0	2	243	16	2	13	0	31	619
04:15 PM	20	271	6	14	0	311	6	0	2	4	12	2	236	25	0	4	267	23	2	28	0	53	643
04:30 PM	36	358	7	8	0	409	3	4	3	2	12	6	251	25	0	2	284	24	2	15	0	41	746
04:45 PM	36	338	11	7	0	392	3	2	1	3	9	13	252	25	0	4	294	20	2	14	0	36	731
Total	109	1270	31	37	1	1448	15	6	9	12	42	27	950	99	0	12	1088	83	8	70	0	161	2739
05:00 PM	27	303	8	5	0	343	7	1	5	1	14	4	206	18	1	5	234	16	2	13	0	31	622
05:15 PM	20	328	4	4	0	356	2	2	3	7	14	3	224	25	0	8	260	20	0	5	0	25	655
05:30 PM	26	368	7	11	0	412	0	0	1	1	2	4	215	19	2	4	244	8	2	11	1	22	680
Grand Total	199	2578	51	63	1	2892	26	11	20	22	79	39	1822	183	4	32	2080	152	14	112	1	279	5330
Apprch %	6.9	89.1	1.8	2.2	0		32.9	13.9	25.3	27.8		1.9	87.6	8.8	0.2	1.5		54.5	5	40.1	0.4		
Total %	3.7	48.4	1	1.2	0	54.3	0.5	0.2	0.4	0.4	1.5	0.7	34.2	3.4	0.1	0.6	39	2.9	0.3	2.1	0	5.2	
Passenger Vehicles	188	2527	40	63	1	2819	26	10	19	22	77	37	1766	181	4	32	2020	149	11	111	1	272	5188
% Passenger Vehicles	94.5	98	78.4	100	100	97.5	100	90.9	95	100	97.5	94.9	96.9	98.9	100	100	97.1	98	78.6	99.1	100	97.5	97.3
Heavy Vehicles	11	51	11	0	0	73	0	1	1	0	2	2	56	2	0	0	60	3	3	1	0	7	142
% Heavy Vehicles	5.5	2	21.6	0	0	2.5	0	9.1	5	0	2.5	5.1	3.1	1.1	0	0	2.9	2	21.4	0.9	0	2.5	2.7

□ Yearly/Seasonal Calculations

Location ID	H8494
Loc On Alias	I-93, 190 feet N. of Southampton St

Year	Annual Growth	AADT
2015	0.3%	159,947
2014	-0.3%	160,392
2013	0.7%	159,962
2012	-0.9%	161,055
2011	-1.7%	159,619
2010	1.6%	156,927
2009		159,480
Average	-0.1%	159,626

Year 2015 Data

Direction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
NB	87629	75063	97399	100588	99573	102690	100805	102196	103171	101850	99194	98121	97357
SB	62422	55054	68976	65625	62632	64850	59672	59450	62901	65375	59324	64210	62541
Total	**150051**	**130117**	**166375**	**166213**	**162205**	**167540**	**160477**	**161646**	**166072**	**167225**	**158518**	**162331**	**159898**
Seasonal									**0.96**				

Year 2014 Data

Direction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
NB	86704	89852	95995	98988	102125	101544	97744	101059	100394	99162	96275	94877	97060
SB	61739	61667	65394	64003	65474	62431	56937	60347	58463	60863	63462	65626	62201
Total	**148443**	**151519**	**161389**	**162991**	**167599**	**163975**	**154681**	**161406**	**158857**	**160025**	**159737**	**160503**	**159260**
Seasonal									**1.00**				

Average Seasonal Adjustement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
								0.98			

SECTION I - CONTINUOUS COUNTING STATION MONTHLY AVERAGE DAILY TRAFFIC

STATION 691 - QUINCY - RTE.I-93 - NORTH OF RTE.28

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	September Adjustment to Year	
09	173,000	175,000	177,697	194,334	196,834	199,477	196,208	194,125	190,885	186,291	176,509	174,000	186,197	0.98	
	-2%	0%	4%	-1%	-1%	0%	-1%	-1%	0%	1%	3%	4%	1%		
11	167,126	175,019	190,197	192,089	194,127	197,487	194,151	190,914	192,702	189,561	186,958	*187,438*	188,147	0.98	
	1%	5%	0%	1%	0%	-1%	-1%	2%	-1%	-2%	0%	-3%	0%		
12	169,602	184,324	189,819	193,864	194,599	195,224	191,887	195,288	190,420	185,580	186,167	*182,504*	188,273	0.99	
	6%	-3%	-3%	-3%	-1%	0%	0%	1%	1%	2%	-1%	-3%	0%		
13	179,376	178,566	184,676	188,415	192,495	194,852	191,244	*197,178*	192,661	189,852	184,753	177,157	187,602	0.97	
												Growth	0.08%	0.98	Sub Average

STATION 703 - ABINGTON - RTE.123 - AT THE BROCKTON C.L.

YR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR		
05	11,765	13,137	13,345	13,910	13,694	14,536	13,543	13,701	13,854	13,505	13,683	*13,585*	13,522	0.98	
	7%	-1%	3%	-1%	1%	-2%	-5%	-3%	-1%	2%	0%	1%	0%		
06	12,635	13,053	13,787	13,800	13,829	14,197	12,875	13,252	13,744	13,804	13,637	*13,677*	13,524	0.98	
	1%	1%	-2%	-1%	0%	-3%	3%	2%	-1%	-1%	-3%	-7%	-1%		
07	12,725	13,219	13,457	13,626	13,808	13,831	13,234	*13,490*	13,544	13,620	13,289	12,763	13,384	0.99	
	-2%	-2%	-2%	0%	-3%	-3%	-2%	-5%	1%	1%	-2%	2%	-1%		
08	12,431	12,909	13,144	13,662	13,430	13,479	13,027	*12,806*	13,646	13,740	13,012	13,034	13,193	0.97	
	-1%	2%	1%	1%	-1%	3%	3%	3%	3%	0%	1%	2%	1%		
09	12,251	13,199	13,301	13,860	13,231	13,817	13,354	*13,212*	14,037	13,712	13,161	13,327	13,372	0.95	
	1%	0%	2%	1%	6%	0%	0%	2%	-1%	1%	1%	-3%	1%		
10	12,356	13,142	13,629	13,942	14,001	13,859	13,299	13,442	13,874	13,868	13,350	*12,989*	13,479	0.97	
	-5%	-4%	-2%	-3%	-3%	-2%	-2%	-3%	-1%	-1%	0%	3%	-2%		
11	11,690	12,662	13,410	13,515	13,585	13,612	12,975	*13,016*	13,668	13,685	13,377	13,350	13,212	0.97	
	6%	4%	0%	0%	-2%	-1%	-6%	0%	1%	0%	0%	0%	0%		
12	12,382	13,150	13,430	13,546	13,366	13,534	12,225	*13,018*	13,740	13,653	13,399	13,378	13,235	0.96	
	-1%	-6%	-3%	0%	0%	0%	5%	0%	-1%	0%	-1%	-1%	-1%		
13	12,301	12,335	13,001	13,557	13,321	13,558	12,876	*13,055*	13,640	13,635	13,199	13,188	13,139	0.96	
												Growth	-0.35%	0.97	Sub Average

Average Adjusment Factor 0.97

Average Yearly Growth Calculated -0.2%
Yearly Growth Factor Used 0.5%

ITALICS = ESTIMATED DATA
MADT

□ Background Projects

G:\Projects\882 - Boston (Brooke HS)\Dwg\882 NPC 12.2.16.dwg

MDM TRANSPORTATION CONSULTANTS, INC. Planners & Engineers

vhb

ATTACHMENTS

SITE SPECIFIC TRIPS
WEEKDAY AM PEAK HOUR VOLUMES

HARVARD COMMONS (99 UNITS)
BOSTON, MA

G:\Projects\882 - Boston (Brooke HS)\Dwg\882 NPC 12.2.16.dwg

NOTES:

S = Signalized Intersection

MDM TRANSPORTATION CONSULTANTS, INC. Planners & Engineers

vhb

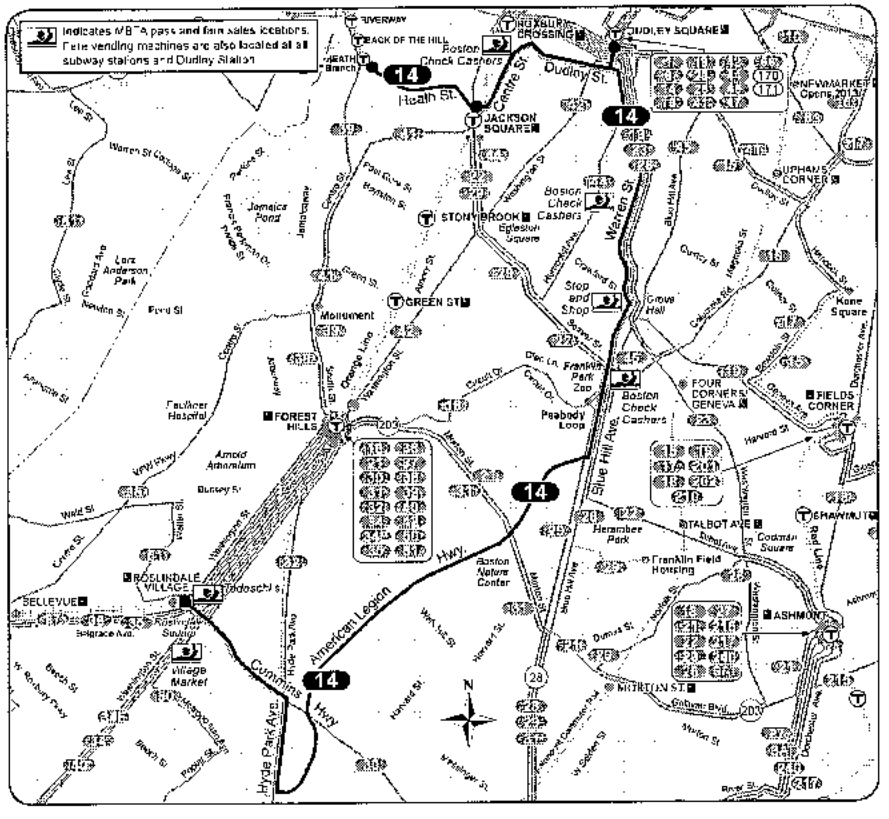
ATTACHMENTS

SITE SPECIFIC TRIPS
WEEKDAY PM PEAK HOUR VOLUMES

HARVARD COMMONS (99 UNITS)
BOSTON, MA

□ Public Transportation Information

Route 14 Roslindale Square - Heath Street Station



14

Summer June 25, 2016 - September 2, 2016

Roslindale Square-Heath Street Station

New fares effective July 1, 2016

Serving

- American Legion Highway
- Boston Police District 2
- Dudley Station
- Green Line
- Grove Hall
- Jackson Square
- Needham Commuter Rail
- Orange Line
- Roxbury District Courthouse

Information 617-222-3200 • 1-800-392-6100
(TTY) 617-222-5146 • www.mbta.com

14 Weekday

Inbound				Outbound			
Leave Roslindale Square	Arrive Dudley Station	Arrive Jackson Square Station	Arrive Heath Street	Leave Heath Street	Arrive Jackson Square Station	Lv/Arrive Dudley Station	Arrive Roslindale Square
6:00A	6:26A	6:33A	6:39A	.....	.....	5:57A	6:16A
6:38	7:12	7:21	7:27	6:15A	6:23A	6:28	7:00
7:16	7:49	7:55	8:02	6:55	7:07	7:14	7:45
7:54	8:26	8:34	8:41	7:33	7:45	7:52	8:22
8:32	9:06	9:12	9:19	8:11	8:24	8:33	9:00
9:10	9:44	9:50	9:57	8:53	9:06	9:15	9:42
10:13	10:44	10:54	10:59	9:33	9:46	9:55	10:22
11:16	11:50	11:54	11:59	10:11	10:24	10:33	11:00
				11:14	11:19	11:27	12:01P
12:19P	12:54P	12:58P	1:03P	12:17P	12:22P	12:30P	1:01P
1:22	1:58	2:04	2:11	1:20	1:32	1:46	2:17
2:07	2:43	2:49	2:56	2:23	2:37	2:51	3:22
2:52	3:28	3:34	3:42	3:08	3:22	3:34	4:13
3:37	4:15	4:21	4:29	3:53	4:06	4:15	4:54
4:22	5:00	5:06	5:14	4:38	4:51	5:00	5:37
5:07	5:43	5:49	5:56	5:23	5:34	5:43	6:15
5:52	6:28	6:32	6:38	6:08	6:19	6:31	7:01
6:37	7:07	7:13	7:19	6:53	7:04	7:16	7:46
7:22	7:49	.....	.....	7:38	7:55	7:58	.....

Fare	Local Bus	Bus + Bus	Rapid Transit	Bus + Rapid Transit
CharlieCard	$1.70	$1.70	$2.25	$2.25
CharlieTicket	$2.00	$2.00	$2.75	$4.75
Cash-on-Board	$2.00	$4.00	$2.75	$4.75
Student*	$0.85	$0.85	$1.10	$1.10
Senior/TAP**	$0.85	$0.85	$1.10	$1.10

VALID PASSES: LinkPass ($84.50/mo.); Local Bus ($55/mo.); *Student LinkPass ($50.00/mo.); **Senior/TAP LinkPass ($30/mo.); and express bus, commuter rail, and boat passes.
FREE FARES: Children 11 and under ride free when accompanied by an adult. Blind Access CharlieCard holders ride free and if using a guide, the guide rides free.

* Requires student CharlieCard, available to students through participating middle schools and high schools.

** Requires Senior/TAP CharlieCard, available to Medicare cardholders, seniors 65+, and persons with disabilities.

14 Saturday

Inbound				Outbound			
Leave Roslindale Square	Lv/Arrive Dudley Station	Arrive Jackson Square Station	Arrive Heath Street	Leave Heath Street	Arrive Jackson Square Station	Arrive Dudley Station	Arrive Roslindale Square
.....	6:45A	6:49A	6:55A	7:00A	7:05A	7:10A	.....
.....	7:15	7:19	7:25	7:30	7:35	7:40	.....
.....	7:45	7:49	7:55	8:00	8:05	8:10	.....
.....	8:15	8:19	8:25	8:30	8:35	8:42	.....
.....	8:45	8:49	8:55	9:05	9:10	9:17	9:46A
8:50A	9:16	9:22	9:26	9:40	9:45	9:52	10:20
9:25	9:51	9:57	10:02	10:15	10:20	10:27	10:55
9:55	10:27	10:33	10:39	10:50	10:55	11:02	11:36
10:30	11:02	11:08	11:14	11:25	11:31	11:37	12:11P
11:10	11:42	11:48	11:55				
11:45	12:18P	12:24P	12:31P				
				12:00N	12:06P	12:12P	12:46P
12:20P	12:52P	12:58P	1:05P	12:35P	12:41	12:47	1:21
12:55	1:28	1:34	1:41	1:10	1:16	1:22	1:56
1:30	2:03	2:09	2:16	1:45	1:51	1:57	2:29
2:05	2:37	2:41	2:48	2:20	2:26	2:34	3:06
2:40	3:12	3:16	3:23	2:55	3:01	3:09	3:40
3:15	3:47	3:51	3:58	3:30	3:36	3:45	4:17
3:50	4:22	4:26	4:33	4:05	4:11	4:20	4:52
4:25	4:57	5:02	5:08	4:40	4:46	4:55	5:27
5:00	5:29	5:35	5:41	5:15	5:21	5:30	5:59
5:35	6:04	6:10	6:16	5:50	5:56	6:05	6:35
6:10	6:39	6:44	6:50	6:25	6:31	6:37	7:06
6:45	7:12	7:17	7:23	7:00	7:05	7:11	7:40

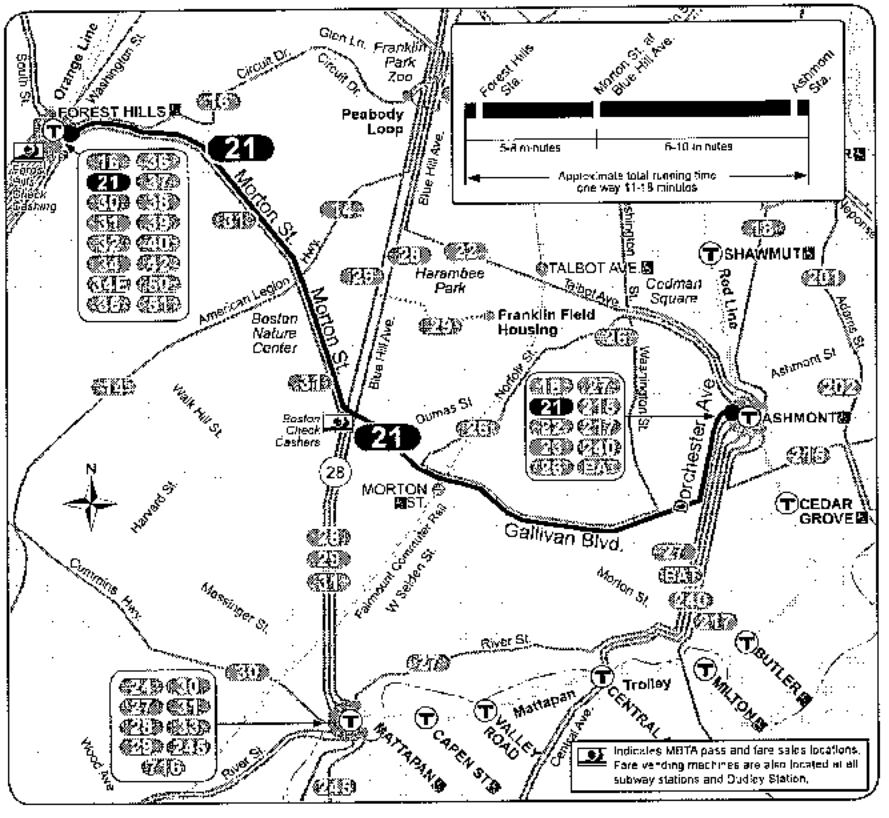
No service on Sunday

All buses are accessible to persons with disabilities

Route 14
Roslindale Square-Heath Street Station

Summer 2016 Holidays
July 4: see Sunday September 5: see Sunday

Route 21 Ashmont Station - Forest Hills Station



21

Summer June 25, 2016 - September 2, 2016

Ashmont Station- Forest Hills Station

New fares effective July 1, 2016

Serving
- Fairmount Commuter Rail
- Multipanhandle Speed Line
- Morton Street
- Needham Commuter Rail
- Orange Line
- Red Line
- Shattuck Hospital
- West Roxbury Courthouse

Massachusetts Bay Transportation Authority

MassDOT

Information 617-222-3200 • 1-800-392-6100
(TTY) 617-222-5146 • www.mbta.com

21 Weekday

Leave Ashmont Station	Inbound Arrive Blue Hill Avenue	Arrive Forest Hills Station	Leave Forest Hills Lower Busway	Outbound Arrive Blue Hill Avenue	Arrive Ashmont Station
5:30A	5:38A	5:47A	4:36A	4:45A	4:51A
5:45	5:53	6:02	5:35	5:40	5:48
6:00	6:08	6:17	6:00	6:05	6:13
6:06	6:14	6:23	6:09	6:14	6:22
6:12	6:20	6:29	6:27	6:33	6:43
6:18	6:26	6:35	6:36	6:42	6:52
6:24	6:32	6:41	6:45	6:51	7:02
6:30	6:38	6:47	6:54	7:00	7:11
6:42	6:50	6:59	7:14	7:21	7:32
6:48	6:56	7:06	7:23	7:30	7:41
6:54	7:03	7:14	7:32	7:39	7:50
7:00	7:09	7:20	7:41	7:48	7:59
7:09	7:18	7:29	7:50	7:57	8:07
7:21	7:30	7:41	7:59	8:05	8:15
7:33	7:42	7:53	8:08	8:14	8:24
7:45	7:54	8:05	8:17	8:23	8:33
7:57	8:06	8:17	8:28	8:34	8:44
8:04	8:13	8:24	8:40	8:46	8:56
8:16	8:25	8:36	8:52	8:58	9:08
8:28	8:37	8:48	9:13	9:19	9:29
8:40	8:49	9:00	9:34	9:40	9:50
8:52	9:01	9:11	9:55	10:01	10:11
9:13	9:21	9:31	*Every*	*20 Mins.*	*Until*
9:34	9:42	9:52	11:55	12:01P	12:11P
9:55	10:03	10:13			
Every	*20 Mins.*	*Until*	12:15P	12:21P	12:31P
11:55	12:03P	12:13P	12:35	12:41	12:51
			12:55	1:01	1:11
12:15P	12:23P	12:33P	1:20	1:26	1:36
12:35	12:43	12:53	1:45	1:51	2:01
12:55	1:03	1:13	2:10	2:16	2:28
1:20	1:28	1:38	2:29	2:35	2:47
1:45	1:52	2:02	2:35	2:41	2:53
2:10	2:17	2:27	2:41	2:47	2:59
2:35	2:42	2:51	2:53	2:59	3:10
2:45	2:52	3:01	3:09	3:17	3:28
2:55	3:02	3:11	3:22	3:30	3:43
3:05	3:12	3:21	3:34	3:43	3:56
3:15	3:22	3:31	3:46	3:55	4:08
3:36	3:43	3:53	*Every*	*13 Mins.*	*Until*
3:48	3:55	4:05	5:30	5:39	5:52
Every	*13 Mins.*	*Until*	5:43	5:52	6:03
5:45	5:54	6:05	5:56	6:04	6:15
6:00	6:09	6:20	6:10	6:18	6:29
6:20	6:29	6:38	6:30	6:38	6:49
6:40	6:48	6:57	6:50	6:58	7:07
7:00	7:08	7:17	7:10	7:15	7:25
7:15	7:23	7:32	7:50	7:56	8:05
7:30	7:38	7:47	8:30	8:36	8:45
8:10	8:18	8:27	9:10	9:16	9:25
8:50	8:58	9:07	10:20	10:26	10:34
9:30	9:37	9:45	11:30	11:35	11:42
10:00	10:07	10:15	12:40A	12:45A	12:52A
11:10	11:17	11:25			
12:20A	12:27A	12:35A			

21 Saturday

Leave Ashmont Station	Inbound Arrive Blue Hill Avenue	Arrive Forest Hills Station	Leave Forest Hills Lower Busway	Outbound Arrive Blue Hill Avenue	Arrive Ashmont Station
6:12A	6:19A	6:25A	5:50A	5:55A	6:03A
6:57	7:04	7:11	6:25	6:30	6:38
7:42	7:49	7:56	7:20	7:25	7:34
8:27	8:35	8:42	8:05	8:11	8:20
9:12	9:20	9:27	8:50	8:56	9:05
9:57	10:05	10:12	9:35	9:41	9:50
10:42	10:50	10:57	10:20	10:26	10:35
11:27	11:35	11:42	11:05	11:11	11:20
			11:50	11:56	12:05P
12:12P	12:20P	12:27P	12:35P	12:41P	12:51P
12:57	1:05	1:12	1:20	1:26	1:36
1:42	1:50	1:57	2:05	2:11	2:21
2:27	2:35	2:42	2:50	2:56	3:06
3:12	3:20	3:27	3:35	3:41	3:51
3:57	4:05	4:12	4:20	4:27	4:36
4:42	4:50	4:57	5:05	5:12	5:21
5:27	5:35	5:42	5:50	5:57	6:06
6:12	6:20	6:27	6:35	6:42	6:51
6:57	7:04	7:11	7:20	7:26	7:36
7:42	7:49	7:56	8:05	8:11	8:21
8:27	8:34	8:41	8:50	8:56	9:06
9:30	9:37	9:44	9:50	9:55	10:05
10:40	10:47	10:54	11:00	11:05	11:15
11:50	11:57	12:03A	12:10A	12:16A	12:24A

21 Sunday

Leave Ashmont Station	Inbound Arrive Blue Hill Avenue	Arrive Forest Hills Station	Leave Forest Hills Lower Busway	Outbound Arrive Blue Hill Avenue	Arrive Ashmont Station
9:45A	9:51A	9:59A	8:50A	8:55A	9:04A
10:45	10:52	10:59	9:50	9:55	10:04
11:45	11:52	11:59	10:50	10:55	11:04
			11:50	11:55	12:04P
12:45P	12:52P	12:59P			
1:45	1:53	1:59	12:50P	12:55P	1:05P
2:45	2:53	3:00	1:50	1:55	2:05
3:45	3:53	4:00	2:50	2:56	3:06
4:45	4:52	5:01	3:50	3:56	4:05
5:45	5:52	6:00	4:50	4:56	5:05
6:45	6:52	6:58	5:50	5:56	6:05
7:45	7:52	7:58	6:50	6:55	7:06
8:45	8:52	8:58	7:50	7:58	8:08
9:45	9:51	9:57	8:50	8:55	9:06

All buses are accessible to persons with disabilities

Route 21
Ashmont Station-Forest Hills Station

Fare	Local Bus	Bus + Bus	Rapid Transit	Bus + Rapid Transit
CharlieCard	$1.70	$1.70	$2.25	$2.25
CharlieTicket	$2.00	$2.00	$2.75	$4.75
Cash-on-Board	$2.00	$4.00	$2.75	$4.75
Student*	$0.85	$0.85	$1.10	$1.10
Senior/TAP**	$0.85	$0.85	$1.10	$1.10

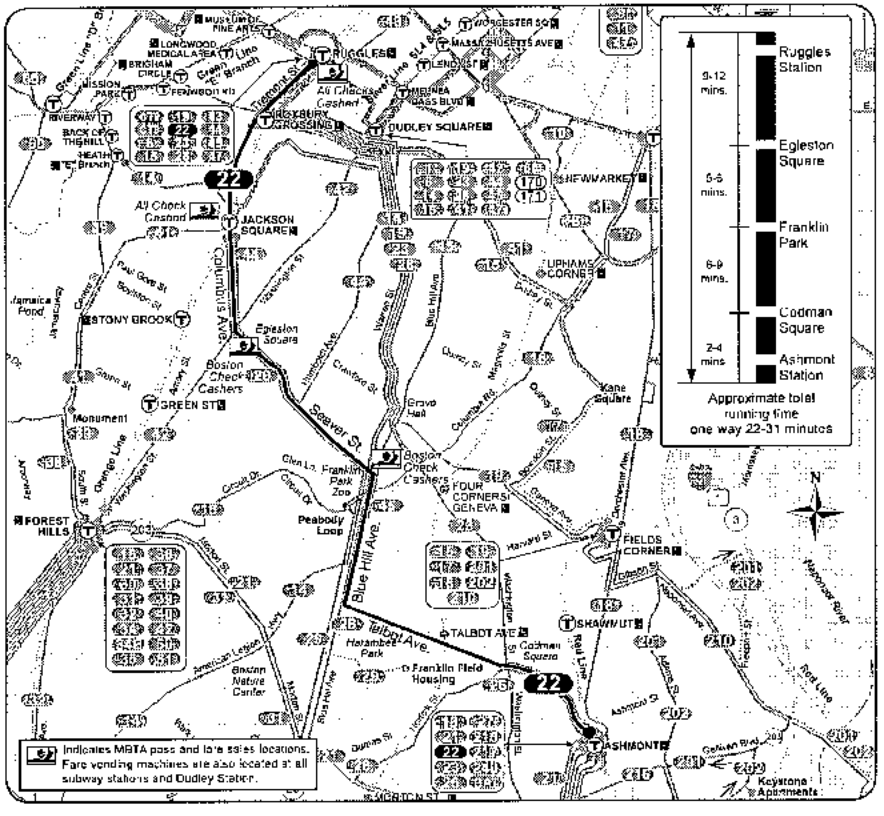
VALID PASSES: LinkPass ($84.50/mo.); Local Bus ($55/mo.); *Student LinkPass ($30.00/mo.); **Senior/TAP LinkPass ($30/mo.); and express bus, commuter rail, and boat passes
FREE FARES: Children 11 and under ride free when accompanied by an adult. Blind Access CharlieCard holders ride free and if using a guide, the guide rides free.

* Requires Student CharlieCard, available to students through participating middle schools and high schools.

** Requires Senior/TAP CharlieCard, available to Medicare cardholders, persons 65+, and persons with disabilities.

Summer 2016 Holidays
July 4: see Sunday September 5: see Sunday

Route 22 Ashmont Station - Ruggles Station



schedule change

22

Summer June 25, 2016 - September 2, 2016

Ashmont Station- Ruggles Station

via Talbot Avenue

New fares effective July 1, 2016

Serving

- Codman Square
- Franklin Field
- Franklin Park Zoo
- Egleston Square
- Jackson Square Station
- Red Line
- Orange Line
- Needham Commuter Rail
- Franklin Commuter Rail
- Providence/Stoughton Commuter Rail

Massachusetts Bay Transportation Authority

massDOT

Information 617-222-3200 • 1-800-392-6100
(TTY) 617-222-5146 • www.mbta.com

22 Weekday

Inbound			Outbound		
Leave Ashmont Station	Arrive Franklin Park	Arrive Ruggles Station	Leave Ruggles Station	Arrive Franklin Park	Arrive Ashmont Station
4:55A	5:03A	5:20A	5:28A	5:36A	5:49A
5:15	5:23	5:40	5:48	5:56	6:10
5:30	5:38	5:55	6:08	6:18	6:33
5:45	5:53	6:15	*Every*	*6 Mins.*	*or Less*
6:00	6:11	6:34	7:00	7:13	7:29
Every	*8 Mins.*	*or Less*	7:10	7:23	7:39
7:00	7:12	7:40	7:20	7:33	7:49
7:10	7:22	7:50	7:30	7:43	7:59
7:20	7:32	8:00	*Every*	*10 Mins*	*Until*
7:30	7:42	8:10	9:10	9:26	9:43
7:40	7:52	8:20	9:24	9:40	9:57
7:50	8:02	8:30	9:38	9:54	10:11
8:00	8:12	8:40	9:52	10:08	10:25
Every	*10 Mins.*	*Until*	*Every*	*14 Mins.*	*Until*
9:00	9:12	9:35	11:58	12:17P	**12:34P**
9:14	9:26	9:49			
9:28	9:40	**10:03**	12:13P	**12:32P**	**12:49P**
9:42	9:54	10:17	*Every*	*15 Mins.*	*Until*
9:56	10:08	10:31	4:13	4:32	4:52
Every	*14 Mins.*	*Until*	4:28	4:47	**5:07**
11:48	**12:00N**	**12:24P**	4:37	4:56	5:16
			4:46	5:05	5:25
12:03P	**12:18P**	12:42P	4:55	5:14	**5:34**
Every	*15 Mins.*	*Until*	5:04	5:23	**5:44**
4:03	4:18	4:38	5:13	5:32	**5:53**
4:18	4:33	4:53	5:22	5:40	6:01
4:33	4:48	5:08	5:31	**5:48**	**6:07**
4:48	5:03	5:23	5:40	5:57	6:13
4:57	5:12	5:32	5:49	6:06	6:22
5:06	5:21	**5:41**	5:58	6:13	6:29
5:15	5:30	5:50	6:08	6:23	6:39
5:24	5:39	**5:59**	6:18	6:33	**6:49**
5:33	5:48	6:08	6:28	6:43	**6:59**
5:42	5:57	6:17	6:38	6:53	7:09
5:51	6:06	6:26	6:48	7:03	7:19
6:00	6:15	6:34	7:03	7:18	7:34
6:10	6:25	6:44	7:18	7:33	7:49
6:20	6:34	6:53	7:35	7:50	8:06
6:30	**6:41**	7:00	7:52	8:07	8:23
6:44	6:55	**7:14**	8:09	8:24	**8:39**
6:58	7:09	7:28	8:26	8:39	8:53
7:13	**7:24**	7:43	8:43	8:55	9:09
7:30	**7:41**	**8:00**	9:00	9:12	**9:26**
7:47	**7:58**	**8:17**	9:17	**9:29**	**9:43**
8:04	8:15	8:33	9:34	9:46	10:00
8:21	**8:31**	**8:47**	9:51	10:03	**10:17**
8:38	**8:47**	9:03	10:08	10:20	**10:34**
8:55	9:04	9:20	10:25	10:37	**10:51**
9:12	9:21	9:37	10:43	10:55	11:09
Every	*17 Mins.*	*Until*	11:03	11:15	11:29
11:11	11:19	11:34	11:23	11:33	**11:44**
11:30	11:38	11:53	11:43	11:52	12:03A
11:50	11:59	12:13A	12:03A	12:12A	12:23
12:10A	12:18A	12:33	12:23	12:32	12:43
12:30	12:38	12:53	12:43	12:52	1:03
12:50	12:58	1:13	aw 1:00	1:26	1:31

22 Saturday

Inbound			Outbound		
Leave Ashmont Station	Arrive Franklin Park	Arrive Ruggles Station	Leave Ruggles Station	Arrive Franklin Park	Arrive Ashmont Station
a 5:00A	5:06A	5:17A	5:25A	5:32A	5:40A
5:22	5:28	5:41	5:39	5:46	5:54
5:37	5:43	5:56	*Every*	*14 Mins.*	*Until*
5:47	5:53	6:06	7:17	7:26	7:36
Every	*15 Mins.*	*Until*	7:33	7:43	7:55
8:17	8:27	8:43	7:49	**7:59**	8:11
8:33	8:43	8:59	8:05	8:15	**8:27**
8:49	8:59	9:18	8:21	**8:31**	8:43
9:05	9:15	9:34	8:37	8:47	8:59
9:21	9:31	9:50	8:53	9:03	9:15
9:37	9:47	10:06	9:09	9:19	9:31
9:55	10:05	10:24	9:25	9:36	9:50
10:12	10:22	10:41	9:41	9:53	10:07
10:30	10:40	10:59	9:57	10:09	10:23
10:44	10:54	11:13	10:13	**10:25**	10:39
10:55	11:05	11:24	10:29	10:41	10:55
11:06	11:16	11:36	10:45	10:57	11:11
11:17	11:27	11:47	11:01	11:13	11:27
11:28	11:38	11:59	11:15	11:27	11:42
11:39	11:50	**12:10P**	11:29	11:43	11:58
11:50	12:01P	**12:21**	11:41	11:55	**12:10P**
			11:52	12:06P	**12:21**
12:01P	**12:12P**	**12:32P**			
12:12	**12:23**	**12:43**	12:03P	12:17P	**12:32P**
12:23	**12:34**	**12:54**	12:14	12:28	**12:43**
12:34	**12:45**	**1:05**	12:25	12:39	**12:54**
12:46	**12:57**	1:17	*Every*	*12 Mins.*	*Until*
12:58	**1:09**	1:29	5:25	5:39	**5:54**
Every	*12 Mins.*	*Until*	5:40	5:54	6:09
5:58	6:08	**6:27**	5:55	6:09	6:24
6:10	6:20	6:39	**6:10**	**6:24**	6:39
6:25	6:35	6:54	6:25	6:39	6:54
6:40	6:50	7:09	6:40	**6:54**	7:07
6:55	7:05	7:23	6:55	7:10	7:22
7:10	**7:19**	**7:37**	7:10	**7:24**	7:36
7:25	7:34	7:52	7:25	7:39	7:51
7:45	7:54	8:12	7:40	7:54	8:06
Every	*20 Mins.*	*Until*	7:55	**8:07**	8:19
12:05A	12:12A	12:26A	*Every*	*20 Mins.*	*Until*
12:30	12:37	12:51	**11:35**	**11:46**	11:57
12:55	1:02	1:16	12:00M	12:10A	12:21A
			12:30A	12:40	12:51
			aw 1:00	1:16	1:23

a - Via Route 45 between Ruggles Station & Blue Hill Ave., at Seaver St.
w - Waits for last train to arrive at Ruggles station.

22 Sunday

Inbound			Outbound		
Leave Ashmont Station	Arrive Franklin Park	Arrive Ruggles Station	Leave Ruggles Station	Arrive Franklin Park	Arrive Ashmont Station
6:15A	6:23A	6:39A	6:06A	6:16A	**6:26A**
6:30	6:38	6:54	*Every*	*17 Mins.*	*Until*
Every	*17 Mins.*	*Until*	6:22	6:32	**8:44**
8:12	8:20	8:36	8:40	8:50	9:02
8:30	8:38	8:54	*Every*	*20 Mins.*	*Until*
Every	*20 Mins.*	*Until*	11:40	11:53	**12:08P**
11:50	**12:00N**	**12:20P**			
			12:00N	**12:13P**	12:29P
12:10P	**12:20P**	**12:41P**	*Every*	*20 Mins.*	*Until*
Every	*20 Mins.*	*Until*	**1:00**	1:13	1:29
1:50	2:02	2:23	1:16	1:31	1:47
2:08	2:20	2:41	1:36	1:49	2:05
2:26	2:38	2:59	1:52	2:05	2:22
2:44	2:56	3:17	2:10	2:24	2:41
3:02	3:14	3:35	2:28	2:42	2:59
3:20	3:32	3:53	2:46	3:00	3:17
3:38	3:49	4:10	3:04	3:19	3:36
3:56	**4:07**	4:28	3:22	3:37	3:54
4:14	4:25	4:46	3:40	3:55	4:12
4:32	4:43	5:04	3:58	4:13	4:30
4:50	5:01	5:22	4:16	4:31	4:48
5:08	5:19	**5:40**	**4:34**	4:49	5:06
5:26	5:37	**5:58**	4:52	5:07	5:24
5:44	5:55	6:15	5:10	5:25	**5:42**
6:02	6:13	6:34	5:28	5:43	6:00
6:20	6:31	6:52	5:46	6:01	6:18
6:38	6:49	**7:10**	6:04	6:19	6:36
6:56	7:07	7:29	6:22	6:37	6:54
7:14	7:25	7:46	6:40	6:55	**7:11**
7:32	7:43	**8:03**	*Every*	*20 Mins.*	*Until*
7:50	8:01	**8:21**	11:40	11:52	12:05A
Every	*20 Mins.*	*Until*	12:10A	12:20A	12:32
12:10A	12:17A	12:32A	12:40	12:50	1:02
12:33	12:40	12:55	aw 1:00	1:13	1:23

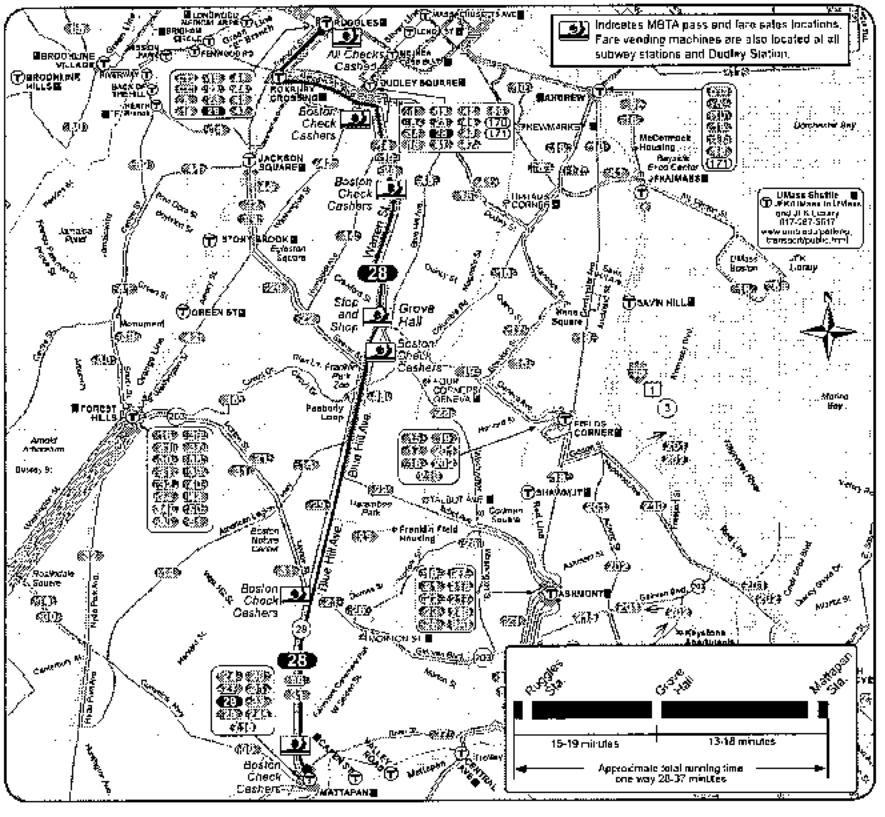
All buses are accessible to persons with disabilities

Fare	Local Bus	Bus + Bus	Rapid Transit	Bus + Rapid Transit
CharlieCard	$1.70	$1.70	$2.25	$2.25
CharlieTicket	$2.00	$2.00	$2.75	$4.75
Cash-on-Board	$2.00	$4.00	$2.75	$4.75
Student*	$0.85	$0.85	$1.10	$1.10
Senior/TAP**	$0.85	$0.85	$1.10	$1.10

VALID PASSES: LinkPass ($60.50/mo.); Local Bus ($55/mo.); *Student LinkPass ($30.00/mo.); **Senior/TAP LinkPass ($30/mo.); and express bus, commuter rail, and boat passes.
FREE FARES: Children 11 and under ride free when accompanied by an adult; Blind Access CharlieCard holders ride free and if using a guide, the guide rides free.
* Requires Student CharlieCard, available to students through participating middle schools and high schools.
** Requires Senior/TAP CharlieCard, available to Medicare cardholders, seniors 65+, and persons with disabilities

Summer 2016 Holidays
July 4: see Sunday September 5: see Sunday

Route 28 Mattapan Station - Ruggles Station



28

Fall September 3, 2016 - December 30, 2016

Mattapan Station-Ruggles Station

Serving

- Dudley Station
- Roxbury District Courthouse
- Grove Hall
- Franklin Park Zoo
- Franklin Field
- Orange Line
- Mattapan High Speed Line
- Needham Commuter Rail
- Franklin Commuter Rail
- Attleboro/Stoughton Commuter Rail

Massachusetts Bay Transportation Authority

MASSDOT

Information 617-222-3200 • 1-800-392-6100
(TTY) 617-222-5146 • www.mbta.com

28 Weekday

Inbound

Leave Mattapan Station	Arrive Franklin Park	Arrive Dudley Station	Arrive Ruggles Station
3:20A	3:25A	a 3:30A	.....
3:59	4:05	a 4:12	.....
b 4:35	.....	5:03	.....
4:40	4:50	4:58	.....
5:08	5:19	5:29	5:33A
5:26	5:37	5:47	5:51
5:44	5:55	6:05	6:15
6:02	6:16	6:27	6:37
6:09	6:23	6:34	6:44
6:16	6:30	6:41	6:51
Every	*7 Minutes*		*Until*
7:19	7:35	7:48	7:57
7:26	7:42	7:55	8:04
7:33	7:49	8:02	8:11
7:40	7:56	8:09	8:18
Every	*10 Minutes*		*or Less*
10:08	10:23	10:35	10:43
10:19	10:34	10:46	10:54
10:29	10:44	10:56	11:06
10:40	10:55	11:08	11:18
10:50	11:04	11:17	11:27
11:01	11:16	11:29	11:39
11:13	11:28	11:41	11:51
11:25	11:40	11:53	12:03P
11:37	11:52	12:05P	12:15
11:49	12:04P	12:17	12:27
11:59	12:14	12:27	12:37
12:09P	12:24P	12:37P	12:47P
12:19	12:34	12:47	12:57
Every	*9 Minutes*		*or Less*
1:31	1:46	2:01	2:11
.....	ts 1:55	2:01	2:09
1:40	1:57	2:09	2:19
1:49	2:05	2:17	2:27
Every	*9 Minutes*		*or Less*
6:30	6:44	6:53	7:02
6:40	6:54	7:03	7:12
6:50	7:04	7:13	7:22
7:02	7:16	7:25	7:34
7:14	7:28	7:37	7:46
7:26	7:40	7:49	7:58
7:38	7:52	8:02	8:10
7:50	8:03	8:12	8:20
8:03	8:13	8:22	8:30
8:16	8:26	8:35	8:43
8:30	8:40	8:49	8:57
8:45	8:55	9:04	9:12
9:00	9:10	9:19	9:27
Every	*20 Minutes*		*Until*
12:40A	12:50A	12:57A	1:03A
w 1:17	1:27	1:34	1:40

Outbound

Leave Ruggles Station	Lv/Arrive Dudley Station	Arrive Franklin Park	Arrive Mattapan Station
.....	b 5:45A	.....	6:09A
5:43A	5:47	5:57A	6:14
6:01	6:07	6:19	6:37
6:19	6:25	6:37	6:55
6:37	6:43	6:55	7:13
6:50	6:56	7:08	7:26
7:01	7:07	7:19	7:37
7:10	7:16	7:28	7:46
7:17	7:23	7:35	7:53
7:24	7:30	7:42	8:00
Every	*10 Minutes*		*or Less*
10:54	11:00	11:17	11:36
11:05	11:11	11:28	11:47
11:16	11:22	11:39	11:58
11:27	11:33	11:50	12:09P
11:38	11:44	12:01P	12:21
11:50	11:56	12:14	12:34
12:02P	12:10P	12:26P	12:48P
12:14	12:22	12:40	1:00
12:26	12:34	12:52	1:12
12:37	12:45	1:03	1:23
Every	*10 Minutes*		*or Less*
1:33	1:41	1:59	2:21
.....	ts 2:00	2:06	2:25
1:42	1:50	2:09	2:31
1:51	1:59	2:16	2:40
2:00	2:08	2:27	2:49
.....	ms 2:08	2:32	2:51
2:09	2:17	2:36	2:58
2:18	2:26	2:45	3:08
2:27	2:35	2:54	3:19
2:35	2:43	3:03	3:28
ls 2:35	2:45	3:01	3:21
2:43	2:51	3:12	3:37
2:51	2:59	3:20	3:45
Every	*9 Minutes*		*or Less*
7:03	7:10	7:25	7:44
7:15	7:22	7:37	7:56
7:27	7:34	7:49	8:06
7:39	7:46	8:01	8:17
7:51	7:58	8:11	8:27
8:03	8:09	8:22	8:38
8:15	8:22	8:35	8:51
8:29	8:35	8:48	9:04
8:42	8:48	9:01	9:17
9:00	9:05	9:19	9:35
Every	*20 Minutes*		*Until*
12:00M	12:04A	12:14A	12:28
12:20A	12:24	12:34	12:48
12:40	12:44	12:54	1:06
w 1:00	1:04	1:14	1:26

28 Saturday

Inbound

Leave Mattapan Station	Arrive Franklin Park	Lv/Arrive Dudley Station	Arrive Ruggles Station
3:20A	3:27A	a 3:33A	.....
3:59	4:06	a 4:12	.....
b 4:28	.....	4:58	.....
4:45	4:54	5:03	.....
5:12	5:19	5:27	5:31A
5:37	5:47	5:55	6:00
6:00	6:10	6:19	6:23
Every	*15 Minutes*		*Until*
7:15	7:27	7:38	7:44
7:30	7:42	7:53	7:59
7:40	7:52	8:03	8:09
7:50	8:02	8:13	8:19
8:00	8:12	8:23	8:29
Every	*11 Minutes*		*Until*
11:51	12:05P	12:20P	12:25P
12:02P	12:17P	12:31P	12:36P
Every	*11 Minutes*		*Until*
5:54	6:09	6:21	6:27
6:07	6:22	6:34	6:40
6:20	6:35	6:47	6:53
6:33	6:48	7:02	7:07
6:46	7:01	7:13	7:18
6:59	7:12	7:24	7:28
7:12	7:25	7:37	7:42
7:25	7:38	7:50	7:55
7:38	7:51	8:03	8:08
7:51	8:04	8:16	8:21
8:06	8:21	8:33	8:38
Every	*17 Minutes*		*Until*
12:06A	12:16A	12:24A	12:29A
12:23	12:33	12:41	12:46
12:40	12:50	12:58	1:03
12:57	1:07	1:15	1:20
w 1:17	1:27	1:35	1:40

Outbound

Leave Ruggles Station	Arrive Dudley Station	Arrive Franklin Park	Arrive Mattapan Station
4:45A	4:49A	4:55A	5:05A
5:07	5:11	5:17	5:27
.....	b 5:19	.....	5:41
5:42	5:46	5:52	6:04
6:00	6:05	6:14	6:26
Every	*15 Minutes*		*Until*
7:15	7:20	7:29	7:45
7:25	7:30	7:41	7:57
7:35	7:42	7:53	8:08
7:45	7:52	8:03	8:19
7:55	8:02	8:13	8:29
8:05	8:13	8:24	8:40
Every	*11 Minutes*		*Until*
11:57	12:05P	12:18P	12:37P
12:08P	12:16P	12:29P	12:48P
Every	*11 Minutes*		*Until*
5:48	5:57	6:11	6:29
6:02	6:10	6:24	6:42
6:15	6:23	6:37	6:55
6:28	6:36	6:50	7:09
6:41	6:49	7:03	7:20
6:54	7:01	7:14	7:31
7:07	7:14	7:27	7:44
7:20	7:27	7:40	7:57
7:33	7:40	7:53	8:10
7:46	7:53	8:06	8:23
7:59	8:06	8:19	8:34
8:16	8:23	8:36	8:53
Every	*17 Minutes*		*Until*
11:57	12:03A	12:14A	12:27A
12:14A	12:20	12:31	12:44
12:31	12:37	12:48	1:01
12:47	12:53	1:04	1:17
w 1:00	1:06	1:17	1:30

Weekday & Saturday note: For additional service between Mattapan and Ruggles Station via Seaver Street after 8:10 pm refer to the Route 29 schedule card.

a - Connects to service to Andrew Station and Logan Airport
b - To/from downtown Boston via River St., Ashmont, and Fields Corner
l - Leaves from Avenue Louis Pasteur at 2:15 pm
m- Leaves from Malcolm X. Blvd.
s - Does NOT run during school vacation
t - Leaves from Townsend and Warrens Streets
w - Waits for last train to arrive at station.

Fall 2016 Holidays

October 10 & November 11: see Weekday
September 5, November 24 & December 26: see Sunday

28 Sunday

Inbound

Leave Mattapan Station	Arrive Franklin Park	Arrive Dudley Station	Arrive Ruggles Station
3:20A	3:26A	a 3:33A	.....
3:59	4:05	a 4:12	.....
4:45	4:51	4:58	.....
b 5:21	.....	5:49	.....
5:39	5:49	5:59	6:03
5:54	6:14	6:25	6:28
6:29	6:39	6:50	6:53
6:54	7:04	7:15	7:18
7:14	7:24	7:35	7:38
7:34	7:44	7:55	7:58
7:54	8:05	8:16	8:22
8:09	8:21	8:32	8:36
Every	*15 Minutes*		*Until*
9:54	10:09	10:23	10:28
10:07	10:22	10:36	10:41
10:21	10:36	10:50	10:55
10:35	10:50	11:04	11:09
10:49	11:04	11:18	11:21
11:02	11:17	11:29	11:34
11:15	11:30	11:42	11:47
11:29	11:44	11:56	12:01P
11:42	11:57	12:09P	12:14
11:56	12:11P	12:23	12:28
12:09P	12:24P	12:41P	12:45P
Every	*14 Minutes*		*Until*
7:37	7:49	8:00	8:05
7:53	8:05	8:16	8:21
8:09	8:21	8:32	8:37
8:26	8:38	8:49	8:54
8:43	8:55	9:06	9:11
9:00	9:12	9:23	9:28
9:17	9:29	9:39	9:44
9:34	9:44	9:54	9:59
9:51	10:01	10:11	10:16
10:08	10:18	10:28	10:33
Every	*17 Minutes*		*Until*
11:50	11:56	12:06A	12:10A
12:07A	12:15A	12:23	12:27
12:24	12:32	12:40	12:44
12:41	12:49	12:57	1:01
12:58	1:06	1:14	1:18
w 1:17	1:25	1:33	1:37

Outbound

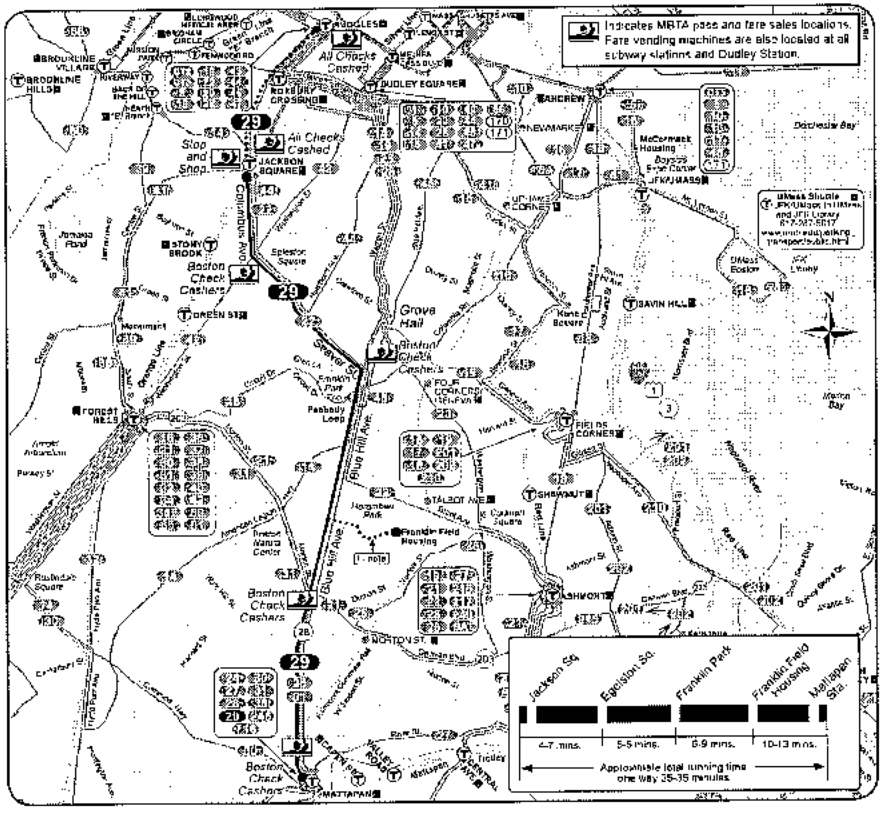
Leave Ruggles Station	Arrive Dudley Station	Arrive Franklin Park	Arrive Mattapan Station
6:10A	6:15A	6:24A	6:38A
6:35	6:40	6:50	7:04
7:00	7:05	7:15	7:29
7:20	7:25	7:35	7:49
Every	*15 Minutes*		*Until*
9:50	9:57	10:09	10:26
10:04	10:11	10:23	10:40
10:18	10:25	10:39	10:55
10:31	10:38	10:51	11:07
10:45	10:52	11:05	11:21
10:58	11:05	11:19	11:34
11:11	11:18	11:31	11:47
11:24	11:31	11:44	12:00N
11:37	11:44	11:57	12:13P
11:50	11:57	12:10P	12:28
12:03P	12:10P	12:23P	12:38P
12:16	12:23	12:36	12:52
12:28	12:38	12:49	1:05
12:49	12:49	1:02	1:18
12:56	1:02	1:15	1:31
1:08	1:15	1:28	1:46
Every	*14 Minutes*		*Until*
6:58	7:05	7:17	7:33
7:13	7:20	7:32	7:48
7:28	7:35	7:47	8:03
7:44	7:51	8:03	8:19
8:00	8:07	8:19	8:36
8:16	8:23	8:34	8:50
8:32	8:38	8:48	9:05
8:48	8:55	9:06	9:22
9:06	9:12	9:23	9:39
9:23	9:29	9:40	9:56
9:40	9:46	9:57	10:11
9:57	10:03	10:13	10:28
10:14	10:20	10:30	10:43
Every	*17 Minutes*		*Until*
11:39	11:45	11:55	12:07A
11:56	12:02A	12:10A	12:22
12:13A	12:18A	12:26	12:38
12:30	12:35	12:43	12:55
12:47	12:52	1:00	1:12
w 1:00	1:05	1:13	1:25

All buses are accessible to persons with disabilities

Fare	Local Bus	Bus + Bus	Rapid Transit	Bus + Rapid Transit
CharlieCard	$1.70	$1.70	$2.25	$2.25
CharlieTicket	$2.00	$2.00	$2.75	$4.75
Cash-on-Board	$2.00	$4.00	$2.75	$4.75
Student*	.....	$0.85	$0.85	$1.10	$1.10
Senior/TAP**	.....	$0.85	$0.85	$1.10	$1.10

VALID PASSES: BlinkPass ($84.50/mo.); Local Bus ($55/mo.); *Student LinkPass ($30.00/mo.); **Senior/TAP LinkPass ($30/mo.); and express bus, commuter rail, and boat passes.
FREE FARES: Children (3 and under ride free when accompanied by an adult). Blind Access CharlieCard holders ride free and if using a guide, the guide rides free.
* Requires Student CharlieCard, available to students through participating middle schools and high schools.
** Requires Senior/TAP CharlieCard, available to Medicare cardholders, seniors 65+, and persons with disabilities.

Route 29 Mattapan Station - Jackson Square Station



29

Summer June 25, 2016 - September 2, 2016

Mattapan Station- Jackson Square Station

New fares effective July 1, 2016

Serving:

- Egleston Square
- Wellington Hill
- Franklin Park Zoo
- Franklin Field
- Orange Line
- Mattapan High Speed Line

Massachusetts Bay Transportation Authority

Information 617-222-3200 • 1-800-392-6100
(TTY) 617-222-5146 • www.mbta.com

29 Weekday

Inbound				Outbound			
Leave Mattapan Station	Arrive Franklin Park	Arrive Jackson Square Station	Arrive Ruggles Station	Leave Ruggles Station	Leave/Arrive Jackson Square Station	Arrive Franklin Park	Arrive Mattapan Station
5:55A	6:06A	6:16A	.....	.....	6:17A	6:25A	6:41A
6:12	6:23	6:33	.....	.....	6:39	6:47	7:04
6:29	6:43	6:54	.....	.....	6:59	7:06	7:24
6:46	7:00	7:11	.....	.....	7:19	7:26	7:44
7:05	7:19	7:30	.....	.....	7:39	7:46	8:03
7:20	7:34	7:45	.....	.....	7:55	8:01	8:18
7:36	7:50	8:01	.....	.....	8:11	8:17	8:34
f 7:52	8:13	8:26	.....	.....	f 8:27	8:34	8:55
8:08	8:22	8:34	.....	.....	8:43	8:49	9:06
8:24	8:41	8:52	.....	.....	8:59	9:05	9:22
f 8:40	8:59	9:15	.....	.....	f 9:30	9:37	9:58
9:00	9:17	9:28	.....	.....	f 10:40	10:46	11:09
f 10:05	10:23	10:32	.....	.....	f 11:50	11:57	12:16P
f 11:15	11:31	11:42	.....				
				.....	f 1:00P	1:07P	1:31P
f 12:25P	12:42P	12:53P	.....	.....	f 2:10	2:17	2:42
f 1:35	1:52	2:03	.....	2:55P	3:04	3:13	3:36
f 2:45	3:02	3:14	.....	.....	f 3:20	3:28	3:53
f 3:15	3:35	3:47	.....	.....	f 3:50	3:58	4:26
3:45	4:02	4:12	.....	.....	4:05	4:17	4:43
f 4:15	4:35	4:45	.....	.....	4:20	4:32	4:58
4:30	4:47	4:57	.....	.....	4:35	4:47	5:12
4:45	5:02	5:12	.....	.....	f 4:50	5:00	5:28
5:00	5:17	5:27	.....	.....	5:05	5:15	5:40
f 5:15	5:34	5:44	.....	.....	5:20	5:30	5:55
5:30	5:47	5:57	.....	.....	5:35	5:45	6:10
5:45	6:01	6:11	.....	.....	f 5:50	6:00	6:28
f 6:00	6:19	6:29	.....	.....	6:05	6:15	6:37
6:15	6:31	6:41	.....	.....	6:20	6:30	6:52
6:30	6:41	6:51	.....	.....	f 6:35	6:45	7:09
8:20	8:31	8:43	8:48P	8:10	8:17	8:27	8:51
8:55	9:06	9:18	9:23	8:35	8:42	8:52	9:19
9:26	9:37	9:49	9:54	9:00	9:06	9:14	9:40
9:41	9:52	10:03	10:08	9:35	9:41	9:49	10:15
10:16	10:25	10:35	10:40	10:10	10:16	10:25	10:51
10:51	11:00	11:10	11:15	10:45	10:51	11:00	11:16
11:20	11:29	11:36	11:43	11:20	11:26	11:31	11:47
11:55	12:03A	12:10A	12:17A	11:55	12:01A	12:04A	12:17A
12:30A	12:38	12:45	12:52	12:30A	12:35	12:38	12:51
f - Via Franklin Field Housing				1:00	1:05	1:08	1:21

29 Saturday

Inbound				Outbound			
Leave Mattapan Station	Arrive Franklin Park	Arrive Jackson Square Station	Arrive Ruggles Station	Leave Ruggles Station	Arrive Jackson Square Station	Arrive Franklin Park	Arrive Mattapan Station
8:20P	8:31P	8:41P	8:48P	8:10P	8:17P	8:25P	8:42P
8:50	9:01	9:10	9:18	8:35	8:41	8:49	9:05
9:15	9:27	9:36	9:44	9:00	9:06	9:14	9:30
9:40	9:52	10:01	10:09	9:25	9:31	9:38	9:54
10:00	10:11	10:20	10:28	9:50	9:55	10:02	10:18
10:25	10:36	10:45	10:53	10:15	10:20	10:27	10:43
10:50	11:01	11:09	11:16	10:40	10:45	10:52	11:08
11:15	11:25	11:33	11:40	11:05	11:10	11:17	11:32
11:40	11:50	11:58	12:05A	11:30	11:35	11:41	11:56
12:05A	12:13A	12:21A	12:28	11:55	12:00M	12:06A	12:21A
12:40	12:48	12:56	1:02	12:20A	12:25A	12:31	12:45
				12:50	12:54	12:58	1:12

No service on Sunday

Summer 2016 Holidays
July 4: see Sunday September 5: see Sunday

NOTE: For additional service along Blue Hill Avenue between Mattapan Station and Seaver Street, please refer to the Route 28 schedule card.

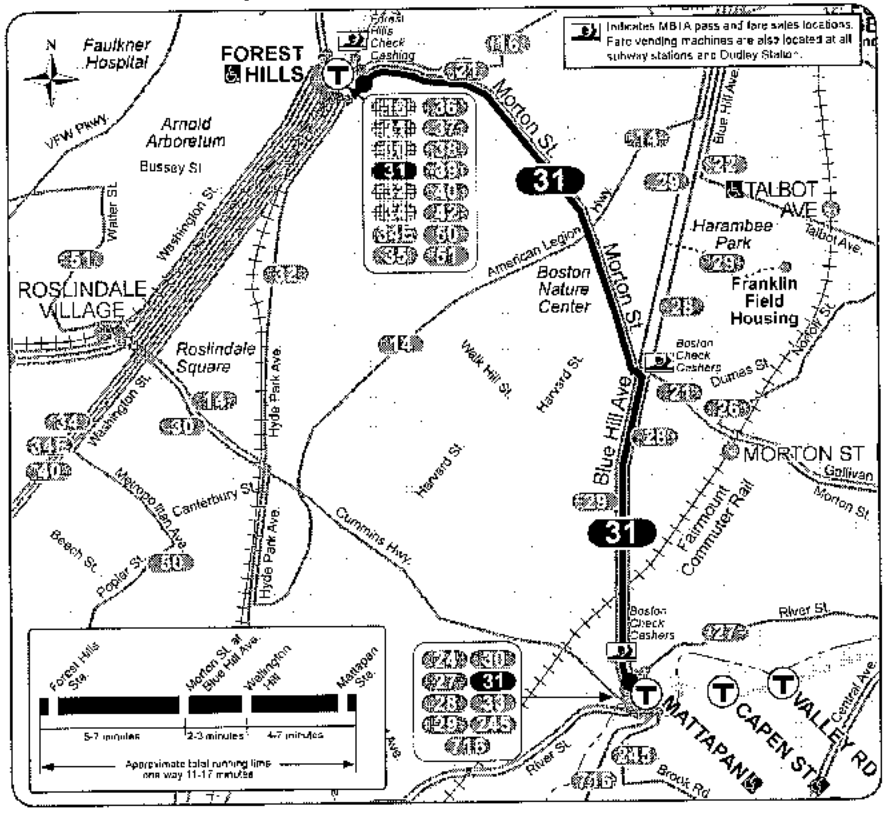
All buses are accessible to persons with disabilities

Route 29
Mattapan Station-
Jackson Square Station

Fare	Local Bus	Bus + Bus	Rapid Transit	Bus + Rapid Transit
CharlieCard	$1.70	$1.70	$2.25	$2.25
CharlieTicket	$2.00	$2.00	$2.75	$4.75
Cash-on-Board	$2.00	$4.00	$2.75	$4.75
Student*	$0.85	$0.85	$1.10	$1.10
Senior/TAP**	$0.85	$0.85	$1.10	$1.10

VALID PASSES: LinkPass ($84.50/mo.); Local Bus ($55/mo.); * Student LinkPass ($30.00/mo.); * Senior/TAP LinkPass ($30/mo.); and express bus, commuter rail, and boat passes
FREE FARES: Children 11 and under ride free when accompanied by an adult; Blind Access CharlieCard holders ride free and if using a guide, the guide rides free.
* Requires Student CharlieCard, available to students through participating middle schools and high schools
** Requires Senior/TAP CharlieCard, available to Medicare cardholders, seniors 65+, and persons with disabilities.

Route 31 Mattapan Station - Forest Hills Station



31

Summer June 25, 2016 - September 2, 2016

Mattapan Station- Forest Hills Station

via Morton Street

New fares effective July 1, 2016

Serving
- Shattuck Hospital
- West Roxbury Courthouse
- Mattapan High Speed Line
- Needham Commuter Rail
- Orange Line

Massachusetts Bay Transportation Authority

massDOT

Information 617-222-3200 • 1-800-392-6100
(TTY) 617-222-5146 • www.mbta.com

31 Weekday

Inbound			Outbound		
Leave Mattapan Station	Arrive Morton Street	Arrive Forest Hills Station	Leave Forest Hills Lower Busway	Arrive Morton Street	Arrive Mattapan Station
4:53A	4:58A	5:05A	4:38A	4:42A	4:48A
5:15	5:20	5:27	5:15	5:19	5:25
5:30	5:35	5:42	5:30	5:34	5:40
5:45	5:50	5:57	5:45	5:49	5:55
5:55	6:00	6:07	5:55	5:59	6:05
Every	*5 Mins.*	*Until*	*Every*	*5 Mins.*	*Until*
7:05	7:13	7:21	6:40	6:45	6:52
7:11	7:19	7:27	6:47	6:52	6:59
7:16	7:24	7:32	6:52	6:57	7:05
Every	*6 Mins.*	*or Less*	6:57	7:03	7:11
9:10	9:16	9:24	7:02	7:09	7:17
9:21	9:27	9:35	7:07	7:14	7:22
9:31	9:37	9:45	7:12	7:19	7:27
Every	*11 Mins.*	*or Less*	7:17	7:24	7:32
11:55	**12:01P**	**12:09P**	7:22	7:29	7:37
			Every	*6 Mins*	*or Less*
12:05P	12:11P	**12:19P**	9:10	9:17	9:25
12:15	**12:21**	**12:29**	9:20	9:27	9:35
12:25	**12:31**	**12:39**	*Every*	*11 Mins.*	*or Less*
12:36	**12:42**	**12:50**	11:55	**12:02P**	**12:13P**
Every	***10 Mins.***	***or Less***			
3:00	**3:06**	**3:14**	**12:05P**	**12:12P**	**12:23P**
3:05	**3:11**	**3:19**	***Every***	***10 Mins.***	***or Less***
3:10	**3:16**	**3:24**	**3:00**	**3:08**	**3:20**
3:15	**3:21**	**3:29**	**3:05**	**3:13**	**3:25**
3:20	**3:26**	**3:34**	**3:10**	**3:18**	**3:30**
3:25	**3:31**	**3:39**	**3:15**	**3:23**	**3:34**
3:30	**3:36**	**3:44**	**3:20**	**3:28**	**3:38**
3:35	**3:41**	**3:49**	**3:25**	**3:32**	**3:42**
3:40	**3:46**	**3:54**	**3:30**	**3:37**	**3:47**
3:45	**3:51**	**3:59**	**3:35**	**3:42**	**3:52**
3:50	**3:56**	**4:04**	**3:40**	**3:47**	**3:57**
3:55	**4:01**	**4:09**	**3:45**	**3:52**	**4:02**
4:00	**4:06**	**4:14**	**3:50**	**3:57**	**4:07**
4:05	**4:11**	**4:19**	**3:55**	**4:02**	**4:12**
Every	***6 Mins.***	***or Less***	**4:00**	**4:07**	**4:17**
6:19	**6:25**	**6:31**	**4:05**	**4:12**	**4:22**
6:31	**6:36**	**6:42**	***Every***	***6 Mins.***	***or Less***
Every	***10 Mins.***	***or Less***	**6:31**	**6:38**	**6:48**
11:20	**11:24**	**11:29**	**6:40**	**6:47**	**6:57**
11:35	**11:39**	**11:44**	***Every***	***10 Mins.***	***or Less***
11:50	**11:54**	**11:59**	**11:50**	**11:55**	12:03A
12:10A	12:14A	12:19A	12:05A	12:10A	12:18
12:25	12:29	12:34	12:25	12:30	12:38
12:45	12:49	12:54	12:45	12:50	12:58
			w 1:05	1:10	1:18

31 Saturday

Inbound			Outbound		
Leave Mattapan Station	Arrive Morton Street	Arrive Forest Hills Station	Leave Forest Hills Lower Busway	Arrive Morton Street	Arrive Mattapan Station
5:00A	5:04A	5:11A	4:47A	4:51A	4:57A
5:30	5:34	5:41	5:15	5:19	5:25
6:00	6:04	6:11	5:45	5:49	5:55
Every	*20 Mins.*	*Until*	6:15	6:19	6:25
9:00	9:05	9:12	6:40	6:44	6:50
9:17	9:22	9:29	*Every*	*20 Mins.*	*Until*
9:28	9:33	9:40	9:20	9:25	9:34
9:41	9:46	9:53	9:35	9:40	9:49
9:54	9:59	10:06	9:48	9:53	10:02
10:07	10:12	10:19	10:01	10:06	10:15
10:20	10:25	10:32	10:14	10:19	10:28
10:33	10:38	10:45	10:27	10:32	10:41
10:46	10:51	10:58	10:40	10:45	10:54
10:59	11:04	11:11	10:53	10:58	11:07
11:12	11:17	11:24	11:06	11:11	11:20
11:25	11:30	11:37	11:19	11:24	11:34
11:38	11:43	11:50	11:32	11:38	11:47
11:51	11:56	**12:03P**	11:45	11:51	12:00N
			11:58	**12:04P**	**12:13P**
12:04P	12:09P	12:16P			
Every	***13 Mins.***	***Until***	12:11P	12:17P	12:26P
5:55	5:59	**6:06**	***Every***	***13 Mins.***	***Until***
6:08	6:12	6:19	6:15	6:21	6:30
6:21	6:25	6:32	6:30	6:36	6:45
6:34	6:38	6:45	6:45	6:51	**7:00**
6:47	6:51	6:58	**7:00**	**7:06**	7:15
7:03	**7:07**	**7:14**	**7:20**	**7:26**	7:35
7:19	**7:23**	**7:30**	7:45	7:51	8:00
7:39	**7:43**	**7:50**	**8:25**	**8:31**	**8:40**
8:05	**8:09**	**8:16**	**8:55**	**9:01**	**9:10**
8:44	**8:48**	**8:54**	**9:25**	**9:31**	**9:40**
9:14	**9:18**	**9:24**	**9:55**	**10:01**	**10:10**
9:44	**9:48**	**9:54**	**10:25**	**10:31**	**10:40**
10:14	**10:18**	**10:24**	**10:55**	**11:01**	**11:10**
10:44	**10:48**	**10:54**	**11:25**	**11:31**	**11:40**
11:14	**11:18**	**11:24**	**11:55**	12:00M	12:07A
11:43	**11:48**	**11:52**	12:25A	12:29A	12:35
12:11A	12:14A	12:20A	w 1:05	1:09	1:16
12:45	12:48	12:54			

w - Waits for last train to arrive at Forest Hills Station.

All buses are accessible to persons with disabilities

31 Sunday

Inbound			Outbound		
Leave Mattapan Station	Arrive Morton Street	Arrive Forest Hills Station	Leave Forest Hills Lower Busway	Arrive Morton Street	Arrive Mattapan Station
6:00A	6:05A	6:12A	5:10A	5:14A	5:21A
Every	*15 Mins.*	*Until*	6:00	6:04	6:11
9:30	9:34	9:41	*Every*	*15 Mins.*	*Until*
Every	*16 Mins.*	*Until*	9:30	9:36	9:43
11:54	11:59	**12:07P**	*Every*	*18 Mins.*	*Until*
			11:54	**12:00N**	12:07P
12:13P	**12:18P**	**12:26P**			
Every	***19 Mins.***	***Until***	**12:12P**	12:18P	12:25P
4:20	**4:26**	**4:34**	***Every***	***19 Mins.***	***Until***
4:39	**4:45**	**4:53**	**4:57**	**5:04**	**5:13**
4:58	**5:03**	**5:10**	**5:16**	**5:23**	**5:32**
5:17	**5:22**	**5:29**	**5:35**	**5:42**	**5:51**
5:36	**5:41**	**5:48**	**5:54**	**6:01**	**6:10**
5:55	**6:00**	**6:07**	**6:13**	**6:20**	**6:29**
6:14	**6:19**	**6:26**	**6:32**	**6:39**	**6:48**
6:33	**6:38**	**6:45**	**6:51**	**6:58**	**7:07**
6:52	**6:57**	**7:04**	**7:06**	**7:13**	**7:22**
7:15	**7:19**	**7:25**	**7:30**	**7:37**	**7:46**
7:50	**7:53**	**8:00**	**8:05**	**8:12**	**8:21**
8:25	**8:28**	**8:35**	**8:40**	**8:47**	**8:56**
9:00	**9:03**	**9:10**	**9:15**	**9:21**	**9:29**
9:35	**9:38**	**9:45**	**9:50**	**9:56**	**10:04**
10:10	**10:13**	**10:20**	**10:25**	**10:31**	**10:39**
10:45	**10:48**	**10:55**	**11:00**	**11:06**	**11:14**
11:25	**11:28**	**11:35**	**11:40**	**11:46**	**11:54**
12:05A	12:09A	12:15A	12:20A	12:26A	12:34A
12:50	12:54	1:00	w 1:05	1:11	1:19

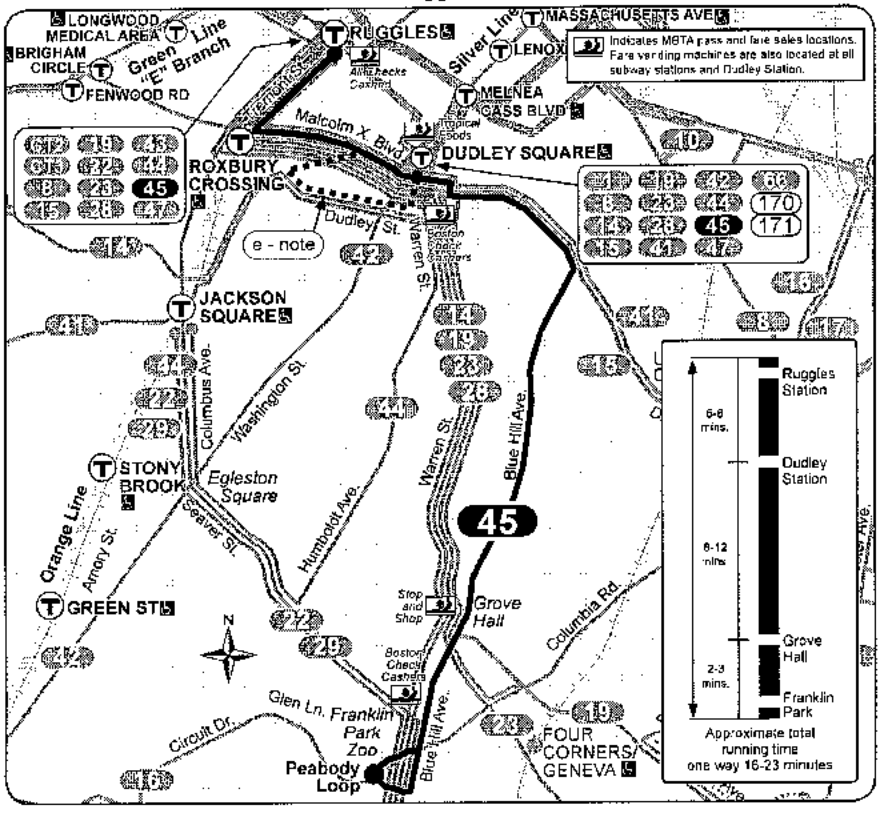
Fare	Local Bus	Bus + Bus	Rapid Transit	Bus + Rapid Transit
CharlieCard	$1.70	$1.70	$2.25	$2.25
CharlieTicket	$2.00	$2.00	$2.75	$4.75
Cash-on-Board	$2.00	$4.00	$2.75	$4.75
Student*	$0.85	$0.85	$1.10	$1.10
Senior/TAP**	$0.85	$0.85	$1.10	$1.10

VALID PASSES: LinkPass [$84.50/mo.]; Local Bus [$55/mo.]; *Student LinkPass [$30.00/mo.]; **Senior/TAP LinkPass [$29/mo.], and express bus, commuter rail, and boat passes.
FREE FARES: Children 11 and under ride free when accompanied by an adult; Blind Access CharlieCard holders ride free and if using a guide, the guide rides free.
* Requires Student CharlieCard, available to students through participating middle schools and high schools.
** Requires Senior/TAP CharlieCard, available to Medicare cardholders, seniors 65+, and persons with disabilities.

Summer 2016 Holidays
July 4: see Sunday September 5: see Sunday

Route 31
Mattapan Station-Forest Hills Station

Route 45 Franklin Park Zoo - Ruggles Station



schedule change

45

Summer June 25, 2016 - September 2, 2016

Franklin Park Zoo- Ruggles Station

New fares effective July 1, 2016

Serving
- Grove Hall
- Blue Hill Avenue
- Eliot Square
- Dudley Station
- Orange Line
- Needham Commuter Rail
- Franklin Commuter Rail
- Providence/Stoughton Commuter Rail

Massachusetts Bay Transportation Authority

MassDOT

Information 617-222-3200 • 1-800-392-6100
(TTY) 617-222-5146 • www.mbta.com

45 Weekday

Inbound			Outbound		
Leave Franklin Park	Arrive Dudley Station	Arrive Ruggles Station	Leave Ruggles Station	Arrive Dudley Station	Arrive Franklin Park
5:15A	5:26A	5:30A	5:34A	5:40A	5:58A
5:45	5:56	6:02	6:04	6:10	6:28
6:00	6:13	6:17	6:30	6:36	6:54
6:11	6:24	6:28	6:41	6:47	7:04
6:22	6:37	6:43	6:52	6:58	7:16
6:33	6:50	6:56	7:03	7:11	7:29
6:44	7:01	7:08	7:14	7:22	7:40
6:55	7:13	7:20	7:25	7:33	7:51
7:05	7:24	7:31	*Every*	*12 Mins.*	*Until*
7:15	7:34	7:41	8:25	8:33	8:51
Every	*12 Mins.*	*Until*	8:37	8:45	9:03
8:15	8:34	8:41	8:49	8:57	9:15
8:27	8:46	8:53	9:01	9:09	9:27
8:38	8:57	9:04	9:17	9:25	9:43
8:49	9:08	9:15	9:33	9:41	9:59
9:00	9:19	9:26	9:49	9:57	10:15
9:16	9:35	9:41	10:14	10:22	10:40
9:32	9:48	9:54	10:39	10:47	11:05
9:48	10:04	10:10	11:04	11:12	11:30
10:04	10:20	10:26	11:29	11:37	11:55
10:20	10:36	10:42	11:54	12:02P	12:20P
10:45	11:01	11:07			
11:10	11:26	11:32	12:19P	12:27P	12:49P
11:35	11:51	11:57	12:44	12:53	1:15
			1:11	1:20	1:38
12:00N	12:16P	12:22P	1:39	1:49	2:11
12:25P	12:41	12:47	2:07	2:17	2:39
12:53	1:09	1:15	2:25	2:35	2:57
1:21	1:38	1:46	2:43	2:53	3:16
1:49	2:08	2:17	3:01	3:13	3:35
2:17	2:37	2:45	3:16	3:28	3:50
2:45	3:05	3:13	3:30	3:42	4:04
3:03	3:22	3:30	3:44	3:56	4:18
3:21	3:40	3:48	3:58	4:10	4:32
3:39	3:59	4:06	4:11	4:23	4:45
3:54	4:13	4:21	4:24	4:36	4:58
4:09	4:28	4:36	4:37	4:49	5:11
4:24	4:43	4:51	4:50	5:02	5:24
4:39	4:58	5:06	5:03	5:15	5:37
4:52	5:11	5:19	5:16	5:28	5:50
5:06	5:25	5:33	5:29	5:41	6:03
5:20	5:39	5:44	5:42	5:54	6:13
5:33	5:48	5:56	5:55	6:05	6:23
5:46	6:01	6:09	6:08	6:17	6:35
5:59	6:14	6:22	6:21	6:30	6:48
6:12	6:27	6:33	6:34	6:43	7:01
6:24	6:37	6:42	6:47	6:56	7:14
6:36	6:48	6:53	7:00	7:09	7:27
6:48	7:00	7:05	7:30	7:38	7:53
7:00	7:12	7:17	e 8:00	8:08	8:23
7:15	7:27	7:32	e 8:30	8:38	8:53
7:30	7:42	7:47	*Every*	*30 Mins.*	*Until*
7:56	8:07	8:12	e 10:30	10:37	10:50
Every	*30 Mins.*	*Until*	e 11:00	11:07	11:20
11:25	11:35	11:39	e 11:30	11:37	11:50
11:55	12:05A	12:09A	e 12:00M	12:07A	12:20A
12:20A	12:30	12:34	a12:25A	12:31	12:39
12:45	12:55	12:59	bw1:00	1:10	1:26

45 Saturday

Inbound			Outbound		
Leave Franklin Park	Arrive Dudley Station	Arrive Ruggles Station	Leave Ruggles Station	Arrive Dudley Station	Arrive Franklin Park
a 5:06A	5:12A	5:17A	5:19A	5:25A	5:39A
5:15	5:25	5:28	5:49	5:55	6:09
5:45	5:55	5:59	6:19	6:25	6:39
6:15	6:26	6:30	6:49	6:55	7:09
6:45	6:56	7:00	7:19	7:25	7:39
7:15	7:26	7:30	7:49	7:55	8:09
7:45	7:56	8:00	8:19	8:25	8:39
8:15	8:26	8:31	8:49	8:58	9:12
8:45	8:56	9:04	9:17	9:26	9:40
9:10	9:23	9:29	9:37	9:46	10:00
9:30	9:43	9:49	9:57	10:06	10:20
9:50	10:03	10:09	10:17	10:26	10:40
10:10	10:23	10:29	10:37	10:46	11:00
10:30	10:43	10:49	10:57	11:06	11:23
10:50	11:03	11:09	11:17	11:26	11:43
11:10	11:23	11:29	11:37	11:46	12:03P
11:30	11:46	11:52	11:57	12:06P	12:23
11:50	12:06P	12:12P			
			12:17P	12:26P	12:43P
12:10P	12:26P	12:32P	*Every*	*20 Mins.*	*Until*
Every	*20 Mins.*	*Until*	2:17	2:26	2:43
2:30	2:45	2:50	2:37	2:46	3:03
2:50	3:05	3:10	2:57	3:06	3:23
3:10	3:25	3:30	3:17	3:26	3:43
3:30	3:45	3:50	3:37	3:46	4:04
3:50	4:05	4:10	3:57	4:07	4:26
4:10	4:25	4:30	4:17	4:28	4:45
4:30	4:45	4:50	4:37	4:45	5:02
4:50	5:05	5:10	4:57	5:05	5:22
5:10	5:25	5:30	5:17	5:25	5:42
5:30	5:45	5:50	5:37	5:45	6:02
5:49	6:04	6:09	5:54	6:02	6:19
6:06	6:21	6:26	6:11	6:19	6:36
6:23	6:36	6:41	6:27	6:35	6:52
6:43	6:56	7:01	6:42	6:50	7:07
7:13	7:26	7:31	7:12	7:20	7:39
7:45	7:58	8:03	7:54	8:01	8:19
8:25	8:37	8:42	8:29	8:36	8:54
9:00	9:11	9:16	9:04	9:11	9:29
9:35	9:46	9:51	9:39	9:47	10:00
10:05	10:16	10:21	10:14	10:22	10:35
10:40	10:51	10:56	10:49	10:57	11:10
11:15	11:26	11:31	11:24	11:31	11:44
11:50	12:01A	12:05A	11:59	12:06A	12:19A
12:25A	12:34	12:38	12:29A	12:36	12:49
12:55	1:04	1:08	bw 1:00	1:07	1:16

All buses are accessible to persons with disabilities

a - From Ashmont Station via Route 22
b - To Ashmont Station via Route 22.
e - Via John Eliot Square
w - Waits for last train to arrive at Ruggles station.

45 Sunday

Inbound			Outbound		
Leave Franklin Park	Arrive Dudley Station	Arrive Ruggles Station	Leave Ruggles Station	Arrive Dudley Station	Arrive Franklin Park
6:30A	6:40A	6:44A	6:10A	6:16A	6:30A
7:15	7:26	7:30	6:50	6:56	7:10
8:00	8:11	8:15	7:35	7:41	7:55
8:45	8:57	9:02	8:20	8:26	8:40
9:30	9:42	9:47	9:05	9:11	9:25
10:15	10:28	10:33	9:50	9:56	10:10
11:05	11:18	11:23	10:40	10:46	11:04
			11:30	11:38	11:54
12:00N	12:13P	12:18P	12:30P	12:38P	12:54P
1:00P	1:13	1:18	1:30	1:38	1:56
2:00	2:16	2:21	2:30	2:38	2:56
3:00	3:14	3:19	3:30	3:38	3:56
4:00	4:14	4:19	4:25	4:33	4:51
4:55	5:09	5:14	5:15	5:23	5:39
5:45	5:57	6:02	6:05	6:13	6:29
6:30	6:41	6:46	6:50	6:58	7:12
7:15	7:26	7:31	7:35	7:43	7:57
8:00	8:11	8:16	8:20	8:28	8:41
8:45	8:56	9:01	9:05	9:12	9:25
9:30	9:40	9:44	9:50	9:57	10:10
10:15	10:25	10:29	10:35	10:42	10:55
11:00	11:10	11:14	11:25	11:32	11:45
			bw 1:00A	1:05A	1:13A

Route 45
Franklin Park Zoo-Ruggles Station

Fare	Local Bus	Bus + Bus	Rapid Transit	Bus + Rapid Transit
CharlieCard	$1.70	$1.70	$2.25	$2.25
CharlieTicket	$2.00	$2.00	$2.75	$4.75
Cash-on-Board	$2.00	$4.00	$2.75	$4.75
Students*	$0.85	$0.85	$1.10	$1.10
Senior/TAP**	$0.85	$0.85	$1.10	$1.10

VALID PASSES: LinkPass ($64.50/mo.); Local Bus ($55/mo.); *Student LinkPass ($30.00/mo.); **Senior/TAP LinkPass ($30/mo.); and express bus, commuter rail, and boat passes.
FREE FARES: Children 11 and under ride free when accompanied by an adult; Blind Access CharlieCard holders ride free and if using a guide, the guide rides free.
* Requires Student CharlieCard, available to students through participating middle schools and high schools.
** Requires Senior/TAP CharlieCard, available to Medicare cardholders, seniors 65+, and persons with disabilities.

Summer 2016 Holidays
July 4: see Sunday September 5: see Sunday

□ Trip Distribution Calculations

Staff Trip Distribution

Count of Zip					To/From Routes								
					American Legion Highway		American Legion Highway		Route 203		Route 203		Total
Zip	Total	Town	# of Staff	% of Total	(From West)		(From East)		(From North)		(From South)		
02130	6	Jamaica Plain	6	9.23%		0.00%		0.00%	100%	9.23%		0.00%	9.23%
02136	6	Hyde Park	6	9.23%	100%	9.23%		0.00%		0.00%		0.00%	9.23%
02118	6	Roxbury	6	9.23%		0.00%	100%	9.23%		0.00%		0.00%	9.23%
02124	3	Dorchester	3	4.62%		0.00%	50%	2.31%		0.00%	50%	2.31%	4.62%
02138	3	Cambridge	3	4.62%		0.00%		0.00%	100%	4.62%		0.00%	4.62%
02135	2	Brighton	2	3.08%		0.00%		0.00%	100%	3.08%		0.00%	3.08%
02446	2	Brookline	2	3.08%		0.00%		0.00%	100%	3.08%		0.00%	3.08%
02131	2	Roslindale	2	3.08%	100%	3.08%		0.00%		0.00%		0.00%	3.08%
02121	2	Dorchester	2	3.08%		0.00%	100%	3.08%		0.00%		0.00%	3.08%
03077	1	Raymond, NH	1	1.54%		0.00%	50%	0.77%	50%	0.77%		0.00%	1.54%
02127	1	South Boston	1	1.54%		0.00%	50%	0.77%		0.00%	50%	0.77%	1.54%
02132	1	West Roxbury	1	1.54%	50%	0.77%		0.00%	50%	0.77%		0.00%	1.54%
02420	1	Lexington	1	1.54%		0.00%		0.00%	100%	1.54%		0.00%	1.54%
02140	1	Cambridge	1	1.54%		0.00%		0.00%	100%	1.54%		0.00%	1.54%
02215	1	Boston	1	1.54%		0.00%	100%	1.54%		0.00%		0.00%	1.54%
02492	1	Needham	1	1.54%	50%	0.77%		0.00%	50%	0.77%		0.00%	1.54%
02186	1	Milton	1	1.54%	50%	0.77%		0.00%		0.00%	50%	0.77%	1.54%
02467	1	Chestnut Hill	1	1.54%		0.00%		0.00%	100%	1.54%		0.00%	1.54%
02176	1	Melrose	1	1.54%		0.00%	50%	0.77%	50%	0.77%		0.00%	1.54%
08062	1	Mullica Hill, NJ	1	1.54%		0.00%		0.00%	100%	1.54%		0.00%	1.54%
02171	1	Quincy	1	1.54%		0.00%		0.00%		0.00%	100%	1.54%	1.54%
02139	1	Cambridge	1	1.54%		0.00%		0.00%	100%	1.54%		0.00%	1.54%
02170	1	Quincy	1	1.54%		0.00%		0.00%		0.00%	100%	1.54%	1.54%
03054	1	Merrimack, NH	1	1.54%		0.00%		0.00%	100%	1.54%		0.00%	1.54%
02169	1	Quincy	1	1.54%		0.00%		0.00%		0.00%	100%	1.54%	1.54%
02134	1	Allston	1	1.54%		0.00%		0.00%	100%	1.54%		0.00%	1.54%
02122	1	Dorchester	1	1.54%		0.00%	100%	1.54%		0.00%		0.00%	1.54%
02481	1	Wellesley Hills	1	1.54%	50%	0.77%		0.00%	50%	0.77%		0.00%	1.54%
02120	1	Roxbury Crossing	1	1.54%		0.00%	50%	0.77%	50%	0.77%		0.00%	1.54%
02129	1	Charlestown	1	1.54%		0.00%	50%	0.77%		0.00%	50%	0.77%	1.54%
06001	1	Avon, CT	1	1.54%		0.00%		0.00%	100%	1.54%		0.00%	1.54%
02125	1	Dorchester	1	1.54%		0.00%	100%	1.54%		0.00%		0.00%	1.54%
01752	1	Marlborough	1	1.54%		0.00%		0.00%	100%	1.54%		0.00%	1.54%
02445	1	Brookline	1	1.54%		0.00%		0.00%	100%	1.54%		0.00%	1.54%
02141	1	Cambridge	1	1.54%		0.00%	50%	0.77%	50%	0.77%		0.00%	1.54%
02150	1	Chelsea	1	1.54%		0.00%	50%	0.77%		0.00%	50%	0.77%	1.54%
02119	1	Boston	1	1.54%		0.00%	50%	0.77%	50%	0.77%		0.00%	1.54%
02149	1	Everett	1	1.54%		0.00%	50%	0.77%		0.00%	50%	0.77%	1.54%
02114	1	Boston	1	1.54%		0.00%	50%	0.77%		0.00%	50%	0.77%	1.54%
02145	1	Somerville	1	1.54%		0.00%		0.00%	50%	0.77%	50%	0.77%	1.54%
19066	1	Merion Station, PA	1	1.54%		0.00%		0.00%	100%	1.54%		0.00%	1.54%
02144	1	Somerville	1	1.54%		0.00%	50%	0.77%	50%	0.77%		0.00%	1.54%
Grand Total	65	Total	65	**100.00%**		15.4%		27.7%		44.6%		12.3%	100%
					SAY	**15%**		**30%**		**45%**		**10%**	**100%**

Student Trip Distribution

Count of Zip					To/From Routes								
Zip	Total	Town	# of Students	% of Total	American Legion Highway (From West)		American Legion Highway (From East)		Route 203 (From North)		Route 203 (From South)		Total
02124	104	Dorchester	104	21.40%		0.00%	50%	10.70%		0.00%	50%	10.70%	21.40%
02136	77	Readville	77	15.84%	100%	15.84%		0.00%		0.00%		0.00%	15.84%
02126	58	Mattapan	58	11.93%	50%	5.97%		0.00%		0.00%	50%	5.97%	11.93%
02121	42	Dorchester	42	8.64%		0.00%	100%	8.64%		0.00%		0.00%	8.64%
02131	39	Roslindale	39	8.02%	100%	8.02%		0.00%		0.00%		0.00%	8.02%
02119	36	Roxbury	36	7.41%		0.00%	50%	3.70%	50%	3.70%		0.00%	7.41%
02125	33	Dorchester	33	6.79%		0.00%	100%	6.79%		0.00%		0.00%	6.79%
02118	16	Roxbury	16	3.29%		0.00%	100%	3.29%		0.00%		0.00%	3.29%
02130	15	Jamaica Plain	15	3.09%		0.00%		0.00%	100%	3.09%		0.00%	3.09%
02120	14	Roxbury Crossing	14	2.88%		0.00%	50%	1.44%	50%	1.44%		0.00%	2.88%
02122	13	Dorchester	13	2.67%		0.00%	100%	2.67%		0.00%		0.00%	2.67%
02127	10	South Boston	10	2.06%		0.00%	50%	1.03%		0.00%	50%	1.03%	2.06%
02115	5	Boston	5	1.03%		0.00%	50%	0.51%	50%	0.51%		0.00%	1.03%
02132	5	West Roxbury	5	1.03%	50%	0.51%		0.00%	50%	0.51%		0.00%	1.03%
02151	4	Revere	4	0.82%		0.00%	100%	0.82%		0.00%		0.00%	0.82%
02128	3	East Boston	3	0.62%		0.00%	100%	0.62%		0.00%		0.00%	0.62%
02301	3	Brockton	3	0.62%	50%	0.31%		0.00%		0.00%	50%	0.31%	0.62%
02210	2	Boston	2	0.41%		0.00%	100%	0.41%		0.00%		0.00%	0.41%
02186	2	Milton	2	0.41%	50%	0.21%		0.00%		0.00%	50%	0.21%	0.41%
02116	2	Boston	2	0.41%		0.00%	50%	0.21%	50%	0.21%		0.00%	0.41%
02368	1	Randolph	1	0.21%	50%	0.10%		0.00%		0.00%	50%	0.10%	0.21%
02135	1	Brighton	1	0.21%		0.00%		0.00%	100%	0.21%		0.00%	0.21%
02026	1	Dedham	1	0.21%	100%	0.21%		0.00%		0.00%		0.00%	0.21%
Grand Total	486	Total	486	**100.00%**		31.2%		40.8%		9.7%		18.3%	100%
					SAY	**30%**		**40%**		**10%**		**20%**	**100%**

□ Capacity Analyses

LEVEL OF SERVICE METHODOLOGY

Capacity analysis of intersections is developed using the Synchro® computer software, which implements the methods of the 2010 Highway Capacity Manual (HCM). The resulting analysis presents a level-of-service (LOS) designation for individual intersection movements and (for signalized intersections) for the entire intersection. The LOS is a letter designation that provides a qualitative measure of operating conditions based on several factors including roadway geometry, speeds, ambient traffic volumes, traffic controls, and driver characteristics. Since the LOS of a traffic facility is a function of the traffic flows placed upon it, such a facility may operate at a wide range of LOS, depending on the time of day, day of week, or period of year. A range of six levels of service are defined on the basis of average delay, ranging from LOS A (the least delay) to LOS F (delays greater than 50 seconds for unsignalized movements, and greater than 80 seconds for signalized movements).

Signalized Intersection Performance Measures

The six LOS designations for signalized intersections may be described as follows:

- *LOS A* describes operations with low control delay; most vehicles do not stop at all.
- *LOS B* describes operations with relatively low control delay. However, more vehicles stop than LOS A.
- *LOS C* describes operations with higher control delays. Individual cycle failures may begin to appear. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.
- *LOS D* describes operations with control delay in the range where the influence of congestion becomes more noticeable. Many vehicles stop and individual cycle failures are noticeable.
- *LOS E* describes operations with high control delay values. Individual cycle failures are frequent occurrences.
- *LOS F* describes operations with high control delay values that often occur with over-saturation. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

The LOS for signalized intersections are calculated using the operational analysis methodology of the 2010 *Highway Capacity Manual*.[1] This method assesses the effects of signal type, timing, phasing, and progression; vehicle mix; and geometrics on delay. LOS designations are based on the criterion of control or signal delay per vehicle. Control or signal delay is a measure of driver discomfort, frustration, and fuel consumption, and includes initial deceleration delay approaching the traffic signal, queue move-up time, stopped delay and final acceleration delay. **Table A1** summarizes the relationship between LOS and control delay. The tabulated control delay criterion may be applied in assigning LOS designations to individual lane groups, to individual intersection approaches, or to entire intersections.

Table A1
LEVEL-OF-SERVICE CRITERIA
FOR SIGNALIZED INTERSECTIONS[1]

Control (Signal) Delay per Vehicle (seconds per vehicle)	Level of Service	
	v/c ≤ 1	v/c > 1
≤10.0	A	F
10.1 to 20.0	B	F
20.1 to 35.0	C	F
35.1 to 55.0	D	F
55.1 to 80.0	E	F
>80.0	F	F

[1]Source: *Highway Capacity Manual 2010,* Transportation Research Board; Washington, DC; 2010.

[1]*Highway Capacity Manual* 2010; Transportation Research Board; Washington, DC; 2010.

Unsignalized Intersection Performance Measures

The six LOS designations for unsignalized intersections may be described as follows:

- *LOS A* represents a condition with little or no control delay to minor street traffic.
- *LOS B* represents a condition with short control delays to minor street traffic.
- *LOS C* represents a condition with average control delays to minor street traffic.
- *LOS D* represents a condition with long control delays to minor street traffic.
- *LOS E* represents operating conditions at or near capacity level, with very long control delays to minor street traffic.
- *LOS F* represents a condition where minor street demand volume exceeds capacity of an approach lane, with extreme control delays resulting.

The LOS designations of unsignalized intersections are determined by application of a procedure described in the 2010 *Highway Capacity Manual.*[2] LOS is measured in terms of average control delay. Mathematically, control delay is a function of the capacity and degree of saturation of the lane group and/or approach under study and is a quantification of motorist delay associated with traffic control devices such as traffic signals and STOP signs. Control delay includes the effects of initial deceleration delay approaching a STOP sign, stopped delay, queue move-up time, and final acceleration delay from a stopped condition. Definitions for LOS at unsignalized intersections are also given in the *Highway Capacity Manual 2010*. **Table A2** summarizes the relationship between LOS and average control delay.

Table A2
LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS[1]

Average Control Delay (seconds per vehicle)	Level of Service	
	v/c ≤ 1	v/c > 1
≤ 10.0	A	F
10.1 to 15.0	B	F
15.1 to 25.0	C	F
25.1 to 35.0	D	F
35.1 to 50.0	E	F
>50.0	F	F

[1]Source: *Highway Capacity Manual 2010,* Transportation Research Board; Washington, DC; 2010.

[2] ibid

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Volume (vph)	4	178	896	29	60	17	879	144	29	15	14	82
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)		200		0		125		0	0		0	0
Storage Lanes		1		0		1		0	0		0	0
Taper Length (ft)		25				25			25			25
Lane Util. Factor	0.95	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00
Frt			0.995				0.979			0.967		
Flt Protected		0.950				0.950				0.976		
Satd. Flow (prot)	0	1787	3505	0	0	1658	3380	0	0	1710	0	0
Flt Permitted		0.950				0.950				0.788		
Satd. Flow (perm)	0	1787	3505	0	0	1658	3380	0	0	1380	0	0
Right Turn on Red				Yes				Yes			Yes	
Satd. Flow (RTOR)			4				22			15		
Link Speed (mph)			30				30			30		
Link Distance (ft)			400				670			200		
Travel Time (s)			9.1				15.2			4.5		
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Heavy Vehicles (%)	0%	1%	2%	17%	0%	41%	5%	2%	3%	0%	14%	2%
Adj. Flow (vph)	4	191	963	31	65	18	945	155	31	16	15	88
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	195	994	0	0	83	1100	0	0	62	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	R NA	Left	Left	Right	R NA	Left	Left	Right	Left	Left	Right	Left
Median Width(ft)			12				12			0		
Link Offset(ft)			0				0			0		
Crosswalk Width(ft)			16				16			16		
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	9	15		9	9	15		9	15		9	15
Number of Detectors	1	1	2		1	1	2		1	2		1
Detector Template	Left	Left	Thru		Left	Left	Thru		Left	Thru		Left
Leading Detector (ft)	20	20	100		20	20	100		20	100		20
Trailing Detector (ft)	0	0	0		0	0	0		0	0		0
Detector 1 Position(ft)	0	0	0		0	0	0		0	0		0
Detector 1 Size(ft)	20	20	6		20	20	6		20	6		20
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 1 Queue (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 1 Delay (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 2 Position(ft)			94				94			94		
Detector 2 Size(ft)			6				6			6		
Detector 2 Type			Cl+Ex				Cl+Ex			Cl+Ex		
Detector 2 Channel												
Detector 2 Extend (s)			0.0				0.0			0.0		
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA		Perm
Protected Phases	5	5	2		1	1	6			4		
Permitted Phases									4			4

Lane Group	SBT	SBR
Lane Configurations		
Volume (vph)	16	81
Ideal Flow (vphpl)	1900	1900
Storage Length (ft)		0
Storage Lanes		1
Taper Length (ft)		
Lane Util. Factor	1.00	1.00
Frt		0.850
Flt Protected	0.960	
Satd. Flow (prot)	1725	1568
Flt Permitted	0.718	
Satd. Flow (perm)	1290	1568
Right Turn on Red		Yes
Satd. Flow (RTOR)		94
Link Speed (mph)	30	
Link Distance (ft)	200	
Travel Time (s)	4.5	
Peak Hour Factor	0.93	0.93
Heavy Vehicles (%)	25%	3%
Adj. Flow (vph)	17	87
Shared Lane Traffic (%)		
Lane Group Flow (vph)	105	87
Enter Blocked Intersection	No	No
Lane Alignment	Left	Right
Median Width(ft)	0	
Link Offset(ft)	0	
Crosswalk Width(ft)	16	
Two way Left Turn Lane		
Headway Factor	1.00	1.00
Turning Speed (mph)		9
Number of Detectors	2	1
Detector Template	Thru	Right
Leading Detector (ft)	100	20
Trailing Detector (ft)	0	0
Detector 1 Position(ft)	0	0
Detector 1 Size(ft)	6	20
Detector 1 Type	Cl+Ex	Cl+Ex
Detector 1 Channel		
Detector 1 Extend (s)	0.0	0.0
Detector 1 Queue (s)	0.0	0.0
Detector 1 Delay (s)	0.0	0.0
Detector 2 Position(ft)	94	
Detector 2 Size(ft)	6	
Detector 2 Type	Cl+Ex	
Detector 2 Channel		
Detector 2 Extend (s)	0.0	
Turn Type	NA	Prot
Protected Phases	4	4
Permitted Phases		

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Detector Phase	5	5	2		1	1	6		4	4		4
Switch Phase												
Minimum Initial (s)	8.0	8.0	8.0		8.0	8.0	8.0		8.0	8.0		8.0
Minimum Split (s)	14.0	14.0	28.0		14.0	14.0	28.0		28.0	28.0		28.0
Total Split (s)	19.0	19.0	42.0		15.0	15.0	38.0		36.0	36.0		36.0
Total Split (%)	20.4%	20.4%	45.2%		16.1%	16.1%	40.9%		38.7%	38.7%		38.7%
Maximum Green (s)	13.0	13.0	37.0		9.0	9.0	33.0		31.0	31.0		31.0
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0	4.0		3.0	3.0		3.0
All-Red Time (s)	2.0	2.0	1.0		2.0	2.0	1.0		2.0	2.0		2.0
Lost Time Adjust (s)		0.0	0.0			0.0	0.0			0.0		
Total Lost Time (s)		6.0	5.0			6.0	5.0			5.0		
Lead/Lag	Lead	Lead	Lag		Lead	Lead	Lag					
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes					
Vehicle Extension (s)	2.0	2.0	2.0		2.0	2.0	2.0		2.0	2.0		2.0
Recall Mode	None	None	Ped		None	None	Ped		None	None		None
Walk Time (s)			8.0				8.0		7.0	7.0		7.0
Flash Dont Walk (s)			15.0				15.0		16.0	16.0		16.0
Pedestrian Calls (#/hr)			0				0		0	0		0
Act Effct Green (s)		11.6	38.0			8.7	29.5			10.6		
Actuated g/C Ratio		0.18	0.59			0.13	0.46			0.16		
v/c Ratio		0.61	0.48			0.37	0.71			0.26		
Control Delay		36.5	12.5			35.0	18.4			24.3		
Queue Delay		0.0	0.0			0.0	0.0			0.0		
Total Delay		36.5	12.5			35.0	18.4			24.3		
LOS		D	B			D	B			C		
Approach Delay			16.4				19.6			24.3		
Approach LOS			B				B			C		
90th %ile Green (s)	13.0	13.0	37.0		9.0	9.0	33.0		15.0	15.0		15.0
90th %ile Term Code	Max	Max	Hold		Max	Max	Max		Gap	Gap		Gap
70th %ile Green (s)	13.0	13.0	37.0		9.0	9.0	33.0		11.9	11.9		11.9
70th %ile Term Code	Max	Max	Hold		Max	Max	Max		Gap	Gap		Gap
50th %ile Green (s)	12.9	12.9	34.0		8.0	8.0	29.1		10.0	10.0		10.0
50th %ile Term Code	Gap	Gap	Hold		Min	Min	Gap		Gap	Gap		Gap
30th %ile Green (s)	10.8	10.8	28.2		8.0	8.0	25.4		8.1	8.1		8.1
30th %ile Term Code	Gap	Gap	Hold		Min	Min	Gap		Gap	Gap		Gap
10th %ile Green (s)	8.0	8.0	38.4		0.0	0.0	24.4		0.0	0.0		0.0
10th %ile Term Code	Min	Min	Dwell		Skip	Skip	Dwell		Skip	Skip		Skip
Queue Length 50th (ft)		75	141			33	191			18		
Queue Length 95th (ft)		#169	230			80	297			52		
Internal Link Dist (ft)			320				590			120		
Turn Bay Length (ft)		200				125						
Base Capacity (vph)		375	2201			241	1813			699		
Starvation Cap Reductn		0	0			0	0			0		
Spillback Cap Reductn		0	0			0	0			0		
Storage Cap Reductn		0	0			0	0			0		
Reduced v/c Ratio		0.52	0.45			0.34	0.61			0.09		

Intersection Summary

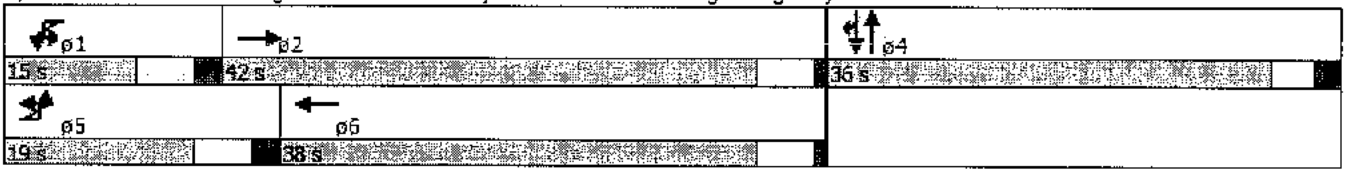
Area Type: Other

Lane Group	SBT	SBR
Detector Phase	4	4
Switch Phase		
Minimum Initial (s)	8.0	8.0
Minimum Split (s)	28.0	28.0
Total Split (s)	36.0	36.0
Total Split (%)	38.7%	38.7%
Maximum Green (s)	31.0	31.0
Yellow Time (s)	3.0	3.0
All-Red Time (s)	2.0	2.0
Lost Time Adjust (s)	0.0	0.0
Total Lost Time (s)	5.0	5.0
Lead/Lag		
Lead-Lag Optimize?		
Vehicle Extension (s)	2.0	2.0
Recall Mode	None	None
Walk Time (s)	7.0	7.0
Flash Dont Walk (s)	16.0	16.0
Pedestrian Calls (#/hr)	0	0
Act Effct Green (s)	10.6	10.6
Actuated g/C Ratio	0.16	0.16
v/c Ratio	0.50	0.26
Control Delay	36.2	8.2
Queue Delay	0.0	0.0
Total Delay	36.2	8.2
LOS	D	A
Approach Delay	23.5	
Approach LOS	C	
90th %ile Green (s)	15.0	15.0
90th %ile Term Code	Gap	Gap
70th %ile Green (s)	11.9	11.9
70th %ile Term Code	Gap	Gap
50th %ile Green (s)	10.0	10.0
50th %ile Term Code	Gap	Gap
30th %ile Green (s)	8.1	8.1
30th %ile Term Code	Gap	Gap
10th %ile Green (s)	0.0	0.0
10th %ile Term Code	Skip	Skip
Queue Length 50th (ft)	41	0
Queue Length 95th (ft)	91	32
Internal Link Dist (ft)	120	
Turn Bay Length (ft)		
Base Capacity (vph)	646	832
Starvation Cap Reductn	0	0
Spillback Cap Reductn	0	0
Storage Cap Reductn	0	0
Reduced v/c Ratio	0.16	0.10

Intersection Summary

Cycle Length: 93
Actuated Cycle Length: 64.5
Natural Cycle: 75
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.71
Intersection Signal Delay: 18.6 — Intersection LOS: B
Intersection Capacity Utilization 69.8% — ICU Level of Service C
Analysis Period (min) 15
90th %ile Actuated Cycle: 77
70th %ile Actuated Cycle: 73.9
50th %ile Actuated Cycle: 68
30th %ile Actuated Cycle: 60.3
10th %ile Actuated Cycle: 43.4
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Kingbird Road/Canterbury Street & American Legion Highway



Intersection	
Int Delay, s/veh	0.2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	1052	0	0	1100	0	33
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	0	0	5	0	39
Mvmt Flow	1131	0	0	1183	0	35

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	1131	0	1722	566
Stage 1	-	-	-	-	1131	-
Stage 2	-	-	-	-	591	-
Critical Hdwy	-	-	4.1	-	6.8	7.68
Critical Hdwy Stg 1	-	-	-	-	5.8	-
Critical Hdwy Stg 2	-	-	-	-	5.8	-
Follow-up Hdwy	-	-	2.2	-	3.5	3.69
Pot Cap-1 Maneuver	-	-	625	-	82	384
Stage 1	-	-	-	-	274	-
Stage 2	-	-	-	-	522	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	625	-	82	384
Mov Cap-2 Maneuver	-	-	-	-	82	-
Stage 1	-	-	-	-	274	-
Stage 2	-	-	-	-	522	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0	15.3
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	384	-	-	625	-
HCM Lane V/C Ratio	0.092	-	-	-	-
HCM Control Delay (s)	15.3	-	-	0	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.3	-	-	0	-

Intersection	
Int Delay, s/veh	4.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	1	0	1	2	0	25	0	30	2	44	20	2
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	74	74	74	74	74	74	74	74	74	74	74	74
Heavy Vehicles, %	0	0	0	0	0	4	0	7	0	30	15	0
Mvmt Flow	1	0	1	3	0	34	0	41	3	59	27	3

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	206	190	28	190	191	42	30	0	0	43	0	0
Stage 1	147	147	-	42	42	-	-	-	-	-	-	-
Stage 2	59	43	-	148	149	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	6.24	4.1	-	-	4.4	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.336	2.2	-	-	2.47	-	-
Pot Cap-1 Maneuver	756	708	1053	774	708	1023	1596	-	-	1403	-	-
Stage 1	860	779	-	978	864	-	-	-	-	-	-	-
Stage 2	958	863	-	859	778	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	707	678	1053	748	678	1023	1596	-	-	1403	-	-
Mov Cap-2 Maneuver	707	678	-	748	678	-	-	-	-	-	-	-
Stage 1	860	746	-	978	864	-	-	-	-	-	-	-
Stage 2	926	863	-	821	745	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	9.3	8.8	0	5.1
HCM LOS	A	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1596	-	-	846	996	1403	-	-
HCM Lane V/C Ratio	-	-	-	0.003	0.037	0.042	-	-
HCM Control Delay (s)	0	-	-	9.3	8.8	7.7	0	-
HCM Lane LOS	A	-	-	A	A	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0	0.1	0.1	-	-

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Volume (vph)	1	93	933	26	24	30	1327	119	12	9	15	47
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)		200		0		125		0	0		0	0
Storage Lanes		1		0		1		0	0		0	0
Taper Length (ft)		25				25			25			25
Lane Util. Factor	0.95	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00
Frt			0.996				0.988			0.945		
Flt Protected		0.950				0.950				0.984		
Satd. Flow (prot)	0	1787	3490	0	0	1568	3486	0	0	1718	0	0
Flt Permitted		0.950				0.950				0.866		
Satd. Flow (perm)	0	1787	3490	0	0	1568	3486	0	0	1512	0	0
Right Turn on Red				Yes				Yes			Yes	
Satd. Flow (RTOR)			3				11			16		
Link Speed (mph)			30				30			30		
Link Distance (ft)			400				670			200		
Travel Time (s)			9.1				15.2			4.5		
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	1%	3%	4%	0%	27%	2%	6%	0%	11%	0%	0%
Adj. Flow (vph)	1	101	1014	28	26	33	1442	129	13	10	16	51
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	102	1042	0	0	59	1571	0	0	39	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	R NA	Left	Left	Right	R NA	Left	Left	Right	Left	Left	Right	Left
Median Width(ft)			12				12			0		
Link Offset(ft)			0				0			0		
Crosswalk Width(ft)			16				16			16		
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	9	15		9	9	15		9	15		9	15
Number of Detectors	1	1	2		1	1	2		1	2		1
Detector Template	Left	Left	Thru		Left	Left	Thru		Left	Thru		Left
Leading Detector (ft)	20	20	100		20	20	100		20	100		20
Trailing Detector (ft)	0	0	0		0	0	0		0	0		0
Detector 1 Position(ft)	0	0	0		0	0	0		0	0		0
Detector 1 Size(ft)	20	20	6		20	20	6		20	6		20
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 1 Queue (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 1 Delay (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 2 Position(ft)			94				94			94		
Detector 2 Size(ft)			6				6			6		
Detector 2 Type			Cl+Ex				Cl+Ex			Cl+Ex		
Detector 2 Channel												
Detector 2 Extend (s)			0.0				0.0			0.0		
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA		Perm
Protected Phases	5	5	2		1	1	6			4		
Permitted Phases									4			4

Lane Group	SBT	SBR
Lane Configurations	↰	↱
Volume (vph)	6	80
Ideal Flow (vphpl)	1900	1900
Storage Length (ft)		0
Storage Lanes		1
Taper Length (ft)		
Lane Util. Factor	1.00	1.00
Frt		0.850
Flt Protected	0.958	
Satd. Flow (prot)	1784	1568
Flt Permitted	0.724	
Satd. Flow (perm)	1348	1568
Right Turn on Red		Yes
Satd. Flow (RTOR)		94
Link Speed (mph)	30	
Link Distance (ft)	200	
Travel Time (s)	4.5	
Peak Hour Factor	0.92	0.92
Heavy Vehicles (%)	17%	3%
Adj. Flow (vph)	7	87
Shared Lane Traffic (%)		
Lane Group Flow (vph)	58	87
Enter Blocked Intersection	No	No
Lane Alignment	Left	Right
Median Width(ft)	0	
Link Offset(ft)	0	
Crosswalk Width(ft)	16	
Two way Left Turn Lane		
Headway Factor	1.00	1.00
Turning Speed (mph)		9
Number of Detectors	2	1
Detector Template	Thru	Right
Leading Detector (ft)	100	20
Trailing Detector (ft)	0	0
Detector 1 Position(ft)	0	0
Detector 1 Size(ft)	6	20
Detector 1 Type	Cl+Ex	Cl+Ex
Detector 1 Channel		
Detector 1 Extend (s)	0.0	0.0
Detector 1 Queue (s)	0.0	0.0
Detector 1 Delay (s)	0.0	0.0
Detector 2 Position(ft)	94	
Detector 2 Size(ft)	6	
Detector 2 Type	Cl+Ex	
Detector 2 Channel		
Detector 2 Extend (s)	0.0	
Turn Type	NA	Prot
Protected Phases	4	4
Permitted Phases		

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Detector Phase	5	5	2		1	1	6		4	4		4
Switch Phase												
Minimum Initial (s)	8.0	8.0	8.0		8.0	8.0	8.0		8.0	8.0		8.0
Minimum Split (s)	14.0	14.0	28.0		14.0	14.0	28.0		28.0	28.0		28.0
Total Split (s)	19.0	19.0	42.0		15.0	15.0	38.0		36.0	36.0		36.0
Total Split (%)	20.4%	20.4%	45.2%		16.1%	16.1%	40.9%		38.7%	38.7%		38.7%
Maximum Green (s)	13.0	13.0	37.0		9.0	9.0	33.0		31.0	31.0		31.0
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0	4.0		3.0	3.0		3.0
All-Red Time (s)	2.0	2.0	1.0		2.0	2.0	1.0		2.0	2.0		2.0
Lost Time Adjust (s)		0.0	0.0			0.0	0.0			0.0		
Total Lost Time (s)		6.0	5.0			6.0	5.0			5.0		
Lead/Lag	Lead	Lead	Lag		Lead	Lead	Lag					
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes					
Vehicle Extension (s)	2.0	2.0	2.0		2.0	2.0	2.0		2.0	2.0		2.0
Recall Mode	None	None	Ped		None	None	Ped		None	None		None
Walk Time (s)			8.0				8.0		7.0	7.0		7.0
Flash Dont Walk (s)			15.0				15.0		16.0	16.0		16.0
Pedestrian Calls (#/hr)			0				0		0	0		0
Act Effct Green (s)		9.0	41.6			8.3	38.1			8.5		
Actuated g/C Ratio		0.14	0.65			0.13	0.59			0.13		
v/c Ratio		0.41	0.46			0.29	0.76			0.18		
Control Delay		31.8	9.9			31.4	17.8			20.7		
Queue Delay		0.0	0.0			0.0	0.0			0.0		
Total Delay		31.8	9.9			31.4	17.8			20.7		
LOS		C	A			C	B			C		
Approach Delay			11.8				18.3			20.7		
Approach LOS			B				B			C		
90th %ile Green (s)	11.5	11.5	35.5		9.0	9.0	33.0		10.2	10.2		10.2
90th %ile Term Code	Gap	Gap	Hold		Max	Max	Max		Gap	Gap		Gap
70th %ile Green (s)	9.5	9.5	34.4		8.1	8.1	33.0		8.4	8.4		8.4
70th %ile Term Code	Gap	Gap	Hold		Gap	Gap	Max		Gap	Gap		Gap
50th %ile Green (s)	8.1	8.1	33.1		8.0	8.0	33.0		8.0	8.0		8.0
50th %ile Term Code	Gap	Gap	Hold		Min	Min	Max		Min	Min		Min
30th %ile Green (s)	8.0	8.0	47.0		0.0	0.0	33.0		8.0	8.0		8.0
30th %ile Term Code	Min	Min	Hold		Skip	Skip	Max		Min	Min		Min
10th %ile Green (s)	0.0	0.0	48.0		0.0	0.0	48.0		0.0	0.0		0.0
10th %ile Term Code	Skip	Skip	Dwell		Skip	Skip	Dwell		Skip	Skip		Skip
Queue Length 50th (ft)		38	140			22	270			8		
Queue Length 95th (ft)		83	215			57	#496			34		
Internal Link Dist (ft)			320				590			120		
Turn Bay Length (ft)		200				125						
Base Capacity (vph)		365	2351			222	2078			746		
Starvation Cap Reductn		0	0			0	0			0		
Spillback Cap Reductn		0	0			0	0			0		
Storage Cap Reductn		0	0			0	0			0		
Reduced v/c Ratio		0.28	0.44			0.27	0.76			0.05		

Intersection Summary

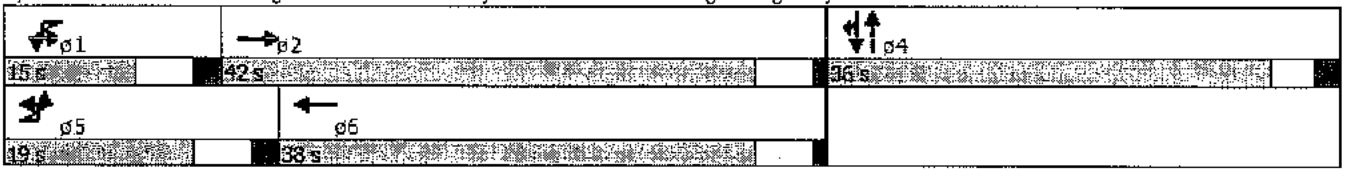
Area Type: Other

Lane Group	SBT	SBR
Detector Phase	4	4
Switch Phase		
Minimum Initial (s)	8.0	8.0
Minimum Split (s)	28.0	28.0
Total Split (s)	36.0	36.0
Total Split (%)	38.7%	38.7%
Maximum Green (s)	31.0	31.0
Yellow Time (s)	3.0	3.0
All-Red Time (s)	2.0	2.0
Lost Time Adjust (s)	0.0	0.0
Total Lost Time (s)	5.0	5.0
Lead/Lag		
Lead-Lag Optimize?		
Vehicle Extension (s)	2.0	2.0
Recall Mode	None	None
Walk Time (s)	7.0	7.0
Flash Dont Walk (s)	16.0	16.0
Pedestrian Calls (#/hr)	0	0
Act Effct Green (s)	8.5	8.5
Actuated g/C Ratio	0.13	0.13
v/c Ratio	0.32	0.30
Control Delay	32.2	9.3
Queue Delay	0.0	0.0
Total Delay	32.2	9.3
LOS	C	A
Approach Delay	18.5	
Approach LOS	B	
90th %ile Green (s)	10.2	10.2
90th %ile Term Code	Gap	Gap
70th %ile Green (s)	8.4	8.4
70th %ile Term Code	Gap	Gap
50th %ile Green (s)	8.0	8.0
50th %ile Term Code	Min	Min
30th %ile Green (s)	8.0	8.0
30th %ile Term Code	Min	Min
10th %ile Green (s)	0.0	0.0
10th %ile Term Code	Skip	Skip
Queue Length 50th (ft)	22	0
Queue Length 95th (ft)	55	33
Internal Link Dist (ft)	120	
Turn Bay Length (ft)		
Base Capacity (vph)	657	813
Starvation Cap Reductn	0	0
Spillback Cap Reductn	0	0
Storage Cap Reductn	0	0
Reduced v/c Ratio	0.09	0.11

Intersection Summary

Cycle Length: 93
Actuated Cycle Length: 64.1
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.76
Intersection Signal Delay: 15.8 — Intersection LOS: B
Intersection Capacity Utilization 78.0% — ICU Level of Service D
Analysis Period (min) 15
90th %ile Actuated Cycle: 70.7
70th %ile Actuated Cycle: 66.9
50th %ile Actuated Cycle: 65.1
30th %ile Actuated Cycle: 65
10th %ile Actuated Cycle: 53
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Kingbird Road/Canterbury Street & American Legion Highway



Intersection	
Int Delay, s/veh	0.1

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	1019	0	0	1500	0	23
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	3	0	0	2	0	57
Mvmt Flow	1108	0	0	1630	0	25

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	1108	0	1923	554
Stage 1	-	-	-	-	1108	-
Stage 2	-	-	-	-	815	-
Critical Hdwy	-	-	4.1	-	6.8	8.04
Critical Hdwy Stg 1	-	-	-	-	5.8	-
Critical Hdwy Stg 2	-	-	-	-	5.8	-
Follow-up Hdwy	-	-	2.2	-	3.5	3.87
Pot Cap-1 Maneuver	-	-	638	-	60	358
Stage 1	-	-	-	-	282	-
Stage 2	-	-	-	-	401	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	638	-	60	358
Mov Cap-2 Maneuver	-	-	-	-	60	-
Stage 1	-	-	-	-	282	-
Stage 2	-	-	-	-	401	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0	15.8
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	358	-	-	638	-
HCM Lane V/C Ratio	0.07	-	-	-	-
HCM Control Delay (s)	15.8	-	-	0	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0	-

Intersection	
Int Delay, s/veh	3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	6	0	1	2	0	10	0	20	1	14	31	6
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	80	80	80	80	80	80	80	80	80	80	80	80
Heavy Vehicles, %	0	0	0	0	0	0	0	6	0	42	4	0
Mvmt Flow	8	0	1	2	0	12	0	25	1	18	39	8

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	110	104	43	104	107	26	46	0	0	26	0	0
Stage 1	78	78	-	26	26	-	-	-	-	-	-	-
Stage 2	32	26	-	78	81	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	6.2	4.1	-	-	4.52	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.578	-	-
Pot Cap-1 Maneuver	873	790	1033	881	787	1056	1575	-	-	1364	-	-
Stage 1	936	834	-	997	878	-	-	-	-	-	-	-
Stage 2	990	878	-	936	832	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	853	779	1033	871	776	1056	1575	-	-	1364	-	-
Mov Cap-2 Maneuver	853	779	-	871	776	-	-	-	-	-	-	-
Stage 1	936	822	-	997	878	-	-	-	-	-	-	-
Stage 2	978	878	-	922	820	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	9.2	8.6	0	2.1
HCM LOS	A	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1575	-	-	875	1020	1364	-	-
HCM Lane V/C Ratio	-	-	-	0.01	0.015	0.013	-	-
HCM Control Delay (s)	0	-	-	9.2	8.6	7.7	0	-
HCM Lane LOS	A	-	-	A	A	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0	0	0	-	-

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Volume (vph)	4	182	919	34	62	24	901	147	33	23	21	84
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)		200		0		125		0	0		0	0
Storage Lanes		1		0		1		0	0		0	0
Taper Length (ft)		25				25			25			25
Lane Util. Factor	0.95	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00
Frt			0.995				0.979			0.963		
Flt Protected		0.950				0.950				0.979		
Satd. Flow (prot)	0	1787	3503	0	0	1619	3379	0	0	1704	0	0
Flt Permitted		0.950				0.950				0.821		
Satd. Flow (perm)	0	1787	3503	0	0	1619	3379	0	0	1429	0	0
Right Turn on Red				Yes				Yes			Yes	
Satd. Flow (RTOR)			5				22			22		
Link Speed (mph)			30				30			30		
Link Distance (ft)			400				670			200		
Travel Time (s)			9.1				15.2			4.5		
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Heavy Vehicles (%)	0%	1%	2%	17%	0%	41%	5%	2%	3%	0%	14%	2%
Adj. Flow (vph)	4	196	988	37	67	26	969	158	35	25	23	90
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	200	1025	0	0	93	1127	0	0	83	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	R NA	Left	Left	Right	R NA	Left	Left	Right	Left	Left	Right	Left
Median Width(ft)			12				12			0		
Link Offset(ft)			0				0			0		
Crosswalk Width(ft)			16				16			16		
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	9	15		9	9	15		9	15		9	15
Number of Detectors	1	1	2		1	1	2		1	2		1
Detector Template	Left	Left	Thru		Left	Left	Thru		Left	Thru		Left
Leading Detector (ft)	20	20	100		20	20	100		20	100		20
Trailing Detector (ft)	0	0	0		0	0	0		0	0		0
Detector 1 Position(ft)	0	0	0		0	0	0		0	0		0
Detector 1 Size(ft)	20	20	6		20	20	6		20	6		20
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 1 Queue (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 1 Delay (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 2 Position(ft)			94				94			94		
Detector 2 Size(ft)			6				6			6		
Detector 2 Type			Cl+Ex				Cl+Ex			Cl+Ex		
Detector 2 Channel												
Detector 2 Extend (s)			0.0				0.0			0.0		
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA		Perm
Protected Phases	5	5	2		1	1	6			4		
Permitted Phases									4			4

Lane Group	SBT	SBR
Lane Configurations		
Volume (vph)	24	83
Ideal Flow (vphpl)	1900	1900
Storage Length (ft)		0
Storage Lanes		1
Taper Length (ft)		
Lane Util. Factor	1.00	1.00
Frt		0.850
Flt Protected	0.963	
Satd. Flow (prot)	1708	1568
Flt Permitted	0.791	
Satd. Flow (perm)	1403	1568
Right Turn on Red		Yes
Satd. Flow (RTOR)		94
Link Speed (mph)	30	
Link Distance (ft)	200	
Travel Time (s)	4.5	
Peak Hour Factor	0.93	0.93
Heavy Vehicles (%)	25%	3%
Adj. Flow (vph)	26	89
Shared Lane Traffic (%)		
Lane Group Flow (vph)	116	89
Enter Blocked Intersection	No	No
Lane Alignment	Left	Right
Median Width(ft)	0	
Link Offset(ft)	0	
Crosswalk Width(ft)	16	
Two way Left Turn Lane		
Headway Factor	1.00	1.00
Turning Speed (mph)		9
Number of Detectors	2	1
Detector Template	Thru	Right
Leading Detector (ft)	100	20
Trailing Detector (ft)	0	0
Detector 1 Position(ft)	0	0
Detector 1 Size(ft)	6	20
Detector 1 Type	Cl+Ex	Cl+Ex
Detector 1 Channel		
Detector 1 Extend (s)	0.0	0.0
Detector 1 Queue (s)	0.0	0.0
Detector 1 Delay (s)	0.0	0.0
Detector 2 Position(ft)	94	
Detector 2 Size(ft)	6	
Detector 2 Type	Cl+Ex	
Detector 2 Channel		
Detector 2 Extend (s)	0.0	
Turn Type	NA	Prot
Protected Phases	4	4
Permitted Phases		

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Detector Phase	5	5	2		1	1	6		4	4		4
Switch Phase												
Minimum Initial (s)	8.0	8.0	8.0		8.0	8.0	8.0		8.0	8.0		8.0
Minimum Split (s)	14.0	14.0	28.0		14.0	14.0	28.0		28.0	28.0		28.0
Total Split (s)	19.0	19.0	42.0		15.0	15.0	38.0		36.0	36.0		36.0
Total Split (%)	20.4%	20.4%	45.2%		16.1%	16.1%	40.9%		38.7%	38.7%		38.7%
Maximum Green (s)	13.0	13.0	37.0		9.0	9.0	33.0		31.0	31.0		31.0
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0	4.0		3.0	3.0		3.0
All-Red Time (s)	2.0	2.0	1.0		2.0	2.0	1.0		2.0	2.0		2.0
Lost Time Adjust (s)		0.0	0.0			0.0	0.0			0.0		
Total Lost Time (s)		6.0	5.0			6.0	5.0			5.0		
Lead/Lag	Lead	Lead	Lag		Lead	Lead	Lag					
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes					
Vehicle Extension (s)	2.0	2.0	2.0		2.0	2.0	2.0		2.0	2.0		2.0
Recall Mode	None	None	Ped		None	None	Ped		None	None		None
Walk Time (s)			8.0				8.0		7.0	7.0		7.0
Flash Dont Walk (s)			15.0				15.0		16.0	16.0		16.0
Pedestrian Calls (#/hr)			0				0		0	0		0
Act Effct Green (s)		11.7	36.1			8.6	29.6			11.1		
Actuated g/C Ratio		0.17	0.53			0.13	0.43			0.16		
v/c Ratio		0.66	0.56			0.46	0.77			0.33		
Control Delay		40.0	13.8			38.7	21.0			24.8		
Queue Delay		0.0	0.0			0.0	0.0			0.0		
Total Delay		40.0	13.8			38.7	21.0			24.8		
LOS		D	B			D	C			C		
Approach Delay			18.1				22.4			24.8		
Approach LOS			B				C			C		
90th %ile Green (s)	13.0	13.0	37.0		9.0	9.0	33.0		16.2	16.2		16.2
90th %ile Term Code	Max	Max	Hold		Max	Max	Max		Gap	Gap		Gap
70th %ile Green (s)	13.0	13.0	37.0		9.0	9.0	33.0		12.9	12.9		12.9
70th %ile Term Code	Max	Max	Hold		Max	Max	Max		Gap	Gap		Gap
50th %ile Green (s)	13.0	13.0	36.3		8.7	8.7	32.0		10.7	10.7		10.7
50th %ile Term Code	Max	Max	Hold		Gap	Gap	Gap		Gap	Gap		Gap
30th %ile Green (s)	11.3	11.3	30.4		8.0	8.0	27.1		8.7	8.7		8.7
30th %ile Term Code	Gap	Gap	Hold		Min	Min	Gap		Gap	Gap		Gap
10th %ile Green (s)	8.4	8.4	37.4		0.0	0.0	23.0		8.0	8.0		8.0
10th %ile Term Code	Gap	Gap	Hold		Skip	Skip	Ped		Min	Min		Min
Queue Length 50th (ft)		82	155			39	203			24		
Queue Length 95th (ft)		#179	247			90	316			63		
Internal Link Dist (ft)			320				590			120		
Turn Bay Length (ft)		200				125						
Base Capacity (vph)		344	1925			215	1661			667		
Starvation Cap Reductn		0	0			0	0			0		
Spillback Cap Reductn		0	0			0	0			0		
Storage Cap Reductn		0	0			0	0			0		
Reduced v/c Ratio		0.58	0.53			0.43	0.68			0.12		

Intersection Summary

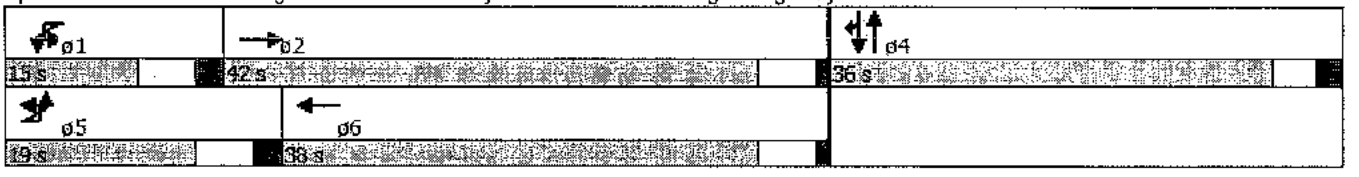
Area Type: Other

Lane Group	SBT	SBR
Detector Phase	4	4
Switch Phase		
Minimum Initial (s)	8.0	8.0
Minimum Split (s)	28.0	28.0
Total Split (s)	36.0	36.0
Total Split (%)	38.7%	38.7%
Maximum Green (s)	31.0	31.0
Yellow Time (s)	3.0	3.0
All-Red Time (s)	2.0	2.0
Lost Time Adjust (s)	0.0	0.0
Total Lost Time (s)	5.0	5.0
Lead/Lag		
Lead-Lag Optimize?		
Vehicle Extension (s)	2.0	2.0
Recall Mode	None	None
Walk Time (s)	7.0	7.0
Flash Dont Walk (s)	16.0	16.0
Pedestrian Calls (#/hr)	0	0
Act Effct Green (s)	11.1	11.1
Actuated g/C Ratio	0.16	0.16
v/c Ratio	0.51	0.27
Control Delay	36.1	8.3
Queue Delay	0.0	0.0
Total Delay	36.1	8.3
LOS	D	A
Approach Delay	24.0	
Approach LOS	C	
90th %ile Green (s)	16.2	16.2
90th %ile Term Code	Gap	Gap
70th %ile Green (s)	12.9	12.9
70th %ile Term Code	Gap	Gap
50th %ile Green (s)	10.7	10.7
50th %ile Term Code	Gap	Gap
30th %ile Green (s)	8.7	8.7
30th %ile Term Code	Gap	Gap
10th %ile Green (s)	8.0	8.0
10th %ile Term Code	Min	Min
Queue Length 50th (ft)	48	0
Queue Length 95th (ft)	97	33
Internal Link Dist (ft)	120	
Turn Bay Length (ft)		
Base Capacity (vph)	643	770
Starvation Cap Reductn	0	0
Spillback Cap Reductn	0	0
Storage Cap Reductn	0	0
Reduced v/c Ratio	0.18	0.12

Intersection Summary

Cycle Length: 93
Actuated Cycle Length: 68.7
Natural Cycle: 75
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.77
Intersection Signal Delay: 20.6 — Intersection LOS: C
Intersection Capacity Utilization 70.7% — ICU Level of Service C
Analysis Period (min) 15
90th %ile Actuated Cycle: 78.2
70th %ile Actuated Cycle: 74.9
50th %ile Actuated Cycle: 71.7
30th %ile Actuated Cycle: 63.1
10th %ile Actuated Cycle: 55.4
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Kingbird Road/Canterbury Street & American Legion Highway



Intersection	
Int Delay, s/veh	0.2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	1086	0	0	1134	0	34
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	0	0	5	0	39
Mvmt Flow	1168	0	0	1219	0	37

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	1168	0	1778	584
Stage 1	-	-	-	-	1168	-
Stage 2	-	-	-	-	610	-
Critical Hdwy	-	-	4.1	-	6.8	7.68
Critical Hdwy Stg 1	-	-	-	-	5.8	-
Critical Hdwy Stg 2	-	-	-	-	5.8	-
Follow-up Hdwy	-	-	2.2	-	3.5	3.69
Pot Cap-1 Maneuver	-	-	605	-	75	373
Stage 1	-	-	-	-	262	-
Stage 2	-	-	-	-	510	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	605	-	75	373
Mov Cap-2 Maneuver	-	-	-	-	75	-
Stage 1	-	-	-	-	262	-
Stage 2	-	-	-	-	510	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0	15.7
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	373	-	-	605	-
HCM Lane V/C Ratio	0.098	-	-	-	-
HCM Control Delay (s)	15.7	-	-	0	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.3	-	-	0	-

Intersection

Int Delay, s/veh 3.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	1	0	1	2	0	26	0	49	2	45	40	2
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	74	74	74	74	74	74	74	74	74	74	74	74
Heavy Vehicles, %	0	0	0	0	0	4	0	7	0	30	15	0
Mvmt Flow	1	0	1	3	0	35	0	66	3	61	54	3

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	262	246	55	246	246	68	57	0	0	69	0	0
Stage 1	177	177	-	68	68	-	-	-	-	-	-	-
Stage 2	85	69	-	178	178	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	6.24	4.1	-	-	4.4	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.336	2.2	-	-	2.47	-	-
Pot Cap-1 Maneuver	695	660	1018	712	660	990	1560	-	-	1372	-	-
Stage 1	829	756	-	947	842	-	-	-	-	-	-	-
Stage 2	928	841	-	828	756	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	647	630	1018	686	630	990	1560	-	-	1372	-	-
Mov Cap-2 Maneuver	647	630	-	686	630	-	-	-	-	-	-	-
Stage 1	829	721	-	947	842	-	-	-	-	-	-	-
Stage 2	895	841	-	789	721	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	9.6	8.9	0	4
HCM LOS	A	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1560	-	-	791	960	1372	-	-
HCM Lane V/C Ratio	-	-	-	0.003	0.039	0.044	-	-
HCM Control Delay (s)	0	-	-	9.6	8.9	7.7	0	-
HCM Lane LOS	A	-	-	A	A	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0	0.1	0.1	-	-

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Volume (vph)	1	95	957	35	25	38	1361	122	17	13	19	48
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)		200		0		125		0	0		0	0
Storage Lanes		1		0		1		0	0		0	0
Taper Length (ft)		25				25			25			25
Lane Util. Factor	0.95	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00
Frt			0.995				0.988			0.947		
Flt Protected		0.950				0.950				0.983		
Satd. Flow (prot)	0	1787	3486	0	0	1552	3485	0	0	1719	0	0
Flt Permitted		0.950				0.950				0.862		
Satd. Flow (perm)	0	1787	3486	0	0	1552	3485	0	0	1507	0	0
Right Turn on Red				Yes				Yes			Yes	
Satd. Flow (RTOR)			5				11			21		
Link Speed (mph)			30				30			30		
Link Distance (ft)			400				670			200		
Travel Time (s)			9.1				15.2			4.5		
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	1%	3%	4%	0%	27%	2%	6%	0%	11%	0%	0%
Adj. Flow (vph)	1	103	1040	38	27	41	1479	133	18	14	21	52
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	104	1078	0	0	68	1612	0	0	53	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	R NA	Left	Left	Right	R NA	Left	Left	Right	Left	Left	Right	Left
Median Width(ft)			12				12			0		
Link Offset(ft)			0				0			0		
Crosswalk Width(ft)			16				16			16		
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	9	15		9	9	15		9	15		9	15
Number of Detectors	1	1	2		1	1	2		1	2		1
Detector Template	Left	Left	Thru		Left	Left	Thru		Left	Thru		Left
Leading Detector (ft)	20	20	100		20	20	100		20	100		20
Trailing Detector (ft)	0	0	0		0	0	0		0	0		0
Detector 1 Position(ft)	0	0	0		0	0	0		0	0		0
Detector 1 Size(ft)	20	20	6		20	20	6		20	6		20
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 1 Queue (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 1 Delay (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 2 Position(ft)			94				94			94		
Detector 2 Size(ft)			6				6			6		
Detector 2 Type			Cl+Ex				Cl+Ex			Cl+Ex		
Detector 2 Channel												
Detector 2 Extend (s)			0.0				0.0			0.0		
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA		Perm
Protected Phases	5	5	2		1	1	6			4		
Permitted Phases									4			4

Lane Group	SBT	SBR
Lane Configurations		
Volume (vph)	11	82
Ideal Flow (vphpl)	1900	1900
Storage Length (ft)		0
Storage Lanes		1
Taper Length (ft)		
Lane Util. Factor	1.00	1.00
Frt		0.850
Flt Protected	0.961	
Satd. Flow (prot)	1769	1568
Flt Permitted	0.730	
Satd. Flow (perm)	1344	1568
Right Turn on Red		Yes
Satd. Flow (RTOR)		94
Link Speed (mph)	30	
Link Distance (ft)	200	
Travel Time (s)	4.5	
Peak Hour Factor	0.92	0.92
Heavy Vehicles (%)	17%	3%
Adj. Flow (vph)	12	89
Shared Lane Traffic (%)		
Lane Group Flow (vph)	64	89
Enter Blocked Intersection	No	No
Lane Alignment	Left	Right
Median Width(ft)	0	
Link Offset(ft)	0	
Crosswalk Width(ft)	16	
Two way Left Turn Lane		
Headway Factor	1.00	1.00
Turning Speed (mph)		9
Number of Detectors	2	1
Detector Template	Thru	Right
Leading Detector (ft)	100	20
Trailing Detector (ft)	0	0
Detector 1 Position(ft)	0	0
Detector 1 Size(ft)	6	20
Detector 1 Type	Cl+Ex	Cl+Ex
Detector 1 Channel		
Detector 1 Extend (s)	0.0	0.0
Detector 1 Queue (s)	0.0	0.0
Detector 1 Delay (s)	0.0	0.0
Detector 2 Position(ft)	94	
Detector 2 Size(ft)	6	
Detector 2 Type	Cl+Ex	
Detector 2 Channel		
Detector 2 Extend (s)	0.0	
Turn Type	NA	Prot
Protected Phases	4	4
Permitted Phases		

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Detector Phase	5	5	2		1	1	6		4	4		4
Switch Phase												
Minimum Initial (s)	8.0	8.0	8.0		8.0	8.0	8.0		8.0	8.0		8.0
Minimum Split (s)	14.0	14.0	28.0		14.0	14.0	28.0		28.0	28.0		28.0
Total Split (s)	19.0	19.0	42.0		15.0	15.0	38.0		36.0	36.0		36.0
Total Split (%)	20.4%	20.4%	45.2%		16.1%	16.1%	40.9%		38.7%	38.7%		38.7%
Maximum Green (s)	13.0	13.0	37.0		9.0	9.0	33.0		31.0	31.0		31.0
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0	4.0		3.0	3.0		3.0
All-Red Time (s)	2.0	2.0	1.0		2.0	2.0	1.0		2.0	2.0		2.0
Lost Time Adjust (s)		0.0	0.0			0.0	0.0			0.0		
Total Lost Time (s)		6.0	5.0			6.0	5.0			5.0		
Lead/Lag	Lead	Lead	Lag		Lead	Lead	Lag					
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes					
Vehicle Extension (s)	2.0	2.0	2.0		2.0	2.0	2.0		2.0	2.0		2.0
Recall Mode	None	None	Ped		None	None	Ped		None	None		None
Walk Time (s)			8.0				8.0		7.0	7.0		7.0
Flash Dont Walk (s)			15.0				15.0		16.0	16.0		16.0
Pedestrian Calls (#/hr)			0				0		0	0		0
Act Effct Green (s)		9.1	41.7			8.4	38.2			8.7		
Actuated g/C Ratio		0.14	0.65			0.13	0.59			0.14		
v/c Ratio		0.41	0.48			0.34	0.78			0.24		
Control Delay		32.1	10.2			32.5	18.9			21.3		
Queue Delay		0.0	0.0			0.0	0.0			0.0		
Total Delay		32.1	10.2			32.5	18.9			21.3		
LOS		C	B			C	B			C		
Approach Delay			12.2				19.5			21.3		
Approach LOS			B				B			C		
90th %ile Green (s)	11.6	11.6	35.6		9.0	9.0	33.0		10.7	10.7		10.7
90th %ile Term Code	Gap	Gap	Hold		Max	Max	Max		Gap	Gap		Gap
70th %ile Green (s)	9.6	9.6	34.0		8.6	8.6	33.0		8.8	8.8		8.8
70th %ile Term Code	Gap	Gap	Hold		Gap	Gap	Max		Gap	Gap		Gap
50th %ile Green (s)	8.1	8.1	33.1		8.0	8.0	33.0		8.0	8.0		8.0
50th %ile Term Code	Gap	Gap	Hold		Min	Min	Max		Min	Min		Min
30th %ile Green (s)	8.0	8.0	47.0		0.0	0.0	33.0		8.0	8.0		8.0
30th %ile Term Code	Min	Min	Hold		Skip	Skip	Max		Min	Min		Min
10th %ile Green (s)	0.0	0.0	48.0		0.0	0.0	48.0		0.0	0.0		0.0
10th %ile Term Code	Skip	Skip	Dwell		Skip	Skip	Dwell		Skip	Skip		Skip
Queue Length 50th (ft)		39	147			25	284			12		
Queue Length 95th (ft)		85	228			64	#525			42		
Internal Link Dist (ft)			320				590			120		
Turn Bay Length (ft)		200				125						
Base Capacity (vph)		364	2343			219	2072			744		
Starvation Cap Reductn		0	0			0	0			0		
Spillback Cap Reductn		0	0			0	0			0		
Storage Cap Reductn		0	0			0	0			0		
Reduced v/c Ratio		0.29	0.46			0.31	0.78			0.07		

Intersection Summary

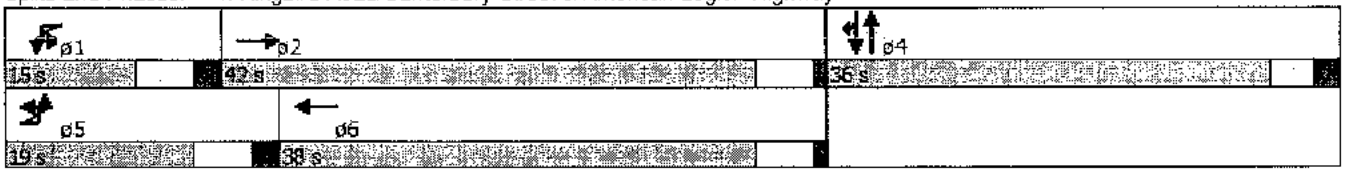
Area Type: Other

Lane Group	SBT	SBR
Detector Phase	4	4
Switch Phase		
Minimum Initial (s)	8.0	8.0
Minimum Split (s)	28.0	28.0
Total Split (s)	36.0	36.0
Total Split (%)	38.7%	38.7%
Maximum Green (s)	31.0	31.0
Yellow Time (s)	3.0	3.0
All-Red Time (s)	2.0	2.0
Lost Time Adjust (s)	0.0	0.0
Total Lost Time (s)	5.0	5.0
Lead/Lag		
Lead-Lag Optimize?		
Vehicle Extension (s)	2.0	2.0
Recall Mode	None	None
Walk Time (s)	7.0	7.0
Flash Dont Walk (s)	16.0	16.0
Pedestrian Calls (#/hr)	0	0
Act Effct Green (s)	8.7	8.7
Actuated g/C Ratio	0.14	0.14
v/c Ratio	0.35	0.30
Control Delay	32.8	9.5
Queue Delay	0.0	0.0
Total Delay	32.8	9.5
LOS	C	A
Approach Delay	19.2	
Approach LOS	B	
90th %ile Green (s)	10.7	10.7
90th %ile Term Code	Gap	Gap
70th %ile Green (s)	8.8	8.8
70th %ile Term Code	Gap	Gap
50th %ile Green (s)	8.0	8.0
50th %ile Term Code	Min	Min
30th %ile Green (s)	8.0	8.0
30th %ile Term Code	Min	Min
10th %ile Green (s)	0.0	0.0
10th %ile Term Code	Skip	Skip
Queue Length 50th (ft)	24	0
Queue Length 95th (ft)	60	34
Internal Link Dist (ft)	120	
Turn Bay Length (ft)		
Base Capacity (vph)	654	810
Starvation Cap Reductn	0	0
Spillback Cap Reductn	0	0
Storage Cap Reductn	0	0
Reduced v/c Ratio	0.10	0.11

Intersection Summary

Cycle Length: 93
Actuated Cycle Length: 64.4
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.78
Intersection Signal Delay: 16.7 — Intersection LOS: B
Intersection Capacity Utilization 79.0% — ICU Level of Service D
Analysis Period (min) 15
90th %ile Actuated Cycle: 71.3
70th %ile Actuated Cycle: 67.4
50th %ile Actuated Cycle: 65.1
30th %ile Actuated Cycle: 65
10th %ile Actuated Cycle: 53
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Kingbird Road/Canterbury Street & American Legion Highway



Intersection

Int Delay, s/veh 0.1

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	1049	0	0	1546	0	24
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	3	0	0	2	0	57
Mvmt Flow	1140	0	0	1680	0	26

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	1140	0	1980	570
Stage 1	-	-	-	-	1140	-
Stage 2	-	-	-	-	840	-
Critical Hdwy	-	-	4.1	-	6.8	8.04
Critical Hdwy Stg 1	-	-	-	-	5.8	-
Critical Hdwy Stg 2	-	-	-	-	5.8	-
Follow-up Hdwy	-	-	2.2	-	3.5	3.87
Pot Cap-1 Maneuver	-	-	620	-	55	348
Stage 1	-	-	-	-	271	-
Stage 2	-	-	-	-	389	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	620	-	55	348
Mov Cap-2 Maneuver	-	-	-	-	55	-
Stage 1	-	-	-	-	271	-
Stage 2	-	-	-	-	389	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0	16.2
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	348	-	-	620	-
HCM Lane V/C Ratio	0.075	-	-	-	-
HCM Control Delay (s)	16.2	-	-	0	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0	-

Intersection

Int Delay, s/veh 2.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	6	0	1	2	0	10	0	33	1	15	52	6
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	80	80	80	80	80	80	80	80	80	80	80	80
Heavy Vehicles, %	0	0	0	0	0	0	0	6	0	42	4	0
Mvmt Flow	8	0	1	2	0	12	0	41	1	19	65	8

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	154	149	69	149	152	42	73	0	0	43	0	0
Stage 1	106	106	-	42	42	-	-	-	-	-	-	-
Stage 2	48	43	-	107	110	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	6.2	4.1	-	-	4.52	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.578	-	-
Pot Cap-1 Maneuver	817	746	1000	824	743	1034	1540	-	-	1344	-	-
Stage 1	905	811	-	978	864	-	-	-	-	-	-	-
Stage 2	971	863	-	903	808	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	798	735	1000	814	732	1034	1540	-	-	1344	-	-
Mov Cap-2 Maneuver	798	735	-	814	732	-	-	-	-	-	-	-
Stage 1	905	799	-	978	864	-	-	-	-	-	-	-
Stage 2	959	863	-	888	796	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	9.4	8.7	0	1.6
HCM LOS	A	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1540	-	-	822	989	1344	-	-
HCM Lane V/C Ratio	-	-	-	0.011	0.015	0.014	-	-
HCM Control Delay (s)	0	-	-	9.4	8.7	7.7	0	-
HCM Lane LOS	A	-	-	A	A	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0	0	0	-	-

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Volume (vph)	4	182	919	130	62	99	901	147	92	35	21	84
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)		200		0		125		0	0		0	0
Storage Lanes		1		0		1		0	0		0	0
Taper Length (ft)		25				25			25			25
Lane Util. Factor	0.95	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00
Frt			0.981				0.979			0.981		
Flt Protected		0.950				0.950				0.970		
Satd. Flow (prot)	0	1787	3410	0	0	1443	3379	0	0	1741	0	0
Flt Permitted		0.950				0.950				0.711		
Satd. Flow (perm)	0	1787	3410	0	0	1443	3379	0	0	1276	0	0
Right Turn on Red				Yes				Yes			Yes	
Satd. Flow (RTOR)			20				22			10		
Link Speed (mph)			30				30			30		
Link Distance (ft)			400				670			200		
Travel Time (s)			9.1				15.2			4.5		
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Heavy Vehicles (%)	0%	1%	2%	17%	0%	41%	5%	2%	3%	0%	14%	2%
Adj. Flow (vph)	4	196	988	140	67	106	969	158	99	38	23	90
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	200	1128	0	0	173	1127	0	0	160	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	R NA	Left	Left	Right	R NA	Left	Left	Right	Left	Left	Right	Left
Median Width(ft)			12				12			0		
Link Offset(ft)			0				0			0		
Crosswalk Width(ft)			16				16			16		
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	9	15		9	9	15		9	15		9	15
Number of Detectors	1	1	2		1	1	2		1	2		1
Detector Template	Left	Left	Thru		Left	Left	Thru		Left	Thru		Left
Leading Detector (ft)	20	20	100		20	20	100		20	100		20
Trailing Detector (ft)	0	0	0		0	0	0		0	0		0
Detector 1 Position(ft)	0	0	0		0	0	0		0	0		0
Detector 1 Size(ft)	20	20	6		20	20	6		20	6		20
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 1 Queue (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 1 Delay (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 2 Position(ft)			94				94			94		
Detector 2 Size(ft)			6				6			6		
Detector 2 Type			Cl+Ex				Cl+Ex			Cl+Ex		
Detector 2 Channel												
Detector 2 Extend (s)			0.0				0.0			0.0		
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA		Perm
Protected Phases	5	5	2		1	1	6			4		
Permitted Phases									4			4

Lane Group	SBT	SBR
Lane Configurations		
Volume (vph)	56	83
Ideal Flow (vphpl)	1900	1900
Storage Length (ft)		0
Storage Lanes		1
Taper Length (ft)		
Lane Util. Factor	1.00	1.00
Frt		0.850
Flt Protected	0.971	
Satd. Flow (prot)	1659	1568
Flt Permitted	0.749	
Satd. Flow (perm)	1280	1568
Right Turn on Red		Yes
Satd. Flow (RTOR)		94
Link Speed (mph)	30	
Link Distance (ft)	200	
Travel Time (s)	4.5	
Peak Hour Factor	0.93	0.93
Heavy Vehicles (%)	25%	3%
Adj. Flow (vph)	60	89
Shared Lane Traffic (%)		
Lane Group Flow (vph)	150	89
Enter Blocked Intersection	No	No
Lane Alignment	Left	Right
Median Width(ft)	0	
Link Offset(ft)	0	
Crosswalk Width(ft)	16	
Two way Left Turn Lane		
Headway Factor	1.00	1.00
Turning Speed (mph)		9
Number of Detectors	2	1
Detector Template	Thru	Right
Leading Detector (ft)	100	20
Trailing Detector (ft)	0	0
Detector 1 Position(ft)	0	0
Detector 1 Size(ft)	6	20
Detector 1 Type	Cl+Ex	Cl+Ex
Detector 1 Channel		
Detector 1 Extend (s)	0.0	0.0
Detector 1 Queue (s)	0.0	0.0
Detector 1 Delay (s)	0.0	0.0
Detector 2 Position(ft)	94	
Detector 2 Size(ft)	6	
Detector 2 Type	Cl+Ex	
Detector 2 Channel		
Detector 2 Extend (s)	0.0	
Turn Type	NA	Prot
Protected Phases	4	4
Permitted Phases		

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Detector Phase	5	5	2		1	1	6		4	4		4
Switch Phase												
Minimum Initial (s)	8.0	8.0	8.0		8.0	8.0	8.0		8.0	8.0		8.0
Minimum Split (s)	14.0	14.0	28.0		14.0	14.0	28.0		28.0	28.0		28.0
Total Split (s)	19.0	19.0	42.0		15.0	15.0	38.0		36.0	36.0		36.0
Total Split (%)	20.4%	20.4%	45.2%		16.1%	16.1%	40.9%		38.7%	38.7%		38.7%
Maximum Green (s)	13.0	13.0	37.0		9.0	9.0	33.0		31.0	31.0		31.0
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0	4.0		3.0	3.0		3.0
All-Red Time (s)	2.0	2.0	1.0		2.0	2.0	1.0		2.0	2.0		2.0
Lost Time Adjust (s)		0.0	0.0			0.0	0.0			0.0		
Total Lost Time (s)		6.0	5.0			6.0	5.0			5.0		
Lead/Lag	Lead	Lead	Lag		Lead	Lead	Lag					
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes					
Vehicle Extension (s)	2.0	2.0	2.0		2.0	2.0	2.0		2.0	2.0		2.0
Recall Mode	None	None	Ped		None	None	Ped		None	None		None
Walk Time (s)			8.0				8.0		7.0	7.0		7.0
Flash Dont Walk (s)			15.0				15.0		16.0	16.0		16.0
Pedestrian Calls (#/hr)			0				0		0	0		0
Act Effct Green (s)		11.7	32.7			9.2	30.1			13.2		
Actuated g/C Ratio		0.16	0.46			0.13	0.42			0.19		
v/c Ratio		0.68	0.72			0.94	0.78			0.66		
Control Delay		43.4	18.7			89.3	23.1			39.7		
Queue Delay		0.0	0.0			0.0	0.0			0.0		
Total Delay		43.4	18.7			89.3	23.1			39.7		
LOS		D	B			F	C			D		
Approach Delay			22.5				31.9			39.7		
Approach LOS			C				C			D		
90th %ile Green (s)	13.0	13.0	37.0		9.0	9.0	33.0		20.7	20.7		20.7
90th %ile Term Code	Max	Max	Max		Max	Max	Max		Gap	Gap		Gap
70th %ile Green (s)	13.0	13.0	37.0		9.0	9.0	33.0		15.5	15.5		15.5
70th %ile Term Code	Max	Max	Hold		Max	Max	Max		Gap	Gap		Gap
50th %ile Green (s)	13.0	13.0	37.0		9.0	9.0	33.0		12.8	12.8		12.8
50th %ile Term Code	Max	Max	Hold		Max	Max	Max		Gap	Gap		Gap
30th %ile Green (s)	11.4	11.4	30.2		9.0	9.0	27.8		10.4	10.4		10.4
30th %ile Term Code	Gap	Gap	Hold		Max	Max	Gap		Gap	Gap		Gap
10th %ile Green (s)	8.4	8.4	23.0		9.0	9.0	23.6		8.0	8.0		8.0
10th %ile Term Code	Gap	Gap	Ped		Max	Max	Hold		Min	Min		Min
Queue Length 50th (ft)		87	192			82	216			66		
Queue Length 95th (ft)		#194	316			#225	349			126		
Internal Link Dist (ft)			320				590			120		
Turn Bay Length (ft)		200				125						
Base Capacity (vph)		331	1812			185	1605			570		
Starvation Cap Reductn		0	0			0	0			0		
Spillback Cap Reductn		0	0			0	0			0		
Storage Cap Reductn		0	0			0	0			0		
Reduced v/c Ratio		0.60	0.62			0.94	0.70			0.28		

Intersection Summary

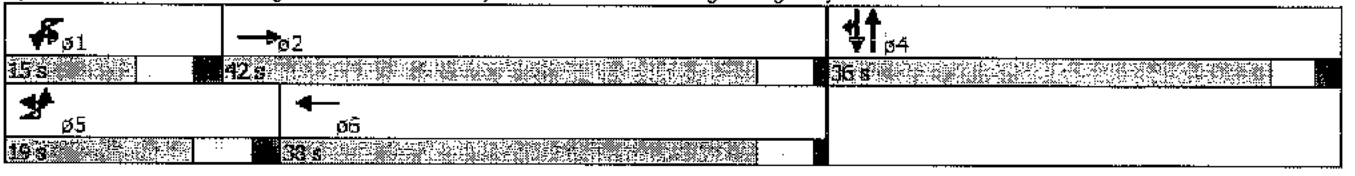
Area Type: Other

Lane Group	SBT	SBR
Detector Phase	4	4
Switch Phase		
Minimum Initial (s)	8.0	8.0
Minimum Split (s)	28.0	28.0
Total Split (s)	36.0	36.0
Total Split (%)	38.7%	38.7%
Maximum Green (s)	31.0	31.0
Yellow Time (s)	3.0	3.0
All-Red Time (s)	2.0	2.0
Lost Time Adjust (s)	0.0	0.0
Total Lost Time (s)	5.0	5.0
Lead/Lag		
Lead-Lag Optimize?		
Vehicle Extension (s)	2.0	2.0
Recall Mode	None	None
Walk Time (s)	7.0	7.0
Flash Dont Walk (s)	16.0	16.0
Pedestrian Calls (#/hr)	0	0
Act Effct Green (s)	13.2	13.2
Actuated g/C Ratio	0.19	0.19
v/c Ratio	0.64	0.24
Control Delay	40.7	7.5
Queue Delay	0.0	0.0
Total Delay	40.7	7.5
LOS	D	A
Approach Delay	28.3	
Approach LOS	C	
90th %ile Green (s)	20.7	20.7
90th %ile Term Code	Gap	Gap
70th %ile Green (s)	15.5	15.5
70th %ile Term Code	Gap	Gap
50th %ile Green (s)	12.8	12.8
50th %ile Term Code	Gap	Gap
30th %ile Green (s)	10.4	10.4
30th %ile Term Code	Gap	Gap
10th %ile Green (s)	8.0	8.0
10th %ile Term Code	Min	Min
Queue Length 50th (ft)	66	0
Queue Length 95th (ft)	124	32
Internal Link Dist (ft)	120	
Turn Bay Length (ft)		
Base Capacity (vph)	567	746
Starvation Cap Reductn	0	0
Spillback Cap Reductn	0	0
Storage Cap Reductn	0	0
Reduced v/c Ratio	0.26	0.12

Intersection Summary

Cycle Length: 93
Actuated Cycle Length: 71.3
Natural Cycle: 75
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.94
Intersection Signal Delay: 27.9
Intersection LOS: C
Intersection Capacity Utilization 72.3%
ICU Level of Service C
Analysis Period (min) 15
90th %ile Actuated Cycle: 82.7
70th %ile Actuated Cycle: 77.5
50th %ile Actuated Cycle: 74.8
30th %ile Actuated Cycle: 65.6
10th %ile Actuated Cycle: 56
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Kingbird Road/Canterbury Street & American Legion Highway



Intersection	
Int Delay, s/veh	0.6

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	1086	0	0	1209	0	83
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	0	0	5	0	39
Mvmt Flow	1168	0	0	1300	0	89

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	1168	0	1818	584
Stage 1	-	-	-	-	1168	-
Stage 2	-	-	-	-	650	-
Critical Hdwy	-	-	4.1	-	6.8	7.68
Critical Hdwy Stg 1	-	-	-	-	5.8	-
Critical Hdwy Stg 2	-	-	-	-	5.8	-
Follow-up Hdwy	-	-	2.2	-	3.5	3.69
Pot Cap-1 Maneuver	-	-	605	-	71	373
Stage 1	-	-	-	-	262	-
Stage 2	-	-	-	-	487	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	605	-	71	373
Mov Cap-2 Maneuver	-	-	-	-	71	-
Stage 1	-	-	-	-	262	-
Stage 2	-	-	-	-	487	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0	17.7
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	373	-	-	605	-
HCM Lane V/C Ratio	0.239	-	-	-	-
HCM Control Delay (s)	17.7	-	-	0	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.9	-	-	0	-

Intersection

Int Delay, s/veh 6.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	1	0	1	2	0	97	0	52	2	248	40	2
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	74	74	74	74	74	74	74	74	74	74	74	74
Heavy Vehicles, %	0	0	0	0	0	4	0	7	0	30	15	0
Mvmt Flow	1	0	1	3	0	131	0	70	3	335	54	3

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	863	799	55	798	799	72	57	0	0	73	0	0
Stage 1	726	726	-	72	72	-	-	-	-	-	-	-
Stage 2	137	73	-	726	727	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	6.24	4.1	-	-	4.4	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.336	2.2	-	-	2.47	-	-
Pot Cap-1 Maneuver	277	321	1018	306	321	985	1560	-	-	1367	-	-
Stage 1	419	433	-	943	839	-	-	-	-	-	-	-
Stage 2	871	838	-	419	432	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	193	240	1018	246	240	985	1560	-	-	1367	-	-
Mov Cap-2 Maneuver	193	240	-	246	240	-	-	-	-	-	-	-
Stage 1	419	323	-	943	839	-	-	-	-	-	-	-
Stage 2	755	838	-	313	323	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	16.2	9.5	0	7.3
HCM LOS	C	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1560	-	-	324	929	1367	-	-
HCM Lane V/C Ratio	-	-	-	0.008	0.144	0.245	-	-
HCM Control Delay (s)	0	-	-	16.2	9.5	8.5	0	-
HCM Lane LOS	A	-	-	C	A	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0	0.5	1	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	203	34	0	0	49	71
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	221	37	0	0	53	77

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	0	0	-	0	478	0
Stage 1	-	-	-	-	0	-
Stage 2	-	-	-	-	478	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	-	-	546	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	624	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	-	-	-	-	546	-
Mov Cap-2 Maneuver	-	-	-	-	546	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	624	-

Approach	EB	WB	SB
HCM Control Delay, s		0	
HCM LOS			-

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	-	-	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-
HCM Control Delay (s)	-	-	-	-	-
HCM Lane LOS	-	-	-	-	-
HCM 95th %tile Q(veh)	-	-	-	-	-

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Volume (vph)	1	95	957	66	25	69	1361	122	77	58	19	48
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)		200		0		125		0	0		0	0
Storage Lanes		1		0		1		0	0		0	0
Taper Length (ft)		25				25			25			25
Lane Util. Factor	0.95	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	1.00
Frt			0.990				0.988			0.983		
Flt Protected		0.950				0.950				0.976		
Satd. Flow (prot)	0	1787	3468	0	0	1506	3485	0	0	1751	0	0
Flt Permitted		0.950				0.950				0.800		
Satd. Flow (perm)	0	1787	3468	0	0	1506	3485	0	0	1435	0	0
Right Turn on Red				Yes				Yes			Yes	
Satd. Flow (RTOR)			9				11			8		
Link Speed (mph)			30				30			30		
Link Distance (ft)			400				670			200		
Travel Time (s)			9.1				15.2			4.5		
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	1%	3%	4%	0%	27%	2%	6%	0%	11%	0%	0%
Adj. Flow (vph)	1	103	1040	72	27	75	1479	133	84	63	21	52
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	104	1112	0	0	102	1612	0	0	168	0	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	R NA	Left	Left	Right	R NA	Left	Left	Right	Left	Left	Right	Left
Median Width(ft)			12				12			0		
Link Offset(ft)			0				0			0		
Crosswalk Width(ft)			16				16			16		
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	9	15		9	9	15		9	15		9	15
Number of Detectors	1	1	2		1	1	2		1	2		1
Detector Template	Left	Left	Thru		Left	Left	Thru		Left	Thru		Left
Leading Detector (ft)	20	20	100		20	20	100		20	100		20
Trailing Detector (ft)	0	0	0		0	0	0		0	0		0
Detector 1 Position(ft)	0	0	0		0	0	0		0	0		0
Detector 1 Size(ft)	20	20	6		20	20	6		20	6		20
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 1 Queue (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 1 Delay (s)	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0		0.0
Detector 2 Position(ft)			94				94			94		
Detector 2 Size(ft)			6				6			6		
Detector 2 Type			Cl+Ex				Cl+Ex			Cl+Ex		
Detector 2 Channel												
Detector 2 Extend (s)			0.0				0.0			0.0		
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA		Perm
Protected Phases	5	5	2		1	1	6			4		
Permitted Phases									4			4

Lane Group	SBT	SBR
Lane Configurations		
Volume (vph)	27	82
Ideal Flow (vphpl)	1900	1900
Storage Length (ft)		0
Storage Lanes		1
Taper Length (ft)		
Lane Util. Factor	1.00	1.00
Frt		0.850
Flt Protected	0.969	
Satd. Flow (prot)	1735	1568
Flt Permitted	0.717	
Satd. Flow (perm)	1284	1568
Right Turn on Red		Yes
Satd. Flow (RTOR)		94
Link Speed (mph)	30	
Link Distance (ft)	200	
Travel Time (s)	4.5	
Peak Hour Factor	0.92	0.92
Heavy Vehicles (%)	17%	3%
Adj. Flow (vph)	29	89
Shared Lane Traffic (%)		
Lane Group Flow (vph)	81	89
Enter Blocked Intersection	No	No
Lane Alignment	Left	Right
Median Width(ft)	0	
Link Offset(ft)	0	
Crosswalk Width(ft)	16	
Two way Left Turn Lane		
Headway Factor	1.00	1.00
Turning Speed (mph)		9
Number of Detectors	2	1
Detector Template	Thru	Right
Leading Detector (ft)	100	20
Trailing Detector (ft)	0	0
Detector 1 Position(ft)	0	0
Detector 1 Size(ft)	6	20
Detector 1 Type	Cl+Ex	Cl+Ex
Detector 1 Channel		
Detector 1 Extend (s)	0.0	0.0
Detector 1 Queue (s)	0.0	0.0
Detector 1 Delay (s)	0.0	0.0
Detector 2 Position(ft)	94	
Detector 2 Size(ft)	6	
Detector 2 Type	Cl+Ex	
Detector 2 Channel		
Detector 2 Extend (s)	0.0	
Turn Type	NA	Prot
Protected Phases	4	4
Permitted Phases		

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Detector Phase	5	5	2		1	1	6		4	4		4
Switch Phase												
Minimum Initial (s)	8.0	8.0	8.0		8.0	8.0	8.0		8.0	8.0		8.0
Minimum Split (s)	14.0	14.0	28.0		14.0	14.0	28.0		28.0	28.0		28.0
Total Split (s)	19.0	19.0	42.0		15.0	15.0	38.0		36.0	36.0		36.0
Total Split (%)	20.4%	20.4%	45.2%		16.1%	16.1%	40.9%		38.7%	38.7%		38.7%
Maximum Green (s)	13.0	13.0	37.0		9.0	9.0	33.0		31.0	31.0		31.0
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0	4.0		3.0	3.0		3.0
All-Red Time (s)	2.0	2.0	1.0		2.0	2.0	1.0		2.0	2.0		2.0
Lost Time Adjust (s)		0.0	0.0			0.0	0.0			0.0		
Total Lost Time (s)		6.0	5.0			6.0	5.0			5.0		
Lead/Lag	Lead	Lead	Lag		Lead	Lead	Lag					
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes					
Vehicle Extension (s)	2.0	2.0	2.0		2.0	2.0	2.0		2.0	2.0		2.0
Recall Mode	None	None	Ped		None	None	Ped		None	None		None
Walk Time (s)			8.0				8.0		7.0	7.0		7.0
Flash Dont Walk (s)			15.0				15.0		16.0	16.0		16.0
Pedestrian Calls (#/hr)			0				0		0	0		0
Act Effct Green (s)		9.4	35.7			8.7	35.0			12.6		
Actuated g/C Ratio		0.13	0.51			0.12	0.50			0.18		
v/c Ratio		0.43	0.63			0.55	0.92			0.63		
Control Delay		35.8	16.0			44.2	29.9			37.2		
Queue Delay		0.0	0.0			0.0	0.0			0.0		
Total Delay		35.8	16.0			44.2	29.9			37.2		
LOS		D	B			D	C			D		
Approach Delay			17.7				30.8			37.2		
Approach LOS			B				C			D		
90th %ile Green (s)	12.7	12.7	37.0		9.0	9.0	33.3		19.7	19.7		19.7
90th %ile Term Code	Gap	Gap	Max		Max	Max	Hold		Gap	Gap		Gap
70th %ile Green (s)	10.1	10.1	34.1		9.0	9.0	33.0		14.8	14.8		14.8
70th %ile Term Code	Gap	Gap	Hold		Max	Max	Max		Gap	Gap		Gap
50th %ile Green (s)	8.5	8.5	32.5		9.0	9.0	33.0		12.1	12.1		12.1
50th %ile Term Code	Gap	Gap	Hold		Max	Max	Max		Gap	Gap		Gap
30th %ile Green (s)	8.0	8.0	33.0		8.0	8.0	33.0		9.7	9.7		9.7
30th %ile Term Code	Min	Min	Hold		Min	Min	Max		Gap	Gap		Gap
10th %ile Green (s)	0.0	0.0	38.9		0.0	0.0	38.9		8.0	8.0		8.0
10th %ile Term Code	Skip	Skip	Dwell		Skip	Skip	Dwell		Min	Min		Min
Queue Length 50th (ft)		42	184			42	332			64		
Queue Length 95th (ft)		95	302			#117	#647			131		
Internal Link Dist (ft)			320				590			120		
Turn Bay Length (ft)		200				125						
Base Capacity (vph)		337	1892			197	1752			651		
Starvation Cap Reductn		0	0			0	0			0		
Spillback Cap Reductn		0	0			0	0			0		
Storage Cap Reductn		0	0			0	0			0		
Reduced v/c Ratio		0.31	0.59			0.52	0.92			0.26		

Intersection Summary

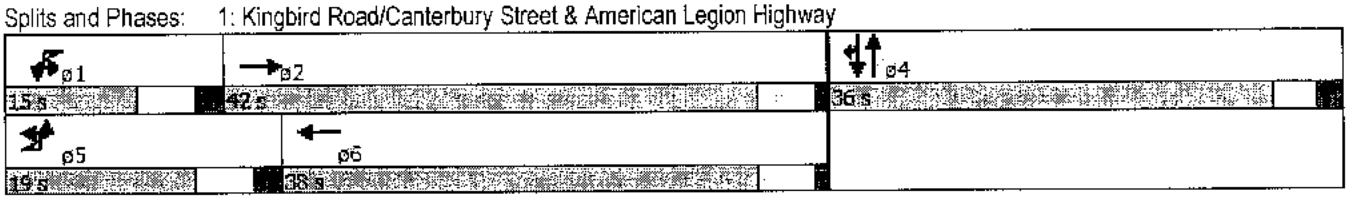
Area Type: Other

Lane Group	SBT	SBR
Detector Phase	4	4
Switch Phase		
Minimum Initial (s)	8.0	8.0
Minimum Split (s)	28.0	28.0
Total Split (s)	36.0	36.0
Total Split (%)	38.7%	38.7%
Maximum Green (s)	31.0	31.0
Yellow Time (s)	3.0	3.0
All-Red Time (s)	2.0	2.0
Lost Time Adjust (s)	0.0	0.0
Total Lost Time (s)	5.0	5.0
Lead/Lag		
Lead-Lag Optimize?		
Vehicle Extension (s)	2.0	2.0
Recall Mode	None	None
Walk Time (s)	7.0	7.0
Flash Dont Walk (s)	16.0	16.0
Pedestrian Calls (#/hr)	0	0
Act Effct Green (s)	12.6	12.6
Actuated g/C Ratio	0.18	0.18
v/c Ratio	0.35	0.25
Control Delay	30.2	7.6
Queue Delay	0.0	0.0
Total Delay	30.2	7.6
LOS	C	A
Approach Delay	18.4	
Approach LOS	B	
90th %ile Green (s)	19.7	19.7
90th %ile Term Code	Gap	Gap
70th %ile Green (s)	14.8	14.8
70th %ile Term Code	Gap	Gap
50th %ile Green (s)	12.1	12.1
50th %ile Term Code	Gap	Gap
30th %ile Green (s)	9.7	9.7
30th %ile Term Code	Gap	Gap
10th %ile Green (s)	8.0	8.0
10th %ile Term Code	Min	Min
Queue Length 50th (ft)	31	0
Queue Length 95th (ft)	72	32
Internal Link Dist (ft)	120	
Turn Bay Length (ft)		
Base Capacity (vph)	578	758
Starvation Cap Reductn	0	0
Spillback Cap Reductn	0	0
Storage Cap Reductn	0	0
Reduced v/c Ratio	0.14	0.12

Intersection Summary

Cycle Length: 93
Actuated Cycle Length: 69.8
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.92
Intersection Signal Delay: 25.6
Intersection LOS: C
Intersection Capacity Utilization 80.8%
ICU Level of Service D
Analysis Period (min) 15
90th %ile Actuated Cycle: 81.7
70th %ile Actuated Cycle: 73.9
50th %ile Actuated Cycle: 69.6
30th %ile Actuated Cycle: 66.7
10th %ile Actuated Cycle: 56.9
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Kingbird Road/Canterbury Street & American Legion Highway



Intersection	
Int Delay, s/veh	0.6

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	1049	0	0	1577	0	80
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	3	0	0	2	0	57
Mvmt Flow	1140	0	0	1714	0	87

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	1140	0	1997	570
Stage 1	-	-	-	-	1140	-
Stage 2	-	-	-	-	857	-
Critical Hdwy	-	-	4.1	-	6.8	8.04
Critical Hdwy Stg 1	-	-	-	-	5.8	-
Critical Hdwy Stg 2	-	-	-	-	5.8	-
Follow-up Hdwy	-	-	2.2	-	3.5	3.87
Pot Cap-1 Maneuver	-	-	620	-	54	348
Stage 1	-	-	-	-	271	-
Stage 2	-	-	-	-	381	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	620	-	54	348
Mov Cap-2 Maneuver	-	-	-	-	54	-
Stage 1	-	-	-	-	271	-
Stage 2	-	-	-	-	381	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0	18.8
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	348	-	-	620	-
HCM Lane V/C Ratio	0.25	-	-	-	-
HCM Control Delay (s)	18.8	-	-	0	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	1	-	-	0	-

Intersection

Int Delay, s/veh 6.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	6	0	1	2	0	115	0	33	1	93	52	6
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	80	80	80	80	80	80	80	80	80	80	80	80
Heavy Vehicles, %	0	0	0	0	0	0	0	6	0	42	4	0
Mvmt Flow	8	0	1	2	0	144	0	41	1	116	65	8

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	415	344	69	344	347	42	73	0	0	43	0	0
Stage 1	301	301	-	42	42	-	-	-	-	-	-	-
Stage 2	114	43	-	302	305	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	6.2	4.1	-	-	4.52	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.578	-	-
Pot Cap-1 Maneuver	551	582	1000	614	580	1034	1540	-	-	1344	-	-
Stage 1	712	669	-	978	864	-	-	-	-	-	-	-
Stage 2	896	863	-	712	666	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	442	530	1000	571	528	1034	1540	-	-	1344	-	-
Mov Cap-2 Maneuver	442	530	-	571	528	-	-	-	-	-	-	-
Stage 1	712	609	-	978	864	-	-	-	-	-	-	-
Stage 2	771	863	-	647	606	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	12.6	9.1	0	4.9
HCM LOS	B	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1540	-	-	480	1020	1344	-	-
HCM Lane V/C Ratio	-	-	-	0.018	0.143	0.086	-	-
HCM Control Delay (s)	0	-	-	12.6	9.1	7.9	0	-
HCM Lane LOS	A	-	-	B	A	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.1	0.5	0.3	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	78	24	0	0	56	105
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	85	26	0	0	61	114

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	0	0	-	0	196	0
Stage 1	-	-	-	-	0	-
Stage 2	-	-	-	-	196	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	-	-	793	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	837	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	-	-	-	-	793	-
Mov Cap-2 Maneuver	-	-	-	-	793	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	837	-

Approach	EB	WB	SB
HCM Control Delay, s		0	
HCM LOS			-

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	-	-	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-
HCM Control Delay (s)	-	-	-	-	-
HCM Lane LOS	-	-	-	-	-
HCM 95th %tile Q(veh)	-	-	-	-	-